Question Set 1

MULTIPLE CHOICE QUESTIONS

Q. Select and write the most appropriate answer from the given alternatives for each subquestion : ***(1 mark each)***

Chapter 1. Solid State

(1) Molecular solids are

(a) crystalline solids (b) amorphous solids

(c) ionic solids (d) metallic solids

(2) The coordination number of atoms in bcc crystal lattice is

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

(3) If r is the radius of an atom and a is an edge length of fcc unit cell, then

(a) $r = \frac{\sqrt{3}}{4}a$ (b) $r = \frac{a}{2\sqrt{2}}$ (c) $r = \frac{a}{2}$ (d) $r = 2\sqrt{2}a$

(4) A single substance that exists in two or more forms is called

(a) polymorphous (b) amorphous

(c) isomorphous (d) monomorphous

(5) Graphite is a

(a) metallic crystal (b) covalent crystal

(c) ionic crystal (d) molecular crystal

(6) An ionic compound crystallises in FCC type structure with 'A' ions at the centre of each face and 'B' ions occupying corners of the cube. The formula of the compound is

(a) AB_4 (b) A_3B (c) AB (d) AB_3

(7) The correct relation between edge length and radius of an atom in simple cubic lattice is ..... . ***(July '22)***

(a) $2a = r$ (b) $\sqrt{3}a = 4r$ (c) $a = 2r$ (d) $\sqrt{2}a = 4r$

(8) In Frenkel defect,

(a) electrical neutrality of the substance is changed.

(b) density of the substance is changed.

(c) both cation and anion are missing.

(d) overall electrical neutrality is preserved.

(9) Schottky defects are observed in which solid among the following?

(a) Brass (b) Cesium chloride

(c) Zinc sulphide (d) Stainless steel

(10) The coordination number of atoms in body-centred cubic structure (bcc) is …… . ***(March '22)***

(a) 4 (b) 6 (c) 8 (d) 12

Ans. (1) (b) amorphous solids **(2)** (d) 8 **(3)** (b) $r = \frac{a}{2\sqrt{2}}$

(4) (a) polymorphous **(5)** (b) covalent crystal **(6)** (b) A_3B **(7)** (c) $a = 2r$ **(8)** (d) overall electrical neutrality is preserved **(9)** (b) Cesium chloride **(10)** (c) 8.

Chapter 2. Solutions

(1) Amongst the following, the solubility of which ionic solid decreases with increase in temperature? ***(Sept. '21)***

(a) KNO_3 (b) NaBr

(c) Na_2SO_4 (d) KCl

(2) Colligative property depends only on …… in a solution.

(a) Number of solute particles (b) Number of solvent particles

(c) Nature of solute particles (d) Nature of solvent particles

(3) Ebullioscopic constant is the boiling point elevation when the concentration of solution is

(a) 1 m (b) 1 M (c) mass % 1 (d) mole fraction 1 of solute

(4) Cryoscopic constant depends on

(a) nature of solvent (b) nature of solute

(c) nature of solution (d) number of solvent molecules

(5) Isotonic solutions are the solutions having the same

(a) surface tension (b) vapour pressure

(c) osmotic pressure (d) viscosity

(6) In calculating osmotic pressure, the concentration of solute is expressed in …… . ***(March '22)***

(a) molarity (b) molality

(c) mole fraction (d) percentage mass

(7) Which of the following solution will have the highest freezing point?

(a) 0.1 M KCl (b) 0.05 M NaCl

(c) 1 M $AIPO_4$ (d) 0.1 M $MgSO_4$

(8) Henry's law constant for a gas CH_3Br is 0.159 mol dm^{-3} atm at 250 °C. What is the solubility of CH_3Br in water at 25 °C and a partial pressure of 0.164 atm?

(a) 0.0159 mol L^{-1} (b) 0.164 mol L^{-1}

(c) 0.026 M (d) 0.042 M

(9) Identify the correct statement in the following :

(a) vapour pressure of solution is higher than that of pure solvent

(b) boiling point of solvent is lower than that of solution

(c) osmotic pressure of solution is lower than that of solvent

(d) osmosis is a colligative property

(10) 0.2 M urea solution can be isotonic with

(a) 0.1 M KBr solution

(b) 0.1 M glucose solution

(c) 0.15 m NaCl solution

(d) 0.2 M KBr solution

Ans. (1) (c) Na_2SO_4 **(2)** (a) Number of solute particles **(3)** (a) 1m **(4)** (a) nature of solvent **(5)** (c) osmotic pressure **(6)** (a) molarity **(7)** (b) 0.05 M NaCl **(8)** (c) 0.026 M **(9)** (b) boiling point of solvent is lower than that of solution **(10)** (a) 0.1 M KBr solution.

Chapter 3. Ionic Equilibria

(1) The value of $[H_3O^+]$ in mol lit^{-1} of 0.001 M acetic acid solution ($Ka = 1.8 \times 10^{-5}$) is …… . ***(March '22)***

(a) 1.34×10^{-1} (b) 1.34×10^{-2}

(c) 1.34×10^{-3} (d) 1.34×10^{-4}

(2) Blood in human body is highly buffered at pH of

(a) 7.4 (b) 7.0 (c) 6.9 (d) 8.1

(3) The conjugate base of $[Zn(H_2O)_4]^{2+}$ is

(a) $[Zn(H_2O)_4]^{2+}NH_3$ (b) $[Zn(H_2O)_3]^{2+}$

(c) $[Zn(H_2O)_3OH]^{+}$ (d) $[Zn(H_2O)H]^{3+}$

(4) The POH value for solution is 4, its hydrogen ion concentration will be

(a) 10^{-4} M (b) 10^{-10} M (c) 10^{-6} M (d) 10^{-8} M

(5) A weak monobasic acid is 0.05% dissociated in 0.02 M solution, dissociation constant of the acid is …… . ***(Sept. '21)***

(a) 5×10^{-10} (b) 5×10^{-9}

(c) 50×10^{-9} (d) 0.5×10^{-9}

(6) The $[H^+]$ for a weak acid of dissociation constant K_a and concentration C is nearly equal to

(a) $\sqrt{\frac{K_a}{C}}$ (b) $\sqrt{K_aC}$ (c) $\frac{K_a}{\sqrt{c}}$ (d) $\frac{c}{K_a}$

(7) Which of the following is a buffer solution?

