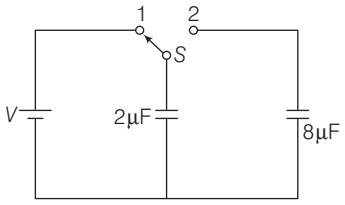
# NEET

(National Eligibility *cum* Entrance Test)

# SOLVED PAPER 2016

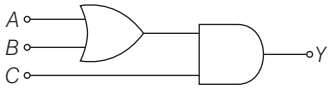
## Physics

**1.** A capacitor of **2 μF** is charged as shown in the figure. When the switch **S** is turned to position 2, the percentage of its stored energy dissipated is




(a) 20% (b) 75%
(c) 80% (d) 0%

**2.** To get output 1 for the following circuit, the correct choice for the input is




(a) $A = 1, B = 0, C = 0$ (b) $A = 1, B = 1, C = 0$
(c) $A = 1, B = 0, C = 1$ (d) $A = 0, B = 1, C = 0$

**3.** A potentiometer wire is 100 cm long and a constant potential difference is maintained across it. Two cells are connected in series first to support one another and then in opposite direction. The balance points are obtained at 50 cm and 10 cm from the positive end of the wire in the two cases. The ratio of emf is

(a) 5 : 4 (b) 3 : 4
(c) 3 : 2 (d) 5 : 1

**4.** When a metallic surface is illuminated with radiation of wavelength λ, the stopping potential is $V$. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential is $\frac{\mathbf{V}}{\mathbf{4}}$. The threshold wavelength for the metallic surface is

(a) 5λ (b) $\frac{5}{2}\lambda$ (c) 3λ (d) 4λ

**5.** Two non-mixing liquids of densities ρ and $\mathbf{n}\rho(n > 1)$ are put in a container. The height of each liquid is $h$. A solid cylinder of length $L$ and density $d$ is put in this container. The cylinder floats with its axis vertical and length $pL$ $(p < 1)$ in the denser liquid. The density $d$ is equal to

(a) $\{2 + (n + 1)p\}\rho$ (b) $\{2 + (n - 1)p\}\rho$
(c) $\{1 + (n - 1)p\}\rho$ (d) $\{1 + (n + 1)p\}\rho$

**6.** Out of the following options which one can be used to produce a propagating electromagnetic wave?

(a) A stationary charge
(b) A chargeless particle
(c) An accelerating charge
(d) A charge moving at constant velocity

**7.** The charge following through a resistance $R$ varies with time $t$ as $\mathbf{Q = at - bt^2}$, where $a$ and $b$ are positive constants. The total heat produced in $R$ is

(a) $\frac{a^3R}{3b}$ (b) $\frac{a^3R}{2b}$ (c) $\frac{a^3R}{b}$ (d) $\frac{a^3R}{6b}$

**8.** At what height from the surface of earth the gravitation potential and the value of $g$ are $-\mathbf{5.4 \times 10^7}$ J kg$^{-2}$ and 6.0 ms$^{-2}$ respectively? (Take, the radius of earth as 6400 km.)
(a) 1600 km (b)1400 km (c) 2000 km (d) 2600 km

**9.** Coefficient of linear expansion of brass and steel rods are $\alpha_1$ and $\alpha_2$. Lengths of brass and steel rods are $l_1$ and $l_2$ respectively. If $(l_2 - l_1)$ is maintained same at all temperatures, which one of the following relations holds good ?
(a) $\alpha_1 l_2^2 = \alpha_2 l_1^2$ (b) $\alpha_1^2 l_2 = \alpha_2^2 l_1$
(c) $\alpha_1 l_1 = \alpha_2 l_2$ (d) $\alpha_1 l_2 = \alpha_2 l_1$

**10.** The intensity at the maximum in a Young's double slit experiment is $I_0$. Distance between two slits is $d = 5\lambda$, where $\lambda$ is the wavelength of light used in the experiment. What will be the intensity infront of one of the slits on the screen placed at a distance $D = 10\, d$ ?
(a) $\frac{I_0}{4}$ (b) $\frac{3}{4}I_0$ (c) $\frac{I_0}{2}$ (d) $I_0$

**11.** Given the value of Rydberg constant is $10\ \text{m}^{-1}$, the wave number of the last line of the Balmer series in hydrogen spectrum will be:
(a) $0.5 \times 10^7$ m$^{-1}$ (b) $0.25 \times 10^7$ m$^{-1}$
(c) $2.5 \times 10^7$ m$^{-1}$ (d) $0.025 \times 10^4$m$^{-1}$

**12.** The ratio of escape velocity at earth $(v_e)$ to the escape velocity at a planet $(v_p)$ whose radius and mean density are twice as that of earth is
(a) $1 : 2\sqrt{2}$ (b) 1: 4 (c) $1 : \sqrt{2}$ (d) 1: 2

**13.** A long solenoid has 1000 turns. When a current of 4A flows through it, the magnetic flux linked with each turn of the solenoid is $4 \times 10^{-3}$ Wb. The self-inductance of the solenoid is
(a) 3 H (b) 2 H (c) 1 H (d) 4 H

**14.** A car is negotiating a curved road of radius $R$. The road is banked at angle $\theta$. The coefficient of friction between the tyres of the car and the road is $\mu_s$. The maximum safe velocity on this road is
(a) $\sqrt{gR\left(\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}\right)}$ (b) $\sqrt{\frac{g}{R}\left(\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}\right)}$
(c) $\sqrt{\frac{g}{R^2}\left(\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}\right)}$ (d) $\sqrt{gR^2\left(\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}\right)}$

**15.** The magnetic susceptibility is negative for
(a) paramagnetic material only
(b) ferromagnetic material only
(c) paramagnetic and ferromagnetic materials
(d) diamagnetic material only

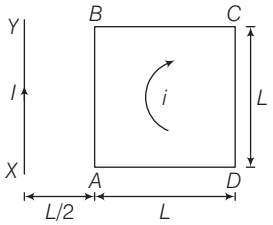
**16.** A siren emitting a sound of frequency 800 Hz moves away from an observer towards a cliff at a speed of 15ms$^{-1}$. Then, the frequency of sound that the observer hears in the echo reflected from the cliff is
(Take, velocity of sound in air = $\mathbf{330}$ ms$^{-1}$)
(a) 800 Hz (b) 838 Hz (c) 885 Hz (d) 765 Hz

**17.** A body of mass 1 kg begins to move under the action of a time dependent force $\mathbf{F} = (2t\,\hat{\mathbf{i}} + 3t^2\hat{\mathbf{j}})$ N, where $\hat{\mathbf{i}}$ and $\hat{\mathbf{j}}$ are unit vectors along **X** and **Y** axis. What power will be developed by the force at the time **(t)**?
(a) $(2t^2 + 4t^4)$ W (b) $(2t^3 + 3t^4)$ W
(c) $(2t^3 + 3t^5)$ W (d) $(2t + 3t^3)$ W

**18.** From a disc of radius $R$ and mass $M$, a circular hole of diameter $R$, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre ?
(a) 13 $MR^2/32$ (b) 11 $MR^2/32$
(c) 9 $MR^2/32$ (d) 15 $MR^2/32$

**19.** In a diffraction pattern due to a single slit of width $a$, the first minimum is observed at an angle 30° when light of wavelength 5000 Å is incident on the slit. The first secondary maximum is observed at an angle of
(a) $\sin^{-1}\left(\frac{2}{3}\right)$
(b) $\sin^{-1}\left(\frac{1}{2}\right)$
(c) $\sin^{-1}\left(\frac{3}{4}\right)$
(d) $\sin^{-1}\left(\frac{1}{4}\right)$

**20.** A square loop **ABCD** carrying a current *i*, is placed near and coplanar with a long straight conductor **XY** carrying a current *I*, the net force on the loop will be




(a) $\frac{\mu_0 Ii}{2\pi}$ (b) $\frac{2\mu_0 IiL}{3\pi}$ (c) $\frac{\mu_0 IiL}{2\pi}$ (d) $\frac{2\mu_0 Ii}{3\pi}$

**21.** A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is $\mathbf{U_1}$, at wavelength 500 nm is $\mathbf{U_2}$ and that at 1000 nm is $\mathbf{U_3}$. Wien's constant, $\mathbf{b = 2.88 \times 10^6}$ nmK. Which of the following is correct?

(a) $U_3 = 0$ (b) $U_1 > U_2$ (c) $U_2 > U_1$ (d) $U_1 = 0$

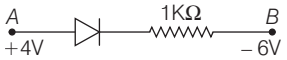
**22.** An air column, closed at one end and open at the other, resonates with a tunning fork when the smallest length of the column is 50 cm. The next larger length of the column resonating with the same tunning fork is

(a) 100 cm (b) 150 cm (c) 200 cm (d) 66.7cm

**23.** The molecules of a given mass of a gas have r.m.s. velocity of 200 $\mathbf{ms^{-1}}$ at 27°C and $\mathbf{1.0 \times 10^5}$ $\mathbf{Nm^{-2}}$ pressure. When the temperature and pressure of the gas are respectively, 127°C and $\mathbf{0.05 \times 10^5}$ $\mathbf{Nm^{-2}}$, the rms velocity of its molecules in $\mathbf{ms^{-1}}$ is

(a) $\frac{400}{\sqrt{3}}$ (b) $\frac{100\sqrt{2}}{3}$ (c) $\frac{100}{3}$ (d) $100\sqrt{2}$

**24.** Consider the junction diode as ideal. The value of current flowing through *AB* is




(a) $10^{-2}$ A (b) $10^{-1}$ A (c) $10^{-3}$ A (d) 0 A

**25.** If the magnitude of sum of two vectors is equal to the magnitude of difference of the two vectors, the angle between these vectors is

(a) 90° (b) 45° (c) 180° (d) 0°

**26.** A astronomical telescope has objective and eyepiece of focal lengths 40 cm 4 cm respectively. To view an object 200 cm away from the objective, the lenses must be separated by a distance

(a) 46.0 cm (b) 50.0 cm
(c) 54.0 cm (d) 37.3 cm

**27.** A *n-p-n* transistor is connected in common emitter configuration in a given amplifier. A load resistance of 800 Ω is connected in the collector circuit and the voltage drop across it is 0.8V. If the current amplification factor is 0.96 and the input resistance of the circuits is 192 Ω, the voltage gain and the power gain of the amplifier will respectively be

(a) 3.69, 3.84 (b) 4, 4
(c) 4, 3.69 (d) 4, 3.84

**28.** A gas is compressed isothermally to half its initial volume. The same gas is compressed separately through an adiabatic process until its volume is again reduced to half. Then

(a) compressing the gas through adiabatic process will require more work to be done
(b) compressing the gas isothermally or adiabatically will require the same amount of work
(c) which of the case (whether compression through isothermal or through adiabatic process) requires more work will depend upon the atomicity of the gas
(d) compressing the gas isothermally will require more work to be done

**29.** A long straight wire of radius **a** carries a steady current *I*. The current is uniformly distributed over its cross-section. The ratio of the magnetic fields **B** and **B′** at radial distances $\frac{\mathbf{a}}{\mathbf{2}}$ and **2 a** respectively, from the axis of the wire is

(a) $\frac{1}{2}$
(b) 1
(c) 4
(d) $\frac{1}{4}$

**30.** Match the corresponding entries of **Column 1** with **Column 2**. [Where $m$ is the magnification produced by the mirror]

| Column 1 | | Column 2 | |
|---|---|---|---|
| A. | $m = -2$ | a. | Convex mirror |
| B. | $m = -\frac{1}{2}$ | b. | Concave mirror |
| C. | $m = +2$ | c. | Real image |
| D. | $m = +\frac{1}{2}$ | d. | Virtual image |

(a) A→ a and c; B→ a and d; C→ a and b; D→ c and d
(b) A→ a and d; B→ b and c; C→ b and d; D→ b and c
(c) A→ c and d; B→ b and d; C→ b and c; D→ a and d
(d) A→ b and c; B→ b and c; C→ b and d; D→ a and d

**31.** If the velocity of a particle is $\mathbf{v = At + Bt^2}$, where $A$ and $B$ are constants, then the distance travelled by it between 1s and 2s is

(a) $3A + 7B$ (b) $\frac{3}{2}A + \frac{7}{3}B$
(c) $\frac{A}{2} + \frac{B}{3}$ (d) $\frac{3}{2}A + 4B$

**32.** A disc and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first?

(a) Sphere
(b) Both reach at the same time
(c) Depends on their masses
(d) Disc

**33.** Two identical charged spheres suspended from a common point by two massless strings of lengths **l**, are initially at a distance $d$ ($d << \mathbf{l}$) apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity **v**. Then, v varies as a function of the distance **x** between the sphere, as

(a) $v \propto x$ (b) $v \propto x^{-\frac{1}{2}}$ (c) $v \propto x^{-1}$ (d) $v \propto x^{\frac{1}{2}}$

**34.** A particle moves so that its position vector is given by $\mathbf{r = \cos \omega t\, \hat{x} + \sin \omega t\, \hat{y}}$, where ω is a constant.

Which of the following is true?

(a) Velocity and acceleration both are parallel to r.
(b) Velocity is perpendicular to r and acceleration is directed towards to origin
(c) Velocity is perpendicular to r and acceleration is directed away form the origin
(d) Velocity and acceleration both are perpendicular to r.

