VITEE 2008

1. Two beams of light will not give rise to an interference pattern, if
   (a) they are coherent
   (b) they have the same wavelength
   (c) they are linearly polarized perpendicular to each other
   (d) they are not monochromatic

2. A slit of width a is illuminated with a monochromatic light of wavelength λ from a distant source and the diffraction pattern is observed on a screen placed at a distance D from the slit. To increase the width of the central maximum one should
   (a) decrease D
   (b) decrease a
   (c) decrease λ
   (d) The width cannot be changed

3. A thin film of soap solution ($n = 1.4$) lies on the top of a glass plate ($n = 1.5$). When visible light is incident almost normal to the plate, two adjacent reflection maxima are observed at two wavelengths 400 and 630 nm. The minimum thickness of the soap solution is
   (a) 420 nm (b) 450 nm
   (c) 630 nm (d) 1260 nm

4. If the speed of a wave doubles as it passes from shallow water into deeper water, its wavelength will be
   (a) unchanged (b) halved
   (c) doubled (d) quadrupled

5. A light whose frequency is equal to 6×10^{14} Hz is incident on a metal whose work function is 2eV. [$h = 6.63 \times 10^{-34}$ Js, $1\text{eV} = 1.6 \times 10^{-19}$ J]
   The maximum energy of the electrons emitted will be
   (a) 2.49 eV (b) 4.49 eV
   (c) 0.49 eV (d) 5.49 eV

6. An electron microscope is used to probe the atomic arrangements to a resolution of 5 Å. What should be the electric potential to which the electrons need to be accelerated?
   (a) 2.5 V (b) 5V
   (c) 2.5 kV (d) 5 kV

7. Which phenomenon best supports the theory that matter has a wave nature?
   (a) Electron momentum
   (b) Electron diffraction
   (c) Photon momentum
   (d) Photon diffraction

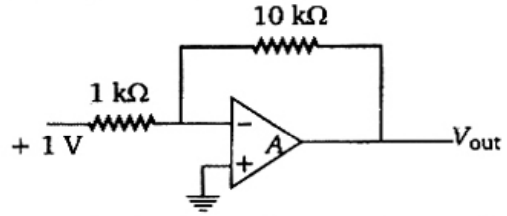
8. The radioactivity of a certain material drops to $\frac{1}{16}$ of the initial value in 2 h. The half-life of this radio nuclide is
   (a) 10 min (b) 20 min
   (c) 30 min (d) 40 min

9. An observer A sees an asteroid with a radioactive element moving by at a speed $= 0.3c$ and measures the radioactivity decay time to be T_A. Another observer B is moving with the asteroid and measures its decay time as T_B. Then T_A and T_B are related as
   (a) $T_B < T_A$
   (b) $T_A = T_B$
   (c) $T_B > T_A$
   (d) Either (A) or (C) depending on whether the asteroid is approaching or moving away from A

10. ^{234}U has 92 protons and 234 nucleons total in its nucleus. It decays by emitting an alpha particle. After the decay it becomes
    (a) ^{232}U (b) ^{232}Pa
    (c) ^{230}Th (d) ^{230}Ra

11. K_α and K_β X-rays are emitted when there is a transition of electron between the levels
    (a) $n = 2$ to $n = 1$ and $n = 3$ to $n = 1$ respectively
    (b) $n = 2$ to $n = 1$ and $n = 3$ to $n = 2$ respectively
    (c) $n = 3$ to $n = 2$ and $n = 4$ to $n = 2$ respectively
    (d) $n = 3$ to $n = 2$ and $n = 4$ to $n = 3$ respectively

12. A certain radioactive material ${}_{Z}X^{A}$ starts emitting α and β particles successively such that the end product is ${}_{Z-3}Y^{A-8}$. The number of α and β particles emitted are
(a) 4 and 3 respectively
(b) 2 and 1 respectively
(c) 3 and 4 respectively
(d) 3 and 8 respectively

13. 

In the circuit shown above, an input of 1 V is fed into the inverting input of an ideal Op-amp *A*. The ouput signal V_{out} will be
(a) + 10 V (b) − 10 V
(c) 0 V (d) infinity

14. When a solid with a band gap has a donor level just below its empty energy band, the solid is
(a) an insulator
(b) a conductor
(c) *p*-type semiconductor
(d) *n*-type semiconductor

15. A *p-n* junction has acceptor impurity concentration of 10^{17} cm^{-3} in the *P* side and donor impurity concentration of 10^{16} cm^{-3} in the *N* side. What is the contact potential at the junction? (kT = thermal energy, intrinsic carrier concentration $n_i = 1.4 \times 10^{10}$ cm^{-3})
(a) $(kT/e) \ln (4 \times 10^{12})$
(b) $(kT/e) \ln (2.5 \times 10^{23})$
(c) $(kT/e) \ln (10^{23})$
(d) $(kT/e) \ln (10^{9})$

16. A Zener diode has a contact potential of 1 V in the absence of biasing. It undergoes Zener breakdown for an electric field of 10^6 V/m at the depletion region of *p-n* junction. If the width of the depletion region is 2.5 μm, what should be the reverse biased potential for the Zener breakdown to occur?
(a) 3.5 V (b) 2.5 V
(c) 1.5 V (d) 0.5 V

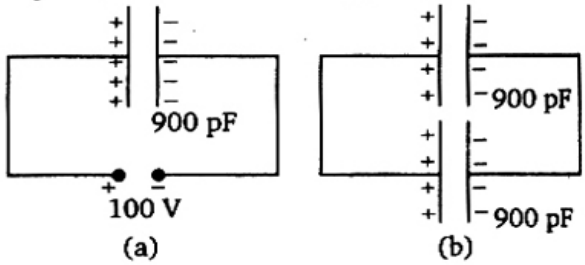
17. In Colpitt oscillator the feedback network

18. The reverse saturation of *p-n* diode
(a) depends on doping concentrations
(b) depends on diffusion lengths of carriers
(c) depends on the doping concentrations and diffusion lengths
(d) depends on the doping concentrations, diffusion length and device temperature

19. A radio station has two channels. One is AM at 1020 kHz and the other FM at 89.5 MHz. For good results you will use
(a) longer antenna for the AM channel and shorter for the FM
(b) shorter antenna for the AM channel and longer for the FM
(c) Same length antenna will work for both
(d) Information given is not enough to say which one to use for which

20. The communication using optical fibres is based on the principle of
(a) total internal reflection
(b) Brewster angle
(c) polarization
(d) resonance

21. In nature, the electric charge of any system is always equal to
(a) half integral multiple of the least amount of charge
(b) zero
(c) square of the least amount of charge
(d) integral multiple of the least amount of charge

22. The energy stored in the capacitor as shown in Fig. (a) is 4.5×10^{-6} J. If the battery is replaced by another capacitor of 900 pF as shown in Fig. (b), then the total energy of system is


(a) 4.5×10^{-6} J (b) 2.25×10^{-6} J
(c) zero (d) 9×10^{-6} J

23. Equal amounts of a metal are converted into cylindrical wires of different lengths *L* and

(c) length = $2L$ and area = $\frac{A}{2}$

(d) All have the same resistance, as the amount of the metal is the same

24. If the force exerted by an electric dipole on a charge q at a distance of 1 m is F, the force at a point 2 m away in the same direction will be

(a) $\frac{F}{2}$ (b) $\frac{F}{4}$

(c) $\frac{F}{6}$ (d) $\frac{F}{8}$

25. A solid sphere of radius R_1 and volume charge density $\rho = \frac{\rho_0}{r}$ is enclosed by a hollow sphere of radius R_2 with negative surface charge density σ, such that the total charge in the system is zero, ρ_0 is a positive constant and r is the distance from the centre of the sphere. The ratio $\frac{R_2}{R_1}$ is

(a) $\frac{\sigma}{\rho_0}$ (b) $\sqrt{2\sigma/\rho_0}$

(c) $\sqrt{\rho_0/(2\sigma)}$ (d) $\frac{\rho_0}{\sigma}$

26. A solid spherical conductor of radius R has a spherical cavity of radius a $(a < R)$ at its centre. A charge $+Q$ is kept at the centre. The charge at the inner surface, outer surface and at a position $r(a < r < R)$ are respectively

(a) $+Q, -Q, 0$ (b) $-Q, +Q, 0$

(c) $0, -Q, 0$ (d) $+Q, 0, 0$

27. A cylindrical capacitor has charge Q and length L. If both the charge and length of the capacitors are doubled, by keeping other parameters fixed, the energy stored in the capacitor

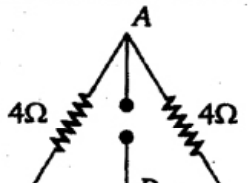
(a) remains same

(b) increases two times

(c) decreases two times

(d) increases four times

28. Three resistances of 4 Ω each are connected as shown in figure. If the point D divides the resistance into two equal halves, the resistance between point A and D will be



29. The resistance of a metal increases with increasing temperature because

(a) the collisions of the conducting electrons with the electrons increase

(b) the collisions of the conducting electrons with the lattice consisting of the ions of the metal increase

(c) the number of conduction electrons decrease

(d) the number of conduction electrons increase

30. In the absence of applied potential, the electric current flowing through a metallic wire is zero because

(a) the electrons remain stationary

(b) the electrons are drifted in random direction with a speed of the order of 10^{-2} cm/s

(c) the electrons move in random direction with a speed of the order close to that of velocity of light

(d) electrons and ions move in opposite direction

31. A meter bridge is used to determine the resistance of an unknwon wire by measuring the balance point length l. If the wire is replaced by another wire of same material but with double the length and half the thickness, the balancing point is expected to be

(a) $\frac{1}{8l}$ (b) $\frac{1}{4l}$

(c) $8l$ (d) $16l$

32. Identify the incorrect statement regarding a superconducting wire

(a) transport current flows through its surface

(b) transport current flows through the entire area of cross-section of the wire

(c) it exhibits zero electrical resistivity and expels applied magnetic field

(d) it is used to produce large magnetic field

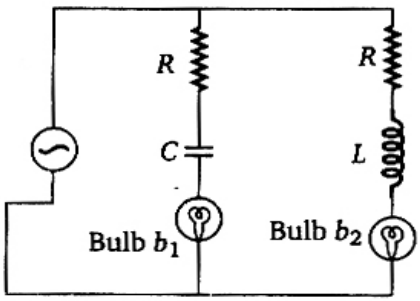
33. A sample of HCl gas is placed in an electric field of 3×10^4 NC^{-1}. The dipole moment of each HCl molecule is 6×10^{-30} Cm. The maximum torque that can act on a molecule is

(a) 2×10^{-34} C^2mN^{-1}

34. When a metallic plate swings between the poles of a magnet
(a) no effect on the plate
(b) eddy currents are set up inside the plate and the direction of the current is along the motion of the plate
(c) eddy currents are set up inside the plate and the direction of the current oppose the motion of the plate
(d) eddy currents are set up inside the plate

35. When an electrical appliance is switched on, it responds almost immediately, because
(a) the electrons in the connecting wires move with the speed of light
(b) the electrical signal is carried by electromagnetic waves moving with the speed of light
(c) the electrons move with the speed which is close to but less than speed of light
(d) the electrons are stagnant

36. Two identical incandescent light bulbs are connected as shown in the figure. When the circuit is an AC voltage source of frequency f, which of the following observations will be correct?