(a) $CH_3COONa + NaCl$ in water

(b) $CH_3COOH + HCl$ in water

(c) $CH_3COOH + CH_3COONa$ in water

(d) $HCl + NH_4Cl$ in water

(8) 0.025 M CH_3COOH is dissociated 9.5%. Hence the pH of the solution is

(a) 2.6244 (b) 3.128 (c) 2.988 (d) 2.267

(9) Which of the following acids has highest pKa value? ***(Sept. '21)***

(a) Monochloroacetic acid (b) Dichloroacetic acid

(c) Trichloroacetic acid (d) Acetic acid

(10) The species which will behave both as a conjugate acid and base is

(a) NH_4OH (b) CO_3^{--} (c) HSO_4^- (d) H_2SO_4

(11) The pH of 10^{-8} M of HCl is

(a) 8 (b) 7 (c) less than 7 (d) greater than 7

(12) Which of the following solution will have pH value equal to 1.0 ?

(a) 50 mL of 0.1 M HCl + 50 mL of 0.1 M NaOH

(b) 60 mL of 0.1 M HCl + 40 mL of 0.1 M NaOH

(c) 20 mL of 0.1 M HCl + 80 mL of 0.1 M NaOH

(d) 75 mL of 0.2 M HCl + 25 mL of 0.2 M NaOH

Ans. **(1)** (d) 1.34×10^{-4} **(2)** (a) 7.4 **(3)** (c) $[Zn(H_2O)_3OH]^+$ **(4)** (b) 10^{-10} **(5)** (b) 5×10^{-9} **(6)** (b) $\sqrt{K_a C}$ **(7)** (c) $CH_3COOH + CH_3COONa$ in water **(8)** (a) 2.6244 **(9)** (d) Acetic acid **(10)** (c) HSO_4^- **(11)** (c) less than 7 **(12)** (d) 75 mL of 0.2 M HCl + 25 mL of 0.2 M NaOH.

Chapter 4. Chemical Thermodynamics

(1) In which of the following, entropy of the system decreases?

(a) Crystallisation of liquid into solid

(b) Temperature of crystalline solid is increased from 0 K to 115 K

(c) $H_{2(g)} \rightarrow 2H_{(g)}$

(d) $2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$

(2) Which of the following reactions is exothermic?

(a) $H_{2(g)} \rightarrow 2H_{(g)}$ (b) $C_{(s)} \rightarrow C_{(g)}$

(c) $2Cl_{(g)} \rightarrow Cl_{2(g)}$ (d) $H_2O_{(s)} \rightarrow H_2O_{(l)}$

(3) Which of the following pairs is an intensive property?

(a) Density, viscosity (b) Surface tension, mass

(c) Viscosity, internal energy (d) Heat capacity, volume

(4) The enthalpy change for the chemical reaction $H_2O_{(s)} \rightarrow H_2O_{(l)}$ is called enthalpy of ..... . ***(March '22)***

(a) vaporisation (b) fusion

(c) combustion (d) sublimation

(5) A gas is allowed to expand in a well insulated container against a constant external pressure of 2.5 bar from an initial volume of 2.5 L to a final volume of 4.5 L. The change in internal energy, ΔU of the gas will be

(a) -500 J (b) $+500$ J (c) -1013 J (d) $+1013$ J

(6) Which of the following are not state functions?

1. $Q + W$ 2. Q 3. W 4. U

(a) 1, 2 and 3 (b) 2 and 3

(c) 1 and 4 (d) 2, 3 and 4

(7) The work done during isothermal irreversible expansion of 2 moles of helium from 2 dm^3 to 4 dm^3 at 1 bar pressure and at 298 K is ..... . ***(July '22)***

(a) 2.0 kJ (b) -2.0 kJ (c) 0.2 kJ (d) -0.2 kJ

(8) The enthalpy of formation for all elements in their standard states is

(a) unity (b) zero

(c) less than zero (d) different elements

(9) 6.24 g of ethanol are vaporized by supplying 5.89 kJ of heat. Enthalpy of vaporization of ethanol will be

(a) 43.4 kJ mol^{-1} (b) 60.2 kJ mol^{-1}

(c) 38.9 kJ mol^{-1} (d) 20.4 kJ mol^{-1}

(10) The relationship between ΔG° of a reaction and its equilibrium constant is

(a) $-\Delta G^\circ = \frac{RT}{\ln K}$ (b) $\Delta G^\circ = \frac{RT}{\ln K}$

(c) $\frac{RT\ln K}{\Delta G^\circ} = -1$ (d) $\Delta G^\circ = RT\ln K$

Ans. (1) (a) Crystallisation of liquid into solid **(2)** (c) $2Cl_{(g)} \rightarrow Cl_{2(g)}$ **(3)** (a) Density, viscosity **(4)** (b) fusion **(5)** (a) -500 J **(6)** (b) 2 and 3 **(7)** (d) -0.2 kJ **(8)** (b) zero **(9)** (a) 43.4 kJ mol^{-1} **(10)** (c) $\frac{RT\ln K}{\Delta G^\circ} = -1$.

Chapter 5. Electrochemistry

(1) Which of the following expressions represent molar conductivity of $Al_2(SO_4)_3$?

(a) $3\lambda^0_{Al^{3+}} + 2\lambda^0_{SO_4^{2-}}$ (b) $2\lambda^0_{Al^{3+}} + 3\lambda^0_{SO_4^{2-}}$

(c) $\frac{1}{3}\lambda^0_{Al^{3+}} + \frac{1}{2}\lambda^0_{SO_4^{2-}}$ (d) $\lambda^0_{Al^{3+}} + 2\lambda^0_{SO_4^{2-}}$

(2) During electrolysis, 2 A current is passed through an electrolytic solution for 965 s. The number of moles of electrons passed will be

(a) 0.02 (b) 0.01 (c) 200 (d) 0.037

(3) Consider the cell,

$Pt\,|\,Cl_{2(g)}\,|\,HCl_{(aq)}\,\|\,HBr_{(aq)}\,|\,Br_{2(l)}\,|\,Pt$. If concentration of HCl is increased, the cell potential will

(a) increase (b) decrease

(c) remain the same (d) become maximum

(4) The standard potential of the cell in the following reaction is …… .

