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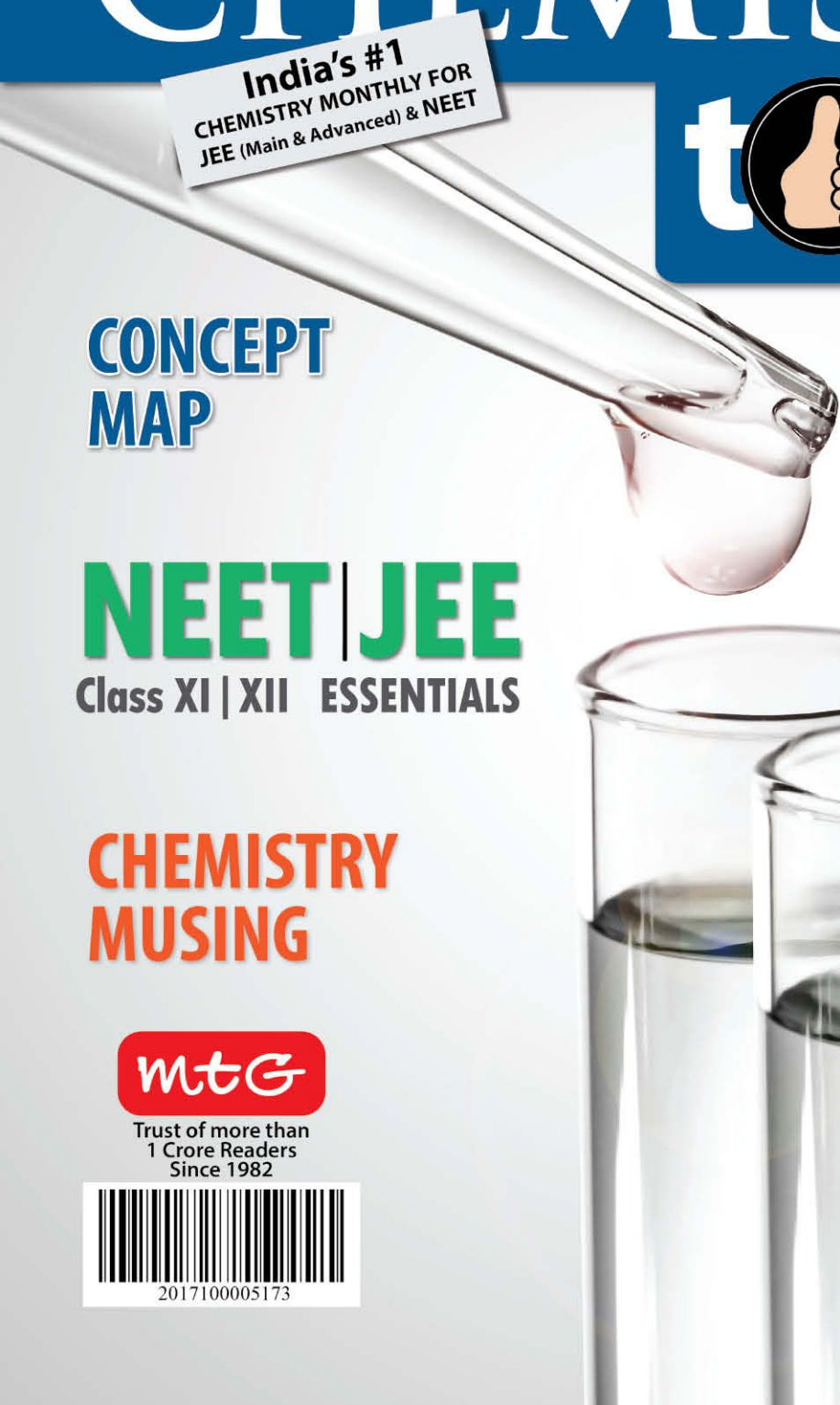
CHEMISTRY today

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CHEMISTRY MUSING

PROBLEM SET 44

*C*hemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIIMS / PMTs with additional study material.
In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.
The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

JEE MAIN/NEET

1. The iodine molecule dissociates into atoms after absorbing light of 4500 Å if one quantum of radiation is absorbed by each molecule. The kinetic energy of iodine atoms is
(Bond energy of I_2 = 240 kJ mol^{-1})
   (a) 21.6×10^{-10} J   (b) 21.6×10^{-20} J
   (c) 2.16×10^{-10} J   (d) 2.16×10^{-20} J

2. The major product in the following reaction is
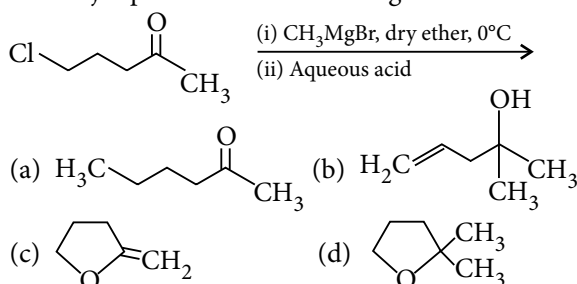
3. A colourless inorganic salt (*A*) decomposes completely at about 523 K to give only two products (*B*) and (*C*) leaving no residue. The product (*B*) is a neutral gas while the product (*C*) is liquid at room temperature and is neutral to litmus. White phosphorus burns in excess of (*B*) to produce a strong dehydrating agent, P_4O_{10}. The compounds (*A*), (*B*) and (*C*) are respectively
   (a) NH_4NO_2, N_2, H_2O (b) NH_4NO_3, N_2O, H_2O
   (c) NH_4Cl, NH_3, NCl (d) $NaNO_3, O_2, NaNO_2$

4.
   In the above reaction sequence, II is
   (a) β-alanine   (b) α-alanine
   (c) ethylenediamine   (d) γ-aminobutyric acid.

5. An aqueous solution of a substance gives a white ppt. on treatment with dilute hydrochloric acid which dissolves on heating. When hydrogen sulphide is passed through the hot acidic solution, a black ppt. is obtained. The substance is a
   (a) Hg_2^{2+} salt   (b) Cu^{2+} salt
   (c) Ag^+ salt   (d) Pb^{2+} salt.

JEE ADVANCED

6. An element crystallises in *fcc* lattice having edge length 400 pm. The maximum diameter which can be placed in interstitial sites without disturbing the structure is
   (a) 1.171 pm   (b) 11.71 pm
   (c) 117.1 pm   (d) 0.117 pm

COMPREHENSION

The process of settling of colloidal particles is known as coagulation of the sol. The particles in any colloidal sol carry a particular charge and can be coagulated by adding suitable electrolytes. Generally, it is observed that, greater the valency of the flocculating ion added, greater is its power to coagulate. Lyophobic sols are generally less stable but can be protected by lyophilic colloids, called protective colloids. Their protective powers are usually expressed in terms of gold number.
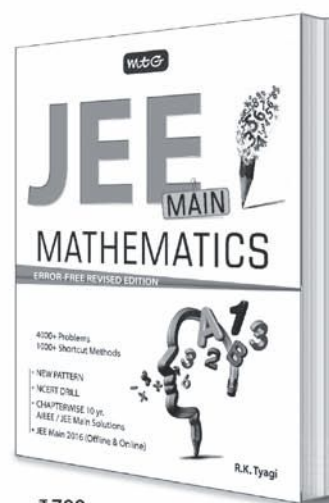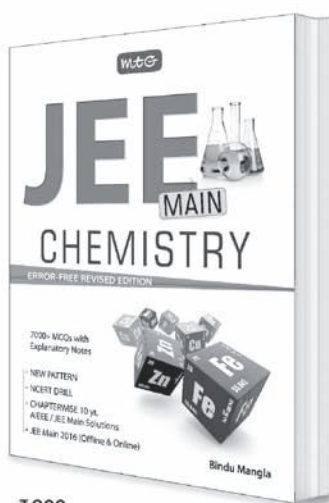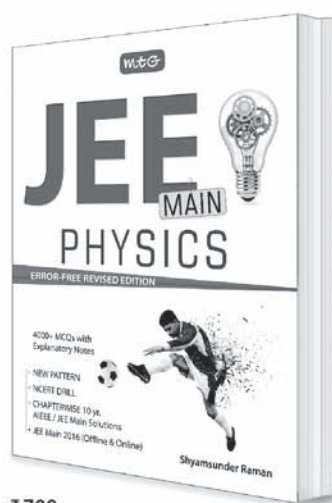
7. SnO_2 is shaken with a small amount of NaOH solution to form a colloidal sol of sodium stannate. The sol thus obtained can be coagulated most easily by
   (a) Na_3PO_4 (b) $AlCl_3$
   (c) $K_4[Fe(CN)_6]$ (d) HCl

8. 50 mL of standard gold sol requires 0.1 g of potato starch for its protection from coagulation. The gold number of potato starch is
   (a) 5   (b) 10   (c) 20   (d) 25

INTEGER VALUE

9. The vapour pressure of pure benzene at a certain temperature is 640 mm Hg. A non-volatile, non-electrolyte solid weighing 2.175 g is added to 39 g of benzene. The vapour pressure of the solution is 600 mm Hg. The molecular weight of the solid substance is 60 + 1.05 *x*. The value of *x* is

10. Consider the following list of reagents :
    acidified $K_2Cr_2O_7$, alkaline $KMnO_4$, $CuSO_4$, H_2O_2, Cl_2, O_3, $FeCl_3$, HNO_3 and $Na_2S_2O_3$
    The total number of reagents that can oxidise aqueous iodide to iodine is   ◈ ◈

PRACTICE PAPER 2017
JEE MAIN

Exam Dates
OFFLINE : 2nd April
ONLINE : 8th & 9th April

1. A white solid (1) on heating evolves CO_2 and gives a white residue (2) which is soluble in water. (2) also gives CO_2 when treated with dilute acid. (1) and (2) are respectively
(a) Na_2CO_3 and $NaHCO_3$
(b) $NaHCO_3$ and Na_2CO_3
(c) $CaCO_3$ and $CaHCO_3$
(d) $CaHCO_3$ and $CaCO_3$

2. Aldol condensation will not be observed in
(a) chloral   (b) phenylacetaldehyde
(c) hexanal   (d) ethanal.

3. In a *fcc* lattice, atom *A* occupies the corner positions and atom *B* occupies the face centred position. If one atom of *B* is missing from one of the face centred points, the formula of the compound is
(a) A_2B (b) AB_2 (c) A_2B_3 (d) A_2B_5

4. In acidic medium, $KMnO_4$ oxidises $FeSO_4$ solution. Which of the following statements is correct?
(a) 10 mL of 1 N $KMnO_4$ solution oxidises 10 mL of 5 N $FeSO_4$ solution.
(b) 10 mL of 1 M $KMnO_4$ solution oxidises 10 mL of 5 M $FeSO_4$ solution.
(c) 10 mL of 1 M $KMnO_4$ solution oxidises 10 mL of 1 M $FeSO_4$ solution.
(d) 10 mL of 1 N $KMnO_4$ solution oxidises 10 mL of 0.1 M $FeSO_4$ solution.

5. The polymer in which the intermolecular force of attraction is weakest, is
(a) nylon   (b) polyvinyl chloride
(c) cellulose   (d) natural rubber.

6. Given, $\Delta G° = - nFE°_{cell}$ and $\Delta G° = - RT \ln K$. The value of $n = 2$ will be given by the slope of which line in the figure ?
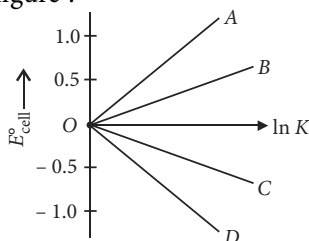
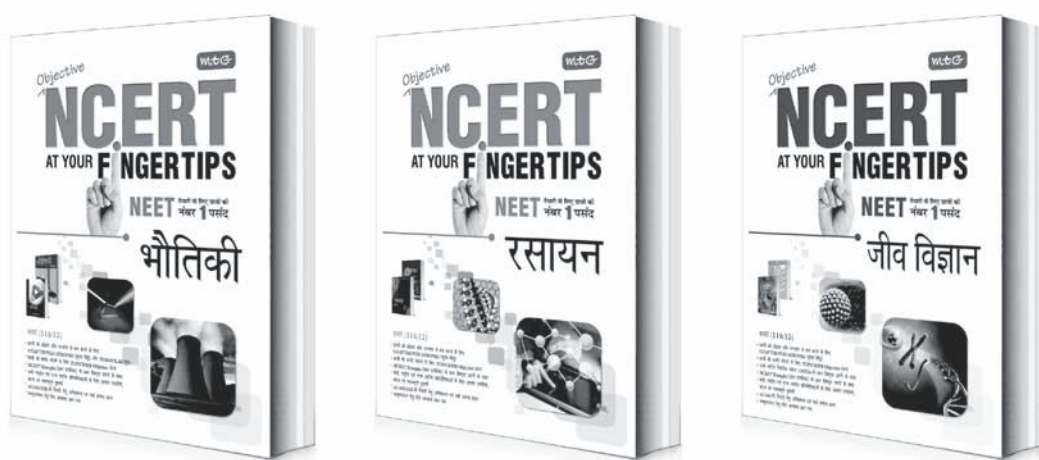**7.** $H_2C_2O_4 \xrightarrow{\Delta}$ gas (*A*) + gas (*B*) + liquid (*C*)
(Oxalic acid)
Gas (*A*) burns with a blue flame and is oxidised to gas (*B*). Gas (*B*) turns lime water milky.
Gas (*A*) + $Cl_2 \longrightarrow$ (*D*) $\xrightarrow{NH_3, \Delta}$ (*E*)
A, *B*, *C*, *D* and *E* are respectively
(a) CO_2, CO, H_2O, $HCOONH_2$, $COCl_2$
(b) CO, CO_2, $COCl_2$, H_2O, $HCOONH_2$
(c) CO, CO_2, H_2O, $COCl_2$, NH_2CONH_2
(d) CO, CO_2, H_2O, NH_2CONH_2, $COCl_2$

8. Square planar complexes of the type *MABXL* (where *A*, *B*, *X* and *L* are unidentate ligands) shows
(a) two *cis* and one *trans* isomers
(b) two *trans* and one *cis* isomers
(c) two *cis* and two *trans* isomers
(d) one *cis* and one *trans* isomers.

9. One mole of an organic compound consumes 4 moles of periodic acid to form HCHO, HCOOH and CHOCOOH. The organic compound is
(a) glucose   (b) fructose
(c) gluconic acid   (d) sorbitol.

10. At constant temperature, the equilibrium constant (K_p) for the decomposition reaction,
$$N_2O_4 \rightleftharpoons 2NO_2$$
is expressed by $K_p = 4x^2P/(1 - x^2)$, where *P* = pressure and *x* = extent of decomposition. Which of the following statements is true?
(a) K_p increases with increase in *P*.
(b) K_p increases with increase in *x*.
(c) K_p increases with decrease in *x*.
(d) K_p remains constant with change in *P* and *x*.

11. $\xrightarrow{NaOH}$ [Intermediate] $\xrightarrow[(ii)\ D^+]{(i)\ CO_2}$ *P*
Here *P* is

(a) *OA*   (b) *OB*   (c) *OC*   (d) *OD*

(a) HOOC—[ring with OD, D] (b) DOOC—[ring with OD, D]

(c) DOOC—[ring with OH, D] (d) $\overline{O}OC$—[ring with OH, D]

12. K_{sp} of $Mg(OH)_2$ is 1×10^{-12}, 0.01 M $MgCl_2$ will be precipitating at the limiting pH
(a) 8 (b) 9 (c) 10 (d) 12

13. A white crystalline solid (A) on boiling with caustic soda solution gave a gas (B) which when passed through an alkaline solution of potassium mercuric iodide gave a brown ppt. The substance (A) on heating gave a gas (C) which rekindled a glowing splinter but did not give brown fumes with nitric oxide. The gases (B), (C) and the substance (A) respectively are
(a) H_2S, NO_2, NaCl (b) NH_3, N_2O, NH_4NO_3
(c) HCl, NO, NH_4Cl (d) CO_2, SO_2, Na_2SO_3

14. One mole of magnesium in the vapour state absorbed 1200 kJ mol^{-1} of energy. If the first and second ionisation energies of Mg are 750 and 1450 kJ mol^{-1} respectively, the final composition of the mixture is
(a) 31% Mg^+ + 69% Mg^{2+}
(b) 69% Mg^+ + 31% Mg^{2+}
(c) 86% Mg^+ + 14% Mg^{2+}
(d) 14% Mg^+ + 86% Mg^{2+}

15. If the molecular weight of $Na_2S_2O_3$ and I_2 are M_1 and M_2 respectively then what will be the equivalent weights of $Na_2S_2O_3$ and I_2 in the following reaction?
$$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$$
(a) M_1, M_2 (b) M_1, $M_2/2$
(c) $2M_1$, M_2 (d) M_1, $2M_2$

16. The ionisation energy of hydrogen atom (in the ground state) is x kJ. The energy required for an electron to jump from 2nd orbit to the 3rd orbit will be
(a) $x/6$ (b) $5x$ (c) $7.2x$ (d) $5x/36$

17. 1 mole of a non ideal gas undergoes a change of state (2.0 atm, 3.0 L, 95 K) $\longrightarrow$ (4.0 atm, 5.0 L, 245 K) with a change in internal energy, $\Delta U = 30.0$ L atm. The change in enthalpy (ΔH) of the process (in L atm) is
(a) 40.0
(b) 42.3
(c) 44.0
(d) not defined because the pressure is not constant.

18. n-Butylamine(I), diethylamine(II) and N, N-dimethylethylamine(III) have the same molar mass. The increasing order of their boiling points is
(a) III < II < I (b) I < II < III
(c) II < III < I (d) II < I < III

19. An organic compound (A) reacts with methyl magnesium iodide to form an addition product which on hydrolysis forms the compound (B). Compound (B) gives blue colour salt in Victor Meyer's test. The compound (A) and (B) are respectively
(a) acetaldehyde, tertiary butyl alcohol
(b) acetaldehyde, ethyl alcohol
(c) acetaldehyde, isopropyl alcohol
(d) acetone, isopropyl alcohol.

20. Aluminium chloride exists as dimer, Al_2Cl_6 in solid state as well as in solution of non-polar solvents such as benzene. When dissolved in water, it gives
(a) $[Al(OH)_6]^{3-}$ + HCl (b) $[Al(H_2O)_6]^{3+}$ + Cl^-
(c) Al^{3+} + Cl^- (d) Al_2O_3 + HCl

21. The time required for 10% completion of a first order reaction at 298 K is equal to that required for its 25% completion at 308 K. If the pre-exponential factor for the reaction is 3.56×10^9 s^{-1}, calculate its rate constant at 318 K.
(a) 0.92×10^{-4} sec^{-1} (b) 9.22×10^{-4} sec^{-1}
(c) 92.2×10^{-4} sec^{-1} (d) 92×10^{-4} sec^{-1}

22. Match the lists I and II and pick the correct matching from the codes given below.

List I		List II
(A) $[Ag(CN)_2]^-$	1.	Square planar and 1.73 B.M.
(B) $[Cu(CN)_4]^{3-}$	2.	Linear and zero
(C) $[Cu(CN)_6]^{4-}$	3.	Octahedral and zero
(D) $[Cu(NH_3)_4]^{2+}$	4.	Tetrahedral and zero
(E) $[Fe(CN)_6]^{4-}$	5.	Octahedral and 1.73 B.M.

(a) A – 2, B – 4, C – 5, D – 1, E – 3
(b) A – 5, B – 4, C – 1, D – 3, E – 2
(c) A – 1, B – 3, C – 4, D – 2, E – 5
(d) A – 4, B – 5, C – 2, D – 1, E – 3.

23. 10 g atoms of an α-active radioactive isotope are disintegrating in a sealed container. In one hour, helium gas collected at STP is 11.2 cm^3. The half-life of the radioactive isotope is
(a) 138.6 hr (b) 1386 hr
(c) 13860 hr (d) 138600 hr

24. Match the column I with column II and mark the appropriate choice.

Column I	Column II
A. Self reduction	P. Lead
B. Carbon reduction	Q. Nickel
C. Thermal decomposition of its carbonyl	R. Copper
D. Decomposition of its iodide	S. Titanium

	A	B	C	D
(a)	P, R	P, S	Q	S
(b)	P, S	P, R	Q	S
(c)	P, R	P, R	Q	S
(d)	P, Q	P, R	Q	S

25. Work done in expansion of an ideal gas from 4 L to 6 L against a constant external pressure of 2.5 atm was used to heat up 1 mole of water at 293 K. If specific heat of water is 4.184 J g^{-1} K^{-1}, then the final temperature of water is
(a) 288 K   (b) 299 K (c) 279 K   (d) 267 K

26. Arrange the following gem-diols in decreasing order of their stability.

I. (cyclopropane gem-diol)   II. (cyclobutane gem-diol)

III. (cyclopentane gem-diol)
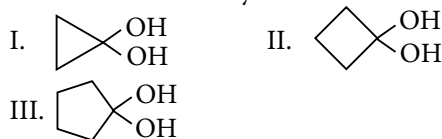
(a) I > II > III   (b) III > II > I
(c) I > III > II   (d) III > I > II

27. Aniline is treated with bromine water to give an organic compound 'X' which when treated with $NaNO_2$ and HCl at 0°C gives a water soluble compound 'Y'. Compound 'Y' on treatment with Cu_2Cl_2 and HCl gives compound 'Z'. Compound 'Z' is
(a) o-bromochlorobenzene
(b) p-bromochlorobenzene
(c) 2, 4, 6-tribromophenol
(d) 2, 4, 6-tribromochlorobenzene.

28. On addition of 1 mL solution of 10% NaCl to 10 mL gold sol in the presence of 0.25 g of starch, the coagulation is just prevented. Starch has the gold number _____.
(a) 0.025   (b) 0.25   (c) 0.5   (d) 250

29. Which of the following reactions taking place in the blast furnace during extraction of iron is endothermic?

(a) $CaCO_3 \longrightarrow CaO + CO_2$
(b) $2C + O_2 \longrightarrow 2CO$
(c) $C + O_2 \longrightarrow CO_2$
(d) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

30. In the following reaction,

(structure of bromo-methylcyclohexane) + $KOH_{(aq)} \longrightarrow$
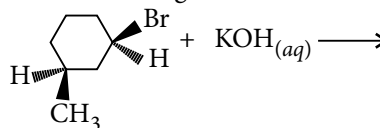
the product formed is
(a) (1R, 3R)-cis-3-methylcyclohexanol
(b) (1R, 3S)-cis-3-methylcyclohexanol
(c) (1S, 3R)-trans-3-methylcyclohexanol
(d) (1S, 3S)-trans-3-methylcyclohexanol.

SOLUTIONS

1. (b): $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$
(1) (2) White residue, soluble in water

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$
(2)   (dil.)

2. (a): Chloral (CCl_3CHO) has no α-hydrogen atom and hence, does not undergo aldol condensation.

3. (d):

Atom A	Atom B
$Z = 8 \times \dfrac{1}{8} = 1$	$Z = 5 \times \dfrac{1}{2} = \dfrac{5}{2}$

$\Rightarrow A : B = 1 : \dfrac{5}{2}$ $\Rightarrow 2 : 5$

So, formula of compound will be A_2B_5.

4. (b): 10 mL of 1 M $KMnO_4$ oxidises 10 mL of 5 M $FeSO_4$ in acidic medium.
$2KMnO_4 + 8H_2SO_4 + 10FeSO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 8H_2O$

5. (d): Natural rubber has the weakest intermolecular forces among the given i.e., van der Waals' forces of attraction and is an example of an elastomer.

6. (b): $- nFE°_{cell} = - RT \ln K$ or $E°_{cell} = \dfrac{RT}{nF} \ln K$

Plot of $\ln K$ vs $E°_{cell}$ will have slope $= \dfrac{1}{2} \dfrac{RT}{F}$ $(n = 2)$.

This will only be possible when $E°_{cell} = 0.5$ which is for the line OB.

7. (c): $H_2C_2O_4 \xrightarrow{\Delta} CO + CO_2 + H_2O$
                (A)   (B)   (C)

$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$
(B)   Lime water   Milkiness

$CO + Cl_2 \longrightarrow COCl_2 \xrightarrow[- 2 HCl]{2NH_3/\Delta} NH_2CONH_2$
(A)   (D)   (E)

8. (a):
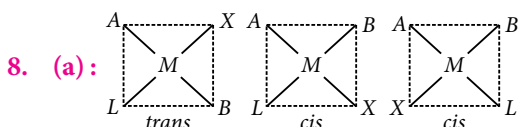
Thus, square planar complex $MABXL$ shows two *cis* and one *trans* isomers.

9. (c):

$$HCHO + 3HCOOH + CHCOOH$$

with an $\overset{\parallel}{O}$ group below.
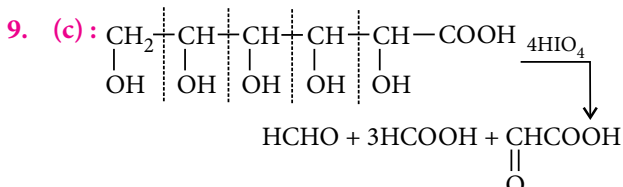
10. (d): The equilibrium constant does not change at all with change in concentration, volume, pressure and presence of a catalyst. It changes only with change in temperature of the system.

11. (c):

12. (b): $Mg(OH)_2 \longrightarrow \underset{S}{Mg^{2+}} + \underset{2S}{2OH^-}$
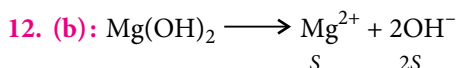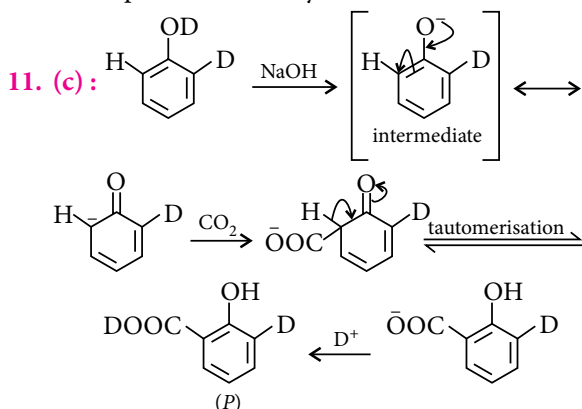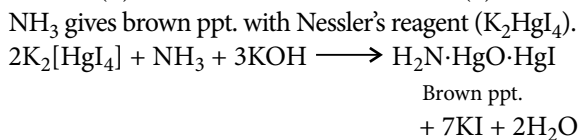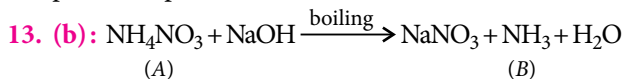
Let S_1 is the solubility in 0.01 M $MgCl_2$ (common ion Mg^{2+}). $\therefore$ $[Mg^{2+}] = (S_1 + 0.01) \approx 0.01$; $[OH^-] = 2S_1$
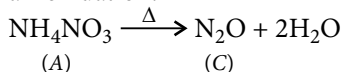
$$K_{sp} = (0.01)(2S_1)^2; \; S_1 = \left(\frac{K_{sp}}{4\times0.01}\right)^{1/2} = \left(\frac{10^{-12}}{4\times10^{-2}}\right)^{1/2}$$

$$= 0.5 \times 10^{-5} \text{ M}$$

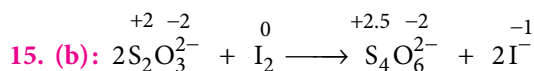$\therefore$ $[OH^-] = 2S_1 = 2 \times 0.5 \times 10^{-5} = 10^{-5}$ M
pOH = 5, pH = 14 – 5 = 9

13. (b): $NH_4NO_3 + NaOH \xrightarrow{\text{boiling}} \underset{(B)}{NaNO_3 + NH_3 + H_2O}$
with NH_4NO_3 labelled (A)

NH_3 gives brown ppt. with Nessler's reagent (K_2HgI_4).
$2K_2[HgI_4] + NH_3 + 3KOH \longrightarrow \underset{\text{Brown ppt.}}{H_2N\cdot HgO\cdot HgI}$
$+ 7KI + 2H_2O$

(A) on heating gives N_2O gas (C) which rekindles a glowing splinter but is not converted into NO_2 by air oxidation.
$\underset{(A)}{NH_4NO_3} \xrightarrow{\Delta} \underset{(C)}{N_2O} + 2H_2O$

14. (b): Energy absorbed in the ionisation of 1 mole of $Mg_{(g)}$ to $Mg^+_{(g)}$ = 750 kJ
Energy unconsumed = 1200 – 750 = 450 kJ mol^{-1}
This energy is required to convert $Mg^+_{(g)}$ to $Mg^{2+}_{(g)}$.

Thus, % of $Mg^{2+}_{(g)} = \frac{450}{1450}\times\frac{100}{1} = 31\%$ and % of

$Mg^+_{(g)} = 100 – 31 = 69\%$

15. (b): $\overset{+2}{2S_2}\overset{-2}{O_3^{2-}} + \overset{0}{I_2} \longrightarrow \overset{+2.5}{S_4}\overset{-2}{O_6^{2-}} + \overset{-1}{2I^-}$
O.N. of S in $S_2O_3^{2-} = 2x – 6 = – 2$ or $x = + 2$
O.N. of S in $S_4O_6^{2-} = 4x – 12 = – 2$ or $x = + 2.5$
Change in O.N. of S per mole = 0.5 × 2 = 1
Similarly, change in O.N. of I per mole = 1 × 2 = 2

Therefore, eq. mass of $Na_2S_2O_3 = \frac{M_1}{1} = M_1$, and

eq. mass of $I_2 = \frac{M_2}{2}$.

16. (d): $(I.E)_H = E_\infty – E_1 = – E_1 = x$
Put $E_1 = – \frac{K}{n^2} = – \frac{K}{1^2} = – K$; $\therefore$ $K = x$

$$\Delta E = E_3 – E_2 = – \frac{K}{3^2} – \left(– \frac{K}{2^2}\right) = K\frac{5}{36} = \frac{5}{36}x$$

17. (c): $H = U + PV$
$H_1 = U_1 + (2 \times 3) = U_1 + 6$
$H_2 = U_2 + (4 \times 5) = U_2 + 20$
$(H_2 – H_1) = (U_2 – U_1) + (20 – 6)$
$\Delta H = \Delta U + 14 = 30 + 14 = 44$ L atm

18. (a): $\underset{n\text{-Butylamine (Primary amine)}}{H_3C—CH_2—CH_2—CH_2—NH_2}$
$\underset{\text{Diethylamine (Secondary amine)}}{CH_3—CH_2—NH—CH_2—CH_3}$
$\underset{N, N\text{-Dimethylethyl amine (Tertiary amine)}}{(CH_3)_2N—C_2H_5}$
Primary amines have two hydrogen atoms available for hydrogen bond formation, while 2° amines have only one hydrogen atom. 3° amines do not have intermolecular association due to absence of hydrogen atom. Thus, order of boiling points of isomeric amines is as follows : 3° < 2° < 1° or III < II < I.
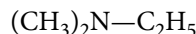
19. (c):
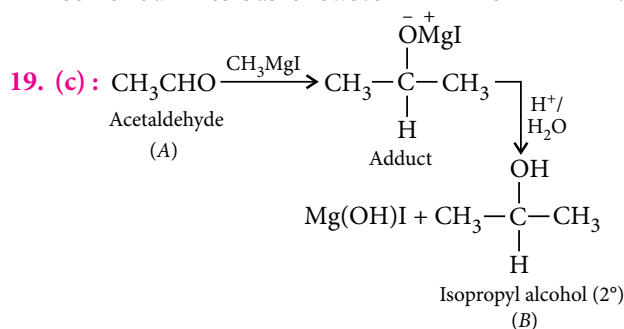
2° alcohols give blue coloured salt in Victor Meyer test.

20. (b): $Al_2Cl_6 + 12H_2O \rightleftharpoons 2[Al(H_2O)_6]^{3+} + 6Cl^-$

21. (b): Given, $t = \dfrac{2.303}{k_{298}} \log_{10} \dfrac{100}{90} = \dfrac{2.303}{k_{308}} \log_{10} \dfrac{100}{75}$

$\therefore \quad \dfrac{k_{308}}{k_{298}} = 2.73$

Also, $2.303 \log_{10} \dfrac{k_{308}}{k_{298}} = \dfrac{E_a}{R} \dfrac{[T_2 - T_1]}{T_1 T_2}$

$\therefore \quad 2.303 \log_{10} 2.73 = \dfrac{E_a}{8.314} \times \dfrac{10}{298 \times 308}$

$\therefore \quad E_a = 76.6227 \text{ kJ mol}^{-1}$

Now, $k = Ae^{-E_a/RT}$

$k_{318} = 3.56 \times 10^9 \times e^{-76622.7/(8.314 \times 318)}$

$= 3.56 \times 10^9 \times 2.59 \times 10^{-13} = 9.22 \times 10^{-4} \text{ sec}^{-1}$

22. (a)

23. (c) : Gram atoms of helium gas formed in 1 hour

$$= \dfrac{11.2}{22400} = 5 \times 10^{-4}$$

i.e., Gram atoms of radioactive isotope disintegrated in one hour $= 5 \times 10^{-4}$

Rate of disintegration $= \lambda N$

$5 \times 10^{-4} = \lambda \times 10$ or $\lambda = 5 \times 10^{-5} \text{ hr}^{-1}$

$t_{1/2} = \dfrac{0.693}{\lambda} = \dfrac{0.693}{5 \times 10^{-5}} \text{ hr} = 13860 \text{ hr}$

24. (c) : A – P, R; B – P, R; C – Q; D – S

Self reduction and carbon reduction are carried out in case of Pb and Cu. Ni is purified by the thermal decomposition of its carbonyl and Ti is purified by the decomposition of its iodide at higher temperature.

25. (b): Since work is done against a constant pressure thus, irreversible.

Given, $\Delta V = (6 - 4) = 2$ L, $P_{ext} = 2.5$ atm

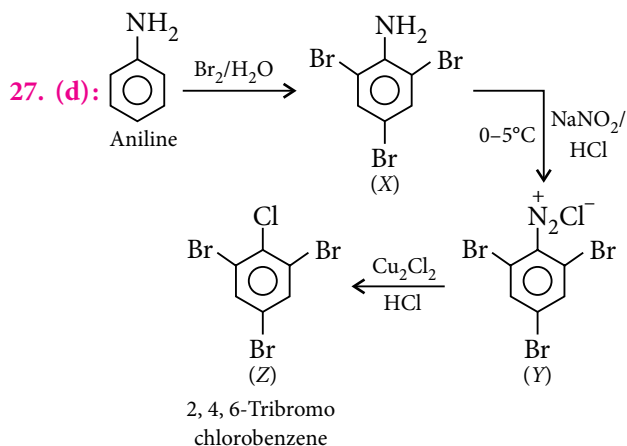$\therefore \quad W = -P_{ext} \times \Delta V = -2.5 \times 2 = -5$ L atm

$= -\dfrac{5 \times 1.987}{0.0821}$ cal $= -\dfrac{5 \times 1.987 \times 4.184}{0.0821}$ J $= -506.31$ J

Now, this work is used in heating 1 mole of water.

$w = n \times C \times \Delta T$

$506.31 = 1 \times 4.184 \times 18 \times \Delta T \quad \left[\begin{array}{l} \because \ C = 4.184 \text{ J g}^{-1}\text{K}^{-1} \\ = 4.184 \times 18 \text{ J mol}^{-1} \end{array} \right]$

$\therefore \quad \Delta T = 6.723$

So, final temperature $= T_1 + \Delta T = 293 + 6.723$

$= 299.723$ K

26. (a) : As the internal angle increases, steric hindrance increases and hence, the stability of the *gem*-diol decreases.

27. (d):

2, 4, 6-Tribromo chlorobenzene

28. (d): By definition, gold number of starch is the amount of starch in mg added to 10 mL standard gold sol which prevents the coagulation of gold on adding 1 mL of 10% NaCl solution. And, the amount of starch is 0.25 g = 250 mg. Hence, gold number is 250.

29. (b): $2C + O_2 \longrightarrow 2CO; \Delta H = +ve,$

It is an endothermic reaction.

30. (d): In S_N2 reaction, inversion of configuration occurs.

(1R, 3S)-*cis*-1-Bromo-3-methylcyclohexane

(1S, 3S)-*trans*-3-methylcyclohexanol

◈ ◈
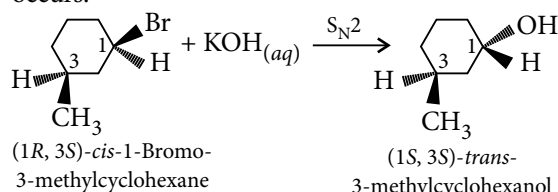
EXAM DATES 2017	
SRMJEEE	1st April to 30th April (Online)
JEE MAIN	2nd April (Offline)
	8th & 9th April (Online)
VITEEE	5th April to 16th April (Online)
NATA	16th April
WBJEE	23rd April
Kerala PET	24th April (Physics & Chemistry)
	25th April (Mathematics)
AMU (Engg.)	30th April
Karnataka CET	2nd May (Biology & Mathematics)
	3rd May (Physics & Chemistry)
NEET	7th May
COMEDK (Engg.)	14th May
BITSAT	16th May to 30th May (Online)
JEE Advanced	21st May
J & K CET	27th May to 28th May
AIIMS	28th May
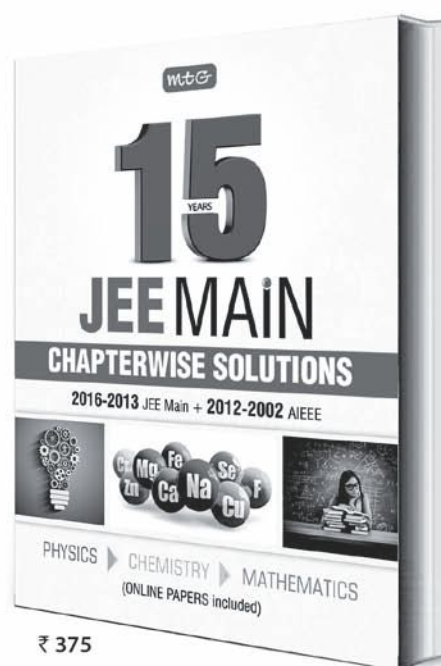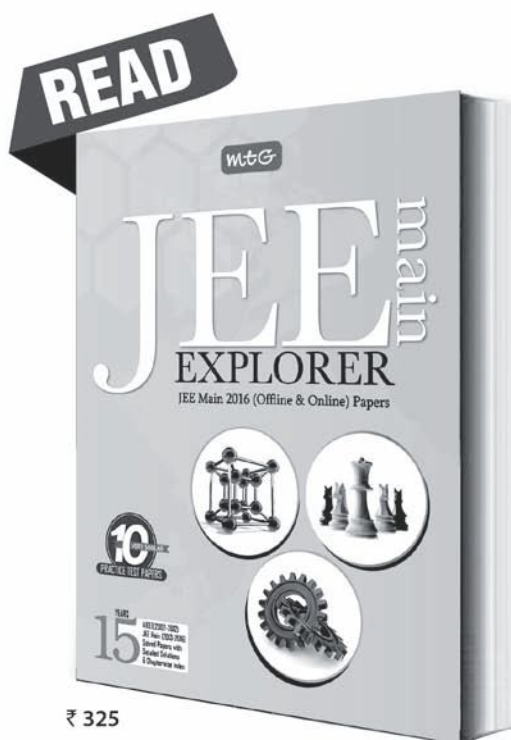
BOOST your NEET score

Practice Paper 2017

1. The IUPAC name of the compound

CONH$_2$ ... CHO is
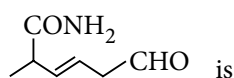
(a) 5-carbamoylhex-1-enal
(b) 2-carbamoylhex-3-enal
(c) 2-methyl-6-oxohex-3-enamide
(d) 6-keto-2-methylhexanamide.

2. The following two reactions of HNO_3 with Zn are given as :

$Zn + conc.\ HNO_3 \longrightarrow Zn(NO_3)_2 + X + H_2O$

$Zn + dil.\ HNO_3 \longrightarrow Zn(NO_3)_2 + Y + H_2O$
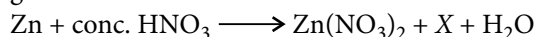
The compounds X and Y respectively are
(a) NO_2 and NO   (b) NO_2 and NO_2
(c) NO and NO_2 (d) NO_2 and NH_4NO_3

3. Which of the following has highest molar conductivity?
(a) Diamminedichloroplatinum(II)
(b) Tetraamminedichlorocobalt(III) chloride
(c) Potassium hexacyanoferrate(II)
(d) Pentacarbonyliron(0)
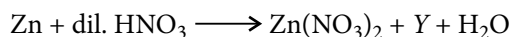
4. Sanger's reagent is used for the identification of
(a) N-terminal of a peptide chain
(b) C-terminal of a peptide chain
(c) side chain of amino acids
(d) molecular mass of the peptide chain.

5. In the following reaction,

$OH^- \xrightarrow{\Delta} X$
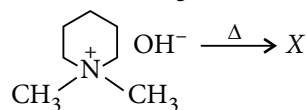
The organic product X is

(a)   (b)
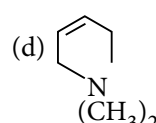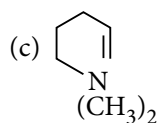
6. Which of the following curves represents the curve of an ideal gas?
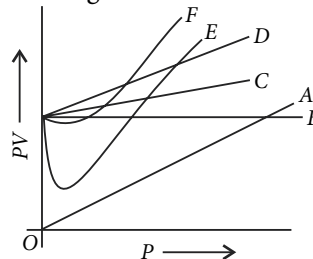
(a) B only   (b) C and D only
(c) E and F only   (d) A and B only

7. Which of the following species is the strongest base?
(a) ^-OH (b) ^-OR
(c) $^-OC_6H_5$ (d) $^-O\!-\!\!\!\diagup\!\!\!-NO_2$

8. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1 M, 0.01 M and 0.001 M, respectively. The value of van't Hoff factor for these solutions will be in the order
(a) $i_A < i_B < i_C$ (b) $i_A > i_B > i_C$
(c) $i_A = i_B = i_C$ (d) $i_A < i_B > i_C$

9. For the reaction,

$H_{2(g)} + \dfrac{1}{2} O_{2(g)} \longrightarrow H_2O_{(l)}$
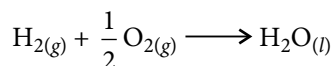
$B.E._{(H-H)} = x_1;\ B.E._{(O=O)} = x_2$ and $B.E._{(O-H)} = x_3$.
If the latent heat of vaporisation of water liquid into water vapour = x_4, then $\Delta_f H$ (heat of formation of liquid water) is

(a) $x_1 + \dfrac{x_2}{2} - x_3 + x_4$

(b) $2x_3 - x_1 - \dfrac{x_2}{2} - x_4$

(c) $x_1 + \dfrac{x_2}{2} - 2x_3 - x_4$

(d) $x_1 + \dfrac{x_2}{2} - 2x_3 + x_4$

10. In the given reactions sequence,

$$MSO_4 \xrightarrow[\text{Wh te}]{NH_4OH} X\downarrow \xrightarrow{NH_4OH}_{\text{Excess}} Y \xrightarrow{H_2S} Z\downarrow$$
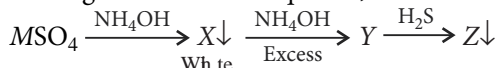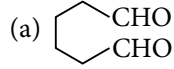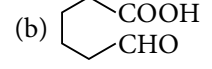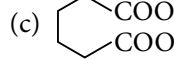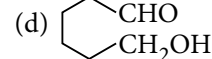
M and Z are respectively
(a) Zn, ZnS   (b) Al, Al$_2$S$_3$
(c) Cu, ZnS   (d) Fe, FeS

11. If the equilibrium constant of $BOH \rightleftharpoons B^+ + OH^-$ at 25°C is 2.5×10^{-6}, then equilibrium constant for $BOH + H^+ \rightleftharpoons B^+ + H_2O$ at the same temperature is
(a) 4.0×10^{-9} (b) 4.0×10^{5}
(c) 2.5×10^{8} (d) 2.5×10^{-6}

12. The product obtained when,

is oxidised with HIO_4 is
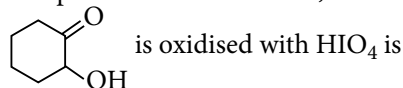
(a)   (b)

(c)   (d)

13. Which is finally produced when acetylene reacts with HCl?
(a) $CH_2{=}CHCl$ (b) CH_3CHCl_2
(c) $ClCH{=}CHCl$ (d) No ᵧ t these

14. An unknown element forms an oxide. What will be the equivalent weight of the element if the oxygen content is 20% by weight?
(a) 16 g   (b) 32 g
(c) 8 g   (d) 64 g

15. The ligand called π-acid is
(a) CO   (b) NH_3
(c) $C_2O_4^{2-}$ (d) ethylenediamine.
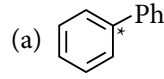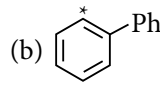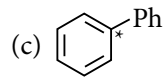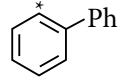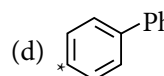
16. Which of the following is an anti-aromatic compound?