(a) Both bulbs will glow alternatively
(b) Both bulbs will glow with same brightness provided frequency $f = \frac{1}{2\pi}\sqrt{(1/LC)}$
(c) Bulb b_1 will light up initially and goes off, bulb b_2 will be ON constantly
(d) Bulb b_1 will blink and bulb b_2 will be ON constantly

37. A transformer rated at 10 kW is used to connect a 5 kV transmission line to a 240 V circuit. The ratio of turns in the windings of the transformer is
(a) 5 (b) 20.8
(c) 104 (d) 40

38. Three solenoid coils of same dimension, same number of turns and same number of layers of winding are taken. Coil 1 with inductance L_1 was wound using a Mn wire of resistance 11 Ω/m; Coil 2 with inductance L_2 was wound using the similar wire but the direction of winding was reversed in each layer; Coil 3 with inductance L_3 was wound using a superconducting wire. The self-inductance of the coils L_1, L_2, L_3 are
(a) $L_1 = L_2 = L_3$ (b) $L_1 = L_2; L_3 = 0$
(c) $L_1 = L_3; L_2 = 0$ (d) $L_1 > L_2 > L_3$

39. Light travels with a speed of 2×10^8 m/s in crown glass of refractive index 1.5. What is the speed of light in dense flint glass of refractive index 1.8?
(a) 1.33×10^8 m/s (b) 1.67×10^8 m/s
(c) 2.0×10^8 m/s (d) 3.0×10^8 m/s

40. A parallel beam of fast moving electrons is incident normally on a narrow slit. A screen is placed at a large distance from the slit. If the speed of the electrons is increased, which of the following statement is correct?
(a) Diffraction pattern is not observed on the screen in the case of electrons
(b) The angular width of the central maximum of the diffraction pattern will increase
(c) The angular width of the central maximum will decrease
(d) The angular width of the central maximum will remains the same

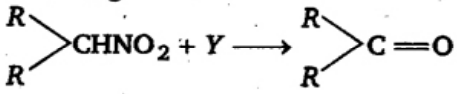
Chemistry

1. $CH_3CH_3 + HNO_3 \longrightarrow ?$
(a) $CH_3CH_2NO_2$
(b) $CH_3CH_2NO_2 + CH_3NO_2$
(c) $2CH_3NO_2$
(d) $CH_2{=}CH_2$

(c) ethanol (d) acetamide

3. Which will not go for diazotisation?
(a) $C_6H_5NH_2$ (b) $C_6H_5CH_2NH_2$

4. Secondary nitroalkanes can be converted into ketones by using *Y*. Identify *Y* from the following



(a) aqueous HCl
(b) aqueous NaOH
(c) $KMnO_4$
(d) CO

5. Alkyl cyanides undergo Stephen reduction to produce
(a) aldehyde (b) secondary amine
(c) primary amine (d) amide

6. The continuous phase contains the dispersed phase throughout, example is
(a) water in milk
(b) fat in milk
(c) water droplets in mist
(d) oil in water

7. The number of hydrogen atoms present in 25.6 g of sucrose ($C_{12}H_{22}O_{11}$) which has a molar mass of 342.3 g is
(a) 22×10^{23}
(b) 9.91×10^{23}
(c) 11×10^{23}
(d) 44×10^{23} H atoms

8. Milk changes after digestion into
(a) cellulose (b) fructose
(c) glucose (d) lactose

9. Which of the following set consists only of essential amino acids?
(a) Alanine, tyrosine, cystine
(b) Leucine, lysine, tryptophane
(c) Alanine, glutamine, lycine
(d) leucine, proline, glycine

10. Which of the following is a ketohexose?
(a) Glucose (b) Sucrose
(c) Fructose (d) Ribose

11. The oxidation number of oxygen in KO_3, Na_2O_2 is
(a) 3, 2 (b) 1, 0
(c) 0, 1 (d) – 0.33, – 1

12. Reaction of PCl_5 and PhMgBr would give

13. Which of the following is not a characteristic of transition elements?
(a) Variable oxidation states
(b) Formation of coloured compounds
(c) Formation of interstitial compounds
(d) Natural radioactivity

14. Cl — P — Cl bond angles in PCl_5 molecule are
(a) 120° and 90° (b) 60° and 90°
(c) 60° and 120° (d) 120° and 30°

15. The magnetic moment of a salt containing Zn^{2+} ion is
(a) 0 (b) 1.87
(c) 5.92 (d) 2

16. The number of formula units of calcium fluoride, CaF_2 present in 146.4 g of CaF_2 (the molar mass of CaF_2 is 78.08 g/mol) is
(a) 1.129×10^{24} CaF_2
(b) 1.146×10^{24} CaF_2
(c) 7.808×10^{24} CaF_2
(d) 1.877×10^{24} CaF_2

17. The IUPAC name of the given compound $[Co(NH_3)_5Cl]Cl_2$ is
(a) penta amino cobalt chloride chlorate
(b) cobalt penta ammine chloro chloride
(c) pentamine chloro cobalt (III) chloride
(d) penta amino cobalt (III) chlorate

18. When SCN^- is added to an aqueous solution containing $Fe(NO_3)_3$, the complex ion produced is
(a) $[Fe(OH_2)_2(SCN)]^{2+}$
(b) $[Fe(OH_2)_5(SCN)]^{2+}$
(c) $[Fe(OH_2)_8(SCN)]^{2+}$
(d) $[Fe(OH_2)(SCN)]^{6+}$

19. Hair dyes contain
(a) copper nitrate (b) gold chloride
(c) silver nitrate (d) copper sulphate

20. Schottky defects occurs mainly in electrovalent compounds where
(a) positive ions and negative ions are of different size
(b) positive ions and negative ions are of same

21. The number of unpaired electrons calculated in $[Co(NH_3)_6]^{3+}$ and $[Co(F_6)]^{3-}$ are
(a) 4 and 4 (b) 0 and 2
(c) 2 and 4 (d) 0 and 4

22. The standard free energy change of a reaction is $\Delta G^\circ = -115$ kJ at 298 K. Calculate the equilibrium constant K_p in $\log K_p$ ($R = 8.314\ JK^{-1}mol^{-1}$).
(a) 20.16 (b) 2.303
(c) 2.016 (d) 13.83

23. If an endothermic reaction occurs spontaneously at constant temperature (T) and pressure (p), then which of the following is true?
(a) $\Delta G > 0$ (b) $\Delta H < 0$
(c) $\Delta S > 0$ (d) $\Delta S < 0$

24. If a plot of $\log_{10} C$ *versus* t gives a straight line for a given reaction, then the reaction is
(a) zero order (b) first order
(c) second order (d) third order

25. A spontaneous process is one in which the system suffers
(a) no energy change
(b) a lowering of free energy
(c) a lowering of entropy
(d) an increase in internal energy

26. The half-life period of a first order reaction is 1 min 40 s. Calculate its rate constant.
(a) $6.93 \times 10^{-3}\ min^{-1}$
(b) $6.93 \times 10^{-3}\ s^{-1}$
(c) $6.93 \times 10^{-3}\ s$
(d) $6.93 \times 10^{3}\ s$

27. The molar conductivities of KCl, NaCl and KNO_3 are 152, 128 and 111 S $cm^2\ mol^{-1}$ respectively. What is the molar conductivity of $NaNO_3$?
(a) 101 S $cm^2 mol^{-1}$
(b) 87 S $cm^2 mol^{-1}$
(c) – 101 S $cm^2 mol^{-1}$
(d) – 391 S $cm^2 mol^{-1}$

28. The electrochemical cell stops working after sometime because
(a) electrode potential of both the electrodes becomes zero

29. The amount of electricity required to produce one mole of copper from copper sulphate solution will be
(a) 1 F (b) 2.33 F
(c) 2 F (d) 1.33 F

30. Dipping iron article into a strongly alkaline solution of sodium phosphate
(a) does not affect the article
(b) forms $Fe_2O_3 \cdot xH_2O$ on the surface
(c) forms iron phosphate film
(d) forms ferric hydroxide

31. Hydroboration oxidation of 4-methyl octene would give
(a) 4-methyl octanol
(b) 2-methyl decane
(c) 4-methyl heptanol
(d) 4-methyl-2-octanone

32. When ethyl alcohol is heated with conc. H_2SO_4, the product obtained is
(a) $CH_3COOC_2H_5$ (b) C_2H_2
(c) C_2H_6 (d) C_2H_4

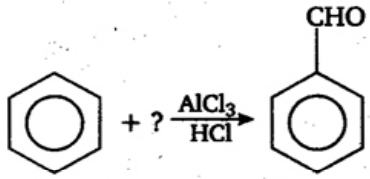
33. Anisole is the product obtained from phenol by the reaction known as
(a) coupling
(b) etherification
(c) oxidation
(d) esterification

34. Ethylene glycol gives oxalic acid on oxidation with
(a) acidified $K_2Cr_2O_7$ (b) acidified $KMnO_4$
(c) alkaline $KMnO_4$ (d) periodic acid

35. Diamond is hard because
(a) all the four valence electrons are bonded to each carbon atoms by covalent bonds
(b) it is a giant molecule
(c) it is made up of carbon atoms
(d) it cannot be burnt

36. A Wittig reaction with an aldehyde gives
(a) ketone compound
(b) a long chain fatty acid
(c) olefin compound
(d) epoxide

37. Cannizaro reaction is given by
(a) HCHO
(b) $\rangle$C(OH)COOH

38. 

Identify the reactant.

