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CHEMISTRY today

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CHEMISTRY MUSING

PROBLEM SET 45

Chemistry 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. *A*, *B*, *C*, *D*, *E*, *F* and *G* are amines, each one of which forms amine hydrochloride containing 32.42% chlorine. What will be the molecular formula of amine?
(a) $C_6H_5NH_2$ (b) $C_3H_7NH_2$
(c) $C_4H_9NH_2$ (d) CH_3NH_2

2. It is required to make a buffer solution of pH = 4, using acetic acid and sodium acetate. How much sodium acetate is to be added to 1 L of N/10 acetic acid? (Dissociation constant of acetic acid = 1.8×10^{-5})
(a) 0.018 g/L (b) 1.476 g/L
(c) 1.081 g/L (d) 1.232 g/L

3. Henry's law constant for CO_2 in water is 1.67×10^8 Pa at 298 K. The quantity of CO_2 in 500 mL of soda water when packed under 2.5 atm CO_2 pressure at 298 K is
(a) 2.78 g (b) 1.85 g (c) 3.12 g (d) 0.12 g

4. If the relative rates of substitution of 1° and 2° hydrogens are in the ratio of 1 : 3.8. What will be the percentage of 2-chlorobutane and 1-chlorobutane respectively formed by chlorination of *n*-butane in the presence of light at 298 K?
(a) 28% , 72% (b) 72% , 28%
(c) 36% , 64% (d) 64% , 36%

5. What will be the angular frequency of an electron occupying the second Bohr's orbit of He^+ ion?
(a) 2.067×10^{16} sec^{-1} (b) 2.067×10^{15} sec^{-1}
(c) 2.067×10^{14} sec^{-1} (d) 2.067×10^{13} sec^{-1}

JEE ADVANCED

6. A constant current was flowing for 2 hours through a KI solution oxidising iodide ion to iodine ($2I^- \rightarrow I_2 + 2e^-$). At the end of the experiment, liberated iodine consumed 21.75 mL of 0.0831 M solution of sodium thiosulphate following the redox change $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$. What was the average rate of current flown in ampere?
(a) 8.718 A (b) 0.0242 A
(c) 1.807 A (d) 4.123 A

COMPREHENSION

To obtain alkan-1-ol from alk-1-ene, the following procedure should be adopted. Alk-1-ene is treated first with diborane, the boron compound formed is then reacted with H_2O_2 to get the desired alcohol. This addition of borane followed by oxidation is known as Hydroboration-oxidation reaction. Another convenient hydroborating agent is the borane-tetrahydrofuran (BH_3—THF) complex.

7. For the following reaction,

$$CH_3-CH=CH_2 \xrightarrow[(ii)\ CH_3COOH]{(i)\ BD_3\ /\ THF} \text{Product}$$

predict the product.
(a) $CH_3-\underset{H}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH_2}}$ (b) $CH_3-\underset{H}{\underset{|}{CH}}-\underset{D}{\underset{|}{CH_2}}$
(c) $CH_3-\underset{D}{\underset{|}{CH}}-\underset{H}{\underset{|}{CH_2}}$ (d) $CH_3-\underset{D}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH_2}}$

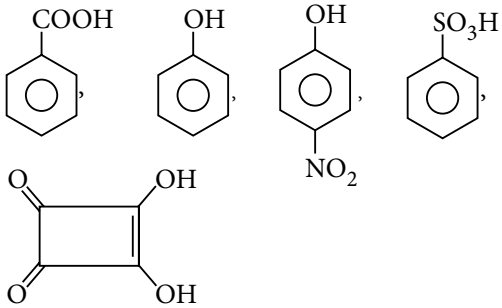
8. In the following reaction,

$$CH_3-CH=CH_2 \xrightarrow[(ii)\ AgNO_3\ /\ NaOH]{(i)\ BH_3\ /\ THF} X$$

product *X* is
(a) $CH_3CH_2CH_2OH$ (b) $CH_3CH_2CH_3$
(c) $CH_3(CH_2)_4CH_3$ (d) $CH_3CH_2CH_2BH_2$

INTEGER VALUE

9. How many of the following compounds will evolve CO_2 gas with $NaHCO_3$?



10. While performing flame test, how many of the following metals show bluish green colour under uranium glass?
Na, K, Ca, Sr, Ba, Cu

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Exam on 7th May

1. The volume strength of 1.5 N H_2O_2 solution is
(a) 4.8 (b) 8.4 (c) 3.0 (d) 8.0

2. If the concentration of glucose ($C_6H_{12}O_6$) in blood is 0.9 g L^{-1}, what will be the molarity of glucose in blood?
(a) 5 M (b) 50 M (c) 0.005 M (d) 0.5 M

3. The ozone in the stratosphere is destroyed by
(a) $^{\bullet}Cl$ (b) $^{\bullet}OH$ (c) $^{\bullet}H$ (d) $^{\bullet}ClO$

4. If $\Delta_o < P$, the correct electronic configuration for d^4 system will be
(a) $t_{2g}^3 e_g^1$ (b) $t_{2g}^4 e_g^0$ (c) $t_{2g}^0 e_g^4$ (d) $t_{2g}^2 e_g^2$

5. Wavelength of high energy transition of H-atom is 91.2 nm. The corresponding wavelength of He^+ is
(a) 91.2 nm (b) 22.8 nm
(c) 54.5 nm (d) 45.6 nm

6. Shape of O_2F_2 is similar to that of
(a) C_2F_2 (b) H_2O_2 (c) H_2F_2 (d) C_2H_2

7. Formation of polyethylene from calcium carbide takes place as follows :

$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

$C_2H_2 + H_2 \longrightarrow C_2H_4$

$nC_2H_4 \longrightarrow \{CH_2—CH_2\}_n$

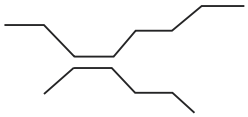
The amount of polyethylene obtained from 64.0 kg of CaC_2 is
(a) 7 kg (b) 14 kg (c) 21 kg (d) 28 kg

8. When ammoniacal solution of $MgSO_4$ is heated with Na_2HPO_4 in presence of NH_4Cl, a white precipitate of _____ is formed.
(a) $Mg(NH_4)PO_4$ (b) $Mg_3(PO_3)_2$
(c) $MgSO_4 . MgCl_2$ (d) $MgSO_4 . Mg_3(PO_4)_2$

9. Arrange the following complexes in the order of decreasing molar conductivity :
(*P*) $Mg[Cr(NH_3)(NO_2)_5]$
(*Q*) $[Cr(NH_3)_5(NO_2)]_3[Co(NO_2)_6]_2$
(*R*) $K[Co(NH_3)_2(NO_2)_4]$
(*S*) $[Cr(NH_3)_3(NO_2)_3]$
(a) $P > Q > R > S$ (b) $P > R > Q > S$
(c) $Q > P > R > S$ (d) $S > R > P > Q$

10. If heavy water is taken as solvent instead of normal water while performing Cannizzaro reaction, the products of the reaction are
(a) $RCOO^-$ and RCH_2OH
(b) $RCOO^-$ and RCH_2OD
(c) RCOOD and RCD_2OD
(d) $RCOO^-$ and RCD_2OD

11. The correct IUPAC name of the following alkene



is
(a) *Z*-3-methyl-4-propyl-3-octene
(b) *E*-3-methyl-4-propyl-3-octene
(c) *E*-4-butyl-3-methyl-3-heptene
(d) *E*-2-ethyl-3-propyl-2-heptene.

12. Select the process that represents smelting.
(a) $Al_2O_3 + 3H_2O \xrightarrow{\Delta} 2Al(OH)_3$
(b) $ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$
(c) $Fe_2O_3 + 3C \xrightarrow{\Delta} 2Fe + 3CO$
(d) $2Pb + O_2 \xrightarrow{\Delta} 2PbO$

13. An energy of 24.6 eV is required to remove one of the electrons from a helium atom. The total energy required to remove both the electrons from helium atom is
(a) 38.2 eV (b) 49.2 eV (c) 51.8 eV (d) 79.0 eV

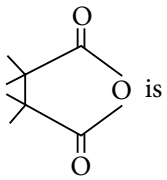
14. A first order reaction is 15% completed in 20 minutes. How long will it take to complete 60% ?
(a) 123.3 minutes (b) 112.7 minutes
(c) 145.2 minutes (d) 138.8 minutes

15. Match the species in column I with the shapes in column II and select the correct option.

Column I	Column II
(A) H_3O^+	(i) Linear
(B) $HC \equiv CH$	(ii) Angular
(C) ClO_2^-	(iii) Tetrahedral
(D) NH_4^+	(iv) Pyramidal

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

16. The correct set of reagents for the following conversion :

$(CH_3)_2CHCOOH \longrightarrow$  is

(a) P_4/I_2, Na, dil H_2SO_4
(b) P_2O_5, $LiAlH_4$
(c) P_2O_5/Δ, H_2O, P_4/I_2, Na
(d) P_4/I_2, Na, P_2O_5/Δ

17. Consider the following reduction reactions :
(i) $Sn^{2+} + 2e^- \rightarrow Sn$; $E^\circ = -0.14$ V
(ii) $Sn^{4+} + 2e^- \rightarrow Sn^{2+}$; $E^\circ = 0.13$ V
Match the column I with column II and choose the correct option.

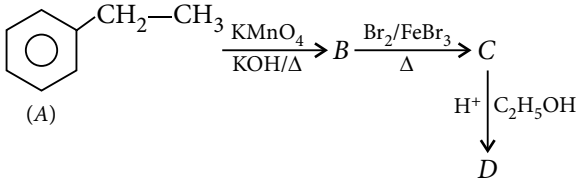
Column I	Column II
(A) $E^\circ_{Sn^{4+}/Sn}$	(i) + 0.005 V
(B) Standard oxidation potential of Sn to Sn^{4+}	(ii) –0.005 V
(C) Disproportionation of Sn^{2+}	(iii) Spontaneous
(D) Oxidation of Sn to Sn^{4+}	(iv) Non-spontaneous

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

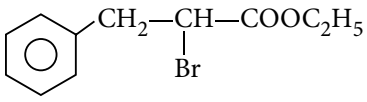
18. Consider three hypothetical ionic compounds AB, A_2B and A_2B_3 where in all the compounds, B is in –2 oxidation state and A has variable oxidation states. What is the correct order of lattice energy of these compounds?
(a) $A_2B > AB > A_2B_3$ (b) $A_2B_3 > AB > A_2B$
(c) $AB > A_2B > A_2B_3$ (d) $A_2B_3 > A_2B > AB$

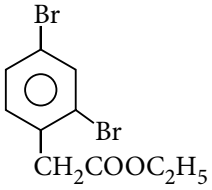
19. A metal (atomic weight = 100) has *ccp* lattice of edge length 400 pm. The correct value for density of the metal (in g cm^{-3}) is (Use $N_A = 6 \times 10^{23}$)
(a) 1.042 (b) 5.021 (c) 10.42 (d) 2.4

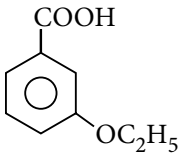
20. In a set of reactions, ethyl benzene yielded a product *D*.

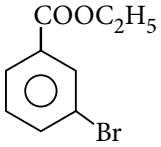


The product *D* would be

(a) 

(b) 

(c) 

(d) 

21. What would be the name of the structure of silicate in which only one oxygen atom of $[SiO_4]^{4-}$ is shared?
(a) Three dimensional silicate
(b) Linear chain silicate
(c) Sheet silicate
(d) Pyrosilicate

22. In a cubic closed packed structure of mixed oxides, the lattice is made up of oxide ions, 20% of tetrahedral voids are occupied by divalent X^{2+} ions and 50% of the octahedral voids are occupied by trivalent Y^{3+} ions. The formula of the oxide is
(a) X_2YO_4 (b) $X_4Y_5O_{10}$
(c) $X_5Y_4O_{10}$ (d) XY_2O_4

23. What will be the pressure exerted by a mixture of 3.2 g of methane and 4.4 g of carbon dioxide contained in a 9 dm^3 flask at 27°C?
(a) 0.82 atm (b) 0.55 atm
(c) 0.27 atm (d) 0.41 atm

24. *m*-Bromoaniline can be prepared by

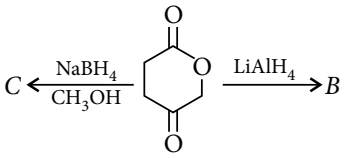
(a) $C_6H_6 \xrightarrow[H_2SO_4]{HNO_3} \xrightarrow[(ii)\ NaOH,\ H_2O]{(i)\ Sn-HCl} \xrightarrow[H_2O]{Br_2}$

(b) $C_6H_6 \xrightarrow[FeBr_3]{Br_2} \xrightarrow[H_2SO_4]{HNO_3} \xrightarrow[Pt]{H_2}$

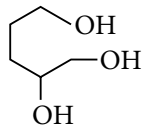
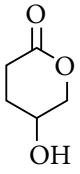
(c) $m\text{-}BrC_6H_4COOH \xrightarrow{SOCl_2} \xrightarrow{NH_3} \xrightarrow{Br_2,\ NaOH}$

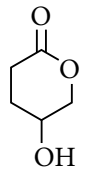
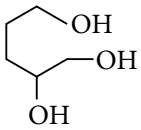
(d) $C_6H_5NH_2 \xrightarrow[Cu_2Br_2]{NaNO_2,\ HCl} \xrightarrow{NaNH_2}$

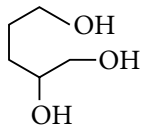
25. In the following sequence of reactions,

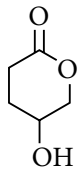


B and *C* are respectively

(a)  and 

(b)  and 

(c)  in both cases

(d)  in both cases.

26. The lattice enthalpy and hydration enthalpy of four compounds are given below :

Compounds	Lattice enthalpy (in kJ mol^{-1})	Hydration enthalpy (in kJ mol^{-1})
P	+ 780	– 920
Q	+ 1012	– 812
R	+ 828	– 878
S	+ 632	– 600

The pair of compounds which is soluble in water is

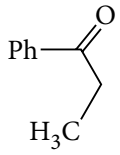
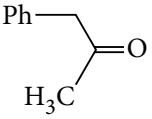
(a) *P* and *Q* (b) *Q* and *R*

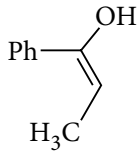
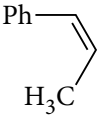
(c) *R* and *S* (d) *P* and *R*

27. In the following reaction,

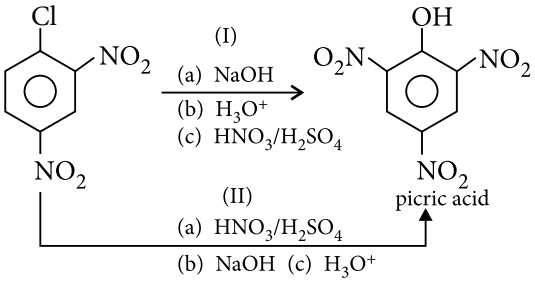
$Ph-C\equiv C-CH_3 \xrightarrow[H_2O]{Hg^{2+}/H^+} A$

A is

(a)  (b) 

(c)  (d) 

28. Picric acid can be obtained by path I or II from 2, 4-dinitrochlorobenzene.



Which is possible path?

(a) Path I (b) Path II

(c) Both I and II (d) Both are not possible

29. The equilibrium constant value for the equilibrium :

$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

changes with

(a) total pressure (b) temperature

(c) catalyst

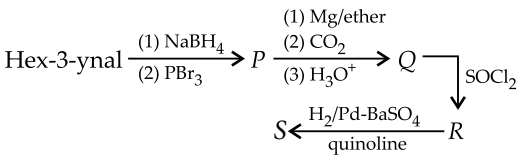
(d) amount of H_2 and I_2 present.

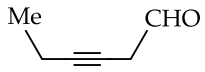
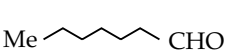
30. What mass of slaked lime would be required to decompose completely 4 g of ammonium chloride?

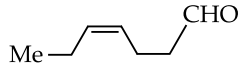
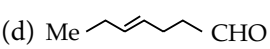
(a) 2.766 g (b) 2.113 g

(c) 3.518 g (d) 5.532 g

31. Identify '*S*' in the following reaction sequence :



(a)  (b) 

(c)  (d) 

32. The final product formed when boric acid is strongly heated is

(a) HBO_2 (b) B_2O_3
(c) $H_2B_4O_7$ (d) H_3BO_4

33. Given :

$E°_{Cr^{3+}/Cr} = -0.74$ V, $E°_{MnO_4^-/Mn^{2+}} = 1.51$ V
$E°_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V, $E°_{Cl/Cl^-} = 1.36$ V
Based on the given data, strongest oxidising agent will be

(a) Cl^- (b) Cr^{3+} (c) Mn^{2+} (d) MnO_4^-

34. Sulphur trioxide can be obtained by which of the following reaction?

(a) $CaSO_4 + C \xrightarrow{\Delta}$
(b) $Fe_2(SO_4)_3 \xrightarrow{\Delta}$
(c) $S + H_2SO_4 \xrightarrow{\Delta}$
(d) $H_2SO_4 + PCl_5 \xrightarrow{\Delta}$

35. Which of the following statements is not true regarding (+)-lactose?

(a) (+)-Lactose contains 8 –OH groups.
(b) On hydrolysis (+)-lactose gives equal amounts of D-(+)-glucose and D-(+)-galactose.
(c) (+)-Lactose is a β-glycoside formed by the union of a molecule of D-(+)-glucose and a molecule of D-(+)-galactose.
(d) (+)-Lactose is a reducing sugar and does not exhibit mutarotation.

36. The equilibrium constant (K) for the reaction, $HA + B \rightleftharpoons BH^+ + A^-$ is 100. If the rate constant for the forward reaction is 10^5, then the rate constant for the reverse reaction will be

(a) 10^7 (b) 10^{-3} (c) 10^3 (d) 10^{-5}

37. A mixture of ethane (C_2H_6) and ethene (C_2H_4) occupies 40 L at 1.00 atm and 400 K. The mixture reacts completely with 130 g of O_2 to produce CO_2 and H_2O. Assuming ideal gas behaviour, the mole fraction of C_2H_4 in the mixture is

(a) 0.66 (b) 0.34
(c) 0.50 (d) 0.84

38. Two liquids X and Y form an ideal solution. The mixture has a vapour pressure of 400 mm at 300 K when mixed in the molar ratio of 1 : 1 and a vapour pressure of 350 mm when mixed in the molar ratio of 1 : 2 at the same temperature. The vapour pressures of the two pure liquids X and Y respectively are

(a) 250 mm, 550 mm
(b) 350 mm, 450 mm
(c) 350 mm, 700 mm
(d) 550 mm, 250 mm

39. Li_2O is one of the most efficient absorbent for CO_2 in spacecrafts, in terms of absorbing capacity per unit mass. If the reaction is $Li_2O + CO_2 \longrightarrow Li_2CO_3$, what is the absorption efficiency of pure Li_2O (*i.e.*, litres of CO_2 per kg of Li_2O)?

(a) 746.66 L/kg (b) 7466.6 L/kg
(c) 74.66 L/kg (d) None of these

40. Due to inert pair effect,

(a) heavier p-block elements show lower oxidation state as stable oxidation state
(b) heavier p-block elements show higher oxidation state as stable oxidation state
(c) strong shielding effect by inner penultimate electrons is observed
(d) the oxidation state is equal to the valence shell electrons.

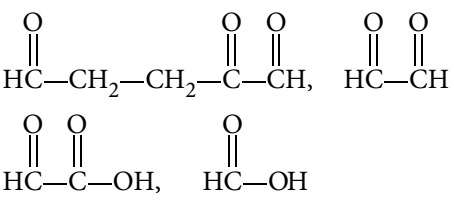
41. ΔH and ΔS for the reaction,

$$Ag_2O_{(s)} \longrightarrow 2Ag_{(s)} + 1/2\ O_{2(g)}$$

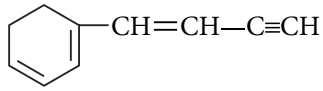
are 30.56 kJ mol^{-1} and 66.00 J K^{-1} mol^{-1} respectively. The temperature at which the free energy change for the reaction will be zero is

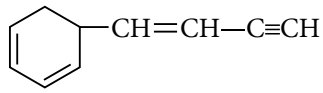
(a) 463 K (b) 35440 K
(c) 20 K (d) 483 K

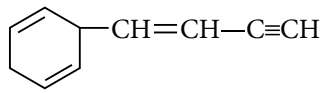
42. An organic compound 'X' on treatment with hydrogen and platinum catalyst, absorbs 5 equivalents of hydrogen to give n-butylcyclohexane. When 'X' is treated with silver nitrate in ethanol, a white precipitate is formed. The precipitate is found to be soluble in dilute acid. Treatment of 'X' with an excess of ozone, followed by dimethylsulphide and water, gives following products,

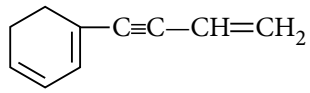


Hence, compound X is

(a) 

(b) 

(c) 

(d) 

43. Determine the standard reduction potential for the half cell reaction, $Cl_2 + 2e^- \longrightarrow 2Cl^-$.
(Given : $Pt^{2+} + 2Cl^- \longrightarrow Pt + Cl_2$, $E°_{cell} = -0.15$ V
$Pt^{2+} + 2e^- \longrightarrow Pt$, $E° = 1.20$ V)
(a) 1.05 V (b) – 1.05 V
(c) – 1.35 V (d) 1.35 V

44. Among 2-chloropropanoic acid, 3-chloropropanoic acid, 2,2-dichloroacetic acid and propanoic acid, the K_a values will be in the order,
(a) 2,2-dichloroacetic acid > 2-chloropropanoic acid > 3-chloropropanoic acid > propanoic acid
(b) 3-chloropropanoic acid > 2-chloropropanoic acid > 2,2-dichloroacetic acid > propanoic acid
(c) 2,2-dichloroacetic acid > 3-chloropropanoic acid > 2-chloropropanoic acid > propanoic acid
(d) 2,2-dichloroacetic acid > propanoic acid > 2-chloropropanoic acid > 3-chloropropanoic acid

45. Which one of the following is employed as a tranquilizer?
(a) Naproxen (b) Tetracycline
(c) Chlorpheniramine
(d) Equanil

SOLUTIONS

1. (b) : The decomposition reaction of H_2O_2 is

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

Thus, 2 mol (or 4 equivalents) of H_2O_2 would give 1 mol (22.4 L at STP) of O_2. 1 L of 4 equivalents of H_2O_2 has a volume strength of 22.4. Thus,

$$1\text{ L of 1.5 equivalents (1.5 N) of } H_2O_2 = \frac{22.4 \times 1.5}{4} = 8.4$$

2. (c) : Molarity of glucose in blood

$$= \frac{\text{No. of moles of glucose}}{\text{Volume of blood (in L)}}$$

$$= \frac{\text{Wt. of glucose}}{\text{Mol. wt. of glucose} \times \text{Volume of blood (in L)}}$$

[Mol. mass of glucose = 180 g/mol]

$$= \frac{0.9\text{ g}}{180\text{ g/mol} \times 1\text{ L}} = 5 \times 10^{-3}\text{ mol L}^{-1} = 0.005\text{ M}$$

3. (a)

4. (a) : If $\Delta_o < P$, then fourth electron will go to higher energy, e_g orbital. Hence, the configuration becomes $t_{2g}^3 e_g^1$.

5. (b) : For H-atom :

$$\frac{1}{\lambda_H} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \quad ...(i)$$

For He^+ ion : $\frac{1}{\lambda_{He^+}} = R_H \times Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ ...(ii)

$$\therefore \quad \lambda_{He^+} = \lambda_H \times \frac{1}{Z^2} = 91.2 \times \frac{1}{2^2} = 22.8\text{ nm}$$

($\because \lambda_H = 91.2$ nm)

6. (b) : O_2F_2 and H_2O_2, both have open book type structure.
In O_2F_2, one O—O bond and two O—F bonds are lying in different planes, *i.e.*, this molecule like H_2O_2 has non-linear and non-planar structure.

7. (d) : Adding first two equations, we have,

$$\underset{64\text{ g}}{CaC_2} + 2H_2O + H_2 \rightarrow Ca(OH)_2 + \underset{28\text{ g}}{C_2H_4}$$

i.e., 64 g of CaC_2 gives 28 g of C_2H_4.
From 3rd equation,

$$nC_2H_4 \rightarrow \{CH_2—CH_2\}_n$$

28*n* g of C_2H_4 gives 28*n* g of polythene
i.e., 28 g of C_2H_4 gives 28 g of polythene.
Hence, 64 g of CaC_2 will give 28 g of polythene or, 64 kg of CaC_2 will give 28 kg of polythene.

8. (a) : $Mg^{2+} + NH_3 + HPO_4^{2-} \longrightarrow \underset{\text{White ppt.}}{Mg(NH_4)PO_4}$

9. (c) : Greater the number of ions and greater the charge on each ion, greater will be the conductivity. The given complexes ionise as,
(*P*) $Mg[Cr(NH_3)(NO_2)_5] \rightleftharpoons Mg^{2+} + [Cr(NH_3)(NO_2)_5]^{2-}$
No. of ions = 2

(*Q*) $[Cr(NH_3)_5(NO_2)]_3[Co(NO_2)_6]_2 \rightleftharpoons 3[Cr(NH_3)_5(NO_2)]^{2+} + 2[Co(NO_2)_6]^{3-}$

No. of ions = 5

(*R*) $K[Co(NH_3)_2(NO_2)_4] \rightleftharpoons K^+ + [Co(NH_3)_2(NO_2)_4]^-$

No. of ions = 2

(*S*) $[Cr(NH_3)_3(NO_2)_3]$ does not ionise,

No. of ions = 0

Order of molar conductivity : (*S*) < (*R*) < (*P*) < (*Q*)

It may be noted that (*P*) and (*R*) have same number of ions but charges on ions in (*P*) is double than that on (*R*).

10. (b): $RCH{=}O \xrightarrow[D_2O]{NaOH} R{-}\underset{OH}{\overset{O^-}{\underset{|}{\overset{|}{C}}}}{-}H \xrightleftharpoons{D_2O}$

$R{-}\underset{OD}{\overset{O^-}{\underset{|}{\overset{|}{C}}}}{-}H \xrightarrow{RCH=O} \left[R{-}\underset{OD}{\overset{O}{\underset{|}{\overset{\|}{C}}}}{-}OD + RCH_2O^-\right]$

$\xrightarrow{D^+ \text{ transfer}} RCOO^- + RCH_2OD$

11. (a)

12. (c) : Smelting is the process of reduction using carbon as a reducing agent.

13. (d): Energy required for the removal of second electron from He-atom

$= +13.6\frac{Z^2}{n^2} = 13.6 \times \frac{2^2}{1^2} = 54.4 \text{ eV}$

Hence, the total energy required for the removal of both the electrons = 24.6 + 54.4 = 79.0 eV

14. (b): For the first order reaction,

$$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]_t}$$

If $[A]_0 = a$, $[A]_t = a - \frac{a \times 15}{100} = 0.85a, t = 20 \text{ min}$

$$k = \frac{2.303}{20}\log\frac{a}{0.85a} = \frac{2.303}{20} \times 0.0706$$

$= 8.13 \times 10^{-3} \text{ min}^{-1}$

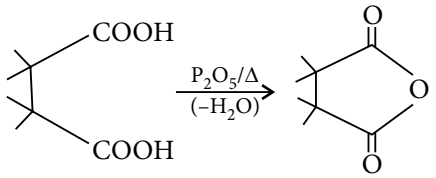
In second case, if $[A]_0 = a$, $[A]_t = a - \frac{a \times 60}{100} = 0.40a$ and time, t = ?

Now, $t = \frac{2.303}{k}\log\frac{[A]_0}{[A]_t} = \frac{2.303}{8.13 \times 10^{-3}}\log\frac{a}{0.40a}$

$= \frac{2.303}{8.13 \times 10^{-3}} \times 0.3979 = 112.7 \text{ min}$

15. (b)

16. (d): $H_3C{-}CH(H_3C){-}COOH \xrightarrow[\text{(HVZ reaction)}]{P_4/I_2} H_3C{-}\underset{I}{C}(H_3C){-}COOH \xrightarrow[\text{(Wurtz reaction)}]{Na}$



17. (b): (A) $Sn^{2+} + 2e^- \longrightarrow Sn$; $E^\circ = -0.14$ V ...(i)

$Sn^{4+} + 2e^- \longrightarrow Sn^{2+}$; $E^\circ = 0.13$ V ...(ii)

On adding equations (i) and (ii),

$Sn^{4+} + 4e^- \longrightarrow Sn$;

$$E^\circ_{Sn^{4+}/Sn} = \frac{n_1E_1^\circ + n_2E_2^\circ}{n_1 + n_2} = \frac{2 \times (-0.14) + 2 \times 0.13}{4}$$

$= -0.005$ V

(B) As, $E^\circ_{Sn^{4+}/Sn} = -0.005$ V

$E^\circ_{Sn/Sn^{4+}} = -E^\circ_{Sn^{4+}/Sn} = +0.005$ V

(C) Disproportionation reaction :

$2Sn^{2+} \longrightarrow Sn^{4+} + Sn$

$E^\circ_{cell} = E^\circ_{Sn^{2+}/Sn} - E^\circ_{Sn^{4+}/Sn^{2+}}$

$= -0.14 - 0.13 = -0.27$ V; the reaction is non-spontaneous.

(D) Since $E^\circ_{Sn/Sn^{4+}} > 0$, oxidation of Sn to Sn^{4+} will be spontaneous.

18. (b): In the given ionic compounds, the oxidation states are

$\overset{+2\ -2}{A}\overset{}{B}$; $\overset{+1\ -2}{A_2}B$ and $\overset{+3\ -2}{A_2}B_3$

Higher the oxidation state of *A* ion, higher will be its lattice energy. Hence, the correct order is as follows :

$A_2B_3 > AB > A_2B$

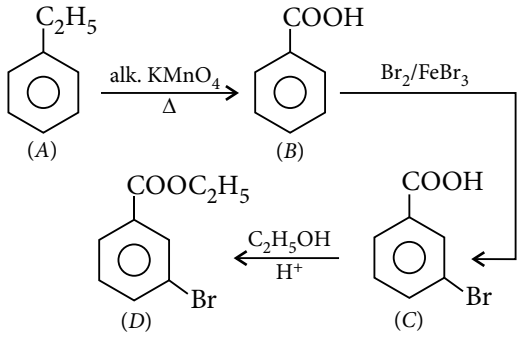
19. (c) : Z for *ccp*, *i.e.*, *fcc* = 4

$$d = \frac{Z \times M}{N_A \times a^3}$$

$$d = \frac{4 \times 100}{(400)^3 \times 10^{-30} \times 6 \times 10^{23}} = \frac{4 \times 100 \times 10^{30}}{64 \times 10^6 \times 6 \times 10^{23}}$$

$= \frac{1000}{96} \approx 10.42 \text{ g cm}^{-3}$

20. (d):



21. (d)

22. (b): No. of oxide ions per unit cell

$$=\frac{1}{8}\times 8+\frac{1}{2}\times 6=4$$

Number of tetrahedral voids per unit cell = 2 × 4 = 8

Number of X^{2+} ions per unit cell $=\frac{20}{100}\times 8=\frac{8}{5}$

Number of octahedral voids per unit cell = 1 × 4 = 4

Number of Y^{3+} ions per unit cell $=\frac{50\times 4}{100}=2$

Hence, formula is $X_{8/5}Y_2O_4$ or $X_4Y_5O_{10}$

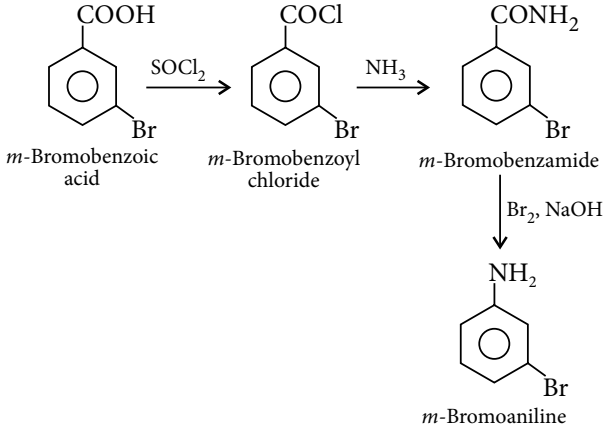
23. (a): $p=\frac{n}{V}RT=\frac{w}{M}\frac{RT}{V}$

$$p_{CH_4}=\left(\frac{3.2}{16}\right)\times\frac{0.0821\times 300}{9}=0.55 \text{ atm}$$

$$p_{CO_2}=\left(\frac{4.4}{44}\right)\times\frac{0.0821\times 300}{9}=0.27 \text{ atm}$$

P_{Total} = 0.55 + 0.27 = 0.82 atm

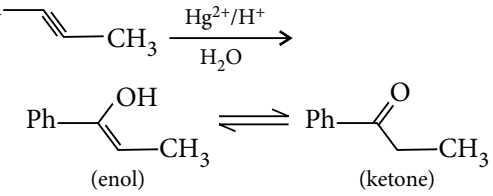
24. (c):



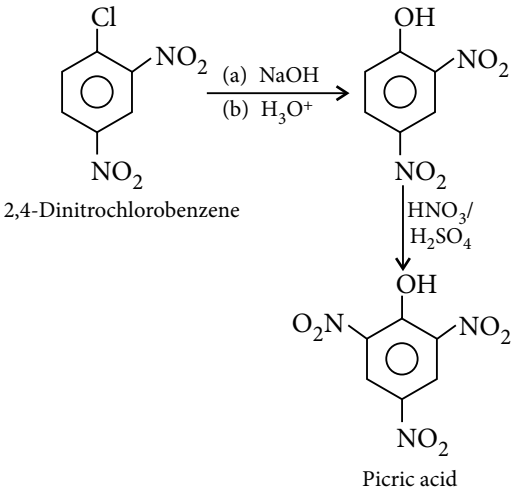
25. (a)

26. (d): A compound is soluble if hydration enthalpy (released) is greater than lattice enthalpy.

27. (a):



28. (a): Path I is feasible since –OH group after I (a) and I (b) activate the benzene ring for nitration. –Cl and two —NO_2 groups deactivate the ring in path II hence, nitration is not possible.



In path I, due to —NO_2 group C—Cl bond weakens which makes nucleophilic substitution reaction possible. Also —NO_2 (deactivating group) prevents oxidation of 2,4-dinitrophenol when further nitrated.

29. (b): The value of equilibrium constant of a reaction depends only on temperature and does not depend upon concentration, pressure or presence of catalyst.

30. (a): The equation representing the decomposition of NH_4Cl by slaked lime, *i.e.*, $Ca(OH)_2$ is

$$Ca(OH)_2 + 2NH_4Cl \longrightarrow CaCl_2 + 2NH_3 + 2H_2O$$

74 g 107 g 111 g 34 g 36 g

From the above equation, 107 g of NH_4Cl is decomposed by 74 g of $Ca(OH)_2$.

MPP CLASS XII ANSWER KEY

1.	(b)	**2.**	(c)	**3.**	(d)	**4.**	(d)	**5.**	(d)
6.	(c)	**7.**	(d)	**8.**	(c)	**9.**	(c)	**10.**	(a)
11.	(d)	**12.**	(c)	**13.**	(a)	**14.**	(b)	**15.**	(c)
16.	(c)	**17.**	(d)	**18.**	(b)	**19.**	(c)	**20.**	(c,d)
21.	(b,c)	**22.**	(a,c,d)	**23.**	(a,b,c,d)	**24.**	(4)	**25.**	(2)
26.	(7)	**27.**	(c)	**28.**	(c)	**29.**	(c)	**30.**	(b)

$\therefore$ 4 g of NH_4Cl will be decomposed by

$$\frac{74}{107}\times 4 \text{ g} = 2.766 \text{ g of } Ca(OH)_2$$

Thus, the mass of slaked lime required = 2.766 g

31. (c) :

$CH_3CH_2C\equiv CCH_2CHO$ (Hex-3-ynal) $\xrightarrow{NaBH_4}$ $CH_3CH_2C\equiv CCH_2CH_2OH$

$CH_3CH_2C\equiv CCH_2CH_2OH \xrightarrow{PBr_3}$ $CH_3CH_2C\equiv CCH_2CH_2Br$ (*P*)

$CH_3CH_2C\equiv CCH_2CH_2Br \xrightarrow[\text{ether}]{Mg}$ $CH_3CH_2C\equiv CCH_2CH_2MgBr$

$CH_3CH_2C\equiv CCH_2CH_2MgBr \xrightarrow[(ii)\ H_3O^+]{(i)\ CO_2}$ $CH_3CH_2C\equiv CCH_2CH_2COOH$ (*Q*)

$CH_3CH_2C\equiv CCH_2CH_2COOH \xrightarrow{SOCl_2}$ $CH_3CH_2C\equiv CCH_2CH_2COCl$ (*R*)

$CH_3CH_2C\equiv CCH_2CH_2COCl \xrightarrow[H_2/Pb\text{-}BaSO_4]{\text{quinoline}}$ $CH_3-CH_2-CH=CH-CH_2CH_2CHO$ (*S*)

32. (b) : The action of heat on boric acid is shown as :

$$\underset{\substack{\text{Orthoboric acid}\\ \text{or}\\ \text{(Boric acid)}}}{4H_3BO_3} \xrightarrow[-4H_2O]{375\text{ K}} \underset{\text{Metaboric acid}}{4HBO_2} \xrightarrow[-H_2O]{435\text{ K}} \underset{\text{Tetraboric acid}}{H_2B_4O_7} \xrightarrow[-H_2O]{\text{red heat}} \underset{\text{Boron trioxide}}{2B_2O_3}$$

33. (d) : MnO_4^- is the strongest oxidising agent because it has the highest reduction potential value.

34. (b) : $Fe_2(SO_4)_3 \xrightarrow{\text{Heat}} Fe_2O_3 + 3SO_3$

35. (d) : (+)–Lactose is a reducing sugar and shows mutarotation.

36. (c) : $HA + B \rightleftharpoons BH^+ + A^-$; $K = 100$

$$K_f = 10^5,\ K_b = ?,\ K_b = \frac{K_f}{K} = \frac{10^5}{100} = 10^3$$

37. (b) : For a gaseous mixture of C_2H_6 and C_2H_4,

$$PV = nRT$$

$\therefore$ $1 \times 40 = n \times 0.082 \times 400 \Rightarrow n = 1.2195$

$\therefore$ Total moles of C_2H_6 and C_2H_4 = 1.2195

Let number of moles of C_2H_6 and C_2H_4 be a and b respectively.

$a + b = 1.2195$ ...(i)

$C_2H_6 + 7/2O_2 \longrightarrow 2CO_2 + 3H_2O$

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

$\therefore$ Number of moles of O_2 needed for complete reaction of the mixture

$$= \frac{7a}{2} + 3b = \frac{130}{32} \quad \text{...(ii)}$$

Solving eqs. (i) and (ii), we get, $a = 0.808$; $b = 0.4115$

$\therefore$ Mole fraction of $C_2H_6 = 0.808/1.2195 = 0.66$

and mole fraction of $C_2H_4 = \frac{0.4115}{1.2195} = 0.34$

38. (d) : $n_X = n_Y = 1$ or $\frac{n_X}{n_Y} = 1$

$$x_X = \frac{1}{1+1} = \frac{1}{2}, x_Y = \frac{1}{1+1} = \frac{1}{2}$$

$$P = p_X^\circ \times x_X + p_Y^\circ \times x_Y = 400 \text{ mm}$$

or $\frac{1}{2}p_X^\circ + \frac{1}{2}p_Y^\circ = 400$ mm ...(i)

When $\frac{n'_X}{n'_Y} = \frac{1}{2}$ at the same temperature,

$x'_X = \frac{1}{3}$ and $x'_Y = \frac{2}{3}$

$\therefore$ $P' = p_X^\circ \times x'_X + p_Y^\circ \times x'_Y = 350$ mm

or $\frac{1}{3}p_X^\circ + \frac{2}{3}p_Y^\circ = 350$ mm ...(ii)

Solving equations (i) and (ii), we get, $p_X^\circ = 550$ mm, $p_Y^\circ = 250$ mm

39. (a) : Li_2O reacts with CO_2 as :

$Li_2O + CO_2 \longrightarrow Li_2CO_3$

i.e., 1 mole of Li_2O (= 30 g Li_2O) reacts with 22.4 L of CO_2 at STP

or 1000 g Li_2O absorbs $= \frac{22.4\times 1000}{30}$

$= 746.66$ L of CO_2

$\therefore$ Absorption efficiency is 746.66 L/kg

40. (a) : Due to inert pair effect, heavier *p*-block elements show low (two units less) oxidation state as the most stable one.