(a)   (b)

(c)   (d)
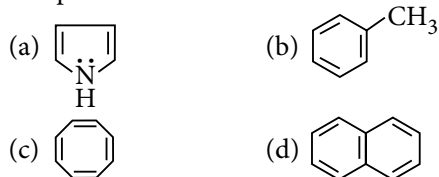
17. Identify the product of the following reaction.
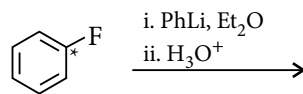
(a)   (b)

(c)

(d)
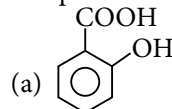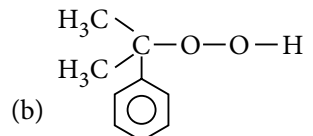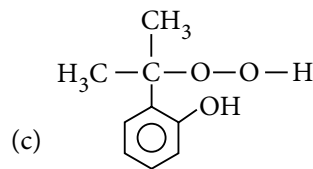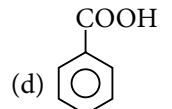
18. The successive ionisation enthalpy values for an element X are given as :
1st ionisation enthalpy = 410 kJ mol^{-1}
2nd ionisation enthalpy = 820 kJ mol^{-1}
3rd ionisation enthalpy = 1100 kJ mol^{-1}
4th ionisation enthalpy = 1500 kJ mol^{-1}
5th ionisation enthalpy = 3200 kJ mol^{-1}
Find out the number of valence electrons for the atom X.
(a) 4   (b) 3   (c) 5   (d) 2

19. Phenol is distilled with Zn dust followed by Friedel–Crafts alkylation with propyl chloride in the presence of $AlCl_3$ to give a compound B. B is oxidised in the presence of air to form the compound C. The structural formula of C is

(a)

(b)

(c)

(d)

20. $\Lambda^\circ_{m(NH_4OH)}$ is equal to
(a) $\Lambda^\circ_{m(NH_4OH)} + \Lambda^\circ_{m(NH_4Cl)} - \Lambda^\circ_{m(HCl)}$
(b) $\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaOH)} - \Lambda^\circ_{m(NaCl)}$
(c) $\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaCl)} - \Lambda^\circ_{m(NaOH)}$
(d) $\Lambda^\circ_{m(NaOH)} + \Lambda^\circ_{m(NaCl)} - \Lambda^\circ_{m(NH_4Cl)}$

21. At the equilibrium position in the process of adsorption
(a) $\Delta H > 0$
(b) $\Delta H = T\Delta S$
(c) $\Delta H > T\Delta S$
(d) $\Delta H < T\Delta S$

22. Distinction between primary, secondary and tertiary alcohols is done by
(a) oxidation method
(b) Lucas test
(c) Victor Meyer method
(d) all of these.

23. The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom will be
(a) $3.08 \times 10^{15} \text{ s}^{-1}$
(b) $2.00 \times 10^{15} \text{ s}^{-1}$
(c) $1.54 \times 10^{15} \text{ s}^{-1}$
(d) $1.03 \times 10^{15} \text{ s}^{-1}$

24. The packing efficiency of the two dimensional square unit cell shown is
(a) 39.27%
(b) 68.02%
(c) 74.05%
(d) 78.54%
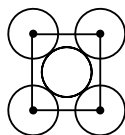
25. In Ramsay and Rayleigh's isolation of noble gases from air, the nitrogen of the air is finally converted into
(a) $NaNO_2$ only
(b) NO and NO_2
(c) $NaNO_3$ only
(d) $NaNO_2$ and $NaNO_3$

26. The gold number of some colloidal solutions are given as :

Colloidal solution	Gold number
A	0.01
B	2.5
C	20

The protective nature of these colloidal solutions follows the order
(a) $C > B > A$
(b) $A > B > C$
(c) $A = B = C$
(d) $B > A > C$

27. $CH_3CH_2NH_2$ contains a basic NH_2 group, but CH_3CONH_2 does not
(a) acetamide is amphoteric in character
(b) in ethyl amine the electron pair on N-atom is delocalised by resonance
(c) in ethyl amine there is no resonance while in acetamide the lone pair of electrons on N-atom is delocalised and is less available for protonation
(d) all of these.

28. Match the options given in column I with column II.

	Column I		Column II
P.	Mathematical expression for rate of reaction	1.	rate constant
Q.	Rate of reaction for zero order reaction is equal to	2.	rate law
R.	Units of rate constant for zero order reaction is same as that of	3.	order of slowest step
S.	Order of a complex reaction is determined by	4.	rate of the reaction

	P	Q	R	S
(a)	1	2	4	3
(b)	3	4	1	2
(c)	2	1	4	3
(d)	2	1	3	4

29. The thermal stability of the hydrides of O, S, Se and Te varies in the order
(a) $H_2Te > H_2Se > H_2S > H_2O$
(b) $H_2O > H_2S > H_2Se > H_2Te$
(c) $H_2O > H_2Se > H_2Te > H_2S$
(d) $H_2S > H_2O > H_2Se > H_2Te$

30. Which of the following amino acids can be used to synthesise the given tripeptide ?
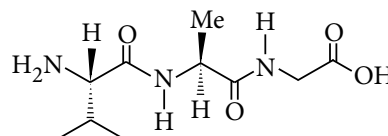
(a) Glycine, leucine and alanine
(b) Alanine, isoleucine and glycine
(c) Valine, alanine and glycine
(d) Alanine, serine and glycine

31. In the anion $HCOO^-$ the two carbon-oxygen bonds are found to be of equal length because
(a) the $C{=}O$ bond is weaker than the $C{-}O$ bond
(b) the anion $HCOO^-$ shows resonance
(c) the anion is obtained by removal of a proton from the acid molecule
(d) the electronic orbitals of carbon atom are hybridised.

32. In chromic acid anhydride (CrO_3), Cr has d^0 configuration but it is bright orange coloured solid, the colour is due to

(a) *d-d* transition
(b) charge transfer ($L \rightarrow M$) transition
(c) charge transfer ($M \rightarrow L$) transition
(d) *p-d* transition.

33. A cylinder filled with a movable piston contains liquid water in equilibrium with water vapours at 25°C. Which one of the following operations results in a decrease in the equilibrium vapour pressure?
(a) Moving the piston downward a short distance
(b) Removing a small amount of vapour
(c) Removing a small amount of the liquid water
(d) Dissolving salt in the water

34. The carbohydrate that yields glucose and galactose on acid hydrolysis is
(a) sucrose   (b) lactose
(c) maltose   (d) starch.

35. During enolisation of the following compound, which of the labelled hydrogen is involved?

(a) H_α (b) H_β
(c) H_γ (d) Any of the three

36. The correct order of the ligands, OH^-, NO_3^-, PPh_3, pyridine, according to their increasing field strength is
(a) $NO_3^- < OH^- <$ pyridine $< PPh_3$
(b) $OH^- < NO_3^- < PPh_3 <$ pyridine
(c) $OH^- < NO_3^- <$ pyridine $< PPh_3$
(d) $NO_3^- < OH^- < PPh_3 <$ pyridine

37. A scarlet compound (A) Pb_3O_4 gives a chocolate brown ppt. (B) and a colourless solution (C) with HNO_3. The brown ppt. (B) is of
(a) PbO_2 (b) $2Pb(NO_3)_2$
(c) PbO (d) none of these.

38. Consider the following sets of quantum numbers :

	n	l	m	s
(i)	3	0	0	+1/2
(ii)	2	2	1	+1/2
(iii)	4	3	−2	−1/2
(iv)	1	0	−1	−1/2
(v)	3	2	3	+1/2

Which of the following sets of quantum number is not possible?

(a) (i), (ii), (iii) and (iv)
(b) (ii), (iv) and (v)
(c) (i) and (iii)
(d) (ii), (iii) and (iv)

39. When excess of KI is added to aqueous $CuSO_4$, the solution acquires dark brown colouration. This is due to the formation of
(a) $CuI_{2(s)}$ (b) $Cu_2I_{2(s)}$
(c) $I_{3(aq)}^-$ (d) $I_{2(s)}$

40. Reaction by which benzaldehyde cannot be prepared is
(a) ⬡ + CO + HCl in presence of anhydrous $AlCl_3$
(b) ⬡—COOH + Zn/Hg and conc. HCl
(c) ⬡—CH_3 + CrO_2Cl_2 in CS_2 followed by H_3O^+
(d) ⬡—COCl + H_2 in presence of Pd-$BaSO_4$

41. Hydrazine reacts with KIO_3 in presence of HCl as
$N_2H_4 + IO_3^- + 2H^+ + Cl^- \longrightarrow ICl + N_2 + 3H_2O$
The equivalent masses of N_2H_4 and KIO_3 respectively are
(a) 16 and 87   (b) 16 and 53.5
(c) 8 and 53.5   (d) 8 and 87

42. Match the polymers given in column I with their chemical names given in column II.

	Column I		Column II
P.	Nylon 6	1.	Polyvinyl chloride
Q.	PVC	2.	Polyacrylonitrile
R.	Acrilan	3.	Polycaprolactum
S.	Natural rubber	4.	*cis*-Polyisoprene

	P	Q	R	S
(a)	1	2	3	4
(b)	4	3	1	2
(c)	3	1	4	2
(d)	3	1	2	4

43. Which of the following will not show geometrical isomerism?

(a) F, Cl on C=C with H, D
(b) F, Cl on C=C with F, Cl

(c)

(d)
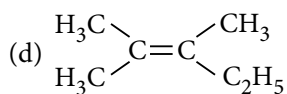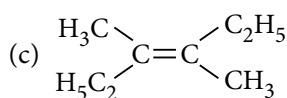
44. Following data is given at 25°C,

$Ag + I^- \longrightarrow AgI + e^-$; $E° = 0.152$ V

$Ag \longrightarrow Ag^+ + e^-$; $E° = 0.800$ V

What is the value of log K_{sp} for AgI?

(a) -37.83 (b) -16.13

(c) -8.12 (d) $+8.612$

45. Antiseptic action of dettol is due to

(a) 4-chloro-3, 5-dimethylphenol

(b) 3-chloro-4, 5-dimethylphenol

(c) 4-chloro-2, 5-dimethylphenol

(d) 5-chloro-3, 4-dimethylphenol.

SOLUTIONS

1. (c):
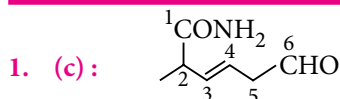
2-Methyl-6-oxohex-3-enamide

2. (d): $Zn + 4HNO_3$ (conc.) $\longrightarrow Zn(NO_3)_2 + 2NO_2$
$+ 2H_2O$

$4Zn + 10HNO_3$(dil.) $\longrightarrow 4Zn(NO_3)_2 + NH_4NO_3$
$+ 3H_2O$

3. (c): $K_4[Fe(CN)_6] \rightleftharpoons 4K^+ + [Fe(CN)_6]^{4-}$

Potassium hexacyanoferrate(II) gives a total of 5 ions in aqueous solution thus, it has the highest molar conductivity whereas other complexes will give lesser number of ions.

4. (a): Sanger's reagent is used for the identification of N-terminal residue of a polypeptide.

5. (c):
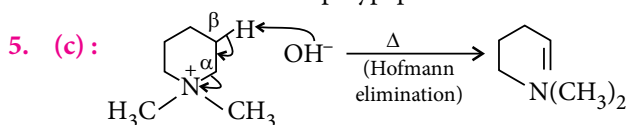
6. (a): For curve B, the value of PV is constant and for an ideal gas, plot of PV vs P is a straight line, parallel to x-axis.

7. (b): ^-OR is the strongest base since R (alkyl) group is an electron releasing group which increases electron density on oxygen.

8. (c): The value of van't Hoff factor for the given solutions will be the same, i.e., $i_A = i_B = i_C$ due to complete dissociation of NaCl (strong electrolyte) in dilute solutions. On complete dissociation value of i for NaCl is 2.

9. (c): $\Delta_f H = (B.E.)_{reactants} - (B.E.)_{products}$

But all the species must be in gaseous state, so in product $[H_2O_{(l)} \longrightarrow H_2O_{(g)}] \Delta H_{vap}$ must be added.

Hence for the reaction, $H_{2(g)} + \frac{1}{2} O_{2(g)} \longrightarrow H_2O_{(l)}$
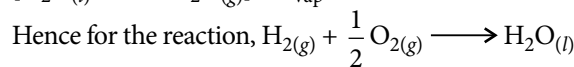
$\Delta_f H = \left[(B.E.)_{H-H} + \frac{1}{2}(B.E.)_{O=O} \right]$
$- [\Delta H_{vap} + 2(B.E.)_{O-H}]$

$= x_1 + \frac{x_2}{2} - [x_4 + 2x_3] \Rightarrow x_1 + \frac{x_2}{2} - x_4 - 2x_3$

10. (a): $ZnSO_4 \xrightarrow{NH_4OH} \underset{(X)}{\underset{(White)}{Zn(OH)_2\downarrow}} \xrightarrow[Excess]{NH_4OH}$

$\underset{(Z)}{ZnS\downarrow} \xleftarrow{H_2S} \underset{(Y)}{\text{Clear solution}}$
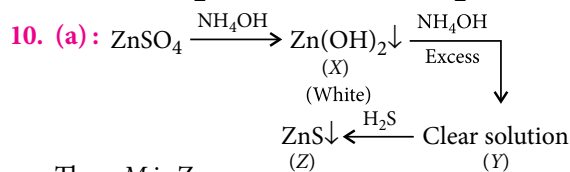
Thus, M is Zn.

11. (c): $BOH \rightleftharpoons B^+ + \bar{O}H$; $(K_b = 2.5 \times 10^{-6})$

$H^+ + \bar{O}H \rightleftharpoons H_2O$; $\left(K = \frac{1}{K_w} \right)$

$\overline{BOH + H^+ \rightleftharpoons B^+ + H_2O; \ K' = ?}$
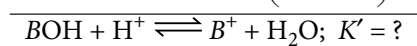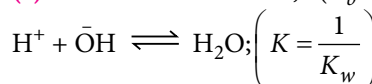
$\therefore \ K' = K_b \times \frac{1}{K_w} = \frac{2.5 \times 10^{-6}}{10^{-14}} = 2.5 \times 10^8$

12. (b):

13. (b): $CH \equiv CH + HCl \longrightarrow CH_2 = CHCl \xrightarrow{HCl}$
CH_3-CHCl_2
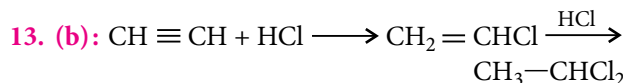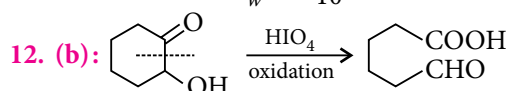
14. (b): Given that oxygen content is 20% by weight, then

eq. wt. of unknown element = $\frac{80}{20} \times 8$ g = 32 g

15. (a)

16. (c): Planar conjugated cyclic compounds containing $4n\pi$ electrons are anti-aromatic, e.g., cyclooctatetraene (8π e^-s).

17. (c):

Biphenyl
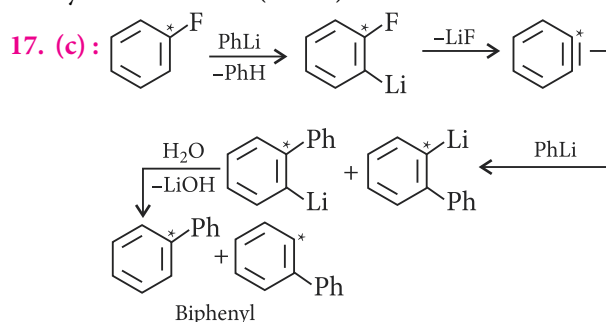
18. (a): Removal of 5th electron requires almost more than double the energy required for removing 4th electron. Therefore, the valence electrons should be 4.

19. (b):

20. (b): $NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$ ...(i)
$NaCl \rightleftharpoons Na^+ + Cl^-$ ...(ii)
$NaOH \rightleftharpoons Na^+ + OH^-$ ...(iii)
$NH_4OH \rightleftharpoons NH_4^+ + OH^-$ ...(iv)
Applying (i) + (iii) – (ii) to get the equation (iv),
$\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaOH)} - \Lambda^\circ_{m(NaCl)} = \Lambda^\circ_{m(NH_4OH)}$
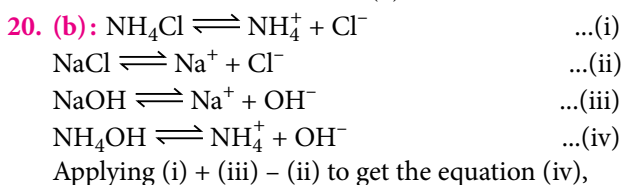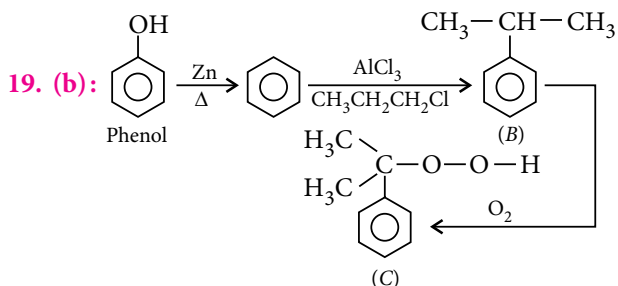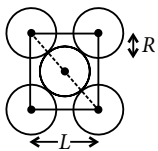
21. (b): At equilibrium during adsorption, $\Delta G = 0$ and ΔH becomes equal to $T\Delta S$.

22. (d)

23. (a): $E_n = \dfrac{-2.18\times10^{-18}}{n^2}$ J atom^{-1}

$\Delta E = E_4 - E_1 = -2.18 \times 10^{-18}\left(\dfrac{1}{4^2} - \dfrac{1}{1^2}\right)$

$= -2.18 \times 10^{-18}\,(-0.9375) \Rightarrow 2.043 \times 10^{-18}$ J atom^{-1}
Also, $\Delta E = h\nu$

$\therefore \quad \nu = \dfrac{\Delta E}{h} = \dfrac{2.043\times10^{-18}}{6.625\times10^{-34}} = 3.08 \times 10^{15}$ s^{-1}

24. (d): $4R = L\sqrt{2}$
so, $L = 2\sqrt{2}R$

Area of square unit cell = $(2\sqrt{2}R)^2$
$= 8R^2$
Area of atoms present in one unit cell
$= \pi R^2 + 4\left(\dfrac{\pi R^2}{4}\right) = 2\pi R^2$
So, packing efficiency $= \dfrac{2\pi R^2}{8R^2}\times100 = \dfrac{\pi}{4}\times100$
$\approx 78.54\%$

25. (d): Nitrogen is finally converted into $NaNO_2$ and $NaNO_3$ in Ramsay and Rayleigh's method.
$N_2 + O_2 \longrightarrow 2NO$
$2NO + O_2 \longrightarrow 2NO_2$
$2NO_2 + 2NaOH \longrightarrow NaNO_2 + NaNO_3 + H_2O$
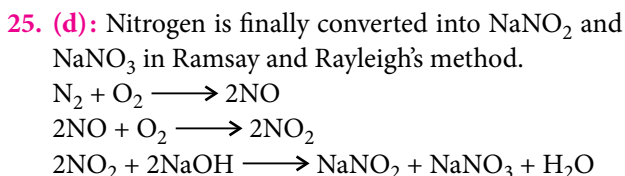
26. (b): Higher the gold number, lower will be the protective power of a colloidal solution.

27. (c)   **28. (c)**

29. (b): Thermal stability decreases as the size of atom increases (down the group). Thus, H_2O is most stable and H_2Te is least stable.

30. (c):
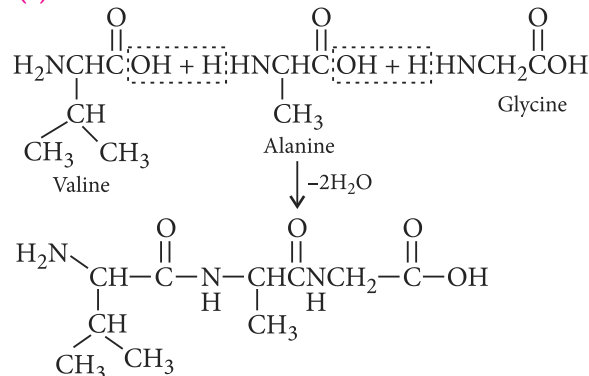
31. (b): As the anion $HCOO^-$ has two resonating structures, so the carbon-oxygen bonds are found to be of equal length.
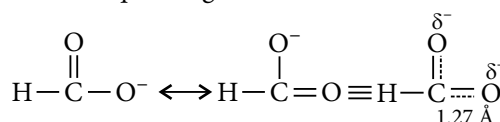
32. (b): The colour of CrO_3 (d^0 configuration) is due to charge transfer from ligand (oxygen) to metal (chromium) and not due to d-d transition.

33. (d): Dissolving salt in a solvent or liquid lowers the vapour pressure.

34. (b): Lactose on hydrolysis with acetic acid gives glucose and galactose.

35. (c): H_γ being located on a saturated carbon is more labile than H_α and H_β and hence, is involved in enolisation.
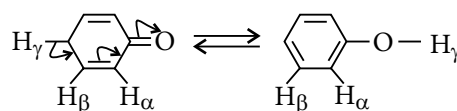
36. (a): $NO_3^- < OH^- < Py < PPh_3$
Weak field ligand   Strong field ligand

37. (a): $Pb_3O_4 + 4HNO_3 \longrightarrow PbO_2\downarrow + 2Pb(NO_3)_2$
Scarlet compound (A)   Brown ppt. (B)   Colourless solution (C)
$+ 2H_2O$
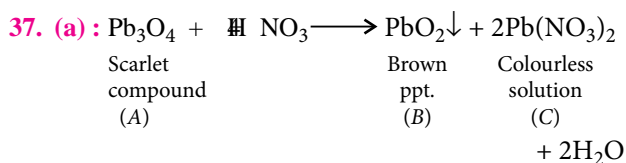
38. (b): (i) represents an electron in $3s$ orbital.
(ii) is not possible as value of l varies from 0 to $(n-1)$.
(iii) represents an electron in $4f$ orbital.

(iv) is not possible as value of m varies from $-l$ to $+l$.
(iv is not possible as value of m varies from $-l$ to $+l$, etc. as m varies greater than l.)

39. (c) : $2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2$;
$$I_{2(s)} + I^-_{(aq)} \longrightarrow I^-_{3(aq)}$$
<div align="center">(dark brown)</div>
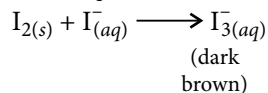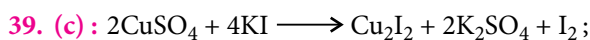
40. (b): Zn-Hg and conc. HCl reduces aldehydes and ketones but carboxylic acid group remains unaffected.

41. (c) : O.N. of N in N_2H_4 is -2 which changes to 0 in N_2.

Hence, eq. mass of $N_2H_4 = \dfrac{\text{molar mass}}{2 \times 2} = \dfrac{32}{4} = 8$

O.N. of iodine changes from $+5$ in IO_3^- to $+1$ in ICl.

Hence, eq. mass of $KIO_3 = \dfrac{\text{molar mass}}{4} = \dfrac{214}{4} = 53.5$

42. (d)

43. (d): $\underset{H_3C}{\overset{H_3C}{>}}C = C\underset{C_2H_5}{\overset{CH_3}{<}}$ will not show geometrical isomerism due to the presence of similar alkyl groups on the same carbon atom of double bond.

44. (b): $Ag + I^- \longrightarrow AgI + e^-, \ E_1^o = 0.152$ V
$$\underline{Ag^+ + e^- \longrightarrow Ag, \ E_2^o = 0.800 \text{ V}}$$
$$\overline{Ag^+ + I^- \longrightarrow AgI, \ E^o = 0.952 \text{ V}}$$
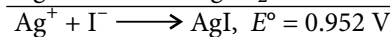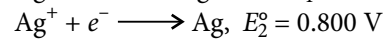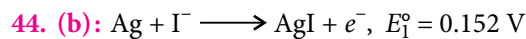
At equilibrium, $E^o = \dfrac{2.303RT}{F} \log K_c$

But $K_c = \dfrac{[AgI]}{[Ag^+][I^-]} = \dfrac{1}{K_{sp}}$

$\therefore \quad 0.952 = -\dfrac{2.303RT}{F}\log K_{sp} = -0.059 \log K_{sp}$

or $\quad \log K_{sp} = -16.13$

45. (a) : 4-Chloro-3,5-dimethylphenol, also called chloroxylenol has antiseptic properties.

NEET 2017*

NOTIFICATION!

PRACTICE PAPER

BITSAT

Exam date : 16th to 30th May 2017

1. Which of the following reactions show the reducing property of hydrochloric acid?
   (a) $ZnCO_3 + 2HCl \rightarrow ZnCl_2 + H_2O + CO_2$
   (b) $Mg + 2HCl \rightarrow MgCl_2 + H_2$
   (c) $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$
   (d) $NH_4OH + HCl \rightarrow NH_4Cl + H_2O$

2. Reduction potentials of some ions are given below. Arrange them in decreasing order of oxidising power.

Ion	ClO_4^-	IO_4^-	BrO_4^-
Reduction potential ($E°$)	1.19 V	1.65 V	1.74 V

   (a) $ClO_4^- > IO_4^- > BrO_4^-$ (b) $IO_4^- > BrO_4^- > ClO_4^-$
   (c) $BrO_4^- > IO_4^- > ClO_4^-$ (d) $BrO_4^- > ClO_4^- > IO_4^-$

3. Which of the following will not give iodoform test?
   (a) *n*-Butyl alcohol   (b) *sec*-Butyl alcohol
   (c) Acetophenone   (d) Acetaldehyde

4. Energy of an electron in hydrogen atom is given by $E = -\dfrac{13.6}{n^2}$ eV. Which one of the following statements is true if *n* is changed from 1 to 3? Energy will
   (a) decrease three times   (b) increase three times
   (c) increase nine times   (d) decrease nine times.

5. In the coagulation of a positive sol, the flocculation powers of Cl^-, SO_4^{2-}, PO_4^{3-} and $[Fe(CN)_6]^{4-}$ are in the order
   (a) $Cl^- > SO_4^{2-} > [Fe(CN)_6]^{4-} > PO_4^{3-}$
   (b) $Cl^- > PO_4^{3-} > SO_4^{2-} > [Fe(CN)_6]^{4-}$
   (c) $[Fe(CN)_6]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$
   (d) $Cl^- > SO_4^{2-} > PO_4^{3-} > [Fe(CN)_6]^{4-}$

6. Which of the following complexes formed by Cu^{2+} ions is most stable?
   (a) $Cu^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+}$; $\log K = 11.6$
   (b) $Cu^{2+} + 4CN^- \rightleftharpoons [Cu(CN)_4]^{2-}$; $\log K = 27.3$
   (c) $Cu^{2+} + 2en \rightleftharpoons [Cu(en)_2]^{2+}$; $\log K = 15.4$
   (d) $Cu^{2+} + 4H_2O \rightleftharpoons [Cu(H_2O)_4]^{2+}$; $\log K = 8.9$

7. The correct decreasing order of acidic character is
   (a) HClO > HBrO > HIO
   (b) HIO > HBrO > HClO
   (c) HBrO > HIO > HClO
   (d) HClO > HIO > HBrO

8. Cellulose, the most important constituent of plant cell wall, is made up of
   (a) branched chain of glucose molecules linked by α (1 $\longrightarrow$ 6) glycosidic bonds at the site of branching
   (b) unbranched chain of glucose molecules linked by α (1 $\longrightarrow$ 4) glycosidic bonds
   (c) branched chain of glucose molecules linked by β (1 $\longrightarrow$ 4) glycosidic bond in straight chain and α (1 $\longrightarrow$ 6) glycosidic bond at the site of branching
   (d) unbranched chain of glucose molecules linked by β (1 $\longrightarrow$ 4) glycosidic bonds.

9. 1.020 g of metallic oxide contains 0.540 g of the metal. If the specific heat of the metal, *M* is 0.216 cal $deg^{-1}g^{-1}$, the molecular formula of its oxide is
   (a) MO (b) M_2O_3 (c) M_2O_4 (d) M_2O

10. The most stable conformation of chlorocyclohexane at room temperature is

(c)   (d)
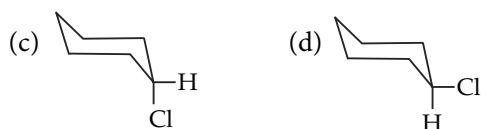
11. Identify the correct statement for change in Gibbs' energy for a system (ΔG_{system}) at constant temperature and pressure.
(a) If $\Delta G_{system} = 0$, the system has attained equilibrium.
(b) If $\Delta G_{system} = 0$, the system is still moving in a particular direction.
(c) If $\Delta G_{system} = 0$, the process is not spontaneous.
(d) If $\Delta G_{system} = 0$, the process is spontaneous.

12. The emf of the three galvanic cells given below are represented by E_1, E_2 and E_3.
I. $Zn \mid Zn^{2+}$ (1 M) $\parallel Cu^{2+}$ (1 M) $\mid Cu$
II. $Zn \mid Zn^{2+}$ (0.1 M) $\parallel Cu^{2+}$ (1 M) $\mid Cu$
III. $Zn \mid Zn^{2+}$ (1 M) $\parallel Cu^{2+}$ (0.1 M) $\mid Cu$
Which of the following is true?
(a) $E_1 > E_2 > E_3$ (b) $E_3 > E_2 > E_1$
(c) $E_3 > E_1 > E_2$ (d) $E_2 > E_1 > E_3$

13. 1500 mL flask contains 400 mg O_2 and 60 mg H_2 at 100°C. What is the total pressure in the flask?
(a) 0.66 atm   (b) 0.867 atm
(c) 8.67 atm   (d) 13.47 atm

14. Which of the following does not represent the correct order of the property indicated?
(a) $Sc^{3+} > Cr^{3+} > Fe^{3+} > Mn^{3+}$: Ionic radii
(b) $Sc < Ti < Cr < Mn$: Density
(c) $Mn^{2+} > Ni^{2+} < Co^{2+} < Fe^{2+}$: Ionic radii
(d) $FeO < CaO > MnO > CuO$: Basic nature

15. A red coloured oxide (X) on treatment with conc. HNO_3 gives a compound (Y). (Y) with HCl produces a chloride (Z) which is insoluble in cold water but soluble in hot water. (Z) can also be formed by treating (X) with conc. HCl. Compounds X, Y and Z are
(a) Pb_3O_4, PbO_2, $PbCl_2$
(b) Mn_3O_4, MnO_2, $MnCl_2$
(c) Fe_3O_4, Fe_2O_3, $FeCl_3$
(d) Fe_3O_4, FeO, $FeCl_2$

16. Which is not true about the coordination compound $[Co(en)_2Cl_2]Cl$?
(a) It exhibits geometrical isomerism.
(b) It exhibits optical isomerism.
(c) It exhibits ionisation isomerism.
(d) It is an octahedral complex.

17. Polarity in a molecule and hence, the dipole moment depends primarily on electronegativity of the constituent atoms and shape of a molecule. Which of the following has the highest dipole moment?
(a) CO_2 (b) HI   (c) H_2O (d) SO_2

18. The rapid change of pH near the stoichiometric point of an acid-base titration is the basis of indicator detection. pH of the solution is related to the ratio of the concentration of conjugate acid (HIn) and base (In$^-$) forms of the indicator by the expression
(a) $\log \dfrac{[In^-]}{[HIn]} = pK_a + pH$
(b) $\log \dfrac{[HIn]}{[In^-]} = K_a + pH$
(c) $\log \dfrac{[HIn]}{[In^-]} = pH - pK_a$
(d) $\log \dfrac{[In^-]}{[HIn]} = pH - pK_a$

19. Correct set of four quantum numbers for the valence (outermost) electron of rubidium ($Z = 37$) is
(a) $5, 0, 0, +\dfrac{1}{2}$ (b) $5, 1, 0, +\dfrac{1}{2}$
(c) $5, 1, 1, +\dfrac{1}{2}$ (d) $6, 0, 0, +\dfrac{1}{2}$

20. If $K_{sp[AgCNS]} = 1 \times 10^{-12}$ and $K_{sp[AgBr]} = 5 \times 10^{-13}$ then the value of simultaneous solubility of AgCNS and AgBr in a solution of water will be
(a) 8.16×10^{-7}, 4.08×10^{-7}
(b) 4.08×10^{-7}, 8.16×10^{-7}
(c) 8.16, 4.08
(d) 1×10^{-12}, 5×10^{-13}

21. Which of the following reactions depicts the oxidising property of SO_2?
(a) $SO_2 + H_2O \longrightarrow H_2SO_3$
(b) $2H_2S + SO_2 \longrightarrow 3S + 2H_2O$
(c) $Cl_2 + SO_2 \longrightarrow SO_2Cl_2$
(d) $2MnO_4^- + 5SO_2 + 2H_2O \longrightarrow 5SO_4^{2-} + 2Mn^{2+} + 4H^+$

22. 500 mL of a hydrocarbon gas burnt in excess of oxygen yielded 2500 mL of CO_2 and 3.0 L of water vapour. The formula of the hydrocarbon is
(a) C_5H_{12} (b) CH_4 (c) C_2H_4 (d) C_3H_6

23. The compound in which carbon uses only sp^3-hybrid orbitals for bond formation is
(a) $(CH_3)_3C-CHO$ (b) $(CH_3)_3C-OH$
(c) NH_2CONH_2 (d) HCOOH

24. Which among the following is aromatic?

(a)   (b)

(c)   (d)
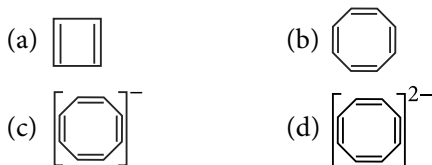
25. RCH_2CH_2OH can be converted to RCH_2CH_2COOH by the following sequence of reagents.
(a) PBr_3, KCN, H_3O^+ (b) PBr_3, KCN, H_2/Pt
(c) KCN, H_3O^+ (d) HCN, PBr_3, H_3O^+

26. Which of the following statements is not true?
(a) London smog is a mixture of smoke and fog.
(b) London smog is oxidising in nature.
(c) Photochemical smog causes irritation in eyes.
(d) Photochemical smog results in the formation of PAN.

27. An element with molar mass 2.7×10^{-2} kg mol^{-1} forms a cubic unit cell with edge length 405 pm. If its density is 2.7×10^3 kg m^{-3}, what is the nature of the cubic unit cell?
(a) Simple cubic   (b) Face-centred
(c) Body-centred   (d) End-centred

28. The ease of dehydrohalogenation with alcoholic KOH in case of 1-Chloroethane (I), 2-Chloropropane (II) and 2-Chloro-2-methylpropane (III) is of the order
(a) III > II > I   (b) I > II > III
(c) II > I > III   (d) I > III > II

29. The correct order of reactivity towards electrophilic substitution is
(a) benzene > phenol > benzoic acid > chlorobenzene
(b) phenol > benzene > chlorobenzene > benzoic acid
(c) chlorobenzene > benzoic acid > phenol > benzene
(d) benzoic acid > chlorobenzene > benzene > phenol.

30. For a reaction, $2K_{(g)} + L_{(g)} \rightarrow 2M_{(g)}$; $\Delta U° = -10.5$ kJ and $\Delta S° = -44.1$ J K^{-1}. Calculate $\Delta G°$ for the reaction and predict whether the reaction will be spontaneous or non-spontaneous?
(a) $\Delta G° = +0.16$ kJ, non-spontaneous
(b) $\Delta G° = -0.16$ kJ, spontaneous
(c) $\Delta G° = +26.12$ kJ, non-spontaneous
(d) $\Delta G° = -26.12$ kJ, spontaneous

31. The vapour pressure of benzene at a certain temperature is 640 mm of Hg. A non-volatile and non-electrolyte solid weighing 2.175 g is added to 39.08 g of benzene. The vapour pressure of the solution is 600 mm of Hg. What is the molecular weight of solid substance?
(a) 59.5 g mol^{-1} (b) 69.5 g mol^{-1}
(c) 79.6 g mol^{-1} (d) 79.9 g mol^{-1}

32. The two isomers X and Y with the formula $Cr(H_2O)_5ClBr_2$ were taken for experiment on depression in freezing point. It was found that one mole of X gave depression corresponding to 2 moles of particles and one mole of Y gave depression due to 3 moles of particles. The structural formulae of X and Y respectively are
(a) $[Cr(H_2O)_5Cl]Br_2$; $[Cr(H_2O)_4Br_2]Cl. H_2O$
(b) $[Cr(H_2O)_5Cl]Br_2$; $[Cr(H_2O)_3ClBr_2] . 2 H_2O$
(c) $[Cr(H_2O)_5Br]BrCl$; $[Cr(H_2O)_4ClBr]Br. H_2O$
(d) $[Cr(H_2O)_4Br_2]Cl.H_2O$; $[Cr(H_2O)_5Cl]Br_2$

33. The correct order of basicities of the following compounds is
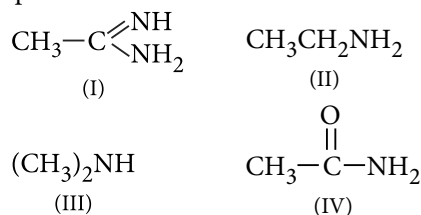
(a) II > I > III > IV   (b) I > III > II > IV
(c) III > I > II > IV   (d) I > II > III > IV

34. In complex hydrides, hydride ions act as ligand and are coordinated to metal ions. These hydrides are good reducing agents. Which of the following hydrides is not a complex hydride?
(a) $LiAlH_4$ (b) $NaBH_4$
(c) $(AlH_3)_n$ (d) $LiBH_4$

35. Match the column I with column II and mark the appropriate choice.

	Column I (Property)		Column II (Metal)
(A)	Element with highest second ionisation enthalpy	(i)	Cr
(B)	Element with highest third ionisation enthalpy	(ii)	Cu
(C)	M in $M(CO)_6$ is	(iii)	Zn
(D)	Element with highest heat of atomisation	(iv)	Ni

(a) (A) → (ii), (B) → (iii), (C) → (i), (D) → (iv)
(b) (A) → (iv), (B) → (iii), (C) → (i), (D) → (ii)
(c) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)
(d) (A) → (i), (B) → (ii), (C) → (iii), (D) → (iv)

36. The Diels—Alder reaction between 1,3-cyclohexa-diene and acrylonitrile gives the adduct,
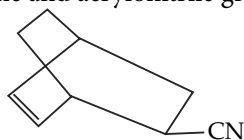
Its IUPAC name is
(a) bicyclo [2.2.2] oct-2-en-5-nitrile
(b) bicyclo [2.2.2] oct-5-en-2-carbonitrile
(c) 3-cyano bicyclo [2.2.2] oct-5-ene
(d) 2-cyano bicyclo [2.2.2] oct-5-ene.

37. Give the decreasing order of reactivities of the following monomers towards cationic addition polymerisation.
I. $MeCH=CH_2$ II. $PhCH=CH_2$
III. $CH_2=CH-COOMe$ IV. $CH_2=CH-Cl$
(a) I > II > III > IV   (b) II > I > IV > III
(c) II > I > III > IV   (d) I > II > IV > III

38. For which of the following amino acids, van-Slyke estimation method is not applicable?
(a) Alanine   (b) Aspartic acid
(c) Serine   (d) Proline

39. The appropriate reagent for the transformation
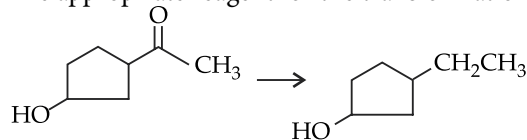
(a) Zn-Hg, HCl   (b) NH_2NH_2, OH^-
(c) H_2/Ni (d) $NaBH_4$

40. Which of the following sets of reactants is used for the preparation of paracetamol from phenol?
(a) HNO_3, H_2/Pd, $(CH_3CO)_2O$
(b) H_2SO_4, H_2/Pd, $(CH_3CO)_2O$
(c) $C_6H_5N_2Cl$, $SnCl_2/HCl$, $(CH_3CO)_2O$
(d) Br_2/H_2O, Zn/HCl, $(CH_3CO)_2O$

SOLUTIONS

1. **(c) :** HCl is oxidised by strong oxidising agents like manganese dioxide, lead dioxide, potassium permanganate, potassium dichromate, etc. hence, acts as a reducing agent.
$$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$$

2. **(c) :** Higher the reduction potential value of a species, greater is its tendency to undergo reduction and stronger is the oxidising power.
$$BrO_4^- > IO_4^- > ClO_4^-$$
$E°/V$ 1.74   1.65   1.19
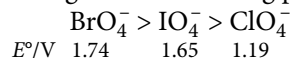
3. **(a) :** Iodoform test is given by the compounds containing CH_3CO- group or $CH_3CH(OH)-$ group (which is oxidised to CH_3CO- group). Sample is heated with I_2 and NaOH, the existence of yellow ppt. indicates the presence of CH_3CO- group or $CH_3CH(OH)-$ group.
e.g., $CH_3CHO + 3I_2 + 4NaOH \longrightarrow$
$$CHI_3 + HCOONa + 3NaI + 3H_2O$$
Iodoform
(yellow ppt.)

$$CH_3CH_2OH \xrightarrow{[O]} CH_3CHO \xrightarrow[NaOH]{I_2} CHI_3$$
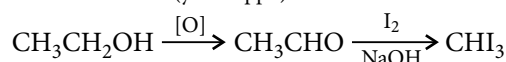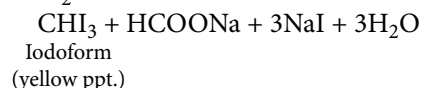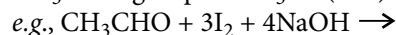
∴ *n*-Butyl alcohol ($CH_3CH_2CH_2CH_2OH$) does not give iodoform test as it does not possess the CH_3CO- or $CH_3CH(OH)-$ group.

4. **(d):** $E \propto \dfrac{1}{n^2}$ *i.e.*, when $n = 3$; E decreases nine times.

5. **(c) :** According to Hardy—Schulze rule, the flocculation power is directly proportional to the charge. Thus, correct order is :
$$[Fe(CN)_6]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$$
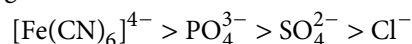
6. **(b):** Stability of a complex depends upon the value of stability constant. Higher the value of K, more stable is the complex. Since, K is highest when $\log K$ is 27.3.
Thus, $[Cu(CN)_4]^{2-}$ is the most stable complex among the given complexes.