(March '22)

$Cd_{(s)} + Cu^{2+}_{(1M)} \longrightarrow Cd^{2+}_{(1M)} + Cu_{(s)}$

$(E^0_{Cd} = -0.403\ V, E^0_{Cu} = 0.334\ V)$

(a) -0.737 V (b) 0.737 V

(c) -0.069 V (d) 0.069 V

(5) On diluting the solution of an electrolyte,

(a) both $\wedge$ and κ increase

(b) both $\wedge$ and κ decrease

(c) $\wedge$ increases and κ decreases

(d) $\wedge$ decreases and κ increases

(6) Consider the half reactions with standard potentials,

i. $Ag^+_{(aq)} + e^- \longrightarrow Ag_{(s)}$ $E^0 = 0.8$ V

ii. $I_{2(s)} + 2e^- \longrightarrow 2I^-_{(aq)}$ $E^0 = 0.53$ V

iii. $Pb^{2+}_{(aq)} + 2e^- \longrightarrow Pb_{(s)}$ $E^0 = -0.13$ V

iv. $Fe^{2+}_{(aq)} + 2e^- \longrightarrow Fe_{(s)}$ $E^0 = -0.44$ V

The strongest oxidising and reducing agents respectively are

(a) Ag and Fe^{2+} (b) Ag^+ and Fe

(c) Pb^{2+} and I^- (d) I_2 and Fe^{2+}

(7) The standard potential of the cell in which the following reaction occurs is

H_{2+} (g, 1 atm) + Cu^{2+} (1 M) $\rightarrow 2H^+$ (1 M) + $Cu_{(s)}$, $(E^0_{Cu} = 0.34\ V)$ is

(a) -0.34 V (b) 0.34 V (c) 0.17 V (d) -0.17 V

(8) For the cell, $Pb_{(s)} | Pb^{2+}$ (1 M) $\| Ag^+$ (1 M) $| Ag_{(s)}$, if concentration of an ion in the anode compartment is increased by a factor of 10, the emf of the cell will

(a) increase by 10 V (b) increase by 0.0296 V

(c) decrease by 10 V (d) decrease by 0.0296 V

(9) The standard emf of the following cell at 298 K is …… .

$Zn_{(s)} | Zn^{+2}{}_{(1\ M)} \| Cr^{+3}{}_{(0.1\ M)} | Cr_{(s)}$

$E^0_{Zn} = -0.76V, E^0_{Cr} = -0.74V$ ***(July '22)***

(a) -0.02 V (b) $+0.02$ V (c) -0.2 V (d) $+0.2$ V

(10) Number of faradays of electricity required to liberate 12 g of hydrogen is

(a) 1 (b) 8 (c) 12 (d) 16

(11) The cell constant of a conductivity cell is given by

(a) $l \times a$ (b) $\frac{a}{l}$ (c) $\frac{1}{l \times a}$ (d) $\frac{l}{a}$

Ans. (1) (b) $2\lambda^0_{Al^{3+}} + 3\lambda^0_{SO_4^{2-}}$ **(2)** (a) 0.02 **(3)** (a) increase

(4) (b) 0.737 V **(5)** (c) $\wedge$ increases and κ decreases **(6)** (b) Ag^+ and Fe

(7) (b) 0.34 V **(8)** (d) decrease by 0.0296 V **(9)** (b) + 0.02 V

(10) (c) 12 **(11)** (d) $\frac{l}{a}$.

Chapter 6. Chemical Kinetics

(1) The elementary reaction

$O_{3(g)} + O_{(g)} \longrightarrow 2O_{2(g)}$ is

(a) unimolecular and second order

(b) bimolecular and first order

(c) bimolecular and second order

(d) unimolecular and first order

(2) The reaction, $3ClO^- \longrightarrow ClO_3^- + 2Cl^-$ occurs in two steps,

(i) $2ClO^- \longrightarrow ClO_2^- + Cl^-$

(ii) $ClO_2^- + ClO^- \longrightarrow ClO_3^- + Cl^-$.

The reaction intermediate is

(a) Cl^- (b) ClO_2^- (c) ClO_3^- (d) ClO^-

(3) The rate constant for the reaction

$2N_2O_{5(g)} \longrightarrow 2N_2O_{4(g)} + O_{2(g)}$ is $4.98 \times 10^{-4}\ s^{-1}$.

The order of reaction is ..... . ***(Sept. '22)***

(a) 0 (b) 1 (c) 2 (d) 3

(4) The rate constant for a first order reaction is $100\ s^{-1}$. The time required for completion of 50% of reaction is

(a) 0.0693 millisecond (b) 0.693 millisecond

(c) 6.93 milliseconds (d) 69.3 milliseconds

(5) Rate law for the reaction,

$2NO + Cl_2 \longrightarrow 2NOCl$ is rate $= k[NO_2]^2[Cl_2]$.

Thus k would increase with

(a) increase of temperature

(b) increase of concentration of NO

(c) increase of concentration of Cl_2

(d) increase of concentrations of both Cl_2 and NO

(6) Time required to complete 90% of the first order reaction is

(a) $\frac{2.303}{k}$ (b) $\frac{2 \times 0.693}{k}$ (c) $\frac{0.693}{2k}$ (d) $\frac{0.3010}{k}$

(7) The rate constant for the reaction

$2N_2O_{5(g)} \longrightarrow 2N_2O_{4(g)} + O_{2(g)}$ is $4.98 \times 10^{-4}\ s^{-1}$.

The order of reaction is

(a) 2 (b) 1 (c) 0 (d) 3

(8) Slope of the graph $\ln [A]_t$ versus t for first order reaction is

(a) $-k$ (b) k (c) $k/2.303$ (d) $-k/2.303$

(9) The rate of reaction for a certain reaction is expressed as

$$\frac{1}{3}\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = -\frac{d[C]}{dt}.$$

The reaction is

(a) $3A \longrightarrow 2B + C$ (b) $2B \longrightarrow 3A + C$

(c) $2B + C \longrightarrow 3A$ (d) $3A + 2B \longrightarrow C$

(10) The rate law for the reaction $aA + bB \longrightarrow P$ is rate $= k[A][B]$. The rate of reaction doubles if

(a) concentrations of A and B are both doubled

(b) [A] is doubled and [B] is kept constant

(c) [B] is doubled and [A] is halved

(d) [A] is kept constant and [B] is halved

(11) The half-life period of zero order reaction $A \longrightarrow$ product is given by

(a) $\frac{[A]_0}{k}$ (b) $\frac{0.693}{k}$ (c) $\frac{[A]_0}{2k}$ (d) $\frac{2[A]_0}{k}$

Ans. (1) (c) bimolecular and second order **(2)** (b) ClO_2^- **(3)** (b) 1 **(4)** (c) 6.93 milliseconds **(5)** (a) increase of temperature **(6)** (a) $\frac{2.303}{k}$ **(7)** (b) 1 **(8)** (a) $-k$ **(9)** (c) $2B + C \longrightarrow 3A$ **(10)** (b) [A] is doubled and [B] is kept constant **(11)** (c) $\frac{[A]_0}{2k}$.