Winners of March 2017 Crossword

- Jyoti Prakash

Winners of February 2017 Crossword

- Devjit Acharjee, West Bengal
- Lakshmi Narayanan, Kerala
- Mahima Kriti

Solution Senders of Chemistry Musing

Set - 44

- Vijayraj S
- Aniruddha Bhattacharjee, West Bengal

41. (a) : According to Gibbs'-Helmholtz equation,

$\Delta G = \Delta H - T\Delta S$

At equilibrium, $\Delta G = 0$

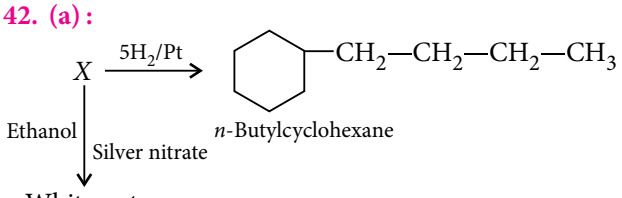
$0 = \Delta H - T\Delta S$ or $\Delta H = T\Delta S$ or $T = \frac{\Delta H}{\Delta S}$

Here, $\Delta H = 30.56 \text{ kJ mol}^{-1} = 30560 \text{ J mol}^{-1}$

$\Delta S = 66.00 \text{ J K}^{-1} \text{ mol}^{-1}$

$\therefore \quad T = \frac{30560}{66} = 463 \text{ K}$

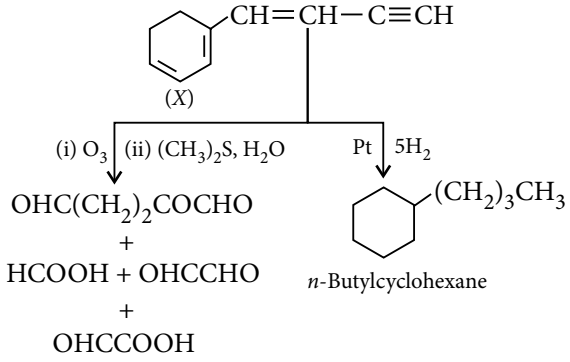
42. (a) :



White ppt.

(It suggests terminal triple bond)

Hence, the product might be the compound given in option (a). This is confirmed by the following reaction sequence :



43. (d): $Pt + Cl_2 \longrightarrow Pt^{2+} + 2Cl^-$; $E_1^\circ = 0.15$ V ...(i)

$\Delta G^\circ = -nFE^\circ_{cell} \Rightarrow \Delta G_1^\circ = -2F(0.15)$

$Pt^{2+} + 2e^- \longrightarrow Pt$; $E_2^\circ = 1.20$ V ...(ii)

$\Delta G_2^\circ = -2F(1.20)$

Adding equations (i) and (ii),

$Cl_2 + 2e^- \longrightarrow 2Cl^-$

Let standard reduction potential for this reaction be E°_{cell}.

$\Delta G^\circ = -nFE^\circ_{cell} = \Delta G_1^\circ + \Delta G_2^\circ$

$-2 \times FE^\circ_{cell} = -2F(0.15) - 2F(1.20)$

$E^\circ_{cell} = 0.15 + 1.20 = 1.35$ V

44. (a) : Acidic strength $\propto K_a$ value

Due to $-I$ effect of –Cl group, chloropropanoic acid is stronger acid than propanoic acid. Further, greater the number of electron withdrawing substituents, greater will be the acidic strength.

Inductive effect decreases rapidly with distance and so is the acidic strength. Hence, the correct order of acidic strength (or K_a values) will be

$Cl_2CHCOOH > ClCH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HCOOH > ClCH_2CH_2COOH > CH_3CH_2COOH$

2, 2-Dichloroacetic acid; 2-Chloropropanoic acid; 3-Chloropropanoic acid; Propanoic acid

45. (d): Equanil is used for the treatment of stress, mild and severe mental diseases *i.e.*, as a tranquilizer.

JEE Advanced

Exam on 21st May

MODEL TEST PAPER 2017

PAPER-1

SECTION–I

(SINGLE CORRECT ANSWER TYPE)

This section contains 7 multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which ONLY ONE is correct. For correct answer 3 marks and for wrong answer –1 mark will be awarded.

1. $Cl_{2(g)} + Ba(OH)_2 \rightarrow X_{(aq)} + BaCl_2 + H_2O$

$X + H_2SO_4 \rightarrow Y + BaSO_4$

$Y \xrightarrow[>365\ K]{\Delta} Z + H_2O + O_2$

Compound Z can also be prepared by the action of conc. H_2SO_4 on $KClO_3$ or by passing dry Cl_2 over $AgClO_3$ heated to 363 K.

Y, Z respectively and magnetic behaviour exhibited by 'Z' are

(a) $HClO_4$, ClO_2, diamagnetic

(b) $HClO_3$, ClO_2, paramagnetic

(c) $HClO_3$, Cl_2O, diamagnetic

(d) $HClO_4$, Cl_2O_7, paramagnetic.

2. An ideal mixture of liquids A and B with 2 moles of A and 2 moles of B has a total vapour pressure of 1 atm at a certain temperature. Another mixture with 1 mole of A and 3 moles of B has vapour pressure greater than 1 atm. When 4 moles of C are added to second mixture, the vapour pressure comes down to 1 atm. Vapour pressure of C in pure state $P_C^\circ = 0.8$ atm What will be the vapour pressures of pure A and pure B ?

(a) $P_A^\circ = 1.2$ atm, $P_B^\circ = 0.7$ atm

(b) $P_A^\circ = 1.2$ atm, $P_B^\circ = 0.6$ atm

(c) $P_A^\circ = 1.4$ atm, $P_B^\circ = 0.6$ atm

(d) $P_A^\circ = 0.6$ atm, $P_B^\circ = 1.4$ atm

3. Calculate the pH at which the following conversion (reaction) will be at equilibrium in basic medium.

$I_{2(s)} \rightleftharpoons I^-_{(aq)} + IO^-_{3(aq)}$

(When the equilibrium concentrations at 300 K are $[I^-] = 0.10$ M and $[IO_3^-] = 0.10$ M . Given :

$\Delta_f G^\circ (I^-_{(aq)}) = -50$ kJ/mole,

$\Delta_f G^\circ (IO^-_{3(aq)}) = -123.5$ kJ/mole,

$\Delta_f G^\circ (H_2O_{(l)}) = -233$ kJ/mole,

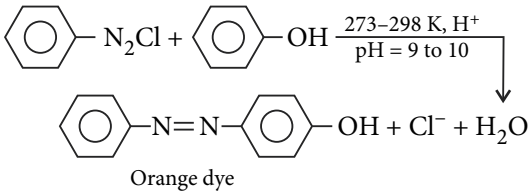
$\Delta_f G^\circ (OH^-_{(aq)}) = -150$ kJ/mole,

$R = \frac{25}{3}$, $\log_e = 2.3$)

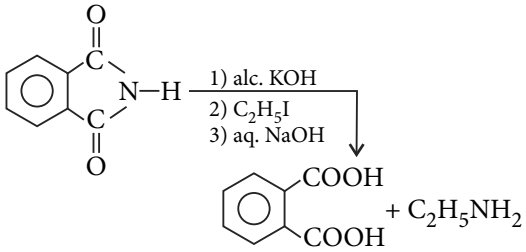
(a) 2 (b) 4 (c) 6 (d) 8

4. Identify the Gabriel phthalimide synthesis reaction.

(a) $R{-}NH_2 + CHCl_3 + 3KOH \xrightarrow{Heat} R{-}N{\cong}C + 3KCl + 3H_2O$

(b) 

Orange dye

(c) 

(d) $R{-}\overset{O}{\overset{\|}{C}}{-}NH_2 \xrightarrow{Br_2 + KOH} R{-}NH_2 + K_2CO_3 + 2KBr + 2H_2O$

By : **Vidyalankar Institute**, P e l Ce n tre, S e n apa i Bapa a Ma g, Dele a (W , Mumba - 8 T el:(2 2 8

5. Compound '*X*' C_7H_8O, is insoluble in H_2O, dil. HCl and aq. $NaHCO_3$ but dissolves in dil. NaOH. When '*X*' is treated with Br_2/H_2O, it is converted rapidly into a compound of formula, $C_7H_5OBr_3$. The compound '*X*' is

(a) *o*-cresol (b) *p*-cresol
(c) *m*-cresol (d) anisole.

6. 1.0 g of a monobasic acid H*A* in 100 g water lowers the freezing point by 0.385 K. If 0.3 g of same acid requires 25 mL of N/5 NaOH solution for complete neutralisation, then % degree of ionisation of acid is (K_f of H_2O = 1.86 K kg mol^{-1})

(a) 18% (b) 24% (c) 42% (d) 64%

7. Some physical properties of four elements *L*, *M*, *Q* and *R* are given below in the table:

Physical properties	***L***	***M***	***Q***	***R***
M.pt. (°C)	–7	63	–189	1083
B.pt. (°C)	58	766	–186	2582
Colour at STP	dark red	silvery	colour-less	browny -red
Density at STP (g cm^{-3})	3.1	0.86	1.7×10^{-3}	8.9

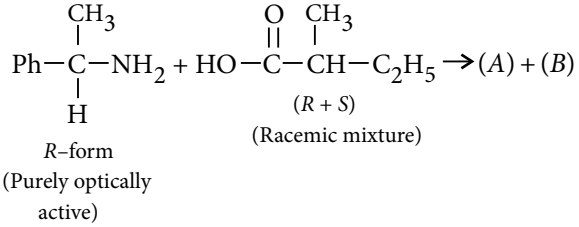
These elements in the order *L*, *M*, *Q* and *R* are from the following groups in the periodic table.

	L	***M***	***Q***	***R***
(a)	group 1	transition elements	group 17	group zero
(b)	group 17	group 1	group zero	transition elements
(c)	group 17	transition elements	group zero	group 1
(d)	transition elements	group 1	group 17	group zero

SECTION–II

(MULTIPLE CORRECT ANSWER TYPE)

This section contains 4 multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which ONE or MORE may be correct. For correct answer 4 marks will be awarded, no negative marks in this section.

8. 

R–form (Purely optically active)

(*R* + *S*) (Racemic mixture)

The correct statement(s) regarding compounds (*A*) and (*B*) is/are

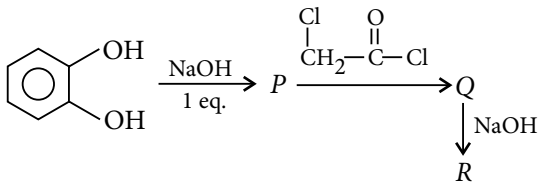
(a) both are optically active in nature
(b) relation between (*A*) and (*B*) is diastereomers
(c) (*A*) and (*B*) are meso compounds
(d) out of (*A*) and (*B*), one is optically active and other is optically inactive.

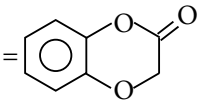
9. Among the following, identify the correct statement(s) ?

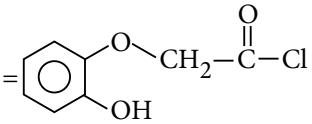
(a) The number of atoms in 100 g of an *fcc* crystal with density, (ρ = 10 g cm^{-3}) and cell edge 200 pm are 5×10^{24}.
(b) Sr–90 radioisotope ($t_{1/2}$ = 27 years) obtained as one of the fission products of Uranium–235. The time required for 1.00 g of the isotope to be reduced to 0.2 g by decay is ≈ 63 years.
(c) The rate of uncatalysed reaction at 127°C is equal to that of the catalysed reaction at 27°C. The catalyst lowers the activation energy by 25%.
(d) Barium permanganate [$Ba(MnO_4)_2$] oxidises ferrous oxalate in dil. H_2SO_4 and itself is reduced to $MnSO_4$. The volume of 0.1 M [$Ba(MnO_4)_2$] is needed to oxidise 50 mL of 0.2 M ferrous oxalate in acidic medium is 30 mL.

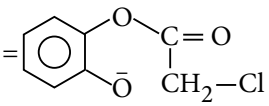
10. Decomposition of $3A_{(g)} \rightarrow 2B_{(g)} + 2C_{(g)}$ follows first order kinetics, initially only *A* is present in the container. Pressures developed after 20 min and infinite time are 3.5 and 4 atm, respectively. Which one is correct?

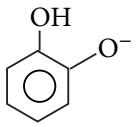
(a) $t_{50\%}$ = 20 min (b) $t_{75\%}$ = 40 min
(c) $t_{99\%}$ = 64/3 min (d) $t_{87.5\%}$ = 60 min

11. 

(a) *R* = 

(b) *Q* = 

(c) *Q* = 

(d) $P =$ 

SECTION–III

(PARAGRAPH TYPE)

This section contains 2 paragraphs. Based upon one of the paragraphs, 2 multiple choice questions and based on the other paragraph, 3 multiple choice questions have to be answered. Each of these questions has four choices (a), (b), (c) and (d) out of which ONLY ONE is correct. For correct answer 3 marks and for wrong answer –1 mark will be awarded.

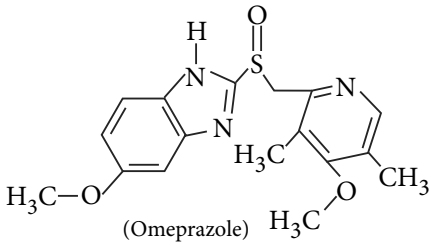
Paragraph for Q. No. 12 and 13

An average adult produces between 2 to 3 L of gastric juice daily. Gastric juice is a thin, acidic digestive fluid secreted by glands present in the stomach. It contains hydrochloric acid among other substances. The pH of gastric juice is about 1.5. The purpose of the highly acidic medium within the stomach is to digest food and to activate certain digestive enzymes. Eating stimulates H^+ ion secretion. However, if the acid content is excessively high then the substances, which remove the excess acid and raise the pH to appropriate level in stomach, are called antacids.

Some common commercial antacid preparations:

Commercial name	Active ingredients
Alka-2	$CaCO_3$
Alka-seltzer	Aspirin, $NaHCO_3$, citric acid
Milk of magnesia	$Mg(OH)_2$
Rolaids	Dihydroxy aluminium sodium carbonate

The reactions of active ingredients with stomach acid produce CO_2 causing the person to belch. The fizzing that takes place when an alka-seltzer tablet dissolves in water is caused by CO_2 which is released by the reaction between citric acid and $NaHCO_3$. In recent years, omeprazole and lansoprazole are also marketed as antacids. These prevent formation of acid in the stomach.



(Omeprazole)

12. One mole of active ingredients in Rolaid can react with how many moles of HCl?

(a) 2 (b) 4 (c) 3 (d) 6

13. During acidity, HCl concentration in stomach rises from a normal value of 8×10^{-2} M to 0.1 M HCl. One rolaid tablet contains 500 mg of active component. What percentage of tablet should be sufficient to return the molarity to normal value if stomach contains 500 mL of an acid?

(a) 100 (b) 72 (c) 25 (d) 88

Paragraph for Q. No. 14 to 16

Piperine, $C_{17}H_{19}O_3N$ is an alkaloid found in black pepper. It is soluble in water, dilute acids and dilute bases. When heated with alkali, it yields piperic acid, ($C_{12}H_{10}O_4$) and the cyclic secondary amine piperidine, $C_5H_{11}N$ (a hydrogenated product of pyridine). Piperic acid is insoluble in H_2O but soluble in aq.NaOH and aq.$NaHCO_3$. It decolourises Br_2/CCl_4 and consumes four bromine atoms. On careful oxidation with $KMnO_4$, it gives oxalic acid, tartaric acid and piperonylic acid, $C_8H_6O_4$. Its equivalent weight is 218. When piperonylic acid is heated with aq.HCl at 200°C it yields HCHO and protocatechuic acid, (3,4-dihydroxybenzoic acid).

Synthesis of piperine

$$\text{Catechol} \xrightarrow[KOH]{CHCl_3} A(C_7H_6O_3) \xrightarrow[NaOH]{CH_2I_2} B(C_8H_6O_3)$$

$$\xrightarrow[NaOH,\,\Delta]{CH_3CHO} C\,(C_{10}H_8O_3) \xrightarrow[CH_3COONa,\,\Delta]{(CH_3CO)_2O}$$

$$\text{Piperic acid} \xrightarrow[SOCl_2]{PCl_5 \text{ or}} D\,(C_{12}H_9O_3Cl) \xrightarrow{\text{piperidine}}$$

Piperine

14. The number of isomers and nature of stereoisomerism exhibited by piperic acid are

(a) 2, optical (b) 4, geometrical

(c) 4, optical and geometrical

(d) 2, geometrical.

15. In the formation of piperic acid from catechol, the name reactions involving new carbon–carbon bond formation are

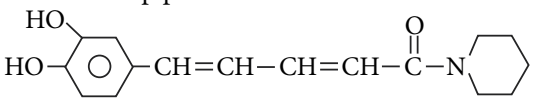
(a) Perkin, Reimer-Tiemann, Knoevenagel

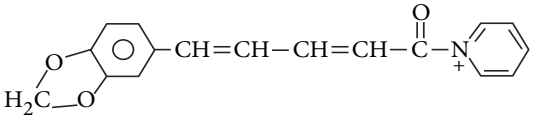
(b) Claisen, Perkin, Cannizzaro

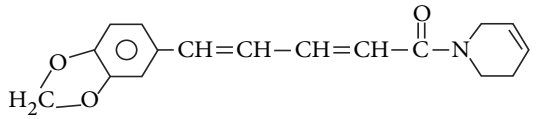
(c) Reimer-Tiemann, Claisen-Schmidt, Perkin

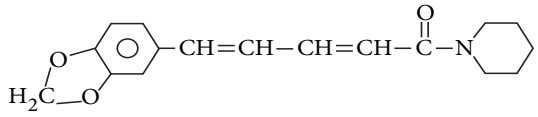
(d) Fries, Reimer-Tiemann, Perkin.

16. The structure of piperine is

(a) 

(b) 

(c) 

(d) 

SECTION–IV

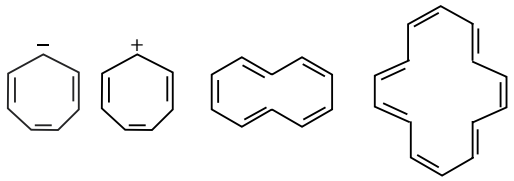
(INTEGER ANSWER TYPE)

This section contains 7 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS. For correct answer 4 marks will be awarded, no negative marks in this section.

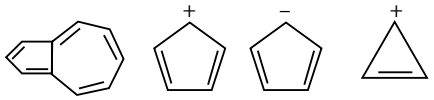
17. For a homogeneous gaseous phase reaction: $2A \rightarrow 3B + C$, the initial pressure of reactant was $P°$ while pressure at time 't' was P. The pressure after time $2t$ is $xP° - \frac{(yP° - P)^z}{P°}$. Assume first order reaction. Find $x \times y \times z$.

18. In a gravimetric determination of P, an aqueous solution of dihydrogen phosphate ion $H_2PO_4^-$ is treated with a mixture of ammonium and magnesium ions to precipitate magnesium ammonium phosphate $Mg(NH_4)PO_4.6H_2O$. This is heated and decomposed to magnesium pyrophosphate, $Mg_2P_2O_7$, which is weighed. A solution of $H_2PO_4^-$ yielded 111/120 g of $Mg_2P_2O_7$. What weight of NaH_2PO_4 was present originally?

19. From the given species, how many are aromatic?

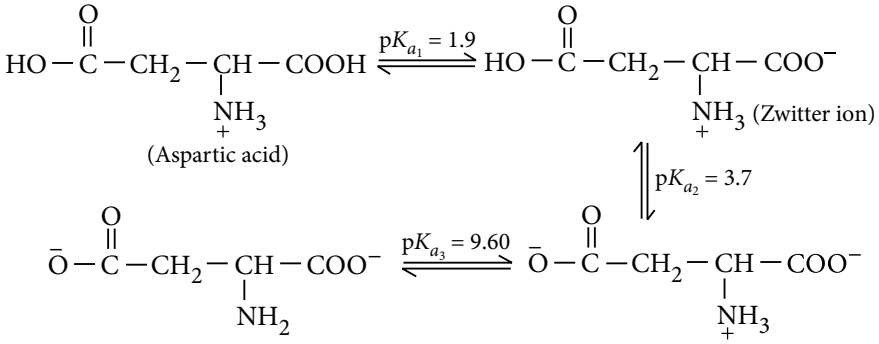


(I) (II) (III) (IV)



(V) (VI) (VII) (VIII)

20. In the following reaction chain;



The isoelectric point of aspartic acid approximately is

21. The total number of reactions in which hydrogen gas is liberated, is

$LiH + H_2O \rightarrow$ $LiH + C_2H_5OH \rightarrow$

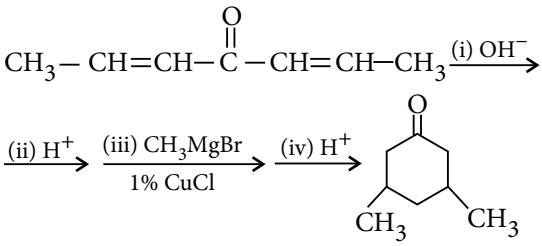
$LiH + HC \equiv CH \rightarrow$ $LiH + HCl \rightarrow$

$LiH + NH_3 \rightarrow$ $3CaH_2 + N_2 \rightarrow$

$B_2H_6 + 2NaH \rightarrow$

22. On heating crystals of $K_4[Fe(CN)_6]$ with H_2SO_4 'x' mol of CO evolved per mol of $K_4[Fe(CN)_6]$. Identify 'x'.

23. Consider the following reaction sequence,



How many times Michael addition reaction can take place?

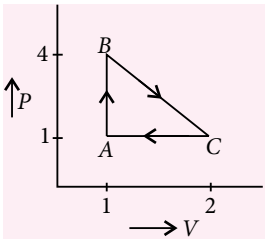
PAPER-2

SECTION–I

(SINGLE CORRECT ANSWER TYPE)

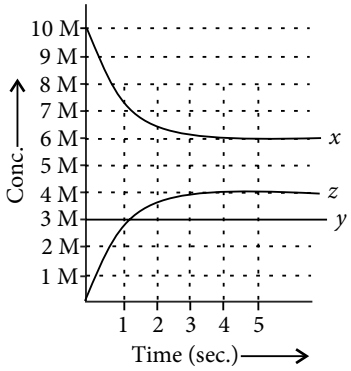
This section contains 8 multiple choice questions. Each question has four choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct. For correct answer 3 marks and for wrong answer –1 mark will be awarded.

1. One mole of an ideal gas is carried through the reversible cyclic process as shown in figure. The maximum temperature attained by the gas during the cycle is



(a) $\frac{7}{6R}$ (b) $\frac{35}{7R}$ (c) $\frac{49}{12R}$ (d) $\frac{21}{15R}$

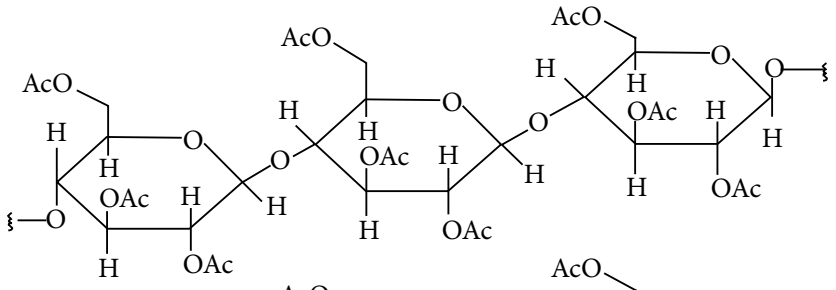
2. x, y and z react in 1 : 1 : 1 stoichiometric ratio. The concentration of x, y and z were found to vary with time as shown in the graph. Which of the following equilibrium reaction may represent the correct variation of concentration with time ?



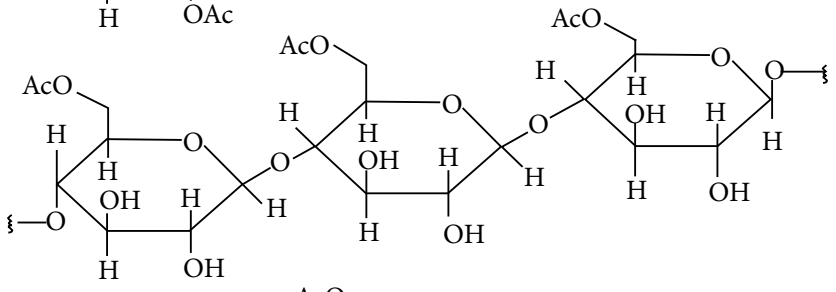
(a) $x_{(g)} + y_{(g)} \rightleftharpoons z_{(g)}$ (b) $x_{(g)} + y_{(s)} \rightleftharpoons z_{(g)}$
(c) $z_{(g)} + y_{(s)} \rightleftharpoons x_{(g)}$ (d) $z_{(g)} + x_{(g)} \rightleftharpoons y_{(g)}$

3. Cellulose upon acetylation with excess acetic anhydride/H_2SO_4 (catalytic) gives cellulose triacetate whose structure is

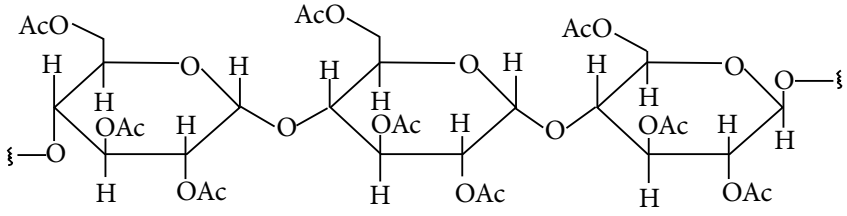
(a)



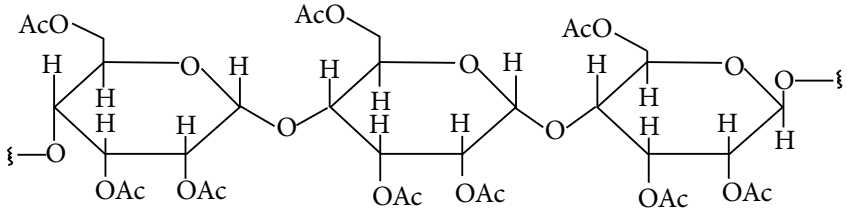
(b)



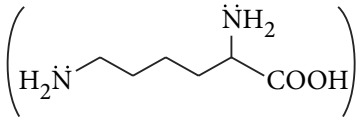
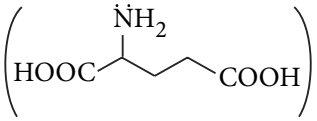
(c)

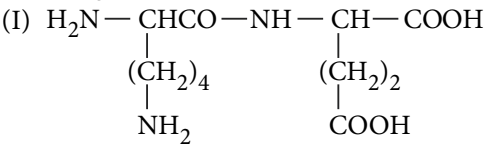


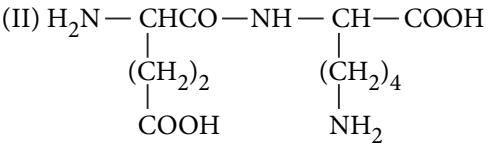
(d)

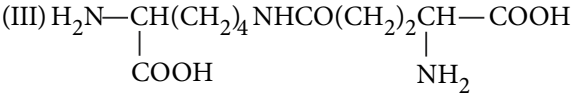


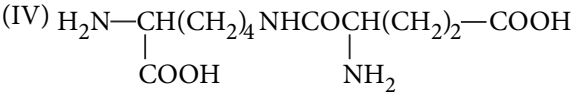
4. As_2S_3 sol carries a negative charge. The maximum precipitating power for this sol is shown by
(a) K_2SO_4 (b) $CaCl_2$
(c) Na_3PO_4 (d) $AlCl_3$

5. The lysine  and glutamine  may be combined to give two dipeptides. Which of the following combinations represents dipeptides?

(I) 

(II) 

(III) 

(IV) 

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

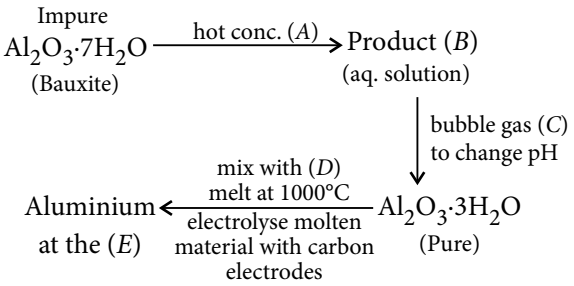
6. The rusting of iron takes place as follows:

$$2H^+ + 2e^- + \frac{1}{2}O_2 \rightarrow H_2O_{(l)};\ E^\circ = +1.23\ V$$

$Fe^{2+} + 2e^- \rightarrow Fe_{(s)}$; $E^\circ = -0.44$ V
Calculate ΔG° for the net process.
(a) -322 kJ mol^{-1} (b) -161 kJ mol^{-1}
(c) -152 kJ mol^{-1} (d) -76 kJ mol^{-1}

7. In a metal oxide, the oxide ions are arranged in corners as well as on the faces and metal cations occupy 2/3rd of octahedral voids, the formula of oxide is
(a) M_2O_3 (b) MO
(c) M_2O (d) MO_2

8. In 1886, an American student, Charles Hall devised a relatively inexpensive process to produce aluminium metal. This process (called the Hall-Heroult process) is now employed to produce over 29 megatonnes of aluminium annually. The basic process may be summarised as follows:



Which of the following entries correctly summarises the reagents, electrodes and products of the process ?

	A	*B*	*C*	*D*	*E*
(a)	NaOH	Al^{3+}	HF	Na_3AlF_6	cathode
(b)	NaOH	$NaAlO_2$	CO_2	NaF	anode
(c)	H_2SO_4	$Al_2(SO_4)_3$	NH_3	Na_3AlF_6	cathode
(d)	NaOH	$NaAlO_2$	CO_2	Na_3AlF_6	cathode

SECTION-II

(MULTIPLE CORRECT ANSWER TYPE)

This section contains 4 multiple choice questions. Each question has four choices (a) , (b) , (c) and (d) out of which ONE or MORE may be correct. For correct answer 4 marks will be awarded, no negative marks in this section.

9. Choose the correct options :

(a) Kolbe electrolysis of potassium succinate gives CO_2 and $CH_2 = CH_2$.

(b) Ethyne is most acidic compound among ethane, ethene and ethyne.

(c) The nodal plane in the π-bond of ethene is located in the molecular plane.

(d) Alkynes are generally less reactive than alkenes towards electrophilic reactions.

10. Which of the following statements are not correct ?

(a) Tertiary butyl alcohol gives positive iodoform test.

(b) $CH_3CH_2-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-CH_2CH_3$ gives positive iodoform test.

(c) The carbon–carbon bond in $R-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-R'$ can be broken by the use of periodic acid and the product obtained are two aldehydes.

(d) The carbon–carbon bond in $R-\underset{\underset{OH}{|}}{\overset{\overset{R'}{|}}{C}}-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-R'$ can be broken by the use of periodic acid giving two aldehydes.

11. Decrease in atomic number is observed in

(a) α-emission

(b) β-emission

(c) positron emission

(d) electron capture.

12. Ammonia on reaction with hypochlorite ion can form

(a) NO (b) NH_4Cl

(c) N_2H_4 (d) HNO_2

SECTION-III

(INTEGER ANSWER TYPE)

This section contains 6 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS. For correct answer 4 marks will be awarded, no negative marks in this section.

13. The relative reactivity of 1° : 2° : 3° hydrogens for chlorination is 1 : 3.8 : 5. The compound 2-methyl butane is monochlorinated. The carbon atoms in this molecule are labelled as follows : [Treat C_4 as different type of carbon from C_1]

$$\overset{①}{CH_3}-\overset{②}{\underset{\underset{①}{CH_3}}{\underset{|}{CH}}}-\overset{③}{CH_2}-\overset{④}{CH_3}$$

The maximum and minimum percentages will occur at x and y carbon atoms respectively. Then $x + y$ is equal to

14. The highest boiling point is expected for which of the following compounds?

(0) Methane (1) Ethane

(2) Propane (3) *n*-Pentane

(4) *n*-Butane (5) Iso-butane

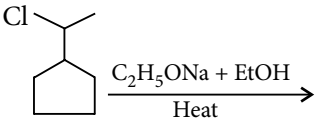
(6) 2,2,3,3-Tetramethylbutane

(7) Iso-pentane (8) *n*-Octane

(9) Iso-octane

SOLUTIONS OF MARCH 2017 CROSSWORD

[2][1]F	I	N	[3]G	E	R	P	R	I	N	[4]T									
L			R				[5]N	I	N	E		[6]L	I	M	O	N	[7]E	N	E
O	[8]C	H	A	L	C	O	N	E	S	F							P		
A			P					[9]C	H	L	O	R	I	N	E		I		
T			[10]H	Y	B	R	I	D		O							M		
A		[11]R	I	C	I	N				N						[12]G	E	[13]A	
T			T								[14]D	[15]E	I	C		E	R	S	
I		[16]B	E	R	Z	E	L	I	U	S			L			L	I	T	
O													L			I	S	A	
N	[17]E	B	U	L	L	I	O	S	C	O	P	Y	I			G	M	T	
	[19][18]G	A	L	V	A	N	I	[20]S	A	T	I	O	N			N		I	
	E							Y					G			I		N	
[22][21]K	R	Y	P	[23]T	O	N		D					H		[24]B	T		E	
E	A			U				N		[25]C			A		O	E			
R	N			[26]T	A	C	T	O	S	O	L	S	[27]M	A	R	S	H		
N	I			T				N		N					D				
E	O			O				E		T		[28]A	R	S	E	N	I	C	
L	L			N						A					A				
							[29]B	O	S	C	H				U				
			[30]H	Y	D	R	O	M	E	T	E	R			X				

15. 

Possible number of elimination products including stereoisomers is

16. Choose the best reagent for the conversion of 1,2-dibromoethane into ethyne.
(0) Alcoholic KOH
(1) $Hg(OOCCH_3)_2/H_2O$ and $NaBH_4$
(2) $ZnCl_2$ and conc.HCl
(3) Zn/CH_3OH
(4) Red P and iodine
(5) Red P and HI
(6) NH_2NH_2 and KOH
(7) H_2 and Ni
(8) Aqueous KOH followed by $NaNH_2$
(9) Alcoholic KOH followed by $NaNH_2$

17. In a constant volume calorimeter, 3.5 g of a gas with molecular weight 28 was burnt in excess at 298 K. The temperature of the calorimeter was found to increase from 298 K to 298.45 K due to the combustion process. Given that the heat capacity of the calorimeter is 2.5 kJ K^{-1}. Calculate the numerical value for the enthalpy of combustion of the gas in kJ mol^{-1}.

18. Presence of which of the following compounds makes water hard ?
Na_2SO_4, $Ca(HCO_3)_2$, $MgCl_2$, Na_2CO_3, $CaSO_4$, KCl, $NaHCO_3$, $MgSO_4$, $CaCl_2$

SECTION-IV

(MATRIX-MATCH TYPE)

This section contains 3 questions. Each question contains statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. The answers to these questions have to be appropriately bubbled in the ORS as per the instructions. For each question in this section, you will be awarded 8 marks if you darken all the bubbles corresponding only to the correct answer and 2 marks for each row. No negative mark will be awarded for an incorrectly bubbled answer.

19. Match the reactions in column I with nature of reactions and type of products in column II.

	Column I		Column II
a.	$AgNO_{3(aq)} + I_2$ (excess) $+ H_2O \rightarrow$	p.	Disproportionation
b.	$K_2MnO_{4(aq)} + CO_{2(g)} \rightarrow$	q.	Comproportionation
c.	$Na_2Cr_2O_7 + C \xrightarrow{\Delta}$	r.	Redox
d.	$CuCl_{2(aq)} + Cu_{(s)} \rightarrow$	s.	One of the products is insoluble in water

20. Match the following:

	Column I		Column II
a.	$C_{graphite(s)} + O_{2(g)} \rightarrow CO_{2(g)}$	p.	$\Delta H^\circ_{combustion}$
b.	$C_{graphite(s)} \rightarrow C_{(g)}$	q.	ΔH°_f
c.	$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$	r.	$\Delta H^\circ_{atomisation}$
d.	$CH_{4(g)} \rightarrow C_{(g)} + 4H_{(g)}$	s.	$\Delta H^\circ_{sublimation}$
		t.	$\Delta S_{system} > 0$

ANSWER

Paper-1

1. (b) 2. (d) 3. (d) 4. (c) 5. (c)
6. (b) 7. (b) 8. (a, b) 9. (a, b, c, d)
10. (a, b, d) 11. (a, c, d) 12. (b)
13. (b) 14. (b) 15. (c) 16. (d) 17. (8)
18. (1) 19. (5) 20. (3) 21. (6) 22. (6)
23. (2)

Paper-2

1. (c) 2. (b) 3. (a) 4. (d) 5. (a)
6. (a) 7. (a) 8. (d) 9. (a, b, c, d)
10. (a, b, d) 11. (a, c, d) 12. (b, c)
13. (7) 14. (8) 15. (2) 16. (9) 17. (9)
18. (5)
19. (a) → (p, r, s); (b) → (p, r, s); (c) → (r, s); (d) → (q, r, s)
20. (a) → (p, q); (b) → (s, t); (c) → (p) ; (d) → (r, t)

For detailed solution to the Sample Paper, visit our website: www.vidyalankar.org

JEE ADVANCED : PRACTICE PAPER *(Full length)*

READY STEADY GO!!

EXAM ON 21ST MAY

PAPER-I

PHYSICS

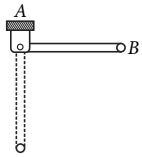
SECTION 1 (Maximum Marks : 15)

- *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. A photon collides with a stationary hydrogen atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. After a time interval of the order of microsecond, another photon collides with same hydrogen atom inelastically with an energy of 15 eV. What will be observed by the detector?
(a) One photon of energy 10.2 eV and an electron of energy 1.4 eV.
(b) Two photons of energy 1.4 eV.
(c) Two photons of energy 10.2 eV.
(d) One photon of energy 10.2 eV and another photon of 1.4 eV.