7. **(a) :** Acidity decreases as the electronegativity of the central halogen decreases from Cl to I in HXO (oxoacids).

8. **(d)**

9. **(b):** Mass of oxygen in the oxide
$$= (1.020 - 0.540) = 0.480 \text{ g}$$
Equivalent mass of the metal $= \dfrac{0.540}{0.480} \times 8 = 9.0$
According to Dulong and Petit's law,
Approx. atomic mass $= \dfrac{6.4}{\text{sp. heat}} = \dfrac{6.4}{0.216} = 29.63$
Valency of the metal $= \dfrac{\text{at. mass}}{\text{eq. mass}} = \dfrac{29.63}{9.0} \approx 3$
Hence, the formula of the oxide is M_2O_3.

10. **(d):** In this conformer Cl is at equatorial position and is least hindered.

11. (a) : When $\Delta G_{sys} = 0$, the system is in equilibrium.

12. (d) : $E_{cell} = E°_{cell} - \dfrac{RT}{nF} \ln \dfrac{[Zn^{2+}]}{[Cu^{2+}]}$

For I, $\dfrac{[Zn^{2+}]}{[Cu^{2+}]} = 1$, $\therefore$ $E_{cell} = E°_{cell}$

For II, $\dfrac{[Zn^{2+}]}{[Cu^{2+}]} = \dfrac{0.1}{1}$

$\therefore$ $E_{cell} = E°_{cell} - \dfrac{0.0591}{n} \log 10^{-1} = E°_{cell} + \dfrac{0.0591}{n}$

For III, $\dfrac{[Zn^{2+}]}{[Cu^{2+}]} = \dfrac{1}{0.1} = 10$

$\therefore$ $E_{cell} = E°_{cell} - \dfrac{0.0591}{n} \log 10 = E°_{cell} - \dfrac{0.0591}{n}$

$\therefore$ $E_2 > E_1 > E_3$

13. (b) : Number of moles of $O_2 = \dfrac{w}{M} = \dfrac{400 \times 10^{-3}}{32}$
$= 0.0125$

Number of moles of $H_2 = \dfrac{w}{M} = \dfrac{60 \times 10^{-3}}{2} = 0.03$

From, $pV = nRT$,

Partial pressure of $O_2 = \dfrac{0.0125 \times 0.0821 \times 373}{1500 \times 10^{-3}}$
$= 0.255$ atm

Partial pressure of $H_2 = \dfrac{0.03 \times 0.0821 \times 373}{1500 \times 10^{-3}}$
$= 0.612$ atm

Total pressure $= 0.255 + 0.612 = 0.867$ atm

14. (a) : Ionic radius of Fe^{3+} (0.64 Å) is less than that of Mn^{3+} (0.66 Å). Other properties vary as indicated.

15. (a) : Compound X, Y and Z are Pb_3O_4, PbO_2 and $PbCl_2$.

$\underset{(X)}{Pb_3O_4} + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + \underset{(Y)}{PbO_2} + 2H_2O$

$\underset{(Y)}{PbO_2} + 4HCl \rightarrow \underset{(Z)}{PbCl_2} + 2H_2O + Cl_2$

$PbCl_2$ is insoluble in cold water but soluble in hot water.

$\underset{(X)}{Pb_3O_4} + 8HCl \rightarrow 3\underset{(Z)}{PbCl_2} + 4H_2O + Cl_2$
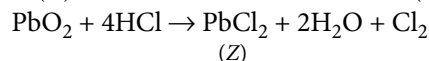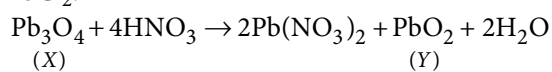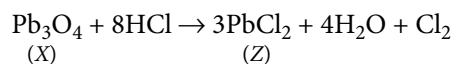
16. (c) : Ionisation isomerism arises when the coordination compounds give different ions in solution, this condition is not satisfied with $[Co(en)_2Cl_2]Cl$.
It is an octahedral complex.

cis-form   *trans*-form
Geometrical isomers

cis-d-isomer   *cis-l*-isomer
Optical isomers
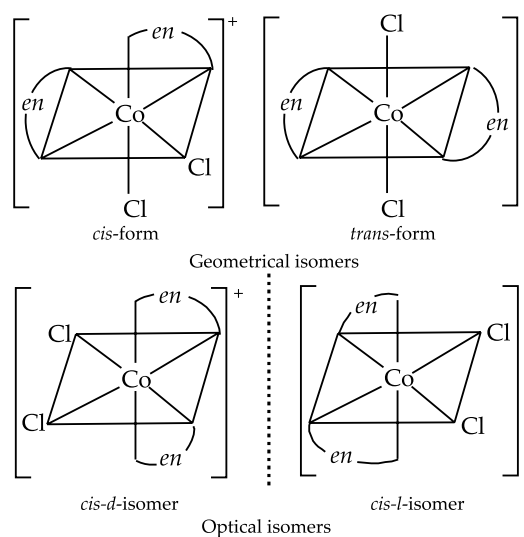
17. (c) : CO_2 being symmetrical has zero dipole moment. Among HI, SO_2 and H_2O, dipole moment is highest for H_2O as the central atom in it contains 2 lone pairs.

$H \rightleftharpoons I$; $H \overset{O}{\diagdown} H$; $O \overset{S}{\diagup} O$
$\mu = 0.38$ D $\mu = 1.84$ D $\mu = 1.60$ D
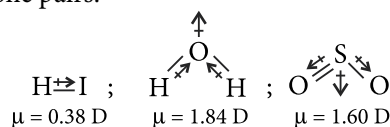
18. (d) : For $HIn \rightleftharpoons H^+ + In^-$

$K_a = \dfrac{[H^+][In^-]}{[HIn]}$

$\therefore$ $pH = pK_a + \log \dfrac{[In^-]}{[HIn]}$

or $pH - pK_a = \log \dfrac{[In^-]}{[HIn]}$

19. (a) : The electronic configuration of Rb is $[Kr]\, 5s^1$
Thus, its valence electron enters in $5s$-orbital.
For $5s$ orbital, $n = 5$
$l = 0$ (as orbital is s)

$m = -l$ to $+l$ including zero, $m = 0$; $s = +\dfrac{1}{2}$

Thus, the correct set of quantum numbers for the valence electron of rubidium is $5, 0, 0, +\dfrac{1}{2}$

20. (a) : Let the solubility of AgCNS and AgBr in water be x and y respectively.

$AgCNS \rightleftharpoons \underset{x}{Ag^+} + \underset{x}{CNS^-}$

$AgBr \rightleftharpoons \underset{y}{Ag^+} + \underset{y}{Br^-}$
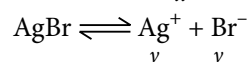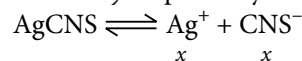
$\therefore$ $[Ag^+] = (x + y)$, $[CNS^-] = x$, $[Br^-] = y$
$K_{sp[AgCNS]} = [Ag^+][CNS^-] = x(x + y)$

$\Rightarrow \quad 1 \times 10^{-12} = x(x+y)$ ...(i)

and $K_{sp[AgBr]} = [Ag^+][Br^-] = y(x+y)$

$\Rightarrow \quad 5 \times 10^{-13} = y(x+y)$ ...(ii)

On solving Eq. (i) and (ii), we get

$\quad x = 8.16 \times 10^{-7}$ mol/L

$\quad y = 4.08 \times 10^{-7}$ mol/L

21. (b): $2H_2S + SO_2 \longrightarrow 3S + 2H_2O$

Here SO_2 acts as an oxidising agent and thus oxidises $H_2S(-2)$ to $S(0)$.

22. (a): $C_xH_y + \left[x + \dfrac{y}{4}\right]O_2 \longrightarrow xCO_2 + \dfrac{y}{2}H_2O_{(v)}$
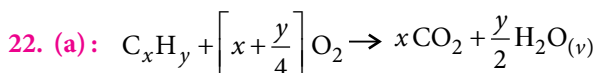
Initial vol.   500 mL   0   0

After reaction   0 $500x$ mL $\dfrac{y}{2} \times 500$ mL

is complete

Now, $500x = 2500$

$\therefore x = 5$

$\dfrac{500\,y}{2} = 3000$

$\therefore y = 12$

Thus, the formula of alkane is C_5H_{12}.

23. (b): The complete structures of the given compounds are as follows :

(a)

$$\text{H}_3\text{C}\ \cdots\ (sp^2 \text{ hybridised})$$

(b)

(All carbons are sp^3 hybridised)

(c)

$$\text{H}-\text{N}-\overset{\overset{\text{O}}{\|}}{\text{C}}-\text{N}-\text{H} \quad sp^2$$

(d)

$$\text{H}-\text{C}{=}\text{O} \atop \text{O}-\text{H}\ (sp^2 \text{ hybridised})$$
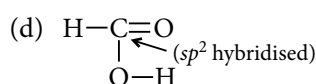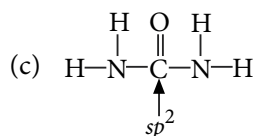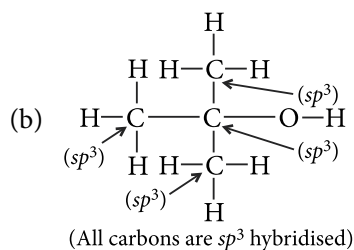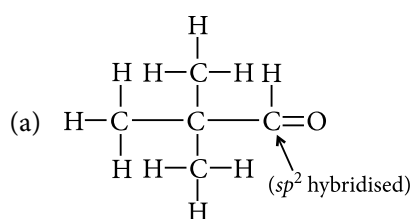
Thus, $(CH_3)_3C{-}OH$ uses only its sp^3-hybrid orbitals for bond formation.

24. (d): Compound $\left[\underset{}{\bigcirc}\right]^{2-}$ has $8+2 = 10\pi$-electrons, hence it is aromatic.

$\square$ has $4\pi e^-$ and $\bigcirc$ has $8\pi e^-$ then, these are antiaromatic compounds while $\left[\bigcirc\right]^-$ has

$8+1 = 9\pi e^-$, hence, it is non-aromatic.

25. (a): $RCH_2CH_2OH \xrightarrow{PBr_3} RCH_2CH_2Br \xrightarrow{KCN}$

$RCH_2CH_2CN \xrightarrow{H_3O^+} RCH_2CH_2COOH$
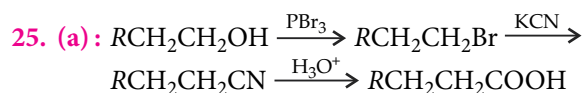
26. (b): London or photochemical smog are the mixture of smoke and fog. London smog is formed in cool humid climate when carbon soot particles combine with gaseous oxides of sulphur. Since in this type of smog, carbon and SO_2 are present, it is reducing in nature. Photochemical smog, on the other hand occurs in warm, dry and sunny climate. It results in the formation of PAN. Since in photochemical smog, O_3 is present, it irritates the eyes, nose, lungs, etc.

27. (b): Number of atoms present in the unit cell

$(Z) = \dfrac{d \times a^3 \times N_A}{M}$

Given, $M = 2.7 \times 10^{-2}$ kg mol^{-1}

$\quad a = 405$ pm $= 405 \times 10^{-12}$ m $= 4.05 \times 10^{-10}$ m

$\quad d = 2.7 \times 10^3$ kg m^{-3}

$\quad N_A = 6.022 \times 10^{23}$ mol^{-1}

Hence,

$Z = \dfrac{(2.7 \times 10^3\,\text{kg m}^{-3})(4.05 \times 10^{-10}\,\text{m})^3 \times (6.022 \times 10^{23}\,\text{mol}^{-1})}{(2.7 \times 10^{-2}\,\text{kg mol}^{-1})}$

$\quad = 4$

Since, there are four atoms per unit cell, the cubic unit cell must be face-centred.

28. (a): Dehydrohalogenation reaction is also called β-elimination reaction and the reactivity of haloalkanes towards elimination reaction is:

$3° > 2° > 1°$.

2-Chloro-2-methylpropane   2-Chloropropane   1-Chloroethane

     3°   2°   1°

     III   II   I
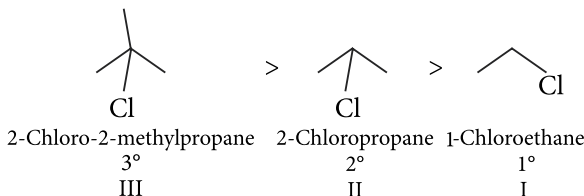
29. (b): In general, electron releasing groups activate and electron withdrawing groups deactivate the benzene ring towards electrophilic substitution.

Hence, the correct order is :

$$\text{OH} > \text{(benzene)} > \text{Cl} > \text{COOH}$$

30. (a) : $2K_{(g)} + L_{(g)} \longrightarrow 2M_{(g)}$
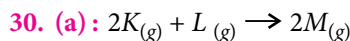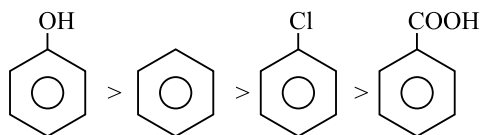
$\Delta n_g = 2 - 3 = -1$

$\Delta H = \Delta U + \Delta n_g RT$

$= -10.5 \times 10^3 + (-1 \times 8.314 \times 298)$

$= -10500 + (-2477.572) = -12977.57 \text{ J} = -12.98 \text{ kJ}$

$\Delta G° = \Delta H° - T\Delta S°$

$= -12.98 - 298 (-44.1 \times 10^{-3})$

$= -12.98 + 13.14 = 0.16 \text{ kJ}$

Since $\Delta G°$ is +ve hence it is a non-spontaneous reaction.

31. (b) : $\dfrac{P° - P_s}{P°} = \dfrac{\dfrac{w}{m}}{\dfrac{w}{m} + \dfrac{W}{M}}$

w/m can be neglected in the denominator as compared to W/M.

$\dfrac{w}{m} \times \dfrac{M}{W} = \dfrac{640 - 600}{640}$

$\dfrac{w}{m} \times \dfrac{M}{W} = \dfrac{40}{640} \Rightarrow \dfrac{2.175 \times 78}{m \times 39.08} = \dfrac{40}{640}$

$m = \dfrac{2.175 \times 78}{39.08} \times \dfrac{640}{40} = 69.46 \text{ g mol}^{-1}$

32. (d) : The structural formula of the complex X is $[Cr(H_2O)_4Br_2]Cl \cdot H_2O$, one mole of which gives 2 moles of particles, i.e., $[Cr(H_2O)_4Br_2]^+ + Cl^-$ and the formula of the complex Y is $[Cr(H_2O)_5Cl]Br_2$, one mole of which gives 3 moles of particles, i.e., $[Cr(H_2O)_5Cl]^{2+} + 2Br^-$.

33. (b) : In $CH_3-C{\Large\langle}{}^{NH}_{NH_2}$, lone pair on $-NH_2$ remains more available for donation and its conjugate acid is resonance stabilised thus, it is most basic. Between $CH_3CH_2NH_2$ and $(CH_3)_2NH$, the later is more basic because of the presence of two alkyl groups which facilitate the donation of lone pair of electrons.

$CH_3-\overset{\overset{O}{\|}}{C}-NH_2$ is least basic as the lone pair of N is involve in resonance.

$$CH_3-\overset{\overset{O}{\|}}{C}-\ddot{N}H_2 \longleftrightarrow CH_3-\overset{\overset{O^-}{|}}{C}=\overset{+}{N}H_2$$
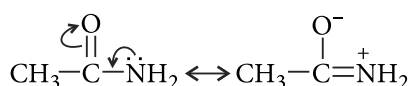
Thus, the correct order of basicity is I > III > II > IV.

34. (c) : $(AlH_3)_n$ is a polymeric hydride like $(BeH_2)_n$, $(MgH_2)_n$, etc.

35. (a)
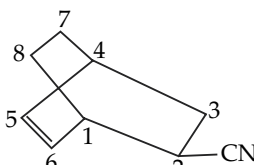
36. (b) :

Bicyclo [2.2.2] oct-5-en-2-carbonitrile

37. (b) : Cationic polymerisation is favoured by the presence of electron donating group (e.g., Me group). The more the electron donating group, the more stable is the intermediate carbocation, and as a result more favoured is the cationic polymerisation.

Stability of $(-\overset{\diagdown}{\underset{\diagup}{C}}{}^+)$ is

II. $Ph \rightarrow CH\overset{\frown}{=}CH_2 \xrightarrow{H^+} Ph-\overset{+}{CH}-CH_3$
$\qquad\qquad\qquad$ (+R and –I effects of Ph)

I. $Me \rightarrow CH\overset{\frown}{=}CH_2 \xrightarrow{H^+} Me-\overset{+}{CH}-CH_3$
$\qquad\qquad\qquad$ (+I effect of Me)

IV. $:\!\ddot{C}l \leftarrow CH\overset{\frown}{=}CH_2 \xrightarrow{H^+} Cl\leftarrow\overset{+}{CH}-CH_3$
$\qquad\qquad\qquad$ (–I and + R effect of Cl)

III. $CH_2\overset{\frown}{=}CH \rightarrow \overset{\overset{O}{\|}}{C}-OMe \xrightarrow{H^+}$
$\qquad\qquad CH_3-\overset{+}{CH}\rightarrow COOMe$
$\qquad\qquad\qquad$ (–I effect of COOMe)
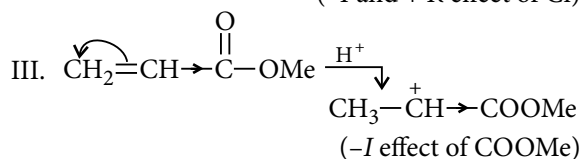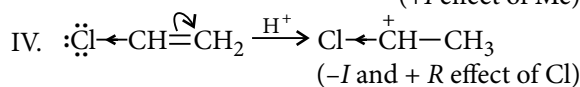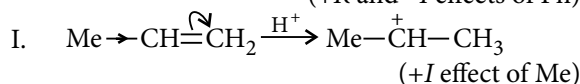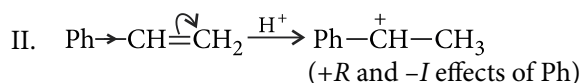
The decreasing reactivity order towards cation polymerisation is (II) > (I) > (IV) > (III).

38. (d) : Proline has a 2° amino group. Hence, it is not estimated by this method.

39. (b) : $-COCH_3$ group can be reduced to $-CH_2CH_3$ by either Zn-Hg, HCl or NH_2NH_2, OH^- but with Zn-Hg, HCl, dehydration of alcohol takes place.

40. (a) :

Phenol $\xrightarrow[\text{(Nitration)}]{HNO_3}$ p-Nitrophenol (NO_2) $\xrightarrow[\text{(Reduction)}]{H_2/Pd}$ p-Aminophenol (NH_2) $\xrightarrow[\text{(Acetylation)}]{(CH_3CO)_2O}$ Paracetamol ($NHCOCH_3$)

◈ ◈
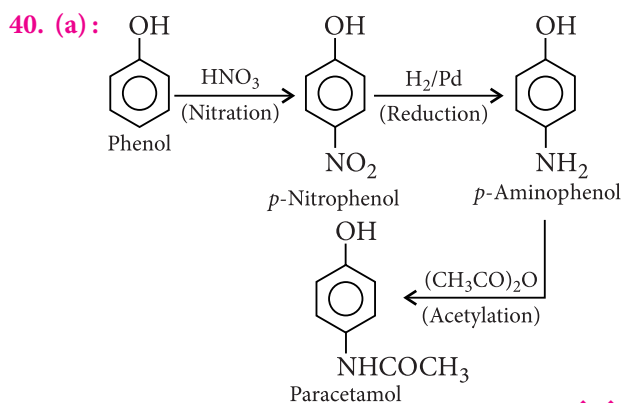
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EXAM ON 21ST MAY

PAPER-I

SECTION 1 (Maximum Marks : 15)

- *This section contains FIVE questions.*
- *Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

  Full Marks : *+3 If only the bubble corresponding to the correct option is darkened.*

  Zero Marks : *0 If none of the bubbles is darkened.*

  Negative Marks : *–1 In all other cases.*

1. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^+ spectrum?
   (a) $n_1 = 1$ to $n_2 = 2$
   (b) $n_1 = 2$ to $n_2 = 4$
   (c) $n_1 = 1$ to $n_2 = 3$
   (d) $n_1 = 2$ to $n_2 = 3$

2. An ideal gas has a specific heat at constant presssure $C_p = \dfrac{5}{2} R$. The gas is kept in a closed vessel of volume 0.0083 m^3, at a temperature of 300 K and pressure $1.6 \times 10^6 \text{ N/m}^2$. An amount of 2.49×10^4 J of energy is supplied to the gas. The final temperature of the gas is
   (a) 375 K
   (b) 575 K
   (c) 675 K
   (d) 475 K

3. In $[Ni(CN)_4]^{2-}$, $[MnBr_4]^{2-}$ and $[CoF_6]^{3-}$ ions, the geometry, hybridisation and magnetic moment, respectively are
   (a) tetrahedral, square planar, octahedral ; sp^3, dsp^2, sp^3d^2 ; 5.9, 0, 4.9
   (b) tetrahedral, square planar, octahedral ; dsp^2, sp^3, sp^3d^2 ; 0, 5.9, 4.9
   (c) square planar, tetrahedral, octahedral ; dsp^2, sp^3, d^2sp^3 ; 5.9, 4.9, 0
   (d) square planar, tetrahedral, octahedral ; dsp^2, sp^3, sp^3d^2 ; 0, 5.9, 4.9

4. In which of the following arrangements, the order is not according to the property indicated against it?
   (a) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ (increasing ionic size)
   (b) $B < C < N < O$ (increasing first ionisation enthalpy)
   (c) $I < Br < F < Cl$ (increasing electron gain enthalpy with negative sign)
   (d) $Li < Na < K < Rb$ (increasing metallic radius)

5. In a polymer sample, 30% of molecules have a molecular mass of 20,000, 40% have 30,000 and the rest 60,000. What is the weight average molecular mass of the polymer?
   (a) 40,300
   (b) 30,600
   (c) 43,333
   (d) 33,353

SECTION 2 (Maximum Marks : 32)

- *This section contains EIGHT questions.*
- *Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s) is(are) correct.*
- *For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

  Full Marks : *+4 If only the bubble(s) corresponding to the correct option(s) is(are) darkened.*

  Partial Marks : *+1 For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*

  Zero Marks : *0 If none of the bubbles is darkened.*

  Negative Marks : *–2 In all other cases.*

- *For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will result in +4 marks; darkening only (A) and (D) will result in +2 marks; and darkening (A) and (B) will result in –2 marks, as a wrong option is also darkened.*

6. Treatment of cyclobutylmethylamine with nitrous acid does not give

   (a) CH$_2$OH   (b)

(c) (d)
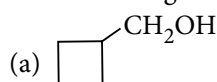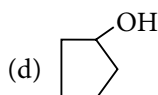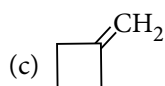
7. The reagent(s) required for the conversion;
$RCH{=}CHR' \longrightarrow RCOOH + HOOCR'$ is/are
(a) O_3 followed by treatment with H_2O_2
(b) hot $KMnO_4/KOH$ followed by acidification
(c) Lemieux reagent
(d) Baeyer's reagent.

8. The pairs of compounds which cannot exist together in aqueous solution are
(a) NaH_2PO_4 and Na_2HPO_4
(b) $NaOH$ and NaH_2PO_4
(c) Na_2CO_3 and $NaHCO_3$
(d) $NaHCO_3$ and $NaOH$

9. Which of the following options is/are correct regarding XeF_6?
(a) It acts as a Lewis acid when it reacts with RbF.
(b) It undergoes complete hydrolysis to give XeO_3.
(c) It fluorinates silica (SiO_2) to give $XeOF_4$.
(d) Hybridisation of XeF_6 is sp^3d^2 with octahedral geometry.

10. Two radioisotopes P and Q with atomic masses 100 u and 200 u respectively are mixed in equal amount by mass. After 20 days, their mass ratio is found to be 1 : 4. If $t_{1/2}$ for P is 10 days, then $t_{1/2}$ for Q is
(a) ∞ days   (b) 10 days
(c) 5 days   (d) 20 days.

11. With reference to the scheme given, which of the given statement(s) about T, U, V and W is (are) correct?
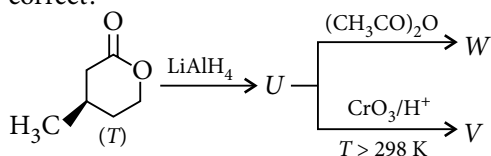
(a) T is soluble in hot aqueous NaOH.
(b) U is optically active.
(c) Molecular formula of W is $C_{10}H_{18}O_4$.
(d) V gives effervescence on treatment with aqueous $NaHCO_3$.

12. A solution of colourless salt H on boiling with excess NaOH produces a non-flammable gas. The gas evolution ceases after sometime. Upon addition of Zn dust to the same solution, the gas evolution restarts. The colourless salt(s) H is (are)
(a) NH_4NO_3 (b) NH_4NO_2
(c) NH_4Cl (d) $(NH_4)_2SO_4$

13. For the given equilibrium;
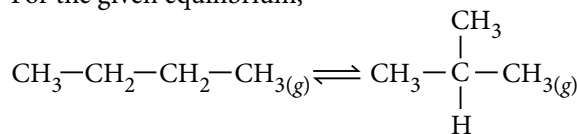
equilibrium constant is found to be 1.732 at 298 K. Now, if in a vessel at 298 K, a mixture of these two gases be taken as represented by the point P in the figure, predict what will happen?
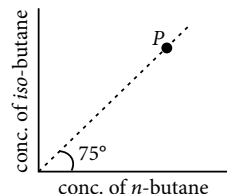
(a) Immediately above equilibrium will be setup.
(b) Above reaction will go in the forward direction till it attains equilibrium.
(c) Above reaction will go in the backward direction till it attains equilibrium.
(d) Nothing can be said.

14. Tropic acid (obtained from the alkaloid atropine), $C_9H_{10}O_3$, gives a positive CrO_3/H_2SO_4 test at 273 K and is oxidised by hot $KMnO_4$ to benzoic acid. Tropic acid is converted by the following sequence of reactions into hydratropic acid :

$$\text{Tropic acid} \xrightarrow{\text{HBr}} (C_9H_9O_2Br)$$

$$\xrightarrow{OH^-} (C_9H_8O_2)(\text{Atropic acid})$$

$$\text{Atropic acid} \xrightarrow{H_2,Ni} \text{Hydratropic acid}(C_9H_{10}O_2)$$
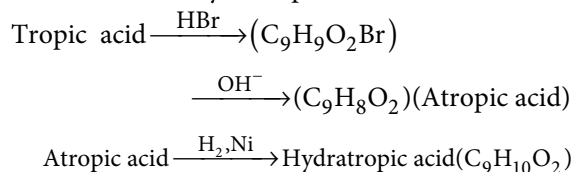
Number of carbon atoms in the ring in tropic acid is

15. Two aqueous solutions as shown, are put in an evacuated chamber. When equilibrium is attained, it is found that one solution contains 0.01% of X and other 0.02% of urea by weight. If the molecular weight of X is $(n \times 10)$ amu, then what is n (X is non-electrolyte and non-volatile solute)?

X in water   Urea in water
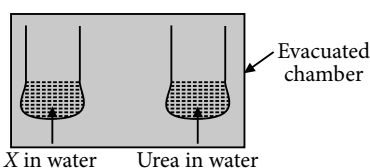
16. Total number of geometrical isomers for the complex $[RhCl(CO)(PPh_3)(NH_3)]$ is

17. How many electrons are transferred when $KMnO_4$ acts as oxidising agent to give $Mn(OH)_3$?

18. The compressibility factor for 1 mole of a van der Waals gas at 0°C and 100 atm pressure is found to be 0.5. Assuming that the volume of a gas molecule is negligible, the van der Waals constant, a is $x.25$. The value of x is

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PAPER-II

1. In the following sequence of reactions, the final product (*B*) is

(a)

(b)

(c)

(d)

2. The correct acidity order of the following is
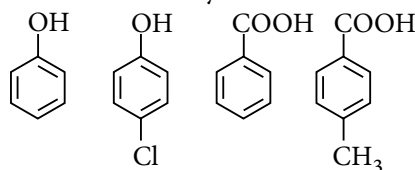
(I)   (II)   (III)   (IV)

(a) III > IV > II > I
(b) IV > III > I > II
(c) III > II > I > IV
(d) II > III > IV > I

3. The percentage of copper in a copper(II) salt can be determined by using a thiosulphate titration. 0.305 g of a copper(II) salt was dissolved in water and added to an excess of potassium iodide solution liberating iodine according to the following equation :

$$2Cu^{2+}_{(aq)} + 4I^-_{(aq)} \rightleftharpoons 2CuI_{(s)} + I_{2(aq)}$$

The iodine liberated required 24.5 cm^3 of a 0.100 mole dm^{-3} solution of sodium thiosulphate.

$$2S_2O_{3(aq)}^{2-} + I_{2(aq)} \longrightarrow 2I^-_{(aq)} + S_4O_{6(aq)}^{2-}$$
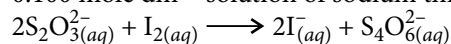
The percentage of copper, by mass in the copper(II) salt is [Atomic mass of copper = 63.5]

(a) 64.2
(b) 51.0
(c) 48.4
(d) 25.5

4. $AgNO_{3(aq)}$ was added to an aqueous KCl solution gradually and the conductivity of the solution was measured. The plot of conductance (Λ) versus the volume of $AgNO_3$ is
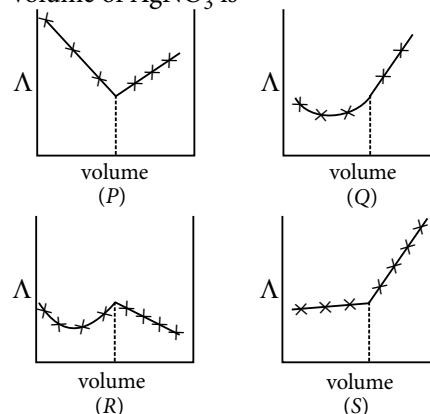
(a) *P*
(b) *Q*
(c) *R*
(d) *S*

5. A red solid is insoluble in water. However, it becomes soluble if some KI is added to water. Heating the red solid in a test tube results in liberation of some violet coloured fumes and droplets of a metal appear on the cooler part of the test tube. The red solid is

(a) HgI_2
(b) HgO
(c) Pb_3O_4
(d) $(NH_4)_2Cr_2O_7$

6. Zinc granules are added in excess to 500 mL of 1 M nickel nitrate solution at 25°C until the equilibrium is reached. If the standard reduction potentials of $Zn^{2+}|Zn$ and $Ni^{2+}|Ni$ are – 0.75 V and – 0.24 V respectively. The concentration of Ni^{2+} in solution at equilibrium is

(a) 0.05×10^{-8} M   (b) 5.5×10^{-18} M
(c) 55×10^{-8} M   (d) 0.75×10^{-8} M

SECTION 2 (Maximum Marks : 32)

- *This section contains EIGHT questions.*
- *Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s) is(are) correct.*
- *For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*
  Full Marks : *+4 If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.*
 **Partial Marks :** *+1 For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*
  Zero Marks : *0 If none of the bubbles is darkened.*
 **Negative Marks :** *–2 In all other cases.*
- *For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will result in +4 marks; darkening only (A) and (D) will result in +2 marks; and darkening (A) and (B) will result in –2 marks, as a wrong option is also darkened.*

7. Which of the following species have the same shape and same bond order?
  (i) CO_2 (ii) N_3^-
  (iii) O_3 (iv) NO_2^-
  (a) (i) and (ii)   (b) (iii) and (iv)
  (c) (i) and (iii)   (d) (ii) and (iv)

8. A metal has cubic close packing (*ccp*) arrangement, the layer sequence of which is shown as :
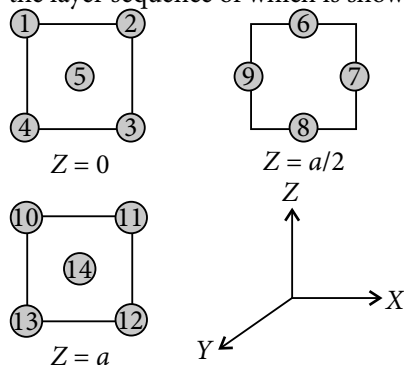
A face diagonal passes through the centre of atom 4 and the centre(s) of which other atom(s)?
  (a) 1   (b) 2, 5
  (c) 8, 12   (d) 9, 10

9. Consider the following compounds :
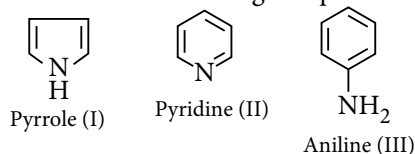
Which of the following statement(s) is/are correct?
  (a) I is more basic than II.

(b) II is more basic than I and III.
(c) III is more basic than II.
(d) I is weakly acidic.

10. Impure ore $\xrightarrow[\text{NaOH}_{(aq.)}]{\text{Excess of}}$ $\begin{array}{l}\nearrow \text{Residue}\\ \searrow \text{Soln.} \xrightarrow[\text{Excess}]{CO_2} \text{Precipitate}\\ \qquad\qquad\xrightarrow{\Delta} \text{Pure ore}\end{array}$
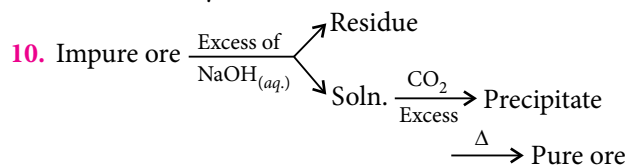
Above method is applicable for
  (a) red bauxite   (b) haematite
  (c) galena   (d) cuprite.

11. Consider the following sequence of reactions :

$$P_4 \xrightarrow{\text{Ba(OH)}_2/\Delta} X \xrightarrow[\text{salt}]{H_2SO_4} Y \text{(oxyacid)} \xrightarrow{\Delta} \underset{\text{(oxyacid)}}{A}$$

$$\underset{\text{(oxyacid)}}{A} \begin{array}{l}\xrightarrow{\Delta} \text{(oxyacid)}\\ \xrightarrow{\Delta} \text{(oxyacid)}\\ \searrow_{\Delta} \text{(oxyacid)}\end{array}$$

In the above sequence of reactions Y and A are respectively
  (a) H_3PO_2 and H_3PO_4 (b) H_3PO_4 and $H_4P_2O_7$
  (c) H_3PO_4 and HPO_3 (d) H_3PO_3 and H_3PO_4

12. Consider the following solutions :
  (i) $C_6H_{12}O_6/H_2O$ (1 M)
  (ii) $NaCl/H_2O$ (1 M)
  (iii) C_6H_5COOH/C_6H_6 (1 M)
  (iv) $(NH_4)_3PO_4/H_2O$ (1 M)
With respect to these solutions select the correct statement(s).
  (a) All are isotonic solutions.
  (b) (iii) is hypotonic of (ii) and (iv).
  (c) (ii) and (iv) are hypertonic of (i).
  (d) (iv) is hypertonic of (i), (ii) and (iii).

13. The correct statement(s) about the following sugars X and Y is (are)
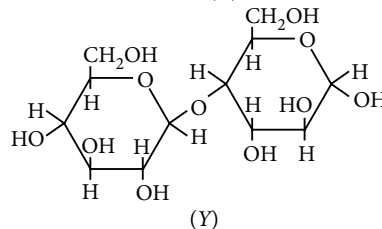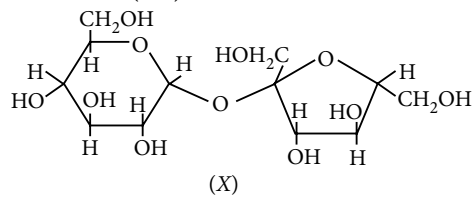
(a) X is a reducing sugar and Y is a non-reducing sugar

(b) X is a non-reducing sugar and Y is a reducing sugar

(c) the glycosidic linkages in X and Y are α and β, respectively

(d) the glycosidic linkages in X and Y are β and α, respectively.

14. 4, 4′-Dinitrodiphenyl is obtained when
(a) 4-nitrochlorobenzene is heated with Na/ether
(b) 4-nitroiodobenzene is heated with copper powder in a sealed tube
(c) diphenyl is heated with a mixture of conc. HNO_3 + conc. H_2SO_4
(d) nitrobenzene is treated with 4-nitro-chlorobenzene in presence of anhyd. $AlCl_3$.

SECTION 3 (Maximum Marks : 12)

- *This section contains TWO paragraphs.*
- *Based on each paragraph, there are TWO questions.*
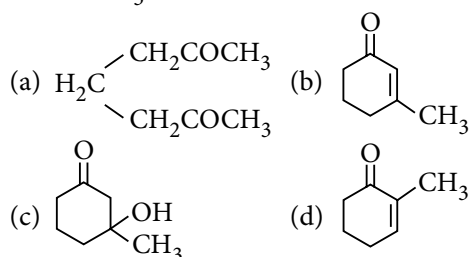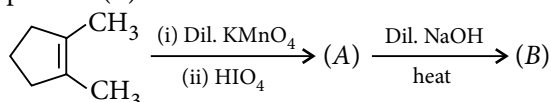- *Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

 **Full Marks :** *+3 If only the bubble corresponding to the correct option is darkened.*

  Zero Marks : *0 In all other cases.*

PARAGRAPH 1

Decomposition of ammonium chloride is an endothermic reaction. The equilibrium may be represented as :

$$NH_4Cl_{(s)} \rightleftharpoons NH_{3(g)} + HCl_{(g)}$$
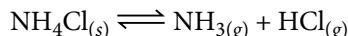
A 6.250 g sample of NH_4Cl is placed in an evacuated 4.0 L container at 27°C. After equilibrium the total pressure inside the container is 0.820 bar and some solid remains in the container.

15. The value of K_p for the reaction at 300 K is
(a) 16.2   (b) 0.168
(c) 1.68   (d) 32.4

16. The amount of solid NH_4Cl left behind in the container at equilibrium is
(a) 2.996   (b) 28.56
(c) 0.2856   (d) 1.320

PARAGRAPH 2

A mixture of two compounds A and B was separated by dissolving in chloroform followed by extraction with aqueous KOH solution. The organic layer containing compound A, when heated with alcoholic solution of KOH produced a compound $C(C_7H_5N)$ associated with an unpleasant odour. The alkaline aqueous layer on the other hand, when heated with chloroform and then acidified gave a mixture of two isomeric compounds D and E of molecular formula $C_7H_6O_2$.

17. Compounds A and B respectively are
(a) C_6H_5OH, $C_6H_5OCH_3$
(b) $C_6H_5NH_2$, C_6H_5OH
(c) C_6H_5OH, $C_6H_5NH_2$
(d) $C_6H_5CH_2OH$, $C_6H_5CH_2NH_2$

18. The compounds D and E respectively are
(a) C_6H_5CHO, o-HO—C_6H_4CHO
(b) C_6H_5CHO, m-HO—C_6H_4CHO
(c) C_6H_5CHO, p-HO—C_6H_4CHO
(d) o-HO—C_6H_4CHO, p-HO—C_6H_4CHO

SOLUTIONS
PAPER-I

1. **(a) :** $\bar{v}_H = \dfrac{1}{\lambda_H} = R\left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$ ...(i)

$\bar{v}_{He^+} = \dfrac{1}{\lambda_{He^+}} = RZ^2\left(\dfrac{1}{2^2} - \dfrac{1}{4^2}\right)$

$= R \times 4\left(\dfrac{1}{4} - \dfrac{1}{16}\right) = R \times \left(\dfrac{4}{4} - \dfrac{4}{16}\right)$

$= R \times \left(1 - \dfrac{1}{4}\right)$ ...(ii)

Comparing equations (i) and (ii), we get
∴ $\Rightarrow n_1 = 1$ and $n_2 = 2$

2. **(c) :** Suppose n moles of gas are present.

∴ $n = \dfrac{PV}{RT} = \dfrac{1.6 \times 10^6 \times 0.0083}{8.3 \times 300} = 5.33$

$C_v = \dfrac{5}{2}R - R = \dfrac{3}{2}R = \dfrac{3}{2} \times 8.3 = 12.45$ J mol^{-1} K^{-1}

Heat supplied at constant volume $(q_v) = n \times C_v \times \Delta T$
$2.49 \times 10^4 = 5.33 \times 12.45 \times \Delta T$

$\Delta T = \dfrac{2.49 \times 10^4}{5.33 \times 12.45} \Rightarrow \Delta T \approx 375$ K

∴   Final temperature, $T_f = 300 + 375 = 675$ K

3. **(d):** In $[Ni(CN)_4]^{2-}$, $Ni^{2+} = 3d^8$, dsp^2 hybridisation (square planar geometry), no unpaired electron is present and magnetic moment is zero.
In $[MnBr_4]^{2-}$, $Mn^{2+} = 3d^5$, sp^3 hybridisation (tetrahedral geometry), $n = 5$,
$\mu = \sqrt{5(5+2)}$ B.M. $= \sqrt{35}$ B.M. $= 5.9$ B.M.
In $[CoF_6]^{3-}$, $Co^{3+} = 3d^6$, sp^3d^2 hybridisation (octahedral geometry),
$n = 4$, $\mu = \sqrt{4(4+2)}$ B.M. $= \sqrt{24}$ B.M. $= 4.9$ B.M.

4. (b)

5. (c) : $\overline{M}_w = \dfrac{\sum N_i M_i^2}{\sum N_i M_i}$

$\overline{M}_w = \dfrac{30(20000)^2 + 40(30000)^2 + 30(60000)^2}{(30 \times 20000) + (40 \times 30000) + (30 \times 60000)}$

$= 43{,}333.33 \approx 43{,}333$

6. (b):

Cyclobutylmethylamine

7. (a, b) : $RCH = CHR' \xrightarrow[\text{(ii) NaIO}_4]{\text{(i) KMnO}_4} RCHO + R'CHO$
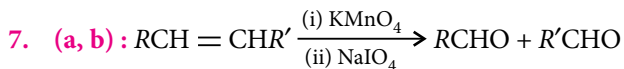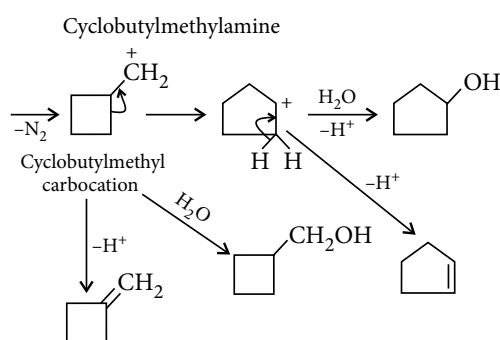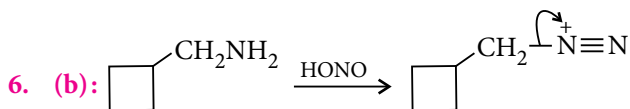
A solution of $NaIO_4$ containing a trace of $KMnO_4$ is called Lemieux reagent.

8. (b, d) : $2NaOH + NaH_2PO_4 \longrightarrow Na_3PO_4 + 2H_2O$
$NaHCO_3 + NaOH \longrightarrow Na_2CO_3 + H_2O$

9. (a, b, c) :
$RbF + XeF_6 \longrightarrow Rb^+[XeF_7]^-$
$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$
$2XeF_6 + SiO_2 \longrightarrow 2XeOF_4 + SiF_4$
XeF_6 is sp^3d^3 hybridised with pentagonal bipyramidal geometry.
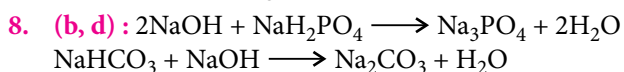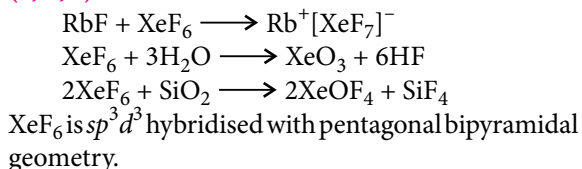
10. (a) : Let w g of each be taken.