(1) HI acid when heated with conc. H_2SO_4 forms

(a) HIO_3 (b) KIO_3 (c) I_2 (d) KI

(2) Ozone layer is depleted by

(a) NO (b) NO_2 (c) NO_3 (d) N_2O_5

(3) The decreasing order for negative values for electron gain enthalpies is

(a) F > Cl > Br (b) Cl > F > Br

(c) Br > Cl > F (d) F > Br > Cl

(4) In the contact process, the catalyst used is

(a) TiO_2 (b) Pt (c) V_2O_5 (d) Fe_2O_3

(5) General electronic configuration of group 16 elements is

(a) ns^2np^3 (b) ns^2np^4 (c) ns^2np^2 (d) ns^2np^5

(6) The decreasing order of electronegativity is

(a) Cl > I > Br (b) Br > I > F

(c) F > Br > I (d) Cl > F > Br

(7) Stability of interhalogen compounds follows the order

(a) BrF > IBr > ICl > ClF > BrCl

(b) IBr > BrF > ICl > ClF > BrCl

(c) ClF > ICl > IBr > BrCl > BrF

(d) ICl > ClF > BrCl > IBr > BrF

(8) BrCl reacts with water to form

(a) HBr (b) $Br_2 + Cl_2$ (c) HOBr (d) HOBr + HCl

(9) The geometry of ClF_3 is

(a) tetrahedral (b) trigonal bipyramidal

(c) square planar (d) triangular

(10) In pyrosulphurous acid, oxidation state of sulphur is

(a) Only + 2 (b) Only + 4

(c) + 2 and + 6 (d) Only + 6

(11) In the following oxyacid, chlorine has + 7 oxidation state : ***(July '22)***

(a) HOCl (b) $HClO_2$ (c) $HClO_3$ (d) $HClO_4$

(12) Which of the following occurs in liquid state at room temperature?

(a) HIO_3 (b) HBr (c) HCl (d) HF

Ans. (1) (c) I_2 **(2)** (a) NO **(3)** (b) Cl > F > Br **(4)** (c) V_2O_5 **(5)** (b) ns^2np^4 **(6)** (c) F > Br > I **(7)** (c) ClF > ICl > IBr > BrCl > BrF **(8)** (d) HOBr + HCl **(9)** (b) trigonal bipyramidal **(10)** (b) only +4 **(11)** (d) $HClO_4$ **(12)** (d) HF.

Chapter 8. Transition and Inner Transition Elements

(1) Electronic configuration of Cu and Cu^{1+}

(a) $3d^{10}, 4s^0; 3d^9, 4s^0$ (b) $3d^9, 4s^1; 3d^9, 4s^0$

(c) $3d^{10}, 4s^1; 3d^{10}, 4s^0$ (d) $3d^8, 4s^1; 3d^{10}, 4s^0$

(2) The colourless transition metal ion amongst the following is ..... . ***(Sept. '21)***

(a) Cu^+ (b) Cu^{++} (c) Ni^{++} (d) Co^{++}

(3) The general electronic configuration of Lanthanoids is

(a) [Xe] $4f^{1-14}\ 5d^{0-1}\ 6s^2$ (b) [Xe] $4f^{2-14}\ 5d^{0-1}\ 6s^2$

(c) [Xe] $4f^{1-13}\ 5d^{0-1}\ 6s^2$ (d) [Xe] $4f^{0-14}\ 5d^{0-1}\ 6s^1$

(4) Chromium (Z = 24) has electronic configuration

(a) [Ar] $4d^4\ 4s^2$ (b) [Ar] $4d^5\ 4s^1$

(c) [Ar] $3d^4\ 3s^1$ (d) [Ar] $3d^5\ 4s^1$

(5) Components of Nichrome alloy are

(a) Ni, Cr, Fe (b) Ni, Cr, Fe, C

(c) Ni, Cr (d) Cu, Fe

(6) General electronic configuration of 3*d*-series of '*d*'-block elements is ..... . ***(July '22)***

(a) [Ar] $3d^{1-10}\ 4s^2$ (b) [Xe] $3d^{1-10}\ 6s^2$

(c) [Kr] $3d^{1-10}\ 5s^2$ (d) [Rn] $3d^{1-10}\ 7s^2$

(7) The most common oxidation state of Lanthanoids is

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

(8) Which of the following transition element shows maximum oxidation state? ***(March '22)***

(a) Sc (b) Fe (c) Mn (d) V

(9) In which of the following series all the elements are radioactive ?

(a) Lanthanides (b) Actinides

(c) *d*-block elements (d) *s*-block elements

(10) A pair of coloured ions is

(a) Cu^{2+} , Zn^{2+} (b) Cr^{3+} , Cu^{+}

(c) Cd^{2+}, Mn^{5+} (d) Fe^{2+} , Fe^{3+}

(11) The highest oxidation state is shown by

(a) Fe (b) Mn (c) Os (d) Cr

(12) Transition elements are good catalysts since

(a) they show variable oxidation states

(b) they have partially filled *d*-orbitals

(c) they have low I.P

(d) they have small atomic radii

Ans. (1) (c) $3d^{10}$, $4s^{1}$; $3d^{10}$, $4s^{0}$ **(2)** (a) Cu^{+}

(3) (a) [Xe] $4f^{1-14}$ $5d^{0-1}$ $6s^{2}$ **(4)** (d) [Ar] $3d^{5}$ $4s^{1}$ **(5)** (c) Ni, Cr **(6)** (a) [Ar] $3d^{1-10}$ $4s^{2}$ **(7)** (b) $+3$ **(8)** (c) Mn **(9)** (b) Actinides **(10)** (d) Fe^{2+}, Fe^{3+} **(11)** (c) Os **(12)** (a) they show variable oxidation states.