2. One end of a uniform rod of length l and mass m is hinged at A. It is released from rest from horizontal position AB as shown in figure. The force exerted by the rod on the hinge when it becomes vertical is



(a) $\frac{3}{2}mg$ (b) $\frac{5}{2}mg$ (c) $3mg$ (d) $5mg$

3. A circular ring of mass 6 kg and radius a is placed such that its centre lies at the origin. Two particles of masses 2 kg each are placed at the intersecting points of the circle with positive x-axis and positive y-axis. Then the angle made by the position vector of centre of mass of entire system with x-axis is
(a) 45° (b) 60°
(c) $\tan^{-1}(4/5)$ (d) 30°

4. To a man moving due north with a speed 5 m s^{-1}, the rain appears to fall vertically. When the man doubles his speed, the rain appears to fall at 60°. Find the actual speed of the rain and its direction.
(a) 10 m s^{-1}, 120° (b) 10 m s^{-1}, 180°
(c) 10 m s^{-1}, 90° (d) 10 m s^{-1}, 60°

5. Magnetic field at the centre of a Bohr's hypothetical hydrogen atom in the n^{th} orbit of the electron is
(a) directly proportional to charge of electron e
(b) directly proportional to e^2
(c) inversely proportional to n^5
(d) directly proportional to n^5

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.*

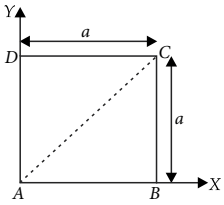
6. Consider the motion of a positive point charge in a region where there are simultaneous uniform electric and magnetic fields $\vec{E} = E_0\hat{j}$ and $\vec{B} = B_0\hat{j}$. At time $t = 0$, this charge has velocity $\vec{v}$ in the x-y plane, making an angle θ with the x-axis. Which of the following option(s) is (are) correct for time $t > 0$?
(a) If θ = 0°, the charge moves in a circular path in the x-z plane.
(b) If θ = 0°, the charge undergoes helical motion with constant pitch along the y-axis.

(c) If θ = 10°, the charge undergoes helical motion with its pitch increasing with time, along the *y*-axis.
(d) If θ = 90°, the charge undergoes linear but accelerated motion along the *y*-axis.

7. It is observed that only 0.39% of the original radioactive sample remains undecayed after eight hours. Hence
(a) the half-life of that substance is 1 hour.
(b) the mean life of the substance is $\frac{1}{\ln 2}$ hour.
(c) decay constant of the substance is ln2 per hour.
(d) if the number of radioactive nuclei of this substance at a given instant is 10^8 then the number left after 30 min would be $\sqrt{2}\times10^7$.

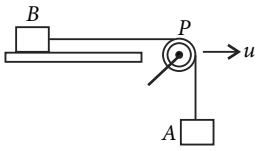
8. Three concentric spherical shells have radii *r*, 2*r* and 3*r* with charges q_1, q_2 and q_3 respectively. Innermost and outermost shells are earthed. Then,
(a) $q_1 + q_3 = -q_2$ (b) $q_1 = -\frac{q_2}{4}$
(c) $\frac{q_3}{q_1} = 3$ (d) $\frac{q_3}{q_2} = -\frac{1}{3}$

9. A force $\vec{F} = (x^2y^2\hat{i} + x^2y^2\hat{j})$ N acts on a particle which moves in the *XY* plane. Choose the correct option(s).



(a) $\vec{F}$ is a conservative force.
(b) Work done for path *ABC* is $\frac{a^5}{3}$ J.
(c) Work done for path *ADC* is $\frac{a^5}{3}$ J.
(d) Work done for path *AC* is $\frac{2a^5}{5}$ J.

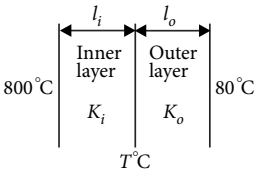
10. In the figure, the pulley *P* moves to the right with a constant speed *u*. The downward speed of *A* is v_A and the speed of *B* to the right is v_B. Then,



(a) $v_A = v_B$ (b) $v_B = u + v_A$
(c) $v_B + u = v_A$
(d) the two blocks have accelerations of the same magnitude.

11. Two springs *A* and *B* have force constants k_1 and k_2 respectively. The ratio of the work done on *A* to that done on *B* in increasing their lengths by the same amount is α and the ratio of the work done on *A* to that done on *B* when they are stretched with the same force is β. Then
(a) $\alpha = \frac{k_1}{k_2}$ (b) $\alpha = \frac{k_2}{k_1}$
(c) $\beta = \frac{k_1}{k_2}$ (d) $\beta = \frac{k_2}{k_1}$

12. A furnace has a two layered wall as shown in the figure. Each layer has the same area of cross section. The temperature *T* at the interface of two layers can be reduced by



(a) increasing the thermal conductivity of outer layer.
(b) decreasing the thermal conductivity of inner layer.
(c) by increasing the thickness of inner layer.
(d) by decreasing the thickness of outer layer.

13. A sound wave of angular frequency ω travels with a speed *v* in a medium of density ρ and bulk modulus *B*. Let *k* be the propagation constant. If *P* and *A* are the pressure amplitude and displacement amplitude respectively, then the intensity of sound wave is
(a) $\frac{1}{2}\omega BkA^2$ (b) $\frac{vP^2}{2B}$
(c) $\frac{P^2}{2\rho v}$ (d) $\frac{P^2}{2\sqrt{\rho B}}$

SECTION 3 (Maximum Marks : 15)

- *This section contains FIVE questions.*
- *The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 to 9, both inclusive.*
- *For each question, darken the bubble corresponding to the correct integer 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 answer is darkened.*
  Zero Marks : *0 In all other cases.*

14. The diameter of a convex lens is *d*. An eye is placed at a distance 3*f* (*f* being the focal length of the lens) to the right of the lens at a distance *d*/4 normally below the optic axis so that the image of an object placed on the optic axis to the left of the lens is not visible for a distance greater than *d*/4. The distance of the object is *nf*. Find the value of *n*.

15. A steady current *I* goes through a wire loop *PQR* having shape of a right angle triangle with *PQ* = 3*x*, *PR* = 4*x* and *QR* = 5*x*. If the magnitude of the magnetic field at *P* due to this loop is $k\left(\frac{\mu_0 I}{48\pi x}\right)$, find the value of *k*.

16. In a car race sound signals emitted by the two cars are detected by the detector on the straight track at the end point of the race. Frequency observed are 330 Hz and 360 Hz and the original frequency is 300 Hz of both cars. Race ends with the separation of 100 m between the cars. Assume both cars move with constant velocity and velocity of sound is 330 m s^{-1}. Find the time (in second) taken by winning car.

17. A parallel plate capacitor is maintained at a certain potential difference. When a 3 mm thick slab is introduced between the plates, in order to maintain the same potential difference, the distance between the plates is increased by 2.4 mm. What is the dielectric constant of the slab?

18. A silver sphere of radius 1 cm and work function 4.7 eV is suspended from an insulating thread in free-space. It is under continuous illumination of 200 nm wavelength light. As photoelectrons are emitted, the sphere gets charged and acquires a potential. The maximum number of photoelectrons emitted from the sphere is $A \times 10^Z$ (where $1 < A < 10$). The value of Z is

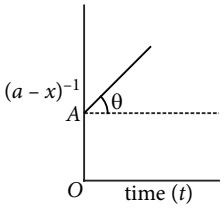
CHEMISTRY

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.*

19. Following is the graph between $(a - x)^{-1}$ and time 't' for a second order reaction.



($\theta = \tan^{-1}(0.5)$, $OA = 2$ L mol^{-1})
Hence, rate at the start of the reaction is

(a) 1.25 mol^{-1} min^{-1} (b) 0.5 mol L^{-1} min^{-1}
(c) 0.125 mol L^{-1} min^{-1} (d) 1.25 mol L^{-1} min^{-1}

20. When a person is deprived of food, in which order does the body use the following sources to produce glucose?

I. Protein breaks down to amino acids used for gluconeogenesis
II. Conversion of glycogen to glucose
III. Catabolism of liquids

(a) I, II and III (b) III, II and I
(c) II, I and III (d) II, III and I

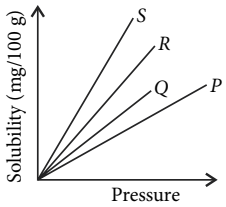
21. A gas expands isothermally against a constant external pressure of 1 atm from a volume of 10 dm^3 to a volume of 20 dm^3. It absorbs 800 J of thermal energy from its surroundings. The ΔU is

(a) –321 J (b) + 123 J (c) –213 J (d) + 231 J

22. The edge length of unit cell of a metal, (having molecular weight 75 g/mol) which crystallises in cubic lattice, is 5 Å. If the density is 2 g/cc, then the radius of metal atom is ($N_A = 6 \times 10^{23}$)

(a) 2.165 Å (b) 2.865 Å
(c) 1.716 Å (d) 3.121 Å

23. The given graph represents the plots of solubility (in mg/100 g) of different gases (P, Q, R, S) versus pressure. Predict the gas which has the highest value of Henry's law constant.



(a) P (b) Q (c) R (d) S

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.*

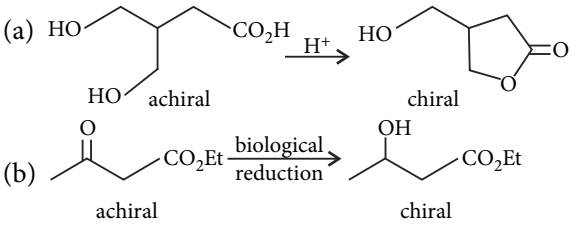
Partial Marks : *+1 For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*

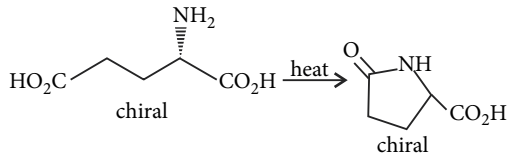
Zero Marks : *0 If none of the bubbles is darkened.*

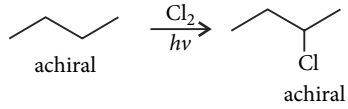
Negative Marks : *–2 In all other cases.*

- *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.*

24. Select correct stereochemistry (chiral/achiral) of the reactants and products.



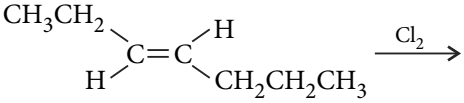
(c) 

(d) 

25. Which of the following statement(s) is (are) wrong?
(a) If the value of $l = 0$, the electron distribution is spherical.
(b) The shape of the orbital is given by magnetic quantum number.
(c) Angular momentum of 1*s*, 2*s*, 3*s* electrons are equal.
(d) In an atom, all electrons travel with the same velocity.

26. If equal volumes of 0.1 M HBr and 0.1 M KOH are mixed, then which of the following is/are correct about the resulting solution?
(a) $[H_3O^+] = 1.0 \times 10^{-7}$ mol L^{-1}
(b) $[OH^-] = 1.0 \times 10^{-7}$ mol L^{-1}
(c) $[K^+] = 0.05$ mol L^{-1} (d) $[Br^-] = 0.05$ mol L^{-1}

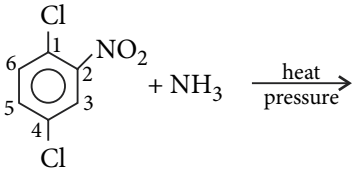
27. Choose the correct sentence about the product(s) formed in the following reaction :



(a) A pair of *meso* compounds
(b) A pair of enantiomers
(c) A pair of diastereomers
(d) A pair of enantiomers and a *meso* compounds

28. When zeolite (which is hydrated sodium aluminium silicate) is treated with hard water, the sodium ions are exchanged with
(a) H^+ ions (b) Ca^{++} ions
(c) SO_4^{--} ions (d) Mg^{++} ions.

29. Which of the following statements is (are) true regarding the following reaction?



(a) No reaction is possible because —Cl is present on benzene ring.
(b) A nucleophilic substitution will take place in which both —Cl will be replaced by two $—NH_2$ groups.
(c) A nucleophilic substitution will take place in which only —Cl attached on C_1 will be replaced by $—NH_2$.
(d) A nucleophilic substitution will take place in which only —Cl attached on C_4 will be replaced by $—NH_2$.

30. A gas described by van der Waals' equation
(a) behaves similar to an ideal gas in the limit of large molar volumes
(b) behaves similar to an ideal gas in the limit of large pressures
(c) is characterised by van der Waals' coefficients that are dependent directly on identity of gas but are independent of temperature
(d) has the pressure that is lower than the pressure exerted by the same behaving ideally.

31. The thermal dissociation equilibrium of $CaCO_{3(s)}$ is studied under different conditions :

$$CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$$

For this equilibrium, the correct statement(s) is (are)
(a) ΔH is dependent on T
(b) K is independent of the initial amount of $CaCO_3$
(c) K is dependent on the pressure of CO_2 at a given T
(d) ΔH is independent of the catalyst, if any.

SECTION 3 (Maximum Marks : 15)

- *This section contains FIVE questions.*
- *The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 to 9, both inclusive.*
- *For each question, darken the bubble corresponding to the correct integer 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 answer is darkened.*

Zero Marks : *0 In all other cases.*

32. The total number of molecules or ions having bond order 2.5 among O_2^+, CN, NO, N_2^+, CO^+, NO^+, O_2^-, CN^-, N_2 is/are

33. The enthalpy change involved in the oxidation of glucose is –2880 kJ mol^{-1}. 25% of this energy is available for muscular work. If 100 kJ of muscular work is needed to walk one kilometre, what is the approximate distance (in km) that a person will be able to walk after eating 120 g of glucose?

34. The ratio of terminal to bridged CO groups in $[Co_2(CO)_8]$ is $x : 1$, then the value of x is

Contd. on Page no. 69

PRACTICE PAPER

BITSAT

Exam date : 16th to 30th May 2017

1. Find out the total number of voids in 0.5 mole of a compound forming hexagonal closed packed structure.
(a) 9.034×10^{23} (b) 6.023×10^{23}
(c) 18.069×10^{23} (d) 3.011×10^{23}

2. How much energy will be required to ionise 1 mole of hydrogen atoms?
(a) 1350 kJ (b) 1350 J
(c) 1312 kJ (d) 1312 J

3. A_1 and A_2 are two ores of metal '*M*'.
A_1 on calcination gives black precipitate, CO_2 and H_2O.
$A_1 \xrightarrow{\text{Calcination}}$ Black ppt. + CO_2 + H_2O
While A_2 on roasting gives metal and a gas.
$A_2 \xrightarrow{\text{Roasting}}$ Metal + Gas
Gas $\xrightarrow{K_2Cr_2O_7 + H_2SO_4}$ *P*(Green coloured)
In the given sequence, A_1 and A_2 respectively are
(a) $CuCO_3$ and Cu_2S
(b) $CuCO_3 . Cu(OH)_2$ and Cu_2S
(c) $CuCO_3$ and Cu_2O
(d) $CuCO_3 . Cu(OH)_2$ and Cu_2O

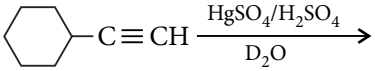
4. The values of observed and calculated molecular weights of silver nitrate are 92.64 and 170 respectively. The degree of dissociation of silver nitrate will be
(a) 52.8% (b) 83.5% (c) 46.7% (d) 60.2%

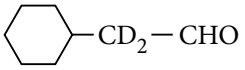
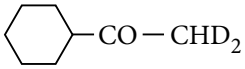
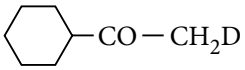
5. The total number of gas molecules in a room of capacity 25 m^3 at a temperature of 27°C and 1 atm pressure will be
(a) 3.011×10^{23} (b) 6.119×10^{23}
(c) 6.119×10^{26} (d) 3.011×10^{26}

6. CaO and NaCl have the same crystal structure and approximately the same ionic radii. If *U* is the lattice energy of NaCl, the approximate lattice energy of CaO is
(a) $\frac{U}{2}$ (b) U (c) $2U$ (d) $4U$

7. '925 fine silver' means
(a) 9.5% Ag + 90.5% Cu
(b) 92.5% Ag + 7.5% Cu
(c) 9.25% Cu + 90.75% Ag
(d) 7.5% Ag + 92.5% Cu

8. What is the product formed when the following reaction takes place?



(a) 
(b) 
(c) 
(d) 

9. The entropy change can be calculated by using the expression, $\Delta S = \frac{q_{rev}}{T}$. When water freezes in a glass beaker what happens?
(a) ΔS(system) decreases but ΔS(surroundings) remains the same.
(b) ΔS(system) increases but ΔS(surroundings) decreases.
(c) ΔS(system) decreases but ΔS(surroundings) increases.
(d) ΔS(system) and ΔS(surroundings) both decrease.

10. Under which of the following reaction conditions, aniline gives *p*-nitro derivative as the major product?
(a) Acetyl chloride/pyridine followed by reaction with conc. H_2SO_4 + conc. HNO_3
(b) Ethyl alcohol/pyridine followed by conc. H_2SO_4 + conc. HNO_3

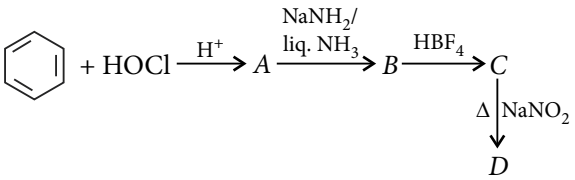
(c) Dil. HCl followed by reaction with conc. H_2SO_4 + conc. HNO_3
(d) Reaction with conc. HNO_3 + conc. H_2SO_4

11. Which of the following statements is not true?
(a) Nascent hydrogen can be produced even at room temperature but atomic hydrogen is produced at elevated temperature.
(b) Nascent hydrogen can never be isolated but atomic hydrogen can be isolated.
(c) Reducing power of atomic hydrogen is much less than that of nascent hydrogen.
(d) Both nascent and atomic hydrogen are more reactive than ordinary hydrogen.

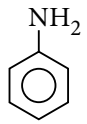
12. Amongst TiF_6^{2-}, CoF_6^{3-}, Cu_2Cl_2 and $NiCl_4^{2-}$, the colourless species are
(a) CoF_6^{3-} and $NiCl_4^{2-}$ (b) TiF_6^{2-} and CoF_6^{3-}
(c) Cu_2Cl_2 and $NiCl_4^{2-}$ (d) TiF_6^{2-} and Cu_2Cl_2

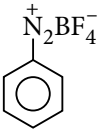
13. The values of K_{sp} of two sparingly soluble salts $Ni(OH)_2$ and AgCN are 2×10^{-15} and 6×10^{-17} respectively. Which salt is more soluble?
(a) $Ni(OH)_2$
(b) AgCN
(c) Both are equally soluble.
(d) Cannot be predicted.

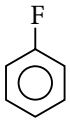
14. In the following sequence of reactions :

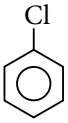


Identify *D*.

(a) 

(b) 

(c) 

(d) 

15. Aniline is diazotised and the diazonium salt hydrolysed to yield phenol which is brominated to produce $C_6H_2(Br_3)OH$. Calculate the mass of the final product obtained from 9.3 g of aniline if the yield in the two steps is 45% and 70% respectively. (Atomic mass of Br = 80)
(a) 1.04 g (b) 10.43 g (c) 14.89 g (d) 23.17 g

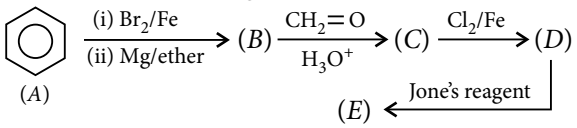
16. A cylinder of gas is assumed to contain 11.2 kg of butane (C_4H_{10}). If a normal family needs 20,000 kJ of energy per day, the cylinder will last in
(Given : ΔH for combustion of butane is – 2658 kJ)
(a) 20 days (b) 22 days
(c) 26 days (d) 24 days.

17. An electric current is passed through an aqueous solution of a mixture of alanine (isoelectric point 6.0), glutamic acid (3.2) and arginine (10.7) buffered at pH 6. What is the fate of the three acids?
(a) Glutamic acid migrates to anode at pH 6. Arginine present as a cation and migrates to the cathode. Alanine as a dipolar ion remains uniformly distributed in solution.
(b) Glutamic acid migrates to cathode and others remain uniformly distributed in solution.
(c) All these remain uniformly distributed in solution.
(d) All three move to cathode.

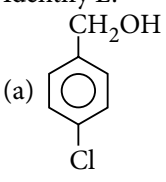
18. Oxidation states of *X*, *Y*, *Z* are +2, +5 and –2 respectively. Formula of the compound formed will be
(a) X_2YZ_6 (b) XY_2Z_6
(c) XY_5Z_2 (d) X_3YZ_4

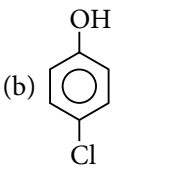
19. Half-life time of a radioactive element *X* is same as the mean life time of another radioactive element *Y*. Initially both of them have same number of atoms, then
(a) *X* and *Y* have the same decay rate initially
(b) *X* and *Y* have the same decay rate always
(c) *Y* will decay at faster rate than *X*
(d) *X* will decay at faster rate than *Y*.

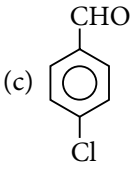
20. Consider the following sequence of reactions :

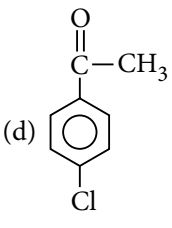


Identify *E*.

(a) 

(b) 

(c) 

(d) 

21. Based upon the following hypothetical equilibrium at 273 K

(i) $XCl_2 \cdot 6H_2O_{(s)} \rightleftharpoons XCl_2 \cdot 2H_2O_{(s)} + 4H_2O_{(g)}$; $K_p = 8.1 \times 10^{-11}$ atm^4

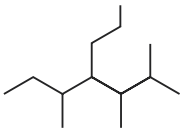
(ii) $Y_2HPO_4 \cdot 12H_2O_{(s)} \rightleftharpoons Y_2HPO_4 \cdot 7H_2O_{(s)} + 5H_2O_{(g)}$; $K_p = 3.2 \times 10^{-9}$ atm^5

(iii) $Z_2SO_4 \cdot 10H_2O_{(s)} \rightleftharpoons Z_2SO_{4(s)} + 10H_2O_{(g)}$; $K_p = 1.0 \times 10^{-30}$ atm^{10}

Which is the most effective dehydrating agent at 273 K? (Aqueous tension at 273 K = 6.0×10^{-3} atm)

(a) $XCl_2 \cdot 6H_2O_{(s)}$ (b) $Y_2HPO_4 \cdot 7H_2O_{(s)}$

(c) $Z_2SO_{4(s)}$ (d) $Z_2SO_4 \cdot 10H_2O_{(s)}$

22. The correct IUPAC name for  is

(a) 5-methyl-4-(1'-2'-dimethylpropyl)heptane

(b) 3-methyl-4-(1', 2'-dimethylpropyl)heptane

(c) 2, 3, 5-trimethyl-4-propylheptane

(d) 4-propyl-2, 3, 5-trimethylheptane.

23. Electrolysis of NaCl solution with inert electrodes for certain period of time gave 600 cm^3 of 1.0 M NaOH in the electrolytic cell. During the same period, 31.80 g of copper was deposited in a copper voltameter in series with the electrolytic cell. What is the percentage of current efficiency in the electrolytic cell? (At. wt. of Cu = 63.6)

(a) 40 (b) 50 (c) 60 (d) 25

24. Aluminium displaces hydrogen from dilute HCl whereas silver does not. The emf of a cell prepared by combining Al/Al^{3+} and Ag/Ag^+ is 2.46 V. The reduction potential of silver electrode is +0.80 V. The reduction potential of aluminium electrode is

(a) + 1.66 V (b) – 3.26 V

(c) + 3.26 V (d) – 1.66 V

25. The hybridisation, oxidation number and shape of central metal ion of Wilkinson's catalyst are respectively

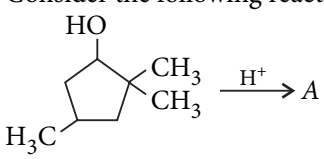
(a) dsp^2, +1, square planar

(b) sp^3, +4, tetrahedral

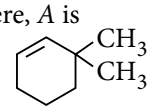
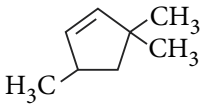
(c) sp^3d, +2, trigonal bipyramidal

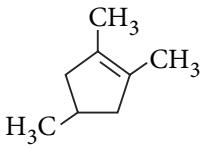
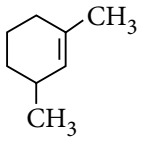
(d) d^2sp^3, +6, octahedral.

26. Consider the following reaction,



Here, A is

(a)  (b) 

(c)  (d) 

27. Consider the following reactions,

$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} C$, $C + B \xrightarrow{k_2} D$

The rate in terms of $-\frac{d[B]}{dt}$ will be

(a) $k_1[A][B] - k_{-1}[C]$

(b) $k_1[A][B] - k_1[C] - k_2[C][B]$

(c) $k_1[A][B] - k_2[C][B]$

(d) $k_1[A][B] - k_{-1}[C] + k_2[C][B]$

28. Aluminium vessels should not be washed with materials containing washing soda since

(a) washing soda is expensive

(b) washing soda is easily decomposed

(c) washing soda reacts with Al to form soluble aluminate

(d) washing soda reacts with Al to form insoluble aluminium oxide.

29. When I_2 is passed through KCl, KF, KBr

(a) Cl_2 and Br_2 are evolved

(b) Cl_2 is evolved

(c) Cl_2, Br_2, F_2 are evolved

(d) none of these.

30. Zeta potential (or electrokinetic potential) is the

(a) potential required to bring about coagulation of a colloidal sol

(b) potential required to give the particles a speed of 1 cm/sec in the sol

(c) potential difference between fixed charged layer and the diffused layer having opposite charges

(d) potential energy of the colloidal particles.

31. Gadolinium belongs to 4f series and its atomic number is 64. Which of the following is the correct electronic configuration of gadolinium?

(a) [Xe]$4f^9\ 5s^1$ (b) [Xe]$4f^7\ 5d^1\ 6s^2$

(c) [Xe]$4f^6\ 5d^2\ 6s^2$ (d) [Xe]$4f^8\ 5d^2$

32. In the nuclear reaction, ${}^7_3Li + {}^1_1H \rightarrow 2{}^4_2He$, the mass loss is nearly 0.02 amu. Hence, the energy released (in million kcal/mol) in the process is approximately

(a) 428 (b) 200 (c) 100 (d) 50

33. Which of the following reactions will yield 2-propanol?

I. $CH_2=CH-CH_3 + H_2O \xrightarrow{H^+}$

II. $CH_3-CHO \xrightarrow[(ii)\ H^+/H_2O]{(i)\ CH_3MgI}$

III. $CH_2O \xrightarrow[(ii)\ H^+/H_2O]{(i)\ C_2H_5MgI}$

IV. $CH_2=CH-CH_3 \xrightarrow{\text{Neutral } KMnO_4}$

(a) I and II only (b) II and III only
(c) I and III only (d) II and IV only

34. Three separate samples of a solution of a single salt gave these results. One formed a white precipitate with excess ammonia solution, one formed a white precipitate with dil. NaCl solution and one formed a black precipitate with H_2S. The salt could be
(a) $AgNO_3$ (b) $Pb(NO_3)_2$
(c) $Hg(NO_3)_2$ (d) $MnSO_4$

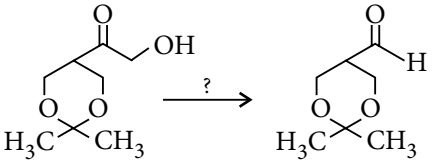
35. Which of the following has largest number of isomers?
(a) $[Ru(NH_3)_4Cl_2]^+$ (b) $[Co(en)_2Cl_2]^+$
(c) $[Ir(PR_3)_2H(CO)]^{2+}$ (d) $[Co(NH_3)_5Cl]^{2+}$

36. The first ionisation potential of Na, Mg, Al and Si are in the order
(a) Na < Mg > Al < Si (b) Na > Mg > Al > Si
(c) Na < Mg < Al > Si (d) Na > Mg > Al < Si

37. Softening of hard water is done using sodium aluminium silicate (zeolite). This causes
(a) adsorption of Ca^{2+} and Mg^{2+} ions of hard water replacing Na^+ ions
(b) adsorption of Ca^{2+} and Mg^{2+} ions of hard water replacing Al^{3+} ions
(c) both are true
(d) none is true.

38. 1.25 g of a sample of Na_2CO_3 and Na_2SO_4 is dissolved in 250 mL solution. 25 mL of this solution neutralises 20 mL of 0.1 N H_2SO_4. The % of Na_2CO_3 in this sample is
(a) 84.8% (b) 8.48%
(c) 15.2% (d) 42.4%

39. The reagents employed to carry out the following transformation are



(a) $LiAlH_4$, H_2SO_4/heat
(b) PCC/CH_2Cl_2 followed by HIO_4
(c) $NaBH_4$/CH_3OH followed by HIO_4
(d) O_3 followed by $(CH_3)_2S$

40. Of the following statements about enzymes which ones are true?
(i) Enzymes lack in nucleophilic groups.
(ii) Enzymes are highly specific both in binding chiral substrates and in catalysing their reactions.
(iii) Enzymes catalyse chemical reactions by lowering the energy of activation.
(iv) Pepsin is a proteolytic enzyme.
(a) (i) and (iv) only (b) (i) and (iii) only
(c) (ii), (iii) and (iv) only
(d) (i) only

SOLUTIONS

1. **(a) :** In hexagonal closed packed structure, there are 6 atoms per unit cell.

$\therefore$ Number of octahedral voids = 6

$\therefore$ Number of tetrahedral voids = $2 \times 6 = 12$

$\therefore$ Total number of voids per atom = $\frac{18}{6} = 3$

$\therefore$ Total number of voids in 1 mole $= 3 \times 6.023 \times 10^{23}$

$\therefore$ Total number of voids in 0.5 mole $= 3 \times 0.5 \times 6.023 \times 10^{23} = 9.034 \times 10^{23}$

2. **(c) :** $I.E. = \frac{Z^2}{n^2} \times 2.178 \times 10^{-18}$ J/atom

For hydrogen, $Z = 1$, $n = 1$

$\therefore$ $I.E. = \frac{1^2}{1^2} \times 2.178 \times 10^{-18}$ J/atom

$I.E.$ per mole $= 2.178 \times 10^{-18} \times 6.023 \times 10^{23}$
$= 1311809.4$ J $\simeq 1312$ kJ

3. **(b) :** A_1, on calcination gives black solid along with CO_2 and H_2O. So, A_1 is basic copper carbonate $[Cu(OH)_2 \cdot CuCO_3]$ while A_2 on roasting gives metal and gas which upon oxidation gives green colour which partially indicates that A_2 is Cu_2S.
So, the confirmatory reactions are :

$$\underset{\substack{\text{Basic copper carbonate}\\(A_1)}}{CuCO_3 \cdot Cu(OH)_2} \xrightarrow{\text{Calcination}} \underset{\text{Black ppt.}}{2CuO_{(s)}} + CO_2\uparrow + H_2O$$

$$\underset{(A_2)}{2Cu_2S} + 3O_2 \longrightarrow 2Cu_2O + 2SO_2\uparrow$$

$$2Cu_2O + Cu_2S \longrightarrow \underset{(A_2)}{} \underset{\text{(Metal)}}{6Cu} + \underset{\text{(Gas)}}{SO_2}\uparrow$$

$$\xrightarrow[+\,H_2SO_4]{K_2Cr_2O_7}$$

$$K_2SO_4 + \underset{\text{(Green coloured)}\ (P)}{Cr_2(SO_4)_3} + 4H_2O$$

4. (b):

	$AgNO_3$	$\longrightarrow$	Ag^+	+	NO_3^-
Initial	1 mole		0		0
After dissociation	$1-\alpha$		α		α

Total number of moles = $1 + \alpha$

$i = 1 + \alpha$ or $\alpha = i - 1$

$$i = \frac{170}{92.64} = 1.835,\ \alpha = i - 1 = 0.835 = 83.5\%$$

5. (c): We know that, $PV = nRT$ ...(i)

Given : $P = 1$ atm; $V = 25 \times 10^3$ L; $T = 300$ K

$R = 0.082$ L atm K^{-1} mol^{-1}

Putting these values in equation (i), we get

$$n = \frac{PV}{RT} = \frac{1\times25\times10^3}{0.082\times300} = 1016 \text{ mol}$$

Number of molecules = $n \times 6.023 \times 10^{23}$

$= 1016 \times 6.023 \times 10^{23} = 6.119 \times 10^{26}$ molecules

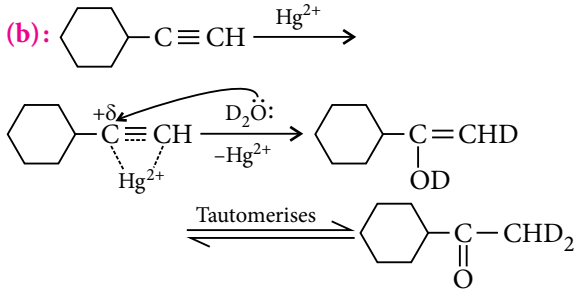
6. (d): Lattice energy, $U = \frac{q_1 q_2}{r^2}$

Since, interionic distances in CaO and NaCl are similar so, r is almost the same. Therefore, lattice energy depends only on charge.

Since, the magnitude of charge on Na^+ and Cl^- ions is same *i.e.,* unity and that on Ca^{2+} and O^{2-} ions is 2 each, therefore, the lattice energy of CaO is four times the lattice energy of NaCl, *i.e.,* $4U$.

7. (b): '925 fine silver' means 925 parts by weight of pure Ag present in Ag-Cu alloy of 1000 parts by weight. Hence, Ag = 92.5%, Cu = 7.5%.

8. (b):



9. (c): When water freezes, the heat is transferred from system to the surroundings, thus entropy of system decreases but entropy of surroundings increases.

10. (a): CH_3COCl forms acetanilide on reaction with aniline and thus, reduces the activity of $-NH_2$ group. Hence, reaction with conc. HNO_3 and H_2SO_4 in presence of CH_3COCl results in the formation of *p*-nitro derivative as major product. In the absence of CH_3COCl, 2,4,6-trisubstituted derivative of aniline will be formed as the major product.

11. (c): Reducing power of atomic hydrogen is much greater than that of nascent hydrogen.

12. (d): Transition metal ions having outer electronic configuration as $3d^0$ and $3d^{10}$ will give colourless compounds due to absence of unpaired electrons.

In TiF_6^{2-}, Ti is in +4 oxidation state.

Electronic configuration of $Ti^{4+} = [Ar]3d^0$

In Cu_2Cl_2, Cu is in +1 oxidation state.

Electronic configuration of $Cu^+ = [Ar]3d^{10}$

Thus, both these compounds will be colourless.

13. (a): $AgCN \longrightarrow \underset{s_1}{Ag^+} + \underset{s_1}{CN^-}$

$K_{sp} = [Ag^+]\,[CN^-] = s_1^2$

$$s_1 = \sqrt{K_{sp}} = \sqrt{6\times10^{-17}} = 7.8 \times 10^{-9} \text{ M}$$

$Ni(OH)_2 \longrightarrow \underset{s_2}{Ni^{2+}} + \underset{2s_2}{2OH^-}$

$K_{sp} = [Ni^{2+}][OH^-]^2 = s_2(2s_2)^2 = 4s_2^3$

$$s_2 = \left(\frac{2\times10^{-15}}{4}\right)^{1/3} = 7.93 \times 10^{-6} \text{ M}$$

Thus, $Ni(OH)_2$ is more soluble.

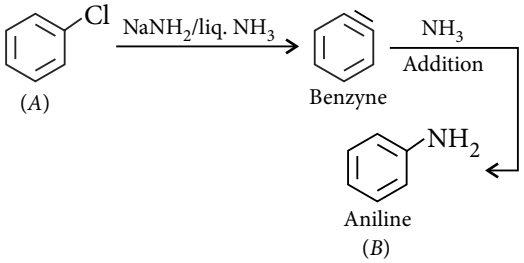
14. (c): At first, generation of electrophile (chloronium ion, Cl^+) takes place which attacks on benzene.

$$HOCl \xrightarrow{H^+} H_2O + \underset{\text{(Electrophile)}}{Cl^+}$$

$$\underset{\text{Benzene}}{C_6H_6} + Cl^+ \xrightarrow{-H^+} \underset{\text{Chlorobenzene}}{C_6H_5Cl}$$

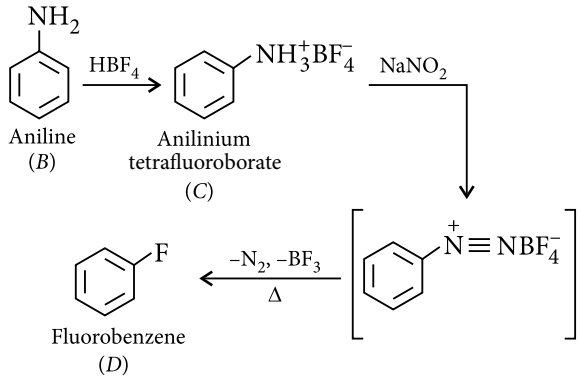
(A)

A on treatment with $NaNH_2$/liq. NH_3 gives aniline (B).



(A) (B)

Balz-Schiemann reaction :



15. (b) : $C_6H_5NH_2 \xrightarrow[H_2O]{\text{Diazotisation}} C_6H_5OH$ (45% yield) $\xrightarrow{\text{Bromination}} C_6H_2(Br_3)OH$ (70% yield)

Mole of C_6H_5OH formed $= \frac{9.3}{93} \times \frac{45}{100} = 0.045$

Mole of $C_6H_2(Br_3)OH = 0.045 \times \frac{70}{100} = 0.0315$

Mass of $C_6H_2(Br_3)OH$ formed $= 0.0315 \times 331$
$= 10.43$ g

16. (c) : Cylinder contains 11.2 kg or 193.10 moles butane. ($\because$ Molecular mass of butane = 58)

$\because$ Energy released by 1 mole of butane = – 2658 kJ

$\therefore$ Energy released by 193.10 moles of butane
$= -2658 \times 193.10 = -5.13 \times 10^5$ kJ

$\therefore$ Cylinder will last in $\frac{5.13 \times 10^5}{20000} = 25.66$ or 26 days.

17. (a) : At pH = 6, glutamic acid exists as a dianionic species and migrates to anode while arginine exists as cationic species and moves to cathode. Alanine does not migrate to any electrode at its isoelectric point.

18. (b) : The oxidation states of X, Y and Z are +2, +5 and –2 respectively.

In $X_2YZ_6 = 2 \times 2 + 5 + 6(-2) \neq 0$

In $XY_2Z_6 = 2 + 5 \times 2 + 6(-2) = 0$

In $XY_5Z_2 = 2 + 5 \times 5 + 2(-2) \neq 0$

In $X_3YZ_4 = 3 \times 2 + 5 + 4\,(-2) \neq 0$

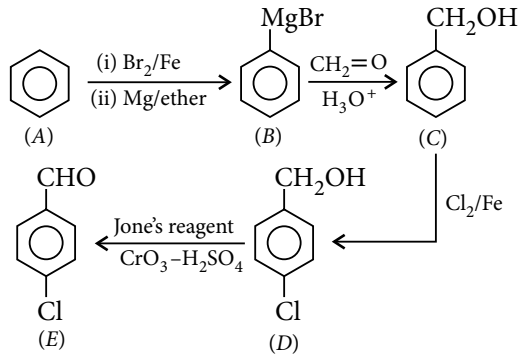
Hence, the formula of the compound is XY_2Z_6.

19. (c) : $(t_{1/2})_X = (t_{mean})_Y$ or $\frac{0.693}{\lambda_X} = \frac{1}{\lambda_Y}$

or $\lambda_X = 0.693\,\lambda_Y$

Hence, $\lambda_X < \lambda_Y$. Therefore Y will decay at a faster rate than X.