Initial mole of $P = \dfrac{w}{100}$; Final mole of $P = \dfrac{w}{5 \times 100}$

Initial mole of $Q = \dfrac{w}{200}$; Final mole of $Q = \dfrac{4w}{5 \times 200}$

For P : $\left(\dfrac{N_0}{N}\right)_P = e^{\lambda_1 t}$ or $\dfrac{w \times 5 \times 100}{100 \times w} = e^{\lambda_1 \times 20}$ ...(i)

For Q : $\left(\dfrac{N_0}{N}\right)_Q = e^{\lambda_2 t}$ or $\dfrac{w \times 5 \times 200}{200 \times w \times 4} = e^{\lambda_2 \times 20}$ ...(ii)

By eqs. (i) and (ii), $4 = e^{(\lambda_1 - \lambda_2) \times 20}$

or $\lambda_1 - \lambda_2 = \dfrac{\log_e 4}{20}$

or $\dfrac{0.693}{10} - \dfrac{0.693}{t} = \dfrac{\log_e 4}{20} \Rightarrow t = \infty$

11. (a, c, d) :
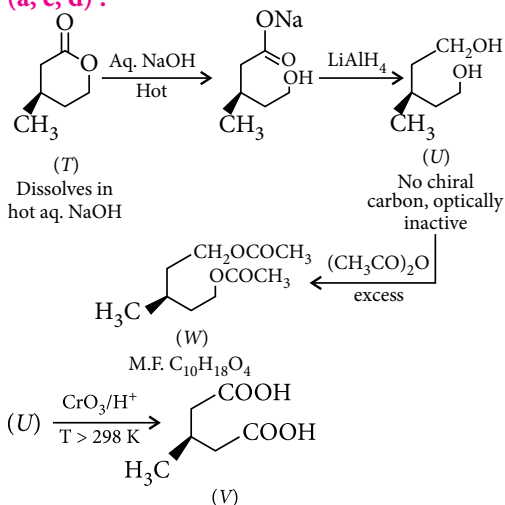
V gives effervescence with $NaHCO_3$ due to evolution of CO_2.

12. (a, b) : All ammonium salts on reaction with alkali produce ammonia, but nitrates and nitrites salts produce ammonia along with nitrates and nitrites which on further reduction with Zn dust again produces ammonia.
$NH_4NO_2 + NaOH \longrightarrow NaNO_2 + NH_3 + H_2O$
$NH_4NO_3 + NaOH \longrightarrow NaNO_3 + NH_3 + H_2O$
$NaNO_2 \xrightarrow[\text{Zn/NaOH}]{+6\,[H]} NaOH + NH_3 + H_2O$
$NaNO_3 + 8[H] \xrightarrow[\text{NaOH}]{\text{Zn}} NaOH + NH_3 + 2H_2O$
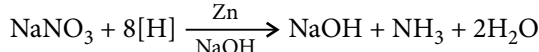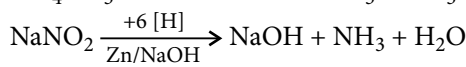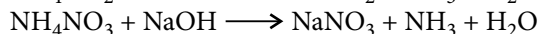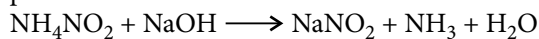
13. (c) : $Q_c = \tan 75° = 3.732 = \dfrac{\text{conc. of } iso\text{-butane}}{\text{conc. of } n\text{-butane}} > K_c$

As $Q_c > K_c$, thus backward reaction takes place till equilibrium is attained.

14. (6) : (a) Since tropic acid is oxidised by CrO_3/H_2SO_4, it suggests the presence of $\diagdown CH{-}OH$ or $-CH_2{-}OH$ group in it.

(b) Tropic acid is also oxidised by hot alkaline $KMnO_4$ into benzoic acid, indicating the presence of a benzene nucleus and atleast one α H-atom in the side chain of tropic acid. Thus, tropic acid should have the following structure :

Tropic acid → (C₉H₉O₂Br) → Atropic acid → Hydratropic acid reaction scheme
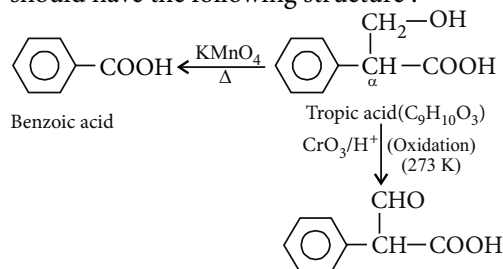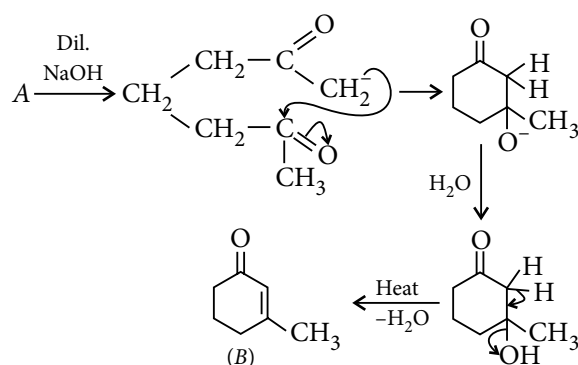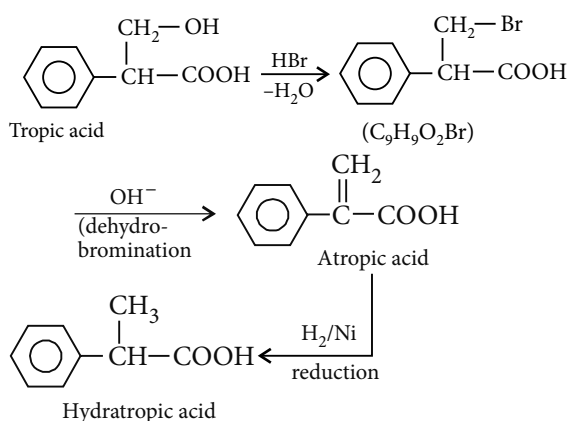
15. (3): At equilibrium, lowering in vapour pressure of both the solutions is same.

Then, $\dfrac{0.01}{M_X} = \dfrac{0.02}{60} \Rightarrow M_X = 30$ amu $\therefore n = 3$

16. (3): $[RhCl(CO)(PPh_3)(NH_3)]$ is a square planar complex of the type $MABCD$. Hence, it has three geometrical isomers as follows :
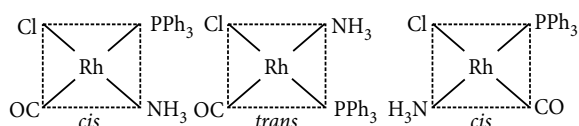
17. (4)

18. (1): $Z = \dfrac{PV}{RT}$; $0.5 = \dfrac{100 \times V}{0.0821 \times 273}$; $V = 0.112$ L

Neglecting b, van der Waals equation reduces to

$\left(P + \dfrac{a}{V^2} \right) V = RT$ or $PV + \dfrac{a}{V} = RT$

or $100 \times 0.112 + \dfrac{a}{0.112} = 0.0821 \times 273$

$a = 1.25$ L² atm mol⁻²

Comparing 1.25 with $x.25$, we get $x = 1$

Paper-II

1. (b):

(A)

(B)
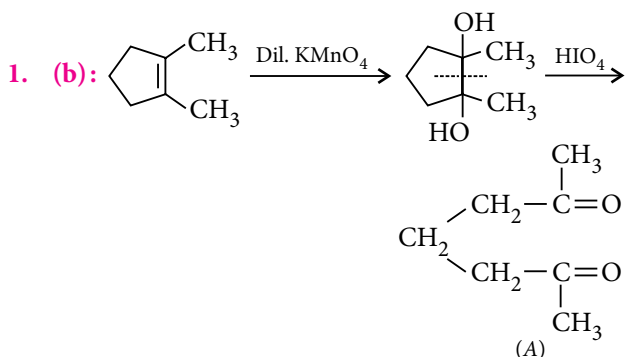
2. (a)

3. (b): Millimoles of hypo ≡ millimoles of iodine × 2
≡ millimoles of Cu^{2+} ions
= 24.5 × 0.1 millimoles

$\therefore$ Mass of copper = 24.5 × 0.1 × 10⁻³ × 63.5 g

So, % of copper = $\dfrac{24.5 \times 0.1 \times 10^{-3} \times 63.5}{0.305} \times 100\%$

= 51.0%

4. (d): $AgNO_{3(aq)} + KCl_{(aq)} \longrightarrow AgCl_{(s)} + KNO_{3(aq)}$
Conductivity of the solution is almost compensated due to formation of $KNO_{3(aq)}$ as Cl^- and NO_3^- both have almost same ionic conductivity. However, after the end point, conductivity increases more rapidly due to addition of excess $AgNO_3$ solution.

5. (a): When KI is added to mercuric iodide it dissolves in it and forms complex.

$\underset{\substack{\text{red solid}\\\text{(insoluble)}}}{HgI_2} + 2KI \longrightarrow \underset{\text{(soluble)}}{K_2[HgI_4]}$
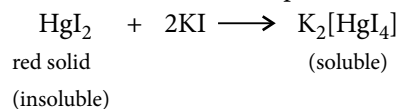
On heating, HgI_2 decomposes as :

$HgI_2 \rightleftharpoons \underset{\substack{\text{(droplets}\\\text{of mercury)}}}{Hg} + \underset{\substack{\text{(violet}\\\text{vapours)}}}{I_2}$
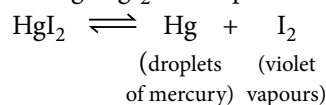
6. (b): The cell reaction is
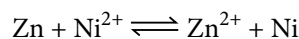
$Zn + Ni^{2+} \rightleftharpoons Zn^{2+} + Ni$

$E_{cell} = E_{cell}^\circ - \dfrac{0.0591}{2} \log \dfrac{[Zn^{2+}]}{[Ni^{2+}]}$

At equilibrium, $E_{cell} = 0$

$\therefore E_{cell}^\circ = \dfrac{0.0591}{2} \log \dfrac{[Zn^{2+}]}{[Ni^{2+}]}$

$E_{Ni^{2+}/Ni}^\circ - E_{Zn^{2+}/Zn}^\circ = \dfrac{0.0591}{2} \log \dfrac{[Zn^{2+}]}{[Ni^{2+}]}$

$$-0.24 - (-0.75) = \frac{0.0591}{2} \log \frac{[Zn^{2+}]}{[Ni^{2+}]}$$

$$\therefore \quad \frac{[Zn^{2+}]}{[Ni^{2+}]} = 1.816 \times 10^{17}$$

This concentration ratio shows that almost whole of the Ni^{2+} ions are reduced to Ni and therefore, the concentration of Zn^{2+} produced from Zn would be nearly 1 M [$\because Ni(NO_3)_2 = 1$ M]. Thus,

$$\frac{1}{[Ni^{2+}]} = 1.816 \times 10^{17} \Rightarrow [Ni^{2+}] = 5.5 \times 10^{-18} \text{ M}$$

7. **(a, b) :** CO_2 and N_3^- are linear with bond order 2. O_3 and NO_2^- are V-shaped and bond order 1.5.

8. **(b, c, d) :** $Z = 0$ forms the bottom layer, $Z = a/2$ forms second layer above it and $Z = a$ forms the third layer. Atoms 5, 6, 7, 8, 9 and 14 are present at the face centres. Atoms 1, 2, 3, 4, 10, 11, 12 and 13 are present at the corners. 4, 5, 2 form one face diagonal 4, 9, 10 form another face diagonal; 4, 8, 12 form one more face diagonal.
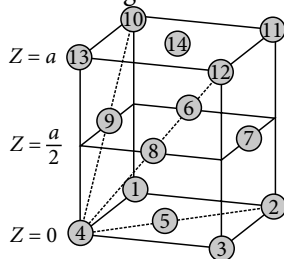
9. **(b, d) :** Due to delocalisation of electrons of the N-atom over the benzene ring in aniline (III) and involvement of these electrons in aromatic sextet formation in pyrrole (I), both these amines are weaker bases than pyridine (II) in which such a delocalisation does not exist since the lone pair of electrons is present in a sp^2-hybridised orbital which lies outside the plane of the ring. Hence, II is more basic than I and III. Further, I is so much less basic that with strong bases, it behaves as a weak acid.

10. **(a)**

11. **(a) :** $P_4 \xrightarrow{OH^-} \underset{\substack{\text{Salt} \\ (X)}}{PH_3 + H_2PO_2^-} \xrightarrow{H^+} \underset{(Y)}{H_3PO_2}$

$$H_4P_2O_7 \xleftarrow[600°C]{\Delta} \xleftarrow[250°C]{\Delta} \underset{(A)}{H_3PO_4 + PH_3} \xleftarrow{\Delta} (Y)$$

$$\downarrow_{600°C}$$

$$HPO_3$$
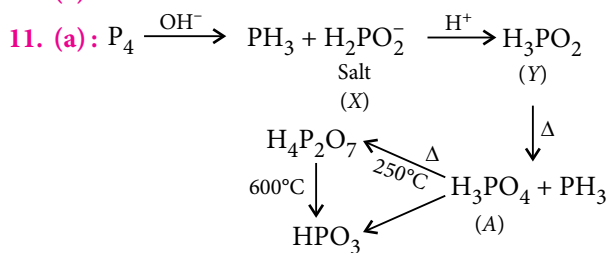
12. **(b, c, d)**   13. **(b, c)**   14. **(a, b, c)**

15. **(b):** $P_{NH_3} = P_{HCl} = \dfrac{0.820}{2}$ bar

$$\therefore \quad K_p = P_{NH_3} \times P_{HCl} = 0.41 \times 0.41 = 0.168$$

16. **(a) :** Moles of gases, $n = \dfrac{PV}{RT} = \dfrac{0.820 \times 4}{0.083 \times 300}$

$$= 0.132 \text{ mol}$$

Moles of NH_3 = Moles of HCl = $\dfrac{0.132}{2} = 0.066$

Moles of NH_4Cl decomposed = Moles of NH_3 = 0.066

Moles of NH_4Cl initially present = $\dfrac{6.250}{53.5} = 0.117$

Moles of NH_4Cl left = 0.117 – 0.066 = 0.051

Mass of NH_4Cl left behind = $0.051 \times 53.5 = 2.73$ g

17. **(b)**

Mixture of $(A) + (B) \xrightarrow[\text{+ aq. KOH}]{CHCl_3}$ Organic layer (A) + Aqueous alkaline layer (B).
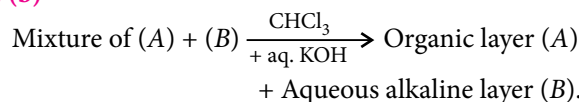
Since compound (A) does not dissolve in alkali, therefore, it may be an amine. Further, since on treatment with $CHCl_3$ and alcoholic KOH, it produces $C(C_7H_5N)$ having unpleasant smell, therefore, (A) may be $C_6H_5NH_2$ and (C) must be C_6H_5NC and the name of the reaction is carbylamine reaction.

$$\underset{\text{Aniline}(A)}{C_6H_5NH_2} + CHCl_3 + \underset{\text{(alc.)}}{3KOH} \xrightarrow[\substack{\text{(Carbylamine} \\ \text{reaction)}}]{\text{Warm}}$$

$$\underset{\substack{\text{Phenyl isocyanide } (C) \\ \text{(unpleasant smell)}}}{C_6H_5NC} + 3KCl + 3H_2O$$
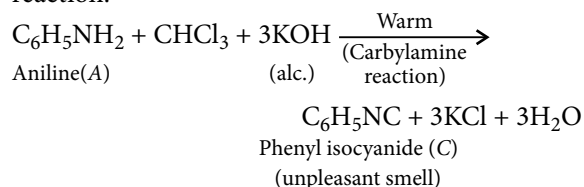
Since aqueous alkaline layer (B) on heating with $CHCl_3$ followed by acidification gives two isomeric compounds having molecular formula $(C_7H_6O_2)$. Therefore, (B) must be phenol, C_6H_5OH. It undergoes Reimer–Tiemann reaction to give a mixture of two isomeric compounds with molecular formula $C_7H_6O_2$. Thus, (D) and (E) are o- and p-hydroxybenzaldehyde.
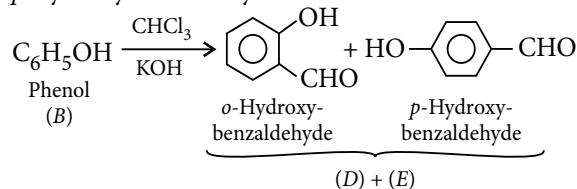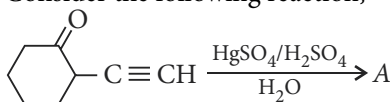
18. **(d)**

◈ ◈
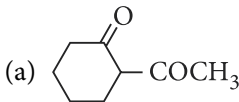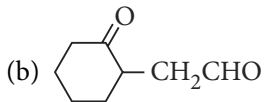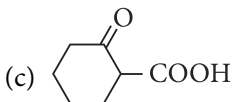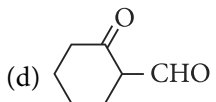
PRACTICE PAPER
AIIMS

Exam on 28th May

1. The order of reactivity of following alkyl halides towards S_N1 reaction is
   (i) $(CH_3)_3CBr$
   (ii) $(C_6H_5)_2CHBr$
   (iii) $(C_6H_5)_2C(CH_3)Br$
   (iv) $(CH_3)_2CHBr$
   (v) C_2H_5Br
   (a) (v) > (iv) > (i) > (ii) > (iii)
   (b) (ii) > (i) > (iii) > (v) > (iv)
   (c) (i) > (iii) > (v) > (ii) > (iv)
   (d) (iii) > (ii) > (i) > (iv) > (v)

2. In the titration of HCl *vs* NH_4OH, the pH at the equivalence point will be
   (a) less than 7
   (b) greater than 7
   (c) equal to 7
   (d) none of these.

3. When current is passed through two cells connected in series, the first cell contains $X(NO_3)_{3(aq)}$ and the second cell contains $Y(NO_3)_{2(aq)}$. The relative atomic masses of X and Y are in the ratio 1 : 2. What is the ratio of the liberated mass of X to that of Y?
   (a) 3 : 2
   (b) 1 : 2
   (c) 1 : 3
   (d) 3 : 1

4. Consider the following reaction,

   The structure of the major product 'A' is

   (a) $-COCH_3$
   (b) $-CH_2CHO$
   (c) $-COOH$
   (d) $-CHO$

5. An element 'X' is strongly electropositive and element 'Y' is strongly electronegative. Both are univalent. The compound formed would be

   (a) $X^+ Y^-$
   (b) $X^- Y^+$
   (c) $X - Y$
   (d) $X \rightarrow Y$

6. In the reaction,
   $BrO_{3(aq)}^- + 5Br_{(aq)}^- + 6H_{(aq)}^+ \longrightarrow 3Br_{2(aq)} + 3H_2O_{(l)}$
   the expression of rate of appearance of bromine $[Br_2]$ to rate of disappearance of bromide ion $[Br^-]$ is

   (a) $\dfrac{d[Br_2]}{dt} = -\dfrac{3}{5}\dfrac{d[Br^-]}{dt}$

   (b) $\dfrac{d[Br_2]}{dt} = -\dfrac{5}{3}\dfrac{d[Br^-]}{dt}$

   (c) $\dfrac{d[Br_2]}{dt} = \dfrac{5}{3}\dfrac{d[Br^-]}{dt}$

   (d) $\dfrac{d[Br_2]}{dt} = \dfrac{3}{5}\dfrac{d[Br^-]}{dt}$

7. Consider the following reaction :
   $$\text{Phenol} \xrightarrow{\text{Zn dust}} X \xrightarrow[\text{Anhydrous AlCl}_3]{\text{CH}_3\text{Cl}} Y \xrightarrow{\text{Alkaline KMnO}_4} Z$$
   The product Z is
   (a) toluene
   (b) benzaldehyde
   (c) benzoic acid
   (d) benzene.

8. A solid (A) which has photographic effect, reacts with the solution of a sodium salt (B) to give a pale yellow ppt. (C). Sodium salt (B) on heating gives brown vapours. A, B and C are respectively
   (a) $AgNO_3$, NaBr, AgBr
   (b) $AgNO_3$, NaCl, AgCl
   (c) $AgNO_3$, NaBr, AgCl
   (d) AgCl, NaBr, AgBr

9. The number of molecules liberated at anode from molten sodium chloride in one minute by a current of 300 milliamperes is
   (a) 5.616×10^{18}
   (b) 5.616×10^{19}
   (c) 5.616×10^{20}
   (d) 5.616×10^{21}

10. Consider the following sequence of reactions :

$$F-\langle \rangle-NO_2 \xrightarrow[\text{DMF, }\Delta]{(CH_3)_2NH} (A) \xrightarrow{\text{Fe/HCl}} (B)$$

The product (B) is

(a) $H_2N-\langle \rangle-N\begin{smallmatrix}CH_3 \\ \\ CH_3\end{smallmatrix}$

(b) $H_2N-\langle \rangle-NH_2$

(c) $O_2N-\langle \rangle-N\begin{smallmatrix}CH_3 \\ \\ H_2N\end{smallmatrix}$

(d) $O_2N-\langle \rangle-NH_2$
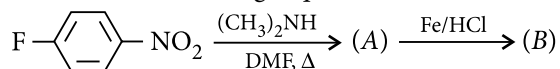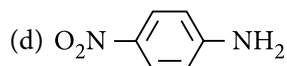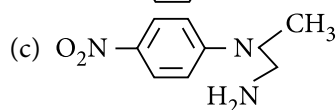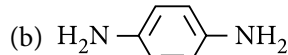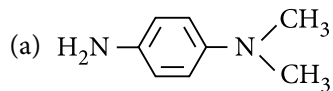
11. The true statement for the oxyacids of phosphorus H_3PO_2, H_3PO_3 and H_3PO_4 is
   (a) the order of their acidity is,
      $H_3PO_4 > H_3PO_3 > H_3PO_2$
   (b) all of them are reducing in nature
   (c) all of them are tribasic acids
   (d) the geometry of phosphorus is tetrahedral in all the three.

12. In vulcanization of rubber,
   (a) sulphur reacts to form a new compound
   (b) sulphur cross-links are introduced
   (c) sulphur forms a very thin protective layer over rubber
   (d) all statements are correct.

13. In which of the following arrangements of XeF_2, XeF_4 and XeF_6, the decreasing order of Xe—F bond length is correct?
   (a) $XeF_2 > XeF_4 > XeF_6$ (b) $XeF_6 > XeF_4 > XeF_2$
   (c) $XeF_4 > XeF_6 > XeF_2$ (d) $XeF_2 > XeF_6 > XeF_4$

14. 2.8 g of a pure alkene containing only one double bond per molecule, reacts completely with 8 g of bromine (in an inert solvent). What is the molecular formula of the alkene?
   (a) C_2H_4 (b) C_4H_8
   (c) C_3H_6 (d) C_6H_{12}

15. The reaction, $A \longrightarrow$ Product, follows first order kinetics. In 40 minutes, the concentration of A changes from 0.1 M to 0.025 M. The rate of reaction, when concentration of A is 0.01 M is
   (a) 1.73×10^{-4} M min^{-1}
   (b) 3.47×10^{-5} M min^{-1}
   (c) 3.47×10^{-4} M min^{-1}
   (d) 1.73×10^{-5} M min^{-1}

16. Consider the following set of reactions :

$$C_6H_6 \xrightarrow[350\text{ K}]{H_2SO_4} A \xrightarrow[H^+/H_2O]{\text{Alkali}} B \xrightarrow[H_2O]{Br_2} C$$
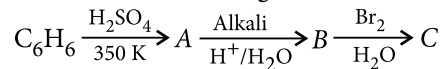
The final product, C is
   (a) o-bromophenol (b) p-bromophenol
   (c) m-bromophenol (d) 2, 4, 6-tribromophenol.

17. Vapour pressures of chloroform ($CHCl_3$) and dichloromethane (CH_2Cl_2) at 25ºC are 200 mm Hg and 41.5 mm Hg respectively. Vapour pressure of the solution obtained by mixing 25.5 g of $CHCl_3$ and 40 g of CH_2Cl_2 at the same temperature will be (Molecular mass of $CHCl_3$ = 119.5 u and molecular mass of CH_2Cl_2 = 85 u)
   (a) 90.9 mm Hg (b) 615.0 mm Hg
   (c) 347.9 mm Hg (d) 285.5 mm Hg

18. In the following reaction sequence, X is

$$X \xrightarrow{Br_2, H_2O} Y \xrightarrow{NaNO_2 + HCl} Z \xrightarrow[C_2H_5OH]{\text{Boiling}}$$
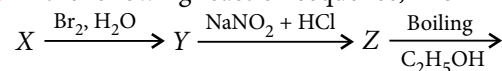
$$\text{Tribromobenzene}$$

   (a) benzoic acid (b) salicylic acid
   (c) phenol (d) aniline.

19. A p-type material is electrically
   (a) positive (b) negative
   (c) neutral
   (d) It depends upon the concentration of p-impurities.

20. A plot of volume (V) vs temperature (T) for a gas at constant pressure is a straight line passing through the origin. The plots at different values of pressure are shown in the figure. Which of the following orders of pressure is correct for the gas?
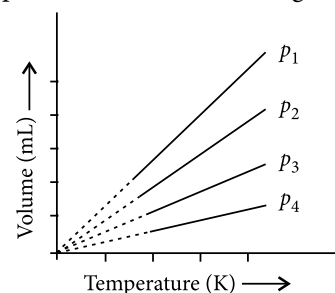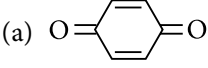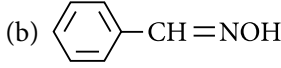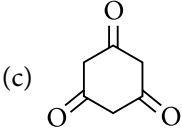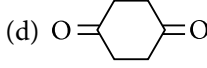
   (a) $p_1 > p_2 > p_3 > p_4$ (b) $p_1 = p_2 = p_3 = p_4$
   (c) $p_1 < p_2 < p_3 < p_4$ (d) $p_1 < p_2 = p_3 < p_4$

21. Which of the following reactions is an example of auto-reduction?
   (a) $Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$
   (b) $Cu_2O + C \longrightarrow 2Cu + CO$
   (c) $Cu^{2+} + Fe \longrightarrow Cu + Fe^{2+}$
   (d) $Cu_2O + \frac{1}{2}Cu_2S \longrightarrow 3Cu + \frac{1}{2}SO_2$

22. Which of the following reactions is not associated with the Solvay process of manufacture of sodium carbonate?
(a) $CO_2 + H_2O \longrightarrow H_2CO_3$
(b) $NH_3 + H_2CO_3 \longrightarrow NH_4HCO_3$
(c) $NaCl + NH_4HCO_3 \longrightarrow NaHCO_3 + NH_4Cl$
(d) $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

23. Consider the following reactions,

Ethanol $\xrightarrow{PBr_3} X \xrightarrow{alc.\ KOH} Y$

$\xrightarrow[\text{(ii) } H_2O,\ heat]{\text{(i) } H_2SO_4,\ \text{room temperature}} Z$;

product Z is
(a) $CH_2 = CH_2$
(b) $CH_3CH_2 - O - CH_2CH_3$
(c) $CH_3 - CH_2 - O - SO_3H$
(d) CH_3CH_2OH

24. Glycerol was distilled with oxalic acid crystals and the products were led into Fehling's solution and warmed. Cuprous oxide was precipitated, which is due to
(a) CO
(b) HCHO
(c) CH_3CHO
(d) HCOOH

25. The order of screening effect of electrons of s, p, d and f orbitals of a given shell of an atom on its outer shell electrons is
(a) $s > p > d > f$
(b) $f > d > p > s$
(c) $p < d < s > f$
(d) $f > p > s > d$

26. Which of the following statements is false?
(a) The lower the concentration of D.O., the more polluted is the water sample.
(b) The tolerable limit of lead in drinking water is 50 ppb.
(c) Water is considered pure if it has BOD less than 5 ppm.
(d) In COD determination, the pollutants resistant to microbial oxidation are not oxidised by oxidising agents like $K_2Cr_2O_7$.

27. The two compounds A and B obtained from 1-butyne can be distinguished by

$B \xleftarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } BH_3} CH_3CH_2C \equiv CH \xrightarrow{H^+/Hg^{2+}} A$

(a) $NaHSO_3$
(b) litmus solution
(c) iodoform test
(d) 2, 4-DNP.

28. At what temperature, the translational kinetic energy of 14 g of nitrogen will be the same as that of 32 g of oxygen at 300 K?

(a) 150 K
(b) 300 K
(c) 600 K
(d) 131.25 K

29. Which of the following equations depicts reducing nature of H_2O_2?
(a) $2[Fe(CN)_6]^{4-} + 2H^+ + H_2O_2 \rightarrow 2[Fe(CN)_6]^{3-} + 2H_2O$
(b) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
(c) $Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$
(d) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

30. Consider the reactions given below. On the basis of these reactions find out which of the algebraic relations given is correct?
(i) $C_{(g)} + 4H_{(g)} \rightarrow CH_{4(g)}$; $\Delta_r H = x$ kJ mol^{-1}
(ii) $C_{(graphite,\ s)} + 2H_{2(g)} \rightarrow CH_{4(g)}$; $\Delta_r H = y$ kJ mol^{-1}
(a) $x = y$
(b) $x = 2y$
(c) $x > y$
(d) $x < y$

31. Which of the following pairs of solutions are expected to be isotonic, temperature being the same?
(a) 0.1 M Glucose and 0.1 M $C_6H_5NH_3Cl$
(b) 0.1 M NaCl and 0.05 M $BaCl_2$
(c) 0.1 M Na_2SO_4 and 0.1 M KNO_3
(d) 0.1 M $BaCl_2$ and 0.075 M $FeCl_3$

32. Which of the following has maximum lattice energy?
(a) Li_2O
(b) Na_2O
(c) MgO
(d) BaO

33. Tautomerism is not exhibited by

(a) O=⬡=O
(b) ⬡-CH=NOH
(c) [cyclohexanone structure with O at top and two O at bottom]
(d) O=⬡=O

34. Extraction of gold and silver involves leaching the metal with CN^- ion. The metal is recovered by
(a) displacement of metal by some other metal from the complex ion
(b) roasting of metal complex
(c) calcination followed by roasting
(d) thermal decomposition of metal complex.

35. Which of the following statements about DNA is not correct?
(a) It has a double helix structure.
(b) It undergoes replication.
(c) The two strands in a DNA molecule are exactly similar.
(d) It contains the pentose sugar, 2-deoxyribose.

36. Which of the following actinoids shows oxidation states upto +7?
(a) Th   (b) Pu   (c) U   (d) Ce

37. In the reaction,
$NaOH + Al(OH)_3 \longrightarrow NaAlO_2 + 2H_2O$
the equivalent mass of $Al(OH)_3$ is
(a) 78   (b) 26
(c) 52   (d) unpredictable.

38. To detect nitrogen in hydrazine (NH_2NH_2) by Lassaigne's extract, it is fused with sodium in presence of
(a) starch   (b) charcoal
(c) sugar   (d) any of these.

39. The percentage of nitrogen in urea is about
(a) 46   (b) 85   (c) 18   (d) 28

40. A solution of ammonia in water contains
(a) H^+ (b) OH^-
(c) NH_4^+
(d) OH^-, NH_4^+ and NH_4OH.

ASSERTION AND REASON

Directions : In the following questions (41-60), a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

41. Assertion : An ionic product is used for any type of electrolytes whereas solubility product is applicable only to sparingly soluble salts.
Reason : Ionic product is defined at any state of the reaction whereas solubility product is only applicable to the saturation stage.

42. Assertion : NO_3^- is trigonal planar while NH_3 is pyramidal.
Reason : N in NO_3^- is sp^2 and in NH_3, it is sp^3 hybridised.

43. Assertion : Deep electric shock causes death of an animal.
Reason : Electric shock coagulates the blood.

44. Assertion : Aldol condensation can be catalysed both by acids and bases.
Reason : β-Hydroxyaldehydes or ketones readily undergo acid-catalysed dehydration.

45. Assertion : Due to Frenkel defect, there is no effect on the density of the crystalline solid.
Reason : In Frenkel defect, no cation or anion leaves the crystal.

46. Assertion : HNO_3 makes iron passive.
Reason : HNO_3 forms a protective layer of ferric nitrate on the surface of iron.

47. Assertion : Benzonitrile is prepared by the reaction of chlorobenzene with potassium cyanide.
Reason : Cyanide ion (CN^-) is a weak nucleophile.

48. Assertion : At constant temperature, PV vs V plot for real gases is not a straight line.
Reason : At high pressure, all gases have $Z > 1$ but at intermediate pressure, most gases have $Z < 1$.

49. Assertion : A spectral line will be seen for $2p_x$ to $2p_y$ transition.
Reason : Energy is released in the form of wave of light when the electrons drop from $2p_x$ to $2p_y$ orbital.

50. Assertion : Hydrolysis of (–)-2-bromooctane proceeds with inversion of configuration.
Reason : This reaction proceeds through the formation of a carbocation.

51. Assertion : Colloidal solutions show colligative properties.
Reason : Colloidal particles are large in size than particles of true solution.

52. Assertion : Both H_3PO_3 and H_3PO_4 have the same number of hydrogen atoms but H_3PO_4 is a tribasic acid and H_3PO_3 is a dibasic acid.

Reason : One mole of each H_3PO_3 and H_3PO_4 is neutralized by 2 moles and 3 moles of NaOH respectively.

53. Assertion : The enthalpy of reaction remains constant in the presence of a catalyst.
Reason : A catalyst participating in the reaction, forms different activated complex and lowers down the activation energy but the difference in energy of reactant and product remains the same.

54. Assertion : Reducing character of hydrides of oxygen family increases from H_2S to H_2Te.
Reason : Thermal stability decreases from H_2S to H_2Te.

55. Assertion : For the Daniell cell : $Zn\,|\,Zn^{2+}\,||\,Cu^{2+}\,|\,Cu$ with $E_{cell} = 1.1$ V, the application of opposite potential greater than 1.1 V results into the flow of electrons from cathode to anode.
Reason : Zinc is deposited at anode and copper is dissolved at cathode.

56. Assertion : Lattice energy in TiO_2 will be much larger than in NaCl.
Reason : The higher value of lattice energy for TiO_2 as compared to that of NaCl is due to increased ionic charge.

57. Assertion : One molal aqueous solution of glucose contains 180 g of glucose in 1 kg water.
Reason : Solution containing one mole of solute in 1000 g of solvent is called one molal solution.

58. Assertion : $[Ti(H_2O)_6]^{3+}$ is coloured while $[Sc(H_2O)_6]^{3+}$ is colourless.
Reason : d-d transition is not possible in $[Sc(H_2O)_6]^{3+}$.

59. Assertion : The non-fusible impurities present in iron ore are removed by $CaCO_3$.
Reason : $CaCO_3$ decomposes to CaO which reacts with SiO_2 to form $CaSiO_3$ slag.

60. Assertion : As a lead storage battery gets discharged, density of electrolyte present in it, decreases.
Reason : Lead and lead dioxide both react with sulphuric acid to form lead sulphate.

SOLUTIONS

1. (d) : More stable the carbocation, more reactive is the alkyl halide in S_N1 reaction. Since the stability of the carbocations decreases in the order :
$(C_6H_5)_2\overset{+}{C}(CH_3) > (C_6H_5)_2\overset{+}{C}H > (CH_3)_3\overset{+}{C}$
$> (CH_3)_2\overset{+}{C}H > \overset{+}{C_2}H_5,$
therefore, reactivity of the alkyl halides decreases in the same order :
(iii) > (ii) > (i) > (iv) > (v).
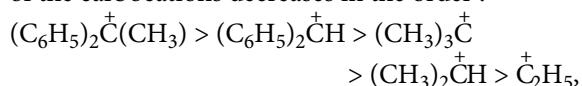
2. (a) : At the equivalence point, equal number of moles of acid and base added and the pH will reflect which species are present.

3. (c) : If atomic mass of $X = a$, then that of $Y = 2a$
As Eq. wt. = Atomic mass/Valency
Eq. wt. of $X = \dfrac{a}{3}$, Eq. wt. of $Y = \dfrac{2a}{2} = a$
According to Faraday's second law;
$\dfrac{\text{Liberated Mass of } X}{\text{Liberated Mass of } Y} = \dfrac{\text{Eq. wt. of } X}{\text{Eq. wt. of } Y}$
$= \dfrac{a/3}{a} = \dfrac{1}{3} = 1:3$

4. (b) : Due to electron withdrawing nature of the keto group, the C_1-atom becomes electron deficient. Hence, it is attacked by the nucleophile H_2O as shown :

(A)
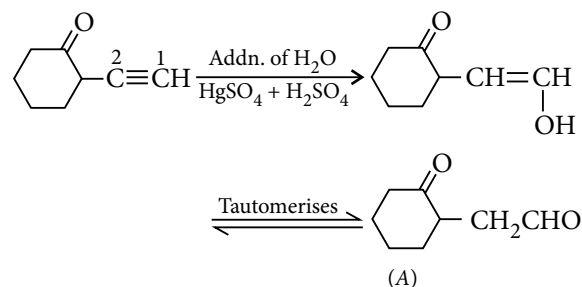
5. (a) : Strongly electropositive, univalent, X will form an 1 : 1 ionic compound with strongly electronegative, univalent Y.
$X + Y \longrightarrow X^+ Y^-$
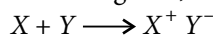
6. (a) : $\dfrac{1}{3}\dfrac{d[Br_2]}{dt} = -\dfrac{1}{5}\dfrac{d[Br^-]}{dt}$
$\dfrac{d[Br_2]}{dt} = -\dfrac{3}{5}\dfrac{d[Br^-]}{dt}$

7. (c) :
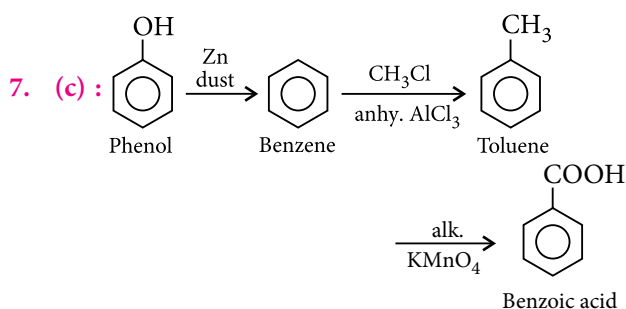
8. (a) : Solid (A) is silver nitrate which has photographic effect, reacts with the solution of NaBr(B) to give a pale yellow ppt. of AgBr. NaBr(B)

on heating gives brown vapours of bromine.

$$AgNO_3 + NaBr \longrightarrow AgBr + NaNO_3$$
$$\text{'A'} \qquad \text{'B'} \qquad \qquad \text{'C'}$$
$$\text{Light yellow ppt.}$$

9. (b) : Quantity of electricity passed

$$= \frac{300}{1000} \times 60 = 18 \text{ coulombs}$$

At anode : $2Cl^- \longrightarrow Cl_2 + 2e^-$

$2F = 2 \times 96500$ coulombs liberate 1 mole of Cl_2

$\therefore$ 18 coulombs will liberate

$$= \frac{1}{2 \times 96500} \times 18 \text{ mole of } Cl_2$$

$$= \frac{1}{2 \times 96500} \times 18 \times 6.022 \times 10^{23} \text{ molecules}$$

$$= 5.616 \times 10^{19} \text{ molecules of } Cl_2$$

10. (a) :

11. (d) : The geometry of P in H_3PO_2, H_3PO_3 and H_3PO_4 is tetrahedral.

12. (b) : Sulphur cross-links are introduced.

13. (a) : The correct decreasing order of Xe—F bond length is

$$\underset{\text{200 pm}}{XeF_2} > \underset{\text{195 pm}}{XeF_4} > \underset{\text{189 pm}}{XeF_6}$$

Bond shortening with increase in highly electronegative F atoms attached to Xe can be explained in terms of increase in charge on Xe atom.

14. (b) : 8 g Br_2 reacts with 2.8 g of alkene, therefore,

mol. wt. of alkene $= \dfrac{2.8}{8} \times 160 = 56$

Thus, the alkene is C_4H_8 ($4 \times 12 + 8 \times 1 = 56$)

15. (c) : For first order reaction,

$$k = \frac{2.303}{t} \log \frac{[A]_0}{[A]} \Rightarrow \frac{2.303}{40} \log \frac{0.1}{0.025}$$

$$k = \frac{2.303 \times 0.603}{40} \Rightarrow k = 0.0347 \text{ min}^{-1}$$

Rate $= k[A] = 0.0347 \times 0.01 = 3.47 \times 10^{-4} \text{ M min}^{-1}$

16. (d) :

17. (a) : $n_{CHCl_3} = \dfrac{25.5}{119.5} = 0.213$

$$n_{CH_2Cl_2} = \frac{40}{85} = 0.47$$

$$P_T = P_A^\circ x_A + P_B^\circ x_B = 200 \times \frac{0.213}{0.683} + 41.5 \times \frac{0.47}{0.683}$$
$$= 62.37 + 28.55 = 90.92 \text{ mm Hg}$$

18. (d) :

19. (c) : A p-type material is electrically neutral as there are only holes and no extra electrons.

20. (c) : Since $pV \propto T$ and $p \propto \dfrac{1}{V}$ hence, volume decreases with pressure. Hence, the order of pressure is $p_1 < p_2 < p_3 < p_4$.

21. (d) : Here cuprous ions reduce itself to Cu.

22. (d)

23. (d) :

$$CH_3CH_2OH \xrightarrow{PBr_3} \underset{(X)}{CH_3CH_2Br} \xrightarrow{\text{alc. KOH}}$$

$$\underset{(Y)}{CH_2 = CH_2} \xrightarrow{H_2SO_4} CH_3 - CH_2 - HSO_4$$

$$\xrightarrow[\text{Heat}]{H_2O} \underset{(Z)}{CH_3CH_2OH}$$

24. (d) :

$$HOOC - COOH \xrightarrow[\text{Decarboxylation}]{\text{Glycerol}}$$

$$HCOOH + CO_2$$

$$HCOOH + \text{Fehling's solution} \longrightarrow$$

$$\underset{\text{red ppt.}}{Cu_2O + CO_2 + H_2O}$$

25. (a) : The screening effect of the orbitals is of the order : $s > p > d > f$.

26. (d) : In COD determination, the pollutants resistant to microbial oxidation are also oxidised by oxidising agents like $K_2Cr_2O_7$.

27. (c) : $CH_3CH_2CH_2CHO \xleftarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } BH_3} CH_3CH_2C \equiv CH$
(an aldehyde)
(B)

$CH_3CH_2C \equiv CH \xrightarrow{H^+/Hg^{2+}} CH_3CH_2COCH_3$
(A ketone with $-COCH_3$ group)
(A)

28. (c) : $K.E. = \dfrac{3}{2} nRT$; $n_{N_2} = \dfrac{14}{28} = 0.5$ mol ; $T_{N_2} = ?$

$n_{O_2} = \dfrac{32}{32} = 1$ mol ; $T_{O_2} = 300$ K

Given, $K.E.$ (N$_2$) = $K.E.$(O$_2$), so $n_{N_2} T_{N_2} = n_{O_2} T_{O_2}$

or $\quad 0.5 \times T_{N_2} = 1 \times 300$ or $T_{N_2} = 600$ K

29. (b) : $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
I_2 is reduced to I^-. Thus, H_2O_2 acts as a reducing agent.

30. (c) : $x > y$ because same bonds are formed in reactions (i) and (ii) but bonds between reactant molecules are broken only in reaction (ii). As energy is absorbed when bonds are broken so, energy released in reaction (i) is greater than that in reaction (ii).