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

39. Maleic acid and fumaric acid are
(a) position isomers
(b) geometric isomers
(c) enantiomers
(d) functional isomers

40. The gas evolved on heating alkali formate with soda-lime is
(a) CO (b) CO_2
(c) hydrogen (d) water vapour

Mathematics

1. If $\vec{a}, \vec{b}, \vec{c}$ be three unit vectors such that $\vec{a} \times (\vec{b} \times \vec{c}) = \frac{1}{2}\vec{b}, \vec{b}$ and $\vec{c}$ being non-parallel. If θ_1 is the angle between $\vec{a}$ and $\vec{b}$ and θ_2 is the angle between $\vec{a}$ and $\vec{c}$, then
(a) $\theta_1 = \frac{\pi}{6}, \theta_2 = \frac{\pi}{3}$ (b) $\theta_1 = \frac{\pi}{3}, \theta_2 = \frac{\pi}{6}$
(c) $\theta_1 = \frac{\pi}{2}, \theta_2 = \frac{\pi}{3}$ (d) $\theta_1 = \frac{\pi}{3}, \theta_2 = \frac{\pi}{2}$

2. The $\vec{r}^2 - \vec{r} \cdot \vec{c} + h = 0, |\vec{c}| > \sqrt{h}$, represents
(a) circle (b) ellipse
(c) cone (d) sphere

3. The simplified expression of $\sin(\tan^{-1} x)$, for any real number x is given by
(a) $\frac{1}{\sqrt{1+x^2}}$ (b) $\frac{x}{\sqrt{1+x^2}}$
(c) $-\frac{1}{\sqrt{1+x^2}}$ (d) $-\frac{x}{\sqrt{1+x^2}}$

4. If $\left|\frac{z-25}{z-1}\right| = 5$, find the value of $|z|$.
(a) 3 (b) 4
(c) 5 (d) 6

5. Argument of the complex number $\left(\frac{-1-3i}{2+i}\right)$ is
(a) 45° (b) 135°
(c) 225° (d) 240°

6. In a triangle ABC, the sides b and c are the roots of the equation $x^2 - 61x + 820 = 0$ and $A = \tan^{-1}\left(\frac{4}{3}\right)$, then a^2 is equal to
(a) 1098 (b) 1096

(a) 6 (b) 8
(c) 12 (d) 9

8. The centre and radius of the sphere $x^2 + y^2 + z^2 + 3x - 4z + 1 = 0$ are
(a) $\left(-\frac{3}{2}, 0, -2\right); \frac{\sqrt{21}}{2}$ (b) $\left(\frac{3}{2}, 0, 2\right); \sqrt{21}$
(c) $\left(-\frac{3}{2}, 0, 2\right); \frac{\sqrt{21}}{2}$ (d) $\left(-\frac{3}{2}, 2, 0\right); \frac{21}{2}$

9. Let A and B are two fixed points in a plane, then locus of another point C on the same plane such that $CA + CB$ = constant, $(> AB)$ is
(a) circle (b) ellipse
(c) parabola (d) hyperbola

10. The directrix of the parabola $y^2 + 4x + 3 = 0$ is
(a) $x - \frac{4}{3} = 0$ (b) $x + \frac{1}{4} = 0$
(c) $x - \frac{3}{4} = 0$ (d) $x - \frac{1}{4} = 0$

11. 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

12. The value of $f(0)$ so that $\frac{(-e^x + 2^x)}{x}$ may be continuous at $x = 0$ is
(a) $\log\left(\frac{1}{2}\right)$ (b) 0
(c) 4 (d) $-1 + \log 2$

13. Let [ ] denotes the greatest integer function and $f(x) = [\tan^2 x]$. Then,
(a) $\lim_{x \to 0} f(x)$ does not exist

14. A spherical balloon is expanding. If the radius is increasing at the rate of 2 cm/min, the rate at which the volume increases (in cubic centimetres per minute) when the radius is 5 cm, is
(a) 10π (b) 100π
(c) 200π (d) 50π

15. The length of the parabola $y^2 = 12x$ cut off by the latusrectum is
(a) $6[\sqrt{2} + \log(1 + \sqrt{2})]$
(b) $3[\sqrt{2} + \log(1 + \sqrt{2})]$
(c) $6[\sqrt{2} - \log(1 + \sqrt{2})]$
(d) $3[\sqrt{2} - \log(1 + \sqrt{2})]$

16. If $I = \int \frac{x^5}{\sqrt{1 + x^3}}\, dx$, then I is equal to
(a) $\frac{2}{9}(1 + x^3)^{\frac{5}{2}} + \frac{2}{3}(1 + x^3)^{\frac{3}{2}} + c$
(b) $\log|\sqrt{x} + \sqrt{1 + x^3}| + c$
(c) $\log|\sqrt{x} - \sqrt{1 + x^3}| + c$
(d) $\frac{2}{9}(1 + x^3)^{\frac{3}{2}} - \frac{2}{3}(1 + x^3)^{\frac{1}{2}} + c$

17. Area enclosed by the curve $\pi[4(x - \sqrt{2})^2 + y^2] = 8$ is
(a) π sq unit (b) 2 sq unit
(c) 3π sq unit (d) 4 sq unit

18. The value of $\int_0^a \sqrt{\frac{a - x}{x}}\, dx$ is
(a) $\frac{a}{2}$ (b) $\frac{a}{4}$
(c) $\frac{\pi a}{2}$ (d) $\frac{\pi a}{4}$

19. Let y be the number of people in a village at time t. Assume that the rate of change of the population is proportional to the number of people in the village at any time and further assume that the population never increases in time. Then, the population of the village at any fixed time t is given by
(a) $y = e^{kt} + c$, for some constants $c \le 0$ and $k \ge 0$
(b) $y = ce^{kt}$, for some constants $c \ge 0$ and $k \le 0$
(c) $y = e^{ct} + k$ for some constants

(a) $\left(y - \frac{dy}{dx}\right)^2 = a^2\left[1 + \left(\frac{dy}{dx}\right)^2\right]$
(b) $\left(y - x\frac{dy}{dx}\right)^2 = a^2\left[1 + \left(\frac{dy}{dx}\right)^2\right]$
(c) $\left(y - x\frac{dy}{dx}\right) = a^2\left[1 + \frac{dy}{dx}\right]$
(d) $\left(y - \frac{dy}{dx}\right) = a^2\left[1 - \frac{dy}{dx}\right]$

21. The differential equation $\left|\frac{dy}{dx}\right| + |y| +$ admits
(a) infinite number of solutions
(b) no solutions
(c) a unique solution
(d) many solutions

22. Solution of the differential equ $x\,dy - y\,dx - \sqrt{x^2 + y^2}dx = 0$ is
(a) $y - \sqrt{x^2 + y^2} = cx^2$
(b) $y + \sqrt{x^2 + y^2} = cx^2$
(c) $y + \sqrt{x^2 + y^2} = cy^2$
(d) $x - \sqrt{x^2 + y^2} = cy^2$

23. Let p, q, r and s be statements and suppos $p \to q \to r \to p$. If $\sim s \to r$, then
(a) $s \to \sim q$ (b) $\sim q \to s$
(c) $\sim s \to \sim q$ (d) $q \to \sim s$

24. In how many number of ways can 10 stu be divided into three teams, one cont four students and the other three?
(a) 400 (b) 700
(c) 1050 (d) 2100

25. If R be a relation defined as aRb iff $|a - b$ then the relation is
(a) reflexive
(b) symmetric
(c) transitive
(d) symmetric and transitive

26. Let S be a finite set containing n elements. the total number of commutative operation on S is
(a) $n^{\left[\frac{n(n+1)}{2}\right]}$ (b) $n^{\left[\frac{n(n-1)}{2}\right]}$
(c) $n^{(n^2)}$ (d) $2^{(n^2)}$

Answers

PHYSICS

1. (d)	**2.** (b)	**3.** (b)	**4.** (c)	**5.** (c)	**6.** (b)	**7.** (b)	**8.** (c)	**9.** (a)	**10.** (d)
11. (a)	**12.** (b)	**13.** (b)	**14.** (d)	**15.** (a)	**16.** (b)	**17.** (b)	**18.** (d)	**19.** (a)	**20.** (a)
21. (d)	**22.** (b)	**23.** (c)	**24.** (d)	**25.** (c)	**26.** (b)	**27.** (b)	**28.** (c)	**29.** (b)	**30.** (c)
31. (c)	**32.** (b)	**33.** (c)	**34.** (c)	**35.** (b)	**36.** (b)	**37.** (b)	**38.** (c)	**39.** (b)	**40.** (c)

CHEMISTRY

1. (b)	**2.** (a)	**3.** (b)	**4.** (a)	**5.** (a)	**6.** (c)	**7.** (b)	**8.** (d)	**9.** (b)	**10.** (c)
11. (d)	**12.** (c)	**13.** (d)	**14.** (a)	**15.** (a)	**16.** (a)	**17.** (c)	**18.** (b)	**19.** (c)	**20.** (b)
21. (d)	**22.** (a)	**23.** (c)	**24.** (b)	**25.** (b)	**26.** (b)	**27.** (b)	**28.** (b)	**29.** (c)	**30.** (a)
31. (a)	**32.** (d)	**33.** (b)	**34.** (c)	**35.** (a)	**36.** (c)	**37.** (a)	**38.** (c)	**39.** (b)	**40.** (c)

MATHEMATICS

1. (c)	**2.** (d)	**3.** (b)	**4.** (c)	**5.** (c)	**6.** (c)	**7.** (d)	**8.** (c)	**9.** (b)	**10.** (d)
11. (b)	**12.** (d)	**13.** (b)	**14.** (c)	**15.** (a)	**16.** (d)	**17.** (d)	**18.** (c)	**19.** (b)	**20.** (b)
21. (b)	**22.** (b)	**23.** (b)	**24.** (d)	**25.** (d)	**26.** (a)	**27.** (b)	**28.** (d)	**29.** (a)	**30.** (b)
31. (b)	**32.** (d)	**33.** (d)	**34.** (d)	**35.** (c)	**36.** (b)	**37.** (c)	**38.** (a)	**39.** (a)	**40.** (d)

1. When two waves of same frequency, same wavelength and same velocity moves in the same direction. Their superposition results in the interference. The two beams are monochromatic.

2. Width of the central maximum,

$$\beta_0 = \frac{2D\lambda}{a}$$

$$\beta_0 \propto \frac{1}{a}$$

$\therefore$ To increase the width of the central maximum one should decrease a.