20. (c) :



p-Chlorobenzaldehyde

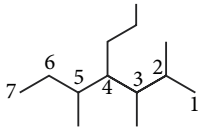
21. (c) : (i) $p_{H_2O} = K_p^{1/4} = (8.1 \times 10^{-11})^{1/4} = 3.0 \times 10^{-3}$ atm

(ii) $p_{H_2O} = (K_p)^{1/5} = (3.2 \times 10^{-9})^{1/5} = 2.0 \times 10^{-2}$ atm

(iii) $p_{H_2O} = (K_p)^{1/10} = (1.0 \times 10^{-30})^{1/10} = 1.0 \times 10^{-3}$ atm

Smaller is the equilibrium p_{H_2O}, more effective will be the lower hydrate or anhydrous salt as dehydrating agent. Hence, Z_2SO_4 is the most effective dehydrating agent.

22. (c) : In the case where two or more chains are of equal length, then the chain with greater number of side chains is selected as the principal chain.



2, 3, 5-trimethyl-4-propylheptane

23. (c) : $NaCl_{(aq)}$ (cathode) :

$2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

$CuSO_{4(aq)}$ (cathode) : $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

Equivalents of OH^- = Moles of OH^- formed

$= \frac{600 \times 1}{1000} = 0.6$

Equivalents of Cu deposited $= \frac{31.8}{63.5/2} = 1.0$

Current efficiency $= \frac{0.6 \times 100}{1}\% = 60\%$

24. (d) : Al is more reactive than Ag, *i.e.*, cell reaction is $Al + 3Ag^+ \longrightarrow Al^{3+} + 3Ag$

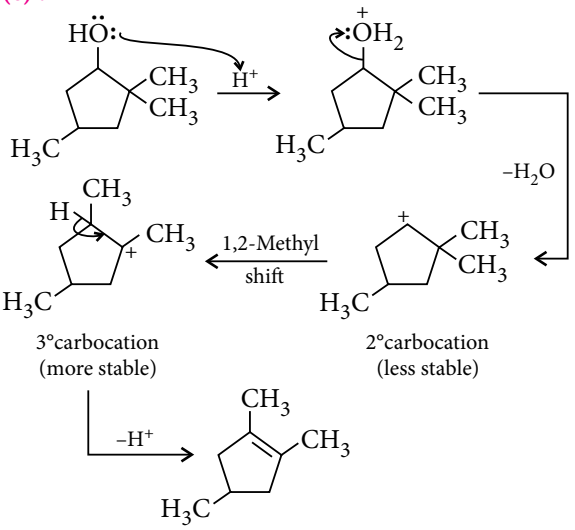
$E_{cell} = E^\circ_{cathode} - E^\circ_{anode} = E^\circ_{Ag^+/Ag} - E^\circ_{Al^{3+}/Al}$

$2.46 = 0.80 - E^\circ_{Al^{3+}/Al}$

$E^\circ_{Al^{3+}/Al} = -1.66$ V

25. (a) : In Wilkinson's catalyst (a homogeneous catalyst), $[(Ph_3P)_3RhCl]$, Rh is dsp^2-hybridised, in +1 oxidation state and the complex has square planar shape.

26. (c) :



27. (d) : From 1st reaction,

$$-\frac{d[B]}{dt} = k_1[A][B] - k_{-1}[C]$$

From 2nd reaction, $-\frac{d[B]}{dt} = k_2[C][B]$

$\therefore$ Total $-\frac{d[B]}{dt} = k_1[A][B] - k_{-1}[C] + k_2[C][B]$

28. (c) : $2Al + Na_2CO_3 + 3H_2O \longrightarrow 2NaAlO_2 + CO_2 + 3H_2$

29. (d) : I_2 being the weakest oxidising agent cannot displace stronger oxidising agents such as F_2, Cl_2 or Br_2 from their salts.

30. (c)

31. (b) : Gd($Z = 64$) : $[Xe]4f^7\ 5d^1\ 6s^2$

32. (a) : Energy released (ΔE) = $\Delta m \times 931.5$ MeV

$$= 0.02 \times 931.5 \times \frac{1.6\times10^{-13}}{4.184} \times \frac{1}{1000} \times 6.023 \times 10^{23}$$

$= 428 \times 10^6$ kcal/mole = 428 million kcal/mole

33. (a) : Reactions I and II give 2-propanol, *i.e.*,

I. $CH_3CH{=}CH_2 + H_2O \xrightarrow[\text{Markovnikov's addition}]{H^+} \underset{\text{2-Propanol}}{CH_3CHOHCH_3}$

II. $CH_3CHO \xrightarrow[(ii)\ H^+/H_2O]{(i)\ CH_3MgI} \underset{\text{2-Propanol}}{CH_3-CH(OH)-CH_3}$

In contrast, reaction III gives 1-propanol and IV gives 1,2-propanediol.

III. $CH_2O \xrightarrow[(ii)\ H^+/H_2O]{(i)\ C_2H_5MgI} \underset{\text{1-Propanol}}{C_2H_5CH_2OH}$

IV. $CH_2{=}CHCH_3 \xrightarrow[KMnO_4]{\text{Neutral}} \underset{\text{1, 2-Propanediol}}{CH_2(OH)-CH(OH)-CH_3}$

34. (b) : The salt can be $Pb(NO_3)_2$. The reactions are,

$Pb(NO_3)_2 + 2NH_4OH \longrightarrow \underset{\text{White ppt.}}{Pb(OH)_2} + 2NH_4NO_3$

$Pb(NO_3)_2 + 2NaCl \longrightarrow \underset{\text{(dil.)}\quad\text{White ppt.}}{PbCl_2} + 2NaNO_3$

$Pb(NO_3)_2 + H_2S \longrightarrow \underset{\text{Black ppt.}}{PbS} + 2HNO_3$

35. (b) : All given compounds have *cis* and *trans* isomers but only *cis*-isomer of $[Co(en)_2Cl_2]^+$ will also have optical isomers (*d* and *l*) due to presence of symmetrical didentate ligand, (*en*).

36. (a) : IE_1 of Mg is higher than that of Na because of increased nuclear charge and also than that of Al because in Mg an *s*-electron has to be removed while in Al it is the 3*p*-electron that has to be removed. Mg also has stable fully filled configuration. The IE_1 of Si is, however, higher than those of Mg and Al because of increased nuclear charge. Thus, the overall order is Na < Mg > Al < Si.

37. (a)

38. (a) : Let the amount of Na_2CO_3 present in the mixture be *x* g. Na_2SO_4 will not react with H_2SO_4. Then

$N_1V_1 = N_2V_2$

$\underbrace{25\times N_1}_{\text{(Solution)}} = \underbrace{0.1\times20}_{H_2SO_4}$

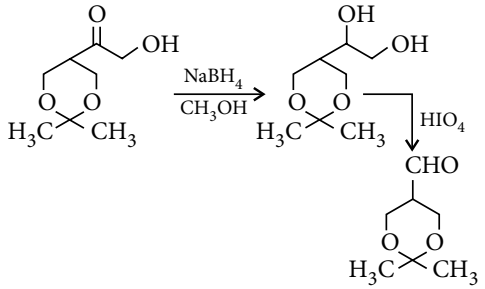
$N_1 = 2/25$

$$\text{Normality}\left(\frac{2}{25}\right) = \frac{x/53\times1000}{250}$$

$$\Rightarrow x = \frac{2\times250\times53}{25\times1000} = 1.06\text{ g}$$

$\therefore$ Percentage of $Na_2CO_3 = \frac{1.06\times100}{1.25} = 84.8\%$

39. (c) :



40. (c)

PRACTICE PAPER AIMS

Exam on 28th May

1. The reaction, $SO_2Cl_2 \longrightarrow SO_2 + Cl_2$ is a first order reaction with $k = 2.2 \times 10^{-5}\ s^{-1}$ at 320°C. The percentage of SO_2Cl_2 that is decomposed on heating after 30 minutes will be
(a) 3.8% (b) 65.4% (c) 39.5% (d) 48.5%

2. ICl_4^- is iso-structural with
(a) IBr_2^- (b) BrO_3^- (c) CH_4 (d) XeF_4

3. Analysis shows that a metal oxide has the empirical formula $M_{0.96}O_{1.00}$. The percentage of M^{2+} ion in this crystal is
(a) 91.67 (b) 8.33 (c) 45.83 (d) 22.92

4. $\frac{1}{4}$ th of Avogadro number of atoms of an element absorb energy 'X' kJ for ionisation, the ionisation energy (kJ) of an atom is
(a) $\frac{2X}{N_0}$ (b) $\frac{4X}{N_0}$ (c) $\frac{4N_0}{X}$ (d) $\frac{N_0}{X}$

5. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below,

$$\frac{1}{2}Cl_{2(g)} \xrightarrow{\frac{1}{2}\Delta_{diss.}H^\circ} Cl_{(g)} \xrightarrow{\Delta_{eg}H^\circ} Cl^-_{(g)} \xrightarrow{\Delta_{hyd.}H^\circ} Cl^-_{(aq)}$$

The energy involved in the conversion of $\frac{1}{2}Cl_{2(g)}$ to $Cl^-_{(aq)}$ (using data, $\Delta_{diss.}H^\circ = 240\ kJ\ mol^{-1}$, $\Delta_{eg}H^\circ_{Cl} = -349\ kJ\ mol^{-1}$, $\Delta_{hyd.}H^\circ = -381\ kJ\ mol^{-1}$) will be
(a) 120 kJ mol^{-1} (b) 150 kJ mol^{-1}
(c) –610 kJ mol^{-1} (d) –850 kJ mol^{-1}

6. If NaCl is dopped with 10^{-4} mole percent of $SrCl_2$, the concentration of cation vacancies will be
(a) $6.023 \times 10^{16}\ mol^{-1}$ (b) $6.023 \times 10^{17}\ mol^{-1}$
(c) $6.023 \times 10^{14}\ mol^{-1}$ (d) $6.023 \times 10^{15}\ mol^{-1}$

7. Occluded hydrogen means
(a) dehydrogenation
(b) hardening of oils
(c) hydrogen adsorbed on metals
(d) hydrogen as fuel.

8. When conc. H_2SO_4 was added into an unknown salt present in a test tube, a brown gas (A) was evolved. This gas intensified when copper turnings were also added into this test tube. On cooling, the gas (A) changed into a colourless gas (B). Identify the gases A and B.
(a) NO_2 and NO_2 (b) NO_2 and N_2O_3
(c) NO_2 and NO (d) NO_2 and N_2O_4

9. Major product of the following reaction will be

$$C_2H_5ONa + CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-Cl \longrightarrow$$

(a) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-OC_2H_5$ (b) $CH_3-\underset{\displaystyle CH_3}{\overset{}{\overset{|}{\underset{|}{C}}}}=CH_2$

(c) $CH_2=CH_2$ (d) $CH_3-\underset{\displaystyle C_2H_5}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-OCH_3$

10. How many grams of concentrated nitric acid should be used to prepare 250 mL of 2.0 M HNO_3? (The concentrated acid contains 70% HNO_3.)
(a) 70.0 g (b) 54.0 g
(c) 45.0 g (d) 90.0 g

11. What will be the mass of NaCl produced when 1.00 mol L^{-1} aqueous solution of sodium hydroxide is neutralised by 200 mL of 2.00 mol L^{-1} aqueous hydrochloric acid?
(a) 23.4 g (b) 58.5 g (c) 29.2 g (d) 87.7 g

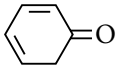
12. At equimolar concentration of Fe^{2+} and Fe^{3+}, what must be the $[Ag^+]$ so that the voltage of the galvanic cell made from $Ag^+ \mid Ag$ and $Fe^{3+} \mid Fe^{2+}$ electrodes equals zero? The cell reaction is

$$Fe^{2+} + Ag^+ \rightleftharpoons Fe^{3+} + Ag$$

$\left(\text{Given}: E^\circ_{Ag^+/Ag} = 0.799\ \text{V},\ E^\circ_{Fe^{3+}/Fe^{2+}} = 0.771\ \text{V}\right)$

(a) 0.474 M (b) 2.98 M
(c) 0.335 M (d) 0.670 M

13. Maximum enolisation takes place in

(a) CH_3COCH_3 (b) CH_3COCH_2CHO
(c) $CH_3COCH_2COCH_3$ (d) 

14. Two labels sticked upon the two bottles containing conc. H_2SO_4 are shown below :

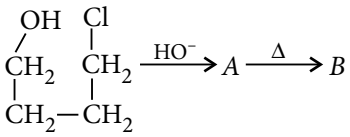
A : Conc. H_2SO_4, (90% by volume), Density = 1.98 g/mL

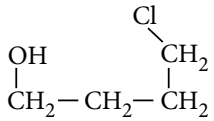
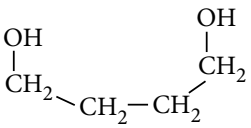
B : Conc. H_2SO_4, (93% by volume), Density = 1.84 g/mL

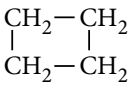
Molalities of acids *A* and *B* respectively are

(a) 8.5, 10.4 (b) 10.4, 8.5
(c) 4.2, 5.2 (d) 5.2, 4.2

15. Major product '*B*' in the following reaction will be



(a)  (b) 

(c)  (d) 

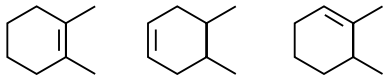
16. How much KOH should be dissolved to prepare one litre of solution having a pH of 12 at 25°C?

(a) 56 g (b) 5.6 g (c) 0.56 g (d) 0.056 g

17. Which of the following statements is true?

(a) In aqueous medium, HF is a stronger acid than HCl.
(b) $HClO_4$ is a weaker acid than $HClO_3$.
(c) HNO_3 is a stronger acid than HNO_2.
(d) H_3PO_5 is a stronger acid than H_2SO_3.

18. Which of the following orders is correct for the ease of electrophilic addition on these alkenes?



I II III

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

19. Which of the following reactions are disproportionation reactions?

(i) $Cu^+ \longrightarrow Cu^{2+} + Cu$

(ii) $3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$

(iii) $2KMnO_4 \longrightarrow K_2MnO_4 + MnO_2 + O_2$

(iv) $2MnO_4^- + 3Mn^{2+} + 2H_2O \longrightarrow 5MnO_2 + 4H^+$

(a) (i), (ii) only (b) (i), (ii), (iii) only
(c) (ii), (iii), (iv) only (d) (i), (iv) only

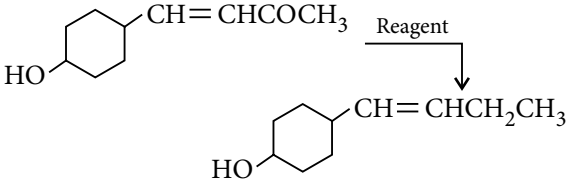
20. In the hardening stage of plaster of Paris, the compound formed is

(a) $CaSO_4$
(b) orthorhombic $CaSO_4 \cdot 2H_2O$
(c) $CaSO_4 \cdot H_2O$
(d) monoclinic $CaSO_4 \cdot 2H_2O$

21. The product obtained when tin is treated with dil. HNO_3 is

(a) NH_4NO_3 (b) H_2SnO_3
(c) $Sn(NO_3)_2$ (d) both (a) and (c).

22. In the given transformation, which of the following is the most appropriate reagent?



(a) Zn-Hg/HCl (b) Na, Liq. NH_3
(c) $NaBH_4$ (d) NH_2NH_2, OH^-

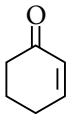
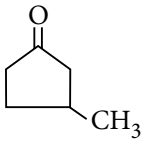
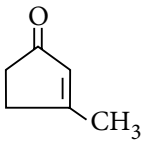
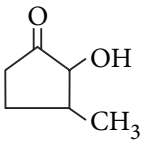
23. For two gases, *A* and *B* with molecular masses M_A and M_B, it is observed that at a certain temperature *T*, the mean velocity of *A* is equal to the root mean square velocity of *B*. Thus, the mean velocity of *A* can be made equal to the mean velocity of *B*, if

(a) *A* is a temperature *T*, and *B* at *T'*, $T > T'$
(b) *A* is lowered to a temperature $T_2 < T$ while *B* is at *T*
(c) both *A* and *B* are raised to a higher temperature
(d) both *A* and *B* are placed at lower temperature.

24. Carbon monoxide is more effective reducing agent than carbon below *T*°C but above this temperature reverse is true. The value of *T* is

(a) 983 (b) 710
(c) 596 (d) 1133

25. The diketone $H_3C-\overset{O}{\overset{\|}{C}}-(CH_2)_2-\overset{O}{\overset{\|}{C}}-CH_3$ on intramolecular aldol condensation gives the product

(a) 
(b) 
(c) 
(d) 

26. An iron cylinder contains helium at a pressure of 250 kPa at 300 K. The cylinder can withstand a pressure of 1×10^6 Pa. The room in which cylinder is placed catches fire. If the melting point of cylinder is 1800 K, then the minimum temperature at which cylinder will burst is
(a) 800 K (b) 1200 K
(c) 1800 K (d) will not burst.

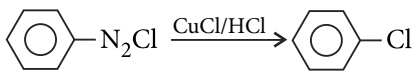
27. Consider the following sequence for extraction of Ag :

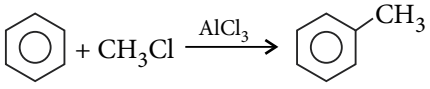
$$(Ag + Pb)\text{ alloy} \xrightarrow[\text{zinc is added}]{\text{Melt and}} (Ag + Pb + Zn)\text{ melt} \xrightarrow{\text{Cool}} \xrightarrow[\text{Layer } Y]{\text{Layer } X}$$

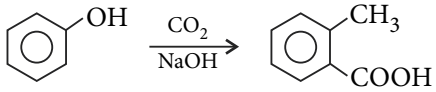
Select the correct statement.
(a) Layer *X* contains Zn and Ag.
(b) Layer *Y* contains Pb and Ag but amount of Ag in this layer is smaller than in layer *X*.
(c) *X* and *Y* are immiscible layers.
(d) All are correct statements.

28. Which of the following is called Sandmeyer reaction?

(a) $2HCHO \xrightarrow{NaOH} CH_3OH + HCOONa$

(b) 

(c) 

(d) 

29. The hypothetical complex triamminediaquachloro cobalt(III) chloride can be represented as
(a) $[Co(NH_3)_3(H_2O)_2Cl]Cl_2$
(b) $[Co(NH_3)_3(H_2O)Cl_3]$
(c) $[Co(NH_3)_3(H_2O)_2Cl]$
(d) $[Co(NH_3)_3(H_2O)_3]Cl_3$

30. For the given sequence of reaction :

$$CH_3CH_2COOH \xrightarrow[\Delta]{Br_2/\text{Red P}} (A) \xrightarrow{\text{alc. } NH_3} (B)$$

the final product (*B*) will be
(a) alanine (b) pyruvic acid
(c) citric acid (d) lactic acid.

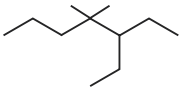
31. Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20×10^{-3} kg of phenol in 1.0 kg of benzene has its freezing point depressed by 0.69 K. Calculate the fraction of phenol dimerised. (K_f for $C_6H_6 = 5.12$ K mol^{-1} kg)
(a) 73.4% (b) 63.3%
(c) 36.7% (d) 26.6%

32. During the process of digestion, the proteins present in food materials are hydrolysed to amino acids. The two enzymes involved in the process,

$$\text{Proteins} \xrightarrow{\text{Enzyme } (A)} \text{Polypeptides} \xrightarrow{\text{Enzyme } (B)} \text{Amino acids}$$

A and *B* respectively are
(a) pepsin and trypsin (b) invertase and zymase
(c) amylase and maltase (d) diastase and lipase.

33. An optically active amine ($C_5H_{13}N$) on treatment with aq. $NaNO_2$/HCl forms an optically inactive alcohol ($C_5H_{12}O$) with evolution of N_2 gas. The amine is
(a) 1-pentanamine (b) 2-pentanamine
(c) 3-pentanamine (d) 2-methylbutanamine.

34. The IUPAC name of  is
(a) 4,4-dimethyl-5-5diethylpentane
(b) 5,5-diethyl-4,4-dimethylpentane
(c) 3-ethyl-4,4-dimethylheptane
(d) 1,1-diethyl-2,2-dimethylpentane.

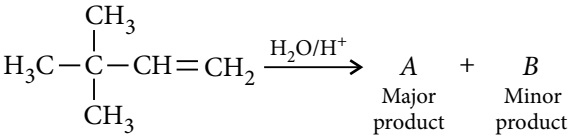
35. Calculate the entropy change when 1 kg of water is heated from 27°C to 200°C forming super-heated steam under constant pressure. Given : specific heat of water = 4180 J/kg - K and specific heat of steam = 1670 + 0.49 *T* J/kg - K (where *T* is absolute temperature) and latent heat of vaporisation = 23×10^5 J/kg.
(a) 7522.5 J (b) 75.22 J
(c) 7.522 J (d) 445.2 J

36. A compound of vanadium has a magnetic moment of 1.73 BM. Choose the correct electronic configuration of the vanadium ion in the compound.

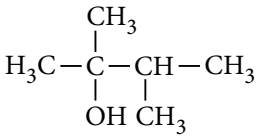
(a) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^2$
(b) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^3$
(c) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^1$
(d) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^0$

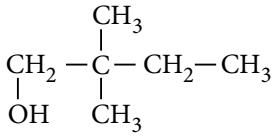
37. Given the polymers,
A = Nylon–6, 6; B = Buna-S; C = Polythene.
Arrange these in increasing order of their intermolecular forces (lower to higher).
(a) $A < B < C$ (b) $C < A < B$
(c) $B < C < A$ (d) $A < C < B$

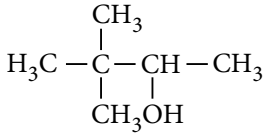
38. In the following reaction,

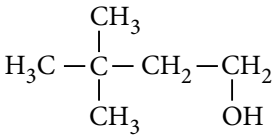


The major product is

(a) 

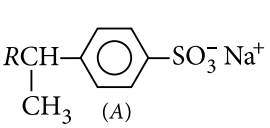
(b) 

(c) 

(d) 

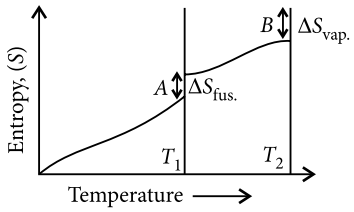
39. For the preparation of a detergent 'A' from benzene, the following steps are involved:

I. $\xrightarrow[\text{HF, Friedel—Crafts}]{RCH=CH_2}$ II. $\xrightarrow{H_2SO_4/SO_3}$

III. $\xrightarrow{NaOH}$ 

These steps should be in sequence
(a) I, II, III (b) II, I, III
(c) II, III, I (d) I, III, II

40. Observe the graph and identify the correct statement.



(a) T_1 is melting point, T_2 is boiling point.
(b) T_1 is boiling point, T_2 is melting point.
(c) ΔS_{fus} is more than $\Delta S_{vap.}$
(d) T_2 is lower than T_1.

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 :** Standard heat enthalpy of diamond is taken as zero.
Reason : In most stable forms, the standard enthalpy of formation is taken as zero.

42. **Assertion :** Melting point of neopentane is higher than that of *n*-pentane but the boiling point of *n*-pentane is higher than that of neopentane.
Reason : Melting point depends upon packing of molecules in the crystal lattice while boiling point depends upon surface area of the molecule.

43. **Assertion :** But-1-ene and 2-methylprop-1-ene are position isomers.
Reason : Position isomers have same molecular formula but different arrangement of carbon atoms.

44. **Assertion :** *p*-Chlorobenzoic acid is stronger than benzoic acid.
Reason : Chlorine has electron donating resonance (+*R*)-effect.

45. **Assertion :** The micelle formed by sodium stearate in water has $-COO^-$ groups at the surface.
Reason : Surface tension of water is reduced by the addition of stearate.

46. **Assertion :** A solution of sucrose in water is dextrorotatory but on hydrolysis in presence of little hydrochloric acid, it becomes laevorotatory.
Reason : Sucrose on hydrolysis gives unequal amounts of glucose and fructose as a result of which change in sign of rotation is observed.

47. **Assertion :** 4^{th} period of periodic table has 8 elements.
Reason : 4^{th} period is related with filling of 4*s* and 4*p*.

48. **Assertion :** $(SiH_3)_3N$ has planar shape while $(CH_3)_3N$ is pyramidal.
Reason : Lone pair of N-atom is used in forming $p\pi$-$d\pi$ bond with Si atom while this bond is not possible with C-atom which does not have *d*-subshell in its valence shell.

49. **Assertion :** 0.1 M NH_4OH at 25°C has less conductance than at 50°C.
Reason : Conductance of a weak electrolyte decreases with increase in temperature.

50. **Assertion :** Coagulating power of Al^{3+} is more than Na^+.
Reason : Greater the valency of the flocculating ion added, greater is its power to cause precipitation.

51. **Assertion :** If edge length of unit cell of LiCl having NaCl type structure is 5.14 Å, the ionic radius of Cl^- ion is 1.82 Å.
Reason : Anion-anion contact is retained in LiCl structure because anions constitute the lattice.

52. **Assertion :** The presence of CO reduces the amount of haemoglobin available in the blood for carrying oxygen to the body cells.
Reason : CO combines with haemoglobin about 200 times less easily than oxygen to form complex.

53. **Assertion :** In the reaction between potassium permanganate and potassium iodide, permanganate ions act as oxidising agent.
Reason : Oxidation state of manganese changes from +2 to +7 during the reaction.

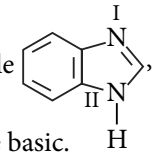
54. **Assertion :** The radius of second orbit of He^+ is equal to that of first orbit of hydrogen.
Reason : The radius of an orbit in hydrogen like species is directly proportional to *n* and inversely proportional to *Z*.

55. **Assertion :** CO_2 molecule is linear.
Reason : Dipole moment of CO_2 is zero.

56. **Assertion :** Superoxides of alkali metals are paramagnetic.
Reason : Superoxides contain the ion O_2^- which has one unpaired electron.

57. **Assertion :** Essential oils are purified by steam distillation.
Reason : Essential oils are volatile and are insoluble in water.

58. **Assertion :** All chemicals added to food items are called food additives.
Reason : All these chemicals increase the nutritive value of the food.

59. **Assertion :** In benzimidazole 

, both the nitrogens N(I) and N(II) are basic.
Reason : Lone pair of electrons present on N(I) is involved in delocalisation.

60. **Assertion :** In rate law, unlike in the expression for equilibrium constants, the exponents for concentrations do not necessarily match the stoichiometric coefficients.
Reason : It is the mechanism and not the balanced chemical equation for the overall change that governs the reaction rate.

SOLUTIONS

1. **(a) :** $k = \frac{2.303}{t}\log\frac{a}{a-x}$

$2.2 \times 10^{-5} = \frac{2.303}{30\times60}\log\frac{a}{a-x}$

$\log\frac{a}{a-x} = \frac{2.2\times10^{-5}\times1800}{2.303} = 0.01719$

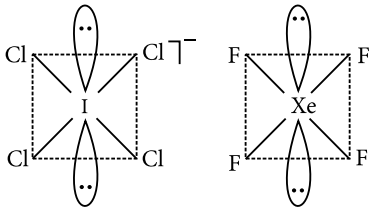
$\frac{a}{a-x}$ = antilog (0.01719) = 1.040

$a = 1.040a - 1.040x$

$0.040a = 1.040\,x$

$\frac{x}{a} = \frac{0.040}{1.040} = 0.038 = 3.8\%$

2. **(d) :** ICl_4^- has four bond pairs and two lone pairs. Therefore, according to VSEPR theory it should be square planar. XeF_4 is also square planar in shape.



3. **(a) :** 96 *M* atoms are associated with 100 O atoms. Out of 96 *M* atoms, suppose *M* present as $M^{2+} = x$
Then, the number of M^{3+} ions will be = 96 – *x*
Total charge on xM^{2+} and $(96 - x)M^{3+}$ should be equal to charge on 100 O^{2-} ions.
$\therefore \quad 2x + 3(96 - x) = 100 \times 2$
$2x + 288 - 3x = 200 \Rightarrow x = 88$

Fraction of M present as $M^{2+} = \frac{88}{96} \times 100 = 91.67\%$

Fraction of M present as $M^{3+} = \frac{(96-88)}{96} \times 100$
$= 8.33\%$

4. (b) : $\frac{1}{4} N_0$ (*i.e.*, $\frac{1}{4}$ mole) atoms require energy = 'X' kJ

$1N_0$ (*i.e.*, 1 mole) atoms require energy = '$4X$' kJ

$\therefore$ 1 atom requires energy = $\frac{4X}{N_0}$ kJ

5. (c) : $\Delta H = \frac{1}{2}\Delta_{diss.}H^\circ + \Delta_{eg}H^\circ + \Delta_{hyd.}H^\circ$

$= \frac{240}{2} + (-349) + (-381) = -610$ kJ mol^{-1}

6. (b) : One Sr^{2+} creates one vacancy at site of Na^+.
100 moles of $Na^+ = 10^{-4}$ mole vacancies

1 mol of $Na^+ = \frac{10^{-4}}{100} \times 6.023 \times 10^{23}$

$= 6.023 \times 10^{17}$ mol^{-1}

7. (c)

8. (d) : $MNO_3 + H_2SO_4 \xrightarrow{\text{Heat}} MHSO_4 + HNO_3$

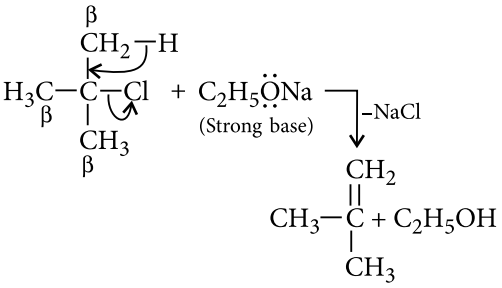
$4HNO_3 \xrightarrow{\text{Heat}} \underset{\substack{\text{Nitrogen dioxide}\\(\text{Brown gas})\\(A)}}{4NO_2} + 2H_2O + O_2$

$\underset{\text{(Copper turnings)}}{Cu} + 4HNO_3 \xrightarrow{\text{Heat}} Cu(NO_3)_2 + 2H_2O + 2NO_2$

$\underset{\substack{(A)\\(\text{Brown gas})}}{2NO_2} \underset{\text{Heat}}{\overset{\text{Cool}}{\rightleftharpoons}} \underset{\substack{(B)\\(\text{Colourless})}}{N_2O_4}$

Hence, $A = NO_2$, $B = N_2O_4$

9. (b) : As sodium ethoxide is a very strong base, hence, elimination reaction predominates over substitution reaction. It is governed by the acidity of β-hydrogen to be eliminated (Hoffmann rule).



10. (c) : Molarity = $\frac{w}{M_B} \times \frac{1000}{V(\text{in mL})}$

$w = \frac{2 \times 63 \times 250}{1000} = \frac{63}{2}$ g

$\because$ 70 g HNO_3 is present in 100 g conc. solution.

$\therefore$ $\frac{63}{2}$ g HNO_3 is present in $\frac{100 \times 63}{70 \times 2} = 45$ g conc. HNO_3 solution.

11. (a) : Both NaOH and HCl are 1 : 1 type of electrolytes. So, the molarity equation is,

$M_{NaOH} \times V_{NaOH} = M_{HCl} \times V_{HCl}$

1.00 mol L^{-1} $\times$ V_{NaOH} = 2.00 mol L^{-1} $\times$ 200 mL

$V_{NaOH} = \frac{2.00 \text{ mol L}^{-1} \times 200 \text{ mL}}{1.00 \text{ mol L}^{-1}} = 400 \text{ mL} = 0.4 \text{ L}$

Amount of NaOH in the given solution
$= M \times V = 1.00 \text{ mol L}^{-1} \times 0.4 \text{ L} = 0.4$ mol

From the reaction stoichiometry,

$\underset{\substack{1 \text{ mol}\\0.4 \text{ mol}}}{NaOH_{(aq)}} + HCl_{(aq)} \longrightarrow \underset{\substack{23 + 35.5 = 58.5 \text{ g}\\58.5 \times 0.4 = 23.4 \text{ g}}}{NaCl_{(aq)}} + H_2O_{(l)}$

In this reaction, 23.4 g of sodium chloride will be formed.

12. (c) : $Fe^{2+} + Ag^+ \rightleftharpoons Fe^{3+} + Ag$

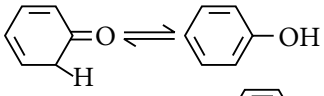
$E_{cell} = E^\circ_{cell} - \frac{0.059}{1} \log \frac{[Fe^{3+}]}{[Fe^{2+}][Ag^+]}$

$E^\circ_{cell} = E^\circ_{(Ag^+|Ag)} - E^\circ_{(Fe^{3+}|Fe^{2+})}$
$= 0.799 - 0.771 = 0.028$ V

For $E_{cell} = 0$, $[Fe^{2+}] = [Fe^{3+}]$

$0 = 0.028 - \frac{0.059}{1} \log \frac{1}{[Ag^+]}$

$\therefore$ $[Ag^+] = 0.335$ M

13. (d) : 

After enolisation of 

, an aromatic compound is formed which is most stable among the products formed in rest three. Hence, (d) shows maximum enolisation.

14. (a) : For acid A;
$w_{acid} = 90$ g, $V_{solution} = 100$ mL,
$d = 1.98$ g/mL, $W_{solution} = 1.98 \times 100 = 198$ g

$\therefore$ $m = \frac{w_{acid}}{M_{acid}} \times \frac{1000}{W_{water(g)}} = \frac{90}{98} \times \frac{1000}{(198-90)}$

$= 8.50$ m

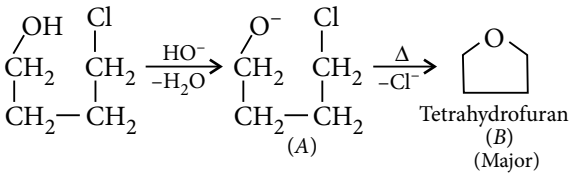
For acid B ;

$w_{acid} = 93$ g, $V_{solution} = 100$ mL,

$d = 1.84$ g/mL, $W_{solution} = 1.84 \times 100 = 184$ g

$$m = \frac{w_{acid}}{M_{acid}} \times \frac{1000}{W_{water(g)}} = \frac{93}{98} \times \frac{1000}{(184-93)} = 10.4 \text{ m}$$

15. (c) : The given reaction is cyclic Williamson's ether synthesis involving S_N2 reaction.



16. (c) : KOH is a strong alkali and is completely dissociated into the constituent ions,

$KOH + H_2O(excess) \longrightarrow K^+_{(aq)} + OH^-_{(aq)}$

In a solution having pH = 12, the hydrogen ion concentration is written by the equation,

$pH = -\log[H^+]$

$12 = -\log[H^+]$

$[H^+] = 10^{-12}$ mol L^{-1}

Since the ionic product of water should have a fixed value hence, at 25°C $K_w = 1.0 \times 10^{-14}$

So, $1.0 \times 10^{-14} = [H^+][OH^-]$

This gives, $[OH^-] = \frac{1.0 \times 10^{-14}}{10^{-12}} = 1.0 \times 10^{-2}$ mol L^{-1}

Since KOH is completely dissociated, hence

$[K^+] = [OH^-] = 1.0 \times 10^{-2}$ mol L^{-1}

Molar mass of KOH = (39 + 16 + 1) g mol^{-1}

= 56 g mol^{-1}

Then, conc. of KOH = 1.0×10^{-2} mol $L^{-1} \times 56$ g mol^{-1}

= 0.56 g L^{-1}

Thus, 0.56 g of KOH should be dissolved per litre of the solution to obtain a solution of pH 12.

17. (c) : The order of acidic strength are :

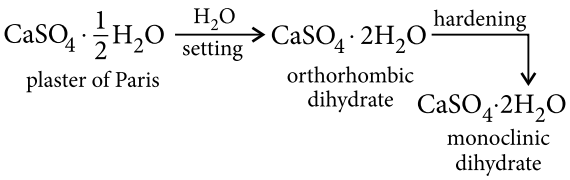
$HCl > HF$; $HClO_4 > HClO_3$; $HNO_3 > HNO_2$;

$H_2SO_3 > H_3PO_5$.

18. (c) : Electrophile approaches easily to electron releasing group, substituted π-electron cloud. Hence, electrophilic addition is carried out rapidly on that sight. Hence, correct order is I > III > II.

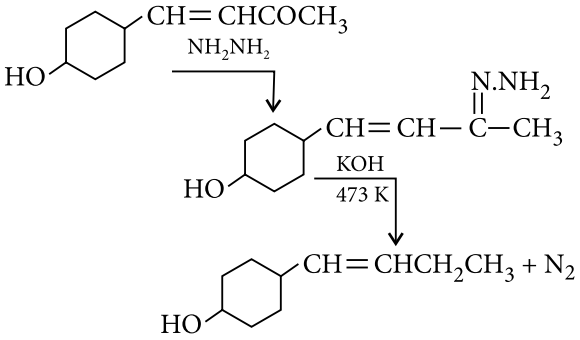
19. (a)

20. (d) : The process of setting of plaster of Paris is described by the following reaction,



21. (d) : $4Sn + 10HNO_3 \xrightarrow[\text{dil.}]{} 4Sn(NO_3)_2 + NH_4NO_3 + 3H_2O$

22. (d) : This is Wolff-Kishner reduction, is used when the carbonyl compound shows acidic character.



23. (b) : $(u_{av})_A = \sqrt{\frac{8RT}{\pi M_A}}$; $(u_{rms})_B = \sqrt{\frac{3RT}{M_B}}$

$\therefore \quad \frac{8}{3\pi} = \frac{M_A}{M_B}$

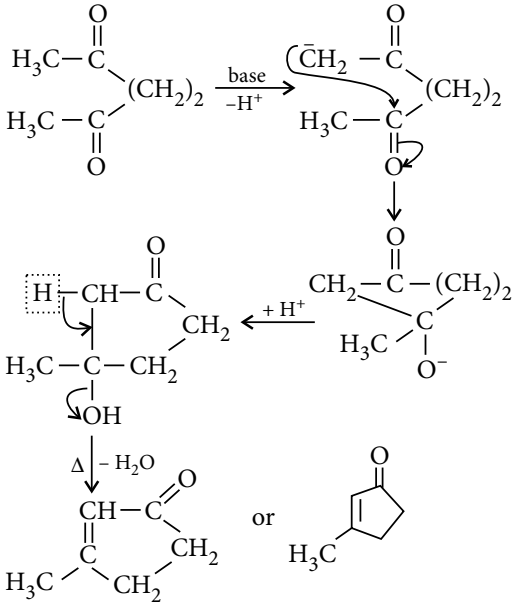
For $(u_{av})_A = \sqrt{\frac{8RT_2}{\pi M_A}}$; $(u_{av})_B = \sqrt{\frac{8RT}{\pi M_B}}$

$\frac{T_2}{T} = \frac{M_A}{M_B} = \frac{8}{3\pi}$

$\therefore \quad T_2 = \frac{8}{3\pi} . T$ or $T_2 < T$

24. (b)

25. (c) :



26. (b) : According to Gay-Lussac's law,

$$\frac{P_1}{T_1}=\frac{P_2}{T_2} \qquad (n, V \text{ constant})$$

Given that, $P_1 = 250$ kPa; $T_1 = 300$ K,

$P_2 = 1 \times 10^6$ Pa; $T_2 = ?$

$$\frac{250\times10^3}{300}=\frac{1\times10^6}{T_2} \Rightarrow T_2 = 1200 \text{ K}$$

Thus, cylinder will burst at 1200 K before it attains its melting point (1800 K).

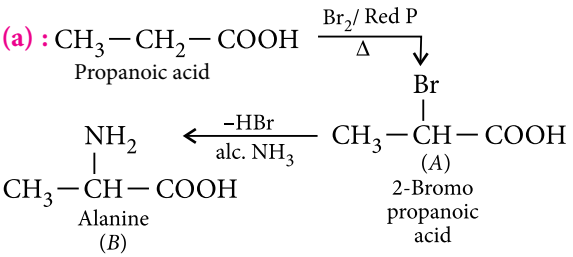
27. (d) : Ag is extracted from argentiferrous lead by Parke's process where Zn and Pb in molten state are immiscible and form separate layers, zinc being lighter forms upper layer (X). Ag is soluble in both but more soluble in upper layer. So, all the statements are correct.