Chapter 9. Coordination Compounds

(1) The coordination number of cobalt in the complex $[Co(en)_2Br_2]Cl_2$ is

(a) 4 (b) 5 (c) 6 (d) 7

(2) IUPAC name of the complex $[Pt(en)_2(SCN)_2]^{2+}$ is

(a) bis(ethylenediamine) dithiocyanatoplatinum(IV) ion

(b) bis(ethylenediamine) dithiocyantoplatinate(IV) ion

(c) dicyanatobis(ethylenediamine)platinate(IV) ion

(d) bis(ethylenediamine)dithiocynatoplatinate(IV) ion

(3) Formula for the compound sodium hexacynoferrate (III) is

(a) $[NaFe(CN)_6]$ (b) $Na_2[Fe(CN)_6]$

(c) $Na[Fe(CN)_6]$ (d) $Na_3[Fe(CN)_6]$

(4) Which of the following complexes exist as *cis* and *trans* isomers?

(1) $[Cr(NH_3)_2Cl_4]^{-}$

(2) $[Co(NH_3)_5Br]^{2+}$

(3) $[PtCl_2Br_2]^{2-}$ (square planar)

(4) $[FeCl_2(NCS)_2]^{2-}$ (tetrahedral)

(a) 1 and 3 (b) 2 and 3 (c) 1 and 2 (d) 4 only

(5) The correct formula for the complex compound, sodium hexacyanoferrate(III) is …… . ***(March '22)***

(a) $Na[Fe(CN)_6]$ (b) $Na_2[Fe(CN)_6]$

(c) $Na_3[Fe(CN)_6]$ (d) $Na_4[Fe(CN)_6]$

(6) When an excess of $AgNO_3$ is added to the complex, one mole of AgCl is precipitated. The formula of the complex is

(a) $[CoCl_2(NH_3)_4]Cl$ (b) $[CoCl(NH_3)_4]Cl_2$

(c) $[CoCl_3(NH_3)_3]$ (d) $[Co(NH_3)_4]Cl_3$

(7) The sum of coordination number and oxidation number of M in $[M(en)_2C_2O_4]Cl$ is

(a) 6 (b) 7 (c) 9 (d) 8

(8) The cationic complex among the following is

(a) $K_3[Fe(CN)_6]$ (b) $Ni(CO)_4$

(c) K_2HgI_4 (d) $[Co(NH_3)_6]Cl_2$

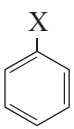
(9) If Z is the atomic number of a metal, X is number of electrons lost forming metal ion and Y is the number of electrons from the ligands, then EAN is

(a) $Z+X+Y$ (b) $X-Z+Y$ (c) $Z-X+Y$ (d) $X+Z-Y$

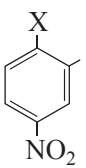
Ans. (1) (c) 6 **(2)** (d) bis(ethylenediamine)dithiocynatoplatinate (IV) ion **(3)** (d) $Na_3[Fe(CN)_6]$ **(4)** (a) 1 and 3 **(5)** (c) $Na_3[Fe(CN)_6]$ **(6)** (a) $[CoCl_2(NH_3)_4]Cl$ **(7)** (c) 9 **(8)** (d) $[Co(NH_3)_6]Cl_2$ **(9)** (c) $Z-X+Y$.

Chapter 10. Halogen Derivatives

(1) The correct order of increasing reactivity of C–X bond towards nucleophile in the following compounds is



(I)



(II)

$(CH_3)_3C-X$ (III)

$(CH_3)_2CH-X$ (IV)

(a) I < II < III < IV (b) II < I < III < IV

(c) III < IV < II < I (d) IV < III < I < II

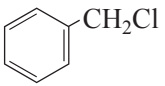
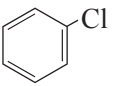
(2) $CH_3 - CH = CH_2 \xrightarrow[\text{peroxide}]{HI}$

The major product of the above reaction is

(a) $I - CH_2 - CH = CH_2$ (b) $CH_3 - CH_2 - CH_2I$

(c) $CH_3 - \underset{\underset{I}{|}}{CH} - CH_3$ (d) $CH_3 - \underset{\underset{I}{|}}{CH} - \underset{\underset{OH}{|}}{CH_2}$

(3) Which of the following is likely to undergo racemization during alkaline hydrolysis?

$CH_3 - \underset{\underset{Cl}{|}}{CH} - C_2H_5$   $CH_3 - \underset{\underset{CH_2Cl}{|}}{\overset{\overset{CH_3}{|}}{CH}}$

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

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

(4) The best method for preparation of alkyl fluorides is

(a) Finkelstein reaction (b) Swartz reaction

(c) Free radical fluorination (d) Sandmeyer's reaction

(5) Identify the chiral molecule from the following :

(a) 1-Bromobutane (b) 1,1-Dibromobutane

(c) 2,3-Dibromobutane (d) 2-Bromobutane

(6) An alkyl chloride on Wurtz reaction gives 2,2,5,5-tetramethyl-hexane. The same alkyl chloride on reduction with zinc-copper couple in alcohol give hydrocarbon with molecular formula C_5H_{12}. What is the structure of alkyl chloride?

(a) $CH_3 - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - CH_2Cl$ (b) $CH_3 - \underset{\underset{Cl}{|}}{\overset{\overset{CH_3}{|}}{C}} - CH_2CH_3$

(c) $CH_3 - CH_2 - \underset{\underset{CH_3}{|}}{CH} - Cl$ (d) $CH_3 - \underset{\underset{CH_3}{|}}{CH} - \underset{\underset{CH_3}{|}}{CH} - CHCl$

(7) Butanenitrile may be prepared by heating

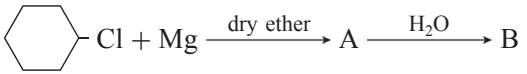
(a) Propanol with KCN (b) butanol with KCN

(c) *n*-butyl chloride with KCN (d) *n*-propyl chloride with KCN

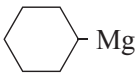
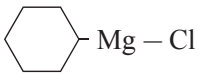
(8) Choose the compound from the following that will react fastest by S_N1 mechanism

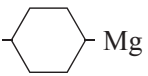
(a) 1-iodobutane (b) 1-iodopropane

(c) 2-iodo-2 methylbutane (d) 2-iodo-3-methylbutane

(9) 

The product 'B' in the above reaction sequence is

(a)  (b) 

(c)  (d)  ***(Sept. '21, July '22)***

(10) Which of the following is used as source of dichlorocarbene

(a) tetrachloromethane (b) chloroform

(c) iodoform (d) DDT

(11) Which of the following is most reactive towards nucleophilic substitution reaction?

(a) $CH_2 = CH - Cl$ (b) $CH_3CH = CHCl$

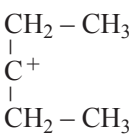
(c) C_6H_5Cl (d) $ClCH_2 - CH = CH_2$

(12) Which of the following compounds is not optically active?