3. $n_1\lambda_1 = n_2\lambda_2$

$\therefore \quad n_1 \times 420 = n_2 \times 630$

or $\quad 2n_1 = 3n_2$

If $\quad n_2 = 2$, then $n_1 = 3$

Therefore, thickness of soap solution is given by

$$\mu_1 t = n_1 \frac{\lambda_1}{2}$$

or $$t = \frac{3 \times 420}{1.4 \times 2} = 450 \text{ nm}$$

4. Since frequency remains unchanged

$$\nu = \nu'$$

$$\frac{v}{\lambda} = \frac{v'}{\lambda'}$$

$$\frac{v}{\lambda} = \frac{2v}{\lambda'}$$

$$\lambda' = \frac{2v}{v}\lambda$$

$$\lambda' = 2\lambda$$

Hence, its wavelength will become twice.

5. $KE_{max} = h\nu - \phi$

where $h\nu$ = energy of incident photon,

ϕ = work function

$$KE_{max} = 6.6\times10^{-34} \times 6\times10^{14} - 2\times1.6\times10^{-19}$$

$$= 3.96\times10^{-19} - 3.2\times10^{-19}$$

$$= \frac{0.76\times10^{-19}}{1.6\times10^{-19}} \text{ eV}$$

$$= 0.475 \text{ eV}$$

6. $$\lambda = \frac{h}{\sqrt{2eVm}}$$

$$5\text{Å} = \frac{6.6\times10^{-34}}{\sqrt{2\times1.6\times10^{-19}\times9.1\times10^{-31}\times V}}$$

$$5\text{Å} = \frac{6.6\times10^{-34}}{5.4\times10^{-25}\sqrt{V}}$$

$$V = \left(\frac{6.6\times10^{-34}}{5.4\times10^{-25}\times5\times10^{-10}}\right)^2$$

$$V = 5.76 \text{ volt}$$

7. Electron diffraction is the diffraction of a beam of electrons by atoms or molecules. The fact that electrons can be diffracted in a similar way to light shows the particles can act as waves.

8. After n half-lives the quantity of a radioactive substance left intact (undecayed) is given by

$$N = N_0\left(\frac{1}{2}\right)^n$$

$$= N_0\left(\frac{1}{2}\right)^{t/T_{1/2}}$$

Here, $\quad N = \frac{1}{16}N_0, t = 2\text{h}$

$$\frac{1}{16}N_0 = N_0\left(\frac{1}{2}\right)^{2/T_{1/2}}$$

$$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^{2/T_{1/2}}$$

Equating the powers on both sides

$$4 = \frac{2}{T_{1/2}}$$

$$T_{1/2} = \frac{1}{2}\text{h} = 30 \text{ min}$$

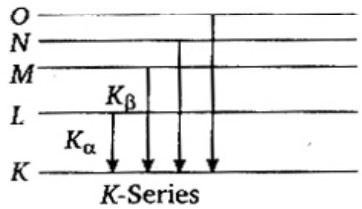
9. Observers in different inertial frames always measure different time intervals between a pair of events.

According to time dilation

$$T_A > T_B$$

10. Alpha particle has mass number 4 and atomic number 2. Therefore, after emission of an alpha particle. The mass number of the ^{234}U will reduce by 4 and after decay it becomes ^{230}Ra.

11. When the colliding electron remove an electron from innermost K-shell (corresponding to $n = 1$) of atom and electron from some higher shell jumps to K-shell to fill up this vacancy, characteristic X-ray of K-series are obtained



K-Series

$\therefore K_\alpha$ and K_β *X*-rays are emitted when there is transition of electron between the levels $n = 2$ to $n = 1$ and $n = 3$ to $n = 1$ respectively.

12. Let there be x α-particles and y β-particles

$$_ZX^A \longrightarrow x\text{He}_2^4 + y\beta_{-1}^0 + Y_{Z-3}^{A-8}$$

then equating the mass numbers

$$A = 4x + A - 8 \qquad \ldots(i)$$

and equating atomic numbers

$$Z = 2x - y + Z - 3 \qquad \ldots(ii)$$

Solving Eqs. (i) and (ii), we get

$$x = 2 \text{ and } y = 1$$

$\therefore$ The number of α and β particles emitted are 2 and 1 respectively.

13. Voltage gain,

$$\frac{V_o}{V_i} = -\frac{R_f}{R_i} = -\frac{10}{1} = -10$$

or $V_o = -10V_i = -10 \times 1 = -10$ volt

14. In *n*-type semiconductor donor energy level lies just below the conduction band also called empty band of minimum energy.

15. Constant potential at the junction

$$V_{\text{constant}} = \frac{kT}{e} \ln\left(\frac{n_a n_d}{n_i^2}\right)$$

$$\therefore V_{\text{constant}} = \frac{kT}{e} \ln\left(\frac{10^{17} \times 10^{16}}{(1.4 \times 10^{10})^2}\right)$$

$$= \frac{kT}{e} \ln (4 \times 10^{12})$$

16. Reverse biased potential for the zener breakdown

$$V_r = Ed$$
$$= 10^6 \times 2.5 \times 10^{-6}$$
$$= 2.5 \text{ volt}$$

17. In Colpitt oscillator two capacitors are placed across a common inductor and the centre of the two capacitors is tapped.

18. The reverse saturation of *p*-*n* diode depends on the doping concentrations, diffusion length and device temperature.

19. For efficient radiation and reception, the height of to be the transmitting and receiving antennas should be comparable to a quarter

Therefore FM has shorter antenna and AM has longer antenna.

20. The communication using optical fibres is based on the principle of total internal reflection.

21. If the charge of an electron is taken as elementary unit *ie*, quanta of charge, the charge on any body will be some integral multiple of *e ie*, $q = ne$ with $n = 1, 2, 3\ldots$

22. Energy stored in the capacitor in Fig (a)

$$\frac{1}{2}\frac{Q^2}{C} = 4.5 \times 10^{-6} \text{ J}$$

If battery in Fig. (a) is replaced by capacitor in Fig. (b),

total energy stored

$$= \frac{1}{2}\left(\frac{1}{2}\frac{Q^2}{C}\right)$$
$$= \frac{1}{2} \times 4.5 \times 10^{-6}$$
$$= 2.25 \times 10^{-6} \text{ J}$$

23. Resistance, $R = \rho\frac{l}{A}$

$$R \propto l \propto \frac{1}{A}$$

$\therefore R$ is maximum when length $= 2L$ and area $= \frac{A}{2}$.

24. Force exerted by an electric dipole on a charge is inversely proportional to the cube of distance of the charge from the centre of the dipole

$$F \propto \frac{1}{r^3}$$

$$\therefore \quad \frac{F}{F'} = \left(\frac{r'}{r}\right)^3$$

$$\frac{F}{F'} = \left(\frac{2}{1}\right)^3$$

$$F' = \frac{F}{8}$$

25. For solid sphere of radius R_1

$$q_1 = \int_0^{R_1} 4\pi r^2 dr\rho$$

$$= \int_0^{R_1} 4\pi r^2 dr \frac{\rho_0}{r}$$

$$q_1 = 4\pi\frac{R_1^2}{2}\rho_0$$

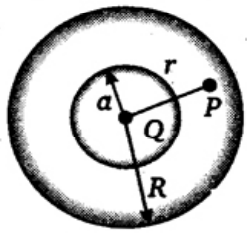
$$q_2 = -4\pi R_2^2\sigma$$

$$q_1 + q_2 = 0$$

$$\left(\frac{R_1}{R_2}\right)^2 = \frac{2\sigma}{\rho_0}$$

$$\frac{R_2}{R_1} = \sqrt{\frac{\rho_0}{2\sigma}}$$

26. The solid conductor with a cavity is shown in figure.



The inner surface of cavity will be $-Q$ due to induction. At outer surface, the charge will be $+Q$ and at a point between P at a position $r(a < r < R)$ will be zero.

27. Energy of a charged capacitor, $E = \frac{1}{2}\frac{Q^2}{C}$

$$C = \frac{2\pi\varepsilon_0 L}{\log_e\left(\frac{b}{a}\right)}$$

$$E = \frac{1}{2}\frac{Q^2}{2\pi\varepsilon_0 L}\log_e\left(\frac{b}{a}\right) \quad \ldots(i)$$

for a cylindrical capacitor.
where L = length of the cylinders
a and b = radii of two concentric cylinders

$$C' = \frac{2\pi\varepsilon_0(2L)}{\log_e\left(\frac{b}{a}\right)}$$

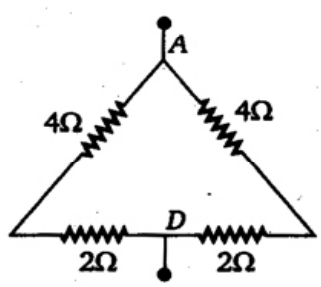
$$E' = \frac{1}{2}\frac{(2Q)^2}{C'}$$

$$= \frac{1}{2}\frac{(2Q)^2}{2\pi\varepsilon_0(2L)}\log_e\left(\frac{b}{a}\right) \quad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$E' = 2E$$

28. The equivalent circuit is given by



Then 6Ω and 6Ω resistances are in parallel on both sides

$$\frac{1}{R} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6}$$

$$= \frac{1}{3}$$

$$R = 3\Omega$$

29. The resistance of a metal increases with increasing temperature this is because, with increase in temperature the ions of the conductor vibrate with greater amplitude and the collision between ions and electrons becomes more frequent.

30. At room temperature, the free electrons in a conductor move randomly with speed of the order of 10^5 m/s. Since, the motion of the electrons is random there is no net charge flow in any direction.

31. In a meter bridge the ratio of two resistances is

$$\frac{R}{R'} = \frac{l}{l'}$$

where l and l' are balancing lengths

Resistance $R = \frac{\rho l}{A} = \frac{\rho l}{\pi r^2}$

If material remains same $\rho = \rho'$

Given $l' = 2l$

$$r' = \frac{r}{2}$$

$$\therefore \quad R' = \frac{\rho l'}{A'}$$

$$= \frac{\rho 2l}{\pi\left(\frac{r}{2}\right)^2}$$

$$= \frac{8\rho l}{\pi r^2}$$

$$R' = 8R$$

Therefore, the new balancing point is expected to be $8\,l$.

32. Supercurrent always flows on the surface of the superconductor.

33. Torque, $\tau = p \times E$

$$\tau_{max} = pE$$

$$= 6 \times 10^{-30} \times 3 \times 10^4$$

$$= 18 \times 10^{-26}\ \text{Nm}$$

34. When a changing magnetic flux is applied to a bulk piece of conducting material then circulating current is called eddy currents are induced in material.

35. The electrical signal is carried by

switching on, an electrical appliance responds almost immediately.