**35.** A piece of ice falls from a height $h$ so that it melts completely. Only one-quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of $h$ is [Latent heat of ice is $\mathbf{3.4 \times 10^5\ J/kg}$ and $\mathbf{g = 10\ N/kg}$]

(a) 544 km
(b) 136 km
(c) 68 km
(d) 34 km

**36.** A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of 2.0 rad $\mathbf{s^{-2}}$. Its net acceleration in $\mathbf{ms^{-2}}$ at the end of 2.0 s is **a** approximately

(a) 7.0 (b) 6.0
(c) 3.0 (d) 8.0

**37.** What is the minimum velocity with which a body of mass **m** must enter a vertical loop of radius $R$ so that it can complete the loop?

(a) $\sqrt{2gR}$
(b) $\sqrt{3gR}$
(c) $\sqrt{5gR}$
(d) $\sqrt{gR}$

**38.** A small signal voltage $\mathbf{V(t) = V_0 \sin \omega t}$ is applied across an ideal capacitor **C**

(a) over a full cycle the capacitor $C$ does not consume any energy from the voltage source
(b) current $I(t)$ is in phase with voltage $V(t)$
(c) current $I(t)$ leads voltage $V(t)$ by 180°
(d) current $I(t)$, lags voltage $V(t)$ by 90°

**39.** A uniform rope of length $L$ and mass $\mathbf{m_1}$ hangs vertically from a rigid support. A block of mass $\mathbf{m_2}$ is attached to the free end of the rope. A transverse pulse of wavelength $\lambda_1$ is produced at the lower end of the rope. The wavelength of the pulse when it reaches the top of the rope is $\lambda_2$. The ratio $\lambda_2/\lambda_1$ is

(a) $\sqrt{\frac{m_1 + m_2}{m_2}}$ (b) $\sqrt{\frac{m_2}{m_1}}$

(c) $\sqrt{\frac{m_1 + m_2}{m_1}}$ (d) $\sqrt{\frac{m_1}{m_2}}$

**40.** An inductor 20 mH, a capacitor 50 $\mu$**F** and a resistor **40** $\Omega$ are connected in series across a source of emf $\mathbf{V = 10 \sin 340}t$. The power loss in AC cirucit is

(a) 0.67 W (b) 0.76 W

(c) 0.89 W (d) 0.51 W

**41.** An electron of mass $m$ and a photon have same energy $E$.The ratio of de-Broglie wavelengths associated with them is

(a) $\left(\frac{E}{2m}\right)^{\frac{1}{2}}$ (b) $c(2mE)^{\frac{1}{2}}$

(c) $\frac{1}{c}\left(\frac{2m}{E}\right)^{\frac{1}{2}}$ (d) $\frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

($c$ being velocity of light)

**42.** When an $\alpha$-particle of mass $m$ moving with velocity $v$ bombards on a heavy nucleus of charge **Ze**, its distance of closest approach from the nucleus depends on $m$ as

(a) $\frac{1}{\sqrt{m}}$ (b) $\frac{1}{m^2}$

(c) $m$ (d) $\frac{1}{m}$

**43.** A refrigerator works between 4°C and 30°C. It is required to remove 600 calories of heat every second in order to keep the temperature of the refrigerated space constant. The power required is

(Take, 1 cal = **4.2** Joules)

(a) 23.65 W

(b) 236.5 W

(c) 2365 W

(d) 2.365 W

**44.** A particle of mass 10 g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration, if the kinetic energy of the particle becomes equal to $\mathbf{8 \times 10^{-4}}$ **J** by the end of the second revolution after the beginning of the motion?

(a) 0.15 m/s$^2$

(b) 0.18 m/s$^2$

(c) 0.2 m/s$^2$

(d) 0.1 m/s$^2$

**45.** The angle of incidence for a ray of light at a refracting surface of a prism is 45°. The angle of prism is 60°. If the ray suffers minimum deviation through the prism, the angle of minimum deviation and refractive index of the material of the prism respectively, are

(a) 30°; $\sqrt{2}$

(b) 45°; $\sqrt{2}$

(c) 30°; $\frac{1}{\sqrt{2}}$

(d) 45°; $\frac{1}{\sqrt{2}}$

# Chemistry

**1.** The addition of a catalyst during a chemical reaction alters which of the following quantities?

(a) Internal energy (b) Enthalpy
(c) Activation energy (d) Entropy

**2.** Predict the correct order among the following.

(a) lone pair-lone pair > bond pair-bond pair > lone pair-bond pair
(b) bond pair-bond pair > lone pair-bond pair > lone pair-lone pair
(c) lone pair-bond pair > bond pair-bond pair > lone pair-lone pair
(d) lone pair-lone pair > lone pair-bond pair > bond pair-bond pair

**3.** The correct statement regarding the basicity of arylamines is

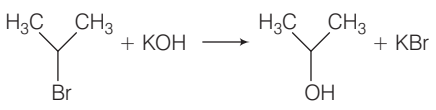
(a) Arylamines are generally more basic than alkylamines because the nitrogen lone-pair electrons are not delocalized by interaction with the aromatic ring π-electron system
(b) Arylamines are generally more basic than alkylamines because of aryl group
(c) Arylamines are generally more basic than alkylamines, because the nitrogen atom in arylamines is *sp*-hybridized
(d) Arylamines are generally less basic than alkylamines because the nitrogen lone-pair electrons are delocalized by interaction with the aromatic ring π-electron system.

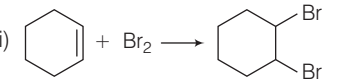
**4.** When copper is heated with conc. $HNO_3$ it produces

(a) $Cu(NO_3)_2$ and NO (b) $Cu(NO_3)_2$, NO and $NO_2$
(c) $Cu(NO_3)_2$ and $N_2O$ (d) $Cu(NO_3)_2$ and $NO_2$

**5.** For the following reactions,

(i) $CH_3CH_2CH_2Br + KOH \longrightarrow CH_3CH{=}CH_2 + KBr + H_2O$

(ii) 


(iii) 

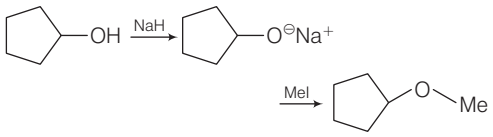

Which of the following statements is correct?

(a) (i) is elimination, reaction, (ii) is substitution and (iii) is addition reaction
(b) (i) is elimination, (ii) and (iii) are substitution reactions
(c) (i) is substitution, (ii) and (iii) are addition reactions
(d) (i) and (ii) are elimination reactions and (iii) is addition reaction

**6.** Two electrons occupying the same orbital are distinguished by

(a) Magnetic quantum number
(b) Azimuthal quantum number
(c) Spin quantum number
(d) Principal quantum number

**7.** The reaction




can be classified as

(a) Alcohol formation reaction
(b) Dehydration reaction
(c) Williamson alcohol synthesis reaction
(d) Williamson ether synthesis reaction

**8.** The electronic configurations of Eu (Atomic no. 63), Gd (Atomic no. 64) and Tb (Atomic no. 65) are

(a) [Xe] $4f^6 5d^1 6s^2$, [Xe] $4f^7 5d^1 6s^2$ and [Xe] $4f^9 6s^2$
(b) [Xe] $4f^6 5d^1 6s^2$, [Xe] $4f^7 5d^1 6s^2$ and [Xe] $4f^8 5d^1 6s^2$
(c) [Xe] $4f^7 6s^2$, [Xe] $4f^7 5d^1 6s^2$ and [Xe] $4f^9 6s^2$
(d) [Xe] $4f^7 6s^2$, [Xe] $4f^8 6s^2$ and [Xe] $4f^8 5d^1 6s^2$

**9.** At 100°C the vapour pressure of a solution of 6.5 g of a solute in 100 g water is 732 mm. If $\mathbf{K_b = 0.52}$, the boiling point of this solution will be

(a) 100°C
(b) 102°C
(c) 103°C
(d) 101°C

**10.** The correct statement regarding the comparison of staggered and eclipsed conformations of ethane, is

(a) The eclipsed conformation of ethane is more stable than staggered conformation, because eclipsed conformation has no torsional strain

(b) The eclipsed conformation of ethane is more stable than staggered conformation even though the eclipsed conformation has torsional strain

(c) The staggered conformation of ethane is more stable than eclipsed conformation, because staggered conformation has no torsional strain

(d) The staggered conformation of ethane is less stable than eclipsed conformation, because staggered conformation has torsional strain

**11.** Which one of the following characteristics is associated with adsorption?

(a) $\Delta G$, $\Delta H$ and $\Delta S$ all are negative
(b) $\Delta G$ and $\Delta H$ are negative but $\Delta S$ is positive
(c) $\Delta G$ and $\Delta S$ are negative but $\Delta H$ is positive
(d) $\Delta G$ is negative but $\Delta H$ and $\Delta S$ are positive

**12.** Match the compounds given in column I with the hybridisation and shape given in column II and mark the correct option.

| Column I | | Column II | |
|---|---|---|---|
| A. | $XeF_6$ | 1. | Distorted octahedral |
| B. | $XeO_3$ | 2. | Square planar |
| C. | $XeOF_4$ | 3. | Pyramidal |
| D. | $XeF_4$ | 4. | Square pyramidal |

**Codes**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 1 | 2 | 4 | 3 |
| (b) | 4 | 3 | 1 | 2 |
| (c) | 4 | 1 | 2 | 3 |
| (d) | 1 | 3 | 4 | 2 |

**13.** The correct statement regarding a carbonyl compound with a hydrogen atom on its alpha-carbon, is

(a) a carbonyl compound with a hydrogen atom on its alpha-carbon rapidly equilibrates with its corresponding enol and this process is known as aldehyde-ketone equilibration

(b) a carbonyl compound with a hydrogen atom on its alpha-carbon rapidly equilibrates with its corresponding enol and this process is known as carbonylation

(c) a carbonyl compound with a hydrogen atom on its alpha-carbon rapidly equilibrates with its corresponding enol and this process is known as keto-enol tautomerism

(d) a carbonyl compound with a hydrogen atom on its alpha-carbon never equilibrates with its corresponding enol

**14.** In a protein molecule various amino acids are linked together by

(a) β-glycosidic bond (b) peptide bond
(c) dative bond (d) α-glycosidic bond

**15.** Match items of Column I with the items of Column II and assign the correct code.

| Column I | | Column II | |
|---|---|---|---|
| A. | Cyanide process | 1. | Ultrapure Ge |
| B. | Froth floatation process | 2. | Dressing of ZnS |
| C. | Electrolytic reduction | 3. | Extraction of Al |
| D. | Zone refining | 4. | Extraction of Au |
| | | 5. | Purification of Ni |

**Codes**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 2 | 3 | 1 | 5 |
| (b) | 1 | 2 | 3 | 4 |
| (c) | 3 | 4 | 5 | 1 |
| (d) | 4 | 2 | 3 | 1 |

**16.** Which of the following is an analgesic?

(a) Penicillin
(b) Streptomycin
(c) Chloromycetin
(d) Novalgin

**17.** Which is the correct statement for the given acids?

(a) Phosphinic acid is a monoprotic acid while phosphonic acid is a diprotic acid
(b) Phosphinic acid is a diprotic acid while phosphonic acid is a monoprotic acid
(c) Both are triprotic acids
(d) Both are diprotic acids

**18.** The pair of electron in the given carbanion, $CH_3C{\equiv}C^-$, is present in which orbitals?

(a) $sp^3$
(b) $sp^2$
(c) $sp$
(d) $2p$

**19.** Consider the molecules $CH_4$, $NH_3$ and $H_2O$. Which of the given statements is false?
(a) The H—O—H bond angle in $H_2O$ is larger than the H—C—H bond angle in $CH_4$
(b) The H—O—H bond angle in $H_2O$ is smaller than the H—N—H bond angle in $NH_3$
(c) The H—C—H bond angle in $CH_4$ is larger than the H—N—H bond angle in $NH_3$
(d) The H—C—H bond angle in $CH_4$, the H—N—H bond angle in $NH_3$ and the H—O—H bond angle in $H_2O$ are all greater than 90°

**20.** Which one of the following statements is correct when $SO_2$ is passed through acidified $K_2Cr_2O_7$ solution?
(a) The solution is decolourized
(b) $SO_2$ is reduced
(c) Green $Cr_2(SO_4)_3$ is formed
(d) The solution turns blue

**21.** The correct thermodynamic conditions for the spontaneous reaction at all temperatures is
(a) $\Delta H > 0$ and $\Delta S < 0$
(b) $\Delta H < 0$ and $\Delta S > 0$
(c) $\Delta H < 0$ and $\Delta S < 0$
(d) $\Delta H < 0$ and $\Delta S = 0$

**22.** Natural rubber has
(a) All *trans*-configuration
(b) Alternate *cis* - and *trans*-configuration
(c) Random *cis* - and *trans*-configuration
(d) All *cis*-configuration

**23.** In which of the following options the order of arrangement does not agree with the variation of property indicated against it?
(a) B < C < N < O (increasing first ionisation enthalpy)
(b) I < Br < Cl < F (increasing electron gain enthalpy)
(c) Li < Na < K < Rb (increasing metallic radius)
(d) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ (increasing ionic size)

**24.** Which of the following reagents would distinguish *cis*-cyclopenta-1, 2-diol from the *trans*-isomer?
(a) Ozone
(b) $MnO_2$
(c) Aluminium isopropoxide
(d) Acetone

**25.** The product obtained as a result of a reaction of nitrogen with $CaC_2$ is
(a) CaCN (b) $CaCN_3$ (c) $Ca_2CN$ (d) $Ca(CN)_2$