28. (b) : Sandmeyer reaction :

$$C_6H_5\overset{+}{N}_2\overset{-}{Cl} \xrightarrow[HCl]{CuCl} C_6H_5Cl + N_2$$

29. (a)

30. (a) :



31. (a) : For the depression in freezing point,

$$\Delta T_f = \frac{1000\times K_f \times w}{W \times M_{exp.}}$$

$$\therefore \quad 0.69 = \frac{1000\times5.12\times20\times10^{-3}}{M_{exp.}\times1}$$

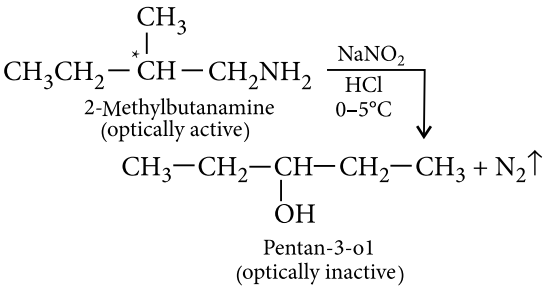
$$\therefore \quad M_{exp} = 148.41 \qquad (M_{normal} \text{ of phenol} = 94)$$

$$\text{van't Hoff factor } (i) = \frac{M_{nor.}}{M_{exp.}} = 1-\alpha+\frac{\alpha}{2}$$

$$\frac{M_{nor.}}{M_{exp.}} = \frac{94}{148.41} = 1-\alpha+\frac{\alpha}{2} \Rightarrow \alpha = 0.734 \text{ or } 73.4\%$$

32. (a)

33. (d) : Since the amine ($C_5H_{13}N$) on treatment with aq. $NaNO_2$/HCl evolves N_2 gas, it must be a 1° amine. Since, the amine is optically active, the $-NH_2$ group cannot be attached to a chiral centre because it will rapidly undergo racemisation due to nitrogen inversion. Therefore, the carbon skeleton must contain a chiral centre. In other words, the amine is 2-methylbutanamine. The reaction looks like,



34. (c)

35. (a) : $\Delta S_p = 2.303\ n \times C_p \times \log\frac{T_2}{T_1}$

Entropy change for heating water from 27°C to 100°C;

$$\Delta S_p = 2.303 \times \frac{1000}{18}\times\frac{4180\times18}{1000}\log\frac{373}{300} = 910.55 \text{ J}$$

Entropy change for heating 1 kg H_2O to 1 kg steam at 100°C;

$$\Delta S = \frac{\Delta H_v}{T} = \frac{23\times10^5}{373} = 6166.21 \text{ J}$$

Entropy change for heating 1 kg steam from 373 to 473 K;

$$\Delta S = \int_{373}^{473}\frac{nC_p\cdot dT}{T} = m\int_{373}^{473}\frac{(1670+0.49T)}{T}dT$$

$= 396.73 + 49 = 445.73$ J, where m = mass in kg

Total entropy change = 910.55 + 6166.21 + 445.73

= 7522.50 J

36. (c) : Magnetic moment (μ) = $\sqrt{n(n+2)}$ BM

(n = number of unpaired electrons)

Given that, $\mu = 1.73$ BM.

$$\therefore \quad 1.73 = \sqrt{n(n+2)} \Rightarrow n^2 + 2n - (1.73)^2 = 0$$

On solving this equation we get, $n = 1$

So, vanadium atom must have one unpaired electron and thus its configuration is

$$_{23}V^{4+} : 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^1$$

37. (c) : Buna-S is an elastomer, thus has weakest intermolecular forces. Nylon-6,6, is a example of fibres, thus has strong intermolecular forces like H-bonding. Polythene is a thermoplastic polymer, thus the intermolecular forces present in polythene are inbetween elastomer and fibres. Thus, the order of intermolecular forces of these polymers is

Buna-S < Polythene < Nylon-6,6 *i.e.*, $B < C < A$

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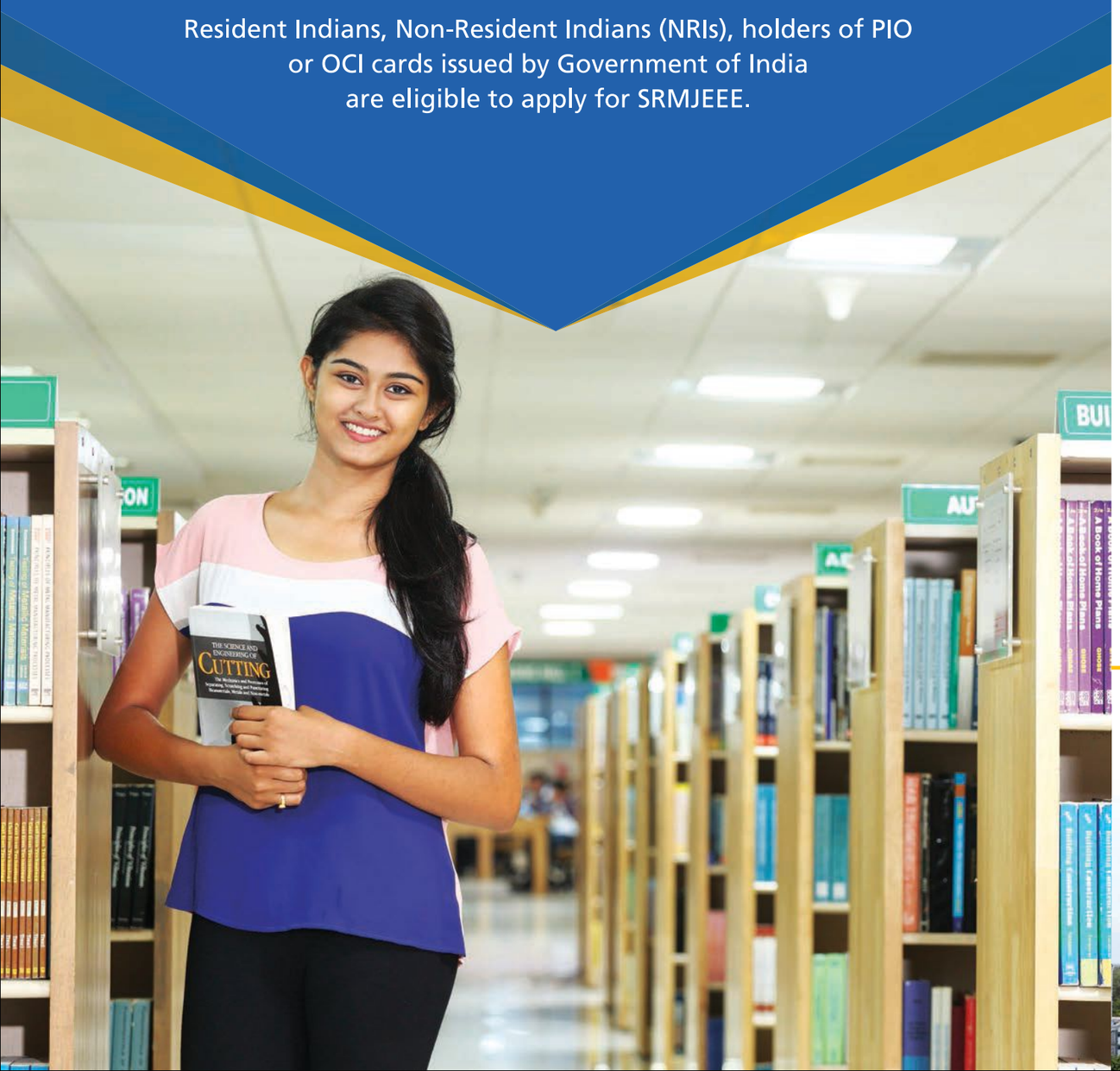

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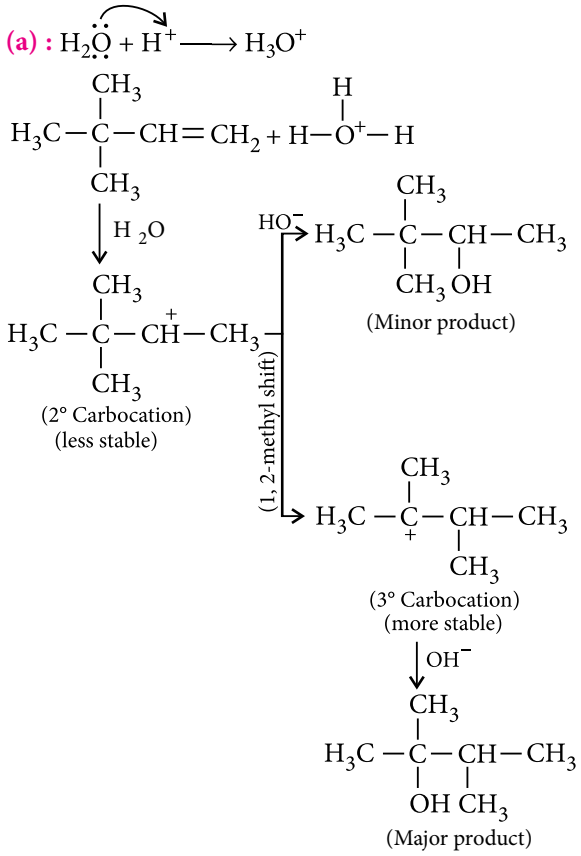
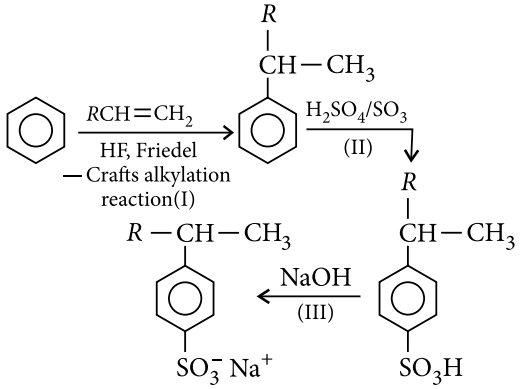
38. (a) :



39. (a) :



40. (a) : T_1 is melting point at which entropy change is entropy of fusion. T_2 is boiling point at which entropy change is entropy of vaporisation.

41. (c) : Graphite is thermodynamically stable form of carbon at STP, so its standard enthalpy is zero, not of diamond.

42. (a)

43. (d) : But-1-ene and 2-methylprop-1-ene are chain isomers. Chain isomers have same molecular formula but different arrangement of carbon atoms.

44. (b) : Chlorine has both +*R*-effect and –*I* effect but –*I* effect outweighs +*R*-effect. –*I* effect of chlorine atom disperses the –ve charge on the benzoate anion and thus, makes *p*-chlorobenzoate anion more stable. As a result, *p*-chlorobenzoic acid is a stronger acid than benzoic acid.

45. (b) **46. (c)**

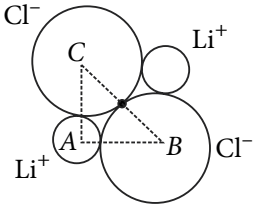
47. (d) : 4th period has 18 elements. Filling of 4th period is related with 4*s*, 3*d* and 4*p*.

48. (a)

49. (c) : Conductance increases with increasing temperature of a weak electrolyte.

50. (a)

51. (a) : If anion-anion contact retained, then according to the figure,



Interionic distance of LiCl

$= \frac{a}{2} = \frac{5.14\,\text{Å}}{2} = 2.57$ Å

$BC = \sqrt{AB^2 + AC^2} = \sqrt{(2.57)^2 + (2.57)^2} = 3.63$ Å

Radius of Cl^- ion $= \frac{1}{2}BC = \frac{1}{2} \times 3.63 = 1.82$ Å

52. (c)

53. (c) : $2\overset{+7}{K}\overset{+7}{Mn}O_4 + 6KI \longrightarrow 2\overset{+4}{Mn}O_2 + 3I_2 + 4K_2O$

54. (d) : The radius of second orbit of He^+ is twice that of the first orbit of hydrogen. Bohr expression for radius of the electron in a particular orbit for hydrogen and hydrogen like species is

$$r_n = \frac{n^2h^2}{4\pi^2 mZe^2}$$

55. (a) : $O \overset{\leftrightarrow}{=} C \overset{\leftrightarrow}{=} O$, resultant dipole moment (μ) = 0. This shows that CO_2 is a linear molecule.

56. (a) **57. (a)**

58. (d) : Only those chemicals which are added to food to improve its storing qualities, appearance, taste, odour and food value are called food additives. Preservatives do not increase the nutritive value of food.

59. (d) : Both the nitrogens are not basic. Only the lone pair of electrons on N(II) are involved in delocalisation.

60. (a)

CONCEPT MAP

PERIODICITY IN PROPERTIES

The basic object of classification is to arrange the facts regarding elements and their compounds in such a way so that we may have greatest control over their characteristics with least possible effort. The repetition of similar physical and chemical properties of elements after regular intervals is known as periodicity in properties.

Class XI

Periodicity in Physical Properties

Ionic Radius

- Across a period : The ionic radii of ions having same charge decreases as atomic number increases.
- Down a group : Increases

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$(Cations)

$F^- < Cl^- < Br^- < I^-$(Anions)

- Cationic radius < Atomic radius < Anionic radius (For isoelectronic species)
- Z/e ratio increases, size decreases and vice-versa.

Atomic Volume

- Across a period : First decreases and then increases.

	Li	Be	B	C	N	O	F	Ne
(cc/mol)	13	5	5	5	14	11	15	17

- Down a group : Increases

	Li	Na	K
(cc/mol)	13	24	46

Density

- Across a period : First increases and then decreases.

	Na	Mg	Al	Si	P	S
(g/cm^3)	1.0	1.7	2.7	2.3	1.8	2.1

- Down a group : Decreases

Be(1.8) , Mg(1.7)

- Highest density solid : Os (22.6)
- Highest density liquid : Hg (13.6)

Electron Gain Enthalpy

- Across a period : More negative

	Li	Be	B	C	N	O	F
(kJ/mol)	–60	+66	–83	–122	+31	–141	–328

- Down a group : Less negative

	H	Li	Na	K	Rb	Cs
(kJ/mol)	–73	–60	–53	–48	–47	–46

Atomic Radius

- Across a period : Decreases

$\text{Atomic radius} \propto 1/Z_{\text{eff}}$

Li > Be > B > C > N > O > F

- Down a group : Increases

H < Li < Na < K < Rb < Cs

- van der Waals' radius > Metallic radius > Covalent radius

Electronegativity

- Across a period : Increases

Li < Be < B < C < N < O < F

- Down a group : Decreases

H > Li > Na > K = Rb > Cs

- F is most electronegative element.

Ionic Character

- Across a period : First decreases and then increases.
- Down a group : Increases

Metallic Character

- Across a period : Decreases
- Down a group : Increases

Ionisation Enthalpy

- Across a period : Increases

Li < Be > B < C < N > O < F

- Down a group : Decreases

H > Li > Na > K > Rb > Cs

Melting and Boiling Points

- Across a period : M.pt. and B.pt. first increase and then decrease.

Element :	Na	Mg	Al	Si	P	S
M.pt. (K):	370.8	924	933	1693	317	392
B.pt. (K) :	1165	1396	2075	2815	557	717.6

- Down a group : They do show regular gradation but pattern of variation is different in different groups.

Element :	Li	Na	K	Rb	Cs
M.pt. (K) :	454	370.8	335	312	302
B.pt. (K) :	1609	1165	1063	973	943

Periodicity in Chemical Properties

Valency

- Across a period : Increases

$NaH < MgH_2 < AlH_3 < SiH_4$

- Down a group : Same

Reducing Nature

- Across a period : Decreases
- Down a group : Increases

Oxidising Nature

- Across a period : Increases
- Down a group : Decreases

Strength of Oxyacids

- Across a period : Increases

$H_3BO_3 < H_2CO_3 < HNO_3$

- Down a group : Decreases

$HNO_3 > H_3PO_4 > H_3AsO_4$

Acidity of Oxides

- Across a period : Increases

$Na_2O < MgO < Al_2O_3 < SiO_2 < P_2O_5 < SO_3 < Cl_2O_7$

- Down a group : Decreases

$N_2O_3 > P_2O_3$

Acidity of Hydrides

- Across a period : Increases

$CH_4 < NH_3 < H_2O < HF$

- Down a group : Increases

$HF < HCl < HBr < HI$

HALOGEN DERIVATIVES

Class XII

The substitution of chlorine atoms into a molecule of alkane results in a compound with anaesthetic properties *e.g.*, chloroform. Increasing the number of chlorine atoms in the compounds increases the depth of anaesthesia given but also increases toxicity. C–F bonds are very stable so their presence leads to non-flammable and unreactive properties. Organofluorine compounds find diverse applications from oil to water repellents to pharmaceuticals, refrigerants and reagents in catalysts.

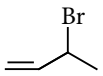
CONCEPT MAP

Halogen Derivatives

When C—*X* carbon is sp^3 hybridised.

Allylic

$C=C-C-X$

e.g., 

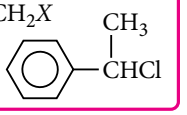
Alkyl

$C_nH_{2n+1}X$

e.g., $CH_3CH_2CH_2Cl$

Benzylic

$C_6H_5CH_2X$

e.g., 

When C—*X* carbon is sp^2 hybridised.

Vinylic

$C=C-X$

e.g., $CH_2=CH-Cl$

Aryl

Halogen is directly attached to the carbon atom of aromatic ring, *e.g.*, C_6H_5Cl

Methods of Preparation

(i) Direct halogenation of alkanes:

Free radical mechanism:

$R-H + X_2 \xrightarrow{h\nu} R-X + HX$

Reactivity order:

Allylic > 3° > 2° > 1° > CH_4

(ii) Addition of HX to alkenes:

$CH_2=CH_2 + HBr \longrightarrow CH_3CH_2Br$

- Unsymmetrical alkenes follow Markovnikov's rule during electrophilic addition.
- If the addition occurs in presence of peroxide, the product will be opposite to Markovnikov's addition (free radical mechanism).

Reactivity order:

HI > HBr > HCl > HF

(iii) From alcohols:

$3R-OH + PX_3 \rightarrow 3R-X + H_3PO_3$

$R-OH + HX \longrightarrow R-X + H_2O$

$R-OH + SOCl_2 \longrightarrow RCl + SO_2\uparrow + HCl\uparrow$

[Darzen's method]

(iv) Hunsdiecker reaction:

$RCOOAg + Br_2 \xrightarrow[\text{reflux}]{CCl_4} R-Br + CO_2 + AgBr$

(v) Finkelstein reaction:

$R-X + NaI \xrightarrow{\text{Dry acetone}} R-I + NaX$

Uses of Some Commercially Important Halogen Derivatives

(i) Chloroform ($CHCl_3$):
- Earlier it was used as anaesthetic but due to its harmful effects it is no longer used for the purpose.
- Used for preparation of chloretone and chloropicrin.
- Used as a solvent for fats, waxes, rubber, resins, etc.

(ii) Iodoform (CHI_3):
- Used as disinfectant.
- Effective as chemical antiseptic.

(iii) Freons or chlorofluorocarbons:
- Used as refrigerants.
- Used as propellant in aerosols such as body spray, hair spray, cleansers, etc.

(iv) DDT:
- Used as a powerful insecticide.
- Effective against *Anopheles* mosquitoes which spread malaria.

(v) Teflon ($-CF_2-CF_2-)_n$:
- Used as non-stick coating for pans and other cookwares.
- Used in containers and pipework for corrosive chemicals.

(i) Reduction:

$R-X + 2[H] \xrightarrow{\text{Ni or Pd}} R-H + HX$

(ii) Wurtz reaction:

$2R-X + 2Na \xrightarrow{\text{Dry ether}} R-R + 2NaX$

(iii) Reaction with metals:

$R-X + Mg \xrightarrow{\text{Dry ether}} \underset{\text{(Grignard reagent)}}{R-MgX}$ (Powder)

$2R-X + 2Zn \xrightarrow{\text{Ether}} R_2Zn + ZnX_2$

$4C_2H_5Br + 4Pb/Na \xrightarrow[\text{sod. lead alloy}]{\text{Dry ether}} \underset{\text{Tetraethyl lead}}{(C_2H_5)_4Pb} + 4NaBr + 3Pb$

(iv) Corey-House reaction:

$R_2CuLi + R'X \longrightarrow R-R' + R-Cu + LiX$

(This reaction can be used to prepare unsymmetrical alkanes.)

(v) Oxidation:

$\underset{\text{1° Alkyl halide}}{R-CH_2X} \xrightarrow{DMSO} \underset{\text{Aldehyde}}{R-\overset{O}{\overset{\|}{C}}-H}$

$\underset{\text{2° Alkyl halide}}{R-\overset{X}{\underset{|}{CH}}-R} \xrightarrow{DMSO} \underset{\text{Ketone}}{R-\overset{O}{\overset{\|}{C}}-R}$

Chemical Properties

Elimination Reactions

(i) Dehydrohalogenation:

$R-CH_2-CH_2-X \xrightarrow{\text{alc. KOH}} R-CH=CH_2$

- Elimination follows the Saytzeff's rule.
- Ease of dehydrohalogenation:

Tertiary > Secondary > Primary

(ii) Action of heat:

$R-CH_2CH_2X \xrightarrow{573\ K} R-CH=CH_2$

Nucleophilic Substitution Reactions

S_N1
- First order kinetics
- Reactivity: 3° > 2° > 1° > CH_3X

S_N2
- Second order kinetics
- Reactivity: CH_3X > 1° > 2° > 3°

(I) Hydrolysis with alkalies:

$RX + AgOH \longrightarrow \underset{\text{(moist)}}{ROH} + AgX$

$R-X \xrightarrow[KOH]{\text{aq.}} R-OH + KX$

(ii) Williamson's synthesis:

$R-X + NaOR' \xrightarrow{\text{Heat}} ROR' + NaX$

(iii) $R-X + KCN \xrightarrow{\text{alc.}} KX + RCN \xrightarrow[\text{conc. HCl}]{H_3O^+} RCONH_2 \xrightarrow[\text{conc. HCl}]{H_3O^+} RCOOH + NH_3$

(iv) $R-X + AgCN \xrightarrow[\Delta]{C_2H_5OH/H_2O} R-N\rightleftharpoons C \xrightarrow[\text{or } LiAlH_4]{Na/C_2H_5OH} R-CH_2NH_2$

$R-N\rightleftharpoons C \xrightarrow{SnCl_2/HCl} R-CH=NH\cdot HCl \xrightarrow{H_3O^+} R-CHO + NH_4Cl$

Miscellaneous Reactions

(See Oxidation under Methods of Preparation)

MPP MONTHLY Practice Paper

Class XII

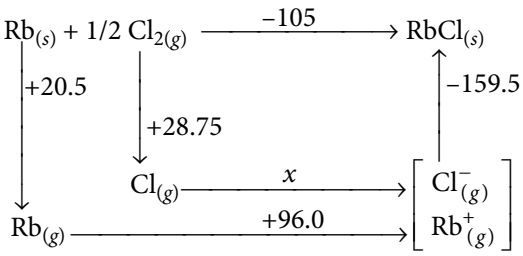
This specially designed column enables students to self analyse their extent of understanding of complete syllabus. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120 **Time Taken : 60 Min.**

NEET / AIIMS

Only One Option Correct Type

1. The Born Haber cycle for rubidium chloride (RbCl) is given below (the energies are in kcal/mol^{-1})



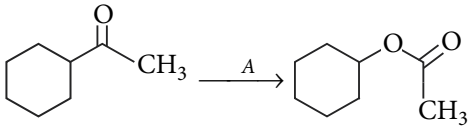
What is the electron affinity of chlorine?

(a) −105 kcal/mol (b) −90.75 kcal/mol
(c) 14.5 kcal/mol (d) 25.75 kcal/mol

2. Which of the following is correct?

(a) Duralumin : Al + Cu + Mg + Ag
(b) German silver : Cu + Zn + C
(c) Gun metal : Cu + Zn + Sn
(d) Solder : Pb + Al

3. The most suitable reagent '*A*', for the reaction



is

(a) O_3
(b) H_2O_2
(c) NaOH-H_2O_2
(d) *m*-Cl–(C_6H_4COOOH)

4. An organic compound having molecular mass 60 is found to contain C = 20%, H = 6.67% and N= 46.67% while rest is oxygen. On heating, it gives NH_3 along with a solid residue. The solid residue gives violet colour with alkaline copper sulphate solution. The compound is

(a) CH_3CONH_2 (b) CH_3NCO
(c) $CH_3CH_2CONH_2$ (d) $(NH_2)_2CO$

5. The cubic unit cell of Al (molar mass = 27 g mol^{-1}) has an edge length of 405 pm and density 2.7 g cm^{-3}. The cubic unit cell is

(a) body centred (b) primitive
(c) edge centred (d) face centred.

6. A reaction was observed for 15 days and the percentage of the reactant remaining after the days indicated was recorded in the following table :

Time (days)	% Reactant remaining
0	100
2	50
4	39
6	25
8	21
10	18
12	15
14	12.5
15	10

Which one of the following best describes the order and half-life of the reaction?

	Reaction order	Half-life (days)
(a)	First	2
(b)	First	6
(c)	Second	2
(d)	Zero	6

7. The number of possible enantiomeric pairs that can be produced during mono-chlorination of 2-methylbutane is

(a) 3 (b) 4 (c) 1 (d) 2

8. The degree of dissociation (α) of a weak electrolyte, A_xB_y is related to van't Hoff factor (i) by the expression

(a) $\alpha = \frac{x+y-1}{i-1}$ (b) $\alpha = \frac{x+y+1}{i-1}$

(c) $\alpha = \frac{i-1}{(x+y-1)}$ (d) $\alpha = \frac{i-1}{x+y+1}$

9. The coagulation values in millimoles per litre of the electrolytes used for the coagulation of As_2S_3 are given below :

I. NaCl = 52

II. $BaCl_2$ = 0.69

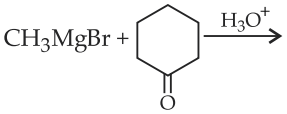
III. $MgSO_4$ = 0.22

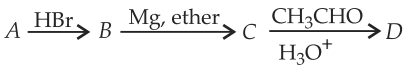
The co rect order of their coagulating power is

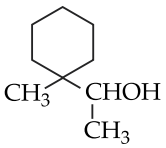
(a) I > II > III (b) II > I > III

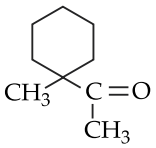
(c) III > II > I (d) III > I > II

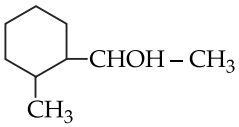
10. In the following sequence of the reactions, identify the final product *D*.

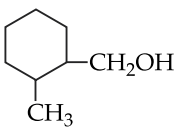




(a) 

(b) 

(c) 

(d) 

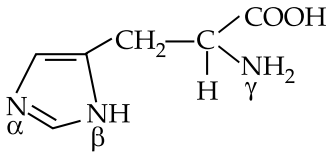
11. Pick out the incorrect statements from the following.

1. Glucose exists in two different crystalline forms, α-*D*-glucose and β-*D*-glucose.
2. α-*D*-glucose and β-*D*-glucose are anomers.
3. α-*D*-glucose and β-*D*-glucose are enantiomers.
4. Cellulose is a straight chain polysaccharide made of only β-*D*-glucose units.
5. Starch is a mixture of amylose and amylopectin, both contain unbranched chain of α-*D*-glucose units.

(a) 1 and 2 only (b) 2 and 3 only

(c) 3 and 4 only (d) 3 and 5 only

12. When the imidazole ring of histidine is protonated, the tendency of nitrogen to be protonated (proton migrates from –COOH) is in the order



(a) $\beta > \gamma > \alpha$ (b) $\gamma > \beta > \alpha$

(c) $\gamma > \alpha > \beta$ (d) $\beta > \alpha > \gamma$

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 :** A mixture of 2-nitrophenol and 4-nitrophenol can be separated by steam distillation.

Reason : 2-Nitrophenol is intramolecularly H-bonded while 4-nitrophenol is intermolecularly H-bonded.

14. **Assertion :** Chloroform is stored in dark coloured bottles.

Reason : Chronic chloroform exposure may cause damage to liver and kidneys.

15. **Assertion :** Hydrometallurgy involves dissolving the ore in a suitable reagent followed by precipitation by a more electropositive metal.

Reason : Copper in bulk quantity is extracted by hydrometallurgy.

JEE MAIN / JEE ADVANCED / PETs

Only One Option Correct Type

16. 0.001 mol of cobalt complex having molecular formula represented by $Co(NH_3)_5(NO_3)(SO_4)$ was passed through a cation exchanger (RSO_3H) and the acid coming out of it, was titrated with 0.1 M NaOH solution. For complete neutralisation of acid coming out of cation exchanger, the volume of NaOH required was 20.00 mL. From the above data we can say that the complex can be represented as
(a) $[Co(NH_3)_5](NO_3)(SO_4)$
(b) $[Co(NH_3)_5SO_4]NO_3$
(c) $[Co(NH_3)_5NO_3]SO_4$
(d) none of the above.

17. What is the dominant intermolecular force or bond that must be overcome in converting liquid CH_3OH to a gas?
(a) Dipole-dipole interactions
(b) Covalent bonds
(c) London-dispersion forces
(d) Hydrogen bonding

18. Calculate the amount of ice that will separate out on cooling a solution containing 50 g of ethylene glycol in 200 g of water to –9.3°C.
(K_f for water = 1.86 K m^{-1})
(a) 161.29 g (b) 38.71 g
(c) 54.12 g (d) 77.42 g

19. The incorrect statements among the following are
I. NCl_5 does not exist while PCl_5 does.
II. Lead prefers to form tetravalent compounds.
III. The three C—O bonds are not equal in carbonate ion.
IV. Both O_2^+ and NO are paramagnetic.
(a) I, III and IV only (b) I and IV only
(c) II and III only (d) I and III only

More than One Options Correct Type

20. The carbon based reduction method is not used for extraction of
(a) Sn from SnO_2
(b) Fe from Fe_2O_3
(c) Al from Al_2O_3
(d) Mg from $MgCO_3.CaCO_3$

21. For the cell, $Tl|Tl^+$ (0.001 M)$||Cu^{2+}$(0.1 M)$|Cu$, E_{cell} at 25°C is 0.826 V. The EMF can be increased
(a) by increasing $[Tl^+]$
(b) by decreasing $[Tl^+]$
(c) by increasing $[Cu^{2+}]$
(d) by decreasing $[Cu^{2+}]$.

22. Which of the following reagents can be used to oxidise primary alcohols to aldehydes?
(a) CrO_3 in anhydrous medium
(b) $KMnO_4$ in acidic medium
(c) Pyridinium chlorochromate
(d) Heat in the presence of Cu at 573 K

23. In a hypothetical reaction $X \longrightarrow Y$, the activation energy for the forward and the backward reactions are 15 and 9 kJ mol^{-1} respectively. The potential energy of X is 10 kJ mol^{-1}. Then
(a) threshold energy of the reaction is 25 kJ
(b) the potential energy of Y is 16 kJ
(c) heat of reaction is 6 kJ
(d) the reaction is endothermic.

Integer Answer Type

24. The maximum covalency shown by Be is

25. For the Mg- Ag cell, how many times the difference between the EMF of the cell and its standard EMF will change if concentration of Mg^{2+} ions is changed from 0.1 M to 0.01 M and that of Ag^+ ions is changed from 0.5 M to 0.25 M?

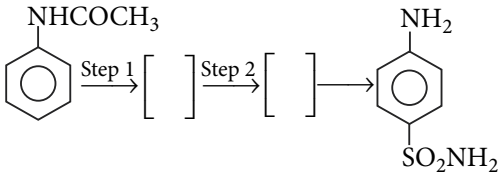
EXAM DATES 2017	
SRMJEEE	1st April to 30th April (Online)
JEE MAIN	2nd April (Offline)
	8th & 9th April (Online)
VITEEE	5th April to 16th April (Online)
NATA	16th April
WBJEE	23rd April
Kerala PET	24th April (Physics & Chemistry)
	25th April (Mathematics)
AMU (Engg.)	30th April
Karnataka CET	2nd May (Biology & Mathematics)
	3rd May (Physics & Chemistry)
NEET	7th May
MHT CET	11th 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
JIPMER	4th June

26. In a *fcc* lattice of X and Y, X atoms are present at the corners while Y atoms are present at the face centres. If one of the X atom from a corner is replaced by monovalent Z atom, then the formula of compound is given as X_aY_bZ. Here a is

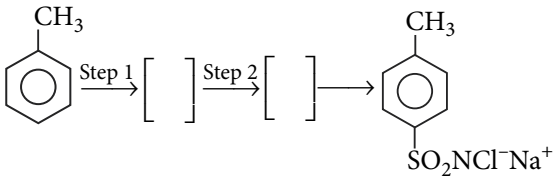
Comprehension Type

Understand carefully the following two reactions and answer the questions given below :

Reaction (i)



Reaction (ii)



27. Which of the steps is common in the two reactions?
(a) 1st step
(b) 2nd step
(c) Both the steps
(d) None of the steps

28. Which of the final products are medicinally important?
(a) Product from reaction (i)
(b) Product from reaction (ii)
(c) Product from both reactions
(d) None of the above

Matrix Match Type

29. Match the compounds given in Column I with their shapes in Column II.

	Column I		**Column II**
(A)	XeO_3	(P)	Trigonal pyramidal
(B)	$XeOF_4$	(Q)	Linear
(C)	BO_3^{3-}	(R)	Square pyramidal
(D)	$I_{3\,(aq)}^-$	(S)	Trigonal planar

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

30. Match the reactions given in Column I with the steps involved in mechanism in Column II.

	Column I		**Column II**
(A)	Benzaldehyde reacts with methanal in presence of NaOH to give benzyl alcohol and sodium methanoate.	(P)	Acidic nature of α-hydrogens
(B)	Propanone reacts with $Ba(OH)_2$ to form 4-hydroxy-4-methylpentan-2-one.	(Q)	Hydride transfer
(C)	Iodoform is produced when butanone is treated with NaOI.	(R)	Halogenation
(D)	Carboxylic acids containing α-hydrogen(s) on treatment with Br_2 in presence of red P give α-haloacids.	(S)	Nucleophilic addition

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

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Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

CHEMISTRY MUSING

SOLUTION SET 44

1. (d) : Bond energy per molecule of $I_2 = \frac{240\times1000}{6.022\times10^{23}}$ J

$= 3.985 \times 10^{-19}$ J

Energy absorbed $= \frac{hc}{\lambda} = \frac{6.626\times10^{-34}\times3\times10^{8}}{4500\times10^{-10}}$

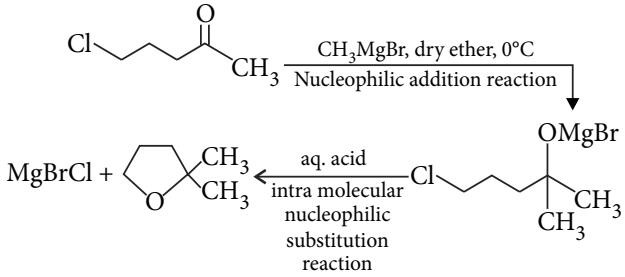
$= 4.417 \times 10^{-19}$ J

$\therefore$ *K.E.* of one I_2 molecule $= (4.417\times10^{-19} - 3.985\times10^{-19})$ J

$= 4.32 \times 10^{-20}$ J

K.E. of one I atom $= \frac{4.32\times10^{-20}}{2} = 2.16 \times 10^{-20}$ J

2. (d) : Nucleophilic addition reaction to carbonyl compound takes place followed by intramolecular nucleophilic substitution reaction.



3. (b) : The colourless inorganic salt (*A*) is ammonium nitrate.

$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

(*A*) (*B*) (*C*)

Product (*B*) N_2O is a neutral gas, product (*C*) H_2O is liquid and neutral to litmus.

$10N_2O + P_4 \longrightarrow P_4O_{10} + 10N_2$

(Dehydrating agent)

4. (a) : $\underset{\text{Succinimide}}{\left[\begin{matrix}CO\\CO\end{matrix}\right]NH} \xrightarrow[\text{(Hydrolysis)}]{NaOH} \underset{\text{(I)}}{\left[\begin{matrix}COOH\\CONH_2\end{matrix}\right.}$

$\xrightarrow[\text{(Hoffmann bromamide reaction)}]{Br_2/KOH} \underset{\text{(II)}}{H_2N-\overset{\beta}{C}H_2-\overset{\alpha}{C}H_2-COOH}$ β-Alanine

5. (d) : $Pb^{2+} + 2HCl \longrightarrow \underset{\text{White ppt.}}{PbCl_2\downarrow} \xrightarrow{H_2S} \underset{\text{Black ppt.}}{PbS\downarrow} + 2HCl$

(dissolves on boiling)

6. (c) : Either octahedral voids $\left(\frac{r_1}{r_2} = 0.414\right)$ or tetrahedral voids $\left(\frac{r_1}{r_2} = 0.225\right)$ are occupied by

[where r_1 is radius of the interstitial site (void) and r_2 is radius of atoms arranged in *fcc*]

interstitial sites in *fcc*.

Since in *fcc*, atoms along face diagonal are touching, thus, $4r_2 = \sqrt{2}\,a$

Required diameter of interstitial sites $= 2r_1$

$= 2 \times 0.414\, r_2 = \frac{2\times0.414\times\sqrt{2}a}{4}$

$= \frac{2\times0.414\times\sqrt{2}\times400}{4} = 117.1$ pm

7. (b) : $SnO_2 + 2NaOH \longrightarrow Na_2SnO_3 + H_2O$

$SnO_2 + SnO_3^{2-} \longrightarrow [SnO_2] : SnO_3^{2-}$

As they form negatively charged particles, they are easily coagulated by $AlCl_3$ in which Al^{3+} cation carries maximum positive charge.

8. (c) : 50 mL of gold for protection requires

$= 0.1$ g $= 100$ mg of starch

$\therefore$ 10 mL of gold will require = 20 mg of starch

$\therefore$ Thus, gold number of starch = 20

9. (5) : We know, $\frac{p^o - p}{p^o} = \frac{n_2}{n_1 + n_2}$

Given that: $p^o = 640$ mm Hg, $p = 600$ mm Hg

Let *M* be the molecular weight of the solute.

Molar mass of benzene $(C_6H_6) = 6 \times 12 + 6$

$= 78$ g mol^{-1}

$n_2 = \frac{2.175}{M}; n_1 = \frac{39}{78}$

$\therefore \quad \frac{640-600}{640} = \frac{2.175/M}{\frac{2.175}{M} + 0.5}; M = 65.25$

$60 + x \times 1.05 = 65.25$

$\therefore \quad x = 5$

10. (7) : Acidified $K_2Cr_2O_7$, $CuSO_4$, H_2O_2, Cl_2, O_3, $FeCl_3$ and HNO_3 oxidise iodide to iodine. Alkaline $KMnO_4$ oxidises aqueous iodide to IO_3^- ion. $Na_2S_2O_3$ is a strong reducing agent which on reaction with I_2 produces I^- ion.