36. At resonance both bulbs will glow with same brightness. At resonance, $X_L = X_C$

or $$2\pi fL = \frac{1}{2\pi fC}$$

or $$f = \frac{1}{2\pi\sqrt{LC}}$$

37. In transformer

$$\frac{n_p}{n_s} = \frac{V_p}{V_s}$$

$$= \frac{5000}{240} = 20.8$$

38. As inductance L_2 was wound using the similar wire but the direction of winding is reversed, so flux through L_2 is zero.

$\therefore$ $L_2 \propto \phi = 0$

Also, $L_1 = L_3$

Therefore, $L_1 = L_3, L_2 = 0$

39. $\mu = \frac{c}{v}$

$\therefore$ $$\frac{\mu}{\mu'} = \frac{v'}{v}$$

$$\frac{1.5}{1.8} = \frac{v'}{2\times10^8}$$

$$v' = \frac{3\times10^8}{1.8}$$

$$= 1.67\times10^8 \text{ m/s}$$

40. Angular fringe width is the ratio of fringe width to distance (D) of screen from the source *ie*,

$$\theta = \frac{\beta}{D}$$

As D is taken large, hence angular fringe width of the central maximum will decrease.

Chemistry

1. Under certain conditions, alkanes react with HNO_3, a hydrogen atom being replaced by a nitro group (NO_2). This process is known as nitration. Nitration of alkane may be carried out in the vapour phase between 150° to 475°C. Whereupon a mixture of mono nitro alkanes is obtained

Example Ethane give a mixture of nitroethane and nitromethane

$$\underset{\text{ethane}}{CH_3-CH_3} + HNO_3 \xrightarrow[-H_2O]{673\text{ K}}$$

$$\underset{\substack{\text{nitro ethane}\\\text{(major)}}}{CH_3-CH_2-NO_2} + \underset{\text{(minor)}}{CH_3NO_2}$$

During nitration chain fission of alkanes also takes place, so CH_3NO_2 is also obtained along with $CH_3CH_2NO_2$

2. In presence of dil HCl, acetamide is hydrolysed by boiling, the product obtained is acetic acid (CH_3COOH).

$$CH_3CONH_2 + H_2O \longrightarrow CH_3COOH + NH_3$$

$$CH_3CONH_2 + H_2O + HCl \rightarrow CH_3COOH + NH_4Cl$$

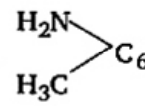
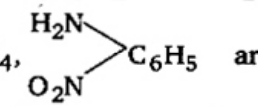
3. Only 1° aromatic amine (primary aromatic amine) form diazonium salts at low temperature (0° – 5°C). A reaction in which $-NH_2$ group is converted into diazo group ($-\overset{+}{N}\equiv N$) is called diazotisation. Diazotised

$$C_6H_5NH_2 + HCl \xrightarrow{0°-5°C} C_6H_5\overset{+}{N}H_3\,Cl^-$$

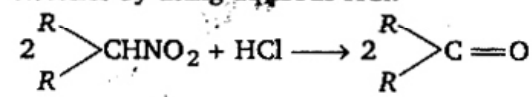
$$NaNO_2 + HCl \xrightarrow{0°-5°C} HNO_2 + NaCl$$

$$C_6H_5\overset{+}{N}H_3\,Cl^- + HNO_2 \xrightarrow{0°-5°C}$$

$$C_6H_5\overset{+}{N}_2\,Cl^- + 2H_2O$$

$C_6H_5NH_2$,   are aromatic primary amines, so undergo diazotisation but $C_6H_5CH_2NH_2$ (aliphatic amine) will not undergo diazotisation.

4. Secondary nitroalkanes can be converted into ketones by using aqueous HCl.



$$+ N_2O + H_2O$$

5. An alkyl cyanide is dissolved in ether or better in ethyl formate or ethyl acetate, and reduced with $SnCl_2$ and HCl, and then steam distilled. This whole process is called Stephen reaction. In this process alkyl cyanide is reduced to aldehyde.

$$CH_3-C\equiv N + 2[H] + HCl \xrightarrow[\text{ether}]{SnCl_2 + HCl}$$

$$CH_3-CH(=O:H_2)=NH\cdot HCl \xrightarrow[\Delta]{H_2O} CH_3CHO + NH_4Cl$$

There is no analogous method for the preparation of ketones.

6. The continuous phase contain the dispersed phase throughout.
   Example is water droplet in mist.

7. Mole of sucrose $= \dfrac{\text{mass of sucrose (in gram)}}{\text{molecular weight of sucrose}}$

$$= \frac{25.6}{342.3} = 0.0747882$$

Formula of sucrose $= C_{12}H_{22}O_{11}$
Number of H atoms in one mole of sucrose = 22
Number of H atoms in 25.6 g of sucrose
$= 22 \times 0.074788 \times 6.023 \times 10^{23}$
$= 9.9 \times 10^{23}$

8. Milk change after digestion into lactose.

9. Essential amino acids(10) are as follows—
   (i) Arginine
   (ii) Histidine
   (iii) Isoleucine
   (iv) Leucine
   (v) Lysine
   (vi) Methionine
   (vii) Phenylalanine
   (viii) Threonine
   (ix) Tryptophane
   (x) Valine

10. The term hexose refers to the presence of six carbon atoms and term keto shows the presence of ketonic group. Thus, the compound which contains 6 C atoms and one $>C=O$ group is called ketohexose. Among the given only glucose and fructose are six C compounds. Out of them, glucose contains an aldehyde group while fructose contains a ketonic group. Hence, the example of ketohexose is fructose.

11. **KO_3**

Suppose O.N. of O = x
$+1 + 3x = 0$
$3x = -1$
$x = -\frac{1}{3}$
$\boxed{x = -0.33}$

Na_2O_2

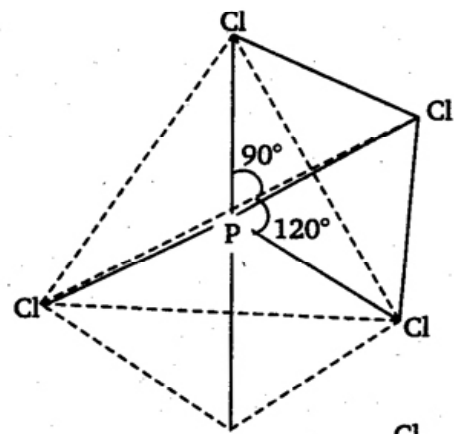
Suppose O.N. of O = x
$2 \times 1 + 2x = 0$
$2 + 2x = 0$
$2x = -2$
$x = -\frac{2}{2}$

12. When phosphorus trichloride reacts with phenyl magnesium bromide (Grignard's reagent), all the three chlorine atoms of PCl_3 are replaced by phenyl group of phenyl magnesium bromide and triphenyl phosphine is obtained.

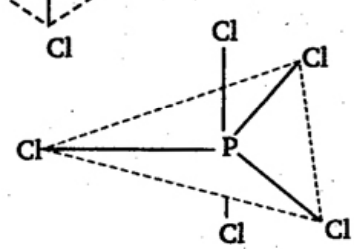
$$PCl_3 + 3PhMgBr \longrightarrow \underset{\text{triphenyl phosphine}}{P(Ph)_3} + 3Mg\begin{matrix}Cl\\Br\end{matrix}$$

13. Natural radioactivity is not a characteristic of transition elements.
   General properties of transition elements are
   (i) Formation of coloured salts
   (ii) Formation of complex salts
   (iii) Magnetic properties
   (iv) Formation of interstitial compounds
   (v) Formation of alloys etc.

14. Cl — P — Cl bond angles in PCl_5 molecule are 120° and 90°. PCl_5, having sp^3d hybridised P atom (trigonal bipyramidal geometry) has two types of bonds; axial and equatorial. These two types of bond have different bond lengths 1, 2, 3 – equatorial bonds and 4, 5 axial bonds



or



15. Magnetic moment of Zn^{2+} $\mu_{\text{effective}} = \sqrt{n(n+2)}$ BM
   where, n = Number of unpaired electrons
   $_{30}Zn = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6 3d^{10}, 4s^2$

$3d^{10}$

⇅	⇅	⇅	⇅	⇅

$n = 0$

So, magnetic moment of Zn^{2+} = zero

16. $CaF_2 = 146.4$ g

Molecular weight of $CaF_2 = 78.08$ g/mol

$$\text{Moles of } CaF_2 = \frac{\text{wt.}}{\text{mo. wt.}}$$

$$= \frac{146.4}{78.08} = 1.875 \text{ mol}$$

Number of CaF_2 atoms in 146.4 g of CaF_2 = No. of moles $\times 6.022 \times 10^{23}$

$= 1.875 \times 6.022 \times 10^{23}$

$= 11.29 \times 10^{23}$

$= 1.129 \times 10^{24}$ CaF_2

17. The IUPAC name of the compound $[Co(NH_3)_5Cl]Cl_2$ is pentaammine chloro cobalt (III) chloride

18. On adding SCN^- to an aqueous solution of $Fe(NO_3)_3$, a blood red colour, due to the formation of $[Fe(H_2O)_5(SCN)]^{2+}$ complex, is obtained. This test is used for the detection of Fe^{3+} ion.

$$SCN^- + Fe(NO_3)_3 + H_2O \longrightarrow \underset{\text{blood red colour}}{[Fe(OH_2)_5(SCN)]^{2+}} + NO_3^-$$

19. Silver nitrate is used in making hair dyes because it reduced to metallic silver and finely divided silver is black in colour.

20. When equal number of cations or anions are missing from their lattice sites (to maintain electrical neutrality), then the defect is called Schottky defect. The defect is observe in highly ionic compounds which have cations and anions of similar size *eg,* NaCl, KCl etc.

21. In both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$, Co is present as Co^{3+}. Thus, the electronic configuration of Co is

$_{27}Co = [Ar]\ 3d^7, 4s^2$

$_{27}Co^{3+} = [Ar]\ 3d^6, 4s^0$

In case of $[Co(NH_3)_6]^{3+}$, NH_3 is a strong field ligand, so pairing of electrons in 3*d*-orbital takes place.