31. (d) : Effective molarity of $BaCl_2$ = $3 \times 0.1 = 0.3$; effective molarity of $FeCl_3$ = $4 \times 0.075 = 0.3$.

32. (c) : In MgO, Mg^{2+} ion is smallest in size and double the charge in comparison to Li^+ and Na^+ ions.

33. (a) : Quinone has an α-hydrogen, however, it is a vinylic hydrogen, so it is very difficult to abstract such a hydrogen and hence, it does not show tautomerism.

34. (a) : The metal in cyanide process is recovered by displacement of metal by some more reactive metal from the complex.
$4M + 8CN^- + 2H_2O + O_2 \rightarrow 4[M(CN)_2]^- + 4OH^-$
$2[M(CN)_2]^- + Zn \rightarrow [Zn(CN)_4]^{2-} + 2M$

35. (c) : The two strands in a DNA molecule are not exactly similar but are complementary.

36. (b) : Pu shows +7 oxidation state.

37. (c) : 1 equivalent of NaOH $\equiv$ 1 equivalent of Al(OH)$_3$
$\therefore \quad$ 40 g of NaOH $\equiv$ 78 g of Al(OH)$_3$
Hence, equivalent mass of Al(OH)$_3$ = 78.

38. (d) : Since NH_2NH_2 does not contain carbon, therefore, during fusion NaCN which is essential for positive Lassaigne's test for N, cannot be formed. Therefore, to form NaCN, NH_2NH_2 is fused with a carbon containing compound such as starch, sugar or even charcoal.

39. (a) : $NH_2CONH_2 \equiv 2N$
1 mol $\qquad$ 2 g atoms
60 g $\qquad$ 28 g

$\therefore$ Percentage of N = $\dfrac{28}{60} \times 100 = 46\%$

40. (d) : NH_3 when dissolved in water forms,
$NH_3 + H_2O \longrightarrow NH_4^+ + OH^- \rightleftharpoons NH_4OH$

41. (b) $\qquad$ **42. (a)** $\qquad$ **43. (a)**

44. (b) : Both carbanion (formed in presence of a base) and enol form (formed in presence of an acid) act as nucleophiles and hence, react with the carbonyl group of aldehydes and ketones to give aldols. These, aldols are further dehydrated in presence of an acid to give α, β-unsaturated aldehydes or ketones.

45. (a) : In a Frenkel defect, an ion leaves its position in the lattice and occupies normally vacant interstitial position. Hence, density remains the same.

46. (c) : Passivity is attained by formation of a thin film of oxide on iron.

47. (d) : Aryl halides (chlorobenzene) do not undergo nucleophilic substitution with KCN because of the low reactivity of the Cl atom, which is because of resonance in chlorobenzene. CN^- is a strong nucleophile.

48. (b) : At constant temperature, plot of *PV vs V* for real gases is not linear because real gases have intermolecular forces of attraction.

49. (d) : $2p_x$ and $2p_y$ have same energy, so neither energy will be released nor spectral line will be seen.

50. (c) : Reaction follows S_N2 mechanism which does not proceed through a carbocation formation.

51. (b) $\qquad$ **52. (b)** $\qquad$ **53. (a)** $\qquad$ **54. (a)**

55. (c) : The application of opposite potential greater than 1.1 V result into the flow of electron from cathode to anode and zinc is deposited at zinc electrode (cathode) and copper is dissolved at copper electrode (anode).

56. (a)

57. (a) : Molality = $\dfrac{\text{Number of moles of solute}}{\text{Weight of solvent (in kg)}}$

If number of moles of solute = 1
Weight of solvent = 1 kg
then, molality = 1, *i.e.*, one molal solution
For glucose ($C_6H_{12}O_6$), molecular weight = 180
number of moles = 180/180 = 1
Weight of water = 1 kg
Hence, molality of the solution is one.

58. (a) $\qquad$ **59. (a)**

60. (a) : Sulphuric acid is consumed due to formation of lead sulphate and hence, density decreases. ◈◈

CHEMISTRY MUSING

SOLUTION SET 43

1. **(d) :** $pV = nRT$

$$pV = \frac{w}{M}RT \; ; \; p_{O_2}V = \frac{w}{32}RT \; ; \; p_{N_2}V = \frac{w}{28}RT$$

$$\frac{p_{O_2}}{p_{N_2}} = \frac{28}{32}; \; p_{O_2} = 0.875\, p_{N_2}$$

2. **(a) :** No. of atoms in unit cell = 1 + 2 = 3
Volume of unit cell = 24×10^{-24} cm^3
Density = 7.2 g cm^{-3}

Now, density $= \dfrac{n \times \text{At.wt.}}{V \times N_A}$

$\therefore \;\; 7.2 = \dfrac{3 \times \text{At.wt.}}{24 \times 10^{-24} \times 6.023 \times 10^{23}} \Rightarrow$ At. wt. = 34.69 g

As, 34.69 g of element contains 6.023×10^{23} atoms

$\therefore \;\;$ 200 g has $\dfrac{6.023 \times 10^{23} \times 200}{34.69}$ atoms

$= 3.4724 \times 10^{24}$ atoms $\approx 3.5 \times 10^{24}$ atoms

3. **(b) :**

(C)
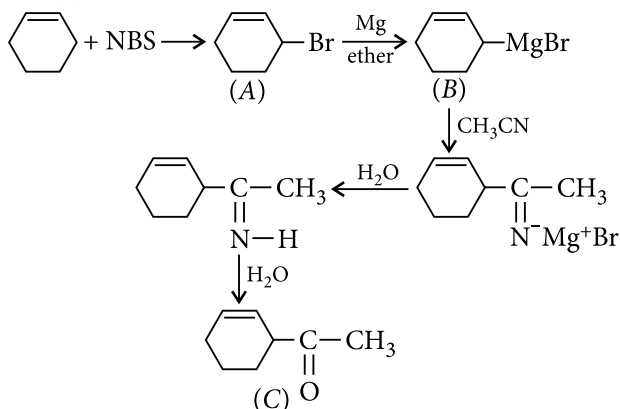
Due to the presence of α-hydrogen it can participate in aldol reaction but will not give Cannizzaro reaction. Also, carbonyl group undergoes Clemmensen reduction in presence of Zn/HCl.

4. **(c) :** (I) Four unpaired electrons.
(II) Three unpaired electrons.
(III) Five unpaired electrons.
(IV) One unpaired electron.

5. **(c) :**
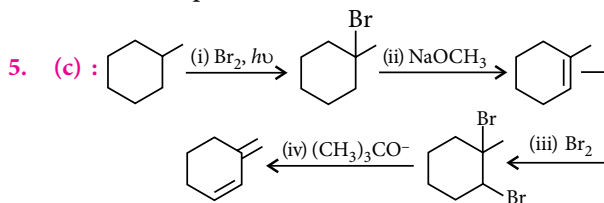
6. **(a) :** We know, $K_{sp}(\text{PbS}) = [\text{Pb}^{2+}][\text{S}^{2-}]$
Since, the lead salt is completely dissociated, $[\text{Pb}^{2+}]$ is equal to the concentration of the lead salt, *i.e.*, $[\text{Pb}^{2+}] = 0.001$ M. If $[\text{S}^{2-}]$ is the concentration of S^{2-} required to just start the precipitation of PbS,

$$[\text{S}^{2-}] = \frac{3.4 \times 10^{-28}}{0.001} = 3.4 \times 10^{-25}\ \text{M}$$

Now, the addition of HCl will suppress the dissociation of H_2S to that extent that is $[\text{S}^{2-}] = 3.4 \times 10^{-25}$ M.
As, HCl is completely ionised. $\therefore \; [\text{H}^+] = [\text{HCl}]$
Let $[\text{HCl}]$ be x, therefore, $[\text{H}^+] = x$

$\text{H}_2\text{S} \rightleftharpoons 2\text{H}^+ + \text{S}^{2-}$
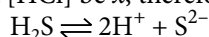
At equilibrium, $[\text{H}_2\text{S}] = 0.1 - 3.4 \times 10^{-25} \approx 0.1$
$[\text{H}^+] = 2 \times 3.4 \times 10^{-25} + x \approx x$
$[\text{S}^{2-}] = 3.4 \times 10^{-25}$

$\therefore \;\; K_a = \dfrac{[\text{H}^+]^2[\text{S}^{2-}]}{[\text{H}_2\text{S}]}$

$$1.1 \times 10^{-23} = \frac{x^2(3.4 \times 10^{-25})}{0.1}$$

$$x^2 = \frac{0.1 \times 1.1 \times 10^{-23}}{3.4 \times 10^{-25}} \Rightarrow x^2 = 3.2356$$

$x = 1.80 \Rightarrow [\text{HCl}] = 1.80$ M

Thus, any concentration of HCl greater than 1.80 M will just prevent the precipitation of PbS.

7. **(d) :** $\text{AlH}_4^- = sp^3$, tetrahedral = $18e^-$
$\text{BH}_4^- = sp^3$, tetrahedral = $10e^-$
$\text{AlCl}_4^- = sp^3$, tetrahedral = $82e^-$

8. **(a) :** In $\text{Al(BH}_4)_3$, each BH_4^- forms two hydrogen bridges.

9. **(3) :** Compounds containing carbonyl group will exhibit both nucleophilic addition reaction as well as Wolff–Kishner reduction reaction.

10. **(2) :** $B^{n+} \longrightarrow B^{(n+4)+}$

millimoles at $t = 0$: $\quad a \qquad\quad 0 \qquad B^{n+} \to B^{(n+2)+} + 2e^-$
$\qquad\qquad t = 10 : (a - x) \qquad x \quad 5e^- + B^{(n+4)+} \to B^{(n-1)+}$

Let normality be N for reducing agent.

Thus, at $t = 0$, $a \times 2 = N \times 25$; $\;\therefore\;\; a = \dfrac{25}{2}N$

At $t = 10$, $\underset{\text{for } B^{n+}}{(a - x) \times 2} \; + \; \underset{\text{for } B^{(n+4)+}}{x \times 5} = N \times 32$

$\therefore \;\; 3x = 7N$ or $x = \dfrac{7}{3}N$

Now, $\quad k = \dfrac{2.303}{10} \log \dfrac{25/2N}{\left(\dfrac{25}{2} - \dfrac{7}{3}\right)N} = \dfrac{2.303}{10} \log \dfrac{25 \times 6}{2 \times 61}$

$k = 2.07 \times 10^{-3}$ min$^{-1} \approx 2 \times 10^{-3}$ min$^{-1} \Rightarrow x = 2$

◈ ◈

CONCEPT MAP

SOME IMPORTANT COMPOUNDS OF GROUP 13 & GROUP 14

Boron and silicon compounds find applications in industry and technology. Agriculture, fire retardants, soaps and detergents rely on boron compounds. Silicon compounds are useful in glass making and electronic devices. Carbon dioxide being heavy and non-supporter of combustion, is used as fire-extinguisher.

Class XI

Group 13

Borax ($Na_2B_4O_7 \cdot 10H_2O$)

Preparation

$$Ca_2B_6O_{11} + 2Na_2CO_3 \xrightarrow{\Delta} Na_2B_4O_7$$
Colemanite $+ 2NaBO_2 + 2CaCO_3$
$$4NaBO_2 + CO_2 \rightarrow Na_2B_4O_7 + Na_2CO_3$$

Properties

$$Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$$
Transparent glassy bead
$$Na_2B_4O_7 + 2NaOH \rightarrow 4NaBO_2 + H_2O$$
$$Na_2B_4O_7 + H_2SO_4 \rightarrow Na_2SO_4 + H_2B_4O_7$$
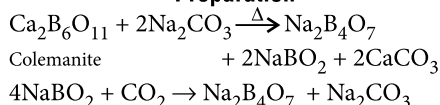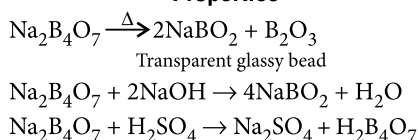
Uses
- As water softener and cleansing agent.
- In the laboratory for *borax bead test*.

Diborane (B_2H_6)

Preparation

$$2NaBH_4 + I_2 \xrightarrow{Diglyme} B_2H_6 + 2NaI + H_2$$
$$2BF_3 + 6NaH \xrightarrow{450\ K} B_2H_6 + 6NaF$$

Properties
$$B_2H_6 + 3O_2 \rightarrow B_2O_3 + 3H_2O;$$
$$\Delta_c H° = -1976\ kJ\ mol^{-1}$$
$$3B_2H_6 + 6NH_3 \rightarrow 3[BH_2(NH_3)_2]^+[BH_4]^-$$
$$\xrightarrow{\Delta} 2B_3N_3H_6 + 12H_2$$
Borazine
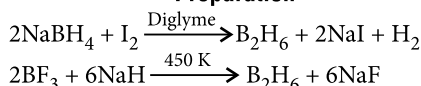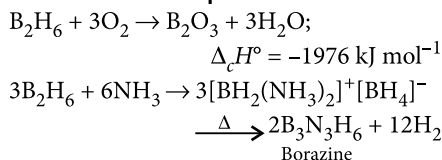
Uses
- For preparing a number of borohydrides such as $LiBH_4$, $NaBH_4$, etc.
- As a reducing agent in organic reactions.

Borazine or Borazole ($B_3N_3H_6$)

Preparation

$$3B_2H_6 + 6NH_3 \xrightarrow{\Delta} 2B_3N_3H_6 + 12H_2$$
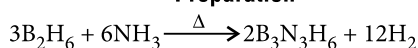
Properties
The π-bond in borazine is formed by back bonding involving filled *p*-orbital of N and vacant *p*-orbital of B. However, borazine is more reactive than benzene.
$$B_3N_3H_6 + 3HCl \rightarrow B_3N_3H_9Cl_3$$
$$B_3N_3H_6 + 9H_2O \rightarrow 3NH_3 + 3H_3BO_3 + 3H_2$$
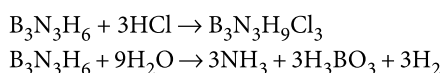
Orthoboric acid (H_3BO_3)

Preparation
$$Na_2B_4O_7 + 2HCl + 5H_2O \rightarrow$$
$$4H_3BO_3 + 2NaCl$$
$$Ca_2B_6O_{11} + 4SO_2 + 11H_2O \rightarrow$$
$$2Ca(HSO_3)_2 + 6H_3BO_3$$

Properties
$$H_3BO_3 \xrightarrow{370\ K} HBO_2 + H_2O$$
$$\xrightarrow[-H_2O]{410\ K} H_2B_4O_7$$
Red | Heat
$$2B_2O_3 + H_2O$$
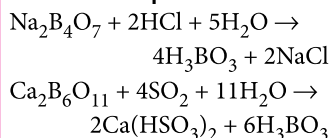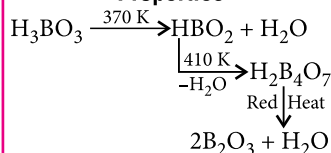
Uses
- It is used in the manufacture of heat resistant borosilicate glass.
- The aqueous solution of boric acid is used as eye wash under the name *boric lotion*.

Silicates

Types of silicates
- Orthosilicates contain discrete SiO_4^{4-} tetrahedra.
- Pyrosilicates contain $Si_2O_7^{6-}$ anions.
- Cyclic or ring silicates contain $(SiO_3)_n^{2n-}$ anions.
- Chain silicates contain $(SiO_3^{2-})_n$ anions.
- Sheet silicates contain $(Si_2O_5)_n^{-2n}$ anions.
- Three dimensional silicates contain three dimensional network structure.

Preparation

$$2CH_3Cl + Si \xrightarrow{Cu\ power}_{570\ K}$$
$$(CH_3)_2SiCl_2 \xrightarrow{+2H_2O}_{-2HCl}$$
$$(CH_3)_2Si(OH)_2$$
$$n(CH_3)_2Si(OH)_2 \xrightarrow{-nH_2O}_{Polymerisation}$$
Silicones

Group 14

Carbon dioxide (CO_2)

Preparation
$$C_{(s)} + O_{2(g)} \xrightarrow{\Delta} CO_{2(g)}$$
$$CH_{4(g)} + 2O_{2(g)} \xrightarrow{\Delta} CO_{2(g)} + 2H_2O_{(g)}$$

Properties
$$CO_2 + 4Na \rightarrow 2Na_2O + C$$
$$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$$
(Insoluble)
$$CO_2 + Zn \rightarrow ZnO + CO$$
$$CO_2 + C \rightarrow 2CO$$
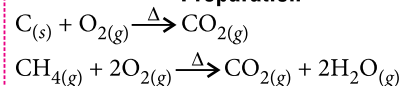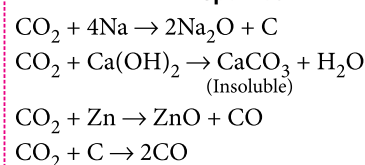
Uses
- In the manufacture of soda.
- As carbogen [mixture of O_2 + CO_2 (5-10%)] in artificial respiration especially for pneumonia patients and victims of CO poisoning.

Silicon dioxide (SiO_2)

Properties
Almost non-reactive due to high Si—O bond enthalpy, however, it is attacked by HF and NaOH.
$$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$$
$$SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$$

Uses
- Quartz is extensively used as a *piezoelectric material*.
- Silica gel is used as a drying agent and as a support for chromatographic materials and catalysts.

Silicones

$$R-\left(\begin{array}{c} R \\ | \\ Si-O \\ | \\ R \end{array}\right)_n$$

where R = alkyl or phenyl group
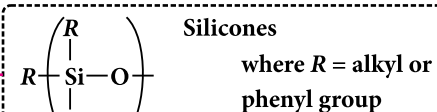
Uses
- They are used as sealant, greases, electrical insulators and for water proofing of fabrics.

STEREOCHEMISTRY

Stereochemistry is a unique part of chemistry concerned with the study of the spatial arrangement of atoms and molecules in the compound, its effect on chemical reaction and relations to the properties of compounds. It is also known as 3D chemistry. Different enantiomers have different selectivity for biological targets and have different biological actions. Hence, stereochemistry have great importance in pharmaceutical industry.

Class XII

CONCEPT MAP

Stereoisomers

The isomers that are different from each other only in the way the atoms are oriented in space are called *stereoisomers*.

Absolute Configuration (*R* and *S* system of nomenclature)

In order to designate absolute configurations a system of nomenclature called *Cahn-Ingold-Prelog system* has been developed.

- Assign priority to the groups attached. Higher atomic number will get higher priority.
- The H atom or group of lowest priority is brought vertically in Fischer projection.

R-configuration
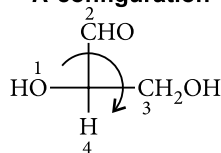
Move the arrow in order of decreasing priority. If it rotates clockwise, configuration is *R* (*rectus*) configuration.

S-configuration
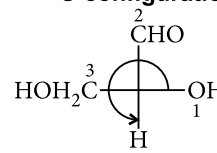
Move the arrow in order of decreasing priority. If it rotates anti-clockwise, then the configuration is *S* (*sinister*) configuration.

Enantiomers

Stereoisomers having non super-imposable mirror images are optically active and these are called *enantiomers*.
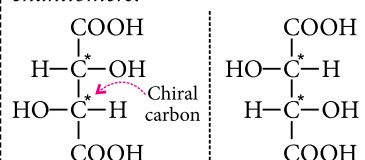
Mirror

(dextrorotatory) *d*-enantiomer — Rotates the plane polarised light towards right.

(laevorotatory) *l*-enantiomer — Rotates the plane polarised light towards left.

Diastereomers

Stereoisomers that are not mirror images of each other are called *diastereomers*.
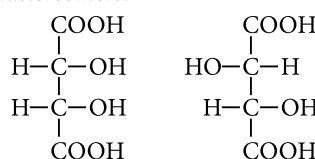
Number of stereoisomers

The number of stereoisomers depends on structure and number of asymmetric carbon atoms present in the molecule.

In unsymmetrical molecule

Number of enantiomers $= 2^n$

Meso forms $= 0$

Total optical isomers $= 2^n$

where, n = number of chiral or asymmetric carbon atoms.

In symmetrical molecule

- When n is odd,

  Number of enantiomers $= 2^{(n-1)} - 2^{(0.5n - 0.5)}$

  Meso forms $= 2^{(0.5n - 0.5)}$

  Total optical isomers $= 2^{(n-1)}$

- When n is even,

  Number of enantiomers $= 2^{(n-1)}$

  Meso forms $= 2^{(n/2-1)}$

  Total optical isomers $= 2^{(n-1)} + 2^{(n/2-1)}$

Meso form

If plane of symmetry is present in the molecule then, one of the isomer will be optically inactive due to internal compensation because half of the molecule will rotate the plane polarised light towards right and another half towards left. So, total rotation of plane polarised light will be zero.

(*Meso*-form)

Racemic mixture

If both *d* and *l* enantiomers present in equal amount (50-50%) then the mixture is optically inactive due to external compensation, the mixture is known as *racemic mixture*.

(*d*-isomer) (50%) + (*l*-isomer) (50%)

Resolution of racemic mixture

The process of separation of a racemic mixture into *d*- and *l*-forms is called *resolution*.

Following are the methods by which a racemic mixture can be resolved:

- Mechanical separation
- Biochemical separation
- Chemical separation
- Chromatographic method
- Selective adsorption method

Racemisation

Conversion of (+) or (−) isomer into its racemic mixture (±) is known as *racemisation*. It is reverse of resolution and can be carried out either by heat, light or use of chemical reagents, etc.

NEET | JEE
ESSENTIALS

Class XI

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Unit 9 — PRINCIPLES RELATED TO PRACTICAL CHEMISTRY

SALT ANALYSIS

The qualitative salt analysis deals with the identification of acidic radicals (anions) and basic radicals (cations) in an inorganic salt or in a mixture of salts.

$$A_xB_y \text{ Salt}$$

A^{y+} Cation (Basic radical)

B^{x-} Anion (Acidic radical)
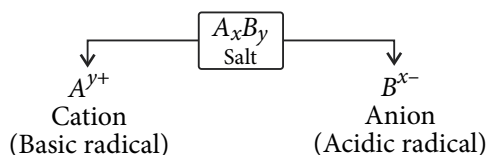
PRELIMINARY TESTS

✤ Note the state (amorphous or crystalline) and colour of the salt.

✤ **Colour of the salt :**

Colour

White
NH_4^+, Pb^{2+}, Al^{3+}, Zn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}

Blue Cu^{2+}

Green Ni^{2+}, Cr^{3+}

Brown Fe^{3+}

Light green Fe^{2+}

Pink Co^{2+}

Light pink Mn^{2+}

✤ **Odour of the salt :**

Odour

Ammoniacal NH_4^+

Vinegar CH_3COO^-

Rotten egg S^{2-}

✤ **Flame test :**

Salt with 1-2 drops of conc. HCl is introduced in the non-luminous (oxidising part) flame of the Bunsen burner using platinum wire.

Cu^{2+} — Greenish blue

K^+ — Lilac

Na^+ — Golden yellow

Ca^{2+} — Brick red

Ba^{2+} — Apple green

Sr^{2+} — Crimson red
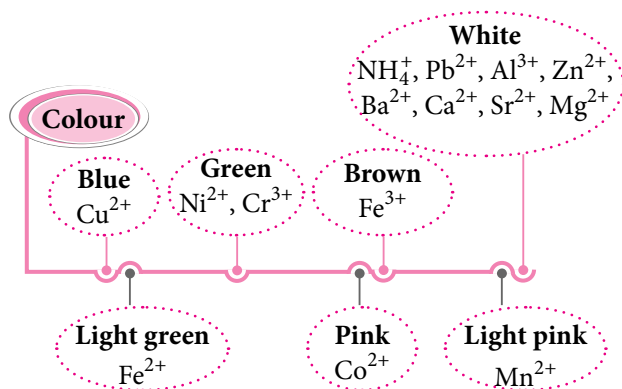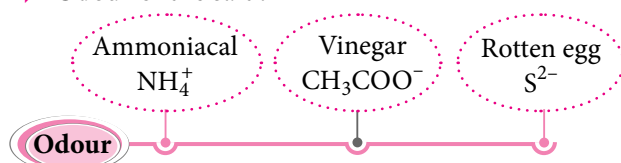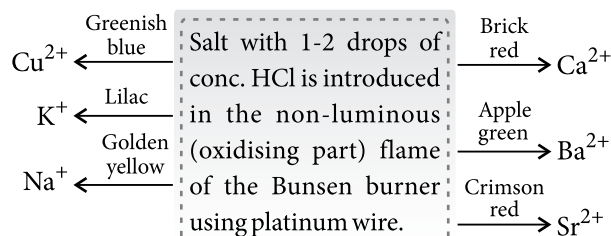
✤ **Borax bead test :**

➤ Borax is heated on a loop of Pt wire, colourless glassy bead of sodium metaborate and boric anhydride is formed.

$$Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7 \xrightarrow{\Delta} \underbrace{2NaBO_2 + B_2O_3}_{\text{Glassy bead}}$$
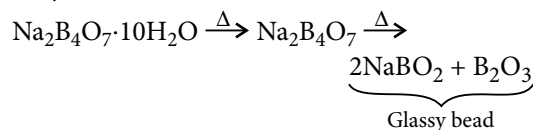
➤ Coloured salts are then heated on the glassy bead, coloured metaborate is formed in the oxidising flame.

Colour of bead in oxidising flame	Ion indicated
Green in hot, light brown in cold	Copper
Pinkish violet in both hot and cold	Manganese
Yellowish brown in hot and pale yellow in cold	Iron
Brown in hot and pale brown in cold	Nickel

ANIONS OR ACIDIC RADICALS

Anions

First group : CO_3^{2-}, S^{2-}, SO_3^{2-}, CH_3COO^-, $S_2O_3^{2-}$, NO_2^-

Second group : Br^-, Cl^-, I^-, NO_3^-, $C_2O_4^{2-}$

Third group : SO_4^{2-}, PO_4^{3-}

↳ **First group :**
Group reagent : dil. HCl

Salt + dil. HCl

Effervescence or evolution of gas shows presence of 1ˢᵗ group

Colourless gas with suffocating smell with yellow ppt. of sulphur $\xrightarrow{\text{Pass through } K_2Cr_2O_7}$ Blackish green solution $\longrightarrow S_2O_3^{2-}$ confirmed

Brown gas (NO_2) $\xrightarrow{\text{Starch iodide paper}}$ Blue $\longrightarrow$ NO_2^- confirmed

Colourless gas with vinegar smell (CH_3COO^- may be present) Salt solution + $FeCl_3$ (neutral) $\longrightarrow$ $(CH_3COO)_3Fe \longrightarrow CH_3COO^-$ confirmed
Blood red colour solution

Colourless gas with suffocating smell (SO_2) $\xrightarrow[\text{through } K_2Cr_2O_7]{\text{Heat and pass}}$ Solution turns green due to $Cr_2(SO_4)_3 \longrightarrow SO_3^{2-}$ confirmed

Colourless gas with rotten egg smell (H_2S gas) $\xrightarrow{\text{Lead acetate}}$ PbS $\longrightarrow S^{2-}$ confirmed
Black ppt.

- Colourless and odourless gas (CO_2 gas) $\xrightarrow{\text{Lime water}}$ $CaCO_3$ (CO_3^{2-} or HCO_3^- may be present)
  milky
- Confirmation test for HCO_3^- & CO_3^{2-}

Salt + water $\rightarrow$ boil and pass through lime water

Lime water turns milky ↓ HCO_3^- confirmed	Lime water does not turn milky ↓ CO_3^{2-} confirmed

↳ **Second group :**
Group reagent : Conc. H_2SO_4

Salt + conc. H_2SO_4
Heat if required

Effervescence or evolution of gas shows presence of 2ⁿᵈ group

Colourless gas with pungent smell (HCl gas) $\xrightarrow{\text{Glass rod dipped in } NH_4OH \text{ is exposed}}$ White fumes (NH_4Cl) ↓ Cl^- may be present

Brown gas $\xrightarrow{\text{Pieces of copper turning}}$ More brown fumes with blue solution ↓ NO_3^- may be present | Not a blue solution ↓ Br^- may be present

Violet gas (I_2) $\xrightarrow{MnO_2 + H_2SO_4}$ Violet colour intensifies (more I_2) ↓ I^- may be present

Colourless and odourless gas (CO + CO_2) $\xrightarrow{\text{Burn}}$ Blue flame ↓ $C_2O_4^{2-}$ may be present

Confirmatory tests of acid radicals :

Nitrate (NO_3^-)

Brown ring test : On treating aqueous solution of salt with freshly prepared solution of ferrous sulphate and concentrated sulphuric acid, gives a brown ring at the junction of two liquids.

$$NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$$
Salt

$$6FeSO_4 + 2HNO_3 + 3H_2SO_4 \longrightarrow$$
$$3Fe_2(SO_4)_3 + 4H_2O + 2NO$$

$$[Fe(H_2O)_6]SO_4 + NO \longrightarrow$$
$$[Fe(H_2O)_5NO]SO_4 + H_2O$$
Brown ring
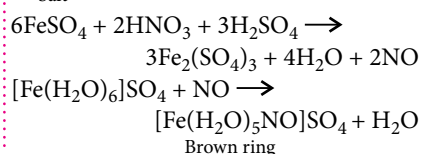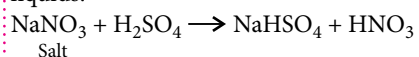
Oxalate ($C_2O_4^{2-}$)

On acidifying sodium carbonate extract with acetic acid and on adding cadmium chloride solution gives white precipitate. Filter and dissolve the precipitate in dilute sulphuric acid and add few drops of potassium permanganate solution. The colour of potassium permanganate is discharged, indicates the presence of oxalate.

$$Na_2C_2O_4 + CaCl_2 \longrightarrow CaC_2O_4\downarrow +$$
Sodium carbonate extract · White ppt.
$$2NaCl$$

$$CaC_2O_4 + H_2SO_4 \longrightarrow H_2C_2O_4 + CaSO_4$$
$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4$$
$$+ 3H_2O + 5[O]$$

$$\begin{matrix} COOH \\ | \\ COOH \end{matrix} + [O] \longrightarrow 2CO_2 + H_2O$$
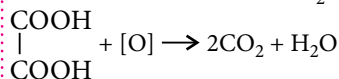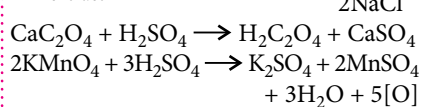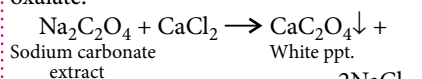
Chloride (Cl^-)

Chromyl chloride test : On heating salt with concentrated sulphuric acid in the presence of potassium dichromate, deep red vapours of chromyl chloride are evolved.

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$$
Salt

$$K_2Cr_2O_7 + 2H_2SO_4 \longrightarrow 2KHSO_4$$
$$+ 2CrO_3 + H_2O$$

$$CrO_3 + 2HCl \longrightarrow CrO_2Cl_2\uparrow + H_2O$$
Chromyl chloride (Red vapours)
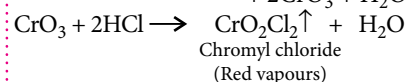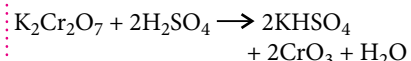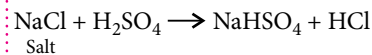
These vapours on passing through sodium hydroxide solution give yellow solution of sodium chromate.

$$CrO_2Cl_2 + 4NaOH \longrightarrow Na_2CrO_4 +$$
Yellow colour
$$2NaCl + 2H_2O$$
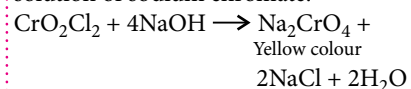
The yellow solution on neutralising with acetic acid and on addition of lead acetate gives yellow precipitate of lead chromate.

$$Na_2CrO_4 + (CH_3COO)_2Pb \longrightarrow$$
$$PbCrO_4\downarrow + 2CH_3COONa$$
Yellow ppt.
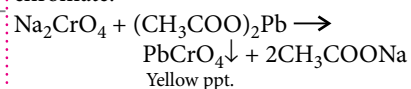
Iodide (I^-)

Layer test : On treating salt with dilute sulphuric acid, chloroform or carbon tetrachloride and chlorine water, gives violet coloured layer.

Chlorine replaces iodine that dissolves in chloroform.

$$2NaI + Cl_2 \longrightarrow 2NaCl + I_2$$
Salt

$$I_2 + Chloroform \longrightarrow Violet\ coloured$$
layer
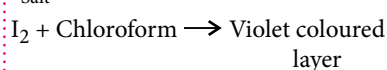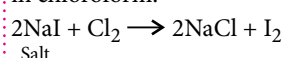
Starch paper test : Violet vapours with starch paper give blue colour.

$$I_2 + Starch \longrightarrow I_2\text{-starch complex}$$
Blue colour
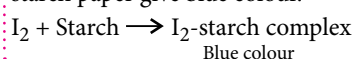
Confirmatory tests for acid radicals of group II

Bromide (Br^-)

Layer test : On treating salt with dilute sulphuric acid, chloroform or carbon tetrachloride and chlorine water gives brown coloured layer. Chlorine replaces bromine that dissolves in chloroform.

$$2NaBr + Cl_2 \longrightarrow 2NaCl + Br_2$$
Salt

$$Br_2 + Chloroform \longrightarrow Brown\ coloured\ layer$$

iNFO SHOTS
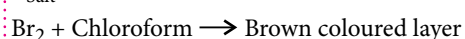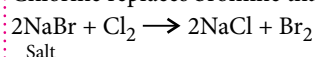
New system to detect mercury in water systems!

A new ultra-sensitive, low-cost and portable system for detecting mercury in environmental water has been developed by University of Adelaide researchers. The researchers team has engineered a nanoporous material called nanoporous anodic alumina to make a special structure called a rugate filter. The surface of the filter has been modified to make it selective to mercury ions. As water flows through the pores of the filter, the mercury ions become attached to the surface. An optical system–reflection spectroscopy–measures the amount of mercury present. A range of tests have shown the sensor can detect mercury at levels of 200 parts per billion in a complex mixture of other metal ions and environmental samples. Continued work will seek to enhance the optical signals for even higher sensitivity. The promising sensing performance of this system along with its cost-competiveness and portability make it an excellent potential alternative to current analytical techniques. This technique could provide the basis for future point-of-analysis systems for monitoring water quality on site and may help implement better monitoring processes around the world.

🔖 **Third group :** These radicals cannot be detected by either dil. H_2SO_4 or conc. H_2SO_4. For detection of these acidic radicals we need some specific tests.

$H_4SiO_4 \longrightarrow F^-$ confirmed
(Gelatinous white)   (Flouride)

$H_2SO_4 + SiO_2$

BaSO₄
White ppt.
(Insoluble in dil. HCl)

$\xleftarrow{\begin{array}{c}BaCl_2\\ dil.\ HCl\end{array}}$ **Salt** $\xrightarrow{\begin{array}{c}H_2SO_4\\ C_2H_5OH\end{array}}$

SO_4^{2-} confirmed
(Sulphate)

(C₂H₅)₃BO₃
Burns with green edged flame

BO_3^{3-} confirmed
(Borate)

2 mL soda extract +
dil. HNO_3 +
ammonium molybdate

$(NH_4)_3PO_4 \cdot 12MoO_3 \longrightarrow PO_4^{3-}$ confirmed
(Canary yellow ppt.)   (Phosphate)
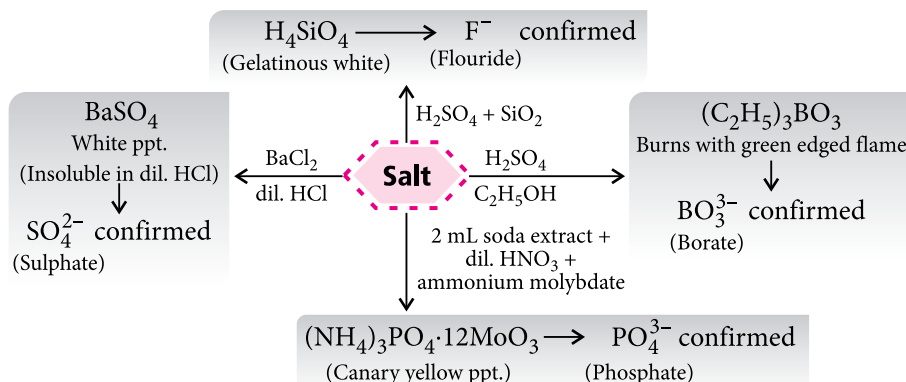
CATIONS OR BASIC RADICALS

Group	Group reagent	Cations	Form of ppt.
I	dil. HCl	Pb^{2+}, Ag^+, Hg_2^{2+}	Chlorides
II	dil. HCl + H_2S gas	Pb^{2+}, Hg^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sb^{3+}, As^{3+}, Sn^{2+}/Sn^{4+}	Sulphides
III	$NH_4Cl + NH_4OH$	Fe^{3+}, Al^{3+}, Cr^{3+}	Hydroxides
IV	$NH_4Cl + NH_4OH + H_2S$ gas	Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}	Sulphides
V	$(NH_4)_2CO_3 + NH_4OH$	Ca^{2+}, Sr^{2+}, Ba^{2+}	Carbonates
VI	$Na_2HPO_4 + NH_4OH$	Mg^{2+}	–

🔖 **Identification of basic radicals :**

Original solution $\xrightarrow{dil.\ HCl}$

Group I
AgCl, PbCl₂, Hg₂Cl₂ (All white).
K_{sp} values of their chlorides are low, hence, $K_{ip} > K_{sp}$ and they get precipitated.

$\xrightarrow{\begin{array}{c}\text{Separate}\\ \text{solution}\\ \text{from ppt.}\end{array}}$ Solution containing groups II, III, IV, V and VI $\xrightarrow{\text{Pass } H_2S \text{ Gas}}$

Group III
Fe(OH)₃ (Reddish brown), Cr(OH)₃ (Green), Al(OH)₃ (White). Common NH_4^+ ion from NH₄Cl decreases the ionisation of NH₄OH thus low $[OH^-]$. Hence, only these hydroxides of lower K_{sp} values are precipitated.

$\xleftarrow{\begin{array}{c}NH_4OH\ in\\ \text{presence of}\\ NH_4Cl\end{array}}$ Solution containing groups III, IV, V and VI $\xleftarrow{\begin{array}{c}\text{Separate}\\ \text{solution}\\ \text{from ppt.}\end{array}}$

Group II
HgS, PbS, Bi₂S₃, CuS (Black), CdS, As₂S₃, SnS₂ (Yellow), Sb₂S₃ (Orange), SnS (Brown). Due to common ion H^+ from HCl, the ionisation of H_2S decreases thus low $[S^{2-}]$. Hence, these sulphides of lower K_{sp} values are precipitated.

Group IV
ZnS (Greenish white), MnS (Buff), CoS, NiS (Black). Basic medium increases the ionisation of H_2S, thus high $[S^{2-}]$. Hence, these sulphides with high values of K_{sp} undergo precipitation.

$\xrightarrow{\begin{array}{c}\text{Separate}\\ \text{solution}\\ \text{from ppt.}\end{array}}$ Solution containing groups V and VI

$\xrightarrow{\begin{array}{c}(NH_4)_2CO_3 \text{ in presence}\\ \text{of } NH_4OH\end{array}}$

Group V
BaCO₃, SrCO₃, CaCO₃ (All white). These carbonates have lower K_{sp} values than that of Mg^{2+}. Hence, they are precipitated before Mg^{2+}

$\xleftarrow{\begin{array}{c}\text{Separate}\\ \text{solution}\\ \text{from ppt.}\end{array}}$ Solution containing group VI $\xleftarrow{\begin{array}{c}Na_2HPO_4\\ \text{in presence}\\ \text{of } NH_4OH\end{array}}$

Group VI
Mg(NH₄)PO₄ (White)

$\xleftarrow{\begin{array}{c}H_2S\ in\\ \text{presence of}\\ NH_4OH\end{array}}$ Solution containing groups IV, V and VI $\xleftarrow{\begin{array}{c}\text{Separate}\\ \text{solution}\\ \text{from ppt.}\end{array}}$

✥ **Confirmatory tests of basic radicals :**

Precipitates	Confirmatory Tests
Group I	
AgCl	Dissolves in NH_4OH, white ppt. of AgCl is again obtained on adding dil. HNO_3. Yellow ppt. of AgI is formed on adding KI.
$PbCl_2$	Dissolves in hot water, gives yellow ppt. of $PbCrO_4$ with K_2CrO_4 and yellow ppt. of PbI_2 with KI.
Hg_2Cl_2	Turns black with NH_4OH. Black residue $\{Hg + Hg(NH_2)Cl\}$ dissolves in aquaregia forming mercuric chloride $(HgCl_2)$. On addition of stannous chloride solution to $HgCl_2$ white ppt. (Hg_2Cl_2) is formed which turns grey (Hg).
Group II A	Precipitates do not dissolve in yellow ammonium sulphide.
HgS	Dissolves in aquaregia, grey ppt. of Hg is obtained with $SnCl_2$ or Cu turnings.
PbS	Dissolves in dil. HNO_3, white ppt. of $PbSO_4$ is obtained on adding dil. H_2SO_4.
Bi_2S_3	Dissolves in dil. HCl, white ppt. of BiOCl is obtained on adding excess of water. Black ppt. of Bi is obtained on adding Na_2SnO_2 solution.
CuS	Blue coloured solution is obtained on adding dil. HNO_3 and excess of NH_4OH which gives chocolate brown ppt. of $Cu_2[Fe(CN)_6]$ with $K_4[Fe(CN)_6]$.
CdS	Colourless solution is obtained on adding dil. HNO_3 and excess of NH_4OH, which gives yellow ppt. of CdS again on adding H_2S.
Group II B	Precipitates dissolve in yellow ammonium sulphide.
As_2S_3	Insoluble sulphide, As_2S_5 is obtained by treating with conc. HCl, which gives yellow ppt. of ammonium arsenomolybdate on adding conc. HNO_3 and heating with ammonium molybdate.
SnS_2 or SnS	Filtrate of sulphide in conc. HCl is reduced to $SnCl_2$ by treating with Fe or Zn which on adding $HgCl_2$ solution initially gives white ppt. of Hg_2Cl_2 and finally turns to grey Hg.
Sb_2S_3	Filtrate of sulphide in conc. HCl gives white ppt. of SbOCl on adding excess of water and orange ppt. of Sb_2S_3 on passing H_2S gas.
Group III	
$Fe(OH)_3$	Dissolves in dil. HCl, gives prussian blue solution or ppt. of $Fe_4[Fe(CN)_6]_3$ on adding $K_4[Fe(CN)_6]$ and blood red coloured $Fe(CNS)_3$ on adding KCNS.
$Cr(OH)_3$	The solution obtained on heating precipitate with NaOH and Br_2 water contains Na_2CrO_4 which gives yellow ppt. of $PbCrO_4$ on treating with acidified lead acetate solution.
$Al(OH)_3$	Dissolves in NaOH and is again precipitated out on boiling with NH_4Cl.
Group IV	Soluble in conc. HCl.
ZnS	Solution $(ZnCl_2)$ is treated with NaOH, a white ppt. of $Zn(OH)_2$ appears which dissolves in excess of NaOH and on passing H_2S, white ppt. of ZnS is obtained.
MnS	Precipitate of MnO_2 is obtained on heating the solution with NaOH and Br_2 water. $HMnO_4$ imparts pink colour to the supernatant liquid on treating the ppt. with excess of HNO_3 and red lead (Pb_3O_4).
Group IV	Insoluble in conc. HCl
CoS	Dissolves in aqua-regia. Yellow ppt. of potassium cobaltinitrite $K_3[Co(NO_2)_6]$ is obtained on adding CH_3COOH (in excess) and KNO_2.
NiS	Dissolves in aqua-regia. Red ppt. of Ni-dmg complex is obtained on adding NH_4OH in excess and dimethyl glyoxime.