**26.** Fog is a colloidal solution of
(a) Gas in liquid (b) Solid in gas
(c) Gas in gas (d) Liquid in gas

**27.** Which one of the following orders is correct for the bond dissociation enthalpy of halogen molecules?
(a) $Cl_2 > Br_2 > F_2 > I_2$ (b) $Br_2 > I_2 > F_2 > Cl_2$
(c) $F_2 > Cl_2 > Br_2 > I_2$ (d) $I_2 > Br_2 > Cl_2 > F_2$

**28.** Equal moles of hydrogen and oxygen gases are placed in container with a pin-hole through which both can escape. What fraction of the oxygen escapes in the time required for one-half of the hydrogen to escape?
(a) 1/4 (b) 3/8 (c) 1/2 (d) 1/8

**29.** Lithium has a bcc structure. Its density is 530 kg $m^{-3}$ and its atomic mass is 6.94 g $mol^{-1}$. Calculate the edge length of a unit cell of lithium metal.
($N_A = 6.02 \times 10^{23}$ $mol^{-1}$)
(a) 352 pm (b) 527 pm
(c) 264 pm (d) 154 pm

**30.** Which of the following statements about the composition of the vapour over an ideal 1:1 molar mixture of benzene and toluene is correct? Assume that the temperature is constant at 25°C.
(Given, vapour pressure data at 25°C, benzene = 12.8 kPa, toluene = 3.85 kPa)
(a) The vapour will contain a higher percentage of toluene
(b) The vapour will contain equal amounts of benzene and toluene
(c) Not enough information is given to make a prediction
(d) The vapour will contain a higher percentage of benzene

**31.** Which of the following has longest C—O bond length? (Free C—O bond length in CO is 1.128 Å.)
(a) $[Co(CO)_4]^-$ (b) $[Fe(CO)_4]^{2-}$
(c) $[Mn(CO)_6]^+$ (d) $Ni(CO)_4$

**32.** Among the following, the correct order of acidity is

(a) $HClO < HClO_2 < HClO_3 < HClO_4$
(b) $HClO_2 < HClO < HClO_3 < HClO_4$
(c) $HClO_4 < HClO_2 < HClO < HClO_3$
(d) $HClO_3 < HClO_4 < HClO_2 < HClO$

**33.** In the reaction,

$$\mathbf{H{-}C{\equiv}CH} \xrightarrow[\text{(ii) } CH_3CH_2Br]{\text{(i) } NaNH_2/\text{liq.}NH_3} \mathbf{X} \xrightarrow[\text{(ii) } CH_3CH_2Br]{\text{(i) } NaNH_2/\text{liq.}NH_3} \mathbf{Y}$$

*X* and *Y* are

(a) *X* = 2 -butyne; *Y* = 3 -hexyne
(b) *X* = 2 -butyne; *Y* = 2 -hexyne
(c) *X* = 1 -butyne; *Y* = 2 -hexyne
(d) *X* = 1 -butyne; *Y* = 3 -hexyne

**34.** *MY* and $NY_3$, two nearly insoluble salts, have the same $\mathbf{K_{sp}}$ values of $\mathbf{6.2 \times 10^{-13}}$ at room temperature. Which statement would be true in regard to *MY* and $\mathbf{NY_3}$?

(a) The molar solubility of *MY* in water is less than that of $NY_3$.
(b) The salts *MY* and $NY_3$ are more soluble in 0.5 M *KY* than in pure water
(c) The addition of the salt of *KY* to solution of *MY* and $NY_3$ will have no effect on their solubilities
(d) The molar solubilities of *MY* and $NY_3$ in water are identical.

**35.** Consider the nitration of benzene using mixed conc. $\mathbf{H_2SO_4}$ and $\mathbf{HNO_3}$. If a large amount of $KHSO_4$ is added to the mixture, the rate of nitration will be

(a) slower (b) unchanged
(c) doubled (d) faster

**36.** The product formed by the reaction of an aldehyde with a primary amine is

(a) Ketone (b) Carboxylic acid
(c) Aromatic acid (d) Schiff base

**37.** The pressure of $H_2$ required to make the potential of $H_2$-electrode zero in pure water at 298 K is

(a) $10^{-12}$ atm (b) $10^{-10}$ atm
(c) $10^{-4}$ atm (d) $10^{-14}$ atm

**38.** The correct statement regarding RNA and DNA, respectively is

(a) The sugar component in RNA is ribose and the sugar component in DNA is 2′-deoxyribose
(b) The sugar component in RNA is arabinose and the sugar component in DNA is ribose
(c) The sugar component in RNA is 2′-deoxyribose and the sugar component in DNA is arabinose
(d) The sugar component in RNA is arabinose and the sugar component in DNA is 2′-deoxyribose

**39.** Which one given below is a non-reducing sugar?

(a) Lactose (b) Glucose
(c) Sucrose (d) Maltose

**40.** Which of the following statements about hydrogen is incorrect?

(a) Hydrogen never acts as cation in ionic salts
(b) Hydronium ion, $H_3O^+$ exists freely in solution
(c) Dihydrogen does not act as a reducing agent
(d) Hydrogen has three isotopes of which tritium is the most common

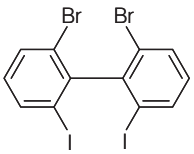
**41.** Consider the following liquid-vapour equilibrium

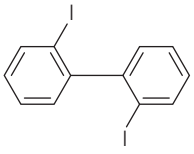
$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

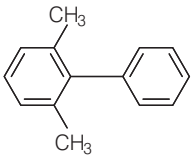
Which of the following relations is correct?

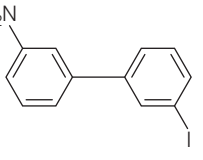
(a) $\frac{d\ln P}{dT} = \frac{-\Delta H_v}{RT}$
(b) $\frac{d\ln P}{dT^2} = \frac{-\Delta H_v}{T^2}$
(c) $\frac{d\ln P}{dT} = \frac{-\Delta H_v}{RT^2}$
(d) $\frac{d\ln G}{dT^2} = \frac{-\Delta H_v}{RT^2}$

**42.** Which of the following biphenyls is optically active?

(a) 


(b) 


(c) 


(d) 

**43.** Which of the following statements is false?
(a) $Ca^{2+}$ ions are important in blood clotting
(b) $Ca^{2+}$ ions are not important in maintaining the regular beating of the heart
(c) $Mg^{2+}$ ions are important in the green parts of plants
(d) $Mg^{2+}$ ions form a complex with ATP

**44.** The ionic radii of $A^+$ and $B^-$ ions are $0.98 \times 10^{-10}$ m and $1.81 \times 10^{-10}$ m. The coordination number of each ion in *AB* is
(a) 4 (b) 8 (c) 2 (d) 6

**45.** The rate of a first-order reaction is 0.04 mol $L^{-1} s^{-1}$ at 10 sec and 0.03 mol $L^{-1} s^{-1}$ at 20 sec after initiation of the reaction. The half-life period of the reaction is
(a) 34.1 s (b) 44.1 s (c) 54.1 s (d) 24.1 s

# Biology

**1.** Which of the following characteristic features always holds true for the corresponding group of animals?

| | | |
|---|---|---|
| (a) | Viviparous | Mammalia |
| (b) | Possess a mouth with an upper and a lower jaw | Chordata |
| (c) | 3-chambered heart with one incompletely divided ventricle | Reptilia |
| (d) | Cartilaginous – endoskeleton | Chondrichthyes |

**2.** Changes in GnRH pulse frequency in females is controlled by circulating levels of
(a) estrogen and inhibin
(b) progesterone only
(c) progesterone and inhibin
(d) estrogen and progesterone

**3.** Microtubules are the constituents of
(a) spindle fibres, centrioles and cilia
(b) centrioles, spindle fibres and chromatin
(c) centrosome, nucleosome and centrioles
(d) cilia, flagella and peroxisomes

**4.** Mitochondria and chloroplast are
I. semi-autonomous organelles.
II. formed by division of pre-existing organelles and they contain DNA but lack protein synthesizing machinery.
Which one of the following options is correct?
(a) II is true but I is false
(b) I is true but II is false
(c) Both I and II are false
(d) Both I and II are correct

**5.** Photosensitive compound in human eye is made up of
(a) opsin and Retinal
(b) opsin and Retinol
(c) transducin and Retinene
(d) guanosine and Retinol

**6.** Chrysophytes, euglenoids, dinoflagellates and slime moulds are included in the kingdom
(a) Protista (b) Fungi
(c) Animalia (d) Monera

**7.** The primitive prokaryotes responsible for the production of biogas from the dung of ruminant animals, include the
(a) thermoacidophiles
(b) methanogens
(c) eubacteria
(d) halophiles

**8.** Identify the correct statement on 'inhibin'
(a) Is produced by granulos cells in ovary and inhibits the secretion of FSH
(b) Is produced by granulos cells in ovary and inhibits the secretion of LH
(c) Is produced by nurse cells in testes and inhibits the secretion of LH
(d) Inhibits the secretion of LH, FSH and prolactin

**9.** It is much easier for a small animal to run uphill than for a large animal, because
(a) smaller animals have a higher metabolic rate
(b) small animals have a lower $O_2$ requirement
(c) the efficiency of muscles in large animals is less than in the small animals
(d) it is easier to carry a small body weight

**10.** A tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant. When the $F_1$ plants were selfed the resulting genotypes were in the ratio of
(a) 1 : 2 : 1 :: Tall heterozygous : Tall homozygous : Dwarf
(b) 3 : 1 :: Tall : Dwarf
(c) 3 : 1 :: Dwarf : Tall
(d) 1 : 2 : 1 :: Tall homozygous : Tall heterozygous : Dwarf

**11.** Depletion of which gas in the atmosphere can lead to an increased incidence of skin cancers
(a) ozone (b) ammonia
(c) methane (d) nitrous oxide

**12.** Which one of the following is a characteristic feature of cropland ecosystem?
(a) Least genetic diversity
(b) The absence of weeds
(c) Ecological succession
(d) The absence of soil organisms

**13.** Tricarpellary, syncarpous gynoecium is found in flowers of
(a) Solanaceae (b) Fabaceae
(c) Poaceae (d) Liliaceae

**14.** In which of the following, all three are macronutrients?
(a) Iron, copper, molybdenum
(b) Molybdenum, magnesium, manganese
(c) Nitrogen, nickel, phosphorus
(d) Boron, zinc, manganese

**15.** Reduction in pH of blood will
(a) reduce the blood supply to the brain
(b) decrease the affinity of hemoglobin with oxygen
(c) release bicarbonate ions by the liver
(d) reduce the rate of heart beat

**16.** Lack of relaxation between successive stimuli in sustained muscle contraction is known as
(a) fatigue (b) tetanus (c) tonus (d) spasm

**17.** Which one of the following statements is wrong?
(a) Golden algae are also called desmids
(b) *Eubacteria* are also called false bacteria
(c) Phycomycetes are also called algal fungi
(d) Cyanobacteria are also called blue-green algae

**18.** Which of the following is a restriction endonuclease?
(a) Protease (b) DNase I (c) RNase (d) *Hind* II

**19.** Which of the following would appear as the pioneer organisms on bare rocks?
(a) Liverworts (b) Mosses
(c) Green algae (d) Lichens

**20.** Water vapour comes out from the plant leaf through the stomatal opening. Through the same stomatal opening carbon dioxide diffuses into the plant during photosynthesis. Reason out the above statements using the following options.
(a) Both processes can happen together because the diffusion coefficient of water and $CO_2$ is different
(b) The above processes happen only during night time
(c) One process occurs during day time and the other at night
(d) Both processes cannot happen simultaneously

**21.** Cotyledon of maize grain is called
(a) coleorhiza (b) coleoptile
(c) scutellum (d) plumule

**22.** Which of the following guards the opening of hepatopancreatic duct into the duodenum?
(a) Ileocaecal valve (b) Pyloric sphincter
(c) Sphincter of Oddi (d) Semilunar valve

**23.** In the stomach, gastric acid is secreted by the
(a) parietal cells (b) peptic cells
(c) acidic cells (d) gastrin secreting cells

**24.** In mammals, which blood vessel would normally carry largest amount of urea?
(a) Dorsal Aorta (b) Hepatic Vein
(c) Hepatic Portal Vein (d) Renal Vein

**25.** The term ecosystem was coined by
(a) AG Tansley (b) E Haeckel
(c) E Warming (d) EP Odum

**26.** Which of the following is required as inducer(s) for the expression of *lac* operon?
(a) galactose
(b) lactose
(c) lactose and galactose
(d) glucose

**27.** Which of the following is wrongly matched in the given table?

| | Microbe | Product | Application |
|---|---|---|---|
| (a) | *Monascus purpureus* | Statins | Lowering of blood cholesterol |
| (b) | *Streptococcus* | Streptokinase | Removal of clot from blood vessel |
| (c) | *Clostridium butylicum* | Lipase | Removal of oil stains |
| (d) | *Trichoderma polysporum* | Cyclosporin–A | Immunosuppr essive drug |

**28.** When does the growth rate of a population following the logistic model equal zero? The logistic model is given as $dN/dt = rN(1-N/K)$
(a) when N nears the carrying capacity of the habitat
(b) when N/K equals zero
(c) when death rate is greater than birth rate
(d) when N/K is exactly one

**29.** Which one of the following statements is not true?
(a) Exine of pollen grains is made up of sporopollenin
(b) Pollen grains of many species cause severe allergies
(c) Stored pollen in liquid nitrogen can be used in the crop breeding programmes
(d) Tapetum helps in the dehiscence of anther