$_{27}Co^{3+} = [Ar]\ 3d^6, 4s^0$

$3d^6$

⇅	⇅	⇅		

(no unpaired electron)

In $[CoF_6]^{3-}$, F is a weak field ligand, thus does not cause pairing. Hence,

$_{27}Co^{3+} = [Ar]\ 3d^6, 4s^0$

$3d^6$

⇅	1	1	1	1

4 unpaired electrons

22. $\Delta G^\circ = -115 \times 10^3$ J,

$T = 298$ K, $R = 8.314$ $JK^{-1}mol^{-1}$

$-\Delta G^\circ = 2.303RT \log_{10} K_p$

$-(-115 \times 10^3) = 2.303 \times 8.314 \times 298 \log_{10} K_p$

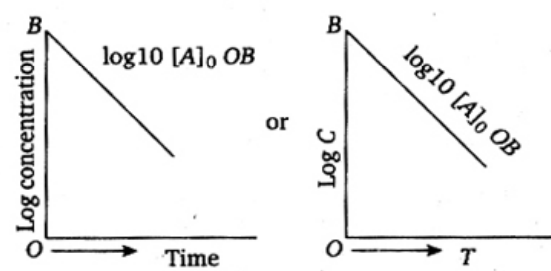
$$\log_{10} K_p = \frac{115000}{2.303 \times 8.314 \times 298}$$

$\log_{10} K_p = 20.16$

23. For endothermic reaction ΔH is positive *ie,* $\Delta H > 0$.

For a spontaneous process ΔG is always Negative and $\Delta G = \Delta H - T\Delta S$ thus, to maintain the value of ΔG negative, ΔS must be positive *ie,* $\Delta S > 0$.

24. A graph between the log concentration (log C) of reactent and time t for the first order, reaction gives a straight line, whose slope is equal to $-\frac{k}{2.303}$



$$\log_{10} C_A = -\frac{kt}{2.303} + \log_{10}(C_A)_0$$

Hence, the order of the above reaction is one.

25. A spontaneous process is one in which the system suffers a lowering of free energy because ΔG = – ve, for a spontaneous reaction

26. $t_{1/2} = 100$ s

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{100}$$

$k = 6.93 \times 10^{-3}$ s^{-1}

27. $NaCl + KNO_3 \longrightarrow NaNO_3 + KCl$

	KCl — NaCl
Molar conductivities	152 128

difference = 24 S cm^2mol^{-1}

Molar conductivities of KNO_3 = 111

Molar conductivities of $NaNO_3$
$= 111 - 24 = 87\ S\ cm^2 mol^{-1}$

28. The electrochemical cell stops working after sometime because electrode potential of both the electrodes become equal.

29. $CuSO_4 \rightleftharpoons Cu^{2+} + SO_4^{2-}$

At cathode : $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$

At anode :

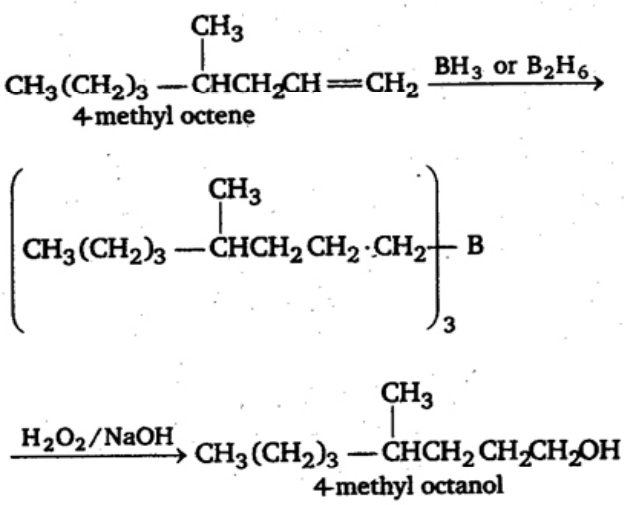
$2H_2O(l) \longrightarrow O_2(g) + 4H^+(aq) + 4e^-$

Thus, for the production of one mole of copper from copper sulphate 2F of electricity is required (because involve 2 electrons).

30. In electrochemical series, iron is placed below sodium, so it cannot displace sodium from its salt solution. Hence, no reaction takes place.

$Fe + Na_3PO_4 \longrightarrow$ No reaction

31. Terminal alkenes react rapidly with diborane to form primary trialkyl boranes which on oxidation gives primary alcohols.



(In general hydroboration oxidation involve the addition of water according to anti-Markownikoff's rule).

32. When ethyl alcohol is heated with conc H_2SO_4 at 160° – 170°C, the product obtained is ethylene (C_2H_4)

$CH_3 - CH_2OH + H_2SO_4 \longrightarrow CH_3CH_2HSO_4 + H_2O$

ethyl hydrogen sulphate

$CH_3 - CH_2HSO_4 \xrightarrow[\Delta]{160-170°C} CH_2 = CH_2 + H_2SO_4$

33. In presence of NaOH or KOH, phenol reacts with alkyl halide and gives phenolic ether (C_6H_5OR).

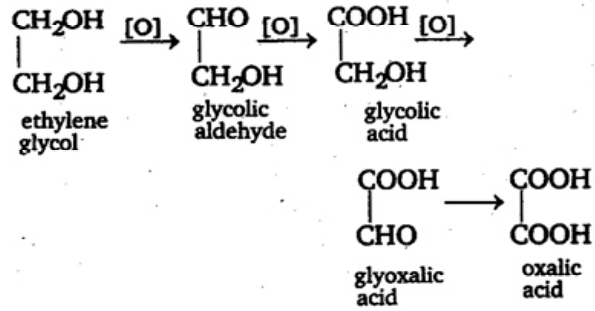
$C_6H_5OH + NaOH \xrightarrow[-H_2O]{} C_6H_5O - Na \xrightarrow[-NaX]{RX} C_6H_5 - O - R$

Vapours of C_6H_5OH and CH_3OH, with red hot ThO_2 (thoria) give anisole (phenolic ether).

$C_6H_5OH + CH_3OH \xrightarrow[\Delta]{ThO_2} C_6H_5OCH_3 + H_2O$

anisole

34. In presence of HNO_3 or alkaline $KMnO_4$



35. In diamond each carbon atom is linked to four other carbon atoms by sigma bond. Each σ C — C bond is formed by the overlapping of sp^3 hybrid orbitals of each carbon atoms. Each carbon atom is present at the centre of a regular tetrahedron. Each carbon atom is surrounded by four other carbon atoms present at the corners of a regular tetrahedron. The octet of each carbon atom is complete.

Structure of diamond is a rigid three dimensional network. This explain high density and hardness of diamond. Diamond is chemically inactive due to rigid three dimensional structure.

High energy is required to break the large number of σ C — C bonds present in diamond. This explain the high melting point of diamond.

tetrahedral structure of diamond

36. This is also a mean of preparing alkene where the position of the double bond is definite. In Wittig reaction, aldehyde (—CHO) and ketone ($>C=O$) react with methylene triphenyl phosphine [$(C_6H_5)_3P=CH_2$] to give alkene.

$$CH_3CHO + (C_6H_5)_3P=CH_2 \longrightarrow \underset{\text{propene}}{CH_3-CH=CH_2} + \underset{\text{triphenyl phosphine oxide}}{(C_6H_5)_3P=O}$$

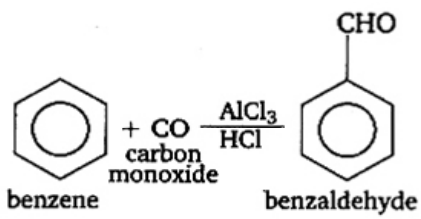
$$\begin{matrix} H_3C \\ H_3C \end{matrix}\!\!>C=O + (C_6H_5)_3P=CH_2 \longrightarrow$$

$$\begin{matrix} H_3C \\ H_3C \end{matrix}\!\!>C=CH_2 + (C_6H_5)_3P=O$$

37. Aldehyde, having no α-hydrogen atom, undergo Cannizaro reaction in which two molecules of the aldehyde are involved, one molecule being converted into the corresponding alcohol, and the other into the acid. The usual reagent for the Cannizaro reaction is aqueous or ethanolic alkali

$$2HCHO + NaOH \longrightarrow HCOONa + CH_3OH$$

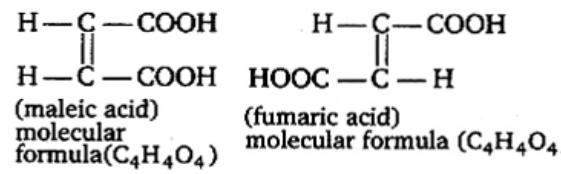
38.



This reaction is known as Gattermann-Koch reaction. Benzaldehyde may be synthesised by bubbling a mixture of CO and HCl through a solution of benzene, and a catalyst consisting of $AlCl_3$ and a small amount of cuprous chloride

$$C_6H_6 + CO + HCl \xrightarrow{AlCl_3} C_6H_5CHO + HCl$$

39. The structures of maleic and fumaric acids are given below



The structures of fumaric and maleic acid suggest that they are geometrical isomers because they have same molecular formula but different spatial arrangement of atoms around a double bond.

When the similar groups are present on same side of double bond, the isomer is called *cis* and when different groups are present on same side of double bond, then the isomer is called *trans*.

Hence, maleic acid is *cis* form and fumaric acid is *trans* form.

40. Generally soda-lime removes CO_2 from an acid but in case of alkali formate it gives alkali carbonate and hydrogen.

$$HCOONa + NaOH \xrightarrow{CaO} Na_2CO_3 + H_2$$

Mathematics

1. Since, $\vec{a} \times (\vec{b} \times \vec{c}) = \frac{1}{2}\vec{b}$

$$\Rightarrow \quad (\vec{a}\cdot\vec{c})\vec{b} - (\vec{a}\cdot\vec{b})\vec{c} = \frac{1}{2}\vec{b}$$

On comparing both sides, we get

$\vec{a}\cdot\vec{c} = \frac{1}{2}$ and $\vec{a}\cdot\vec{b} = 0$

Now, $\vec{a}\cdot\vec{c} = \frac{1}{2}$

$$\Rightarrow \quad \vec{a}\cdot\vec{c}\cos\theta_2 = \frac{1}{2}$$

$\Rightarrow \cos\theta_2 = \frac{1}{2}$ ($\because \vec{a}$ and $\vec{c}$ are unit vectors)

$$\Rightarrow \quad \cos\theta_2 = \cos\frac{\pi}{3}$$

$$\Rightarrow \quad \theta_2 = \frac{\pi}{3}$$

and $\vec{a}\cdot\vec{b} = 0$

$$\Rightarrow \quad |\vec{a}||\vec{b}|\cos\theta_1 = 0$$

$\Rightarrow \cos\theta_1 = \cos\frac{\pi}{2}$ ($\because \vec{a}$ and $\vec{b}$ are unit vectors)

$$\Rightarrow \quad \theta_1 = \frac{\pi}{2}$$

Hence, $\theta_1 = \frac{\pi}{2}$ and $\theta_2 = \frac{\pi}{3}$.