(a) Lactic acid (b) Secondary butyl chloride

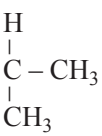
(c) *n*-Propyl iodide (d) Glucose

(13) Which of the following carbocations is least stable?

(a) 

(b) $CH_3 - CH_2 - {}^{+}CH - CH_2 - CH_3$

(c) $CH_3 - CH_2 - {}^{+}CH_2$

(d) 

(14) Carbon tetrachloride is used as

(a) anaesthetic (b) antiseptic

(c) dry cleaning agent (d) fire extinguisher

(15) The preparation of alkyl fluoride from alkyl chloride in presence of metallic fluorides is known as

(a) Williamson's reaction (b) Finkelstein reaction

(c) Swartz reaction (d) Wurtz reaction

Ans. (1) (d) IV < III < I < II **(2)** (b) $CH_3 - CH_2 - CH_2I$

(3) (a) Only I **(4)** (b) Swartz reaction **(5)** (d) 2-Bromobutane

(6) (a) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-CH_2Cl$ **(7)** (d) *n*-propyl chloride with KCN

(8) (c) 2-iodo-2 methylbutane **(9)** (d)  **(10)** (b) chloroform

(11) (d) $ClCH_2{-}CH = CH_2$ **(12)** (c) *n*-Propyl iodide

(13) (c) $CH_3{-}CH_2{-}\ ^+CH_2$ **(14)** (c) dry cleaning agent **(15)** (c) Swartz reaction.

Chapter 11. Alcohols, Phenols and Ethers

(1) Which of the following represents the increasing order of boiling points of (1), (2) and (3)?

(1) $CH_3 - CH_2 - CH_2 - CH_2 - OH$

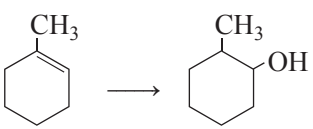
(2) $(CH_3)CHOCH_3$

(3) $(CH_3)_3COH$

(a) (1) < (2) < (3) (b) (2) < (1) < (3)

(c) (3) < (2) < (1) (d) (2) < (3) < (1)

(2) Which is the best reagent for carrying out following conversion?



(a) $LiA1H_4$ (b) Conc. H_2SO_4, H_2O

(c) H_2 / Pd (d) B_2H_6, $H_2O_2 - NaOH$

(3) Which of the following substrate will give ionic organic product on reaction?

(a) $CH_3 - CH_2 - OH + Na$ (b) $CH_3 - CH_2 - OH + SOCl_2$

(c) $CH_3 - CH_2 - OH + PCl_5$ (d) $CH_3 - CH_2 - OH + H_2SO_4$

(4) Which is the most resistant alcohol towards oxidation reaction among the following ?

(a) $CH_3 - CH_2 - OH$ (b) $(CH_3)_2CH - OH$

(c) $(CH_3)_3C - OH$ (d) $C_2H_5\underset{\displaystyle CH_3}{\underset{|}{C}}H - OH$

(5) Resorcinol on distillation with Zn dust gives

(a) Cyclohexane (b) Benzene

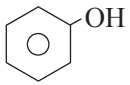
(c) Toluene (d) Benzene-1,3-diol

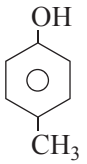
(6) Anisole on heating with concerntrated HI gives

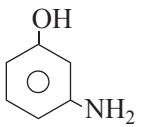
(a) Iodobenzene (b) Phenol + Methanol

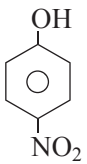
(c) Phenol + Iodomethane (d) Iodobenzene + Methanol

(7) Which of the following is the least acidic compound ?

(a) 

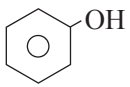
(b) 

(c) 

(d) 

(8) The compound incapable of hydrogen bonding with water is

(a) $CH_3 - CH_2 - O - CH_3$ (b) $CH_3 - CH_2 - CH_2 - CH_3$

(c) 

(d) $CH_3 - CH_2 - CH_2 - OH$

(9) Ethers react with cold and concentrated H_2SO_4 to form

(a) oxonium salt (b) alkene (c) alkoxides (d) alcohols

(10) Ethyl alcohol $\xrightarrow[443\ K]{\text{conc. } H_2SO_4}$ A $\xrightarrow{HBr}$ Ethyl bromide. Identify A.

(a) Ethyl hydrogen sulphate (b) Ethylene

(c) Isopropyl hydrogen sulphate (d) Acetic acid

(11) An oxygen atom in ether is

(a) sp^2-hybridized (b) sp^3-hybridized

(c) sp-hybridized (d) sp^2d-hybridized

(12) Natalite is a mixture of

(a) diethyl ether and methanol

(b) diethyl ether and ethanol

(c) dimethyl ether and methanol

(d) dimethyl ether and ethanol

(13) Isopropylbenzene on air oxidation followed by decomposition by dilute acid gives …… . ***(March '22)***

(a) C_6H_5OH (b) $C_6H_5COOCH_3$

(c) C_6H_5COOH (d) C_6H_5CHO

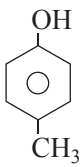
(14) Correct IUPAC name of tert-butyl alcohol is …… . ***(July '22)***

(a) 2-Methylbutan-1-ol (b) 2-Methylbutan-2-ol

(c) 2-Methylpropan-2-ol (d) 2-Methylpropan-1-ol

Ans. (1) (a) (1) < (2) < (3) **(2)** (b) Conc. H_2SO_4, H_2O

(3) (a) $CH_3 - CH_2 - OH + Na$ **(4)** (c) $(CH_3)_3C - OH$ **(5)** (b) Benzene

(6) (b) Phenol + Methanol **(7)** (b) 

(8) (b) $CH_3 - CH_2 - CH_2 - CH_3$

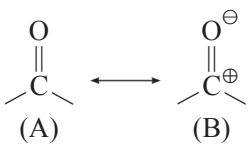
(9) (a) oxonium salt **(10)** (b) Ethylene **(11)** (b) sp^3-hybridized

(12) (b) diethyl ether and ethanol **(13)** (a) C_6H_5OH

(14) (c) 2-Methylpropan-2-ol.