**30.** In bryophytes and pteridophytes, transport of male gametes requires
(a) insects (b) birds
(c) water (d) wind

**31.** Which of the following is not a stem modification?
(a) Thorns of citrus
(b) Tendrils of cucumber
(c) Flattened structures of *Opuntia*
(d) Pitcher of *Nepenthes*

**32.** Which one of the following cell organelles is enclosed by a single membrane?
(a) Chloroplasts
(b) Lysosomes
(c) Nuclei
(d) Mitochondria

**33.** Analogous structures are a result of
(a) convergent evolution
(b) shared ancestry
(c) stabilising selection
(d) divergent evolution

**34.** Which one of the following statements is wrong?
(a) Cellulose is a polysaccharide
(b) Uracil is a pyrimidine
(c) Glycine is a sulphur containing amino acid
(d) Sucrose is a disaccharide

**35.** Proximal end of the filament of stamen is attached to the
(a) connective (b) placenta
(c) thalamus or petal (d) anther

**36.** Which of the following is not required for any of the techniques of DNA fingerprinting available at present?
(a) Zinc finger analysis
(b) Restriction enzymes
(c) DNA-DNA hybridisation
(d) Polymerase chain reaction

**37.** Which one of the following characteristics is not shared by birds and mammals?
(a) Breathing using lungs
(b) Viviparity
(c) Warm blooded nature
(d) Ossified endoskeleton

**38.** Select the incorrect statement
(a) LH and FSH triggers ovulation in ovary
(b) LH and FSH decrease gradually during the follicular phase
(c) LH triggers secretion of androgens from the Leydig cells
(d) FSH stimulates the Sertoli cells which help in spermiogenesis

**39.** The amino acid, tryptophan is the precursor for the synthesis of
(a) thyroxine and tri-iodothyronine
(b) estrogen and progesterone
(c) cortisol and cortisone
(d) melatonin and serotonin

**40.** Joint Forest Management Concept was introduced in India during
(a) 1970s (b) 1980s
(c) 1990s (d) 1960s

**41.** One of the major components of cell wall of most fungi is
(a) peptidoglycan (b) cellulose
(c) hemicellulose (d) chitin

**42.** A complex of ribosomes attached to a single strand of RNA is known as
(a) polymer
(b) polypeptide
(c) okazaki fragment
(d) polysome

**43.** Which of the following features is not present in the phylum–Arthropoda?
(a) Metameric segmentation
(b) Parapodia
(c) Jointed appendages
(d) Chitinous exoskeleton

**44.** Asthma may be attributed to
(a) allergic reaction of the mast cells in the lungs
(b) inflammation of the trachea
(c) accumulation of fluid in the lungs
(d) bacterial infection of the lungs

**45.** Pick out the correct statements.
I. Haemophilia is a sex-linked recessive disease
II. Down's syndrome is due to aneuploidy.
III. Phenylketonuria is an autosomal recessive gene disorder
IV. Sickle cell anaemia is an X - linked recessive gene disorder
(a) II and IV are correct
(b) I, III and IV are correct
(c) I, II and III are correct
(d) I and IV are correct

**46.** The two polypeptides of human insulin are linked together by
(a) phosphodiester bonds
(b) covalent bonds
(c) disulphide bridges
(d) hydrogen bonds

**47.** The coconut water from tender coconut represents
(a) fleshy mesocarp
(b) free-nuclear proembryo
(c) free-nuclear endosperm
(d) endocarp

**48.** Which of the following is not a feature of the plasmids?
(a) Circular structure
(b) Transferable
(c) Single-stranded
(d) Independent replication

**49.** Which is the National Aquatic Animal of India?
(a) River dolphin (b) Blue whale
(c) Sea-horse (d) Gangetic shark

**50.** The *Avena* curvature is used for bioassay of
(a) $GA_3$ (b) IAA (c) Ethylene (d) ABA

**51.** Which of the following is the most important cause of animals and plants being driven to extinction?
(a) Alien species invasion
(b) Habitat loss and fragmentation
(c) Co-extinctions
(d) Over-exploitation

**52.** Which of the following approaches does not give the defined action of contraceptive?

| | | |
|---|---|---|
| (a) | Intra uterine devices | Increase phagocytosis of sperms, suppress sperm motility and fertilising capacity of sperms |
| (b) | Hormonal contraceptives | Prevent/ retard entry of sperms, prevent ovulation and fertilisation |
| (c) | Vasectomy | Prevents spermatogenesis |
| (d) | Barrier methods | Prevent fertilisation |

**53.** In a test cross involving $\mathbf{F_1}$ dihybrid flies, more parental-type offspring were produced than the recombinant type offspring. This indicates
(a) chromosomes failed to separate during meiosis
(b) the two genes are linked and present on the same chromosome
(c) both of the characters are controlled by more than one gene
(d) the two genes are located on two different chromosomes

**54.** A typical fat molecule is made up of
(a) One glycerol and three fatty acid molecules
(b) One glycerol and one fatty acid molecule
(c) Three glycerol and three fatty acid molecules
(d) Three glycerol molecules and one fatty acid molecule

**55.** Match the terms in Column I with their description in Column II and choose the correct option.

| Column I | Column II |
|---|---|
| A. Dominance | 1. Many genes govern a single character |
| B. Codominance | 2. In a heterozygous organism only one allele expresses itself |
| C. Pleiotropy | 3. In a heterozygous organism both alleles express themselves fully |
| D. Polygenic inheritance | 4. A single gene influences many characters |

Code

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 2 | 3 | 4 | 1 |
| (b) | 4 | 1 | 2 | 3 |
| (c) | 4 | 3 | 1 | 2 |
| (d) | 2 | 1 | 4 | 3 |

**56.** Which of the following statements is not correct?

(a) Insects that consume pollen or nectar without bringing about pollination are called pollen nectar robbers
(b) Pollen germination and pollen tube growth are regulated by chemical components of pollen interacting with those of the pistil
(c) Some reptiles have also been reported as pollinators in some plant species
(d) Pollen grains of many species can germinate on the stigma of a flower, but only one pollen tube of the same species grows into the style

**57.** Which of the following features is not present in *Periplaneta americana*?

(a) Indeterminate and radial cleavage during embryonic development
(b) Exoskeleton composed of N-acetylglucosamine
(c) Metamerically segmented body
(d) Schizocoelom as body cavity

**58.** Water soluble pigments found in plant cell vacuoles are

(a) chlorophylls
(b) carotenoids
(c) anthocyanins
(d) xanthophylls

**59.** A cell at telophase stage is observed by a student in a plant brought from the field. He tells his teacher that this cell is not like other cells at telophase stage. There is no formation of cell plate and thus the cell is containing more number of chromosomes as compared to other dividing cells. This would result in

(a) polyploidy
(b) somaclonal variation
(c) polyteny
(d) aneuploidy

**60.** A plant in your garden avoids photorespiratory losses, has improved water use efficiency, shows high rates of photosynthesis at high temperatures and has improved efficiency of nitrogen utilisation. In which of the following physiological groups would you assign this plant?

(a) $C_4$
(b) CAM
(c) Nitrogen-fixer
(d) $C_3$

**61.** In higher vertebrates, the immune system can distinguish self-cells and non-self. If this property is lost due to genetic abnormality and it attacks self-cells, then it leads to

(a) graft rejection
(b) auto-immune disease
(c) active immunity
(d) allergic response

**62.** Emerson's enhancement effect and red drop have been instrumental in the discovery of

(a) two photosystems operating simultaneously
(b) photophosphorylation and cyclic electron transport
(c) oxidative phosphorylation
(d) photophosphorylation and non-cyclic electron transport

**63.** Select the correct statement.

(a) *Salvinia*, *Ginkgo* and *Pinus* all are gymnosperms
(b) *Sequoia* is one of the tallest trees
(c) The leaves of gymnosperms are not well adapted to extremes of climate
(d) Gymnosperms are both homosporous and heterosporous

**64.** Which of the following is not a characteristic feature during mitosis in somatic cells?
(a) Disappearance of nucleolus
(b) Chromosome movement
(c) Synapsis
(d) Spindle fibres

**65.** Blood pressure in the pulmonary artery is
(a) more than that in the carotid
(b) more than that in the pulmonary vein
(c) less than that in the venae cavae
(d) same as that in the aorta

**66.** Which of the following structures is homologous to the wing of a bird?
(a) Wing of a moth
(b) Hind limb of rabbit
(c) Flipper of whale
(d) Dorsal fin of a shark

**67.** Seed formation without fertilisation in flowering plants involves the process of
(a) budding
(b) somatic hybridization
(c) apomixis
(d) sporulation

**68.** Name the chronic respiratory disorder caused mainly by cigarette smoking
(a) asthma
(b) respiratory acidosis
(c) respiratory alkalosis
(d) emphysema

**69.** Spindle fibres attach on to
(a) kinetochore of the chromosome
(b) centromere of the chromosome
(c) kinetosome of the chromosome
(d) telomere of the chromosome

**70.** In context of amniocentesis, which of the following statement is incorrect?
(a) It is used for prenatal sex determination
(b) It can be used for detection of down syndrome
(c) It can be used for detection of cleft palate
(d) It is usually done when a woman is between 14-16 weeks pregnant

**71.** Stems modified into flat green organs performing the functions of leaves are known as
(a) phyllodes (b) phylloclades
(c) scales (d) cladodes

**72.** In a chloroplast the highest number of protons are found in
(a) lumen of thylakoids
(b) inter membrane space
(c) antennae complex
(d) stroma

**73.** Nomenclature is governed by certain universal rules. Which one of the following is contrary to the rules of nomenclature?
(a) The first word in a biological name represents the genus name and the second is a specific epithet
(b) The names are written in Latin and are Italicised
(c) When written by hand, the names are to be underlined
(d) Biological names can be written in any language

**74.** In meiosis crossing over is initiated at
(a) leptotene (b) zygotene
(c) diplotene (d) pachytene

**75.** Antivenom injection contains preformed antibodies while polio drops that are administered into the body contain
(a) harvested antibodies
(b) gamma globulin
(c) attenuated pathogens
(d) activated pathogens

**76.** The *Taq* polymerase enzyme is obtained from
(a) *Thiobacillus ferroxidans*
(b) *Bacillus subtilis*
(c) *Pseudomonas subtilis*
(d) *Thermus aquaticus*

**77.** Which of the following most appropriately describes haemophilia?
(a) X-linked recessive gene disorder
(b) Chromosomal disorder
(c) Dominant gene disorder
(d) Recessive gene disorder

**78.** The standard petal of a papilionaceous corolla is also called
(a) pappus (b) vexillum (c) corona (d) carina

**79.** Which part of the tobacco plant is infected by *Meloidegyne incognitia*?
(a) Leaf (b) Stem (c) Root (d) Flower

**80.** Which of the following statements is wrong for viroids?
(a) They are smaller than viruses
(b) They cause infections
(c) Their RNA is of high molecular weight
(d) They lack a protein coat

**81.** Which of the following statements is not true for cancer cells in relation to mutations?
(a) Mutations destroy telomerase inhibitor
(b) Mutations inactivate the cell control
(c) Mutations inhibit production of telomerase
(d) Mutations in proto-oncogenes accelerate the cell cycle

**82.** Which type of tissue correctly matches with its location?

| | Tissue | Location |
|---|---|---|
| (a) | Areolar tissue | Tendons |
| (b) | Transitional epithelium | Tip of nose |
| (c) | Cuboidal epithelium | Lining of stomach |
| (d) | Smooth muscle | Wall of intestine |

**83.** Which of the following pairs of hormones are not antagonistic (having opposite effects) to each other?

| | | |
|---|---|---|
| (a) | Insulin | Glucagon |
| (b) | Aldosterone | Atrial Natriuretic Factor |
| (c) | Relaxin | Inhibin |
| (d) | Parathormone | Calcitonin |

**84.** Specialised epidermal cells surrounding the guard cells are called
(a) subsidiary cells (b) bulliform cells
(c) lenticels (d) complementary cells

**85.** Fertilisation in humans is practically feasible only if
(a) the ovum and sperms are transported simultaneously to ampullary - isthmic junction of the fallopian tube
(b) the ovum and sperms are transported simultaneously to ampullary-isthmic junction of the cervix
(c) the sperms are transported into cervix within 48 hrs of release of ovum in uterus
(d) the sperms are transported into vagina just after the release of ovum in fallopian tube

**86.** Which one of the following is the starter codon?
(a) UGA (b) UAA
(c) UAG (d) AUG

**87.** A river with an inflow of domestic sewage rich in organic waste may result in
(a) increased population of aquatic food web organisms
(b) an increased production of fish due to biodegradable nutrients
(c) death of fish due to lack of oxygen
(d) drying of the river very soon due to algal bloom

**88.** Following are the two statements regarding the origin of life
I. The earliest organisms that appeared on the earth were non-green and presumably anaerobes.
II. The first autotrophic organisms were the chemoautotrophs that never released oxygen.
Of the above statements which one of the following options is correct?
(a) II is correct but I is false
(b) Both I and II are correct
(c) Both I and II are false
(d) I is correct but II is false

**89.** A system of rotating crops with legume or grass pasture to improve soil structure and fertility is called
(a) contour farming
(b) strip farming
(c) shifting agriculture
(d) ley farming

**90.** Gause's principle of competitive exclusion states that
(a) Competition for the same resources excludes species having different food preferences
(b) No two species can occupy the same niche indefinitely for the same limiting resources
(c) Larger organisms exclude smaller ones through competition
(d) More abundant species will exclude the less abundant species through competition

# Answers with Solutions

## Physics

**1.** *(c)* Consider the given figure, When the switch $S$ is connected to point 1, then initial energy stored in the capacitor can be given as

$$= \frac{1}{2}(2\mu F) \times V^2.$$

When the switch $S$ is connected to point 2, energy dissipated on connection across 8 μF will be

$$= \frac{1}{2}\left(\frac{C_1C_2}{C_1 + C_2}\right).V^2$$

$$= \frac{1}{2} \times \frac{2\mu F \times 8\,\mu F}{10\,\mu F} \times V^2$$

$$= \frac{1}{2} \times (1.6\,\mu F) \times V^2$$

Therefore, % loss of energy $= \frac{1.6}{2} \times 100 = 80\%$.