$2Na_2S_2O_3 + I_2 \longrightarrow 2NaI + Na_2S_4O_6$

MPP CLASS XI ANSWER KEY

1.	(c)	**2.**	(b)	**3.**	(a)	**4.**	(d)	**5.**	(d)
6.	(c)	**7.**	(c)	**8.**	(d)	**9.**	(a)	**10.**	(c)
11.	(b)	**12.**	(c)	**13.**	(c)	**14.**	(c)	**15.**	(c)
16.	(d)	**17.**	(a)	**18.**	(d)	**19.**	(d)	**20.**	(a,b,c)
21.	(c,d)	**22.**	(a,b,c,d)	**23.**	(b,d)	**24.**	(3)	**25.**	(4)
26.	(2)	**27.**	(a)	**28.**	(a)	**29.**	(a)	**30.**	(a)

ADVANCED CHEMISTRY BLOC

(THERMODYNAMICS)

Mlka CR ayO id sha

SECOND LAW OF THERMODYNAMICS

All non-equilibrium situations tend to shift towards equilibrium situations on their own or in a natural way, but a change from an equilibrium state of a system to a non-equilibrium state cannot occur without an external help to the system from the surroundings.

A system approaching an equilibrium state can be made to do work, for example, as your mobile battery is approaching towards equilibrium (getting discharged) it is made to do work that is to run the phone.

It is clear from laws of thermodynamics, ($\Delta U = \Delta q + \Delta w$), complete conversion of heat into work is possible in a non-cyclic isothermal process. But a continuously operating machine must use a cyclic process and for such process, efficiencies cannot be 100%. Efficiency (E) is defined as :

$$E = \frac{|w|}{|q_1|}$$

$|w|$ and $|q_1|$ are the modulus of work done and heat absorbed.

By Carnot theorem, it can be shown that

$$E = 1 - \frac{T_2}{T_1}$$

T_2 is temperature of sink and T_1 that of source. The efficiency becomes more and more as temperature of sink approaches to '0' K.

Since it is impossible to reach '0' kelvin in finite number of steps (this is also an alternative statement of third law), 100% efficiency is never achievable.

Entropy

Change in functions ΔU and ΔH are insufficient to indicate the feasibility of a process. It was, therefore, necessary to search out new additional state functions which could help us to predict the feasibility of a process. Second law, introduced two new functions entropy (S) and free energy (G) in this context.

Without going much into the reason and the source of the equation, let's move straight to calculation (which you generally found in questions) :

$$\Delta S = \int_1^2 \frac{dq_{rev}}{T}$$

But calculation is always carried out with q_{rev} never with q_{irrev}.

For different processes,

- Reversible phase change at constant temperature and pressure (such as boiling of water at boiling point) :

$$\Delta S = \frac{\Delta H}{T}$$

- Perfect gas change of state :

$$\Delta S = nC_V \ln\frac{T_2}{T_1} + nR \ln\frac{V_2}{V_1}$$

- Entropy of mixing for ideal gases at constant T and P :

$\Delta S_{mix} = -n_1 R \ln x_1 - n_2 R \ln x_2$

(considering two components where x_1 and x_2 are the mole fractions.)

The second law in its most useful form of practical applications is :

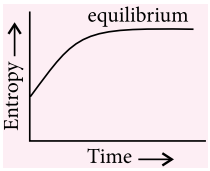
$$dS \geq \frac{dq}{T}$$

Thus, we conclude,

$\Delta S > 0$ (irreversible, isolated)

$\Delta S = 0$ (reversible, isolated)

Thus, when a natural process occurs in an isolated system, the entropy increases spontaneously until the equilibrium is reached.

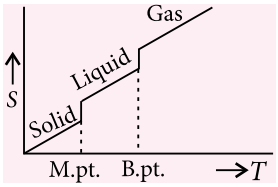


As far as questions are concerned, you must remember :

- **Isothermal reversible expansion :**
  $\Delta S_{sys} > 0$, $\Delta S_{sur} < 0$
  $\Delta S_{total} = 0$
- **Adiabatic reversible expansion :**
  $\Delta S_{sys} = 0$, $\Delta S_{sur} = 0$
  $\Delta S_{total} = 0$
- **Adiabatic irreversible expansion :**
  $\Delta S_{sys} > 0$, $\Delta S_{sur} = 0$
  $\Delta S_{total} = 0$
- **Isothermal irreversible compression :**
  $\Delta S_{sys} < 0$, $\Delta S_{sur} > 0$
  $\Delta S_{total} < 0$
  And we conclude that since all natural processes are irreversible the entropy of the universe increases. This is another statement of second law.

Notes :

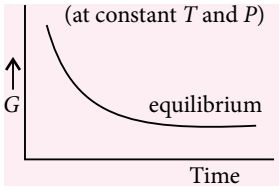
- The entropies of all perfectly crystalline material approaches zero as temperature approaches zero kelvin, this is third law.
- Few substances have residual entropies even at zero kelvin like CO, NO, N_2O, even H_2.
- For bigger molecules, standard entropy value is higher .
- For $H^+_{(aq)}$, standard entropy is zero.
- The increase in temperature results in increase in entropy.



Free energy

At constant T and P the equilibrium condition is the minimisation of Gibb's free energy (G).

The greatest advantage of Gibb's free energy is that it can predict the spontaneity of the process by looking into the system only (unlike entropy which considers both system and surroundings).



ΔG_{sys} (const. T and P) < 0 is the criteria of spontaneity.

Also, $-\Delta G = w_{net}$

For a reversible process at constant T and P, the decrease in Gibb's energy corresponds to maximum work done by the system excluding P-V work.

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. At the same temperature calculate the ratio of average velocity of SO_2 to CH_4.
(a) 2 : 3 (b) 3 : 4 (c) 1 : 2 (d) 1 : 6

2. In which of the following the oxidation number of oxygen has been arranged in increasing order?
(a) $OF_2 < KO_2 < BaO_2 < O_3$
(b) $BaO_2 < KO_2 < O_3 < OF_2$
(c) $BaO_2 < O_3 < OF_2 < KO_2$
(d) $OF_2 < O_3 < KO_2 < BaO_2$

3. For an indicator, HIn

$$\underset{A}{HIn} \rightleftharpoons H^+ + \underset{B}{In^-}$$

as the pH changes from $pK_{In} - 1$ to $pK_{In} + 1$, $\frac{[B]}{[A]}$
(a) will vary from 0.1 to 10
(b) will vary from 10 to 0.1
(c) will vary from 1 to 10
(d) will vary from 10 to 1.

4. If 30 mL of H_2 and 20 mL of O_2 react to form water, what is left at the end of the reaction?
(a) 10 mL of H_2 (b) 5 mL of H_2
(c) 10 mL of O_2 (d) 5 mL of O_2

5. The enthalpy of hydrogenation of cyclohexene is -119.5 kJ mol^{-1}. If resonance energy of benzene is -150.4 kJ mol^{-1}, its enthalpy of hydrogenation would be
(a) -269.9 kJ mol^{-1} (b) -358.5 kJ mol^{-1}
(c) -508.9 kJ mol^{-1} (d) -208.1 kJ mol^{-1}

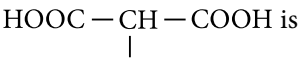
6. Borate salts when heated with conc. H_2SO_4 and C_2H_5OH produce characteristic green colouration on flame due to the formation of a volatile compound
(a) $(C_2H_5)_3B$ (b) B_2H_6
(c) $(C_2H_5)_3BO_3$ (d) B_2O_3

7. In diborane (B_2H_6) there are
(a) three $3c$-$2e^-$ bonds and three $2c$-$2e^-$ bonds
(b) four $3c$-$2e^-$ bonds and two $2c$-$2e^-$ bonds
(c) two $3c$-$2e^-$ bonds and four $2c$-$2e^-$ bonds
(d) none of the above.

8. Cl_2 and SO_2 are pollutants but used in bleaching of textiles. Bleaching action of Cl_2 and SO_2 is due to

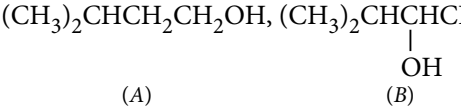
	Cl_2	SO_2
(a)	oxidation	oxidation
(b)	reduction	reduction
(c)	reduction	oxidation
(d)	oxidation	reduction

9. The correct IUPAC name of



(a) 2-carboxypropane-1, 3-dioic acid
(b) 2-carboxymalonic acid
(c) 1, 1,1-tricarboxymethane
(d) propane-1, 2, 3-tricarboxylic acid.

10. $(CH_3)_2CHCH=CH_2$ changes to *A*, *B* and *C* by using



(*A*) (*B*)

$(CH_3)_2\underset{\underset{C}{|}}{\overset{OH}{CH}}CH_2CH_3$

(a) H_2O/H^+, BH_3·THF/H_2O_2·NaOH, $Hg(OAc)_2$ /$NaBH_4$·NaOH

(b) H_2O/H^+, $Hg(OAc)_2$/$NaBH_4$·NaOH, BH_3·THF/H_2O_2·NaOH

(c) BH_3·THF/H_2O_2·NaOH, $Hg(OAc)_2$/ $NaBH_4$·NaOH, H_2O/H^+

(d) BH_3·THF/H_2O_2·NaOH, H_2O/H^+, $Hg(OAc)_2$/$NaBH_4$·NaOH

11. The number of electrons involved in the reduction of nitrate ion to hydrazine is

(a) 8 (b) 7

(c) 5 (d) 3

12. A certain mass of gas occupies a volume of 300 cc at 27°C and 620 mm pressure. The volume of this gas at 47°C and 640 mm pressure will be

(a) 400 cc (b) 510 cc

(c) 312 cc (d) 350 cc

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 :** It is impossible to determine the exact position and exact momentum of an electron simultaneously.
Reason : The path of an electron in an atom is clearly defined.

14. **Assertion :** Kjeldahl method is not applicable to nitro compound, azo compound and pyridine.
Reason : Kjeldahl method is used for halogen estimation.

15. **Assertion :** Bromobenzene upon reaction with Br_2/Fe gives 1, 4-dibromobenzene as the major product.
Reason : In bromobenzene, the inductive effect of the bromo group is more dominant than the mesomeric effect in directing the incoming electrophile.

JEE MAIN / JEE ADVANCED / PETs

Only One Option Correct Type

16. An inorganic compound (X) which produces brick red colouration as flame. When (X) dissolves in water produces alkaline solution and a combustible gas (Y).(X) and (Y) are respectively.

(a) CaO, O_2 (b) Ca_3N_2, NH_3

(c) $CaCO_3$, CO_2 (d) CaH_2, H_2

17. The correct order of acidic strength is

(a) $Cl_2O_7 > SO_2 > P_4O_{10}$

(b) $K_2O > CaO > MgO$

(c) $CO_2 > N_2O_5 > SO_3$

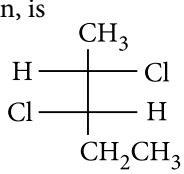
(d) $Na_2O > MgO > Al_2O_3$

18. The degree of dissociation of dinitrogen tetraoxide, $N_2O_{4(g)} \longrightarrow 2NO_{2(g)}$ at temperature T and total pressure P is α. Which one of the following is the correct expression for the equilibrium constant (K_p) at this temperature?

(a) $\frac{2\alpha}{(1-\alpha)^2}$ (b) $\frac{\alpha^2 P}{(1-\alpha)}$

(c) $\frac{4\alpha^2}{(1-\alpha^2)}$ (d) $\frac{4\alpha^2 P}{(1-\alpha^2)}$

19. The configuration of 2, 3-dichloropentane whose structure is shown, is



(a) 2*R*, 3*R* (b) 2*R*, 3*S*

(c) 2*S*, 3*R* (d) 2*S*, 3*S*

More than One Options Correct Type

20. Which of the following are wrong statements?

(a) NO is more harmful than NO_2.

(b) SO_2 is more harmful than SO_3.

(c) Acid rain contains mainly HNO_3.

(d) Acid rain contains mainly H_2SO_4 and lesser concentrations of HNO_3 and HCl.

21. 22.44 kJ energy is required to convert 8 g of gaseous atom of metal M to $M^+_{(g)}$ if $I.E._1$ of metal M = 374 kJ/mol. Select correct statement for metal M.

(a) 0.6 mole gaseous ion (M^+) are formed.

(b) Same energy can convert all $M^+_{(g)}$ to $M^{2+}_{(g)}$.

(c) Atomic mass of metal = 133.33 g mol^{-1}.

(d) 3.613×10^{22} atoms of M are converted to $M^+_{(g)}$.

22. H_2 can be obtained from
(a) the reaction of water with ionic hydrides
(b) water gas by oxidation of CO into CO_2 (by steam) which can be easily removed by dissolving in H_2O
(c) electrolysis of water
(d) reaction of NaOH with Zn.

23. Isotones of $^{76}_{32}Ge$ are
(a) $^{77}_{32}Ge$ (b) $^{77}_{33}As$ (c) $^{77}_{34}Se$ (d) $^{78}_{34}Se$

Integer Answer Type

24. $CH_3-C\equiv CH \xrightarrow[2.\ D_3O^+]{1.\ NaNH_2} A \xrightarrow[Pd\text{-}BaSO_4]{D_2} B$

Total number of deuterium atoms in the final product is

25. How many of the following metals liberate dihydrogen from water either at room temperature or on heating?

Zn, Mg, Na, Al, Ti, Cr, W

26. The equilibrium constant K_{sp} for the given reaction is found to be $x \times 10^{-10}$.

$AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)}$

Using the data $\Delta G°_f(AgCl) = -109.4$ kJ, $\Delta G°_f(Ag^+) = 77.1$ kJ and $\Delta G°_f(Cl^-) = -131.2$ kJ.

The value of x is

Comprehension Type

BeO and $Be(OH)_2$ are amphoteric while the oxides and hydroxides of other alkaline earth metals are basic. The solubility of hydroxides increases as we move down the group from Be to Ba but the solubility of sulphates and carbonates decreases in that order. The thermal stability of carbonates and sulphates of alkaline earth metals increases from Be to Ba as we move from top to bottom in the group.

27. Which of the following metal carbonates decomposes on heating?
(a) $MgCO_3$ (b) Na_2CO_3
(c) K_2CO_3 (d) Rb_2CO_3

28. The solubility in water of sulphates down the Be group is Be > Mg > Ca > Sr > Ba. This is due to
(a) high heat of solvation for smaller ions like Be^{2+}
(b) increasing molecular weight
(c) decreasing lattice energy
(d) increase in melting points.

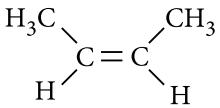
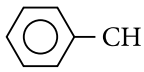
Matrix Match Type

29. Match the molecules given in Column I with their characteristics given in Column II.

Column I	Column II
(A) O_2^-	(P) Bond order 2.5 and paramagnetic
(B) N_2	(Q) Bond order 1.5 and paramagnetic
(C) N_2^+	(R) Bond order 1 and paramagnetic
(D) B_2	(S) Bond order 3 and diamagnetic

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

30. Match the terms given in Column I with the compounds given in Column II.

Column I	Column II
(A) Markovnikov product	(P) $CH_3-CH=CH_2 \xrightarrow[H_2O_2,\ hv]{HBr}$
(B) Anti-Markovnikov product	(Q)  $\xrightarrow{CHCl_3 + KOH}$
(C) Peroxide effect	(R)  $\xrightarrow{HCl}$
(D) Mixture of stereoisomers	(S) $CF_3-CH=CH_2 \xrightarrow{HBr}$

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

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

CONCEPT BOOSTER

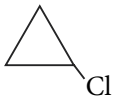
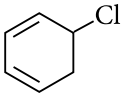
Dear students, hope you all are fine. As I have always told, your learning process becomes abortive if it is not accompanied with practice. Make regular habit of practicing problems. This article 'Problems on Hydrocarbons' will help you for that. Always set timer before solving a problem, then only you can get fruitful results. Regards your very own.

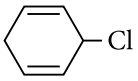
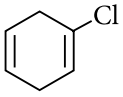
*Arunava Sarkar

1. Give the number of isomers including stereoisomers obtained after the monochlorination of isopentane.

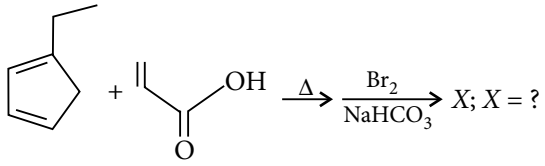
(a) 2 (b) 3
(c) 4 (d) None of these

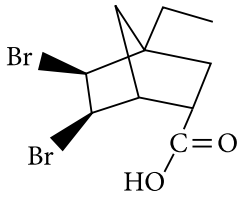
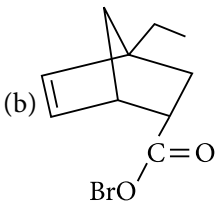
2. Which one is dehydrohalogenated most easily?

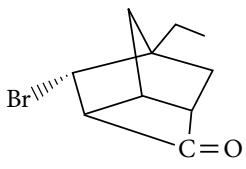
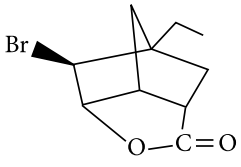
(I)  (II) 

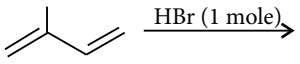
(III)  (IV) 

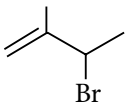
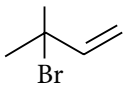
(a) I (b) II
(c) III (d) IV

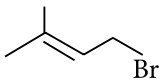
3. 

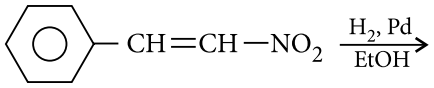
(a)  (b) 

(c)  (d) 

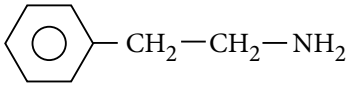
4. 

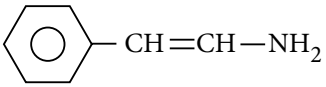
(a)  (b) 

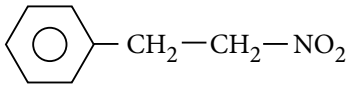
(c)  (d) None of these

5. 

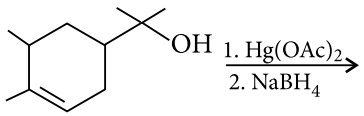
Identify the major product.

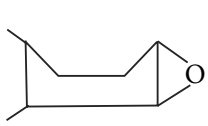
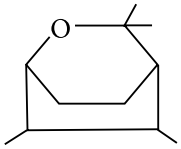
(a) 

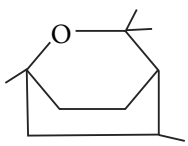
(b) 

(c) 

(d) None of these

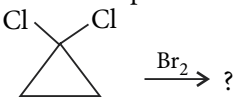
6. 

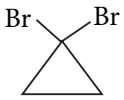
(a)  (b) 

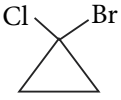
(c)  (d) None of these

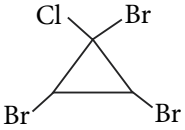
*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

7. Predict the product for the following case,

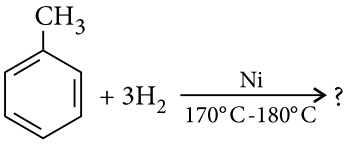


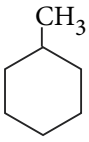
(a) 

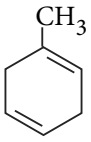
(b) 

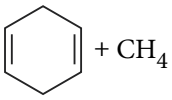
(c) 

(d) None of these

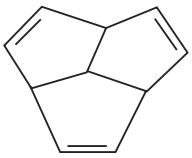
8. 

(a) 

(b) 

(c) 

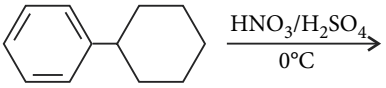
(d) None of these

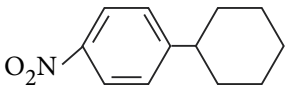
9. 

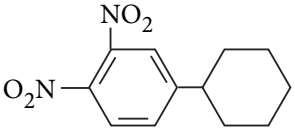
This species is

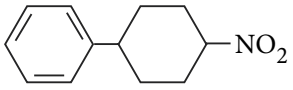
(a) aromatic (b) non-aromatic

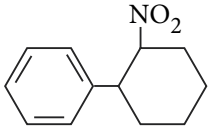
(c) anti-aromatic (d) heterocyclic.

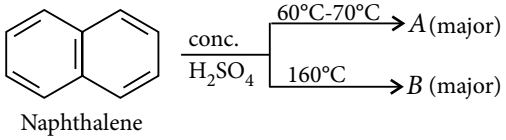
10. 

(a) 

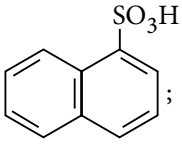
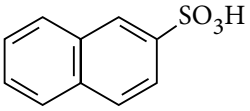
(b) 

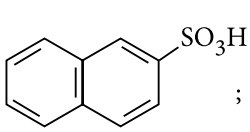
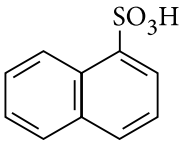
(c) 

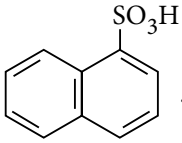
(d) 

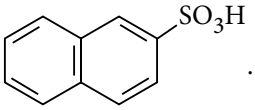
11. 

Naphthalene

(a) $A =$  ; $B =$ 

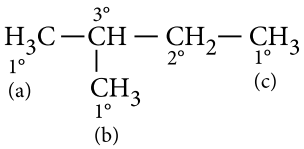
(b) $A =$  ; $B =$ 

(c) Both will be  .

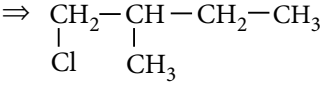
(d) Both will be  .

SOLUTIONS

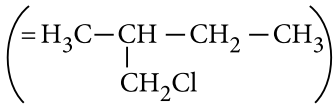
1. **(d):** Isopentane is



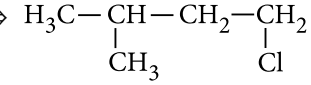
Substitution at 1°(a) or 1°(b) carbon will give the same product. It will be :



1-chloro-2-methylbutane

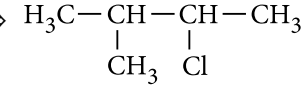


Substitution at 1°(c) carbon will give a different product.



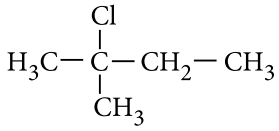
(1-chloro-3-methylbutane)

Substitution at 2° carbon will give different product.



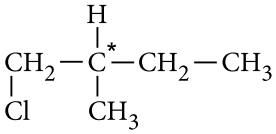
(2-chloro-3-methylbutane)

Substitution at 3° carbon will give different product.

(Z) ⇒ 

(2-chloro-2-methylbutane)

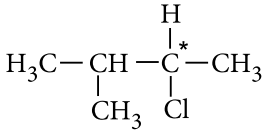
(*W*) has chiral carbon;



Two optically active isomers are possible.

(*X*) doesn't have any chiral carbon.

(*Y*) has chiral carbon;



Two optically active isomers are possible.

(*Z*) doesn't have any chiral carbon.

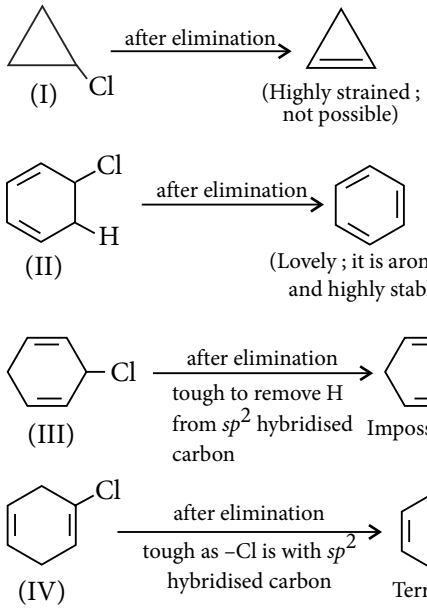
W + *X* + *Y* + *Z*

↓ ↓ ↓ ↓

2 + 1 + 2 + 1 = 6 isomers

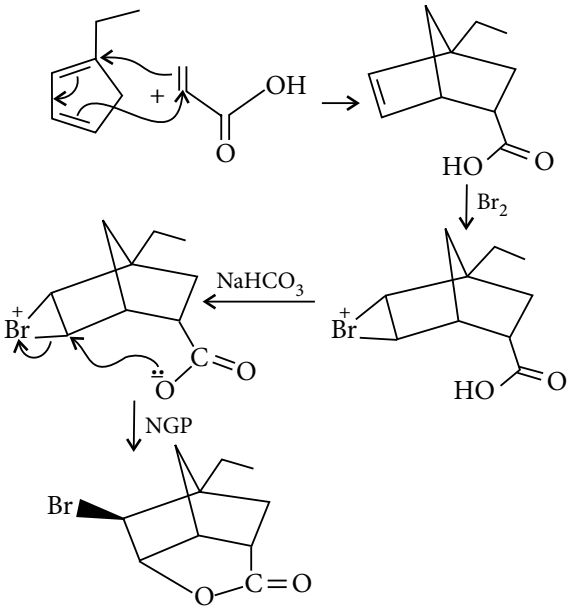
(including stereoisomers)

2. (b): Idea is, after dehydrohalogenation who gives the most stable product.



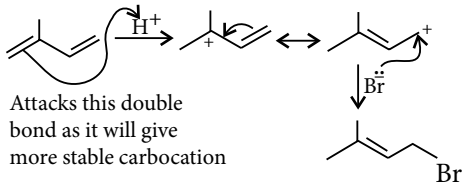
So, correct option is (b), (II).

3. (d): There will be the formation of a six membered ring through Diels–Alder reaction.



∴ Correct option is (d).

4. (c):



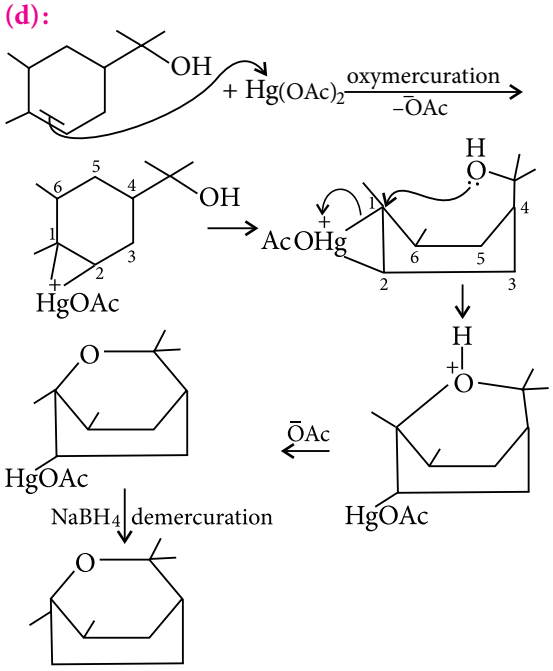
Attacks this double bond as it will give more stable carbocation

∴ Correct option is (c).

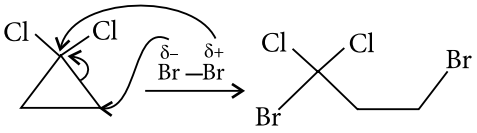
5. (a): H_2 + Pd will reduce double bond as well as $-NO_2$ group.

∴ Correct option is (a).

6. (d):



7. **(d):** Cyclopropane is under severe strain. Therefore, it is always ready to undergo ring opening reactions.



∴ Option (d) is correct.

Remember, when a carbanionic centre attached with two chlorine atoms, substitution reaction takes place. Also remember, in presence of sunlight ring opening and substitution takes place via free radical path.

8. **(a):** Under vigorous conditions, Ni/H_2 will destroy the double bonds of benzene.

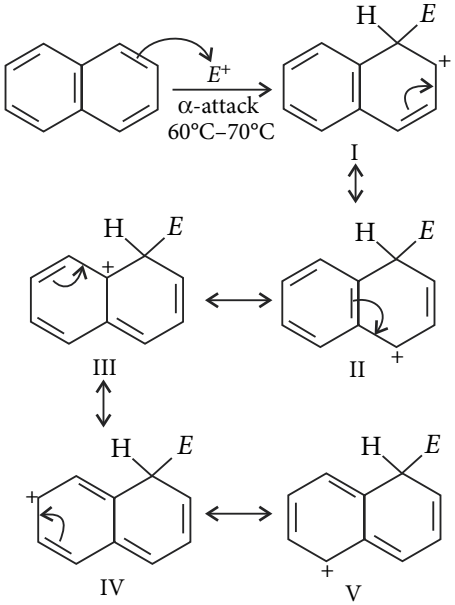
∴ Option (a) will be the correct option.

9. **(b):** System is not conjugated. So, it is non-aromatic.

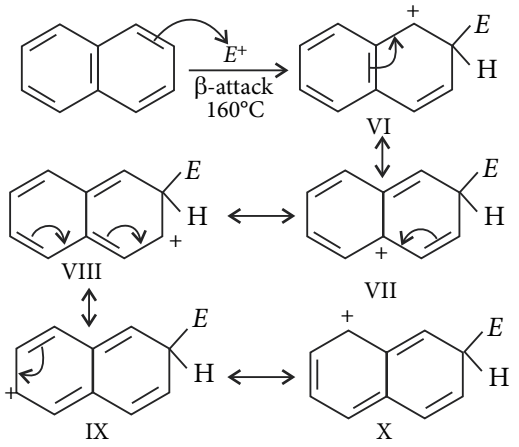
∴ Option (b) is correct.

10. **(a):** Nitration will take place at *o*- or *p*-positions of the aromatic ring if *+I*-effect group is attached to the benzene ring. Hence, option (a) is correct. Lower temperature prevents polynitration.

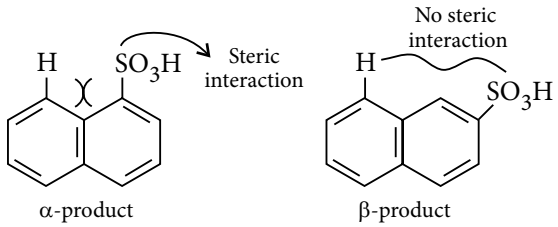
11. **(a):** While electrophilic substitution reaction takes place in naphthalene there are two positions where it can take place, α and β.



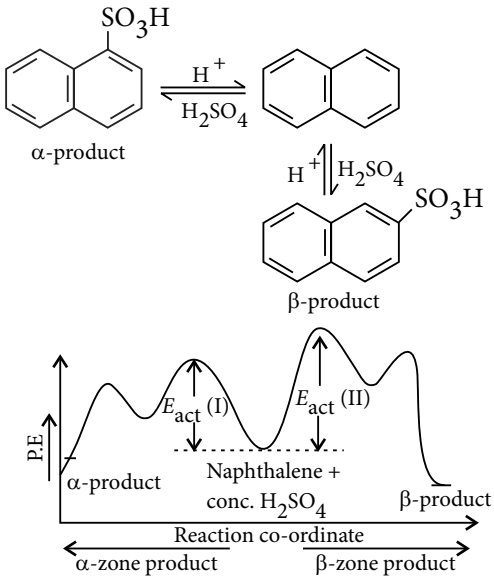
Now, understand a very simple thing, for α-attack there are two structures whereas for β-attack there is only one structure which is aromatic. For α-attack the aromatic structures are I and II and for β-attack the aromatic structure is VI.



So, intermediates for α-attack are more stable than that for β-attack. So, α-product must be kinetically controlled product and at low temperature this becomes irreversible in nature and the exclusive product. α-product is thermodynamically less stable than β-product due to steric reason.



This is why at higher temperature reaction occurs to give thermodynamically more stable β-product. At higher temperature reaction is also reversible in nature. At higher temperature the readily formed α-product desulfonates and gives β-product.



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Contd. from Page no. 30

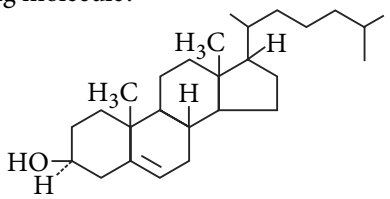
35. A vessel contains $A_{(g)}$ and $B_{(g)}$ at 2 atm and 4 atm respectively at T K, the mixture is allowed to attain equilibrium at T K, according to the reaction,

$$8B_{(g)} \rightleftharpoons 8A_{(g)} + C_{(s)}$$

At equilibrium, $\left(\frac{n_A}{n_B}\right)_{eq.} = \left(\frac{n_B}{n_A}\right)_{initial}$

Find the value of y if $K_c = 2^y$.

36. How many chiral centres are present in the following molecule?



Cholesterol

MATHEMATICS

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.*

37. The number of integral solutions of $x + y + z = 0$ with $x \geq -5$, $y \geq -5$, $z \geq -5$ is

(a) 135 (b) 136 (c) 455 (d) 105

38. A survey of people in a given region showed that 20% were smokers. The probability of death due to lung cancer, given that a person smoked, was 10 times the probability of death due to lung cancer, given that a person did not smoke. If the probability of death due to lung cancer in the region is 0.006, what is the probability of death due to lung cancer given that a person is a smoker?

(a) 1/140 (b) 1/70 (c) 3/140 (d) 1/10

39. The number of non-zero diagonal matrices of order 4 satisfying $A^2 = A$ is

(a) 2 (b) 4 (c) 16 (d) 15

40. If $\sin x + \text{cosec } x = 2$, then $\sin^n x + \text{cosec}^n x$ is equal to

(a) 2 (b) 2^n (c) 2^{n-1} (d) 2^{n-2}

41. If $g(x)$ is a polynomial satisfying $g(x)\, g(y) = g(x) + g(y) + g(xy) - 2$ for all real x and y and $g(2) = 5$, then $\lim_{x \to 3} g(x)$ is

(a) 9 (b) 10 (c) 25 (d) 20

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.*

42. On the ellipse $4x^2 + 9y^2 = 1$, the points at which the tangents are parallel to the line $8x = 9y$ are

(a) $\left(\frac{2}{5}, \frac{1}{5}\right)$ (b) $\left(-\frac{2}{5}, \frac{1}{5}\right)$

(c) $\left(-\frac{2}{5}, -\frac{1}{5}\right)$ (d) $\left(\frac{2}{5}, -\frac{1}{5}\right)$

43. Let $S_n = \sum_{k=1}^{n} \frac{n}{n^2 + kn + k^2}$ and $T_n = \sum_{k=0}^{n-1} \frac{n}{n^2 + kn + k^2}$, for $n = 1, 2, 3, \ldots$. Then,

(a) $S_n < \frac{\pi}{3\sqrt{3}}$ (b) $S_n > \frac{\pi}{3\sqrt{3}}$

(c) $T_n < \frac{\pi}{3\sqrt{3}}$ (d) $T_n > \frac{\pi}{3\sqrt{3}}$

44. If the parabola $x^2 = ay$ makes an intercept of length $\sqrt{40}$ units on the line $y - 2x = 1$ then a is equal to

(a) 1 (b) –2 (c) –1 (d) 2

45. If $y(x)$ satisfies the differential equation $y' - y \tan x = 2x \sec x$ and $y(0) = 0$, then

(a) $y\left(\frac{\pi}{4}\right) = \frac{\pi^2}{8\sqrt{2}}$ (b) $y'\left(\frac{\pi}{4}\right) = \frac{\pi^2}{18}$

(c) $y\left(\frac{\pi}{3}\right) = \frac{\pi^2}{9}$ (d) $y'\left(\frac{\pi}{3}\right) = \frac{4\pi}{3} + \frac{2\pi^2}{3\sqrt{3}}$

46. If the first and the $(2n-1)^{th}$ terms of an A.P., G.P. and H.P. are equal and their n^{th} terms are respectively a, b, c then always

(a) $a = b = c$ (b) $a \geq b \geq c$

(c) $a + c = b$ (d) $ac - b^2 = 0$

47. In R^3, let L be a straight line passing through the origin. Suppose that all the points on L are at a constant distance from the two planes $P_1 : x + 2y - z + 1 = 0$ and $P_2 : 2x - y + z - 1 = 0$. Let M be the locus of the feet of the perpendiculars drawn from the points on L to the plane P_1. Which of the following points lie(s) on M?

(a) $\left(0, -\frac{5}{6}, -\frac{2}{3}\right)$ (b) $\left(-\frac{1}{6}, -\frac{1}{3}, \frac{1}{6}\right)$

(c) $\left(-\frac{5}{6}, 0, \frac{1}{6}\right)$ (d) $\left(-\frac{1}{3}, 0, \frac{2}{3}\right)$

48. In a triangle PQR, P is the largest angle and $\cos P = \frac{1}{3}$. Further the incircle of the triangle touches the sides PQ, QR and RP at N, L and M respectively, such that the lengths of PN, QL and RM are consecutive even integers. Then possible length(s) of the side(s) of the triangle is (are)

(a) 16 (b) 18 (c) 24 (d) 22

49. Consider the system of equations :

$x + y + z = 0$, $\alpha x + \beta y + \gamma z = 0$, $\alpha^2 x + \beta^2 y + \gamma^2 z = 0$

Then the system of equations has

(a) a unique solution for all values of α, β, γ

(b) infinite number of solutions if any two of α, β, γ are equal

(c) a unique solution if α, β, γ are distinct

(d) more than one, but finite number of solutions depending on values of α, β, γ

SECTION 3 (Maximum Marks : 15)

- *This section contains FIVE questions.*
- *The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 to 9, both inclusive.*
- *For each question, darken the bubble corresponding to the correct integer 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 answer is darkened.*

Zero Marks : *0 In all other cases.*

50. The expression

$$\frac{1}{\sqrt{(3x+1)}}\left[\left(\frac{1+\sqrt{3x+1}}{2}\right)^7 - \left(\frac{1-\sqrt{3x+1}}{2}\right)^7\right]$$

is a polynomial in x of degree

51. If the matrix $A = \begin{bmatrix} 1 & 2 & 3 & 0 \\ 2 & 4 & 3 & 2 \\ 3 & 2 & 1 & 3 \\ 6 & 8 & 7 & \alpha \end{bmatrix}$ is of the rank 3, then $\alpha =$

52. $\lim\limits_{x \to 0} \frac{e^{5x} - e^{4x}}{x} =$

53. If $[x]$ denotes the greatest integer less than or equal to x, then the value of $\int_0^2 (|x-2| + [x])\,dx$ is equal to

54. Let $f(x) = \begin{cases} \frac{x^3 + x^2 - 16x + 20}{(x-2)^2}, & \text{if } x \neq 2 \\ b, & \text{if } x = 2 \end{cases}$

If $f(x)$ is continuous for all x, then b is equal to

PAPER-II

PHYSICS

SECTION 1 (Maximum Marks : 18)

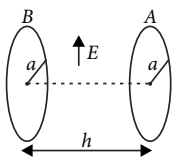
- *This section contains SIX questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories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

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

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

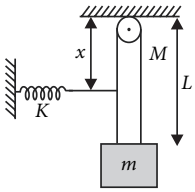
Negative Marks : *–1 In all other cases.*

1. Two circular rings A and B, each of radius a = 130 cm are placed co-axially with their axes horizontal in a uniform electric field $E = 10^5$ N C^{-1} directed vertically upward as shown in figure. Distance between centres of these rings A and B is h = 40 cm. Ring A has a positive charge of q_1 = 10 μC and ring B has a negative charge of q_2 = – 20 μC. A particle of mass 100 g and carrying a positive charge q = 10 μC is released from rest at the centre of ring A. Calculate its velocity when it reaches to the centre of ring B.