Chapter 12. Aldehydes, Ketones and Carboxylic Acids

(1) In the following resonating structures A and B, the number of unshared electrons in valence shell present on oxygen respectively are



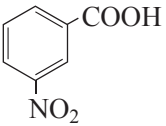
(A) (B)

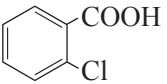
(a) 2, 4 (b) 2, 6 (c) 4, 6 (d) 6, 4

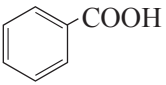
(2) In the Wolff-Kishner reduction, alkylaryl ketones are reduced to alkyl benzenes. During this change, ketones are first converted into

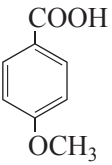
(a) acids (b) alcohols (c) hydrazones (d) alkenes

(3) Which one of the following has lowest acidity ?

(a) 

(b) 

(c) 

(d) 

(4) Diborane reduces

(a) ester group (b) nitro group

(c) halo group (d) acid group

(5) Benzaldehyde does not show positive test with

(a) Schiff reagent (b) Tollen's reagent

(c) Sodium bisulphite solution (d) Fehling's solution

(6) Identify 'B' in the following reaction :

$$CH_3-C=N \xrightarrow{CH_3MgI} A \xrightarrow[HCl]{2HOH} B + NH_3 + MgIOH$$

(a) Magnesium intermediate (b) Ethanol

(c) Propanal (d) Propanone

(7) An organic compound (A) C_3H_8O on oxidation gives (B) $C_3H_6O_2$. The compound A may be

(a) an ester (b) an alcohol

(c) an aldehyde (d) a ketone

(8) The blue colour of Fehling's solution is due to

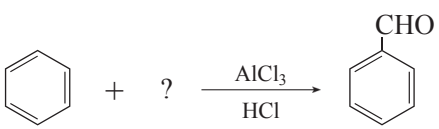
(a) Cu_2O (b) $CuCO_3$ (c) CuO (d) Cu^{++} ions

(9) The reaction of $C_6H_5CH=CHCHO$ with $LiAlH_4$ gives

(a) $C_6H_5CH_2CH_2CH_2OH$ (b) $C_6H_5CH_2CH_2CHO$

(c) $C_6H_5CH=CHCH_2OH$ (d) $C_6H_5CH_2CHOHCH_3$

(10) Identify the reactant in the following reaction :



(a) H_2O (b) HCHO (c) CO (d) CH_3CHO

(11) Margarine contains –

(a) acetaldehyde (b) propionaldehyde

(c) butyraldehyde (d) formaldehyde

(12) The carbon atom of the carboxylic group is

(a) sp^3-hybridized (b) sp^2-hybridized

(c) *sp*-hybridized (d) unhybridized

(13) Popcorn has butter flavour which contains

(a) butan-1-one (b) butane-2,3-dione

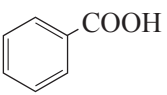
(c) butan-2-one (d) butyric acid

(14) The product obtained in the following reaction

$CH_3 - CH = CH - CH_2 - CHO \xrightarrow{H_2/Ni}$ is ..... . ***(Sept. '21)***

(a) Pentan-3-en-1-ol (b) Pentan-1-ol

(c) Pentan-2-ol (d) Pentanal

Ans. (1) (c) 4, 6 **(2)** (c) hydrazones **(3)** (c) 

(4) (d) acid group **(5)** (d) Fehling's solution

(6) (d) Propanone **(7)** (b) an alcohol **(8)** (d) Cu^{++} ions

(9) (a) $C_6H_5CH_2CH_2CH_2OH$ **(10)** (c) CO **(11)** (c) butyraldehyde

(12) (b) sp^2-hybridized **(13)** (b) butane-2, 3-dione **(14)** (b) Pentan-1-ol.

Chapter 13. Amines

(1) The hybridization of nitrogen in primary amine is ..... .

(a) *sp* (b) sp^2 (c) sp^3 (d) sp^3d

(2) Isobutylamine is an example of ..... .

(a) 2° amine (b) 3° amine

(c) 1° amine (d) quaternary ammonium salt

(3) Which one of the following compounds has the highest boiling point ?

(a) *n*-Butylamine (b) sec-Butylamine

(c) Isobutylamine (d) tert-Butylamine

(4) Which of the following has the highest basic strength ?

(a) Trimethylamine (b) Methylamine

(c) Ammonia (d) Dimethylamine

(5) Which type of amine does produce N_2 when treated with HNO_2 ?

(a) Primary amine (b) Secondary amine

(c) Tertiary amine (d) Both primary and secondary amines

(6) Carbylamine test is given by …… . ***(Sept. '21)***

(a) aniline (b) dimethyl amine

(c) trimethyl amine (d) both dimethyl amine and trimethyl amine

(7) Which one of the following compounds does not react with acetyl chloride ?

(a) $CH_3 - CH_2 - NH_2$ (b) $(CH_3 - CH_2)_2NH$

(c) $(CH_3 - CH_2)_3N$ (d) $C_6H_5 - NH_2$

(8) Which of the following compounds will dissolve in aqueous NaOH after undergoing reaction with Hinsberg reagent ?

(a) Ethyl amine (b) Triethyl amine

(c) Trimethyl amine (d) Diethyl amine

(9) Which of the following compounds contains azo linkage ?

(a) Hydrazine (b) *p*-Hydroxyazobenzene

(c) N-Nitrosodiethylamine (d) Ethylenediamine

(10) The correct order of increasing basic strength is …… .

(a) $NH_3 < CH_3NH_2 < (CH_3)_2NH$

(b) $CH_3NH_2 < (CH_3)_2NH < NH_3$

(c) $CH_3NH_2 < NH_3 < (CH_3)_2NH$

(d) $(CH_3)_2NH < NH_3 < CH_3NH_2$

(11) Acid anhydride on reaction with primary amine gives compound having a functional group …… . ***(March '22)***

(a) amide (b) nitrile (c) secondary amine (d) imine

(12) The most basic amine amongst the following is …… . ***(July '22)***

(a) CH_2NH_2 (b) $(CH_3)_2NH$ (c) $(CH_3)_3N$ (d) $C_2H_5NH_2$

Ans. (1) (c) sp^3 **(2)** (a) 2° amine **(3)** (a) *n*-Butylamine

(4) (d) Dimethylamine **(5)** (a) Primary amine **(6)** (a) aniline

(7) (c) $(CH_3 - CH_2)_3N$ **(8)** (a) Ethyl amine

(9) (b) *p*-Hydroxyazobenzene **(10)** (a) $NH_3 < CH_3NH_2 < (CH_3)_2NH$

(11) (a) amide **(12)** (b) $(CH_3)_2NH$.