**2.** *(c)* Consider the given figure,

The resultant boolean expression of the above logic circuit will be

$$Y = (A + B).C$$

Now, let us try with inputs $A$, $B$ and $C$ given in the options and lets see, which one of them will give output 1 at $Y$.

If $A = 0, B = 0, C = 0$

$\Rightarrow \quad Y = (0 + 0).0$

$\Rightarrow \quad Y = 0$

If $A = 1, B = 1, C = 0$

$\Rightarrow \quad Y = (1 + 1).0$

$\Rightarrow \quad Y = 1.0$

$\Rightarrow \quad Y = 0$

If $A = 1, B = 0, C = 1$

$\Rightarrow \quad Y = (1 + 0).1 \quad \Rightarrow \quad Y = 1.1$

$\Rightarrow \quad Y = 1$

If $A = 0, B = 1, C = 0$

$\Rightarrow \quad Y = (0 + 1).0$

$\Rightarrow \quad Y = 1.0$

$\Rightarrow \quad \boxed{Y = 0}$

So, we have seen that among the given options, only option (c) is the correct choice, i.e.,

Output $Y = 1$ only when inputs $A = 1, B = 0$ and $C = 1$.

**3.** *(c)* According to question, emf of the cell is directly proportional to the balancing length *i.e.,*

$$E \propto l \qquad \ldots(i)$$

Now, in the first case, cells are connected in series to support one another *i.e.,*

Net emf $= E_1 + E_2$

From equation (i), $E_1 + E_2 = 50$ cm (given) $\quad \ldots(ii)$

Again cells are connected in series in opposite direction *i.e,*

Net emf $= E_1 - E_2$

From equation (i), $E_1 - E_2 = 10 \qquad \ldots(iii)$

From equation (ii) and (iii)

$$\frac{E_1 + E_2}{E_1 - E_2} = \frac{50}{10}$$

$$\Rightarrow \quad \frac{E_1}{E_2} = \frac{5 + 1}{5 - 1}$$

$$= \frac{6}{4} = \frac{3}{2}$$

**4.** *(c)* In Ist case, when a metallic surface is illuminated with radiation of wavelength λ, the stopping potential is $V$.

So, photoelectric equation can be written as

$$eV = \frac{hc}{\lambda} - \frac{hc}{\lambda_0} \qquad \ldots(i)$$

In IInd Case, when the same surface is illuminated with radiation of wavelength 2λ, the stopping potential is $\frac{V}{4}$. So, photoelectric equation can be written as

$$\frac{eV}{4} = \frac{hc}{2\lambda} - \frac{hc}{\lambda_0}$$

$$\Rightarrow \quad eV = \frac{4hc}{2\lambda} - \frac{4hc}{\lambda_0} \qquad \ldots(ii)$$

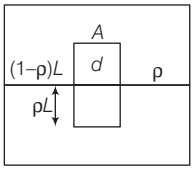
From eqs. (i) and (ii), we get

$$\Rightarrow \quad \frac{hc}{\lambda} - \frac{hc}{\lambda_0} = \frac{4hc}{2\lambda} - \frac{4hc}{\lambda_0}$$

$$\Rightarrow \quad \frac{1}{\lambda} - \frac{1}{\lambda_0} = \frac{2}{\lambda} - \frac{4}{\lambda_0}$$

$$\Rightarrow \quad \lambda_0 = 3\lambda$$

**5.** *(c)* According to question, the situation can be drawn as following.




Applying Archemedies principle

Weight of cylinder = $(\text{upthrust})_1 + (\text{upthrust})_2$

*i.e.,* $ALdg = (1 - P)\, LA\rho g + (PLA)\, n\rho g$

$\Rightarrow$ $d = (1 - P)\,\rho + Pn\rho$

$= \rho - P\rho + n\,P\rho$

$= \rho + (n - 1)\,P\rho$

$= \rho\,[1 + (n - 1)\,\rho]$

**6.** *(c)* A particle is known that an electric charge at rest has electric field in the region around it, but no magnetic field. A moving charge produces both the electric and magnetic fields. If a charge is moving with a constant velocity, the electric and magnetic fields will not change with time, hence no EM wave will be produced. But if the charge is moving with a non-zero acceleration, both the electric and magnetic field will change with space and time, it then produces EM wave. This shows that accelerated charge emits electromagnetic waves.

**7.** *(d)* Given, charge $Q = at - bt^2$ ...(i)

$\because$ We know that current, $I = \dfrac{d\theta}{dt}$

So, eq. (i) can be written as

$$I = \frac{d}{dt}(at - bt^2)$$

$\Rightarrow$ $I = a - 2bt$ ...(ii)

For maximum value of $t$, till the current exist is given by

$\Rightarrow$ $a - 2bt = 0$

$\therefore$ $t = \dfrac{a}{2b}$ ...(iii)

$\because$ The total heat produced $(H)$ can be given as

$$H = \int_0^t I^2 R\, dt$$

$$= \int_0^{a/2b} (a - 2bt)^2\, R\, .\, dt \quad \left\{\because\ t = \frac{a}{2b}\right\}$$

$$= \int_0^{a/2b} (a^2 + 4b^2t^2 - 4abt)\, Rdt$$

$$H = \left[a^2t + 4b^2\,\frac{t^3}{3} - \frac{4abt^2}{2}\right]_0^{a/2b} R$$

Solving above equation we get,

$\Rightarrow$ $H = \dfrac{a^3R}{6b}$

**8.** *(d)* Gravitational potential at some height $h$ from the surface of the earth is given by

$$V = -\frac{GM}{R + h} \quad \text{...(i)}$$

And acceleration due to gravity at some height $h$ from the earth surface can be given as

$$g' = \frac{GM}{(R + h)^2} \quad \text{...(ii)}$$

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

$$\frac{|V|}{g'} = \frac{GM}{(R + h)} \times \frac{(R + h)^2}{GM}$$

$\Rightarrow$ $\dfrac{|V|}{g'} = R + h$ (iii)

$\because$ $V = -5.4 \times 10^7$ J kg$^{-2}$ and $g' = 6.0$ ms$^{-2}$

Radius of earth, $R = 6400$ km.

Substitute these values in eq. (iii), we get

$$\frac{5.4 \times 10^7}{6.0} = R + h \Rightarrow 9 \times 10^6 = R + h$$

$\Rightarrow$ $h = (9 - 6.4) \times 10^6 = 2.6 \times 10^6$ m

$\Rightarrow$ $h = 2600$ km

**9.** *(c)* According to question,

Coefficient of linear expression of brass = $\alpha_1$

Coefficient of linear expression of steel = $\alpha_2$

Length of brass and steel rods are $l_1$ and $l_2$ respectively.

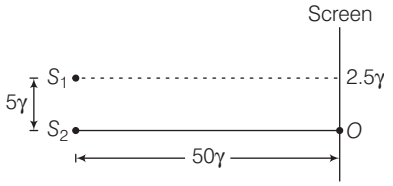
As given difference increase in length $(l_2' - l_1')$ is same for all temperature.

So, $l_2' - l_1' = l_2 - l_1$

$\Rightarrow$ $l_2\,(1 + \alpha_2\Delta t) - l_1\,(1 + \alpha_1\,\Delta t) = l_2 - l_1$

$\Rightarrow$ $l_2\alpha_2 = l_1\alpha_1$

**10.** *(c)*




In the above figure, $S_1$ and $S_2$ are the two different slits.

Given, distance between slits $S_1$ and $S_2$, $d = 5\ \lambda$

distance between screen and slits, $D = 10d = 50\lambda$

Here, $\lambda$ is the wavelength of light used in the experiment.

According to question, the intensity at maximum in this Young's double slit experiment is $I_0$.

$\Rightarrow \quad I_{\max} = I_0$

$\because$ Path difference $= \dfrac{dY_n}{D} = \dfrac{d \times \frac{d}{2}}{10d} = \dfrac{d}{20} = \dfrac{\lambda}{4}$

$\{\because \ d = 5\lambda\}$

A path difference of $\lambda$ corresponds to phase difference $2\pi$

So, for path difference $\lambda/4$, phase difference

$$\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \pi/2 = 90°$$

As we know, $I = I_0 \cos^2 \dfrac{\phi}{2}$

$\Rightarrow \quad I = I_0 \cos^2 \dfrac{90°}{2}$

$\Rightarrow \quad I = I_0 \times \left(\dfrac{1}{\sqrt{2}}\right)^2 \Rightarrow I = \dfrac{I_0}{2}$

**11.** *(b)* Given, Rydberg constant, $R = 10^7 \ \text{m}^{-1}$

$\because$ For last line in Balmer series, $n_2 = \infty$, $n_1 = 2$.

As we know that

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \Rightarrow \frac{1}{\lambda} = 10^7\left(\frac{1}{2^2} - \frac{1}{\infty}\right)$$

$\Rightarrow \quad \bar{\nu} = \dfrac{1}{\lambda} = \dfrac{10^7}{4} = 0.25 \times 10^7 \ \text{m}^{-1}$

**12.** *(a)* Since, the escape velocity of earth can be given as

$$v_e = \sqrt{2gR} = R\sqrt{\frac{8}{3}\pi G\rho} \quad [\rho = \text{density of earth}]$$

$\Rightarrow \quad v_e = R\sqrt{\dfrac{8}{3}\pi G\rho} \quad \ldots(i)$

As it is given that the radius and mean density of planet are twice as that of earth. So, escape velocity at planet will be

$$v_p = 2R\sqrt{\frac{8}{3}\pi G 2\rho} \quad \ldots(ii)$$

Divide, eq. (i) by eq. (ii), we get

$$\frac{v_e}{v_p} = \frac{R\sqrt{\frac{8}{3}\pi G\rho}}{2R\sqrt{\frac{8}{3}\pi G 2\rho}}$$

$\Rightarrow \quad \dfrac{v_e}{v_p} = \dfrac{1}{2\sqrt{2}}$

**13.** *(c)* Given, Number of turns of solenoid, $N = 1000$.

Current, $I = 4A$

Magnetic flux, $\phi_B = 4 \times 10^{-3}$ Wb

$\because$ Self inductance of solenoid is given by

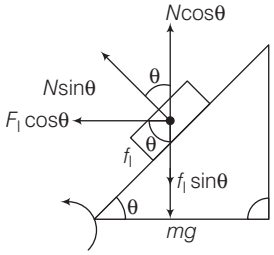
$$L = \frac{\phi_B . N}{I} \quad \ldots(i)$$

Substitute the given values in equation (i), we get

$$L = \frac{4 \times 10^{-3} \times 1000}{4}$$

$= 1 \ H$

**14.** *(a)* According to question, a car is negotiating a curved road of radius $R$. The road is banked at angle $\theta$ and the coefficient of friction between the tyres of car and the road is $\mu_s$. So, this given situation can be drawn as shown in figure below.




Considering the case of vertical equilibrium

$$N \cos\theta = mg + f_l \sin\theta$$

$\Rightarrow \quad mg = N \cos\theta - f_l \sin\theta \quad \ldots(i)$

Considering the case of horizontal equilibrium,

$$N \sin\theta + f_l \cos\theta = \frac{mv^2}{R} \quad \ldots(ii)$$

Divide eqs. (i) and (ii), we get

$$\frac{v^2}{Rg} = \frac{\sin\theta + \mu_s \cos\theta}{\cos\theta - \mu_s \sin\theta} \quad [f_l \propto \mu_s]$$

$\Rightarrow \quad v = \sqrt{Rg\left(\dfrac{\sin\theta + \mu_s \cos\theta}{\cos\theta - \mu_s \sin\theta}\right)}$

$\Rightarrow \quad v = \sqrt{Rg\left(\dfrac{\tan\theta + \mu_s}{1 - \mu_s \tan\theta}\right)}$

**15.** *(d)* As we know the relation between the magnetic permeability and susceptibility of material i.e.

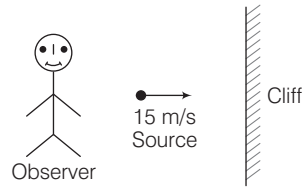
$$\mu_r = 1 + \chi_m \quad \ldots(i)$$

$\because$ For diamagnetic substances, $\mu_r < 1$

So, according to equation (i), the magnetic susceptibility ($\chi_m$) of diamagnetic substance will be negative.

While in the case of para and ferromagnetic substances, diamagnetic susceptibility is positive.

**16.** *(b)* According to question, situation can be drawn as follows.




Frequency of sound that the observer hear in the echo reflected from the cliff is given by

$$f' = \left(\frac{v}{v - v_S}\right)$$

where $f$ = original frequency of source;

$v$ = velocity of sound

$v_s$ = velocity of source

So, $$f' = \left(\frac{330}{330 - 15}\right) 800 = 838 \text{ Hz}$$

**17.** *(c)* According to question, a body of mass 1 kg begins to move under the action of time dependent force,

$$\mathbf{F} = (2t\hat{\mathbf{i}} + 3t^2\hat{\mathbf{j}})\ N$$

where $\hat{\mathbf{i}}$ and $\hat{\mathbf{j}}$ are unit vectors along $X$ and $Y$-axis.