2. The given equation is

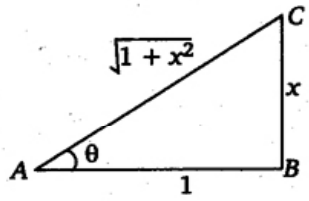
$\vec{r}^2 - 2\vec{r}\cdot\vec{c} + h = 0$, $|\vec{c}| > \sqrt{h}$

This is a equation of sphere in diameter form

ie, $(\vec{r} - \vec{a})\cdot(\vec{r} - \vec{b}) = 0$

3. Let $\tan^{-1} x = \theta$

$\therefore \sin(\tan^{-1} x) = \sin\theta$



$= \frac{BC}{AC} = \frac{x}{\sqrt{1+x^2}}$

4. Let $z = x + iy$

$\therefore \left|\frac{z-25}{z-1}\right| = 5$

$\Rightarrow \quad \left|\frac{(x-25)+iy}{(x-1)+iy}\right| = 5$

$\Rightarrow \quad |(x-25)+iy| = 5|(x-1)+iy|$

$\Rightarrow \quad \sqrt{(x-25)^2+y^2} = 5\sqrt{(x-1)^2+y^2}$

On squaring both sides, we get

$(x-25)^2 + y^2 = 25\{(x-1)^2 + y^2\}$

$\Rightarrow x^2 - 50x + 625 + y^2 = 25x^2 - 50x + 25 + 25y^2$

$\Rightarrow 24x^2 + 24y^2 = 600$

$\Rightarrow x^2 + y^2 = 25$

$\Rightarrow \sqrt{x^2+y^2} = 5 \quad [\because |z| = \sqrt{(x^2+y^2)}]$

$\Rightarrow |z| = 5$

5. $\left(\frac{-1-3i}{2+i}\right) = \frac{-1-3i}{2+i} \times \frac{2-i}{2-i}$

$= \frac{-2+i-6i+3i^2}{4+1}$

$= \frac{-2-5i-3}{5} = \frac{-5-5i}{5} = -1-i$

$\therefore$ Argument of $\left(\frac{-1-3i}{2+i}\right) = \tan^{-1}\left(\frac{-1}{-1}\right)$

$= 225°$

[Since the given number lies on a IIIrd quadrant]

6. The given equation is

$x^2 - 61x + 820 = 0$

$\Rightarrow x^2 - 41x - 20x + 820 = 0$

$\Rightarrow (x-41)(x-20) = 0$

$\Rightarrow x = 41, 20$

Let $b = 41$ and $c = 20$

Also, $A = \tan^{-1}\left(\frac{4}{3}\right)$

$\therefore$ By cosine formula,

$a^2 = b^2 + c^2 - 2bc\cos A$

$= 41^2 + 20^2 - 2 \times 41 \times 20 \times \frac{3}{5}$

$= 2081 - 984 = 1097$

7. Here, $\vec{a}_1 = 6\hat{i} + 2\hat{j} + 2\hat{k}$, $\vec{a}_2 = -4\hat{i} + 0\hat{j} - \hat{k}$, $\vec{b}_1 = \hat{i} - 2\hat{j} + 2\hat{k}$ and $\vec{b}_2 = 3\hat{i} - 2\hat{j} - 2\hat{k}$

$\therefore$ Shortest distance $= \left[\frac{(\vec{a}_2 - \vec{a}_1)\cdot(\vec{b}_1 \times \vec{b}_2)}{|\vec{b}_1 \times \vec{b}_2|}\right]$

$= \left|\frac{(-10\hat{i} - 2\hat{j} - 3\hat{k})\cdot(8\hat{i} + 8\hat{j} + 4\hat{k})}{\sqrt{64+64+16}}\right|$

$= \left|\frac{-108}{12}\right| = 9$

8. The given equation of sphere is

$x^2 + y^2 + z^2 + 3x - 4z + 1 = 0$

On comparing this equation with general equation of sphere $x^2 + y^2 + z^2 + 2ux + 2vy + 2wz + d = 0$,

we get $u = \frac{3}{2}$, $v = 0$, $w = -2$ and $d = 1$

$\therefore$ Coordinates of centre of sphere

$= (-u, -v, -w)$

$= \left(-\frac{3}{2}, 0, 2\right)$

and radius of sphere $= \sqrt{u^2 + v^2 + \omega^2 - d}$

$= \sqrt{\frac{9}{4} + 4 - 1} = \sqrt{\frac{9+12}{4}}$

$= \frac{\sqrt{21}}{2}$

9. If A and B are two fixed points in a plane, then the locus of another point C on the same plane such that $CA + CB$ = constant, $(> AB)$ is an ellipse.

10. The equation of parabola is

$y^2 + 4x + 3 = 0$

$\Rightarrow \quad y^2 = -4\left(x + \frac{3}{4}\right)$

Let $X = x + \frac{3}{4}$ and $Y = y$

$\therefore$ Equation of parabola becomes

$Y^2 = -4X$

The equation of directrix of parabola is

$X = 1 \quad (\because a = 1)$

$\Rightarrow \quad x + \frac{3}{4} = 1$

11. Since, $g(x)\,g(y) = g(x) + g(y) + g(xy) - 2$

Now, at $x = 0, y = 2$, we get

$g(0)\,g(2) = g(0) + g(2) + g(0) - 2$

$[\because g(2) = 5]$

$\Rightarrow \quad 5g(0) = 5 + 2g(0) - 2$

$\Rightarrow \quad 3g(0) = 3$

$\Rightarrow \quad g(0) = 1$

$g(x)$ is given in a polynomial and by the relation given $g(x)$ cannot be linear.

Let $g(x) = x^2 + k$

$\Rightarrow \quad g(x) = x^2 + 1 \qquad [\because g(0) = 1]$

$\therefore$ From Eq. (i),

$(x^2 + 1)(y^2 + 1) = x^2 + 1 + y^2 + 1 + x^2y^2 + 1 - 2$

$\therefore \lim_{x \to 3} g(x) = g(3) = 3^2 + 1 = 10$

12. $\because f(x) = \dfrac{-e^x + 2^x}{x}$

and $f(x)$ is continuous at $x = 0$

$\therefore \lim_{x \to 0} f(x) = f(0)$

$\Rightarrow \quad \lim_{x \to 0} \dfrac{-e^x + 2^x}{x} = f(0)$

$\Rightarrow \lim_{x \to 0} \dfrac{-e^{-x} + 2^x \log 2}{1} = f(0)$

(using L'Hospital's rule)

$\Rightarrow \quad -e^0 + 2^0 \log 2 = f(0)$

$\Rightarrow \quad f(0) = -1 + \log 2$

13. Given, $f(x) = [\tan^2 x]$

$\therefore \lim_{x \to 0} f(x) = \lim_{x \to 0} [\tan^2 x] = 0$

and $\quad f(0) = [\tan^2 0] = 0$

Thus, $f(x)$ is continuous at $x = 0$.

14. Let r be the radius of spherical balloon.

$\therefore$ Volume, $V = \dfrac{4}{3}\pi r^3$

$\dfrac{dV}{dt} = \dfrac{4}{3}\pi 3r^2 \dfrac{dr}{dt}$

$= 4\pi r^2 \dfrac{dr}{dt}$

$= 4\pi r^2 \cdot (2) \qquad \left(\because \dfrac{dr}{dt} = 2\right)$

$\Rightarrow \quad \dfrac{dV}{dt} = 8\,\pi r^2\ \text{cm}^3/\text{min}$

Now, when $r = 5$ cm

$\therefore \dfrac{dV}{dt} = 8\,\pi(5)^2 = 200\,\pi\ \text{cm}^3/\text{min}$

and equation of latusrectum is

$x = 3 \qquad \ldots(ii)$

From Eqs. (i) and (ii), we get

$y^2 = 36$

$\Rightarrow \quad y = \pm 6$

$\therefore$ Coordinates of end points of a latusrectum are (3, 6) and (3, – 6).

$\therefore$ Required length $= 2\int_0^3 \sqrt{1 + \left(\dfrac{dy}{dx}\right)^2}\,dx$

$= 2\int_0^3 \sqrt{1 + \left(\dfrac{6}{y}\right)^2} = 2\int_0^3 \sqrt{\dfrac{12x + 36}{12x}}\,dx$

$= 2\int_0^3 \dfrac{x + 3}{\sqrt{x^2 + 3x}}\,dx$

$= 2\left[\sqrt{x^2 + 3x} + \dfrac{3}{2}\log\left|\left(x + \dfrac{3}{2}\right) + \sqrt{x^2 + 3x}\right|\right]_0^3$

$= 2\left[3\sqrt{2} + \dfrac{3}{2}\log\left(\dfrac{9}{2} + 3\sqrt{2}\right) - \dfrac{3}{2}\log\left(\dfrac{3}{2}\right)\right]$

$= 2[3\sqrt{2} + 3\log(\sqrt{2} + 1)]$

$= 6[\sqrt{2} + \log(1 + \sqrt{2})]$

16. Given, $\quad I = \int \dfrac{x^5}{\sqrt{1 + x^3}}\,dx$

Let $\quad 1 + x^3 = t$

$\Rightarrow \quad 3x^2\,dx = dt$

$\Rightarrow \quad x^2 dx = \dfrac{dt}{3}$

$\therefore \quad I = \int \dfrac{(t - 1)}{\sqrt{t}} \cdot \dfrac{dt}{3} = \dfrac{1}{3}\int (\sqrt{t} - t^{-1/2})\,dt$

$= \dfrac{1}{3}\left[\dfrac{2t^{3/2}}{3} - 2t^{1/2}\right] + c$

$= \dfrac{2}{9}(1 + x^3)^{3/2} - \dfrac{2}{3}(1 + x^3)^{1/2} + c$

17. The given equation can be rewritten as

$\dfrac{(x - \sqrt{2})^2}{2/\pi} + \dfrac{y^2}{8/\pi} = 1$

Which represents an ellipse.