Group V	Soluble in acetic acid.
$BaCO_3$	Yellow ppt. of $BaCrO_4$ is obtained on adding K_2CrO_4 to solution.
$SrCO_3$	White ppt. of $SrSO_4$ is obtained on adding $(NH_4)_2SO_4$ to solution.
$CaCO_3$	White ppt. of CaC_2O_4 is obtained on adding $(NH_4)_2C_2O_4$ to solution.
Group VI	
Mg^{2+}	White ppt. of $Mg(NH_4)PO_4$ is formed on adding Na_2HPO_4 and NH_4OH to solution.
Zero	
NH_4^+	Salt evolves NH_3 gas on heating with NaOH which gives dense white fumes of NH_4Cl with HCl and a brown ppt. of $H_2N \cdot HgO \cdot HgI$ on adding Nessler's reagent, K_2HgI_4.

DETECTION OF N, S, Cl IN ORGANIC COMPOUNDS

LASSAIGNE'S TEST

↬ It is a general test for the detection of halogen, nitrogen and sulphur in organic compounds. These elements are covalently bonded to the organic compounds. In order to detect them, these have to be converted into their ionic forms. This is done by fusing the organic compound with sodium metal. The ionic compounds formed during the fusion are extracted in aqueous solution and can be detected by simple chemical tests.

↬ **Lassaigne's extract :** A small pellet of metallic sodium together with a little amount of the substance is heated to red hot in an ignition tube. It is then suddenly plunged into about 10 mL of distilled water in a China dish. The mixture is boiled well and filtred. Filtrate is known as Lassaigne's extract (L.E.).
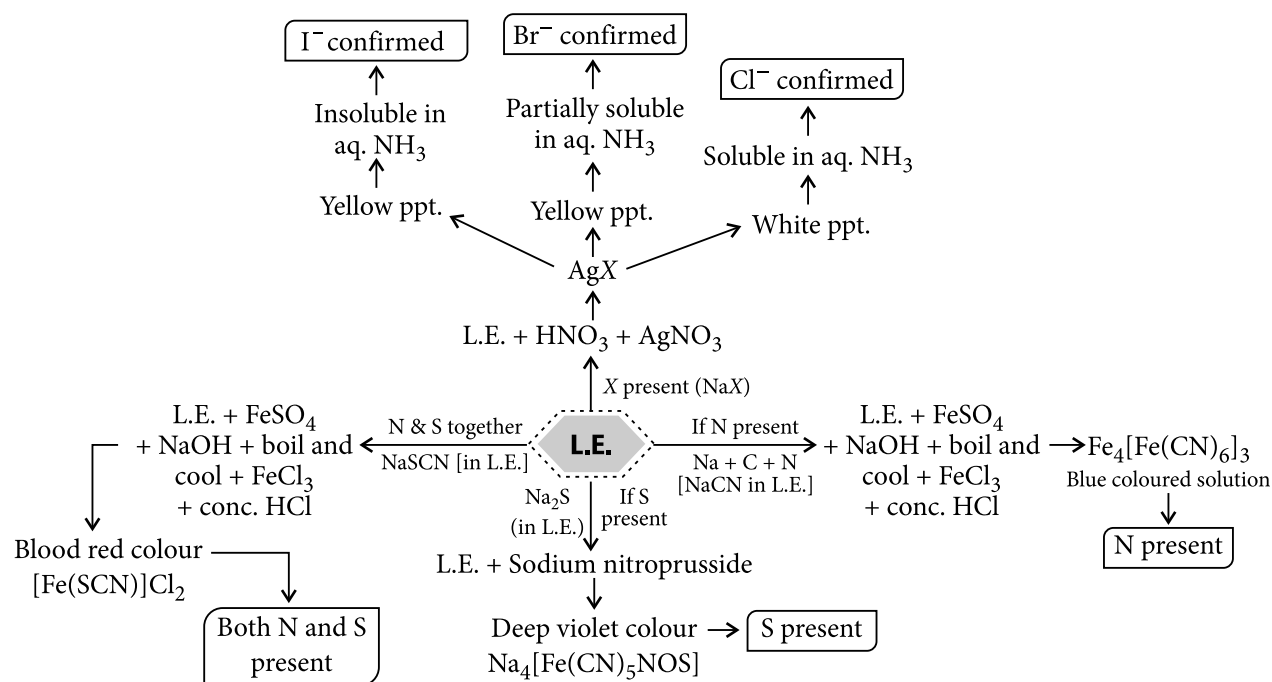
↬ When sodium fusion is carried out with excess of sodium, thiocyanate decomposes to cyanide and sulphide ions which give their usual tests. Thus, we do not get blood red colour with ferric chloride even though N and S both are present.

$$Na + C + N + S \longrightarrow NaCNS$$
$$\text{Sodium thiocyanate}$$
$$NaCNS + 2Na \longrightarrow NaCN + Na_2S$$
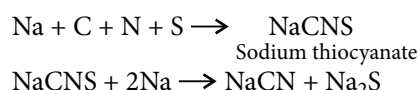
↬ Lassaigne's test fails in case of compounds which contain nitrogen but no carbon e.g., hydrazine (NH_2NH_2) and hydroxylamine (NH_2OH).

TITRATION

One of the important methods in quantitative analysis is volumetric analysis, a commonly used laboratory technique. It is used to determine the unknown concentration of a sample by measuring its volume.

ACID BASE TITRATION

↳ It is a method used to determine the strength of an acid or alkali and this type of titration is based on the neutralisation reaction.

$$AH + BOH \longrightarrow AB + H_2O$$
(Acid) (Base) (Salt)
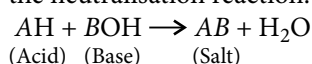
INDICATOR

↳ An indicator is a chemical substance that undergoes a colour change at the end point. The end point of an acid-base titration can be determined using acid-base indicators. Acid base indicators are either weak organic acids or weak organic bases. The colour change of an indicator depends on the pH of the medium. The un-ionized form of an indicator has one colour, but its ionized form has a different colour.

For example, consider the indicator phenolphthalein, whose ionization can be written as :

$$HPh + H_2O \longrightarrow H_3O^+ + Ph^-$$
Colourless   Pink
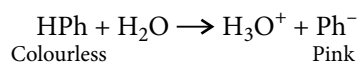
↳ **Some common examples of acid-base indicators :**

Indicators	pH Range	Acid	Base
Phenolphthalein	8.0 - 10.0	Colourless	Pink
Methyl orange	3.1 - 4.4	Red	Orange
Methyl red	4.4 - 6.2	Red	Yellow
Phenol red	6.4 - 8.0	Yellow	Red
Thymol blue	1.2 - 2.8	Red	Yellow
Thymol blue	8.0 - 9.6	Yellow	Blue
Methyl yellow	2.9 - 4.0	Red	Yellow

TITRIMETRIC CALCULATIONS

↳ **Strength of a solution :** It is the amount of solute in grams present per litre of the solution.
   - Strength (g/L) = Normality × Eq. wt.
   - Strength (g/L) = Molarity × Mol. mass

↳ **Normality equation :** $\underset{\text{(Solution 1)}}{N_1V_1} = \underset{\text{(Solution 2)}}{N_2V_2}$

↳ **Molarity equation :** $\underset{\text{(Solution 1)}}{M_1V_1n_1} = \underset{\text{(Solution 2)}}{M_2V_2n_2}$

$[\because N = M \times n, \text{ where } n = \text{valency factor}]$

SPEED PRACTICE

1. To a solution of an acid radical, $MgSO_4$ solution is added and white ppt. appears only on heating. The acid radical may be
(a) CO_3^{2-} (b) SO_3^{2-} (c) HCO_3^- (d) $C_2O_4^{2-}$

2. In second group, H_2S is passed in the presence of dil. HCl because
(a) HCl checks incomplete precipitation of higher group radicals
(b) HCl checks precipitation of sulphur
(c) both (a) and (b)
(d) none of the above.

3. During the titration of CH_3COOH with NaOH, the pH at the end point is likely to be
(a) less than 7   (b) more than 7
(c) equal to 7
(d) depends upon molarity of NaOH.

4. An aqueous solution of a salt gave white precipitate on treatment with dilute HCl. The precipitate dissolved in boiling water. Both the solutions give white precipitate with dilute H_2SO_4 and yellow precipitate with K_2CrO_4 and KI separately. The metal ion present in the solution is
(a) Hg(II) (b) Hg(I) (c) Pb(II)   (d)Cu (II)

5. Potassium chromate solution is added to an aqueous solution of a metal chloride. The precipitate thus obtained is insoluble in acetic acid. This is subjected to flame test, the colour of the flame is
(a) lilac   (b) apple green
(c) crimson red   (d) golden yellow.

6. An aqueous solution of 6.3 g oxalic acid dihydrate is made up to 250 mL. The volume of 0.1 N NaOH required to completely neutralise 10 mL of this solution is
(a) 40 mL (b) 20 mL (c) 10 mL   (d) 4 mL

7. Which one of the following statements is correct when SO_2 is passed through acidified $K_2Cr_2O_7$ solution?
(a) SO_2 is reduced.
(b) Green $Cr_2(SO_4)_3$ is formed.
(c) The solution turns blue.
(d) The solution is decolourised.

(NEET Phase-I 2016)

8. In the separation of Cu^{2+} and Cd^{2+} in 2nd group qualitative analysis of cations, tetrammine copper(II) sulphate and tetramminecadmium(II) sulphate react with KCN to form the corresponding cyano complexes. Which one of the following pairs of the complexes and their relative stability enable the separation of Cu^{2+} and Cd^{2+}?
(a) $K_3[Cu(CN)_4]$ more stable and $K_2[Cd(CN)_4]$ less stable.
(b) $K_2[Cu(CN)_4]$ less stable and $K_2[Cd(CN)_4]$ more stable.
(c) $K_2[Cu(CN)_4]$ more stable and $K_2[Cd(CN)_4]$ less stable.
(d) $K_3[Cu(CN)_4]$ less stable and $K_2[Cd(CN)_4]$ more stable.

9. 0.45 g of acid (molecular weight 90) is neutralised by 20 mL of 0.5 N caustic potash. The basicity of acid is
(a) 1   (b) 2   (c) 3   (d) 4

10. 35.4 mL of HCl is required for the neutralisation of a solution containing 0.275 g of sodium hydroxide. The normality of hydrochloric acid is
(a) 0.97 N   (b) 0.142 N
(c) 0.194 N   (d) 0.244 N

11. The reagent(s) that can selectively precipitate S^{2-} from a mixture of S^{2-} and SO_4^{2-} in aqueous solution is (are)
(a) $CuCl_2$ (b) $BaCl_2$
(c) $Pb(OOCCH_3)_2$ (d) $Na_2[Fe(CN)_5NO]$

(JEE Advanced 2016)

12. Two solutions of HCl, A and B have concentrations of 0.5 N and 0.1 N respectively. The volume of solutions A and B required to make 2 litre of 0.2 N HCl are
(a) 0.5 L of A and 1.5 L of B
(b) 1.5 L of A and 0.5 L of B
(c) 1.0 L of A and 1.0 L of B
(d) 0.75 L of A and 1.25 L of B.

13. In group IV analysis NH_4OH is added before passing H_2S gas because
(a) the sulphides of group IV are insoluble in NH_4OH
(b) the sulphides of other metals are soluble in NH_4OH

(c) the concentration of S^{2-} ions is high enough to precipitate the sulphides of group IV

(d) the sulphides of second group are soluble in NH_4OH.

14. A solution of a metal ion when treated with KI gives a red precipitate which dissolves in excess of KI to give a colourless solution. Moreover, the solution of metal ion on treatment with a solution of cobalt(II) thiocyanate gives rise to deep blue crystalline precipitate. The metal ion is
(a) Pb^{2+} (b) Hg^{2+} (c) Cu^{2+} (d) Co^{2+}

15. In the following reaction sequence in aqueous solution, the species X, Y and Z, respectively are

$$S_2O_3^{2-} \xrightarrow[\substack{\text{Clear} \\ \text{solution}}]{Ag^+} X \xrightarrow[\substack{\text{White} \\ \text{precipitate}}]{Ag^+} Y \xrightarrow[\substack{\text{Black} \\ \text{precipitate}}]{\text{With time}} Z$$

(a) $[Ag(S_2O_3)_2]^{3-}$, $Ag_2S_2O_3$, Ag_2S
(b) $[Ag(S_2O_3)_3]^{5-}$, Ag_2SO_3, Ag_2S
(c) $[Ag(SO_3)_2]^{3-}$, $Ag_2S_2O_3$, Ag
(d) $[Ag(SO_3)_3]^{3-}$, Ag_2SO_4, Ag

(JEE Advanced 2016)

16. Lassaigne's test for nitrogen is positive for which compound?
(a) NH_2OH (b) NH_2NH_2
(c) H_2NCONH_2 (d) All of these

17. When intimate mixture of potassium dichromate and KCl is heated with conc. H_2SO_4, which of the following is produced in the form of red vapours?
(a) CrO_3 (b) Cr_2O_3
(c) CrO_2Cl_2 (d) $CrCl_3$

18. A laboratory reagent on strongly heating gives two oxides of sulphur. On addition of aq. NaOH solution to its aqueous solution a dirty green precipitate is obtained. Identify the reagent.
(a) $FeSO_4$ (b) $CuSO_4$
(c) $Al_2(SO_4)_3$ (d) None of these

19. 25 mL of a solution of barium hydroxide on titration with a 0.1 molar solution of hydrochloric acid gave a titre value of 35 mL. The molarity of barium hydroxide solution was
(a) 0.14 M   (b) 0.28 M   (c) 0.35 M   (d) 0.07 M

20. The hottest region of Bunsen flame shown in the figure below is

(a) region 1   (b) region 2
(c) region 3   (d) region 4.

(JEE Main 2016)

21. Cl_2 gas is continuously passed with constant shaking through Lassaigne's extract containing CS_2. If the extract contains both NaBr and NaI, first a violet colour is produced, then the organic layer turns colourless and finally orange colour is seen in the CS_2 layer. The CS_2 turns colourless between violet and orange colour due to the formation of
(a) IBr   (b) ICl   (c) $BrCl_3$ (d) NaI_3

22. A solution containing Na_2CO_3 and $NaHCO_3$ is titrated against HCl. The volume of the acid used when methyl orange is added as indicator is 'x' mL and the volume of the acid used when phenolphthalein is added as indicator separately is 'y' mL. The volume of HCl used for the neutralisation of $NaHCO_3$ will be
(a) $(x - y)$ mL   (b) $(x - 2y)$ mL
(c) $(x + y)$ mL   (d) $(x + 2y)$ mL

23. In the titration of sodium carbonate with hydrochloric acid taken in burette the indicator used is
(a) phenolphthalein for first equivalence point and methyl orange for second equivalence point
(b) methyl orange for first equivalence point and phenolphthalein for second equivalence point
(c) either methyl orange or phenolphthalein for both equivalence points
(d) thymol blue for both equivalence points.

24. A blue colouration is not obtained when
(a) ammonium hydroxide dissolves in copper sulphate
(b) copper sulphate solution reacts with $K_4[Fe(CN)_6]$
(c) ferric chloride reacts with sodium ferrocyanide
(d) anhydrous white $CuSO_4$ is dissolved in water.

25. Sodium extract is heated with concentrated HNO_3 before testing for halogens because
(a) Ag_2S and AgCN are soluble in acidic medium
(b) silver halides are totally insoluble in nitric acid
(c) S^{2-} and CN^-, if present, are decomposed by conc. HNO_3 and hence, do not interfere in the test
(d) Ag reacts faster with halides in acidic medium.

(JEE Main 2016 online)

26. Which of the following statements is wrong?
(a) Using Lassaigne's test, nitrogen and sulphur present in an organic compound can be tested.

(b) Using Beilstein's test, the presence of halogens in a compound can be tested.

(c) In Lassaigne's filtrate, the nitrogen in an organic compound is converted to NaCN.

(d) In the estimation of carbon, an organic compound is heated with CaO in a combustion tube.

27. The brown ring test for nitrates depends on
(a) the reduction of nitrate to nitric oxide
(b) oxidation of nitric oxide to nitrogen dioxide
(c) reduction of ferrous sulphate to iron
(d) oxidising action of sulphuric acid.

28. The following four solutions are kept in separate beakers and copper metal is put in each of them. Which solution will become blue after sometime?
(a) $AgNO_3$ solution (b) $Zn(NO_3)_2$ solution
(c) $Ba(NO_3)_2$ solution (d) $NaNO_3$ solution

29. An aqueous solution of $FeSO_4$, $Al_2(SO_4)_3$ and chrome alum is heated with excess of Na_2O_2 and filtered. The materials obtained are
(a) a colourless filtrate and a green residue
(b) a yellow filtrate and a green residue
(c) a yellow filtrate and a brown residue
(d) a green filtrate and a brown residue.

30. Which of the following plots represents the graph of pH against volume of alkali added in titration of NaOH and HCl?

(a) pH / Volume →
(b) pH / Volume →
(c) pH / Volume →
(d) pH / Volume →
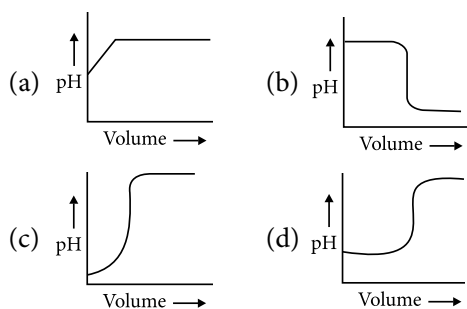
SOLUTIONS

1. **(c) :** $2NaHCO_3 + MgSO_4 \longrightarrow Mg(HCO_3)_2 + Na_2SO_4$
Soluble

$$Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_3 + H_2O + CO_2$$
White ppt.

2. **(a) :** Due to common ion effect, the ionisation of H_2S is suppressed by HCl and only group II basic radicals are precipitated. Higher groups are not precipitated.

3. **(b) :** In the titration of CH_3COOH with NaOH, phenolphthalein is used as an indicator. It gives

pink colour in NaOH when the pH is more than 7.

4. **(c) :** $Pb^{2+} + 2Cl^- \longrightarrow PbCl_2 \downarrow$

$PbCl_{2(s)} + H_2O \xrightarrow{\text{Boil}} PbCl_{2(aq)}$

$PbCrO_4 \xleftarrow{K_2CrO_4} Pb^{2+} \xrightarrow{H_2SO_4} PbSO_4$
Yellow ppt.   ↓ KI   White ppt.

PbI_2
Yellow ppt.
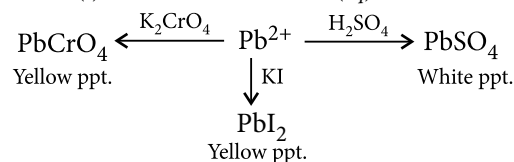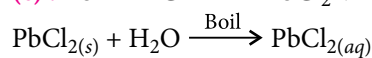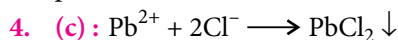
5. **(b) :** $BaCl_2 + K_2CrO_4 \longrightarrow BaCrO_4 + 2KCl$
$BaCrO_4$ is insoluble in acetic acid and Ba gives apple green colour in flame test.

6. **(a) :** Normality of oxalic acid $= \dfrac{6.3 \times 1000}{63 \times 250} = 0.4$ N

$N_1V_1 = N_2V_2$
$V_1 \times 0.1 = 10 \times 0.4$ $\therefore$ $V_1 = 40$ mL

7. **(b) :** $K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 +$
$\qquad\qquad\qquad\qquad\qquad Cr_2(SO_4)_3 + H_2O$
(Green)
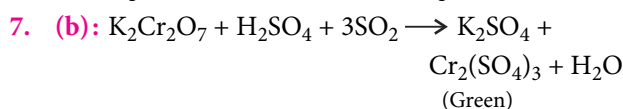
8. **(a) :** $K_3[Cu(CN)_4]$ is more stable whereas $K_2[Cd(CN)_4]$ is less stable.

9. **(b) :** Eq. of acid = Eq. of base,
$$\therefore \frac{0.45}{\text{Eq. wt.}} = \frac{20 \times 0.5}{1000} \Rightarrow \text{Eq. wt} = 45$$

$$\text{Basicity} = \frac{\text{Mol. wt.}}{\text{Eq. wt.}} = \frac{90}{45} = 2$$

10. **(c) :** Number of equivalents of NaOH
$$= \frac{\text{Mass}}{\text{Equivalent mass}} = \frac{0.275}{40} = 6.875 \times 10^{-3}$$

Number of equivalents of HCl = Number of equivalents of NaOH

$$\frac{NV}{1000} = 6.875 \times 10^{-3}$$

$$\frac{N \times 35.4}{1000} = 6.875 \times 10^{-3} \quad \text{or} \quad N = 0.194 \text{ N}$$

11. **(a) :** (a) Cu^{2+} will give black precipitate of CuS while $CuSO_4$ is soluble.
$Cu^{2+} + S^{2-} \longrightarrow$ CuS ↓ ; $Cu^{2+} + SO_4^{2-} \longrightarrow CuSO_4$
Black precipitate   Soluble
(b) Ba^{2+} will give white precipitate of $BaSO_4$ while BaS is soluble.
$Ba^{2+} + S^{2-} \longrightarrow BaS$; $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$
Soluble   White precipitate
(c) Pb^{2+} will give precipitate with both S^{2-} and SO_4^{2-}.
$Pb^{2+} + S^{2-} \longrightarrow$ PbS ↓ ; $Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4$ ↓
Black precipitate   White precipitate
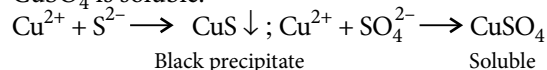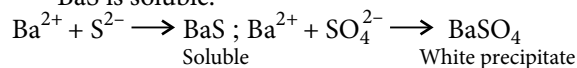
(d) $2Na^+ + S^{2-} \longrightarrow Na_2S \xrightarrow{Na_2[Fe(CN)_5NO]} Na_4[Fe(CN)_5NOS]$ Purple solution

$2Na^+ + SO_4^{2-} \longrightarrow Na_2SO_4$ Soluble
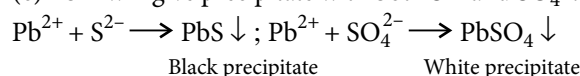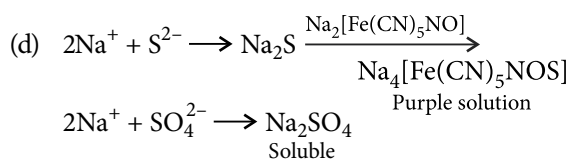
12. (a): x L of 0.5 N HCl + (2 – x) L of 0.1 N HCl

   = 2 L of 0.2 N HCl

i.e., $0.5x + 0.2 - 0.1x = 0.4$

$0.4x = 0.4 - 0.2 = 0.2$ or $x = \dfrac{0.2}{0.4} = 0.5$

13. (c)

14. (b): $Hg^{2+} + 2I^- \longrightarrow HgI_2$ Red ppt.

$HgI_2 + 2KI \longrightarrow K_2HgI_4$ Soluble

$Hg^{2+} + [Co(SCN)_2] \longrightarrow [Hg(SCN)_2] + Co^{2+}$ (blue ppt.)

15. (a): $Ag^+ + 2S_2O_3^{2-} \longrightarrow [Ag(S_2O_3)_2]^{3-} \xrightarrow{Ag^+}$ (Excess)   Argentothiosulphate (X) (Soluble)

$Ag_2S_2O_3 \xrightarrow[\text{(due to hydrolysis)}]{\text{With time}} Ag_2S$ (Y) (White ppt.)   (Z) (Black ppt.)
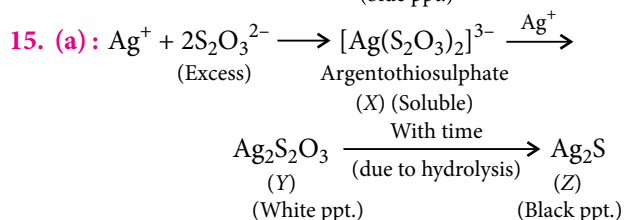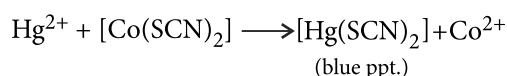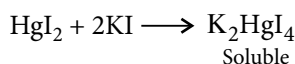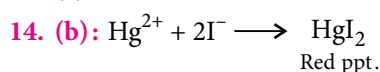
16. (c): Hydroxylamine and hydrazine, both do not have carbon, hence, NaCN will not be formed in Lassaigne's extract leading to negative test for nitrogen.

17. (c): $K_2Cr_2O_7 + 4KCl + 6H_2SO_4 \xrightarrow{Heat} 2CrO_2Cl_2 +$ Chromyl chloride (red vapours) $6KHSO_4 + 3H_2O$
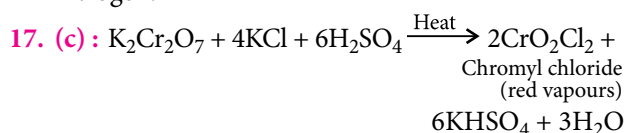
18. (a): The reagent is FeSO$_4$ which gives SO$_2$ and SO$_3$ on heating.
$2FeSO_4 \longrightarrow Fe_2O_3 + SO_2 \uparrow + SO_3 \uparrow$
Ferrous sulphate
Ferrous sulphate gives dirty green coloured Fe(OH)$_2$ with aqueous NaOH.
$FeSO_4 + 2NaOH \longrightarrow Fe(OH)_2 + Na_2SO_4$ (Dirty green)
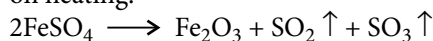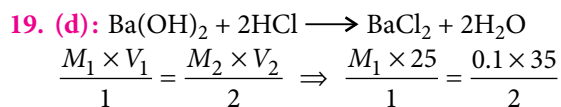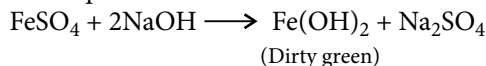
19. (d): $Ba(OH)_2 + 2HCl \longrightarrow BaCl_2 + 2H_2O$
$\dfrac{M_1 \times V_1}{1} = \dfrac{M_2 \times V_2}{2} \Rightarrow \dfrac{M_1 \times 25}{1} = \dfrac{0.1 \times 35}{2}$
$M_1 = 0.07$ M

20. (b): Region-2 is the region of the blue flame which is the hottest region of Bunsen flame.

21. (b): I$_2$ first liberated combines with Cl$_2$ to form colourless iodine monochloride.

$I_2 + Cl_2 \longrightarrow 2ICl$
(Violet)   (Colourless)
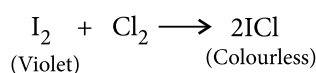
22. (b): Methyl orange (M) indicates the neutralisation of both Na$_2$CO$_3$ and NaHCO$_3$ in a mixture with HCl solution and the volume used is 'x' mL.
$Na_2CO_3 + 2HCl \xrightarrow{M} 2NaCl + H_2O + CO_2$
$NaHCO_3 + HCl \xrightarrow{M} NaCl + H_2O + CO_2$
Phenolphthalein (P) indicates the neutralisation of Na$_2$CO$_3$ only upto single stage, *i.e.*, upto NaHCO$_3$ stage with HCl and the volume used is 'y' mL.
$Na_2CO_3 + HCl \xrightarrow{P} NaHCO_3 + NaCl$
∴ For complete neutralisation of Na$_2$CO$_3$, the volume of HCl used will be '$2y$' mL. Hence, the volume of HCl used for neutralisation of NaHCO$_3$ only = (x – $2y$) mL.
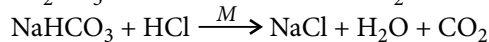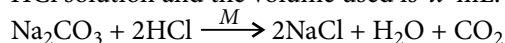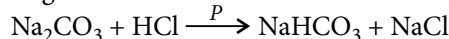
23. (a): In the titration of sodium carbonate with hydrochloric acid first equivalence point appears at pH of about 8.3, hence, phenolphthalein is used as indicator for first equivalence point. Whereas, second equivalence point appears at pH of about 3.9, hence, methyl orange is used as indicator for second equivalence point.

24. (b): $2CuSO_4 + K_4[Fe(CN)_6] \longrightarrow Cu_2[Fe(CN)_6]$ Chocolate ppt. $+ 2K_2SO_4$
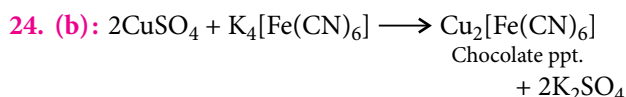
25. (c): S^{2-} and CN^- ions if present may interfere by giving white ppt. of AgCN and black ppt. of Ag$_2$S with AgNO$_3$. Thus, before testing for halogens they are decomposed by conc. HNO$_3$, so that they do not interfere in the test.

26. (d): In the estimation of carbon, organic compound is heated with CuO in a combustion tube.
$CuO + C \longrightarrow Cu + CO \uparrow$
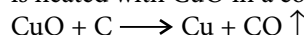
27. (a): The brown ring is appeared due to the formation of a brown complex between nitric oxide (formed as a result of reduction of the nitrate ion by Fe^{2+} ions) and Fe^{2+} ions.
$NO_{3(aq)}^- + 3Fe_{(aq)}^{2+} + 4H_{(aq)}^+ \longrightarrow NO_{(g)} + 3Fe_{(aq)}^{3+} + 2H_2O_{(l)}$
$Fe_{(aq)}^{2+} + NO_{(g)} + 5H_2O_{(l)} \longrightarrow [Fe(H_2O)_5NO]_{aq}^{2+}$
Pentaaquanitrosonium ion (I) (Brown complex)

28. (a): $Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + 2Ag$ Blue
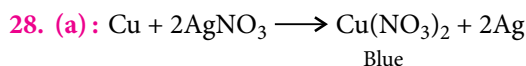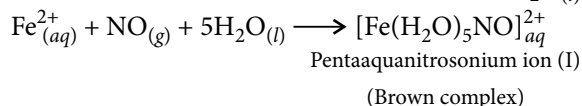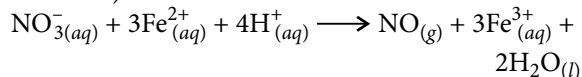
29. (b): Yellow filtrate is due to chromate ion (CrO_4^{2-}) and green residue is due to Fe(OH)$_2$.

30. (c)

◈◈

MPP | MONTHLY Practice Paper

Class XI

This specially designed column enables students to self analyse their extent of understanding of complete syllabus. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120　　　　　　　　　　　　　　　　　**Time Taken : 60 Min.**

NEET / AIIMS

Only One Option Correct Type

1. 1.12 mL of a gas X is produced at STP by the action of 2.3 mg of an alcohol with methyl magnesium iodide. The molecular mass of alcohol and the gas X are respectively
   (a) 32 ; CH_4　　　　　(b) 46 ; CH_4
   (c) 46 ; C_2H_6　　　　(d) none of these.

2. The wave number of electromagnetic radiations emitted during the transition in between two energy levels of Li^{2+} ion whose principal quantum number sum is 4 and difference is 2, is
   (a) $3.5\,R_H$　(b) $4\,R_H$　(c) $8\,R_H$　(d) $\dfrac{8}{9}R_H$

3. The root mean square velocity of a gas molecule at 100 K and 0.5 atm pressure is 106.4 m s^{-1}. If the temperature is raised to 400 K and the pressure is raised to 2 atm, the root mean square velocity becomes
   (a) 106.4 m s^{-1}　　　(b) 425.6 m s^{-1}
   (c) 212.8 m s^{-1}　　　(d) 851.2 m s^{-1}

4. What will be the heat of formation of methane if the heat of combustion of carbon is '$-x$' kJ, heat of formation of water is '$-y$' kJ and heat of combustion of methane is '$-z$' kJ?
   (a) $(-x - y + z)$ kJ　　(b) $(-z - x + 2y)$ kJ
   (c) $(-x - 2y - z)$ kJ　　(d) $(-x - 2y + z)$ kJ

5. 'a' moles of PCl_5 is heated in a closed container to equilibrate $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ at a pressure of P atm. If 'x' moles of PCl_5 dissociate at equilibrium, then

   (a) $\dfrac{x}{a} = \dfrac{K_p}{K_p + P}$　　(b) $\dfrac{x}{a} = \left(\dfrac{K_p + P}{K_p}\right)^{1/2}$
   (c) $\dfrac{x}{a} = \left(\dfrac{K_p}{P}\right)^{1/2}$　　(d) $\dfrac{x}{a} = \left(\dfrac{K_p}{K_p + P}\right)^{1/2}$

6. In a polar molecule, the ionic charge is 4.8×10^{-10} e.s.u. If the interionic distance is 1 Å, then the dipole moment is
   (a) 41.8 debye　　　　(b) 4.18 debye
   (c) 4.8 debye　　　　(d) 0.48 debye

7. If the collision frequency of a gas at 1 atm pressure is Z, then its collision frequency at 0.5 atm is
   (a) $1.0\,Z$　(b) $0.25\,Z$　(c) $2\,Z$　(d) $0.50\,Z$

8. If M is the molecular weight of FeC_2O_4, then its equivalent weight in the conversion, $FeC_2O_4 \longrightarrow Fe^{3+} + CO_2$ is
   (a) $\dfrac{M}{3}$　　　　　　(b) $\dfrac{M}{6}$
   (c) $\dfrac{M}{2}$　　　　　　(d) equal to M.

9. The volume of 0.05 M $KMnO_4$ solution required to oxidise completely 2.70 g of oxalic acid ($H_2C_2O_4$) in acidic medium will be
   (a) 120 cm^3　　　　(b) 240 cm^3
   (c) 360 cm^3　　　　(d) 480 cm^3

10. Which one of the following is present as an active ingredient in bleaching powder for bleaching action?
    (a) $CaOCl_2$　　　　(b) $Ca(OCl)_2$
    (c) CaO_2Cl　　　　(d) $CaCl_2$

11. The correct order of decreasing ionic character of lead dihalides is :
(a) $PbF_2 > PbCl_2 > PbBr_2 > PbI_2$
(b) $PbF_2 > PbBr_2 > PbCl_2 > PbI_2$
(c) $PbF_2 > PbI_2 > PbCl_2 > PbBr_2$
(d) $PbCl_2 > PbBr_2 > PbF_2 > PbI_2$

12. The compound which will not show tautomerism is
(a) $PhCH{=}CHOH$
(b) $PhCH{=}CHOCH_3$
(c) $CH_2{=}\overset{+}{N}\overset{O^-}{\diagup}\underset{OH}{\diagdown}$
(d) $PhCH{=}NOH$

Assertion and Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** CH_4 does not react with Cl_2 in dark.
Reason : Chlorination of CH_4 takes place in sunlight.

14. **Assertion :** Suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.
Reason : Catalytic converters greatly reduce pollution caused by automobiles.

15. **Assertion :** Absolute ethanol cannot be obtained by simple fractional distillation of a mixture of alcohol and water.
Reason : The absolute alcohol boils at 78.3°C.

JEE MAIN / JEE ADVANCED / PETs
Only One Option Correct Type

16. The electron affinity values (in kJ mol^{-1}) of three halogens X, Y and Z are respectively –349, –333 and –325. Then X, Y and Z are respectively
(a) F_2, Cl_2 and Br_2
(b) Cl_2, F_2 and Br_2
(c) Cl_2, Br_2 and F_2
(d) Br_2, Cl_2 and F_2.

17. The number of nodal planes present in σ^*s-orbital is
(a) 0 (b) 3 (c) 1 (d) 2

18. The ionisation enthalpies of lithium and sodium are 520 kJ mol^{-1} and 495 kJ mol^{-1} respectively. The energies required to convert all the atoms present in 7 mg of lithium vapours and 23 mg of sodium vapours to their respective gaseous cations respectively are
(a) 52 J, 49.5 J
(b) 520 J, 495 J
(c) 49.5 J, 52 J
(d) 495 J, 520 J

19. An ideal gas has a volume V at temperature T. During a change, it follows an additional law VP^2 = constant. The final temperature of the gas when it expands to a volume $2V$ will be
(a) $2T$ (b) $\sqrt{2}\,T$ (c) $1.5T$ (d) $2.5T$

More than One Options Correct Type

20. The reversible expansion of an ideal gas under adiabatic and isothermal conditions is shown in the figure. Which of the following statement(s) is (are) correct?
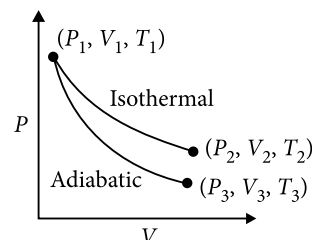
(a) $T_1 = T_2$
(b) $T_3 > T_1$
(c) $w_{isothermal} > w_{adiabatic}$
(d) $\Delta U_{isothermal} > \Delta U_{adiabatic}$

21. Which of the following statements are not correct?
(a) K_w is always constant and equal to 10^{-14}.
(b) pH + pOH = pK_w at all temperatures.
(c) Salts of weak acid and weak base do not undergo hydrolysis.
(d) Addition of sodium acetate to acetic acid increases the pH of acetic acid.

22. In an exothermic reaction, heat is evolved, and system loses heat to the surroundings. For such system
(a) q_p will be negative
(b) $\Delta_r H$ will be negative
(c) q_p will be positive
(d) $\Delta_r H$ will be positive.

23. Examine the following two structures for the anilinium ion and choose the incorrect statements.

(a) II is not an acceptable canonical structure because carbonium ions are less stable than ammonium ions.

(b) II is not an acceptable canonical structure because it is non-aromatic.

(c) II is not an acceptable canonical structure because nitrogen has 10 valence electrons.

(d) II is an acceptable canonical structure.

Integer Answer Type

24. How many of the following compounds are used as stabilizers for H_2O_2 to check its decomposition?

K_2O, H_3PO_4, glycerol, Na_2O, alcohol, acetanilide

25. The number of alkali metals existing as liquid at 303 K is

Li, Na, K, Rb, Cs, Fr

26. When Sn (IV) chloride is treated with excess of conc. HCl, the complex $[SnCl_6]^{2-}$ is formed. The oxidation state of Sn in the complex is

Comprehension Type

Alkenes and alkynes undergo electrophilic addition reactions but alkynes are less reactive than alkenes in these reactions even though they contain two π-bonds. Although the addition of unsymmetrical reagents to unsymmetrical alkenes and alkynes generally occurs in accordance with Markovnikov's rule, yet there are many exceptions.

27. Propene on reaction with chlorine water gives

(a) (b)

(c) (d)
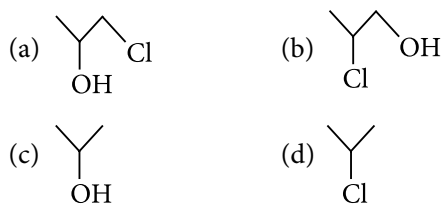
28. Addition of HCl to 3, 3, 3-trichloropropene gives

(a) $Cl_3CCH_2CH_2Cl$ (b) $Cl_3CCHClCH_3$

(c) $Cl_2CHCHClCH_2Cl$ (d) $Cl_2CHCH_2CHCl_2$

Matrix Match Type

29. Match the terms given in Column I with the compounds given in Column II.

Column I	Column II
(A) Acid rain	(P) $CHCl_2CHF_2$
(B) Photochemical smog	(Q) CO
(C) Combination with haemoglobin	(R) CO_2
(D) Depletion of ozone layer	(S) NO_2
	(T) Unsaturated hydrocarbons

	A	B	C	D
(a)	Q	P	R, S	S, T
(b)	R, S	S, T	Q	P
(c)	R, S	Q	P	S, T
(d)	S, T	R, S	Q	P

30. Match the terms given in Column I with the compounds given in Column II.

Column I	Column II
(A) Entropy of vapourisation	(P) decreases
(B) K for spontaneous process	(Q) is always positive
(C) Crystalline solid state	(R) Lowest entropy
(D) ΔU in adiabatic expansion	(S) $\dfrac{\Delta H_{vap}}{T_b}$ of ideal gas

	A	B	C	D
(a)	P	Q	R	Q, S
(b)	P	R	Q	Q, S
(c)	Q, S	Q	P	R
(d)	Q, S	Q	R	P

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NEET | JEE ESSENTIALS

Class XII

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Unit 9 — PRINCIPLES RELATED TO PRACTICAL CHEMISTRY

ORGANIC COMPOUNDS

PREPARATION

🔖 **Acetanilide :** It is an acetyl derivative of aniline.

➤ It is prepared by acetylation of aniline.
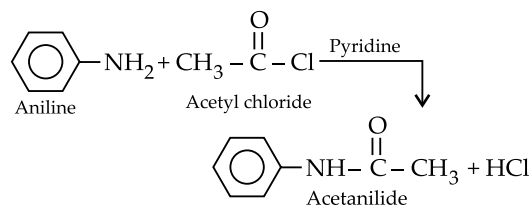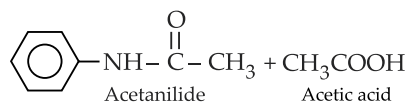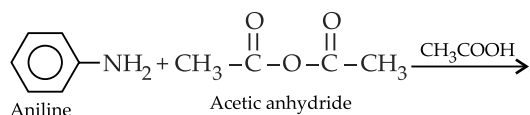
➤ It is a nucleophilic acyl substitution reaction in which aniline acts as a nucleophile and acetic anhydride acts as an electrophile.

🔖 **p-Nitroacetanilide :** It is a nitro derivative of acetanilide.

➤ It is prepared by nitration of acetanilide with nitrating mixture.
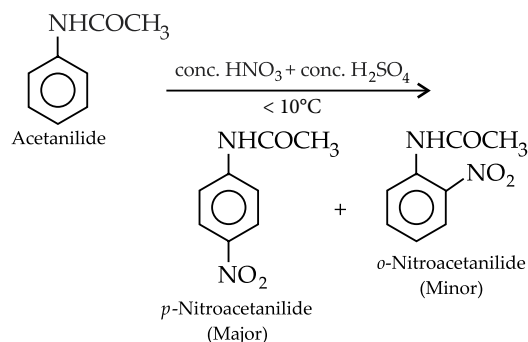
➤ It is an electrophilic substitution reaction in which acetanilide acts as nucleophile and nitronium ion acts as an electrophile.

🔖 **Aniline yellow :** It is an azo dye also known as p-aminoazobenzene.

➤ It is prepared by coupling of benzenediazonium chloride with aniline in acidic medium.
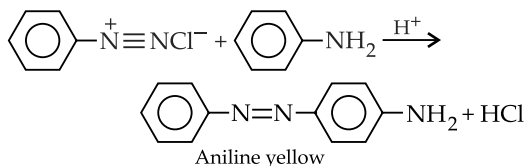
🔖 **Iodoform :** It is triiodomethane and is an iodine analogue of chloroform. It is used as a mild antiseptic and disinfectant.

➤ It is prepared by treating an organic compound containing CH_3-CH- group (ethanol,

$\overset{\text{OH}}{|}$
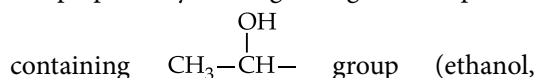
propan-2-ol, butan-2-ol) or $CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-$ group (acetaldehyde, acetone, butan-2-one, acetophenone) with iodine in presence of sodium or potassium hydroxide.

$$CH_3CH_2OH \xrightarrow[\text{or NaOI}]{\text{KOI}} CH_3CHO \quad \text{(Oxidation)}$$

$$CH_3CHO \xrightarrow[\text{or NaOI}]{\text{KOI}} CI_3CHO \quad \text{(Iodination)}$$

$$CI_3CHO + NaOH \longrightarrow$$
$$\underset{\text{Iodoform}}{CHI_3} + HCOONa \text{ (Hydrolysis)}$$
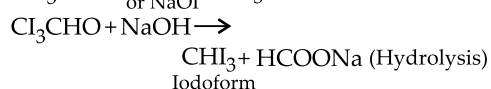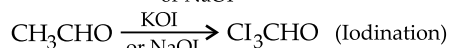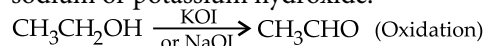
➤ With acetone no initial oxidation takes place.

$$CH_3COCH_3 \xrightarrow[\text{(Iodination)}]{\text{NaOI}} CI_3COCH_3$$

$$CI_3COCH_3 + NaOH \xrightarrow{\text{Hydrolysis}} CHI_3 + CH_3COONa$$
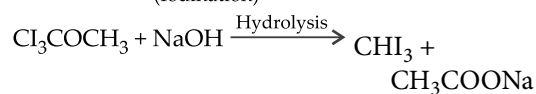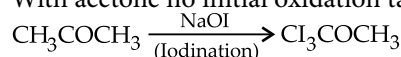
↭ **Dibenzalacetone :** Dibenzalacetone is prepared by aldol condensation of acetone with two equivalents of benzaldehyde. It is a base catalysed aldol condensation.