$\because$ $\mathbf{F} = m\mathbf{a}$

$\Rightarrow$ $$\mathbf{a} = \frac{\mathbf{F}}{m}$$

$\Rightarrow$ $$\mathbf{a} = \frac{(2t\hat{\mathbf{i}} + 3t^2\hat{\mathbf{j}})}{1} \qquad \{\because\ m = 1 \text{ kg}\}$$

$\Rightarrow$ $$\mathbf{a} = (2t\hat{\mathbf{i}} + 3t^2\hat{\mathbf{j}})\ \text{m/s}^2$$

$\because$ acceleration, $a = \frac{dv}{dt}$

$\Rightarrow$ $$dv = a\,dt \qquad \ldots(i)$$

Integrating both sides, we get

$$\int dv = \int a\,dt$$

$$= \int (2t\hat{\mathbf{i}} + 3t^2\hat{\mathbf{j}})\,dt$$

$$\mathbf{v} = t^2\hat{\mathbf{i}} + t^3\hat{\mathbf{j}}$$

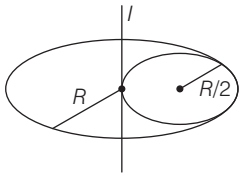
$\because$ Power developed by the force at the time $t$ wil be given as

$$P = \mathbf{F} \cdot \mathbf{v} = (2t\hat{\mathbf{i}} + 3t^2\hat{\mathbf{j}}) \cdot (t^2\hat{\mathbf{i}} + t^3\hat{\mathbf{j}})$$

$$= (2t.t^2 + 3t^2.t^3)$$

$$P = (2t^3 + 3t^5)\ \text{W}$$

**18.** *(a)* Considering the information given in the question, let us draw the figure




If the above figure is considered, then moment of inertia of disc will be given as

$$I = I_{\text{remain}} + I_{(R/2)}$$

$\Rightarrow$ $$I_{\text{remain}} = I - I_{(R/2)}$$

Putting the values, we get

$$= \frac{MR^2}{2} - \left[\frac{\frac{M}{4}\left(\frac{R}{2}\right)^2}{2} + \frac{M}{4}\left(\frac{R}{2}\right)^2\right]$$

$$= \frac{MR^2}{2} - \left[\frac{MR^2}{32} + \frac{MR^2}{16}\right]$$

$$= \frac{MR^2}{2} - \left[\frac{MR^2 + 2MR^2}{32}\right]$$

$$= \frac{MR^2}{2} - \frac{3MR^2}{32} = \frac{16MR^2 - 3MR^2}{32}$$

$$I_{\text{remain}} = \frac{13MR^2}{32}$$

**19.** *(c)* As the first minimum is observed at an angle of 30° in a diffraction pattern due to a single slit of width $a$.

i.e., $n = 1,\ \theta = 30°$

$\because$ According to Bragg's law of diffraction,

$$a \sin\theta = n\lambda$$

$\Rightarrow$ $$a \sin 30° = (1)\,\lambda \qquad (n = 1)$$

$\Rightarrow$ $$a = 2\lambda \qquad \ldots(i) \quad \left\{\because\ \sin 30° = \frac{1}{2}\right\}$$

For Ist secondary maxima

$\Rightarrow$ $$a \sin\theta_1 = \frac{3\lambda}{2}$$

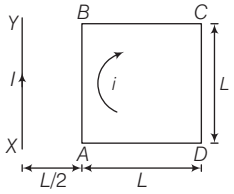
$\Rightarrow$ $$\sin\theta_1 = \frac{3\lambda}{2a} \qquad \ldots(ii)$$

Substitute value of $a$ from eq. (i) to eq. (ii), we get

$$\sin\theta_1 = \frac{3\lambda}{4\lambda} \Rightarrow \sin\theta_1 = \frac{3}{4}$$

$$\Rightarrow \quad \theta_1 = \sin^{-1}\left(\frac{3}{4}\right)$$

**20.** *(d)* Consider the given figure,




From the above figure, it can be seen that the direction of currents in a long straight conductor $XY$ and arm $AB$ of a square loop $ABCD$ are in the same direction. So, there exist a force of attraction between the two conductors, which will be experienced by $F_{BA}$ as

$$F_{BA} = \frac{\mu_0 IiL}{2\pi\left(\frac{L}{2}\right)}$$

In the case of $XY$ and arm $CD$, the direction of currents are in the opposite direction. So, there exist a force of repulsion which wil be experienced by $CD$ as

$$F_{CD} = \frac{\mu_0 IiL}{2\pi\left(\frac{3L}{2}\right)}$$

Therefore, net force on the loop $ABCD$ will be

$$F_{\text{loop}} = F_{BA} - F_{CD} = \frac{\mu_0 IiL}{2\pi}\left[\frac{1}{(L/2)} - \frac{1}{(3L/2)}\right]$$

$$F_{\text{loop}} = \frac{2\mu_0 iI}{3\pi}$$

**21.** *(c)* Given, temperature, $T_1 = 5760$ K

Since, it is given that energy of radiation emitted by the body at wavelength 250 nm in $U_1$, at wavelength 500 nm is $U_2$ and that at 1000 nm is $U_3$.

$\because$ According to Wien's law, we get

$$\lambda_m T = b$$

where, $b$ = Wien's constant = $2.88 \times 10^6$ nmK

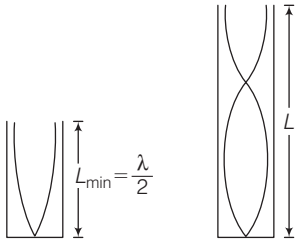
$$\Rightarrow \quad \lambda_m = \frac{b}{T}$$

$$\Rightarrow \quad \lambda_m = \frac{2.88 \times 10^6 \text{ nmK}}{5760 \text{ K}}$$

$$\Rightarrow \quad \lambda_m = 500 \text{ nm}$$

$\because$ $\lambda_m$ = wavelength corresponding to maximum energy, so, $U_2 > U_1$.

**22.** *(b)* The smallest length of the air column is associated with fundamental mode of vibration of the air column as shown in the diagram.




$$\because \quad L_{\min} = \frac{\lambda}{4}$$

$$\Rightarrow \quad 50 \text{ cm} = \frac{\lambda}{4} \Rightarrow \lambda = 200 \text{ cm}$$

The next higher length of the air column is

$$L = \frac{\lambda}{4} + \frac{\lambda}{2} = \frac{\lambda + 2\lambda}{4} = \frac{3\lambda}{4}$$

$$= \frac{3}{4} \times 200 = 150 \text{ cm}$$

**23.** *(a)* It is given that

$$v_{\text{rms}} = 200 \text{ ms}^{-1}, T_1 = 300 \text{ K}, P_1 = 10^5 \text{ N/m}^2$$

$$T_2 = 400 \text{ K}, P_2 = 0.05 \times 10^5 \text{ N/m}^2$$

As, rms velocity of gas molecules,

$$\because \quad v_{\text{rms}} \propto \sqrt{T} \qquad \left(\because v_{\text{rms}} = \sqrt{\frac{3RT}{m}}\right)$$

For two different cases

$$\Rightarrow \quad \frac{(v_{\text{rms}})_1}{(v_{\text{rms}})_2} = \sqrt{\frac{T_1}{T_2}}$$

$$\Rightarrow \quad \frac{200}{(v_{\text{rms}})_2} = \sqrt{\frac{300}{400}} = \sqrt{\frac{3}{4}}$$

$$\Rightarrow \quad (v_{\text{rms}})_2 = \frac{2}{\sqrt{3}} \times 200 = \frac{400}{\sqrt{3}} \text{ ms}^{-1}$$

**24.** *(a)* Let us assume that current through the diode is $I$.

From the given condition

$$\because \quad I = \frac{V_A - V_B}{R} = \frac{4 - (-6)}{1 \text{ K}\Omega} = \frac{10}{1 \times 10^3} = 10^{-2} \text{ A}$$

**25.** *(a)* Suppose two vectors are $\mathbf{P}$ and $\mathbf{Q}$.

It is given that

$$|\mathbf{P} + \mathbf{Q}| = |\mathbf{P} - \mathbf{Q}|$$

Let angle between **P** and **Q** is $\phi$.

$\therefore \quad P^2 + Q^2 + 2PQ\cos\phi = P^2 + Q^2 - 2PQ\cos\phi$

$\Rightarrow \quad 4PQ\cos\phi = 0$

$\Rightarrow \quad \cos\phi = 0 \qquad [\because P, Q \neq 0]$

$\Rightarrow \quad \phi = \frac{\pi}{2} = 90°$

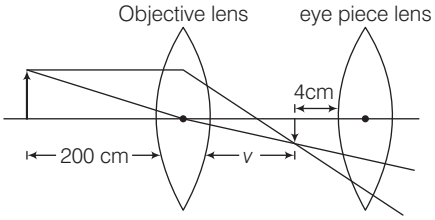
**26.** *(c)* According to question

Focal length of objective lens $(F_0) = +40$ cm

Focal length of eyepiece lens $(F_e) = 4$ cm

Object distance for objective lens $(u_0) = -200$ cm

Applying lens formula for objective lens




$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$\Rightarrow \quad \frac{1}{v} - \frac{1}{-200} = \frac{1}{40}$

$\Rightarrow \quad \frac{1}{v} = \frac{1}{40} - \frac{1}{200} = \frac{5-1}{200} = \frac{4}{200}$

$\Rightarrow \quad v = 50$ cm

Image will be form at first focus of eyepiece lens.

So, for normal adjustment distance between objectives and eye piece lense (length of tube) will be

$$v + F_e \Rightarrow 50 + 4 \Rightarrow 54 \text{ cm}$$

**27.** *(d)* Given, resistance across load, $R_L = 800\ \Omega$

Voltage drop across load, $V_L = 0.8$ V

Input resistance of circuit, $R_i = 192\ \Omega$.

Collector current is given by,

$$I_C = \frac{V_L}{R_L} = \frac{0.8}{800} = \frac{8}{8000} = 1 \text{ mA}$$

$\because$ Current amplification $= \frac{\text{Output current}}{\text{Input current}}$

$$= \frac{I_C}{I_B} = 0.96 \Rightarrow I_B = \frac{1 \text{ mA}}{0.96}$$

$\because$ Voltage gain,

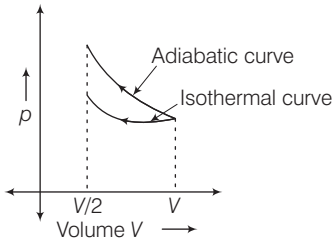
$$A_V = \frac{V_L}{V_{in}} = \frac{V_L}{I_B R_i} = \frac{0.8 \times 0.96}{10^{-3} \times 192} = 4 \Rightarrow A_V = 4$$

and Power gain,

$$A_P = \frac{I_C^2 R_L}{I_B^2 R_i} = \left(\frac{I_C}{I_B}\right)^2 . \frac{R_L}{R_i} = (0.96)^2 \times \frac{800}{192}$$

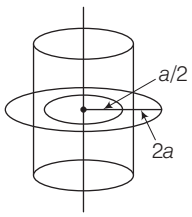
$A_P = 3.84$

**28.** *(a)* The solution of this question can be understood by plotting a *p-V* graph for the compression of a gas isothermally and adiabatically simultaneously to half of its initial volume. *i.e.*




Since, the isothermal curve is less steeper than the adiabatic curve. So, area under the *p-V* curve for adiabatic process has more magnitude than isothermal curve. Hence, work done in adiabatic process will be more than in isothermal process.

**29.** *(b)* Consider two amperian loops of radius $\frac{a}{2}$ and $2a$ as shown in the diagram. Applying Ampere's circuital law for these loops we get,




$$\oint \mathbf{B} \cdot \mathbf{d}L = \mu_0 I_{\text{enclosed}}$$

For the smaller loop

$\Rightarrow \quad B \times 2\pi \frac{a}{2} = \mu_0 \times \frac{I}{\pi a^2} \times \pi \left(\frac{a}{2}\right)^2$

$$= \mu_0 I \times \frac{1}{4} = \frac{\mu_0 I}{4}$$

$\Rightarrow \quad B_I = \frac{\mu_0 I}{4\pi a}$, at distance $\frac{a}{2}$ from the axis of the wire.

Similarly, for bigger amperian loop.

$$B' \times 2\pi (2a) = \mu_0 I$$

[total current enclosed by Amperian loop is 2]

$$\Rightarrow \qquad B' = \frac{\mu_0 I}{4\pi a}$$

at distance $2a$ from the axis of the wire.

So, ratio of, $\frac{B}{B'} = \frac{\mu_0 I}{4\pi a} \times \frac{4\pi a}{\mu_0 I} = 1$

**30.** *(d)* A concave mirror forms real and virtual images, whose magnification can be negative or positive depending upon the position of the object.

If object is placed between focus and pole the image obtained will be virtual and its magnification will be positive. In all other cases concave mirror forms real images whose magnification will be negative.

A convex mirror always forms a virtual image whose magnification will always be positive.