(1) $CH_2OH - CO - (CHOH)_4 - CH_2OH$ is an example of

(a) Aldohexose (b) Aldoheptose

(c) Ketotetrose (d) Ketoheptose

(2) Open chain formula of glucose does not contain

(a) Formyl group (b) Anomeric hydroxyl group

(c) Primary hydroxyl group (d) Secondary hydroxyl group

(3) Which of the following does not apply to $CH_2NH_2 - COOH$?

(a) Neutral amino acid (b) L-amino acid

(c) Exists as zwitter ion (d) Natural amino acid

(4) Tryptophan is called essential amino acid because

(a) it contains aromatic nucleus

(b) it is present in all the human proteins

(c) it cannot be synthesised by human body

(d) it is essential constituent of enzymes

(5) A disulfide link gives rise to the following structure of protein.

(a) Primary (b) Secondary

(c) Tertiary (d) Quaternary

(6) RNA has

(a) A – U base pairing (b) P – S – P – S backbone

(c) double helix (d) G – C base pairing

(7) Protein are also called

(a) polysaccharides (b) polypeptides

(c) polyglycerides (d) polyster

(8) The secondary structure of a protein is determined by

(a) coordinate bond (b) covalent bond

(c) ionic bond (d) hydrogen bond

(9) Precipitation of protein is referred to as

(a) destruction of proteins (b) separation of proteins

(c) denaturation of proteins (d) fragmentation of proteins

(10) Maltose is a

(a) polysaccharide (b) disaccharide

(c) trisaccharide (d) monosaccharide

(11) Lactose on hydrolysis gives …… . ***(July '22)***

(a) galactose + glucose (b) 2 molecules of glucose

(c) fructose + glucose (d) fructose + galactose

Ans. (1) (d) Ketoheptose **(2)** (b) Anomeric hydroxyl group **(3)** (d) Natural amino acid **(4)** (c) it cannot be synthesised by human body **(5)** (c) Tertiary **(6)** (a) A – U base pairing **(7)** (b) polypeptides **(8)** (d) hydrogen bond **(9)** (c) denaturation of proteins **(10)** (b) disaccharide **(11)** (a) galactose + glucose.

Chapter 15. Introduction to Polymer Chemistry

(1) Nylon fibres are

(a) semisynthetic fibres (b) polyamide fibres

(c) polyester fibres (d) cellulose fibres

(2) Which of the following is naturally occurring polymer?

(a) Telfon (b) Polyethylene (c) PVC (d) Protein

(3) Silk is a kind of …… fibre.

(a) semisynthetic (b) synthetic (c) an animal (d) a vegetable

(4) Dacron is another name of

(a) Nylon 6 (b) Orlon (c) Novolac (d) Terylene

(5) Which of the following is made up of polyamides?

(a) Dacron (b) Rayon (c) Nylon (d) Jute

(6) The number of carbon atoms present in the ring of ε-caprolactam is

(a) Five (b) Two (c) Seven (d) Six

(7) Terylene is …… .

(a) Polyamide fibre (b) Polyester fibre

(c) Vegetable fibre (d) Protein fibre

(8) PET is formed by …… .

(a) addition (b) condensation

(c) alkylation (d) hydration

(9) Chemically pure cotton is …… .

(a) Acetate rayon (b) Viscose rayon

(c) Cellulose nitrate (d) Cellulose

(10) Teflon is chemically inert, due to presence of …… .

(a) C – H bond (b) C – F bond

(c) H – bond (d) C = C bond

(11) Thermocol is a homopolymer of ……

(a) terephthalic acid (b) acrylonitrile

(c) methyl α-cyanoacrylate (d) styrene

(12) Number of carbon atoms present in isoprene unit is …… .

(Sept. '21)

(a) 6 (b) 5 (c) 4 (d) 3

Ans. (1) (b) polyamide fibres **(2)** (d) Protein **(3)** (c) an animal **(4)** (d) Terylene **(5)** (c) Nylon **(6)** (d) Six **(7)** (b) Polyester fibre **(8)** (b) condensation **(9)** (d) Cellulose **(10)** (b) C – F bond **(11)** (d) styrene **(12)** (b) 5.

Chapter 16. Green Chemistry and Nanochemistry

(1) The development that meets the needs of present without compromising the ability of future generations to meet their own need is known as

(a) continuous development (b) sustainable development

(c) true development (d) irrational development

(2) Which of the following is γ-isomer of BHC ?

(a) DDT (b) lindane (c) chloroform (d) chlorobenzene

(3) The prefix 'nano' comes from

(a) French word meaning billion

(b) Greek word meaning dwarf

(c) Spanish word meaning particle

(d) Latin word meaning invisible

(4) Which of the following information is given by FTIR technique ?

(a) Absorption of functional groups

(b) Particle size

(c) Confirmation of formation of nanoparticles

(d) Crystal structures

(5) The concept of green chemistry was coined by

(a) Born Haber (b) Nario Taniguchi

(c) Richard Feynman (d) Paul T. Anastas

(6) The term nanotechnology was first used by whom and when ?

(a) Richard Feynman, 1959 (b) Nario Taniguchi, 1974

(c) Eric Drexter, 1986 (d) Sumia Lijima, 1991

(7) The science which deals with the design and synthesis of material on nanoscale with different size and shape is called

(a) nanoscience (b) nanochemistry

(c) nanophysics (d) nanotechnology

(8) The catalyst used in photocatalysis is

(a) gold (b) Raney Ni (c) TiO_2 (d) Al_2O_3

(9) The most common method used for synthesis of nanomaterials is

(a) sol-gels method (b) only sol method

(c) only gel method (d) colloidal dispersion method

(10) The constituents of carbon nanotubes are

(a) nanosized graphite sheets (b) nanosized carbon black

(c) nanosized coal black (d) None of the above

(11) The name of metal nanoparticle which acts as highly effective bacterial disinfectant in water purification process is …… . ***(March '22)***

(a) carbon black (b) silver (c) gold (d) copper

Ans. (1) (b) sustainable development **(2)** (b) lindane **(3)** (b) Greek word meaning dwarf **(4)** (a) Absorption of functional groups **(5)** (d) Paul T. Anastas **(6)** (b) Nario Taniguchi, 1974 **(7)** (b) nanochemistry **(8)** (c) TiO_2 **(9)** (a) sol-gels method **(10)** (a) nanosized graphite sheets **(11)** (b) silver.