Benzaldehyde + Acetone $\xrightarrow{2H_2O}$ Dibenzalacetone (1,5-Diphenyl-1,4-pentadien-3-one)

↭ **Detection of phenol :**

Detection of Functional Groups

↭ **Detection of unsaturation :**
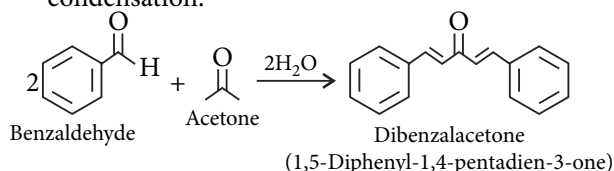
↭ **Detection of alcohol :**

Note : These tests of phenol, can be used to distinguish between alcohols and phenols, as these tests cannot be given by alcohols.

Detection of carbonyl groups

For ketones only

Iodoform test (for methyl ketones)

$R-CO-CH_3 + 3I_2$
$+ 4NaOH \rightarrow 3NaI$
$+ CHI_3\downarrow + RCOONa$
Yellow ppt. $+ 3H_2O$

Sodium nitroprusside test

Sodium nitroprusside solution + NaOH + $RCOR$
$\rightarrow$ Appearance of wine-red colour.

For both aldehydes/ketones

NaHSO$_3$ test

$>C=O + NaHSO_3$

$\rightarrow >C\!\!\begin{smallmatrix}OH\\SO_3^-Na^+\end{smallmatrix}$
(White ppt.)

Brady's reagent test (2, 4-DNP)

$>C=O + H_2NNH-\!\!\bigcirc\!\!\begin{smallmatrix}NO_2\\ \\ \end{smallmatrix}\!\!-NO_2$
2,4-Dinitrophenylhydrazine

$\rightarrow >C=NNH-\!\!\bigcirc\!\!\begin{smallmatrix}NO_2\\ \\ \end{smallmatrix}\!\!-NO_2$
(Orange or red ppt.)

For aldehydes only

Schiff's test

Schiff's reagent + $R-CHO$
(Colourless) $\downarrow$
Deep red or violet colour complex

Benedict's test (Cu^{2+} ions complexed with citrate ions)

$RCHO + 2Cu(OH)_2 + NaOH$
$\rightarrow RCOONa + Cu_2O\downarrow +$
Red ppt.
$3H_2O$

Fehling's test (Cu^{2+} ions complexed with tartarate ions)

$RCHO + 2Cu^{2+} +$
$3OH^- \rightarrow 2Cu^+\downarrow +$
Red ppt.
$RCOO^- + 2H_2O$

Tollens' test

$RCHO + 2[Ag(NH_3)_2]OH$
$\downarrow$
$RCOONH_4$
$+ 3NH_3 + H_2O + 2Ag_{(s)}\downarrow$
Silver mirror

Detection of amino group :

Amino group

Nitrous acid test

Sample + HNO_2

Evolution of N_2 gas indicates 1° amine group

Formation of yellow oily compound indicates 2° amine group

Formation of water soluble nitrite salts indicates 3° amine group

Isocyanide test

Sample + $CHCl_3$ + KOH

Offensive smell of isocyanide con rms the presence of 1° aliphatic or aromatic amine

Azo dye test

Sample

$\bigcirc\bigcirc-OH$ $\xrightarrow{NaNO_2 + HCl}$

$\bigcirc\bigcirc\begin{smallmatrix}-OH\\N=N-\bigcirc\end{smallmatrix}$

Orange azo dye
(1° Aromatic amine group present)

Detection of carboxylic acid group :

Test	Experiment	Inference
Litmus test	Few drops of sample on blue litmus	Blue litmus paper turns red.
NaHCO$_3$ test	Sample + NaHCO$_3$ solution	Brisk effervescence of CO$_2$ indicates presence of —COOH group.
Ester test	Sample + Alcohol + conc. H$_2$SO$_4$	Fruity smell of ester inferes the presence of —COOH group.

| FeCl$_3$ test | $3R\text{COOH} + \text{FeCl}_3 \longrightarrow (R\text{COO})_3\text{Fe}$
 (Coloured ppt.)
 $+ 3\text{HCl}$ | Wine red ppt. : acetic acid
 Red colour changes to brown ppt. : formic acid
 No colour change or light yellow colour : oxalic acid
 Violet coloured ppt. : salicylic acid
 Buff coloured ppt. : benzoic acid |

↳ **Detection of nitro group :**

| Mulliken Barker test | $R\text{NO}_2 + 4[\text{H}] \xrightarrow{\text{Zn + NH}_4\text{Cl}} R\text{NHOH} + \text{H}_2\text{O}$
 $R\text{NHOH} + 2[\text{Ag(NH}_3)_2]\text{OH} \longrightarrow R\text{NO} + 2\text{H}_2\text{O} + 4\text{NH}_3$
 $+ \quad 2\text{Ag}\downarrow$
 Grey black ppt. | Appearance of greyish black ppt. indicates the presence of $-\text{NO}_2$ group. |
| Ferrous hydroxide test | $R\text{NO}_2 + 6\text{Fe(OH)}_2 + 4\text{H}_2\text{O} \longrightarrow R\text{NH}_2 + 6\text{Fe(OH)}_3\downarrow$
 Light green $\qquad\qquad$ Red brown ppt. | Appearance of brown ppt. indicates the presence of $-\text{NO}_2$ group. |

CHARACTERISTICS TESTS OF CARBOHYDRATES, FATS AND PROTEINS

↳ **Tests for carbohydrates :**

Tests for carbohydrates

Simple carbohydrates → Monosaccharides or disaccharides + Benedict's solution (Blue coloured) → Changes to orange red or brick red

Complex sugar → Starch + I$_2$ solution (Lugol's reagent) (Yellowish-brown) → Changes to dark purple/black
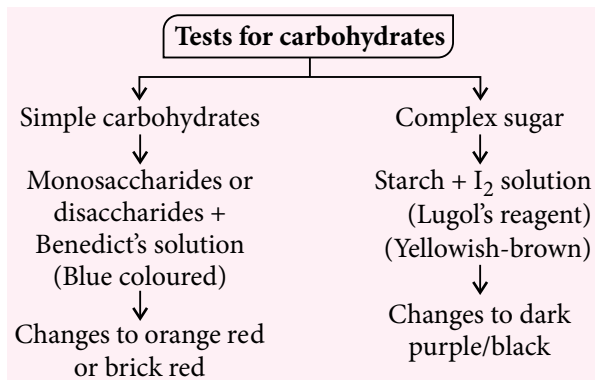
↳ **Tests for lipids :**

➢ **Grease spot test :** Lipid leaves translucent spot on unglazed brown paper bags.

➢ **Sudan red test :** Sudan red is a fat soluble dye that stains lipids red.

↳ **Test for proteins :**

➢ **Biuret test :**

Biuret solution (Blue) + Sample $\longrightarrow$ Purple or pink solution $\left(\begin{array}{l}\text{For peptides with} \\ \text{chain length of at} \\ \text{least 3-amino acids}\end{array}\right)$

PHYSICAL CHEMISTRY

TITRIMETRIC EXERCISES

↳ **Strength of a solution :** It is the amount of solute in grams present per litre of the solution.

➢ Strength (g/L) = Normality × Eq. wt.

➢ Strength (g/L) = Molarity × Mol. mass

↳ **Normality equation :** $\underset{\text{(Solution 1)}}{N_1 V_1} = \underset{\text{(Solution 2)}}{N_2 V_2}$

↳ **Molarity equation :** $\underset{\text{(Solution 1)}}{M_1 V_1 n_1} = \underset{\text{(Solution 2)}}{M_2 V_2 n_2}$

[$\because N = M \times n$, where n = valency factor]

↳ **Percentage purity of a given salt**

$= \dfrac{\text{Strength of pure sample}}{\text{Strength of given sample}} \times 100$

Titration of Mohr's salt vs KMnO$_4$

● $2\text{KMnO}_4 + 8\text{H}_2\text{SO}_4 + 10\text{FeSO}_4\cdot(\text{NH}_4)_2\text{SO}_4\cdot6\text{H}_2\text{O} \longrightarrow \text{K}_2\text{SO}_4 +$
$2\text{MnSO}_4 + 5\text{Fe}_2(\text{SO}_4)_3 + 10(\text{NH}_4)_2\text{SO}_4 + 68\text{H}_2\text{O}$
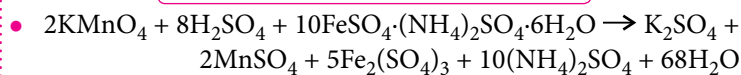
● *Calculation :*

$\dfrac{M_{\text{KMnO}_4} \times V_{\text{KMnO}_4}}{M_{\text{Mohr's salt}} \times V_{\text{Mohr's salt}}} = \dfrac{1}{5}$

Titration of oxalic acid vs KMnO$_4$

● $2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 + 5\begin{array}{l}\text{COOH} \\ | \\ \text{COOH}\end{array}\cdot2\text{H}_2\text{O}$
$\downarrow$
$\text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 18\text{H}_2\text{O} + 10\text{CO}_2$

● *Calculation :*

$\dfrac{M_{\text{KMnO}_4} \times V_{\text{KMnO}_4}}{M_{\text{Oxalic acid}} \times V_{\text{Oxalic acid}}} = \dfrac{2}{5}$

Redox titrations

Proceed with transfer of electrons

THERMOCHEMISTRY

✎ **Enthalpy of dissolution of copper sulphate :** It is the heat change involved during the dissolution of one mole of a solute in such a large excess of solvent so that no further heat change occurs on dilution.

$$CuSO_{4(s)} + H_2O \longrightarrow CuSO_{4(aq)}$$
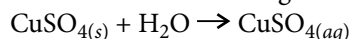
➤ Dissolution of $CuSO_4$ in water is exothermic. The enthalpy of solution of $CuSO_{4(s)}$ is calculated from the highest temperature attained during its dissolution.

➤ *Calculation* : If dissolution of w g of $CuSO_4$ in 200 g solvent (water) causes $\Delta t°C$ change in temperature, then

Heat evolved (q) = Mass × Specific heat × Change in temperature

$q = (200 + W) \times 4.2 \times \Delta t$ J

where, W is water equivalent of calorimeter (given).

Enthalpy of dissolution of $CuSO_4$ in water

$$= \frac{q \times 159.5 \times 10^{-3}}{w} \text{ kJ}$$

[∵ Molar mass of $CuSO_4$ = 159.5 g]

✎ **Enthalpy of neutralisation of strong acid and strong base :** It is the enthalpy change accompanying the neutralisation of one gram equivalent of a base by an acid in dilute solution at a given temperature.

$$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$$
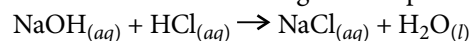
It is an exothermic reaction.

➤ The heat of neutralisation of a strong acid by a strong base in their dilute solutions is generally 57.3 kJ. The reaction may be represented as :

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O; \Delta H = -57.3 \text{ kJ}$$
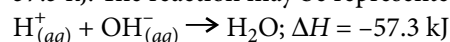
➤ *Calculation* : Heat evolved during neutralisation of 100 mL of 0.5 N HCl,

$q = (200 + W) \times \Delta t \times 4.2$ J where, W is water equivalent of calorimeter (given).

Thus, enthalpy of neutralisation of 1000 mL of 1 N HCl and NaOH $= \dfrac{q}{0.5 \times 100}$ kJ

- -

MPP CLASS XI	**ANSWER**	**KEY**		
1. (b)	2. (c)	3. (c)	4. (d)	5. (d)
6. (c)	7. (b)	8. (a)	9. (b)	10. (a)
11. (a)	12. (b)	13. (b)	14. (b)	15. (b)
16. (b)	17. (c)	18. (b)	19. (b)	20. (a,c,d)
21. (a,c)	22. (a,b)	23. (a,b,d)	24. (4)	25. (2)
26. (4)	27. (a)	28. (a)	29. (b)	30. (d)

✎ **Kinetic study of reaction of iodide ion with hydrogen peroxide at room temperature :**

Overall reaction (Clock reaction)

Main reaction

$$H_2O_{2(aq)} + 2I^-_{(aq)} + 2H^+_{(aq)} \xrightarrow{\text{Slow}} I_{2(aq)} + 2H_2O_{(l)}$$

Monitor reaction

$$2S_2O_{3(aq)}^{2-} + I_{2(aq)} \xrightarrow{\text{Fast}} S_4O_{6(aq)}^{2-} + 2I^-_{(aq)}$$

Indicator reaction

$$I_{2(aq)} + \text{starch}_{(aq)} \longrightarrow \text{Blue colour}$$
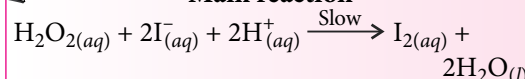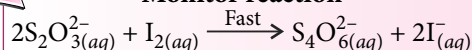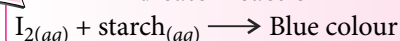
✎ As the concentration of thiosulphate ion is kept constant, the different time taken (t_c) for the appearance of blue colour with change in concentration of either reactant indicates the relative rate of reaction.

Initial rate $\propto \dfrac{1}{t_c}$

The rate of reaction decreases with decrease in the concentration of KI.

The graph of $1/t_c$ versus volume of KI solution is a straight line.
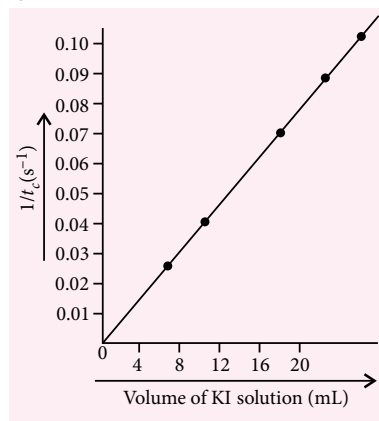
Rate of reaction ∝ Concentration of KI

Similarly, by keeping I^- ion concentration constant and taking different concentrations of H_2O_2, the rate *w.r.t.* H_2O_2 can be found out.

ELECTROCHEMISTRY

✎ **Variation of cell potential in $Zn|Zn^{2+}||Cu^{2+}|Cu$ with change in concentration of electrolytes ($CuSO_4$ and $ZnSO_4$) at room temperature :**

Theory

> **Nernst equation :**

$$E_{cell} = E_{cell}^\circ - \frac{2.303RT}{nF} \log \frac{[Zn^{2+}]}{[Cu^{2+}]} \quad ...(i)$$

$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$, $T = 298$ K and $F = 96500$ C

At anode :

$$Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^-$$

At cathode :

$$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$$
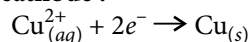
Thus, $n = 2$,

$$E^\circ_{cell} = E^\circ_{Cu^{2+}/Cu} - E^\circ_{Zn^{2+}/Zn} = +0.34 - (-0.76)$$
$$= 1.10 \text{ V}$$

Substituting E°_{cell}, n, R, T and F in eq. (i)

$$E_{cell} = 1.10 - \frac{0.059}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

Procedure :

> Clean the electrodes of copper and zinc using a sand paper.
> Put the solution of copper sulphate in beaker and the solution of zinc sulphate in a porous pot.
> Connect the voltmeter with electrodes, close the circuit and note down the cell potentials.
> Repeat the experiment by taking the solutions of $CuSO_4$ and $ZnSO_4$ at different concentrations.

> **Observation :**

Concentration of [Zn^{2+}]	Concentration of [Cu^{2+}]	Theoretical E_{cell}
1 M	1 M	1.10 V
0.1 M	1 M	1.1295 V
0.01 M	1 M	1.1591 V
0.001 M	1 M	1.1886 V
1 M	0.1 M	1.0705 V
1 M	0.01 M	1.0409 V
1 M	0.001 M	1.0114 V

> **Result :**

> E_{cell} decreases with increase in concentration of Zn^{2+} in $ZnSO_4$.
> E_{cell} increases with increase in concentration of Cu^{2+} in $CuSO_4$.

INORGANIC COMPOUNDS

PREPARATION

> **Mohr's salt (Ferrous ammonium sulphate) :**

> It is a double salt containing ferrous sulphate and ammonium sulphate in equimolar amounts.
> It is prepared by dissolving an equimolar mixture of hydrated ferrous sulphate and ammonium sulphate in water containing a little amount of sulphuric acid to prevent the hydrolysis.

$$FeSO_4 \cdot 7H_2O + (NH_4)_2SO_4 \longrightarrow$$
$$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O + H_2O$$
(Mohr's salt)
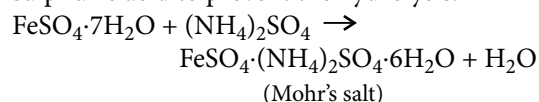
> **Potash alum (*Phitkari*) :**

> It is a double salt containing potassium sulphate and aluminium sulphate in equimolar amounts.
> It is prepared by dissolving an equimolar mixture of hydrated aluminium sulphate and potassium sulphate in water containing a little amount of sulphuric acid to prevent the hydrolysis.

$$K_2SO_4 + Al_2(SO_4)_3 \cdot 18H_2O + 6H_2O \longrightarrow$$
$$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$$
(Potash alum)
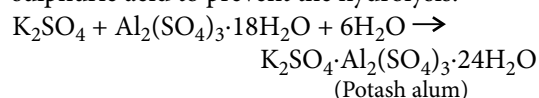
iNFO SHOTS

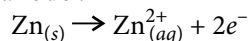### Fluorescent sensor provides low-cost diagnosis of cystic fibrosis!

Scientists have developed a new diagnostic test for cystic fibrosis. The new device provides a cheaper, easier way to detect levels of chloride in sweat, which are elevated in cystic fibrosis patients. Cystic fibrosis is caused by two faulty copies of a gene that affects the flow of chloride in and out of cells, leading to damage to the lungs and digestive system. Testing chloride levels in sweat is done by manual titration–a labour-intensive technique that is subject to human error and can miss cases. But a new system is based on a fluorescent dye that decreases in the presence of chloride, allowing the test to be automated. To create the sensor, the researchers first developed a citrate-based dye that emits fluorescent light. In the presence of chloride, however, the amount of light given off by the molecule diminishes: the more chloride, the less fluorescence. The new test can detect chloride over a wider range of concentrations and, because it's automated, it avoids the problem of human error. Besides detecting chloride, the new fluorescence-based system can also tell the difference between three ions: chloride, bromide, and iodide.

SPEED PRACTICE

1. The volume of 0.05 M $KMnO_4$ solution required to completely oxidise 2.70 g of oxalic acid ($H_2C_2O_4$) in acidic medium is
   (a) 120 cm^3
   (b) 240 cm^3
   (c) 360 cm^3
   (d) 480 cm^3

2. Which of the following can be used to distinguish between pentan-2-one and pentan-3-one?
   (a) $NaHSO_3$
   (b) Brady's reagent
   (c) Tollens' reagent
   (d) Iodoform test

3. The product formed by the reaction of an aldehyde with a primary amine is
   (a) carboxylic acid
   (b) aromatic acid
   (c) Schiff's base
   (d) ketone.
   (NEET Phase-I 2016)

4. In the preparation of p-nitroacetanilide from aniline, titration is not done by nitrating mixture because
   (a) on nitration it gives o-nitroacetanilide
   (b) it gives a mixture of o- and p-nitroaniline
   (c) $-NH_2$ group gets oxidised
   (d) it forms a mixture of o-and p-nitroacetanilide.

5. During experiment to calculate heat of neutralisation of strong acid and strong base, temperature should be recorded till
   (a) constant temperature is achieved
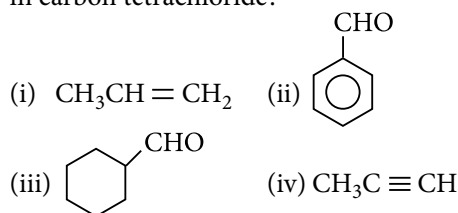   (b) maximum temperature is achieved
   (c) minimum temperature is achieved
   (d) none of these.

6. When 3.92 g L^{-1} of sample of Mohr's salt reacts completely with 50 mL N/10 $KMnO_4$ solution. The percentage purity of the sample of Mohr's salt is
   (a) 50   (b) 70   (c) 37   (d) 40

7. Amount of oxalic acid present in solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4. The titration gives unsatisfactory result when carried out in the presence of HCl, because HCl
   (a) oxidises oxalic acid to CO_2 and H_2O
   (b) gets oxidised by oxalic acid to chlorine
   (c) furnishes H^+ ions in addition to those from oxalic acid

   (d) reduces permanganate to Mn^{2+} ion.

8. In a protein molecule various amino acids are linked together by
   (a) peptide bonds
   (b) dative bonds
   (c) α-glycosidic bonds
   (d) β-glycosidic bonds.
   (NEET Phase-I 2016)

9. Two aromatic compounds having formula, C_7H_8O which are easily identifiable by $FeCl_3$ solution test (violet colouration) are
   (a) o-cresol and benzyl alcohol
   (b) m-cresol and p-cresol
   (c) o-cresol and p-cresol
   (d) methylphenyl ether and benzyl alcohol.

10. Formic acid can be distinguished from acetic acid by reaction with
    (a) $NaHCO_3$
    (b) dilute, acidified $KMnO_4$ solution
    (c) 2, 4-dinitrophenylhydrazine
    (d) Na metal.

11. The carboxyl functional group ($-COOH$) is present in
    (a) picric acid
    (b) barbituric acid
    (c) ascorbic acid
    (d) aspirin.

12. The volume of 0.1 M oxalic acid that can be completely oxidised by 20 mL of 0.025 M $KMnO_4$ solution is
    (a) 125 mL
    (b) 25 mL
    (c) 12.5 mL
    (d) 37.5 mL

13. The most appropriate method of making egg-albumin sol is
    (a) break an egg carefully and transfer the transparent part of the content to 100 mL of 5% w/V saline solution and stir well
    (b) keep the egg in boiling water for 10 minutes. After removing the shell, transfer the yellow part of the content to 100 mL of 5% w/V saline solution and homogenise with a mechanical shaker
    (c) keep the egg in boiling water for 10 minutes. After removing the shell, transfer the white

part of the content to 100 mL of 5% w/V saline solution and homogenise with a mechanical shaker

(d) break an egg carefully and transfer only the yellow part of the content to 100 mL of 5% w/V saline solution and stir well.
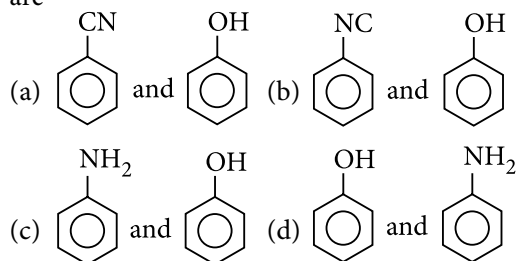
(JEE Main 2016 online)

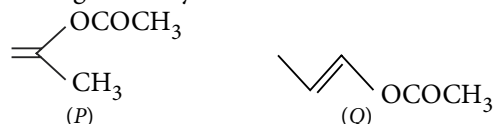**14.** Which of the following discharges colour of bromine in carbon tetrachloride?

(i) $CH_3CH = CH_2$

(ii) benzaldehyde (CHO on benzene ring)

(iii) cyclohexane with CHO

(iv) $CH_3C \equiv CH$

(a) (i) and (iv)
(b) (i), (iii) and (iv)
(c) (i), (ii) and (iv)
(d) All of these

15. A mixture of two aromatic compounds A and B is separated by dissolving in chloroform followed by extraction with aqueous KOH solution. The alkaline aqueous layer gives a mixture of two isomeric compounds on treatment with carbon tetrachloride. The organic layer containing compound A gives an unpleasant odour on treatment with alcoholic solution of KOH. Compounds A and B respectively are

(a) benzene with CN and benzene with OH
(b) benzene with NC and benzene with OH
(c) benzene with NH$_2$ and benzene with OH
(d) benzene with OH and benzene with NH$_2$

16. The product of acid hydrolysis of P and Q can be distinguished by

(P) isopropenyl acetate (OCOCH$_3$, CH$_3$)
(Q) allyl acetate (OCOCH$_3$)

(a) Lucas reagent
(b) 2, 4-DNP
(c) Fehling solution
(d) $NaHSO_3$

17. A variable, opposite external potential (E_{ext}) is applied to the cell : $Zn|Zn^{2+}(1\ M)||Cu^{2+}(1\ M)|Cu$, of potential 1.1 V. When $E_{ext} < 1.1$ V and $E_{ext} > 1.1$ V respectively, electrons flow from

(a) anode to cathode and cathode to anode

(b) cathode to anode and anode to cathode
(c) cathode to anode in both the cases
(d) anode to cathode in both the cases.

(JEE Main 2015 online)

18. A salt made of bivalent ions, each of which is capable of decolourising acidified $KMnO_4$ solution. The salt is likely to be
(a) stannic chloride
(b) ferric sulphate
(c) ferrous sulphate
(d) ferrous oxalate.

19. In the cell;
$Zn\ |Zn^{2+}\ (C_1)||Cu^{2+}\ (C_2)|\ Cu$,
$E_{cell} - E^{\circ}_{cell} = 0.0591$ V. The ratio C_1/C_2 at 298 K will be
(a) 2
(b) 100
(c) 10^{-2}
(d) 1

20. Which of the following statements about aniline yellow is not correct?
(a) It is an azo dye.
(b) It is a basic dye.
(c) It can be prepared by heating diazoamino-benzene with aniline and aniline hydrochloride.
(d) It can be prepared by coupling benzene-diazonium chloride with phenol in the basic medium.

21. The purpose of adding dilute sulphuric acid in the preparation of Mohr's salt is
(a) to prevent the hydrolysis of ferrous sulphate
(b) to increase the solubility of the salts used
(c) to prevent the precipitation of carbonates of metals
(d) to neutralise ammonium salt.
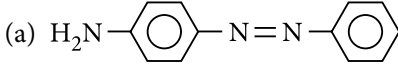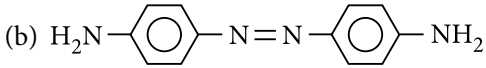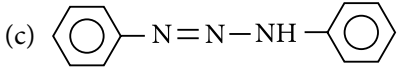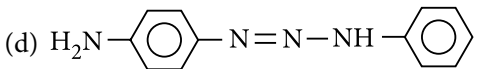
22. Complete hydrolysis of starch gives
(a) glucose and fructose in equimolar amount
(b) galactose and fructose in equimolar amount
(c) glucose only
(d) glucose and galactose in equimolar amount.

(JEE Main 2015 online)

23. Dilute sulphuric acid is most suitable for carrying out $KMnO_4$ titrations. This is because
(a) it reacts with $KMnO_4$ to liberate nascent oxygen
(b) it reacts with the reducing agents used in the titration
(c) the end point in the titration is sharp
(d) it does not react with $KMnO_4$ or the reducing agents used.
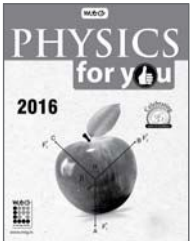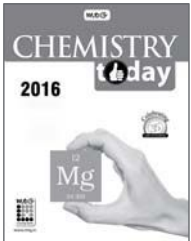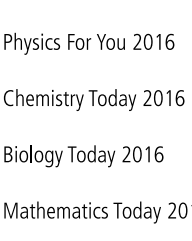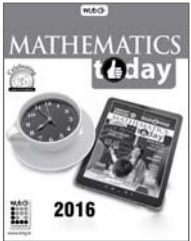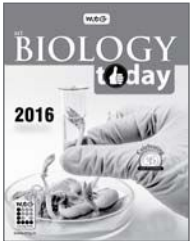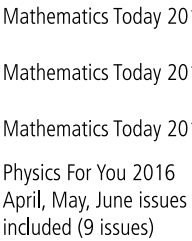
24. The sign for enthalpy of solution of $CuSO_4.5H_2O$ and $CuSO_4$ (anhydrous) respectively are
   (a) +, +   (b) –, –
   (c) +, –   (d) –, +

25. Enthalpy of neutralisation of ammonium hydroxide with HCl is –51.3 kJ. Hence, enthalpy of dissociation of NH_4OH is
   (a) 2.3 kJ   (b) 3.5 kJ
   (c) 4.7 kJ   (d) 6.0 kJ

26. The structure of diazoaminobenzene formed during the preparation of aniline yellow is

   (a) H_2N—⬡—$N=N$—⬡

   (b) H_2N—⬡—$N=N$—⬡—NH_2

   (c) ⬡—$N=N$—NH—⬡

   (d) H_2N—⬡—$N=N$—NH—⬡

27. For the identification of β-naphthol using dye test, it is necessary to use
   (a) dichloromethane solution of β-naphthol
   (b) acidic solution of β-naphthol
   (c) neutral solution of β-naphthol
   (d) alkaline solution of β-naphthol.

   (JEE Advanced 2014)

28. If the concentration of iodide ions in the following reaction is increased,
$$H_2O_2 + 2I^- + 2H^+ \longrightarrow I_2 + 2H_2O$$
   then rate of reaction
   (a) will increase   (b) will decrease
   (c) may increase or decrease   (d) remains same.

29. Which of the following substances is not used for preparing lyophilic sol?
   (a) Starch   (b) Gum
   (c) Gelatin   (d) Metal sulphide

30. Alums can be represented by general formula $M_2SO_4 \cdot M'_2(SO_4)_3 \cdot 24H_2O$ in which
   (a) M is bivalent metal and M' is trivalent metal
   (b) M is trivalent metal and M' is monovalent metal
   (c) M is monovalent metal and M' is trivalent metal
   (d) M and M' both are bivalent metals.

ANSWER KEY

1. (b)	**2.** (d)	**3.** (c)	**4.** (c)	**5.** (a)
6. (a)	**7.** (d)	**8.** (a)	**9.** (a)	**10.** (b)
11. (d)	**12.** (c)	**13.** (a)	**14.** (b)	**15.** (c)
16. (c)	**17.** (d)	**18.** (d)	**19.** (c)	**20.** (d)
21. (a)	**22.** (c)	**23.** (d)	**24.** (c)	**25.** (d)
26. (c)	**27.** (d)	**28.** (a)	**29.** (d)	**30.** (c)

CLASS XII

ACE YOUR WAY CBSE

Practice Paper 2017

Time Allowed : 3 hours
Maximum Marks : 70

Exam on 25th March

GENERAL INSTRUCTIONS

(i)   All questions are compulsory.

(ii)   Q. no. 1 to 5 are very short answer questions and carry 1 mark each.

(iii)   Q. no. 6 to 10 are short answer questions and carry 2 marks each.

(iv)   Q. no. 11 to 22 are also short answer questions and carry 3 marks each.

(v)   Q. no. 23 is a value based question and carries 4 marks.

(vi)   Q. no. 24 to 26 are long answer questions and carry 5 marks each.

(vii)   Use log table if necessary, use of calculators is not allowed.

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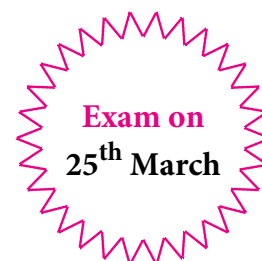
1. What is an adsorption isotherm?

2. Write down the electronic configuration of gadolinium (Gd). (At. number : Gd = 64)

3. Write the structure of the compound : 4-*tert*-butyl-3-iodoheptane

4. What happens when ferrimagnetic Fe_3O_4 is heated at 850 K and why?

5. Write the equation involved in the acetylation of salicylic acid.

6. $[Fe(CN)_6]^{4-}$ and $[Fe(H_2O)_6]^{2+}$ are of different colours in dilute solutions. Why?

OR

Discuss the nature of bonding in metal carbonyls.

7. Knowing the electron gain enthalpy values for $O \rightarrow O^-$ and $O \rightarrow O^{2-}$ as –141 and 702 kJ mol^{-1} respectively, how can you account for the formation of large number of oxides having O^{2-} species and not O^-?

8. Calculate the mass of ascorbic acid (vitamin C, $C_6H_8O_6$) to be dissolved in 75 g acetic acid to lower its freezing point by 1.5°C. (K_f = 3.9 K kg mol^{-1})

9. A first order reaction has a specific reaction rate of 10^{-3} sec^{-1}. How much time will it take for 10 g of the reactant to reduce to 2.5 g? (Given : log 2 = 0.301, log 4 = 0.6021, log 6 = 0.778)

10. How will you distinguish between $(CH_3)_2NH$ and $(CH_3)_3N$?

11. Answer the following :

(i) In a cubic close-packed structure of a mixed oxide one-eighth of tetrahedral voids are occupied by divalent ions, X^{2+} while one half of the octahedral voids are occupied by trivalent ions, Y^{3+}. What is the formula of the compound?

(ii) Ferric oxide crystallises in a hexagonal close packed array of oxide ions with two out of every three octahedral holes occupied by ferric ions. Derive the formula of the ferric oxide.

12. State the principle involved in refining of metals by each of the following methods :

(i) Zone refining   **(ii)** Vapour phase refining
(iii) Electrolytic refining

13. Answer the following :

(i) In the ring test of NO_3^- ion, Fe^{2+} ion reduces nitrate ion to nitric oxide, which combines with $Fe^{2+}_{(aq)}$ ion to form brown complex. Write the reactions involved in the formation of brown ring.

(ii) Write the structure of pyrophosphoric acid and peroxomonophosphoric acid.

14. $NiCl_2[P(C_2H_5)_3]_2$ exhibits temperature dependent magnetic behaviour (paramagnetic or diamagnetic). Predict

the coordination geometries of Ni^{2+} in which the complex behave as paramagnetic and diamagnetic.

15. Answer the following :
(i) Explain why
(a) the dipole moment of chlorobenzene is lower than that of cyclohexyl chloride?
(b) alkyl halides, though polar, are immiscible with water?
(ii) Draw the structure of major monohalo product in the following reaction :

$$\bigcirc\!\!\!| + Cl_2 \xrightarrow[\text{Dark}]{\text{Fe}}$$

16. Explain the following :
(i) How does a delta form at the meeting place of sea and river water?
(ii) What happens when dialysis is prolonged?
(iii) How does the precipitation of colloidal smoke take place in Cottrell precipitator?
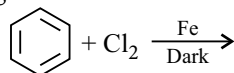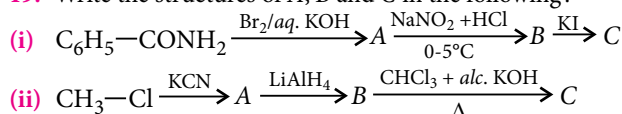
17. The degree of dissociation of $Ca(NO_3)_2$ in a dilute aqueous solution containing 7.0 g of the salt per 100 g of water at 100°C is 70 percent. If the vapour pressure of water at 100°C is 760 mm, calculate the vapour pressure of the solution.

OR

At some temperature, the vapour pressure of pure benzene (C_6H_6) is 0.256 bar and that of pure toluene $(C_6H_5CH_3)$ is 0.0925 bar. If the mole fraction of toluene in solution is 0.6. Then,
**(i)** what will be the total pressure of the solution?
(ii) what will be the mole fraction of each component in vapour phase?

18. Answer the following :
(i) What is a developer used in photography and how does it work?
(ii) How will you synthesise
(a) 1-phenylethanol from a suitable alkene?
(b) cyclohexylmethanol using an alkyl halide by an S_N2 reaction?

19. Write the structures of *A*, *B* and *C* in the following :
(i) $C_6H_5\!-\!CONH_2 \xrightarrow{Br_2/aq.\ KOH} A \xrightarrow[0\text{-}5°C]{NaNO_2 +HCl} B \xrightarrow{KI} C$
(ii) $CH_3\!-\!Cl \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[\Delta]{CHCl_3 +\ alc.\ KOH} C$

20. Account for the following :
(i) Why does compound (*A*) given below not form an oxime?

AcO———H
H———OAc
AcO———H ⟩ O
H———OAc
H———
   CH$_2$OAc
    (*A*)
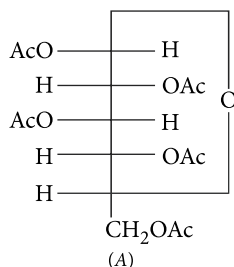
(ii) Why must vitamin C be supplied regularly in diet?
(iii) Activation energy for the acid catalysed hydrolysis of

sucrose is 6.22 kJ mol^{-1}, while the activation energy is only 2.15 kJ mol^{-1} when hydrolysis is catalysed by the enzyme sucrase. Explain.

21. Answer the following :
(i) The half-life for radioactive decay of ^{14}C is 5730 years. An archaeological artifact containing wood had only 80% of the ^{14}C found in a living tree. Calculate the age of the sample.
(ii) Why does the rate of a reaction not remain constant throughout the reaction process?

22. Answer the following :
(i) Why does *cis*-polyisoprene possess elastic properties?
(ii) Which factor imparts crystalline nature to a polymer like nylon?
(iii) Why should the monomers used in addition polymerisation through free radical pathway be very pure?

23. Sonam is a student of Class XII. Once her mother fell down from stairs and her leg bruised with lot of pain. Sonam gave her mother a non-narcotic analgesic which was safe to use. Her mother questioned if there is some other type of analgesic as well. Sonam replied affirmatively and told her mother that narcotic analgesics should be taken only when one is in acute pain.
After reading the above passage, answer the following questions :
(i) What values are expressed by Sonam by her choice about using narcotic and non-narcotic analgesics?
(ii) Give some examples of narcotic and non-narcotic analgesics.
(iii) Give one example of an antipyretic which also acts as an analgesic. How does it work as an analgesic?

24. Answer the following :
(i) In the button cells, widely used in watches and other devices, the following reaction takes place :
$Zn_{(s)} + Ag_2O_{(s)} + H_2O_{(l)} \longrightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2OH^-_{(aq)}$
Determine $E°$ and $\Delta G°$ for the reaction.
(Given : $E°_{Ag^+/Ag}$ = + 0.80 V, $E°_{Zn^{2+}/Zn}$ = −0.76 V)
(ii) What type of a battery is the lead storage battery? Write the anode and the cathode reactions and the overall reaction occurring in a lead storage battery when current is drawn from it.
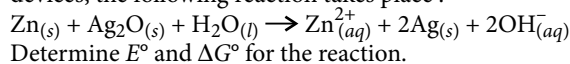
OR

Answer the following :
(i) The cell in which the following reaction occurs,
$2Fe^{3+}_{(aq)} + 2I^-_{(aq)} \longrightarrow 2Fe^{2+}_{(aq)} + I_{2(s)}$ has $E°_{cell}$ = 0.236 V at 298 K, calculate the standard Gibbs energy and the equilibrium constant of the cell reaction.
(ii) The chemistry of corrosion of iron is essentially an electrochemical phenomenon. Explain the reactions occurring during the corrosion of iron in the atmosphere.

25. Answer the following :
(i) A blackish brown coloured solid '*A*' when fused with alkali metal hydroxide in presence of air, produces a dark green coloured compound '*B*', which on electrolytic oxidation

in alkaline medium gives a dark purple coloured compound '*C*'. Identify *A*, *B* and *C* and write the reactions involved.

(ii) What happens when an acidic solution of the green compound (*B*) is allowed to stand for some time? Give the equation involved. What is this type of reaction called?

OR

Answer the following :

(i) Explain why mercury(I) ion exists as Hg_2^{2+} ion, while copper(I) exists as Cu^+ ion.

(ii) Assign suitable reasons for the following :

(a) Mn^{2+} compounds are more stable than Fe^{2+} compounds towards oxidation to their +3 oxidation state.

(b) In the 3*d* series from Sc (Z = 21) to Zn (Z = 30), the enthalpy of atomisation of Zn is the lowest.

(c) Sc^{3+} is colourless in aqueous solution whereas Ti^{3+} is coloured.

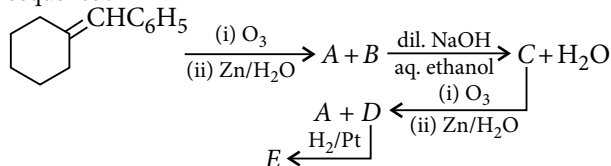**26.** Identify compounds (*A* to *D*) in the following reactions sequence :
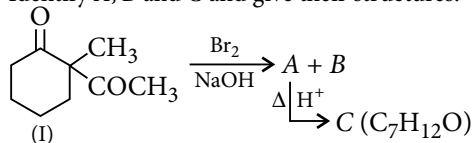
$$\begin{array}{c} \text{CHC}_6\text{H}_5 \\ \bigcirc \end{array} \xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} A + B \xrightarrow[\text{aq. ethanol}]{\text{dil. NaOH}} C + H_2O$$

$$A + D \xleftarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3}$$
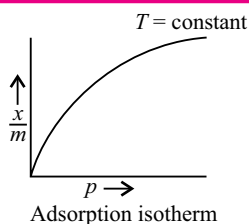
$$E \xleftarrow{\text{H}_2/\text{Pt}}$$

OR

Answer the following :

(i) A compound with molecular formula, $C_4H_{10}O_3$ on acetylation with acetic anhydride gives a compound with molecular weight 190. Find out the number of hydroxyl groups present in the compound.

(ii) Identify *A*, *B* and *C* and give their structures.

$$\begin{array}{c} \text{O} \\ \bigcirc \overset{\text{CH}_3}{\underset{\text{COCH}_3}{}} \\ (I) \end{array} \xrightarrow[\text{NaOH}]{\text{Br}_2} A + B \xrightarrow[\Delta]{\text{H}^+} C\ (C_7H_{12}O)$$
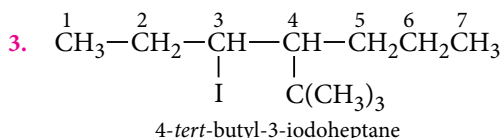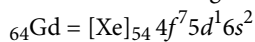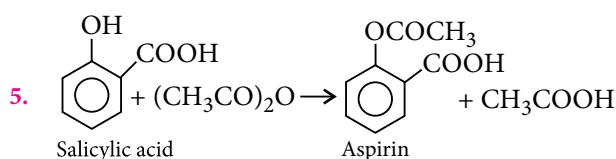
SOLUTIONS

1. Adsorption isotherm is the variation of the amount of gas adsorbed by the adsorbent with pressure at constant temperature.

Adsorption isotherm

2. The electronic configuration of gadolinium is
$$_{64}\text{Gd} = [\text{Xe}]_{54}\ 4f^7 5d^1 6s^2$$

3. $\overset{1}{C}H_3 - \overset{2}{C}H_2 - \overset{3}{C}H - \overset{4}{C}H - \overset{5}{C}H_2 \overset{6}{C}H_2 \overset{7}{C}H_3$
with $|$ I under C3 and $|$ C(CH$_3$)$_3$ under C4
4-*tert*-butyl-3-iodoheptane

4. When ferrimagnetic Fe_3O_4 is heated at 850 K, it loses ferrimagnetism and becomes paramagnetic due to alignment of spins in one direction.

5.
$$\begin{array}{c} \text{OH} \\ \bigcirc \text{COOH} \end{array} + (CH_3CO)_2O \longrightarrow \begin{array}{c} \text{OCOCH}_3 \\ \bigcirc \text{COOH} \end{array} + CH_3COOH$$
Salicylic acid   Aspirin

6. In $[Fe(CN)_6]^{4-}$, CN^- is a strong field ligand hence, pairing of electrons takes place.
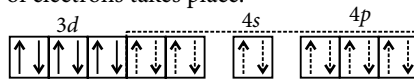
In $[Fe(H_2O)_6]^{2+}$, H_2O is a weak field ligand hence, pairing does not take place.