**31.** *(b)* Velocity of the particle is given as

$$v = At + Bt^2$$

where $A$ and $B$ are constants.

$$\Rightarrow \qquad \frac{dx}{dt} = At + Bt^2 \qquad \left[\because\ v = \frac{dx}{dt}\right]$$

$$\Rightarrow \qquad dx = (At + Bt^2)\, dt$$

Integrating both sides, we get

$$\int_{x_1}^{x_2} dx = \int_1^2 (At + Bt^2)\, dt$$

$$\Rightarrow \qquad \Delta x = x_2 - x_1 = A\int_1^2 t\, dt + B\int_1^2 t^2 dt$$

$$= A\left[\frac{t^2}{2}\right]_1^2 + B\left[\frac{t^3}{3}\right]_1^2$$

$$= \frac{A}{2}(2^2 - 1^2) + \frac{B}{3}(2^3 - 1^3)$$

$\therefore$ Distance travelled between $1s$ and $2s$ is

$$\Delta x = \frac{A}{2} \times (3) + \frac{B}{3}(7) = \frac{3A}{2} + \frac{7B}{3}$$

**32.** *(a)* Acceleration of an object rolling down an inclined plane is given by

$$a = \frac{g \sin\theta}{1 + I/mr^2}$$

where, $\theta$ = angle of inclination of the inclined plane

$m$ = mass of the object

$I$ = moment of inertia about the axis through centre of mass

For disc, $\frac{I}{mr^2} = \frac{1/2\ mr^2}{mr^2} = \frac{1}{2}$

For solid sphere, $\frac{I}{mr^2} = \frac{2/5 mr^2}{mr^2} = \frac{2}{5}$

For hollow sphere, $\frac{I}{mr^2} = \frac{2/3 mr^2}{mr^2} = \frac{2}{3}$

$\therefore$ $$a_{\text{disc}} = \frac{g \sin\theta}{1 + \frac{1}{2}} = \frac{2}{3} g \sin\theta$$

$$= 0.66\, g \sin\theta$$

$$a_{\text{solid sphere}} = \frac{g \sin\theta}{1 + \frac{2}{5}} = \frac{5}{7} g \sin\theta$$

$$= 0.71\ g \sin\theta$$

$$a_{\text{hollow sphere}} = \frac{g \sin\theta}{1 + \frac{2}{3}} = \frac{3}{5} g \sin\theta$$

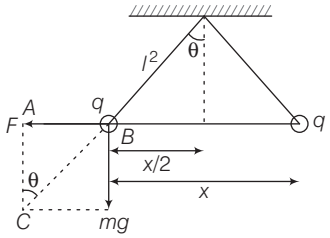
$$= 0.6\, g \sin\theta$$

Clearly, $a_{\text{solid sphere}} > a_{\text{disk}} > a_{\text{hollow sphere}}$

Type of sphere is not mentioned in the question. Therefore, we will assume the given sphere as solid sphere.

$\therefore$ $a_{\text{solid sphere}} = a_{\text{hollow sphere}} > a_{\text{disk}}$

**33.** *(b)* According to question, two identical charged spheres suspended from a common point by two massless strings of length $L$.




$\because$ In $\Delta ABC$

$$\tan\theta = \frac{F}{mg}$$

or $$\frac{F}{mg} = \tan\theta \qquad \ldots(i)$$

Since, the charges begins to leak from both the spheres at a constant rate. As a result, the spheres approach each other with velocity $v$.

Therefore, equation (i) can be rewritten as

$$\frac{Kq^2}{x^2 mg} = \frac{x/2}{\sqrt{l^2 - \frac{x^2}{4}}}$$

$$\Rightarrow \quad \frac{Kq^2}{x^2 mg} = \frac{x}{2l} \quad \text{or} \quad q^2 \propto x^3$$

$$\Rightarrow \quad q \propto x^{3/2}$$

$$\Rightarrow \quad \frac{dq}{dt} \propto \frac{d(x^{3/2})}{dx} \cdot \frac{dx}{dt}$$

$$\Rightarrow \quad \frac{dq}{dt} \propto x^{1/2} . v$$

$$\Rightarrow \quad v \propto \frac{1}{x^{1/2}} \text{ or } v \propto x^{-1/2}$$

**34.** *(b)* Position vector of the particle is given by

$$\mathbf{r} = \cos \omega t\, \hat{\mathbf{x}} + \sin \omega t\, \hat{\mathbf{y}}$$

where $\omega$ is a constant.

Velocity of the particle is

$$\mathbf{v} = \frac{d\mathbf{r}}{dt} = \frac{d}{dt}(\cos \omega t\, \hat{\mathbf{x}} + \sin \omega t\, \hat{\mathbf{y}})$$

$$= (-\sin \omega t)\, \omega \hat{\mathbf{x}} + (\cos \omega t)\, \omega \hat{\mathbf{y}}$$

$$= -\omega (\sin \omega t\, \hat{\mathbf{x}} - \cos \omega t\, \hat{\mathbf{y}})$$

Acceleration of the particles

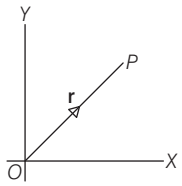
$$\mathbf{a} = \frac{d\mathbf{v}}{dt} = \frac{d}{dt}[-\omega \sin \omega t\, \hat{\mathbf{x}} + \omega \cos \omega t\, \hat{\mathbf{y}}]$$

$$= -\omega^2 \cos \omega t\, \hat{\mathbf{x}} - \omega^2 \sin \omega t\, \hat{\mathbf{y}}$$

$$= -\omega^2 (\cos \omega t\, \hat{\mathbf{x}} + \sin \omega t\, \hat{\mathbf{y}})$$

$$\Rightarrow \quad \mathbf{a} = -\omega^2\, \mathbf{r} = \omega^2 (-\mathbf{r})$$

Assuming the particle as $P$, then its position vector is directed as shown in the diagram.




Therefore, acceleration is directed towards $-\mathbf{r}$ that is towards "$O$" (origin).

Now, we have

$$\mathbf{v} \cdot \mathbf{r} = -\omega (\sin \omega t\, \hat{\mathrm{x}} - \cos \omega t\, \hat{\mathbf{y}}) \cdot (\cos \omega t\, \hat{\mathbf{x}} + \sin \omega t\, \hat{\mathbf{y}})$$

$$= -\omega [\sin \omega t \cdot \cos \omega t + 0 + 0 - \sin \omega t \cdot \cos \omega t]$$

$$= -\omega (0) = 0 \qquad [\because \ \hat{\mathbf{x}} \perp \hat{\mathbf{y}}]$$

$$\Rightarrow \quad \mathbf{v} \perp \mathbf{r}$$

Thus, velocity is perpendicular to $\mathbf{r}$.

**35.** *(b)* According to question as conservation of energy, energy gained by the ice during its fall from height $h$ is given by

$$E = mgh$$

As given, only one quarter of its energy is absorbed by the ice.

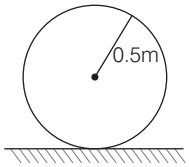
So, $$\frac{mgh}{4} = mL_f$$

$$\Rightarrow \quad h = \frac{mL_f \times 4}{mg} = \frac{L_f \times 4}{g} = \frac{3.4 \times 10^5 \times 4}{10}$$

$$= 13.6 \times 10^4$$

$$= 13600 \text{ m} = 136 \text{ km}$$

**36.** *(d)* According to given question, a uniform circular disc of radius 50 cm at rest is free to turn about an axis having perpendicular to its plane and passes through its centre. This situation can be shown by the figure given below:




$\therefore$ Angular acceleration, $\alpha = 2 \text{ rad s}^{-2}$ (given)

Angular speed, $\omega = \alpha t = 4 \text{ rad s}^{-1}$

$\because$ Centripetal acceleration,

$$a_c = \omega^2 r = (4)^2 \times 0.5 = 16 \times 0.5$$

$$a_c = 8 \text{ m/s}^2$$

$\because$ Linear acceleration at the end of $2s$,

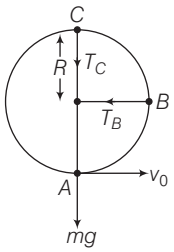
$$a_t = \alpha r = 2 \times 0.5 \quad \Rightarrow \quad a_t = 1 \text{ m/s}^2$$

Therefore, the net acceleration at the end of 2.0 s is given by

$$a = \sqrt{a_c^2 + a_t^2}$$

$$a = \sqrt{(8)^2 + (1)^2} = \sqrt{65} \Rightarrow a \approx 8 \text{ m/s}^2$$

**37.** *(c)* According to question, we have




Let the tension at point $A$ be $T_A$. So, from Newton's second law

$$T_A - mg = \frac{mv_c^2}{R}$$

Energy at point $A = \frac{1}{2} mv_0^2$ ...(i)

Energy at point $C$ is

$$\frac{1}{2} mv_c^2 + mg \times 2R \quad \text{...(ii)}$$

Applying Newton's 2nd law at point $C$

$$T_c + mg = \frac{mv_c^2}{R}$$

To Complete the loop $T_c \geq 0$

So, $mg = \frac{mv_c^2}{R}$

$\Rightarrow$ $v_c = \sqrt{gR}$ ...(iii)

From equation (i) and (ii) by conservation of energy

$$\frac{1}{2} mv_0^2 = \frac{1}{2} mv_c^2 + 2mgR$$

$\Rightarrow$ $\frac{1}{2} mv_0^2 = \frac{1}{2} mgR + 2mgR \times 2$

$(\because\ v_c = \sqrt{gR})$

$\Rightarrow$ $v_0^2 = gR + 4gR$

$\Rightarrow$ $v_0 = \sqrt{5gR}$

**38.** *(a)* For an AC circuit containing capacitor only, the phase difference between current and voltage will be $\frac{\pi}{2}$ (i.e. 90°).

In this case current is ahead of voltage by $\frac{\pi}{2}$.

Hence, power in this case is given by

$$P = VI \cos \phi$$

($\phi$ = phase difference between voltage and current)

$$P = VI \cos 90° = 0$$

**39.** *(a)* According to question, we have

Wavelength of transphase pulse

$$\lambda = \frac{\nu}{f} \quad \text{...(i)}$$

($\nu$ = velocity of the wave; $f$ = frequency of the wave)

As we know

$$\nu = \sqrt{\frac{T}{\mu}} \quad \text{...(ii)}$$

($T$ = tension in the spring; $\mu$ = mass per unit length of the rope)

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

$$\lambda = \frac{1}{f}\sqrt{\frac{T}{\mu}}$$

$\Rightarrow$ $\lambda \propto \sqrt{T}$

So, for two different case, we get

$$\frac{\lambda_2}{\lambda_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{m_1 + m_2}{m_2}}$$

**40.** *(d)* Given,

Inductance $L = 20$ mH

Capacitance, $C = 50\ \mu$F

Resistance, $R = 40\ \Omega$

emf, $V = 10 \sin 340\ t$

$\because$ Power loss in AC circuit will be given as

$$P_{av} = I_V^2\ R = \left[\frac{E_V}{Z}\right]^2 .R$$

$$= \left(\frac{10}{\sqrt{2}}\right)^2 . 40 \left[\frac{1}{40^2 + \left(340 \times 20 \times 10^3 - \frac{1}{340 \times 50 \times 10^{-6}}\right)^2}\right]$$

$$= \frac{100}{2} \times 40 \times \frac{1}{1600 + (6.8 - 58.8)^2}$$

$$= \frac{2000}{1600 + 2704} \approx 0.46\ \text{W} \approx 0.51\ \text{W}$$

**41.** *(d)* Since, it is given that electron has mass $m$.

de-Broglie's wavelength for an electron will be given as

$$\lambda_e = \frac{h}{P} \quad \text{...(i)}$$

where, $h$ = Planck's constant

$P$ = Linear momentum of electron

As kinetic energy of electron, $E = \frac{P^2}{2m}$

$\Rightarrow$ $P = \sqrt{2mE}$ ...(ii)

From equation (i) and (ii), we get

$$\lambda_e = \frac{h}{\sqrt{2mE}} \quad \text{...(iii)}$$

Energy of a photon can be given as

$$E = h\nu$$

$$\Rightarrow \quad E = \frac{hc}{\lambda_p}$$

$$\Rightarrow \quad \lambda_p = \frac{hc}{E} \quad \ldots(iv)$$

Hence, $\lambda_p$ = de-Broglie's wavelength of photon.

Now, divide equation (iii) by (iv), we get

$$\frac{\lambda_e}{\lambda_p} = \frac{h}{\sqrt{2mE}} \cdot \frac{E}{hc}$$

$$\Rightarrow \quad \frac{\lambda_c}{\lambda_p} = \frac{1}{c} \cdot \sqrt{\frac{E}{2m}}$$

**42.** *(d)* When an $\alpha$-particle of mass $m$ moving with velocity $v$ bombards on a heavy nucleus of charge $Ze$, then there will be no loss of energy as in this case, initial kinetic energy of $\alpha$-particle = potential energy of $\alpha$-particle at closest approach.

$$\Rightarrow \quad \frac{1}{2} mv^2 = \frac{2Ze^2}{4\pi\varepsilon_0 r_0}$$

$$\Rightarrow \quad \boxed{r_0 \propto \frac{1}{m}}$$

This is the required distance of closest approach to $\alpha$-particle from the nucleus.