Here, $a = \sqrt{\dfrac{2}{\pi}}$ and $b = \sqrt{\dfrac{8}{\pi}}$

Area enclosed in an ellipse $= \pi ab$

$= \pi\sqrt{\dfrac{2}{\pi}}\sqrt{\dfrac{8}{\pi}} = \sqrt{16}$

$= 4$ sq unit

18. Let $I = \int_0^a \sqrt{\dfrac{a - x}{x}}\,dx$

Put $x = a \sin^2\theta$ and $dx = 2a \sin\theta \cos\theta\,d\theta$

$$= 2a\int_0^{\pi/2} \cos^2\theta\, d\theta$$

$$= 2a \times \frac{1}{2} \times \frac{\pi}{2} = \frac{\pi a}{2}$$

19. Given that, $\frac{dy}{dt} \propto y$

$$\Rightarrow \quad \frac{dy}{dt} = ky$$

$$\Rightarrow \quad \frac{1}{y}\,dy = k\,dt$$

On integrating, we get

$$\log y = \log c + kt$$

$$\Rightarrow \quad \log y - \log c = kt$$

$$\Rightarrow \quad \log \frac{y}{c} = kt$$

$$\Rightarrow \quad \frac{y}{c} = e^{kt}$$

$$\Rightarrow \quad y = ce^{kt}$$

20. The equation of straight line touching the circle $x^2 + y^2 = a^2$ is

$$x\cos\theta + y\sin\theta = a \qquad \ldots(i)$$

On differentiating w.r.t. x, regarding θ as a constant

$$\cos\theta + y'\sin\theta = 0 \qquad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$\cos\theta = \frac{ay'}{xy' - y} \text{ and } \sin\theta = -\frac{a}{xy' - y}$$

$\because \cos^2\theta + \sin^2\theta = 1$

$$\therefore \quad \frac{a^2y'^2 + a^2}{(xy' - y)^2} = 1$$

$$\Rightarrow \quad \left(y - x\frac{dy}{dx}\right)^2 = a^2\left[1 + \left(\frac{dy}{dx}\right)^2\right]$$

21. The differential equation $\left|\frac{dy}{dx}\right| + |y| + 3 = 0$ admits no solution, since three positive quantities cannot add to give zero.

22. Given equation can be rewritten as

$$\frac{dy}{dx} = \frac{\sqrt{x^2 + y^2} + y}{x} \qquad \ldots(i)$$

Which is a homogeneous differential equation.

Put $y = vx \Rightarrow \frac{dy}{dx} = v + x\frac{dv}{dx}$

$\therefore$ From Eq. (i),

$$v + x\frac{dv}{dx} = \frac{\sqrt{x^2 + v^2x^2} + vx}{x}$$

$$\Rightarrow \quad \frac{dv}{\sqrt{1 + v^2}} = \frac{dx}{x}$$

On integrating, we get

$$\log(v + \sqrt{1 + v^2}) = \log x + \log c$$

$$\Rightarrow \quad \log\left(\frac{y}{x} + \sqrt{1 + \frac{y^2}{x^2}}\right) = \log cx$$

$$\Rightarrow \quad y + \sqrt{x^2 + y^2} = cx^2$$

23. $\because p \to q \to r \to p$ and $\sim s \to r$

s	q	r	$\sim s$	$\sim q$	r	$\sim s \to r$	$\sim s \to s$
T	T	T	T	F	T	T	T
T	F	T	T	T	T	T	T
F	T	T	F	F	T	F	F
F	F	T	F	T	T	T	T
T	T	F	T	F	F	T	T
T	F	F	T	T	F	T	T
F	T	F	F	F	F	F	F
F	F	F	F	T	F	T	T

$\Rightarrow$ Options (c) and (d) are not true also $\sim s \to r$

$\therefore$ Option (a) is not true.

Hence, option (b) is correct.

24. Required number of ways $= \frac{10!}{4! \times 3! \times 3! \times 2!}$

$$= 2100.$$

25. Since, R is defined as aRb iff $|a - b| > 0$.

For reflexive aRa iff $|a - a| > 0$

Which is not true. So R is not reflexive.

For symmetric aRb iff $|a - b| > 0$

Now, bRa iff $|b - a| > 0$

$$\Rightarrow \quad |a - b| > 0 \Rightarrow aRb$$

Thus, R is symmetric.

For transitive aRb iff $|a - b| > 0$,

bRc iff $|b - c| > 0$

$$\Rightarrow \quad |a - b + b - c| > 0$$

$$\Rightarrow \quad |a - c| > 0$$

$$\Rightarrow \quad |c - a| > 0 \Rightarrow aRc$$

Thus, R is also transitive.

26. $\because S$ be a finite set containing n elements. Then total number of commutative binary operation on S is $n^{\left[\frac{n(n+1)}{2}\right]}$.

27. Required probability distribution is poisson distribution.

28. Required probability $= {}^4C_2\left(\frac{3}{4}\right)^2\left(\frac{1}{4}\right)^2$

$$= \frac{4!}{2!2!} \times \frac{9}{16} \times \frac{1}{16}$$

$$= \frac{24}{4} \times \frac{9}{16} \times \frac{1}{16} = \frac{27}{128}$$

29. $\bar{x} = \dfrac{8+12+13+15+22}{5} = \dfrac{70}{5} = 14$

x	$(x-\bar{x})$	$(x-\bar{x})^2$
8	−6	36
12	−2	4
13	−1	1
15	+1	1
22	+8	64
$\Sigma x = 70$	$\Sigma(x-\bar{x}) = 0$	$\Sigma x^2 = 106$

$$\therefore \sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}}$$
$$= \sqrt{\frac{106}{5}} = \sqrt{21.2}$$
$$= 4.604$$

30. For binomial distribution
$0 <$ variance $<$ mean
$\Rightarrow \quad 0 < \beta < \alpha$

31. The given system of equations are
$$x + y + z = 0,$$
$$2x + 3y + z = 0,$$
and $$x + 2y = 0$$
Here, $\begin{vmatrix} 1 & 1 & 1 \\ 2 & 3 & 1 \\ 1 & 2 & 0 \end{vmatrix} = 1(0-2) - 1(0-1) + 1(4-3)$
$$= -2 + 1 + 1 = 0$$
$\therefore$ This system has infinite solutions.

32. $\begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}^4 = I$

Now, $$\begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}^2 = \begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}\begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}$$
$$= \begin{bmatrix} ab & 0 \\ 0 & ab \end{bmatrix}$$

and $$\begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}^4 = \begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}^2\begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}^2$$
$$= \begin{bmatrix} ab & a \\ 0 & ab \end{bmatrix}\begin{bmatrix} ab & 0 \\ 0 & ab \end{bmatrix}$$
$$= \begin{bmatrix} a^2b^2 & 0 \\ 0 & a^2b^2 \end{bmatrix}$$

But $$\begin{bmatrix} 0 & a \\ b & 0 \end{bmatrix}^4 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad \text{(given)}$$

$\Rightarrow$ $$\begin{bmatrix} a^2b^2 & 0 \\ 0 & a^2b^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$\Rightarrow$ $$a^2b^2 = 1$$

33. If $D = \text{diag}(d_1, d_2, \ldots, d_n)$
$\therefore D^{-1} = \text{diag}(d_1^{-1}, d_2^{-1}, \ldots, d_n^{-1})$

34. $\begin{vmatrix} a & b-y & c-z \\ a-x & b & c-z \\ a-x & b-y & c \end{vmatrix} = 0$

$\Rightarrow$
$$a\begin{vmatrix} b & c-z \\ b-y & c \end{vmatrix} - (b-y)\begin{vmatrix} a-x & c-z \\ a-x & c \end{vmatrix} + (c-z)\begin{vmatrix} a-x & b \\ a-x & b-y \end{vmatrix} = 0$$
$\Rightarrow a(bc - bc + bz + cy - yz) - (b-y)$
$(ac - cx - ac + az + cx - xz) + (c-z)$
$(ab - ay - bx + xy - ab + bx) = 0$
$\Rightarrow a(bz + cy - yz) - (b-y)(az - xz) + (c-z)$
$(xy - ay) = 0$
$\Rightarrow abz + acy - ayz - abz + bxz + ayz - xyz$
$+ cxy - acy - xyz + ayz = 0$
$\Rightarrow ayz + bxz - 2xyz + cxy = 0$
$\Rightarrow ayz + bxz + cxy = 2xyz$
$\Rightarrow \dfrac{ayz}{xyz} + \dfrac{bxz}{xyz} + \dfrac{cxy}{xyz} = 2$
$\Rightarrow \dfrac{a}{x} + \dfrac{b}{y} + \dfrac{c}{z} = 2$

35. Given, $x^2 - n = 0$
$\Rightarrow \quad x = \pm\sqrt{n}$
$\therefore n = 1, 4, 9, 16, 25, 36$
$\therefore$ Required probability $= \dfrac{6}{40} = \dfrac{3}{20}$

36. $x^4 + \sqrt{x^4 + 20} = 22$
$\Rightarrow x^4 + 20 + \sqrt{x^4 + 20} = 22 + 20$
$\Rightarrow (x^4 + 20) + \sqrt{x^4 + 20} = 44$
Let $\sqrt{x^4 + 20} = y$
$\therefore y^2 + y - 44 = 0$
Hence, the number of real roots of the equation is 2.

37. $\because \alpha$ and β be the roots of $x^2 - ax + b = 0$.
$\therefore \alpha^2 - a\alpha + b = 0$ and $\beta^2 - a\beta + b = 0$
Now, $A_{n+1} - aA_n + bA_{n-1}$
$$= \alpha^{n+1} + \beta^{n+1} - a(\alpha^n + \beta^n) + b(\alpha^{n-1} + \beta^{n-1})$$
$$= \alpha^{n-1}(\alpha^2 - a\alpha + b) + \beta^{n-1}(\beta^2 - a\beta + b)$$
$$= 0$$

38. $\because b, c$ and a are in AP.
$\therefore \dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$

$\Rightarrow \quad a = \frac{b}{\sin B} = \frac{c}{\sin C} \quad (\because \angle A = 90°)$

$\Rightarrow \quad \sin B = \frac{b}{a}, \sin C = \frac{c}{a}$

Hence, option (a) satisfies this equation.

39. The cartesian form of an equation of plane is

$$x + 3y - z = 0$$

and $\quad y + 2z = 0$

The line of intersection of two planes is

$(x + 3y - z) + \lambda(y + 2z) = 0$

Since, it is passing through $(-1, -1, -1)$

$\therefore \quad (-1, -3 + 1) + \lambda(-1 - 2) = 0$

$\Rightarrow \quad -3 - 3\lambda = 0$

$\Rightarrow \quad \lambda = -1$

$\therefore (x + 3y - z) - 1(y + 2z) = 0$

$\Rightarrow \quad x + 2y - 3z = 0$

Hence, equation of plane is

$\vec{r} \cdot (\hat{i} + 2\hat{j} - 3\hat{k}) = 0$

40. Area of triangle

$$= \left\| \begin{matrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -1 & 1 \\ 2 & 4 & 3 \end{matrix} \right\|$$

$= |-7\hat{i} - \hat{j} + 6\hat{k}| = \sqrt{49 + 1 + 36}$

$= \sqrt{86}$