Both ligands show different magnitude of crystal field splitting energy due to different nature hence, absorb different wavelengths and show different colours.

OR
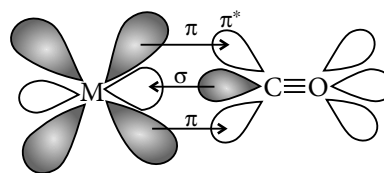
Synergic bonding

The metal-carbon bond in metal carbonyls possess both σ and π character. The $M-C$ σ bond is formed by the donation of lone pair of electrons on the carbonyl carbon into a vacant orbital of the metal. The $M-C$ π bond is formed by the donation of a pair of electrons from a filled *d*-orbital of metal into the vacant antibonding π^* orbital of carbon monoxide. The metal to ligand bonding creates a synergic effect which strengthens the bond between CO and the metal.

7. This can be explained with the help of electronic configuration.
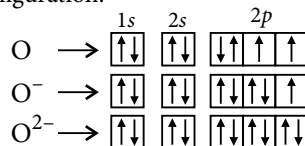
As O^{2-} has most stable configuration amongst these. So, formation of O^{2-} is much more easier. In solid state, large amount of energy (lattice enthalpy) is released when oxides are formed with divalent O^{2-} ions. It is greater lattice enthalpy of the crystal lattice of oxide (O^{2-}) which compensates for the high energy required to add the second electron.

8. Lowering in freezing point (ΔT_f) = 1.5°C
Mass of solvent (CH_3COOH), w_1 = 75 g
Mass of solute, w_2 = ?
Molar mass of solute, $C_6H_8O_6$, M_2 = 72 + 8 + 96 = 176 g mol^{-1}

$$\Delta T_f = K_f \times \frac{w_2 \times 1000}{M_2 \times w_1}$$

or $w_2 = \dfrac{M_2 \times w_1 \times \Delta T_f}{1000 \times K_f} = \dfrac{176 \times 75 \times 1.5}{1000 \times 3.9} = 5.08$ g

9. We know that for a first order reaction,

$$t = \frac{2.303}{k} \log \frac{a}{a-x}$$

Here, initial concentration, a = 10 g and concentration left after time t sec. = 2.5 g, *i.e.*, $(a - x)$ = 2.5 g

Specific reaction constant, $k = 10^{-3}$ sec^{-1}

∴ Time required for the reactant to reduce to 2.5 g

$$= \frac{2.303}{10^{-3}\,s^{-1}} \times \log \frac{10}{2.5} = \frac{2.303}{10^{-3}} \times \log 4 = \frac{2.303}{10^{-3}} \times 0.6021$$
$$= 1386.6 \text{ sec}$$

10. These can be distinguished by Liebermann's nitrosoamine reaction. $(CH_3)_2NH$ (dimethylamine) on treatment with HNO_2 (generated in situ by the action of dil. HCl on $NaNO_2$) gives yellow coloured oily *N*-nitrosodimethylamine.

$$(CH_3)_2NH + HO-N{=}O \rightarrow \underset{\text{\textit{N}-Nitrosodimethylamine}}{(CH_3)_2N-N{=}O} + H_2O$$
Dimethylamine

N-Nitrosodimethylamine on warming with a crystal of phenol and conc. H_2SO_4 forms a green solution which when made alkaline with aqueous NaOH turns deep blue and then red on dilution.
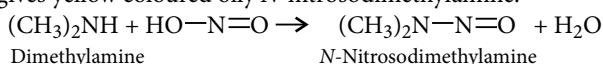
$(CH_3)_3N$ (trimethylamine), on the other hand, being a 3° amine does not give this test.

11. (i) Let the number of O^{2-} ions in the crystal be *N*.

∴ Number of tetrahedral voids = $2N$
Number of octahedral voids = N

∴ Number of X^{2+} ions = $\frac{1}{8} \times 2N = \frac{N}{4}$

Number of Y^{3+} ions = $\frac{1}{2} \times N = \frac{N}{2}$

$X^{2+} : Y^{3+} : O^{2-} = \frac{1}{4} : \frac{1}{2} : 1 = 1 : 2 : 4$

∴ The formula of the compound is XY_2O_4.

(ii) There is one octahedral hole for each atom in hexagonal closed packed arrangement. If the number of oxide ions (O^{2-}) per unit cell is *x*, then

Number of Fe^{3+} ions = 2/3 × octahedral holes = $\frac{2}{3} \times x = \frac{2x}{3}$

∴ Ratio of $Fe^{3+} : O^{2-} = \frac{2x}{3} : x = 2 : 3$

Thus, formula of compound is Fe_2O_3.

12. (i) Zone refining is based on the principle that the impurities are more soluble in the melt than in the solid state of the metal.

(ii) In vapour phase refining, the metal is converted into a suitable volatile compound and then decomposed to give pure metal. So, the two requirements are :

(a) The metal should form a volatile compound with a suitable reagent.

(b) The volatile compound should be easily decomposable, so that the recovery is easy.

(iii) Zinc is refined by electrolytic refining. In this method, the impure metal is made to act as anode. A strip of the same metal in pure form is used as cathode. They are put in a suitable electrolytic bath containing soluble salt of the same metal. The more basic metal remains in the solution and the less basic ones go to the anode mud.

At anode : $Zn \rightarrow Zn^{2+} + 2e^-$

At cathode : $Zn^{2+} + 2e^- \rightarrow Zn$

13. (i) $NO_3^- + 3Fe^{2+} + 4H^+ \rightarrow NO + 3Fe^{3+} + 2H_2O$

$[Fe(H_2O)_6]^{2+} + NO \rightarrow \underset{\text{Brown ring}}{[Fe(H_2O)_5(NO)]^{2+}} + H_2O$

(ii)
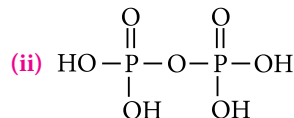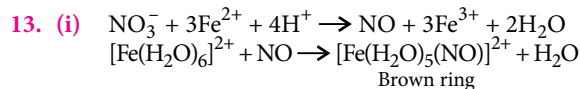
Pyrophosphoric acid
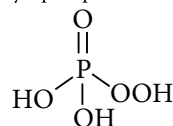
Peroxomonophosphoric acid

14. In the given complex, $NiCl_2[P(C_2H_5)_3]_2$, nickel is in +2 oxidation state and the ground state electronic configuration of Ni^{2+} ion in free gaseous state is
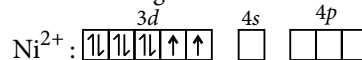
For the given four coordinated complex to be paramagnetic, it must possess unpaired electrons in the valence shell. To satisfy this condition, lone pairs from the four ligands occupy the four sp^3 hybrid orbitals as :
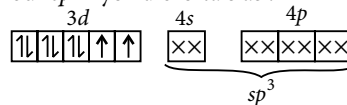
Therefore, geometry of paramagnetic complex must be tetrahedral. On the other hand, for complex to be diamagnetic, there should not be any unpaired electrons in the valence shell. This condition can be fulfilled by pairing electrons of $3d$-orbitals as
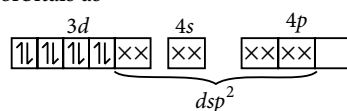
The above electronic arrangement gives dsp^2 hybridisation and therefore, square planar geometry.

15. (i) (a) There are two reasons :

1. In case of chlorobenzene, carbon to which chlorine is attached is sp^2 hybridised and is more electronegative than the corresponding carbon in cyclohexyl chloride which is sp^3 hybridised. So, the net dipole moment is lower in chlorobenzene.

Chlorobenzene   Cyclohexyl chloride
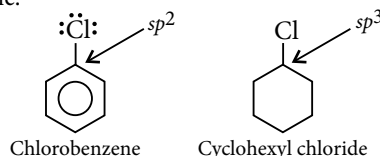
2. In chlorobenzene C—Cl bond has some double bond character so, its bond length is smaller. Hence, dipole moment is smaller than cyclohexyl chloride which has a longer C—Cl single bond.

(b) Alkyl halides are polar but are insoluble in water because energy required to break the intermolecular H – bonding among water molecules is much higher than energy released by water–halide interaction.

(ii)

$$\text{Benzene} + Cl_2 \xrightarrow[\text{Dark}]{Fe} \text{Chlorobenzene}$$
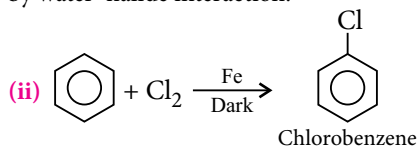
16. (i) River water is a colloidal solution of clay and mud. Sea water contains many salts or electrolytes. When these electrolytes come in contact with river water where river and sea meet, coagulation of clay and mud takes place and delta is formed.

(ii) When dialysis is prolonged, the traces of electrolytes are also removed. These electrolytes stabilise the colloid and when removed completely, make the colloid unstable and the colloid gets coagulated.

(iii) Smoke is a colloidal solution of carbon particles in air. In Cottrell precipitator, when smoke is allowed to pass through a chamber having a number of metal plates attached to a metal, will be connected to a source of high potential. The charged particles of smoke get attracted by oppositely charged electrode and get precipitated after losing their charges.

17. Calculated (normal) molecular mass of $Ca(NO_3)_2 = 164$. Calculated (normal) lowering of vapour pressure will be given by

$$\frac{\Delta p}{p^\circ} = \frac{w_2/M_2}{w_1/M_1}$$

$$\therefore \quad \frac{(\Delta p)_{cal}}{760} = \frac{7/164}{100/18} \quad \text{or } (\Delta p)_{cal} = 5.84 \text{ mm}$$

As $Ca(NO_3)_2$ is 70% dissociated, degree of dissociation, $\alpha = 0.70$.

	$Ca(NO_3)_2 \rightleftharpoons$	Ca^{2+}	$+ 2NO_3^-$
Initial moles	1	0	0
Moles after dissociation	$1 - \alpha$	α	2α

Total $= 1 + 2\alpha$

$\therefore$ van't Hoff factor,

$$i = \frac{(\Delta p)_{obs}}{(\Delta p)_{cal}} = \frac{1 + 2\alpha}{1} = 1 + 2\alpha$$

or $\quad \dfrac{(\Delta p)_{obs}}{5.84} = 1 + 2 \times 0.70$

or $\quad (\Delta_p)_{obs} = 14.0 \text{ mm}$

i.e., $p^\circ - p_s = 14.0 \text{ mm}$

or $\quad p_s = p^\circ - 14.0 = 760 - 14.0 = 746.0 \text{ mm}$

OR

(i) According to Raoult's law,

For toluene, $\quad p_T = p_T^\circ \times x_T$
$$p_T^\circ = 0.0925 \text{ bar}$$
and $\quad\quad\quad x_T = 0.6$
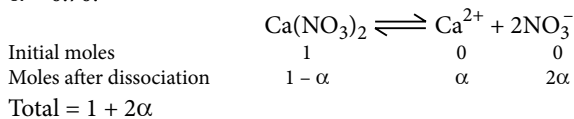
Then, $\quad p_T = 0.0925 \times 0.6 = 0.0555 \text{ bar}$

For benzene,

$$p_B = p_B^\circ \times x_B$$
$$x_B = 1 - x_T = 1 - 0.6 = 0.4$$

and $p_B^\circ = 0.256$ bar

Then, $\quad p_B = 0.256 \times 0.4 = 0.1024$ bar

Total vapour pressure of solution,

$$P_{total} = p_T + p_B = 0.0555 + 0.1024 = 0.158 \text{ bar}$$

(ii) Mole fraction of toluene in vapour phase,

$$y_T = \frac{p_T}{P_{total}} = \frac{0.0555}{0.158} = 0.351$$

Mole fraction of benzene in vapour phase,

$$y_B = \frac{p_B}{P_{total}} = \frac{0.1024}{0.158} = 0.648$$

18. (i) Hydroquinone (or benzene-1,4-diol) is used as a developer in photography because it reduces Ag^+ ions present on the exposed film to metallic silver.

$$HO-\langle\rangle-OH + 2Ag^+ \longrightarrow O=\langle\rangle=O + 2H^+ + 2Ag\downarrow$$

Hydroquinone $\quad\quad$ *p*-Benzoquinone
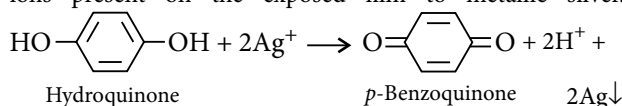
(ii) (a) Addition of H_2O to ethenylbenzene (or styrene) in presence of dil. H_2SO_4 gives 1-phenylethanol.

Ethenylbenzene or Styrene $+ H-OH \xrightarrow[\text{Markovnikov's addition}]{\text{dil. } H_2SO_4}$ 1-Phenylethanol
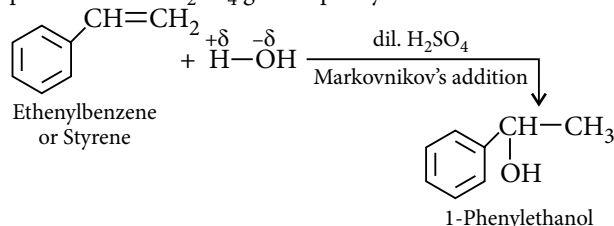
(b) Hydrolysis of cyclohexylmethyl bromide by aqueous NaOH gives cyclohexylmethanol.

Cyclohexylmethyl bromide $+ NaOH \xrightarrow[S_N2, \text{Hydrolysis}]{\Delta}$ Cyclohexylmethanol $+ NaBr$

19. (i)

$$\text{CONH}_2 \xrightarrow[aq. \text{ KOH}]{Br_2} \text{NH}_2 (A) \xrightarrow[0–5°C]{NaNO_2 + HCl} N_2^+Cl^- (B) \xrightarrow{KI} I (C)$$

(ii) $CH_3-Cl \xrightarrow{KCN} CH_3CN \xrightarrow{LiAlH_4} CH_3CH_2NH_2$
$\quad\quad\quad\quad\quad\quad (A) \quad\quad\quad\quad\quad (B)$

$CH_3CH_2NC \xleftarrow[\Delta]{CHCl_3 + alc. \text{ KOH}}$
(C)
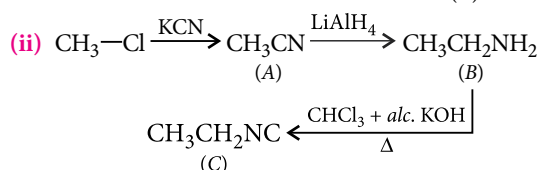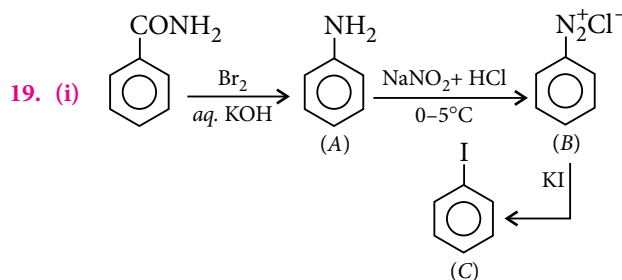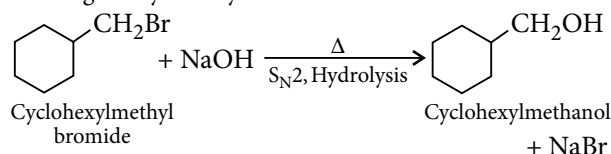
20. (i) Glucose pentaacetate (*A*) does not have a free –OH at C-1 and so cannot be converted to the open chain form to give –CHO group hence, it does not form the oxime.
(ii) Vitamin C is water soluble hence it is readily excreted in urine and cannot be stored in the body.
(iii) Enzymes are biocatalysts which reduce the magnitude of activation energy by providing alternative path. In the hydrolysis of sucrose, the enzyme sucrase reduces the activation energy from 6.22 kJ mol^{-1} to 2.15 kJ mol^{-1}.

21. (i) $t_{1/2} = \dfrac{0.693}{k}$ (For first order reaction)

$\therefore \quad k = \dfrac{0.693}{t_{1/2}} = \dfrac{0.693}{5730}\, \text{yr}^{-1}$

We know that,

$t = \dfrac{2.303}{k} \log \dfrac{[R]_0}{[R]} = \dfrac{2.303}{\dfrac{0.693}{5730}} \log \dfrac{100}{80}$

$= \dfrac{2.303 \times 5730}{0.693} \log \dfrac{100}{80} = \dfrac{2.303 \times 5730}{0.693} \log 1.25$

$= \dfrac{2.303 \times 5730}{0.693} \times 0.0969 = 1845\ \text{yr (approx.)}$

Therefore, the age of the given archaeological artifact containing wood is 1845 years.
(ii) The rate of a reaction does not remain constant throughout the reaction process because the rate of the reaction depends upon concentration of reactants which keeps on decreasing.

22. (i) The *cis*-polyisoprene molecule consists of various chains held together by weak van der Waals interactions and has a coiled structure. Hence, it can be stretched like a spring and exhibits elastic properties.

(ii) Strong intermolecular forces like hydrogen bonding lead to close packing of polymer chains and thus, impart crystalline nature to nylon.

(iii) Even the traces of impurities may act like inhibitors which stop the growth of the polymers and polymers with shorter chain length are formed. Hence, pure monomers are required for polymerisation through free radical pathway.
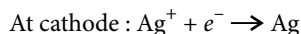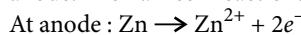
23. (i) Sonam expressed values about the safety in choosing analgesics and her awareness about drugs. Non-narcotic analgesics are non-addictive and hence, are safe to use but narcotic analgesics are addictive, *i.e.*, habit forming and hence, are not safe to use. Therefore, narcotic analgesics should be used only in severe pain such as post-operative pain, cardiac pain, pains of terminal cancer and in child birth.
(ii) Examples of non-narcotic analgesics are : aspirin, paracetamol, naproxen, ibuprofen and diclofenac sodium. Examples of narcotic analgesics are : morphine, codeine and heroin.
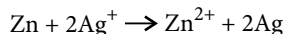**(iii)** Aspirin acts both as an antipyretic as well as an analgesic. Its analgesic action is due to the reason that it inhibits the synthesis of prostaglandins which stimulate inflammation in the tissues and cause pain.

24. (i) Since, $E^{\circ}_{\text{Ag}^+/\text{Ag}} > E^{\circ}_{\text{Zn}^{2+}/\text{Zn}}$, the zinc electrode is the anode. The half-cell reactions are as follows :
At anode : $\text{Zn} \longrightarrow \text{Zn}^{2+} + 2e^-$
At cathode : $\text{Ag}^+ + e^- \longrightarrow \text{Ag}$
Overall cell reaction is
$\quad \text{Zn} + 2\text{Ag}^+ \longrightarrow \text{Zn}^{2+} + 2\text{Ag}$
$E^{\circ}_{\text{cell}} = E^{\circ}_{\text{cathode}} - E^{\circ}_{\text{anode}} = 0.80\ \text{V} - (-0.76)\ \text{V}$
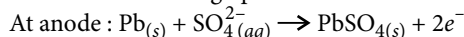$\quad = 0.80\ \text{V} + (0.76)\ \text{V} = 1.56\ \text{V}$
Number of electrons involved is 2. Therefore, ΔG° value is given by the formula,
$\Delta G^{\circ} = -nFE^{\circ}_{\text{cell}} = -2 \times 96500\ \text{C mol}^{-1} \times 1.56\ \text{V}$
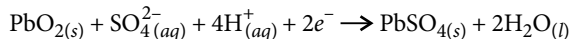$\quad = -301080\ \text{J mol}^{-1} = -301.08\ \text{kJ mol}^{-1}$
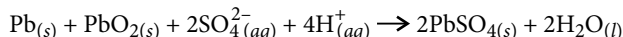
(ii) Lead storage battery is a secondary cell.
Cell reactions during operation are :
At anode : $\text{Pb}_{(s)} + \text{SO}_{4(aq)}^{2-} \longrightarrow \text{PbSO}_{4(s)} + 2e^-$
At cathode :
$\text{PbO}_{2(s)} + \text{SO}_{4(aq)}^{2-} + 4\text{H}^+_{(aq)} + 2e^- \longrightarrow \text{PbSO}_{4(s)} + 2\text{H}_2\text{O}_{(l)}$
Overall reaction :
$\text{Pb}_{(s)} + \text{PbO}_{2(s)} + 2\text{SO}_{4(aq)}^{2-} + 4\text{H}^+_{(aq)} \longrightarrow 2\text{PbSO}_{4(s)} + 2\text{H}_2\text{O}_{(l)}$

OR

(i) Two half reactions for the given redox reaction may be written as :
$2\text{Fe}^{3+}_{(aq)} + 2e^- \longrightarrow 2\text{Fe}^{2+}_{(aq)}$
$2\text{I}^- \longrightarrow \text{I}_2 + 2e^-$
2 moles of electrons are involved in the reaction, so $n = 2$
$\Delta_r G^{\circ} = -nFE^{\circ}_{\text{cell}} = -(2\ \text{mol}) \times (96500\ \text{C mol}^{-1}) \times (0.236\ \text{V})$
$\quad = -45548\ \text{J} = -45.55\ \text{kJ}$
$\log K_c = -\dfrac{\Delta G^{\circ}}{2.303\, RT}$
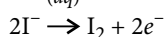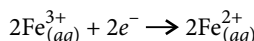
$\quad = -\dfrac{(-45.55\ \text{kJ})}{2.303 \times (8.314 \times 10^{-3}\ \text{kJ K}^{-1}) \times (298\ \text{K})} = 7.983$

$K_c = $ antilog $(7.983) = 9.616 \times 10^7$
(ii) According to electrochemical theory of rusting, the impure iron surface behaves like small electrochemical cell. Moisture having dissolved CO_2 or O_2 acts as an electrolyte. The reactions are given below :
At anode : $\text{Fe} \longrightarrow \text{Fe}^{2+} + 2e^-$; $E^{\circ}_{\text{Fe}^{2+}/\text{Fe}} = -0.44\ \text{V}$
At cathode : $2\text{H}^+ + \dfrac{1}{2}\text{O}_2 + 2e^- \longrightarrow \text{H}_2\text{O}$; $E^{\circ}_{\text{H}^+/\text{O}_2/\text{H}_2\text{O}} = 1.23\ \text{V}$

....
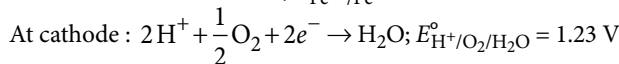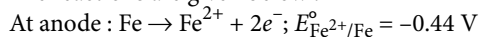
MPP CLASS XII			ANSWER	**KEY**
1. (b)	**2.** (b)	**3.** (c)	**4.** (b)	**5.** (b)
6. (d)	**7.** (a)	**8.** (a)	**9.** (a)	**10.** (c)
11. (c)	**12.** (b)	**13.** (a)	**14.** (a)	**15.** (b)
16. (d)	**17.** (c)	**18.** (a)	**19.** (d)	**20.** (b,d)
21. (a,b,c)	**22.** (b,c)	**23.** (a,b,c)	**24.** (8)	**25.** (9)
26. (6)	**27.** (b)	**28.** (a)	**29.** (c)	**30.** (b)

Overall reaction :

$$Fe + 2H^+ + \frac{1}{2}O_2 \rightarrow Fe^{2+} + H_2O; E^\circ_{cell} = 1.67 \text{ V}$$

The ferrous ions formed react with the dissolved oxygen or oxygen from the air to form ferric oxide with further production of H^+ ions.

$$2Fe^{2+} + \frac{1}{2}O_2 + 2H_2O \rightarrow Fe_2O_3 + 4H^+$$

Ferric oxide then undergoes hydration to form rust as follow :

$$Fe_2O_3 + xH_2O \rightarrow Fe_2O_3 \cdot xH_2O$$
$$\text{(Rust)}$$

25. (i) $\quad MnO_2 + 4KOH + 2O_2 \xrightarrow{\text{Fuse}} 2K_2MnO_4 + 2H_2O$

$\quad\quad$ Pyrolusite (A) $\quad\quad\quad\quad\quad$ Potassium
$\quad\quad$ (Blackish brown) $\quad\quad\quad\quad$ manganate (B)
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ (Green coloured)

$2K_2MnO_4 + H_2O + [O] \xrightarrow[\text{medium}]{\text{Alkaline}} 2KMnO_4$

$\quad$ (B) $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ Potassium permanganate (C)
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ (Purple coloured)
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ + 2KOH

(ii) When acidic solution of green compound (B), *i.e.*, potassium manganate is allowed to stand for some time, it disproportionates to give permanganate as follows :

$$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$$

These type of reactions are called disproportionation reactions.

OR

(i) The electronic configuration of Hg(I) is $[Xe]4f^{14}5d^{10}6s^1$. It has one unpaired electron in the valence 6*s*-subshell. It is paramagnetic but actually Hg(I) compounds are diamagnetic. This change can be explained by assuming that the singly filled 6*s*-orbitals of two Hg^+ ions overlap to form Hg—Hg covalent bond.

Therefore, Hg^+ ion exists as dimeric species, *i.e.*, Hg_2^{2+}. On the other hand, Cu(I) ion has electronic configuration $[Ar]3d^{10}$. It has no unpaired electron to form dimeric Cu_2^{2+} species and therefore, it exists as Cu^+ ion.

(ii) (a) Electronic configuration of Mn^{2+} is $3d^5$ which is half filled and hence, stable. Therefore, third ionisation enthalpy is very high, *i.e.*, 3rd electron cannot be lost easily. In case of Fe^{2+}, electronic configuration is $3d^6$. Hence, it can lose one electron easily to give the stable configuration, $3d^5$.

(b) Zinc (Z = 30) has completely filled *d*-orbitals ($3d^{10}$). The extent of metallic bonding is more, more will be enthalpy of atomisation. Due to absence of unpaired electrons, the inter-atomic electronic bonding is the weakest in Zn and thus, has least enthalpy of atomisation.

(c) Only those ions are coloured which have partially filled *d*-orbitals facilitating *d-d* transitions.
Electronic configuration of $Sc^{3+} = [Ar]$
Electronic configuration of $Ti^{3+} = [Ar]3d^1$

26.

Now compound (B) has α-hydrogens but (A) does not, therefore, in presence of dil. NaOH, cross aldol condensation occurs between them to give (C).

Reductive ozonolysis of (C) gives (D) and (A).

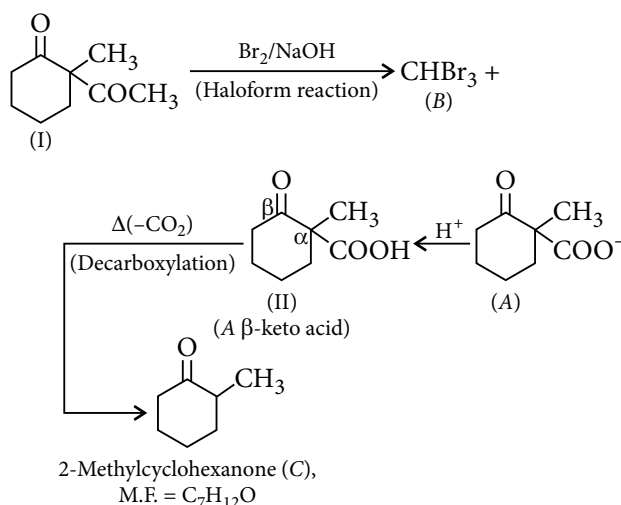(D) on catalytic reduction gives cyclohexane-1, 2-diol (E).

OR

(i) During acetylation, one H-atom (at. mass = 1 amu) of the OH group is replaced by an acetyl group, *i.e.*, CH_3CO (molecular mass = 43 amu).

$$-OH + (CH_3CO)_2O \longrightarrow -O-COCH_3 + CH_3COOH$$

In other words, acetylation of each OH group increases mass by (43 – 1 =) 42 amu. Now, the molecular mass of $C_4H_{10}O_3$ = 106 amu while that of the acetylated product is 190 amu, therefore, the number of OH groups in the compound

$$= \frac{190 - 106}{42} = 2$$

(ii) The given compound (I) contains CH_3CO- group and hence, in presence of $Br_2/NaOH$, it undergoes haloform reaction to give sodium salt of carboxylic acid (*A*) and bromoform, $CHBr_3$(*B*). (*A*) on protonation gives the corresponding acid (II). (II) being a β-keto acid readily undergoes decarboxylation on heating to give 2-methylcyclohexanone (*C*).

2-Methylcyclohexanone (*C*),
M.F. = $C_7H_{12}O$

MPP | MONTHLY Practice Paper | Class XII

This specially designed column enables students to self analyse their extent of understanding of complete syllabus. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Time Taken : 60 Min.

NEET / AIIMS
Only One Option Correct Type

1. The fraction of the total volume occupied by the atoms present in a simple cube is

   (a) $\dfrac{\pi}{4}$ (b) $\dfrac{\pi}{6}$ (c) $\dfrac{\pi}{3\sqrt{2}}$ (d) $\dfrac{\pi}{4\sqrt{2}}$

2. 1.0 molar solution of the complex salt, $CrCl_3 \cdot 6H_2O$, displays an osmotic pressure of $3RT$. 0.5 L of the same solution on treatment with excess of $AgNO_3$ solution will yield (assume $\alpha = 1$)
   (a) 0.5 mol of AgCl   (b) 1.0 mol of AgCl
   (c) 1.5 mol of AgCl   (d) 3.0 mol of AgCl.

3. A galvanic cell is set up from a zinc bar weighing 100 g and 1.0 litre of 1.0 M $CuSO_4$ solution. How long would the cell run if it is assumed to deliver a steady current of 1.0 ampere?
   (Atomic mass of Zn = 65)
   (a) 1.1 hr   (b) 46 hr   (c) 53.6 hr   (d) 24 hr

4. The rate constant of a zero order reaction is 0.2 mol dm^{-3} hr^{-1}. If the concentration of the reactant after 30 minutes is 0.05 mol dm^{-3}, then its initial concentration would be
   (a) 0.01 mol dm^{-3} (a) 0.15 mol dm^{-3}
   (c) 0.25 mol dm^{-3} (d) 4.00 mol dm^{-3}

5. Which of the following will show Tyndall effect?
   (a) Aqueous solution of soap below critical micelle concentration.
   (b) Aqueous solution of soap above critical micelle concentration.
   (c) Aqueous solution of sodium chloride.
   (d) Aqueous solution of sugar.

6. Which of the following reactions is an example of calcination process?
   (a) $2Ag + 2HCl + [O] \longrightarrow 2AgCl + H_2O$
   (b) $2Zn + O_2 \longrightarrow 2ZnO$
   (c) $2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$
   (d) $MgCO_3 \longrightarrow MgO + CO_2$

7. The following acids have been arranged in the order of decreasing acid strength. Identify the correct order.
   I. ClOH   II. BrOH
   III. IOH
   (a) I > II > III   (b) II > I > III
   (c) III > II > I   (d) I > III > II

8. What would happen when a solution of potassium chromate is treated with an excess of dilute nitric acid?
   (a) $Cr_2O_7^{2-}$ and H_2O are formed.
   (b) CrO_4^{2-} is reduced to Cr^{3+}.
   (c) CrO_4^{2-} is oxidised to Cr^{7+}.
   (d) Cr^{3+} and $Cr_2O_7^{2-}$ are formed.

9. Among the following, the species having square planar geometry for central atom are
   (i) XeF_4 (ii) SF_4
   (iii) $[NiCl_4]^{2-}$ (iv) $[PdCl_4]^{2-}$
   (a) (i) and (iv)   (b) (i) and (ii)
   (c) (ii) and (iii)   (d) (iii) and (iv)

10. $$\underset{\text{(major)}}{B} \xleftarrow[CH_3CH_2OH]{CH_3CH_2O^-Na^+} CH_3 - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - Br \xrightarrow{CH_3CH_2OH} \underset{\text{(major)}}{A}$$

Identify *A* and *B*.
(a) Both *A* and *B* are $(CH_3)_3COCH_2CH_3$.
(b) Both *A* and *B* are $(CH_3)_2C = CH_2$.
(c) *A* is $(CH_3)_3COCH_2CH_3$ and *B* is $(CH_3)_2C = CH_2$.
(d) *A* is $(CH_3)_2C = CH_2$ and *B* is $(CH_3)_3COCH_2CH_3$.

11. An organic compound with molecular formula, $C_2H_6O_2$ evolves H_2 when treated with sodium metal and gives two moles of formaldehyde on oxidation with HIO_4. The compound is
(a) acetic acid (b) methyl acetate
(c) ethylene glycol (d) ethyl alcohol.

12. In the given reaction sequence,
Phenol $\xrightarrow{Zn\ dust}$ X $\xrightarrow[Anhyd.\ AlCl_3]{CH_3Cl}$ Y $\xrightarrow[KMnO_4]{Alk.}$ Z, the product *Z* is
(a) benzaldehyde (b) benzoic acid
(c) benzene (d) toluene.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** Acylation of amines gives a monosubstituted product whereas alkylation of amines gives polysubstituted product.
Reason : Acyl group sterically hinders the approach of further acyl group.

14. **Assertion :** α-amino acids exist as internal salt in solution as they have amino and carboxylic acid groups in near vicinity.
Reason : H⁺ ion given by carboxyl group (—COOH) is captured by amino group (—NH_2) having lone pair of electrons.

15. **Assertion :** Detergents are preferred to soaps for washing purposes.
Reason : Detergents having branched hydrocarbon chains are non-biodegradable.

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Only One Option Correct Type

16. Element '*X*' crystallises in a 12 coordination *fcc* lattice. On applying high temperature, it changes to 8 coordination *bcc* lattice. The ratio of the density

of the crystal lattice before and after applying high temperature will be
(a) $1:1$ (b) $3:2$
(c) $\sqrt{2}:\sqrt{3}$ (d) $2(\sqrt{2})^3:(\sqrt{3})^3$

17. The ionic strength of a solution containing 0.1 mole/kg of KCl and 0.2 mole/kg of $CuSO_4$ is
(a) 0.3 (b) 0.6
(c) 0.9 (d) 0.2

18. Compound '*A*' (molecular formula C_3H_8O) is treated with acidified potassium dichromate to form a product '*B*' (molecular formula C_3H_6O). '*B*' forms a shining silver mirror on warming with ammoniacal silver nitrate. '*B*' when treated with an aqueous solution of $H_2NCONHNH_2.HCl$ and sodium acetate gives a product '*C*'. Identify the structure of '*C*'.
(a) $CH_3CH_2CH = NNHCONH_2$
(b) $CH_3—C=NNHCONH_2$ with CH_3 below
(c) $CH_3—C=NCONHNH_2$ with CH_3 below
(d) $CH_3CH_2CH = NCONHNH_2$

19. A dark brown solid (*X*) reacts with NH_3 to form a mild explosive which decomposes to give a violet coloured gas. (*X*) also reacts with H_2 to give an acid (*Y*). (*Y*) can also be prepared by heating its salt with H_3PO_4. *X* and *Y* are respectively
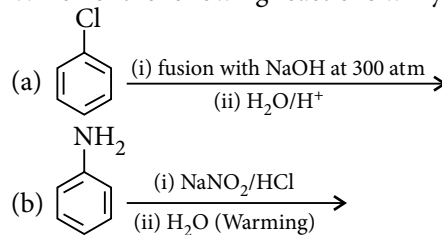(a) Cl_2, HCl (b) SO_2, H_2SO_4
(c) Br_2, HBr (d) I_2, HI

More than One Options Correct Type

20. Aryl halides are less reactive towards nucleophilic substitution reactions as compared to alkyl halides due to
(a) longer carbon-halogen bond
(b) resonance stabilisation
(c) the inductive effect
(d) sp^2-hybridised carbon attached to halogen.

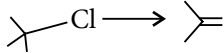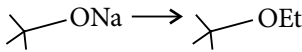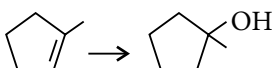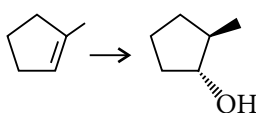21. Which of the following reactions will yield phenol?
(a) [Cl-benzene] $\xrightarrow[(ii)\ H_2O/H^+]{(i)\ fusion\ with\ NaOH\ at\ 300\ atm}$
(b) [NH_2-benzene] $\xrightarrow[(ii)\ H_2O\ (Warming)]{(i)\ NaNO_2/HCl}$

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(c) $\xrightarrow[\text{(ii) NaOH, (Heating)}]{\text{(i) Oleum}}$ (iii) H$^+$

(d) $\xrightarrow[\text{(ii) HCl}]{\text{(i)NaOH}_{(aq)},\ 298\ K/1\ atm}$

22. An aqueous pink solution of cobalt(II) chloride changes to deep blue on addition of excess of HCl. This is because
(a) $[Co(H_2O)_6]^{2+}$ is transformed into $[CoCl_6]^{4-}$
(b) $[Co(H_2O)_6]^{2+}$ is transformed into $[CoCl_4]^{2-}$
(c) tetrahedral complexes have smaller crystal field splitting than octahedral complexes
(d) tetrahedral complexes have larger crystal field splitting than octahedral complexes.

23. Arenium ion involved in the bromination of aniline is

(a)
(b)
(c)
(d)

Integer Answer Type

24. The total number of α and β particles emitted in the nuclear reaction, $^{238}_{92}U \rightarrow\ ^{214}_{82}Pb$ is

25. An organic compound undergoes first order decomposition. The time taken for its decomposition to 1/8 and 1/10 of its initial concentration are $t_{1/8}$ and $t_{1/10}$ respectively. What is the value of $\dfrac{[t_{1/8}]}{[t_{1/10}]} \times 10$? (take $\log_{10} 2 = 0.3$)

26. Amongst the following the total number of compounds soluble in sodium bicarbonate is 2, 4, 6-trinitrophenol, benzoic acid, salicylic acid, acetyl chloride, acetic anhydride, trifluoroethanol, acetamide, benzenesulphonic acid

Comprehension Type

Transition metal compounds are coloured due to *d-d* transition and charge transfer. Colour due to *d-d* transition is shown by transition metal compounds having d^1 to d^9 electrons whereas the compounds containing d^0 and d^{10} configurations are intensely coloured due to charge transfer transitions.

27. Which of the following compounds is not coloured?
(a) $Na_2[CuCl_4]$ (b) $Na_2[CdCl_4]$
(c) $K_4[Fe(CN)_6]$ (d) $K_3[Fe(CN)_6]$

28. The purple colour of $[Ti(H_2O)_6]^{3+}$ ion is due to
(a) unpaired *d*-electron
(b) transfer of an electron
(c) intermolecular vibrations
(d) presence of water molecules.

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Matrix Match Type

29. All the compounds listed in column I react with water. Match the result of the respective reactions with the appropriate options listed in column II.

Column I	Column II
(A) $(CH_3)_2SiCl_2$	(P) Hydrogen halide formation
(B) XeF_4	(Q) Redox reaction
(C) Cl_2	(R) Reacts with glass
(D) VCl_5	(S) Polymerisation
	(T) O_2 formation

	A	B	C	D
(a)	P, Q	P	P, Q, R, T	P, S
(b)	P, S	P, Q, R, T	P	P, Q
(c)	P, S	P, Q, R, T	P, Q	P
(d)	P, S	P, Q	P, Q, R, T	P

30. Match the chemical conversions in column I with the appropriate reagents in column II.

Column I	Column II
(A) Cl $\longrightarrow$	(P) (i) $Hg(OAc)_2$ (ii) $NaBH_4$
(B) ONa $\longrightarrow$ OEt	(Q) NaOEt
(C) $\longrightarrow$ OH	(R) Et — Br
(D) $\longrightarrow$ OH	(S) (i) BH_3 (ii) H_2O_2/NaOH

	A	B	C	D
(a)	P	Q	R	S
(b)	Q	R	P	S
(c)	Q	R	S	P
(d)	S	P	Q	R

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CROSS WORD

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ACROSS

1. The region in an infrared spectrum below 1500 wave numbers. (11)

5. The sum of oxidation numbers of lead in litharge and manganese in permanganate ion. (4)

6. The major constituent of the oil from orange peel. (8)

8. The trivial name given to α, β-unsaturated ketones obtained by condensing an aromatic aldehyde with an aryl methyl ketone in presence of a base. (9)

9. A chemical used as a weapon with devastating and horrific effect in the 1914-18 war. (8)

10. A molecular structure or state which has the characteristics of two or more other structures. (6)

11. A poisonous protein of the lectin class produced from the seeds of the castor bean. (5)

14. Chemicals used to break and remove snow or ice. (7)

16. He is credited with coining the term, "catalysis". (9)

17. Determination of molecular weight of a substance by observing the elevation in boiling point of solution. (12)

18. Process of applying a protective zinc coating to prevent rusting. (13)

21. An element named for the Greek word for "hidden". (7)

26. Colloidal sols containing non-spherical particles which are capable of orientating themselves in a streaming potential. (9)

27. Methane is called as _____ gas. (5)

28. The oxide of this metalloid is toxic and has been used as a vermin poison. (7)

29. _____ process is an industrial method for preparation of hydrogen by water gas. (5)

30. A device which measures the relative density of two liquids. (10)

DOWN

2. A method by which hydrophobic particles of an ore are separated from hydrophilic particles in a metallurgical process. (10)

3. A non metal, which has layers of hexagonally arranged carbon atoms. (8)

4. It is slippery, corrosion resistant plastic. (6)

7. A type of isomerism shown by substances which contain several asymmetric centres but differ in the configuration around one asymmetric carbon. (9)
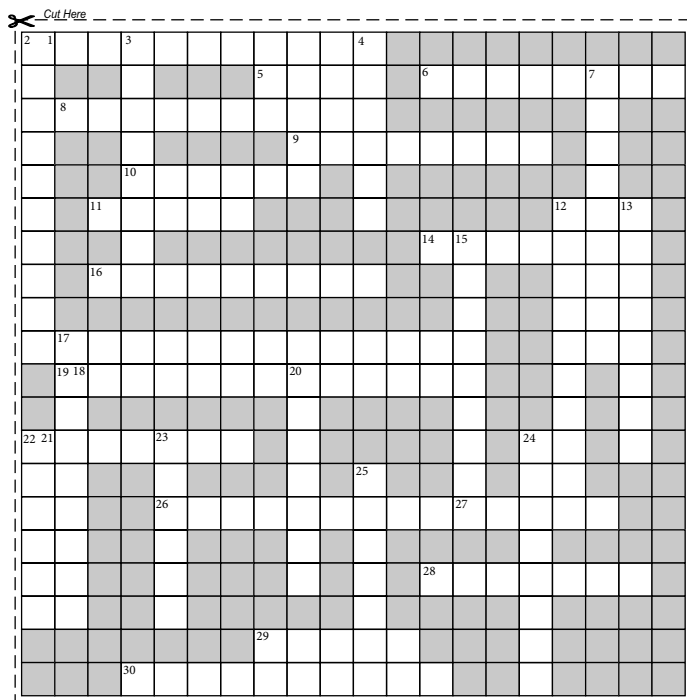
12. A high explosive made from a gel of nitroglycerine and nitrocellulose in a base of wood pulp and sodium or potassium nitrate. (9)

13. It is estimated that the amount of this element in the earth's crust at any particular time is less than 30 grams. (8)

15. Graph of free energy change with temperature is called _____ diagram. (9)

19. A primary alcohol which is a constituent of geranium oil. (8)

20. A mesoionic heterocyclic aromatic chemical compound. (7)

22. The nucleus and all inner shell electrons in an atom except the valence electrons. (6)

23. The isomorphous salt, $M_2^{I}SO_4M^{II}SO_4 \cdot 6H_2O$ where, M^I is an alkali metal and M^{II} is a dipositive transition metal. (6)

24. _____ is a mixture of copper sulphate and slaked lime and used as a fungicide. (8)

25. _____ process is used for making sulphur (VI) oxide. (7)