(a) $6\sqrt{2}$ m s^{-1} (b) $4\sqrt{2}$ m s^{-1}
(c) 7 m s^{-1} (d) 32 m s^{-1}

2. A rod of mass M and length L is hung from a support. A spring of constant K fixed to a support on the left as shown is attached to the rod at a point distance x from the pivot. The frequency of the oscillation is



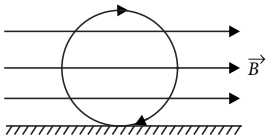
(a) $\frac{1}{2\pi}\sqrt{\frac{K}{(M+2m)}}$ (b) $\frac{1}{2\pi}\sqrt{\frac{K}{\left(\frac{M}{3}+2m\right)}}$

(c) $2\pi\sqrt{\frac{K}{\left(\frac{M}{3}+2m\right)}}$ (d) $2\pi\sqrt{\frac{M+2m}{K}}$

3. When a body is placed in surroundings at a constant temperature of 20°C and heated by a 10 W heater, its temperature remains constant at 40°C. If the temperature of the body is now raised from 20°C to 80°C in 5 min at a uniform rate, the total heat it will lose to the surroundings will be
(a) 3000 J (b) 3600 J (c) 4500 J (d) 5400 J

4. A tank is filled with water upto a height of 3 m from the bottom. A hole is made in the wall at a height of 52.5 cm from the bottom of the tank. If the ratio of area of the hole to area of the cross-section of the tank is 0.1, then velocity of water coming out of the hole is
(a) 6 m s^{-1} (b) 7 m s^{-1}
(c) 5 m s^{-1} (d) 4 m s^{-1}

5. A conducting ring of mass 2 kg and radius 0.5 m is placed on a smooth horizontal plane. The ring carries a current I = 4 A.



A horizontal magnetic field B = 10 T is switched on at time t = 0 as shown in figure. The initial angular acceleration of the ring will be
(a) 40π rad s^{-2} (b) 20π rad s^{-2}
(c) 5π rad s^{-2} (d) 15π rad s^{-2}

6. Monochromatic light of wavelengths 400 nm and 560 nm are incident simultaneously and normally on double slit apparatus whose slit separation is 0.1 mm and screen distance is 1 m. Distance between areas of total darkness will be
(a) 4 mm (b) 5.6 mm
(c) 14 mm (d) 28 mm

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 :*
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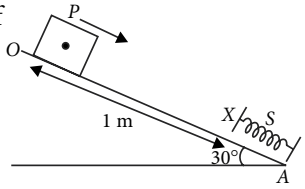
  Partial Marks : *+1 For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*
  Zero Marks : *0 If none of the bubbles is darkened.*
  Negative Marks : *–2 In all other cases.*
- *For example, if (a), (c) and (d) are all the correct options for a question, 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.*

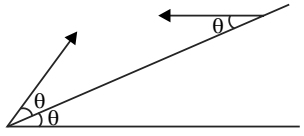
7. AO is a plane surface of angle of inclination of 30°. It has a smooth section of length OX = 1 m and a massless spring S over the rough section XA of the inclined plane as shown in figure. A block P of mass 5 kg slides from rest at O and compresses the spring by 10 cm before it is stopped and then the block ascends a length of 0.70 m from X before it slides back again. Then during this whole motion, (g = 10 m s^{-2})



(a) the work done against frictional force is zero
(b) the work done against frictional force is 7.5 J
(c) the gravitational potential energy transferred to the spring during its compression is 2.5 J
(d) the gravitational potential energy transferred to the spring during its compression is 23.75 J.

8. A wave equation which gives the displacement along the y-direction is given by $y = 10^{-4}\sin(60t + 2x)$ where x and y are in metre and t in second. This represents a wave
(a) travelling with a velocity of 30 m s^{-1} in the negative x-direction
(b) of wavelength π m
(c) of frequency (30/π) hertz
(d) of amplitude 10^{-4} m travelling along the negative x-direction.

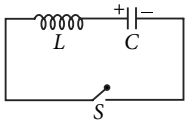
9. From an inclined plane two particles are projected with same speed at same angle θ,



one up and other down the plane as shown in figure. Which of the following statement(s) is/are correct?

(a) The particles will collide the plane with same speed
(b) The time of flight of each particle are same
(c) Both particles strike the plane perpendicularly
(d) The particles will collide in mid air if projected simultaneously and time of flight of each particle is less than the time of collision

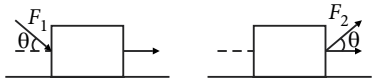
10. A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch S. The switch is closed at time $t = 0$. Which of the following statement(s) is/are correct?



(a) The maximum current in the circuit is $V_0\sqrt{\frac{C}{L}}$
(b) Potential across capacitor becomes zero for the first time at $t = \pi\sqrt{LC}$
(c) Energy stored in the inductor at time $t = \frac{\pi}{2}\sqrt{LC}$ is $\frac{1}{4}CV_0^2$
(d) Maximum energy stored in the inductor is $\frac{1}{2}CV_0^2$

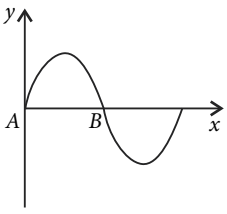
11. H^+, He^+ and O^+ all having the same kinetic energy pass through a region in which there is a uniform magnetic field perpendicular to their velocities. The masses of H^+, He^+ and O^+ are 1 amu, 4 amu and 16 amu respectively. The
(a) H^+ will be deflected most
(b) O^+ will be deflected most
(c) He^+ and O^+ will be deflected equally
(d) all will be deflected equally.

12. In the two cases shown, the coefficient of kinetic friction between the block and the surface is the same and both the identical blocks are moving with the same uniform speed. If $\sin\theta = mg/4F_2$, then



(a) $F_1 = F_2$ (b) $F_1 < F_2$ (c) $F_1 > F_2$ (d) $F_1 = 2F_2$

13. The tension in a stretched string fixed at both ends is changed by 2%, the fundamental frequency is found to get changed by 15 Hz. Select the correct statement(s)



(a) Wavelength of the string of fundamental frequency does not change.
(b) Velocity of propagation of wave changes by 2%.
(c) Velocity of propagation of wave changes by 1%
(d) Original frequency is 1500 Hz.

14. A charged particle with velocity $\vec{v} = x\hat{i} + y\hat{j}$ moves in a magnetic field $\vec{B} = y\hat{i} + x\hat{j}$. The magnitude of magnetic force acting on the particle is F. Which one of the following statement(s) is/are correct?
(a) No force will act on particle, if $x = y$.
(b) $F \propto (x^2 - y^2)$ if $x > y$.
(c) The force will act along z-axis, if $x > y$.
(d) The force will act along y-axis, if $y > x$.

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

Zero Marks : *0 In all other cases.*

PARAGRAPH 1

A rod of length 1 m is rigidly clamped at its midpoint. Longitudinal stationary waves are set up in such a manner that there are two nodes on either side of the midpoint. The amplitude of antinode is 2 μm.

15. What is the frequency of the rod if Young's modulus of the rod is 2×10^{11} N m^{-2} and the density of rod is 8000 kg m^{-3}?
(a) 3125 Hz (b) 6250 Hz
(c) 12500 Hz (d) 25000 Hz

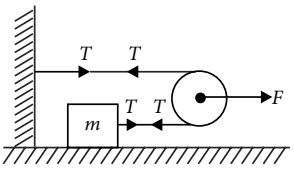
16. Write the equation of motion at a point 2 cm from its midpoint.
(a) $2 \times 10^{-6}\cos 2.6\pi \sin 25000\pi t$
(b) $10^{-6}\cos 1.3\pi \sin 25000\pi t$
(c) $10^{-6}\cos 1.3\pi \sin 12500\pi t$
(d) $2 \times 10^{-6}\cos 1.3\pi \sin 12500\pi t$

PARAGRAPH 2

An object at rest remains at rest and an object in motion will continue its motion with a constant velocity unless it experiences a net external force. But the magnitude of force given by Newton's 2nd law and 3rd law represents or gives the information about the nature of force. The second law gave a specific way of determining how the velocity changes under different influences called forces. There are so many forces calculated by Newton's law such as normal force,

tension, viscous force, weight but Newton's laws are not applicable, when velocity of an object comparable to the velocity of light and microscopic particle. If the system contains large number of particles, then if we apply the Newton's laws, concept of centre of mass is included.

17. Pulley and strings are massless. The force acting on the block of mass m



(a) $2F$ (b) F (c) $\frac{F}{2}$ (d) $4F$

18. A particle of mass m moves along a circle of radius R. The modulus of average value of force acting on particle over the distance equal to a quarter of circle, if the particle moves uniformly with velocity v is

(a) $\sqrt{2}\, mv^2/\pi r$ (b) $2\sqrt{2}\, mv^2/\pi r^2$
(c) $2\sqrt{2}\, mv^2/\pi r$ (d) $mv^2/\pi r$

CHEMISTRY

SECTION 1 (Maximum Marks : 18)

- *This section contains SIX questions.*
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- *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.*

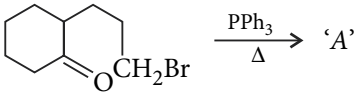
19. In the button cell widely used in watches and other devices, the following reaction takes place :

$Zn_{(s)} + Ag_2O_{(s)} + H_2O_{(l)} \longrightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2OH^-_{(aq)}$

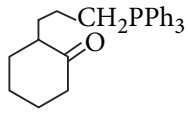
What will be the value of $\Delta_r G°$ for the reaction?
(Given : $Zn^{2+} + 2e^- \longrightarrow Zn$, $E° = -0.76$ V;
$Ag_2O + H_2O + 2e^- \longrightarrow 2Ag + 2OH^-$, $E° = 0.344$ V)

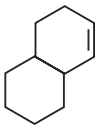
(a) -8.02×10^4 J (b) 1.60×10^5 J
(c) -2.13×10^5 J (d) 4.26×10^5 J

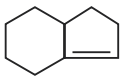
20. Consider the following reaction,

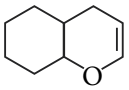


'A' is

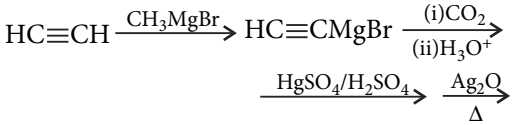
(a) 

(b) 

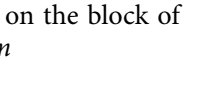
(c) 

(d) 

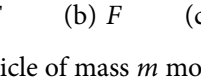
21. End product of the following sequence of reactions,

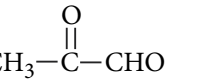


is

(a) 

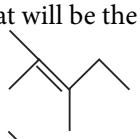
(b) $CH_2(COOH)_2$

(c) 

(d) 

22. When 

undergoes dehydration reaction in presence of concentrated H_2SO_4 then what will be the major product?

(a) 

(b) 

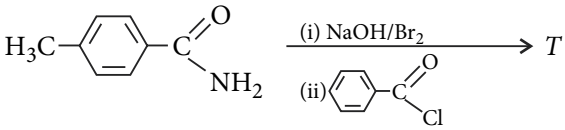
(c) 

(d) 

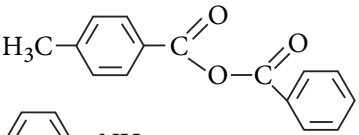
23. Which of the following statements is not correct from the view point of molecular orbital theory?

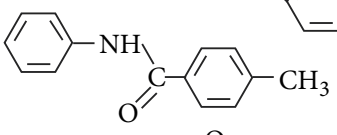
(a) Be_2 is not a stable molecule.
(b) He_2 is not stable but He_2^+ is expected to exist.
(c) Bond strength of N_2 is maximum amongst the homonuclear diatomic molecules belonging to the second period.
(d) The order of energies of molecular orbitals in N_2 molecule is $\sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$.

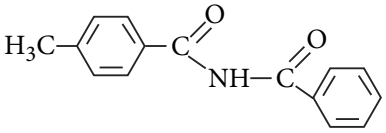
24. In the reaction,

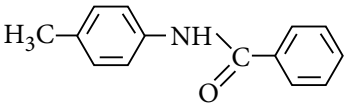


the structure of the product T is

(a) 

(b) 

(c) 

(d) 

SECTION 2 (Maximum Marks : 32)

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- *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.*

25. Some oxidation reactions of methane are given below. Which of them is/are controlled oxidation reactions?

(a) $CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$

(b) $CH_{4(g)} + O_{2(g)} \longrightarrow C_{(s)} + 2H_2O_{(l)}$

(c) $CH_{4(g)} + O_{2(g)} \xrightarrow{Mo_2O_3} HCHO + H_2O$

(d) $2CH_{4(g)} + O_{2(g)} \xrightarrow{Cu/523\ K/100\ atm} 2CH_3OH$

26. Which of the following conditions show the polluted environment ?

(a) pH of rain water is 5.6

(b) Amount of carbon dioxide in the atmosphere is 0.03%

(c) Biochemical oxygen demand is 10 ppm

(d) Eutrophication

27. Which of the following compounds give(s) colour due to charge transfer transitions?

(a) Cu_2O (b) $[Fe(H_2O)_5NO]SO_4$

(c) Ni-dmg complex (d) $NiSO_4.7H_2O$

28. The correct functional group X and the reagent/ reaction conditions Y in the following reaction are

$X(CH_2)_4X \xrightarrow[\text{(ii)}\ \mathrm{HO{-}C(=O){-}(CH_2)_4{-}C(=O){-}OH}]{\text{(i) } Y}$ Condensation polymer

(a) $X = COOCH_3$, $Y = H_2$/Ni/heat

(b) $X = CONH_2$, $Y = H_2$/Ni/heat

(c) $X = CONH_2$, $Y = Br_2$/NaOH

(d) $X = CN$, $Y = H_2$/Ni/heat

29. How many α- and β-particles will be emitted respectively when $^{232}_{90}Th$ converts into $^{208}_{82}Pb$?

(a) 6, 4 (b) 4,6 (c) 5,5 (d) 3,6

30. Select the correct statements.

(a) In the decomposition of an oxide into metal, entropy increases.

(b) To make ΔG negative, $T\Delta S > \Delta H$.

(c) Ellingham diagram represents change in free energy with temperature.

(d) Reduction of an oxide with aluminium is called van Arkel process.

31. Which reagent does not give oxygen as one of the products during oxidation with ozone?

(a) SO_2 (b) $SnCl_2/HCl$

(c) H_2S (d) PbS

32. Which of the following statements is/are correct when a mixture of NaCl and $K_2Cr_2O_7$ is gently warmed with conc. H_2SO_4?

(a) Deep red vapours are evolved.

(b) Vapours when passed into NaOH solution gives a yellow solution of Na_2CrO_4.

(c) Chlorine gas is evolved.

(d) Chromyl chloride is formed.

SECTION 3 (Maximum Marks : 12)

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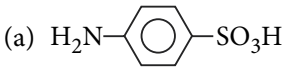
PARAGRAPH 1

During the detection of elements by Lassaigne's test, the covalent compounds are converted into ionic compounds by fusion with metallic sodium. The nitrogen, sulphur and halogens present in the organic compound are converted into cyanides, sulphides and halides respectively which are then detected by their usual tests.

33. An organic compound containing N, S and O as extra elements is fused with sodium metal and then extracted with water. The species which is not present in the solution of extract is

(a) CN^- (b) CNS^- (c) NO_3^- (d) S^{2-}

34. Which of the following compounds will give blood red colour in Lassaigne's test?

(a) 

(b) $(NH_2)_2CO$

(c) $C_6H_5SO_3H$

(d) $(NH_4)_2SO_4$

PARAGRAPH 2

In stereoisomerism, the isomers differ only in the spatial arrangement of groups about the central metal atom. It is of two types : (i) Geometrical isomerism, this isomerism arises in heteroleptic complexes due to the difference in geometrical complexes and geometrical arrangement of the ligands around the central atom. (ii) Optical isomerism, this isomerism is shown by chiral molecules, *i.e.*, the molecules which do not have plane of symmetry.

35. The number of isomers exhibited by $[Cr(NH_3)_3Cl_3]$ is
(a) 2 (b) 3 (c) 4 (d) 5

36. Which of the following will exhibit optical isomerism?
(a) $[Cr(en)(H_2O)_4]^{3+}$
(b) $[Cr(en)_3]^{3+}$
(c) *trans*-$[Cr(en)Cl_2(NH_3)_2]^{+}$
(d) *trans*-$[Cr(en)_2Cl_2]^{+}$

MATHEMATICS

SECTION 1 (Maximum Marks : 18)

- *This section contains SIX questions.*
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  Negative Marks : *–1 In all other cases.*

37. $\lim\limits_{x\to 1}\left(\dfrac{1+x}{2+x}\right)^{\left(\frac{1-\sqrt{x}}{1-x}\right)}$

(a) is 1 (b) does not exist
(c) is $\sqrt{\dfrac{2}{3}}$ (d) is ln 2

38. If $I=\int\limits_0^1 \dfrac{dx}{1+x^{\pi/2}}$, then

(a) $\log_e 2 < I < \pi/4$ (b) $\log_e 2 > I$
(c) $I = \pi/4$ (d) $I = \log_e 2$

39. If the angle between the curves $y = 2^x$ and $y = 3^x$ is α, then the value of $\tan\alpha$ is equal to

(a) $\dfrac{\log(3/2)}{1+(\log 2)(\log 3)}$ (b) $\dfrac{6}{7}$

(c) $\dfrac{1}{7}$ (d) $\dfrac{\log(6)}{1+(\log 2)(\log 3)}$

40. The solution of the differential equation $y\sin(x/y)dx = (x\sin(x/y) - y)dy$ satisfying $y(\pi/4) = 1$ is

(a) $\cos\dfrac{x}{y}=\log_e y+\dfrac{1}{\sqrt{2}}$ (b) $\sin\dfrac{x}{y}=\log_e y+\dfrac{1}{\sqrt{2}}$

(c) $\sin\dfrac{x}{y}=\log_e x-\dfrac{1}{\sqrt{2}}$

(d) $\cos\dfrac{x}{y}=-\log_e x-\dfrac{1}{\sqrt{2}}$

41. Let α, β be two distinct roots of $a\cos\theta + b\sin\theta = c$, where a, b and c are three real constants and $\theta \in [0, 2\pi]$. Then $\alpha + \beta$ is also a root of the same equation, if

(a) $a + b = c$ (b) $b + c = a$
(c) $c + a = b$ (d) $c = a$

42. If $x_1, x_2, ..., x_{18}$ are observations such that $\sum\limits_{j=1}^{18}(x_j-8)=9$ and $\sum\limits_{j=1}^{18}(x_j-8)^2=45$, then the standard deviation of these observations is

(a) $\sqrt{\dfrac{81}{34}}$ (b) 5 (c) $\sqrt{5}$ (d) 3/2

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.*

43. Let PQR be a triangle. Let $\vec{a}=\overrightarrow{QR}, \vec{b}=\overrightarrow{RP}$ and $\vec{c}=\overrightarrow{PQ}$. If $|\vec{a}|=12$, $|\vec{b}|=4\sqrt{3}$ and $\vec{b}\cdot\vec{c}=24$, then which of the following is (are) true?

(a) $\frac{|\vec{c}|^2}{2}-|\vec{a}|=12$

(b) $\frac{|\vec{c}|^2}{2}+|\vec{a}|=30$

(c) $|\vec{a}\times\vec{b}+\vec{c}\times\vec{a}|=48\sqrt{3}$

(d) $\vec{a}\cdot\vec{b}=-72$

44. The tangent PT and the normal PN to the parabola $y^2 = 4ax$ at a point P on it meet its axis at points T and N, respectively. The locus of the centroid of the triangle PTN is a parabola whose

(a) vertex is $\left(\frac{2a}{3},0\right)$ (b) directrix is $x = 0$

(c) latus rectum is $\frac{2a}{3}$ (d) focus is $(a, 0)$

45. Let $f: R \to R$ be such that $f(2x - 1) = f(x)$ for all $x \in R$. If f is continuous at $x = 1$ and $f(1) = 1$, then

(a) $f(2) = 1$

(b) $f(2) = 2$

(c) f is continuous only at $x = 1$

(d) f is continuous at all points

46. The angle of intersection between the curves $y = [|\sin x| + |\cos x|]$ and $x^2 + y^2 = 10$, where $[x]$ denotes the greatest integer $\le x$, is

(a) $\tan^{-1}(3)$ (b) $\tan^{-1}(-3)$

(c) $\tan^{-1}(\sqrt{3})$ (d) $\tan^{-1}(1/\sqrt{3})$

47. If the equation $x^2 + y^2 - 10x + 21 = 0$ has real roots $x = \alpha$ and $y = \beta$ then

(a) $3 \le x \le 7$ (b) $3 \le y \le 7$

(c) $-2 \le y \le 2$ (d) $-2 \le x \le 2$

48. If $[x]$ denotes the greatest integer $\le x$, then the value of $\lim_{x\to 0} |x|^{[\cos x]}$ is

(a) 0 (b) 1

(c) –1 (d) does not exist

49. If A, B are two events such that $P(A \cup B) \ge \frac{3}{4}$ and $\frac{1}{8} \le P(A \cap B) \le \frac{3}{8}$ then

(a) $P(A)+P(B)\le\frac{11}{8}$ (b) $P(A)\cdot P(B)\le\frac{3}{8}$

(c) $P(A)+P(B)\ge\frac{7}{8}$ (d) None of these

50. If $\cos x$ and $\sin x$ are solutions of the differential equation $a_0\frac{d^2y}{dx^2}+a_1\frac{dy}{dx}+a_2y=0$, where a_0, a_1, a_2 are real constants then which of the following is/are always true?

(a) $A\cos x + B\sin x$ is a solution, where A and B are real constants.

(b) $A\cos\left(x+\frac{\pi}{4}\right)$ is a solution, where A is a real constant.

(c) $A\cos x \sin x$ is a solution, where A is real constant.

(d) $A\cos\left(x+\frac{\pi}{4}\right)+B\sin\left(x-\frac{\pi}{4}\right)$ is a solution, where A and B are real constants.

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

Consider the circle $x^2 + y^2 = 9$ and the parabola $y^2 = 8x$. They intersect at P and Q in the first and the fourth quadrants, respectively. Tangents to the circle at P and Q intersect the x-axis at R and tangents to the parabola at P and Q intersect the x-axis at S.

51. The ratio of the areas of the triangles PQS and PQR is

(a) $1 : \sqrt{2}$ (b) 1 : 2 (c) 1 : 4 (d) 1 : 8

52. The radius of the circumcircle of the triangle PRS is

(a) 5 (b) $3\sqrt{3}$ (c) $3\sqrt{2}$ (d) $2\sqrt{3}$

PARAGRAPH 2

A fair die is tossed repeatedly until a six is obtained. Let X denote the number of tosses required.

53. The probability that $X \ge 3$ equals

(a) $\frac{125}{216}$ (b) $\frac{25}{36}$ (c) $\frac{5}{36}$ (d) $\frac{25}{216}$

54. The conditional probability that $X \ge 6$ given $X > 3$ equals

(a) $\frac{125}{216}$ (b) $\frac{25}{216}$ (c) $\frac{5}{36}$ (d) $\frac{25}{36}$

SOLUTIONS

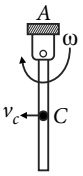
PAPER-I

1. (a) : The photon of energy 10.2 eV excites the electron from $n = 1$ to $n = 2$ as

$E_2 - E_1 = -3.4\text{ eV} - (-13.6\text{ eV}) = 10.2\text{ eV}$

The electron returns to the ground state in less than a microsecond and releases a photon of energy 10.2 eV. As the ionisation energy is 13.6 eV, the second photon of 15 eV energy ionises the atom by ejecting an electron and the balance of energy (15 eV – 13.6 eV = 1.4 eV) is retained by the ejected electron.

2. (b) : The rod will rotate about A. Therefore, from conservation of mechanical energy, Decrease in gravitational potential energy = increase in rotational kinetic energy about A



or $\quad mg\dfrac{l}{2} = \dfrac{1}{2}I_A\omega^2 \quad$ or $\quad mg\dfrac{l}{2} = \dfrac{1}{2}\left(\dfrac{ml^2}{3}\right)\omega^2$

$\therefore \quad \omega^2 = \dfrac{3g}{l} \qquad \ldots(i)$

Centripetal force of COM of rod in this position is

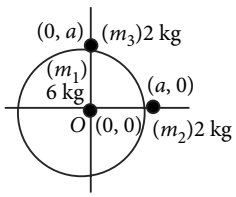
$m\dfrac{l}{2}\omega^2 = \dfrac{3mg}{2}$ (towards A)

Let F be the force exerted by the hinge on the rod upwards. Then

$F - mg = \dfrac{3mg}{2} \qquad \therefore \quad F = \dfrac{5}{2}mg$

or force exerted by the rod on the hinge is $\dfrac{5}{2}mg$ downwards.

3. (a) : It is clear from figure that coordinates of centre of mass C,



$$X_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

$$= \frac{6\times0 + 2\times0 + 2\times a}{6+2+2} = \frac{a}{5}$$

$\therefore \quad (X_{CM}, Y_{CM}) = \left(\dfrac{a}{5}, \dfrac{a}{5}\right)$

Hence $\overrightarrow{OC} = \dfrac{a}{5}\hat{i} + \dfrac{a}{5}\hat{j}$

$\therefore$ Angle made by $\overrightarrow{OC}$ with x-axis

$= \tan^{-1}\left(\dfrac{y}{x}\right) = \tan^{-1}\left(\dfrac{a/5}{a/5}\right) = 45°$

4. (a) : Let $\vec{v}_r = v_{rx}\hat{i} + v_{ry}\hat{j}$ and $\vec{v}_m = 5\hat{i}$ (in 1st case)

$\vec{v}_{rm} = (v_{rx} - v_m)\hat{i} + v_{ry}\hat{j}$

Case (i) : $\tan 90° = \dfrac{v_{ry}}{v_{rx} - 5}$ or $v_{rx} = 5\text{ m s}^{-1}$

Case (ii) : $\vec{v}_{rm} = (5\hat{i} - 10\hat{i}) + v_{ry}\hat{j} \quad (\because \vec{v}_m = 10\hat{i})$

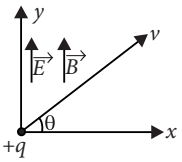
$\tan 60° = \dfrac{v_{ry}}{5-10}$ or $v_{ry} = -5\sqrt{3}$

$\vec{v}_r = 5\hat{i} - 5\sqrt{3}\hat{j} \Rightarrow |\vec{v}_r| = 10\text{ m s}^{-1}$

$\angle\phi = \tan^{-1}\left(\dfrac{-5\sqrt{3}}{5}\right)$ or $\phi = 120°$

5. (c)

6. (c, d) : Here, $\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{j}$



If θ = 0°, then due to magnetic force path is circular but due to electric force qE_0 (↑) q will have accelerated motion along y-axis.

So combined path of q will be a helical path with variable pitch. So (a) and (b) are wrong.

If θ = 10° then due to $v\cos\theta$, path is circular and due to qE_0 and $v\sin\theta$, q has accelerated motion along y-axis so combined path is a helical path with variable pitch. So (c) is correct.

If θ = 90° then F_B = 0 and due to qE_0 motion is accelerated along y-axis. So (d) is correct.

7. (a, b, c) : Here, t = 8 hours

As $N = N_0e^{-\lambda t}$ or $\dfrac{N}{N_0} = e^{-\lambda t}$

$0.0039 = e^{-\lambda 8}$ or $e^{\lambda 8} = \dfrac{1}{0.0039}$

$e^{\lambda 8} = 256$ or $e^{\lambda 8} = 2^8$

Taking natural logarithm on both sides, we get

$8\lambda = 8\ln 2$ or $\lambda = \ln 2$ per hour

Option (c) is correct.

$T_{1/2} = \dfrac{\ln 2}{\lambda} = 1\text{ hour}$

Option (a) is correct.

Mean time, $\tau = \dfrac{1}{\lambda} = \dfrac{1}{\ln 2}$ hour

Option (b) is correct.

$N = (10)^8\left(\dfrac{1}{2}\right)^{\left(\frac{1}{2}\right)} = \dfrac{1}{\sqrt{2}}\times10^8 = N = 5\sqrt{2}\times10^7$

Option (d) is incorrect.

8. (a, b, c) **9. (b, c, d)** **10. (b, d)**

11. (a, d) : As, $F_1 = k_1x$, $F_2 = k_2x$.

Work done $W_1 = \frac{1}{2}k_1x^2$ and $W_2 = \frac{1}{2}k_2x^2$

or $\alpha = \frac{W_1}{W_2} = \frac{k_1}{k_2}$

When the springs are stretched by the same force F, the extensions in springs A and B are x_1 and x_2 respectively which are given by

$F = k_1x_1 = k_2x_2$ or $\frac{x_1}{x_2} = \frac{k_2}{k_1}$ ...(i)

Work done $W_1' = \frac{1}{2}k_1x_1^2$ and $W_2' = \frac{1}{2}k_2x_2^2$

$\therefore \quad \frac{W_1'}{W_2'} = \frac{k_1}{k_2}\cdot\frac{x_1^2}{x_2^2}$ ...(ii)

Using (i) and (ii) we get

$\beta = \frac{W_1'}{W_2'} = \frac{k_1}{k_2}\cdot\frac{k_2^2}{k_1^2} = \frac{k_2}{k_1}$

12. (a, b, c, d) : Rate of heat flow $H = \frac{800 - 80}{\left(\frac{l_i}{K_iA}\right) + \left(\frac{l_o}{K_oA}\right)}$

which is also equal to $\frac{800 - T}{\left(\frac{l_i}{K_iA}\right)}$. Using these two relations we get, $T = 800 - \frac{720}{1 + \left(\frac{K_i}{K_o}\right)\left(\frac{l_o}{l_i}\right)}$. Thus one can reduce the temperature at the interface by any of the four options given.

13. (a, b, c, d) : Intensity, by definition, is the energy flowing per unit area per unit time.

The intensity is related to the displacement amplitude A of the sound wave by

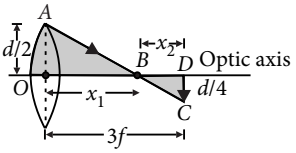
$I = \frac{1}{2}\rho v\omega^2A^2$

The displacement amplitude is given by $A = \frac{P}{Bk}$, where $k\left(=\frac{\omega}{v}\right)$ is the propagation constant.

The speed is given by $v = \sqrt{\frac{B}{\rho}}$.

Use these relations to get the required expressions.

14. (2) :



From similar triangles AOB and BDC

$\frac{OB}{BD} = \frac{AO}{CD}$ or $\frac{x_1}{x_2} = \frac{(d/2)}{(d/4)}$

or $x_1 = 2x_2$

As $x_1 + x_2 = 3f$, $2x_2 + x_2 = 3f$ or $x_2 = f$

i.e. $x_1 = 2f$

$\therefore \quad n = 2.$

15. (7)

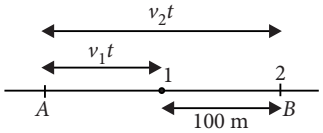
16. (4) : Let the velocities of car 1 and car 2 be v_1 m s^{-1} and v_2 m s^{-1}.

$\therefore$ Apparent frequencies of sound emitted by car 1 and car 2 as detected at end point are

$\upsilon_1 = \frac{\upsilon_0 v}{v - v_1}$ and $\upsilon_2 = \frac{\upsilon_0 v}{v - v_2}$

$\therefore \quad 330 = \frac{300 \times 330}{330 - v_1}$ or $v_1 = 30$ m s^{-1}

and $360 = \frac{300 \times 330}{330 - v_2}$ or $v_2 = 55$ m s^{-1}



The distance between both the cars just when the 2nd car reaches point B(as shown in figure) is

100 m = $v_2t - v_1t$

$t = \frac{100}{v_2 - v_1} = \frac{100}{55 - 30} = 4$ s

17. (5) : The capacitance of a parallel plate capacitor in air is given by

$C = \frac{\varepsilon_0 A}{d}$ ...(i)

By introducing a slab of thickness t, the new capacitance C' becomes

$C' = \frac{\varepsilon_0 A}{d' - t\left(1 - \frac{1}{K}\right)}$ ...(ii)

The charge ($Q = CV$) remains the same in both the cases.

Hence

$\frac{\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{d' - t\left(1 - \frac{1}{K}\right)}$

or $d = d' - t\left(1 - \frac{1}{K}\right)$

Here, $d' = d + 2.4 \times 10^{-3}$ m, $t = 3$ mm $= 3 \times 10^{-3}$ m
Substituting these values, we get

$$d = d + (2.4 \times 10^{-3}) - 3 \times 10^{-3}\left(1 - \frac{1}{K}\right)$$

or $$(2.4 \times 10^{-3}) = 3 \times 10^{-3}\left(1 - \frac{1}{K}\right)$$

Solving it, we get $K = 5$

18. (7)

19. (c) : $k = \frac{1}{t}\left[\frac{1}{a-x} - \frac{1}{a}\right]$ for second order reaction.

$$\therefore \quad \frac{1}{a-x} = kt + \frac{1}{a}$$

$\because$ The given graph between $(a - x)^{-1}$ and time 't' is linear.

$\therefore$ slope $= k = \tan\theta = 0.5$ L mol^{-1} min^{-1}

$OA = \frac{1}{a} = 2$ L mol^{-1}

$\therefore \quad a = 0.5$ mol L^{-1}

For second order reaction, rate of reaction is proportional to the square of concentration.

Rate $= k(a)^2 = 0.5 \times 0.5 \times 0.5 = 0.125$ mol L^{-1} min^{-1}

20. (c)

21. (c) : $w = -p\Delta V = -p(V_2 - V_1) = -1(20 - 10)$ atm dm^3

$= -10$ atm dm$^3 = -10 \times 101.27$ J $= -1012.7$ J

$\Delta U = q + w = 800 - 1012.7 = -212.7$ J ≈ -213 J

22. (a) : $d = \frac{Z \times M}{a^3 \times N_A}$ or $Z = \frac{d \times a^3 \times N_A}{M}$

$$Z = \frac{(2\text{ g cm}^{-3})(5\times10^{-8}\text{cm})^3(6\times10^{23}\text{mol}^{-1})}{75\text{ g mol}^{-1}} = 2$$

Since, the number of atoms per unit cell is 2. It indicates that the metal has body centred cubic (*bcc*) lattice.

For *bcc* lattice, body diagonal of the unit cell,
4 × atomic radius (r) = $\sqrt{3}$ × edge length (a)

$$\therefore \quad 4r = \sqrt{3} \times 5\text{ Å} \text{ or } r = \frac{\sqrt{3}}{4} \times 5\text{ Å} = 2.165\text{ Å}$$

23. (a) : The graph reveals that the solubility of gas P is lowest. Thus, the value of K_H for gas P is highest because higher the value of K_H, lower is the solubility of the gas.

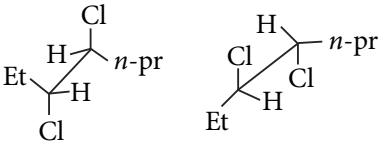
24. (a, b, c) **25. (b, d)**

26. (a,b,c,d) : $HBr + KOH \longrightarrow KBr + H_2O$;
volume of the resulting solution will be doubled and the solution will be neutral (pH = 7).

Hence, $[K^+] = [Br^-] = \frac{0.1}{2} = 0.05$ mol L^{-1}

$[H_3O^+] = [OH^-] = 1.0 \times 10^{-7}$ mol L^{-1}

27. (b) : Bridged ion would generate a pair of enantiomers.



28. (b,d) : When hard water is passed through zeolite, Ca^{2+} and Mg^{2+} react with sodium zeolite and form calcium and magnesium zeolites.

$Na_2Al_2Si_2O_8 . xH_2O + Ca^{2+} \longrightarrow CaAl_2Si_2O_8 . xH_2O + 2Na^+$

$Na_2Al_2Si_2O_8 . xH_2O + Mg^{2+} \longrightarrow MgAl_2Si_2O_8 . xH_2O + 2Na^+$

29. (c) : —Cl group present at *o*- or *p*- positions to the electron withdrawing group is activated towards nucleophilic substitution reaction. Hence, only —Cl present at the *o*- or *p*-position to the —NO_2 group will be replaced by —NH_2 group.

30. (a, c, d) **31. (a, b, c, d)**

32. (5) : O_2^+, CN, NO, N_2^+ and CO^+ have bond order of 2.5.

33. (5) : Mass of glucose = 120 g

No. of moles of glucose $= \frac{120}{180} = 0.67$

Heat produced after eating 0.67 mol of glucose

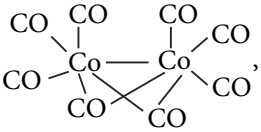
$= 0.67 \times 2880 = 1929.6$ kJ

Energy available for muscular work

$$= 1929.6 \times \frac{25}{100} = 482.4\text{ kJ}$$

Approximate distance that a person will walk

$$= \frac{482.4}{100} = 4.824\text{ km} \approx 5\text{ km}$$

34. (3) : $[Co_2(CO)_8]$ has six terminal and two bridged CO groups 

, the ratio is 6 : 2 *i.e.*, 3 : 1. Hence, the value of x is 3.

35. (8) :

	$8B_{(g)}$	$\rightleftharpoons$	$8A_{(g)}$	+	$C_{(s)}$
Initial no. of moles :	$\frac{4V}{RT}$		$\frac{2V}{RT}$		
No. of moles at eq. :	$\frac{4V}{RT} - x$		$\frac{2V}{RT} + x$		

Given that, at equilibrium,

$$\left(\frac{n_A}{n_B}\right)_{eq.} = \left(\frac{n_B}{n_A}\right)_{initial}$$

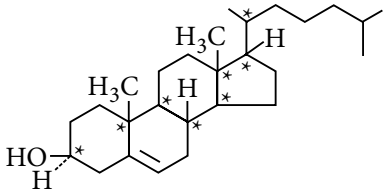
$$\frac{\frac{2V}{RT}+x}{\frac{4V}{RT}-x} = \frac{\frac{4V}{RT}}{\frac{2V}{RT}}$$

$\therefore \quad x = \frac{2V}{RT}$

$\therefore \quad K_c = \frac{\left(\frac{4V}{RT}\right)^8}{\left(\frac{2V}{RT}\right)^8} = 2^8 = 2^y$

$\therefore \quad y = 8$

36. (8):



Cholesterol

37. (b): $x + y + z = 0, x \geq -5, y \geq -5, z \geq -5$

Let $x = \alpha - 5, \alpha \geq 0, y = \beta - 5, \beta \geq 0, z = \gamma - 5, \gamma \geq 0$

Now, $(\alpha - 5 + \beta - 5 + \gamma - 5) = 0 \Rightarrow \alpha + \beta + \gamma = 15$

No. of integral solution $= {}^{15+3-1}C_{3-1} = {}^{17}C_2 = 136.$

38. (c): Let S = smoker, S' = Non-smoker, D = death by cancer

Using conditional probability, we can write

$P(D) = P(S)\,P(D \mid S)$ or $P(S')\,P(D \mid S')$

$$0.006 = \frac{20}{100}\cdot P(D|S) + \frac{80}{100}\cdot P(D|S') = \frac{1}{5}\cdot x + \frac{4}{5}\cdot\frac{x}{10}$$

[Let $P(D \mid S) = x$ and given $P(D \mid S) = 10 \cdot P(D \mid S')$]

$\Rightarrow \quad x = \frac{3}{140}$

39. (d): Let $A = \begin{bmatrix} d_1 & 0 & 0 & 0 \\ 0 & d_2 & 0 & 0 \\ 0 & 0 & d_3 & 0 \\ 0 & 0 & 0 & d_4 \end{bmatrix}$

$$A^2 = A\cdot A = \begin{bmatrix} d_1^2 & 0 & 0 & 0 \\ 0 & d_2^2 & 0 & 0 \\ 0 & 0 & d_3^2 & 0 \\ 0 & 0 & 0 & d_4^2 \end{bmatrix}$$

Given, $A^2 = A$

$\therefore \quad d_i^2 = d_i \; (i = 1, 2, 3, 4) \quad$ or $\quad d_i\,(d_i - 1) = 0$

$\Rightarrow \quad d_i = 0$ or 1 for $i = 1, 2, 3, 4$

$\therefore$ Each diagonal elements can be chosen in 2 ways (either 0 or 1). As there are 4 diagonal elements.

$\therefore$ No. of ways $= 2 \times 2 \times 2 \times 2 = 16$

$\therefore$ No. of non-zero diagonal matrices

$= 16 - 1 = 15 \quad [\because$ One of them is zero matrix]

40. (a): $\sin x + \operatorname{cosec} x = 2$ (given) ...(i)

Squaring both sides, we get

$\sin^2 x + \operatorname{cosec}^2 x + 2 = 4$ or $\sin^2 x + \operatorname{cosec}^2 x = 2$

$\therefore$ For $n = 2, \sin^n x + \operatorname{cosec}^n x = 2$

On cubing, equation (i) gives

$\sin^3 x + \operatorname{cosec}^3 x + 3(2) = 8$

or $\sin^3 x + \operatorname{cosec}^3 x = 8 - 6 = 2$

$\therefore$ For $n = 3, \sin^n x + \operatorname{cosec}^n x = 2$

For $n = 4, (\sin x + \operatorname{cosec} x)^4 = 16$

$\Rightarrow (\sin^2 x + \operatorname{cosec}^2 x + 2)^2 = 16$

$\Rightarrow \sin^4 x + \operatorname{cosec}^4 x + 4 + 2 + 4(2) = 16$

$\Rightarrow \sin^4 x + \operatorname{cosec}^4 x = 16 - 14 = 2$

Proceeding in the same way, we find that

$\sin^n x + \operatorname{cosec}^n x = 2 \; \forall \; n \in N.$

41. (b): Since, $g(x)\,g(y) = g(x) + g(y) + g(xy) - 2$

Now, at $x = 0, y = 2$, we get $g(0)\,g(2) = g(0) + g(2) + g(0) - 2$

$\Rightarrow \quad 5g(0) = 5 + 2g(0) - 2 \Rightarrow 3g(0) = 3 \Rightarrow g(0) = 1$

$g(x)$ is given in a polynomial and by the given relation $g(x)$ can not be linear.

Let $g(x) = x^2 + k \Rightarrow g(x) = x^2 + 1 \; [\because g(0) = 1]$

$\therefore \quad (x^2 + 1)(y^2 + 1) = x^2 + 1 + y^2 + 1 + x^2 y^2 + 1 - 2$

$\therefore \quad \lim_{x \to 3} g(x) = g(3) = 3^2 + 1 = 10$

42. (b, d): We have, $4x^2 + 9y^2 = 1$ ...(i) & $8x = 9y$ ...(ii)

Differentiating (i) w.r.t. x, we get

$$8x + 18y\frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = -\frac{4x}{9y}$$

$\Rightarrow$ slope of tangent $= \frac{-4x}{9y}.$

Also, slope of line (ii) $= \frac{8}{9}$

Since line (ii) is parallel to the tangent.

$\therefore \quad \frac{-4x}{9y} = \frac{8}{9} \quad \Rightarrow \quad x = -2y$

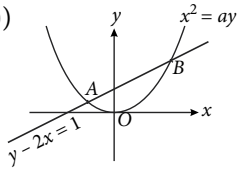
From (i), $4(4y^2) + 9y^2 = 1 \Rightarrow y^2 = \frac{1}{25} \Rightarrow y = \pm\frac{1}{5}$

When $y = \frac{1}{5}, \; x = -\frac{2}{5}$; when $y = -\frac{1}{5}, \; x = \frac{2}{5}$

$\therefore \quad$ Points are $\left(-\frac{2}{5}, \frac{1}{5}\right)$ and $\left(\frac{2}{5}, -\frac{1}{5}\right)$

43. (a, d)

44. (a, b) : Let $A(x_1, y_1)$, $B(x_2, y_2)$) be the points of intersection.



On solving, $x^2 = a(2x + 1)$

$\Rightarrow \quad x^2 - 2ax - a = 0$

$\therefore \quad x_1 + x_2 = 2a, x_1x_2 = -a$

Now, $AB = \sqrt{40} \Rightarrow \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} = \sqrt{40}$

$\Rightarrow \quad \sqrt{(x_2 - x_1)^2 + \{2(x_2 - x_1)\}^2} = \sqrt{40}$

$\Rightarrow \quad 5\{(x_2 - x_1)^2\} = 40 \Rightarrow (x_1 + x_2)^2 - 4x_1x_2 = 8$

$\Rightarrow \quad 4a^2 + 4a = 8 \Rightarrow a^2 + a - 2 = 0 \Rightarrow a = 1, -2$

45. (a, d) : $\dfrac{dy}{dx} - y \tan x = 2x \sec x$

It is a linear differential equation.

$\therefore \quad$ I.F. $= e^{-\int \tan x\, dx} = e^{-\ln(\sec x)} = \cos x$

The solution is $y \cdot \cos x = \int 2x \sec x \cos x\, dx = x^2 + c$

We have $y(0) = 0 \Rightarrow c = 0 \quad \therefore \; y = x^2 \sec x$

$$y\left(\frac{\pi}{4}\right) = \frac{\pi^2}{16} \cdot \sqrt{2} = \frac{\pi^2}{8\sqrt{2}} \Rightarrow y' = 2x \sec x + x^2 \sec x \tan x$$

$$y'\left(\frac{\pi}{3}\right) = 2 \cdot \frac{\pi}{3} \cdot 2 + \frac{\pi^2}{9} 2 \cdot \sqrt{3} = \frac{4\pi}{3} + \frac{2\pi^2}{3\sqrt{3}}$$

46. (b, d) : In any series of $(2n - 1)$ terms, the middle term is t_n. According to problem, t_n of A.P., G.P. and H.P. are a, b, c respectively. Hence, a, b, c are A.M., G.M. and H.M. respectively.

$\because \quad$ A.M. $\geq$ G.M. $\geq$ H.M. $\Rightarrow \quad a \geq b \geq c$

Further, $(\text{G.M.})^2 = (\text{A.M.}) \times (\text{H.M.})$

$\therefore \quad b^2 = ac \quad \Rightarrow \quad ac - b^2 = 0$

47. (a, b) : By geometrical condition, line L is parallel to the line of intersection of P_1 and P_2.

A vector along L is $(\hat{i} + 2\hat{j} - \hat{k}) \times (2\hat{i} - \hat{j} + \hat{k})$

$= \hat{i} - 3\hat{j} - 5\hat{k}$

Any point on L is $A(\lambda, -3\lambda, -5\lambda)$

The foot of perpendicular from A to plane P_1 is

$$\frac{\alpha - \lambda}{1} = \frac{\beta + 3\lambda}{2} = \frac{\gamma + 5\lambda}{-1} = -\frac{\lambda - 6\lambda + 5\lambda + 1}{1 + 4 + 1} = -\frac{1}{6}$$

$\therefore \quad$ The foot of perpendicular is

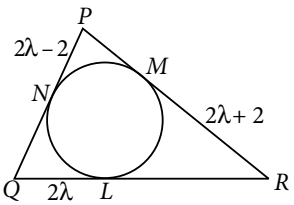
$$\left(\lambda - \frac{1}{6}, -3\lambda - \frac{1}{3}, -5\lambda + \frac{1}{6}\right)$$

48. (b, d) : Let $PN = 2\lambda - 2$,

$QL = 2\lambda$ and $MR = 2\lambda + 2$

So $PQ = 4\lambda - 2$,

$QR = 4\lambda + 2$, $RP = 4\lambda$



Since, $\cos P = \dfrac{1}{3}$

$\Rightarrow \quad 3[(4\lambda)^2 + (4\lambda - 2)^2 - (4\lambda + 2)^2] = 2 \cdot 4\lambda(4\lambda - 2)$

$\Rightarrow \quad 3\{16\lambda^2 - 32\lambda\} = 8\lambda(4\lambda - 2) \Rightarrow 16\lambda^2 = 80\lambda$

$\therefore \quad \lambda = 5$

The sides are 18, 20 and 22.

49. (b, c) : $D = \begin{vmatrix} 1 & 1 & 1 \\ \alpha & \beta & \gamma \\ \alpha^2 & \beta^2 & \gamma^2 \end{vmatrix} = \begin{vmatrix} 1 & 0 & 0 \\ \alpha & \beta - \alpha & \gamma - \alpha \\ \alpha^2 & \beta^2 - \alpha^2 & \gamma^2 - \alpha^2 \end{vmatrix}$

$(C_2 \to C_2 - C_1, C_3 \to C_3 - C_1)$

$= (\beta - \alpha)(\gamma - \alpha)(\gamma - \beta) = (\alpha - \beta)(\beta - \gamma)(\gamma - \alpha)$

$\because \quad D = 0 \Rightarrow$ trivial as well as non-trivial solution and so the number of solutions will be infinite.

$\because \quad D \neq 0 \Rightarrow$ system has only trivial solution.

50. (3) : $$\frac{1}{\sqrt{(3x+1)}}\left[\left(\frac{1+\sqrt{3x+1}}{2}\right)^7 - \left(\frac{1-\sqrt{3x+1}}{2}\right)^7\right]$$

$$= \frac{1}{2^7\sqrt{(3x+1)}}\left[\left(1+\sqrt{3x+1}\right)^7 - \left(1-\sqrt{3x+1}\right)^7\right] \quad \ldots(\text{i})$$

Now, $\left(1+\sqrt{3x+1}\right)^7 - \left(1-\sqrt{3x+1}\right)^7$

$$= 2\left[{}^7C_1\left(\sqrt{3x+1}\right) + {}^7C_3\left(\sqrt{3x+1}\right)^3 + {}^7C_5\left(\sqrt{3x+1}\right)^5 + {}^7C_7\left(\sqrt{3x+1}\right)^7\right]$$

$= 2\sqrt{3x+1} \times [7 + 35(3x+1) + 21(3x+1)^2 + (3x+1)^3]$

Now, putting above value in (i), so the given expression becomes

$\dfrac{1}{2^6}[42 + 105x + 21(3x + 1)^2 + (3x + 1)^3]$

So, degree of given expression is 3.

51. (5) : $\because$ A has rank 3

$\therefore \quad |A| = 0 \Rightarrow \alpha = 5$

52. (1) : $$\lim_{x \to 0} \frac{e^{5x} - e^{4x}}{x}$$

$$= \lim_{x \to 0} \frac{\left(1 + 5x + \dfrac{(5x)^2}{\underline{|2}} + \ldots\infty\right) - \left(1 + 4x + \dfrac{(4x)^2}{\underline{|2}} + \ldots\infty\right)}{x}$$

$$= \lim_{x \to 0} \frac{x + x^2\left(\dfrac{25}{2} - \dfrac{16}{2}\right) + \ldots\infty}{x} = 1$$

53. (3) : $\int_0^2 (|x-2|+[x])dx = \int_0^2 |x-2|\,dx + \int_0^2 [x]\cdot dx$

$= \int_0^2 -(x-2)dx + \int_0^1 [x]dx + \int_1^2 [x]dx$

$= \left[2x - \frac{x^2}{2}\right]_0^2 + 0 + \int_1^2 1dx = (4-2) + (2-1) = 3$

54. (7) : $f(x) = \begin{cases} \frac{x^3+x^2-16x+20}{(x-2)^2}, & \text{if } x \neq 2 \\ b, & \text{if } x = 2 \end{cases}$

$\therefore \quad \lim_{x\to 2} f(x) = \lim_{x\to 2} \frac{x^3+x^2-16x+20}{(x-2)^2}$

$= \lim_{x\to 2} \frac{(x-2)(x+5)(x-2)}{(x-2)^2} = \lim_{x\to 2}(x+5) = 2+5 = 7$

$\because$ $f(x)$ is continuous for all x.

$\therefore \quad f(2) = \lim_{x\to 2} f(x) \quad \Rightarrow \quad b = 7$

PAPER-II

1. (a) : $F_e = qE = 10 \times 10^{-6} \times 10^5 = 1$ N

$mg = 100 \times 10^{-3} \times 10 = 1$ N

This means weight of particle is balanced by electrostatic force.

Net force on the particle is due to charge on rings only.

Potential energy of particle at centre of ring A

$$U_i = U_0 + \frac{1}{4\pi\varepsilon_0}\frac{qq_1}{a} + \frac{1}{4\pi\varepsilon_0}\cdot\frac{(-qq_2)}{\sqrt{a^2+h^2}}$$

(where U_0 = potential energy due to electric field E)

Potential energy of particle at centre of ring B

$$U_f = U_0 + \frac{1}{4\pi\varepsilon_0}\frac{qq_1}{\sqrt{a^2+h^2}} + \frac{1}{4\pi\varepsilon_0}\cdot\frac{(-qq_2)}{a}$$

Applying conservation of energy

Increase in kinetic energy of particle at centre of ring B = Loss of potential energy

$$\frac{1}{2}mv^2 = U_i - U_f$$

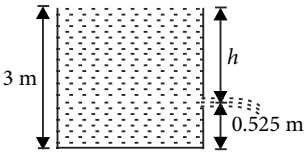
Substituting the values and evaluating we get

$v = 6\sqrt{2}$ m s^{-1}

2. (b) **3. (c)**

4. (b) : Let a_1 be the area of cross section of tank and a_2 be the area of hole, v_2 be velocity of water coming out of the hole (velocity of efflux)

Let v_1 be the speed at which the level decreases in the tank.



Using the equation of continuity, we get

$a_1v_1 = a_2v_2$

Given, $\frac{a_2}{a_1} = 0.1$

$\therefore \quad v_2 = \frac{a_1}{a_2}v_1 = 10v_1$ ...(i)

Using the Bernoulli's theorem, we get

$P_0 + \rho gh + \frac{1}{2}\rho v_1^2 = P_0 + \frac{1}{2}\rho v_2^2$

$v_2^2 - v_1^2 = 2gh \Rightarrow v_1^2 \propto (10^2 - 1) = 2gh$

$v_1^2 = \sqrt{\frac{2\times 9.8\times 2.475}{99}} = 0.7$ m s^{-1}

Velocity of water coming out of the hole

$v = 10v_1 = 7$ m s^{-1}

5. (a)

6. (d) : At the area of total darkness, in double slit apparatus, minima will occur for both the wavelengths which are incident simultaneously and normally.

$\therefore \quad \frac{(2n+1)\lambda_1}{2} = \frac{(2m+1)\lambda_2}{2}$ or $\frac{2n+1}{2m+1} = \frac{\lambda_2}{\lambda_1}$

or $\frac{2n+1}{2m+1} = \frac{560}{400} = \frac{7}{5}$ or $10n = 14m + 2$

By inspection, the two solutions are

(i) if $m_1 = 2, n_1 = 3$ (ii) if $m_2 = 7, n_2 = 10$

$\therefore$ Distance between areas correspond to these points.

$\therefore$ Distance $\Delta S = \frac{D\lambda_1}{d}\left[\frac{(2n_2+1)-(2n_1+1)}{2}\right]$

Put $n_2 = 10$ and $n_1 = 3$,

$\Delta S = \frac{1 \times (400 \times 10^{-9})}{0.1 \times 10^{-3}}\left[\frac{21-7}{2}\right]$

or $\Delta S = 4 \times 7 \times 10^{-3}$ m or $\Delta S = 28$ mm.

7. (b, d) : Work is done against friction in the rough section during compression in both ascent and descent of the mass. This results in energy loss from the gravitational potential energy. Hence work done against frictional force is the difference in gravitational potential energy of the mass at its highest points.

The vertical difference x in heights

$= (1.0 - 0.7)\sin 30° = 0.15$ m

Hence, work done against friction = mgx

$= 5 \times 10 \times 0.15 = 7.5$ J

The gravitational potential energy transferred to the spring is the energy of the spring at its maximum compression.

Since equal work is done against friction during descent as well as ascent.

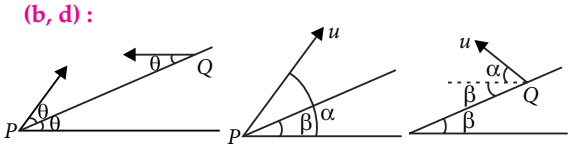
Work done against friction during descent $= \frac{7.5}{2} = 3.75$ J

Hence, gravitational potential energy transferred to the spring

$= [5 \times 10 \times (1.10 \sin 30°) - 3.75] = [27.5 - 3.75] = 23.75$ J

8. **(a, b, c, d)**

9. **(b, d) :**



Time of flight of P is

$$T_1 = \frac{2u\sin(2\theta-\theta)}{g\cos\theta} = \frac{2u\tan\theta}{g} \quad \text{...(i)}$$

and time of flight of Q is

$$T_2 = \frac{2u\sin\theta}{g\cos\theta} = \frac{2u\tan\theta}{g} \quad \text{...(ii)}$$

From equations (i) and (ii)

$\therefore \quad T_1 = T_2$

Further acceleration of both the particles is g downwards. Therefore, relative acceleration between the two is zero or relative motion between the two is uniform. Now relative velocity of P with respect to Q is towards PQ. Therefore, collision will take place between the two in mid air.

10. **(a, d) :** This is a L-C circuit. Therefore,

$q = q_0\cos\omega t$ and $V = V_0\cos\omega t$

where $\omega = \frac{1}{\sqrt{LC}}$ or $T = 2\pi\sqrt{LC}$

$$i = \frac{dq}{dt} = -q_0\omega\sin(\omega t)$$

(a) maximum current in the circuit is

$$i_{max} = q_0\omega = CV_0\frac{1}{\sqrt{LC}} = V_0\sqrt{\frac{C}{L}}$$

(b) potential across capacitor becomes zero after time

$$t = \frac{T}{4} = \frac{\pi}{2}\sqrt{LC}$$

(c) at time $t = \frac{\pi}{2}\sqrt{LC}$ or $\frac{T}{4}$ energy stored in the capacitor is zero. Thus, the energy $\frac{1}{2}CV_0^2$ will be stored in the inductor.

(d) the maximum energy stored in the inductor will be $\frac{1}{2}CV_0^2$

11. **(a, c) :** Magnetic force on a charged particle provides the necessary centripetal force required for circular motion of the charged particle, when a uniform magnetic field is imposed perpendicular to its velocity.

$$\therefore \quad qvB = \frac{mv^2}{r} \quad \text{or} \quad r = \frac{mv}{qB} \quad \text{...(i)}$$

Kinetic energy $= \frac{1}{2}mv^2$

$$\text{or} \quad K = \frac{1}{2}mv^2 \quad \text{or} \quad v = \sqrt{\frac{2K}{m}} \quad \text{...(ii)}$$

$\therefore \quad r = \frac{m}{qB} \times \sqrt{\frac{2K}{m}}$, from (i) and (ii).

$$\text{or} \quad r = \frac{\sqrt{2Km}}{qB} \quad \therefore \quad \text{For } H^+, \ r_1 = \frac{\sqrt{2K\times 1}}{eB} = \frac{\sqrt{2K}}{eB}$$

$$\text{For } He^+, \ r_2 = \frac{\sqrt{2K\times 4}}{(e)B} = \frac{\sqrt{8K}}{eB} = 2r_1$$

$$\text{For } O^{++}, \ r_3 = \frac{\sqrt{2K\times 16}}{(2e)B} = \frac{\sqrt{8K}}{eB} = 2r_1$$

(a) H^+ will be deflected most as its radius is least.

(c) He^+ and O^+ will be deflected equally.

12. **(c, d) :** If θ is the angle made by the direction of force with the horizontal, we have

$F_1\cos\theta = \mu(mg + F_1\sin\theta)$ and

$F_2\cos\theta = \mu(mg - F_2\sin\theta)$.

Clearly $F_1 > F_2$ so that option (c) is correct.

If $\sin\theta = \frac{mg}{4F_2}$, two relations written above becomes

$$F_1\cos\theta = \mu\left(mg + \frac{mgF_1}{4F_2}\right) \text{ and}$$

$$F_2\cos\theta = \mu\left(mg - \frac{mgF_2}{4F_2}\right).$$

$$\text{Thus, } \frac{F_1}{F_2} = \frac{1+(F_1/4F_2)}{(3/4)} \Rightarrow F_1 = 2F_2$$

13. **(a, c, d) :** Wavelength depends on length which is fixed. Thus, wavelength does not change.

Further $v = \sqrt{T/m}$ or $v \propto T^{1/2}$

$\therefore$ percentage change in $v = \frac{1}{2}$ × percentage change in T

$= \frac{1}{2}(2) = 1\%$

i.e. Speed and hence frequency will change by 1%. Change in frequency is 15 Hz which is 1% of 1500 Hz.

Therefore, original frequency should be 1500 Hz.

14. (a, b, c) : Here $\vec{v} = x\hat{i} + y\hat{j}$

$\vec{B} = y\hat{i} + x\hat{j}$

If $x = y$ then $\vec{v} \| \vec{B}$ *i.e.*; $\vec{F} = 0$

Hence, option (a) is correct

As $\vec{F} = q(\vec{v} \times \vec{B}) = q\left[(x\hat{i} + y\hat{j}) \times (y\hat{i} + x\hat{j})\right]$

$= (x^2 - y^2)\hat{k}$

Now, if $x > y$, $F \propto x^2 - y^2$ and force is along z-axis. But if $y > x$, force will be along negative z-axis.

$\therefore$ Option (b) and (c) are also correct.

15. (c) **16. (a)**

17. (c) : Equation of motion for pulley,

$F - 2T = m_P \times a$

Since pulley is massless *i.e.*, $m_P = 0$

$F = 2T$, $\therefore$ $T = \frac{F}{2}$

18. (c) : $F = \frac{dp}{dt} = \frac{m\Delta v}{\Delta t}$

For quarter of a circle,

$\Delta v = v\sqrt{2}$ and $\Delta t = \frac{\pi r}{2v}$ $\therefore$ $F = \frac{2\sqrt{2}\, mv^2}{\pi r}$

19. (c) : In this cell, zinc acts as anode and silver acts as cathode.

$E^\circ_{cell} = E^\circ_{Ag_2O/Ag} - E^\circ_{Zn^{2+}/Zn} = 0.344 - (-0.76) = 1.104\ V$

$\Delta_r G^\circ = -nFE^\circ_{cell} = -2 \times 96500 \times 1.104 = -2.13 \times 10^5\ J$

20. (c)

21. (b): $HC{\equiv}CH \xrightarrow[-CH_4]{CH_3MgBr} HC{\equiv}CMgBr \xrightarrow[(ii)H_3O^+]{(i)\ CO_2}$

$\overset{\delta+}{H}C{\equiv}\overset{\delta-}{C}-COOH \xrightarrow{(HgSO_4 + H_2SO_4)} H-\underset{OH}{\underset{|}{C}}{=}CH-COOH$

$\xrightleftharpoons{\text{Tautomerises}} H-\overset{O}{\overset{\|}{C}}-CH_2-COOH$

$\xrightarrow[\text{oxidation}]{Ag_2O} HO-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-OH$

Malonic acid

22. (d): $H_3C-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-CH_2-CH_2-CH_2-OH \xrightarrow[-H_2O]{H^+}$

$H_3C-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-CH_2-CH_2-\overset{+}{C}H_2 \xrightarrow{1,2\text{-}H^-\ shift}$

$H_3C-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-CH_2-\overset{+}{C}H-CH_3 \xrightarrow{-H^+}$

$H_3C-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-CH{=}CH-CH_3$

23. (d): For N_2 molecule, order of energies of the molecular orbitals is :

$\sigma 2s < \sigma^* 2s < \pi 2p_x = \pi 2p_y < \sigma 2p_z < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$

24. (d): $H_3C-C_6H_4-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{NaOH/Br_2}$

$H_3C-C_6H_4-NH_2 \xrightarrow{C_6H_4-\overset{O}{\overset{\|}{C}}-Cl}$

$H_3C-C_6H_4-NH-\overset{O}{\overset{\|}{C}}-C_6H_5$

25. (c, d) : Reactions (c) and (d) in which CH_4 does not undergo complete combustion to give CO_2 and H_2O are controlled oxidation reactions. Whereas reaction (b) is an example of incomplete combustion.

26. (c,d) **27. (a, b, c)**

28. (b,c,d) : Condensation polymers are formed by condensation of diols or diamines with dicarboxylic acids.

(a) $H_3COOC-(CH_2)_4-COOCH_3 \xrightarrow{H_2/\ Ni/\ heat}$ No reaction

(b) $H_2N-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[\text{(Amides are reduced to amines)}]{H_2/\ Ni/\ heat}$

$H_2N-CH_2-(CH_2)_4-CH_2-NH_2$

(c) $H_2N-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[\text{(Hofmann bromamide reaction)}]{Br_2/NaOH} H_2N-(CH_2)_4-NH_2$

(d) $NC-(CH_2)_4-CN \xrightarrow[\text{(Nitriles are reduced to 1° amines)}]{H_2/Ni/heat} H_2NCH_2-(CH_2)_4-CH_2NH_2$

29. (a) : Let number of α-particles emitted be m and number of β-particles emitted be n.

Hence, $^{232}_{90}Th \longrightarrow {}^{208}_{82}Pb + m\,{}^{4}_{2}He + n\,{}^{0}_{-1}e$ ...(i)

On equalising mass numbers on both sides of eq. (i), we get

$232 = 208 + (m \times 4) + n \times 0 \Rightarrow 4m = 232 - 208$

$m = \frac{24}{4} = 6$ (number of α-particles emitted)

Similarly, on equalising atomic numbers on both sides of eq. (i), we get

$90 = 82 + (m \times 2) + [n \times (-1)] = 82 + 2m - n$

or, $2m - n = 90 - 82 = 8$

or, $n = 2m - 8 = 2 \times 6 - 8 = 4$

(number of β-particles emitted)

30. (a, b, c)

31. (a, b) : $H_2S + O_3 \longrightarrow H_2O + S + O_2$

$PbS + 4O_3 \longrightarrow PbSO_4 + 4O_2$

32. (a, b, d) **33. (c)** **34. (a)**

35. (a) : $[Cr(NH_3)_3Cl_3]$ gives two geometrical isomers facial (*fac*) and meridional (*mer*).

36. (b) : When an octahedral complex contains all the three bidentate ligands, it shows optical isomerism because it lacks plane of symmetry.

37. (c) : $\lim_{x\to1}\left(\frac{1+x}{2+x}\right)^{\frac{(1-\sqrt{x})}{(1+\sqrt{x})(1-\sqrt{x})}} = \lim_{x\to1}\left(\frac{1+x}{2+x}\right)^{\frac{1}{1+\sqrt{x}}} = \sqrt{\frac{2}{3}}$

38. (a) : If $0 < x < 1$, then

$x^1 > x^{\pi/2} > x^2 \quad \left[\because \frac{\pi}{2} = 1.57 \text{ (app.)}\right]$

$\Rightarrow 1 + x > 1 + x^{\pi/2} > 1 + x^2$

$\Rightarrow \frac{1}{1+x} < \frac{1}{1+x^{\pi/2}} < \frac{1}{1+x^2}$

$\Rightarrow \int_0^1 \frac{dx}{1+x} < \int_0^1 \frac{dx}{1+x^{\pi/2}} < \int_0^1 \frac{dx}{1+x^2}$

$\Rightarrow \left[\log(1+x)\right]_0^1 < I < \left[\tan^{-1}x\right]_0^1 \Rightarrow \log 2 < I < \frac{\pi}{4}$

39. (a) : $y = 2^x$ ... (i) $y = 3^x$ ...(ii)

$m_1 = \frac{dy}{dx} = 2^x \log 2$, $m_2 = \frac{dy}{dx} = 3^x \log 3$

(0, 1) is the point of intersection of the two curves.

$\therefore \quad m_1 = \left(\frac{dy}{dx}\right)_{(0,1)} = \log 2$, $m_2 = \left(\frac{dy}{dx}\right)_{(0,1)} = \log 3$

$\therefore \quad \tan\alpha = \frac{\log 3 - \log 2}{1 + \log 2 \times \log 3} = \frac{\log\frac{3}{2}}{1 + (\log 2)(\log 3)}$

40. (a) : $\sin\left(\frac{x}{y}\right)(x\,dy - y\,dx) = y\,dy$

$\Rightarrow \quad -\sin\left(\frac{x}{y}\right)\left(\frac{ydx - xdy}{y^2}\right) = \frac{dy}{y}$

On integrating, $\cos\left(\frac{x}{y}\right) = \log_e y + C$

$\because \quad y\left(\frac{\pi}{4}\right) = 1$ (given)

$\therefore \quad \cos\frac{\pi}{4} = \log_e 1 + C \quad \Rightarrow C = \frac{1}{\sqrt{2}}$

$\therefore \quad \cos\left(\frac{x}{y}\right) = \log_e y + \frac{1}{\sqrt{2}}$

41. (d) : $\because$ α, β are roots of $a\cos\theta + b\sin\theta = c$ ... (i)

$\therefore \quad a\cos\alpha + b\sin\alpha = c$ ...(ii)

$a\cos\beta + b\sin\beta = c$ ...(iii)

(iii) – (ii) gives

$a \cdot 2\sin\left(\frac{\alpha+\beta}{2}\right)\sin\left(\frac{\alpha-\beta}{2}\right) - b \cdot 2\cos\left(\frac{\alpha+\beta}{2}\right)\sin\left(\frac{\alpha-\beta}{2}\right) = 0$

$\Rightarrow \quad \tan\left(\frac{\alpha+\beta}{2}\right) = \frac{b}{a}$ ...(iv)

If α + β is also a root of (i) then

$a\cos(\alpha + \beta) + b\sin(\alpha + \beta) = c$

$\Rightarrow \quad \frac{a\left\{1 - \left(\frac{b}{a}\right)^2\right\}}{1 + \left(\frac{b}{a}\right)^2} + \frac{b \cdot 2\left(\frac{b}{a}\right)}{1 + \left(\frac{b}{a}\right)^2} = c$ [using (iv)]

$\Rightarrow \quad \frac{a(a^2 - b^2) + 2b^2a}{a^2 + b^2} = c \Rightarrow a = c.$

42. (d)

43. (a, c, d) : As $\vec{a} + \vec{b} + \vec{c} = 0$

$\Rightarrow \quad a^2 = b^2 + c^2 + 2\vec{b}\cdot\vec{c}$

$\Rightarrow \quad 144 = 48 + c^2 + 48 \Rightarrow c^2 = 48 \Rightarrow c = 4\sqrt{3}$

Again, $c^2 = a^2 + b^2 + 2\vec{a}\cdot\vec{b}$

$\Rightarrow \vec{a}\cdot\vec{b} = \dfrac{48-144-48}{2} = -72$

$|\vec{a}\times\vec{b} + \vec{c}\times\vec{a}| = |\vec{a}\times\vec{b} + \vec{a}\times\vec{b}| = 2|\vec{a}\times\vec{b}|$

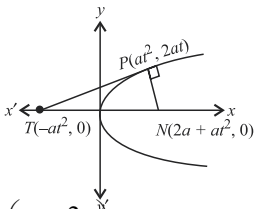
$= 2\sqrt{a^2b^2 - (\vec{a}\cdot\vec{b})^2} = 2\sqrt{12^2\cdot 48 - (-72)^2} = 48\sqrt{3}$

44. (a, d) : Let centroid of the triangle PTN is (α, β)

$\Rightarrow \alpha = \dfrac{at^2 + (-at^2) + 2a + at^2}{3}$ and $\beta = \dfrac{2at}{3}$

Eliminating 't' we get,

$$3\alpha = a\left[\frac{9\beta^2}{4a^2} + 2\right]$$



The locus of (α, β) is

$3x = \dfrac{9y^2}{4a} + 2a \Rightarrow y^2 = \dfrac{4a}{3}\left(x - \dfrac{2a}{3}\right)$

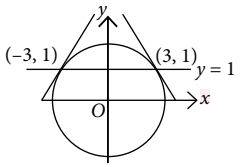
$\therefore$ vertex $\left(\dfrac{2a}{3}, 0\right)$, focus $(a, 0)$

45. (a, d)

46. (a, b) : $|\sin x| + |\cos x| = \sqrt{1 + |\sin 2x|}$

So, $1 < |\sin x| + |\cos x| \le \sqrt{2}$.

$y = [|\sin x| + |\cos x|] = 1$.



$x^2 + y^2 = 10$

$\Rightarrow 2x + 2y\dfrac{dy}{dx} = 0$

So, angle is either $\tan^{-1}(-3)$ or $\tan^{-1}(3)$.

47. (a, c) : $x^2 + y^2 - 10x + 21 = 0$

$x^2 - 10x + (y^2 + 21) = 0$

It has real roots if $D \ge 0 \Rightarrow 100 - 4(y^2 + 21) \ge 0$

$\Rightarrow y^2 + 21 \le 25 \Rightarrow y^2 \le 4 \Rightarrow -2 \le y \le 2$

Also, $y^2 + (x^2 - 10x + 21) = 0$ will have real roots if

$D \ge 0 \Rightarrow 0 - 4(x^2 - 10x + 21) \ge 0 \Rightarrow (x-3)(x-7) \le 0$

$\Rightarrow 3 \le x \le 7$

48. (b): We have, $\lim\limits_{x\to 0} |x|^{[\cos x]}$ ...(i)

When $x \to 0$, then $0 \le \cos x \le 1 \Rightarrow [\cos x] = 0$ when $x \ne 0$

From (i), we have $\lim\limits_{x\to 0} |x|^0 = \lim\limits_{x\to 0} 1 = 1$

49. (a, c) : $P(A \cup B) \ge \dfrac{3}{4}$ and $\dfrac{1}{8} \le P(A \cap B) \le \dfrac{3}{8}$

Let $P(A) + P(B)$ be x.

$\therefore \quad x - P(A \cap B) \ge \dfrac{3}{4}$

$\Rightarrow \quad x - \dfrac{3}{4} \ge P(A \cap B) \ge \dfrac{1}{8} \Rightarrow x \ge \dfrac{7}{8} \quad \because P(A \cup B) \le 1$

$\Rightarrow x - P(A \cap B) \le 1$

$\Rightarrow \quad x - 1 \le P(A \cap B) \le \dfrac{3}{8} \Rightarrow x \le \dfrac{11}{8}$

50. (a, b, d)

51. (c) : Area of $\Delta PQR = \dfrac{1}{2}\times 4\sqrt{2}\times 8 = 16\sqrt{2}$ sq units

Area of $\Delta PQS = \dfrac{1}{2}\times 2\times 4\sqrt{2} = 4\sqrt{2}$ sq units

$\dfrac{\text{ar }\Delta PQS}{\text{ar }\Delta PQR} = \dfrac{1}{4}$

52. (b): Equation of perpendicular bisector of SR is $x = 4$ ...(i)

Equation of perpendicular bisector of PS is

$y - \sqrt{2} = \dfrac{-1}{\sqrt{2}}(x - 0)$ or $\sqrt{2}y + x = 2$ ...(ii)

Circumcentre is point of intersection of (i) and (ii),

$x = 4, y = -\sqrt{2} \quad \therefore \quad C(4, -\sqrt{2})$

$\therefore \quad$ radius $= PC = \sqrt{(3)^2 + (3\sqrt{2})^2} = 3\sqrt{3}$ units

53. (b): $P(X \ge 3) = 1 - P(X \le 2)$

$= 1 - \{P(X = 1) + P(X = 2)\}$

$= 1 - \{P(6) + P(6'6)\} = 1 - P(6) - P(6')P(6)$

$= 1 - \dfrac{1}{6} - \dfrac{5}{6}\times\dfrac{1}{6} = 1 - \dfrac{1}{6} - \dfrac{5}{36} = \dfrac{36-6-5}{36} = \dfrac{25}{36}$

54. (d): Required probability

$P\left(\dfrac{X \ge 6}{X > 3}\right) = \dfrac{P(X \ge 6)}{1 - P(X \le 3)} = \dfrac{1 - P(X \le 5)}{1 - P(X \le 3)}$

$= \dfrac{1 - \{P(X=1) + P(X=2) + ... + P(X=5)\}}{1 - \{P(X=1) + P(X=2) + P(X=3)\}}$

$= \dfrac{1 - \left\{\dfrac{1}{6} + \dfrac{5}{6}\cdot\dfrac{1}{6} + \left(\dfrac{5}{6}\right)^2\cdot\dfrac{1}{6} + ... + \left(\dfrac{5}{6}\right)^4\cdot\dfrac{1}{6}\right\}}{1 - \left\{\dfrac{1}{6} + \dfrac{5}{6}\cdot\dfrac{1}{6} + \left(\dfrac{5}{6}\right)^2\cdot\dfrac{1}{6}\right\}}$

$= \dfrac{1 - \left\{\dfrac{1}{6}\cdot\dfrac{1-(5/6)^5}{1-(5/6)}\right\}}{1 - \left\{\dfrac{1}{6}\cdot\dfrac{1-(5/6)^3}{1-(5/6)}\right\}} = \left(\dfrac{5}{6}\right)^2 = \dfrac{25}{36}$

CROSS WORD

Readers can send their responses at editor@mtg.in or post us with complete address by 25th of every month to win exciting prizes. Winners' name with their valuable feedback will be published in next issue.

ACROSS

4. A polymeric form of galactose found in hemicellulose. (8)

5. Gas used for filling incandescent metal filament electric bulbs. (5)

7. Notation for a stereochemical arrangement where all of the higher priority substituents are located on the same side of the double bond. (8)

8. A mixture of concentrated oxide ore and aluminium powder. (8)

10. A process in which RBC will shrink in hypertonic solution. (9)

15. Movement of gas molecules through a small opening. (8)

18. Reciprocal of the coefficient of viscosity. (8)

24. Important anti-cancer drug originally isolated from Pacific yew trees. (5)

25. A cyclic diester formed from α-hydroxyacids. (7)

26. The correctness of a measurement. (8)

28. Metal which gives a blue colour (in cold conditions) in oxidising flame in borax bead test. (6)

29. Particles evolved in artificial radioactive element when *n*/*p* ratio is lower than the required value for nuclear stability. (9)

30. The scientist who suggested an approach to electronegativity based on ionisation energy and electron affinity of an atom. (8)

DOWN

1. The yellow pigment present in egg yolk. (11)

2. The separation of colloidal sol into two liquid phases. (12)

3. Alternative name for acetaldehyde. (7)

6. Energy of a single wavelength of light. (13)

9. Orderly arrangement of micelles. (9)

11. A salt which is prepared from sodium dithionite and formaldehyde, is used as a reducing agent for vat dyeing. (9)

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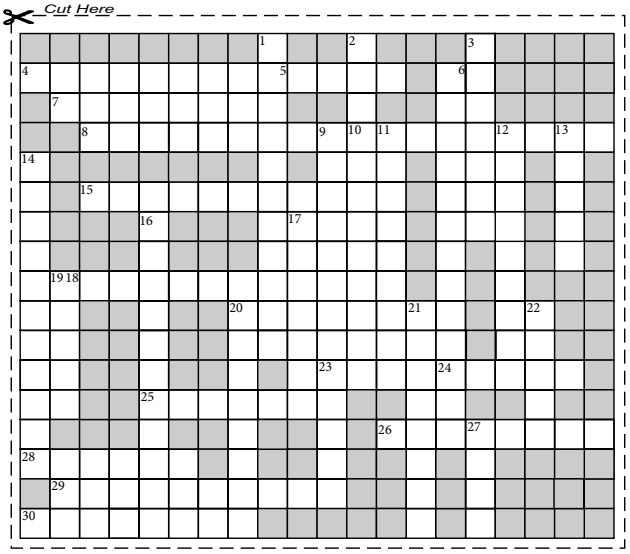

12. Element which is known as duckbill platypus. (8)

13. Industrial name of sodium peroxide. (5)

14. A graph of entropy of a substance against temperature. (10)

16. The number of milligrams of KOH required to neutralise the free acid present in one gram of the oil or fat. (9)

17. Another name for solid carbon dioxide. (7)

19. Chlorofluorocarbon compound of methane and ethane. (5)

20. Most impure form of iron. (8)

21. The form of carbon obtained by burning wood, cellulose or any other carbonous matter in a limited supply of air. (8)

22. Naturally occurring sodium carbonate, $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$ formed by evaporation of soda lakes. (5)

23. Unit of frequency. (5)

27. The diamide of carbonic acid. (4)