**43.** *(b)* Given, temperature of source, $T = 30°C = 30 + 273$

$$T_1 = 303 \text{ K}$$

Temperature of sink, $T_2 = 4°C = 4 + 273$

$$T_2 = 277 \text{ K}$$

As, we know that

$$\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \quad \frac{Q_2 + W}{Q_2} = \frac{T_1}{T_2} \qquad \{\because W = Q_1 - Q_2\}$$

where $Q_2$ is the amount of heat drawn from the sink (at $T_2$), $W$ is workdone on working substance, $Q_1$ is amount of heat rejected to source (at room temperature $T_1$).

$$\Rightarrow \quad WT_2 + T_2Q_2 = T_1Q_2$$

$$\Rightarrow \quad WT_2 = T_1Q_2 - T_2Q_2$$

$$\Rightarrow \quad WT_2 = Q_2 (T_1 - T_2)$$

$$\Rightarrow \quad W = Q_2 \left( \frac{T_1}{T_2} - 1 \right)$$

$$\Rightarrow \quad W = 600 \times 4.2 \times \left( \frac{303}{277} - 1 \right)$$

$$W = 600 \times 4 .2 \times \left( \frac{26}{277} \right)$$

$$W = 236.5 \text{ Joules}$$

$$\text{Power} = \frac{\text{Work done}}{\text{Time}}$$

$$= \frac{W}{t} = \frac{236.5}{1} = 236.5\text{W}$$

**44.** *(d)* Given, mass of particle $m = 0.01$ kg.

Radius of circle along which particle is moving, $r = 6.4$ cm.

$\because$ Kinetic energy of particle, KE $= 8 \times 10^{-4}$ J

$$\Rightarrow \quad \frac{1}{2} mv^2 = 8 \times 10^{-4} \text{ J}$$

$$\Rightarrow \quad v^2 = \frac{16 \times 10^{-4}}{0.01} = 16 \times 10^{-2} \quad \ldots(i)$$

As it is given that KE of particle is equal to $8 \times 10^{-4}$ J by the end of second revolution after the beginning of motion of particle. It means, its initial velocity ($u$) is 0 m/s at this moment.

$\because$ By Newton's 3rd equation of motion,

$$v^2 = u^2 + 2a_t s$$

$$\Rightarrow \quad v^2 = 2a_t S \quad \text{or} \quad v^2 = 2a_t (4\pi r)$$

$\{\because$ particle covers 2 revolutions$\}$

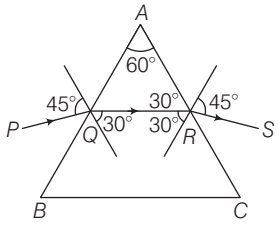
$$\Rightarrow \quad a_t = \frac{v^2}{8\pi r}$$

$$= \frac{16 \times 10^{-2}}{8 \times 3.14 \times 6.4 \times 10^{-2}}$$

$\{\because$ from equation (i), $v^2 = 16 \times 10^{-2}\}$

$$\therefore \quad a_t = 0.1 \text{ m/s}^2$$

**45.** *(a)* Consider a ray of light $PQ$ incident an the surface $AB$ and moves along $RS$, after passing through the prism $ABC$.




It is given that the incident ray suffers minimum deviation. Therefore, the ray inside the prism must be parallel to the base $BC$ of the prism.

From the geometry of the prism and the ray diagram, it is clear that

angle of incidence, $i = 45°$

angle of refraction $r = r' = 30°$

angle of emergence, $e = 45°$

Therefore, minimum deviation suffered by the ray is

$$\delta_{min} = (i + e) - (r + r')$$
$$= 90° - 60° = 30°$$

Also we know that

$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\frac{A}{2}}$$

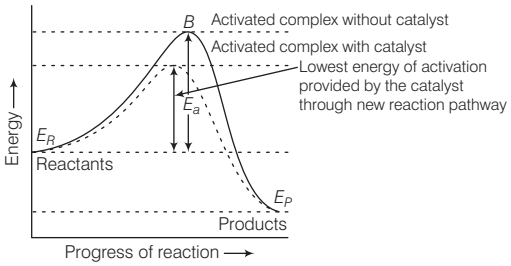
where, $\mu$ = refractive index of the material of the prism.

$A$ = angle of prism = 60°

$$\therefore \quad \mu = \frac{\sin\left(\frac{60° + 30°}{2}\right)}{\sin\frac{60°}{2}}$$
$$= \frac{\sin 45°}{\sin 30°}$$
$$= \frac{1/\sqrt{2}}{1/2} = \frac{2}{\sqrt{2}} = \sqrt{2}$$

# Chemistry

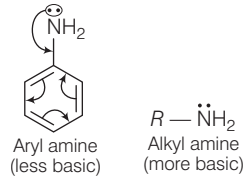
**1.** *(c)* A catalyst is a substance which alters the reaction rate but itself remains unchanged in amount and chemical composition at the end of the reaction. It provides a new reaction path with a lower energy barrier (lowering activation energy).




**2.** *(d)* According to the postulate of VSEPR theory, a lone pair occupies more space than a bonding pair, since it lies closer to the central atom. This means that the repulsion between the different electron pairs follow the order.

$$lp - lp > lp - bp > bp - bp$$

**3.** *(d)*




Due to delocalisation of lone pair of electrons of N-atom to the benzene ring, it losses its basicity and becomes less basic than alkyl amine.

On the other hand, alkyl amine has free lone pair of electron as well as +I-effect of alkyl group increases electron density on N-atom enhancing its basic nature.

**4.** *(d)* Nitric acid acts as an oxidising agent while reacting with copper. When dil. $HNO_3$ reacts, reaction proceeds as:

$$3Cu + 8HNO_3(dil.) \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

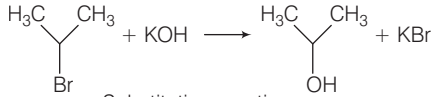
and when conc. $HNO_3$ is used, reaction proceeds as

$$Cu + 4HNO_3(conc.) \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

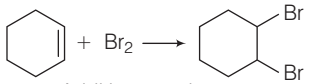
**5.** *(a)* $CH_3CH_2CH_2Br + KOH \longrightarrow$

$$CH_3CH = CH_2 + KBr + H_2O$$

Elimination reaction



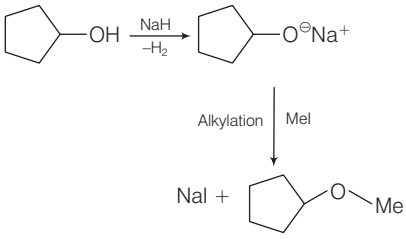

Substitution reaction




Addition reaction

**6.** *(c)* Two electrons occupying the same orbital has equal spin but the directions of their spin are opposite. Hence, spin quantum number, $s$, (represented +1/2 and – 1/2) distinguishes them.

**7.** *(d)* The formation of ether from alcohol in the presence of base followed by alkylation is known as Williamson ether synthesis reaction.



**8.** *(c)* Electronic configuration of $_{83}Eu$

$$= [Xe]_{54}\ 4f^7 6s^2$$

Electronic configuration of $_{64}Gd$

$$= [Xe]_{54}\ 4f^7 5d^1 6s^2$$

Electronic configuration of $_{65}Tb = [Xe]_{54}\ 4f^9 6s^2$

**9.** *(d)* From Raoult's law of partial pressure,

$$\frac{p_A^\circ - p_S}{p_S} = \frac{n_B}{n_A}$$

$$\Rightarrow \quad \frac{760 - 732}{732} = \frac{W_B \times M_A}{M_B \times W_A}$$

$$\Rightarrow \quad \frac{28}{732} = \frac{6.5 \times 18}{M_B \times 100}$$

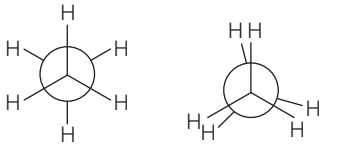
$$\Rightarrow \quad M_B = 30.6$$

$$\therefore \Delta T_b = 0.52 \times \frac{6.5 \times 1000}{30.6 \times 100} = 1.10$$

$\therefore$ Boiling point = 100 + 1.10

$$= 101.1^\circ C \approx 101^\circ C$$

**10.** *(c)* Due to the absence of torsional strain staggered conformation of ethane is more stable than eclipsed conformation of it.



Staggered conformation Eclipsed conformation

**11.** *(a)* Adsorption is a spontaneous process that occurs with release in energy and decrease in the randomness (i.e. entropy) of the adsorbed substance.

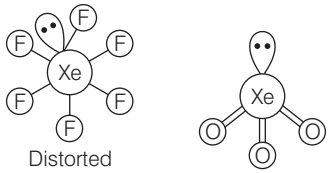
For a spontaneous process, $\Delta G$ must be negative.

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

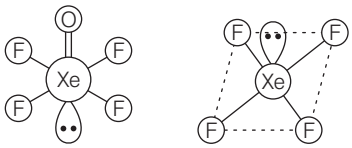
As the process is exothermic and randomness of molecule (entropy) decreases hence, both $\Delta H$ and $\Delta S$ will be negative as well.

**12.** *(d)* A – 1, B – 3, C – 4, D – 2

The structure of the xenon compounds are represented below:

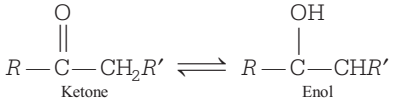


Distorted octahedral $XeF_6$ Pyramidal $XeO_3$



Square pyramidal $XeOF_4$ Square planar $XeF_4$

**13.** *(c)* In keto-enol tautomerism, a carbonyl compound with a hydrogen atom on its alpha-carbon rapidly equilibrates with its corresponding enol.

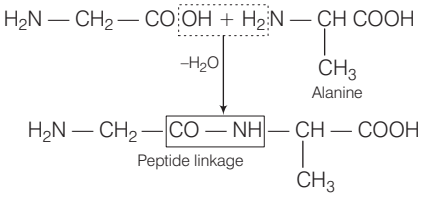


Ketone Enol

(containing $\alpha$-hydrogen)

**14.** *(b)* Two amino acids in a protein are linked by a peptide bond.

e.g. glycylalanine is formed when carboxyl group of glycine combines with the amino group of alanine.



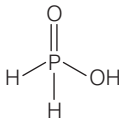
Glycylalanine (Gly-Ala)

**15.** *(d)* A – 4, B – 2, C – 3, D – 1

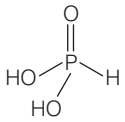
- It is a metallurgical technique for extracting Au (gold) from low grade ore by converting the Au to a water-soluble coordination complex.
- This process is used for dressing of sulphide ore, i.e. ZnS.
- This process is used for extraction of Al which is carried out in a steel tank lined inside with graphite. Here, graphite serves as cathode. The electrolyte consists of alumina dissolved in fused cryolite ($Na_3AlF_6$) and fluorspar ($CaF_2$).
- This process is used for ultra pure Ge element. An ingot of Ge is first purified by zone refining. Then a small amount of antimony is placed in the molten zone which is passed through the pure Ge with the proper choice of rate of heating and other variables.

**16.** *(d)*
- Novalgin (Dipyrone) is a non-narcotic analgesic used as pain reliever.
- Penicillin is an antibiotic used for curing rheumatic fever.
- Streptomycin is an antibiotic drug.
- Chloromycetin is an antibiotic drug.

**17.** *(a)* Phosphinic acid



Phosphonic acid



Due to the presence of one replaceable proton in phosphinic acid, it is monoprotic acid. And due to presence of two replaceable proton in phosphinic acid, it is diprotic acid.

**18.** *(c)* $\text{Hybridisation} = \dfrac{\text{Number of } \sigma\text{-electrons}}{2}$

$$= \frac{2 + 2\ (\text{negative ion})}{2} = 2 = sp$$

Hence, in the carbanion, $CH_3C \equiv C^{\ominus}$, pair of electron as (–)ve charge is present in *sp*-hybridised-orbital.

**19.** *(a)* As the number of lone pair of electrons on central element increases, repulsion between those lone pair of electrons increases and therefore, bond angle decreases.

| Molecules | Bond angle |
|---|---|
| $CH_4$ (no lone pair of electrons) | 109.5° |
| $NH_3$ (one lone pair of electrons) | 107.5° |
| $H_2O$ (two lone pair of electrons) | 104.45° |

**20.** *(c)* When $SO_2$ is passed through acidified $K_2Cr_2O_7$ solution, green chromium sulphate is formed. In this reaction, oxidation state of Cr changes from +6 to +3.

$$\underset{\text{OS of Cr}=+6}{K_2Cr_2O_7} + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 + \underset{\substack{\text{OS of Cr}=+3\\ \text{Green}}}{Cr_2(SO_4)_3} + H_2O$$

The appearance of green colour is due to the reduction of chromium metal.

**21.** *(b,d)* We have the Gibbs Helmholtz reaction for spontaneity as

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

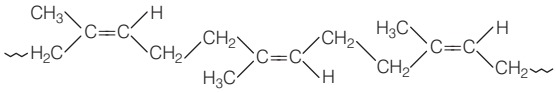
For reaction to be spontaneous, $\Delta G$ must be negative.

For this, $\Delta H$ should be negative and $\Delta S$ should be positive.

$\therefore$ $\Delta H < 0$ and $\Delta S > 0$.

and also $\Delta S = 0$ shows $\Delta G$ a negative quantity.

**22.** *(d)* The repeating unit in natural rubber has the *cis*-configurations with chain extensions on the same side of the ethylene double bond, which is essential for elasticity. If the configuration is *trans*, the polymer is either a hard plastic or a substance like *gutta-percha*.



Natural rubber
All *cis*-configuration

**23.** *(a,b)*

First ionisation energy is the energy required to remove an electron from outermost shell.

Hence, correct order is B < C < O < N.

For option (b)

Electron gain enthalpy is the energy required to gain an electron in the outermost shell.

Hence, the correct order is I < Br < F < Cl.

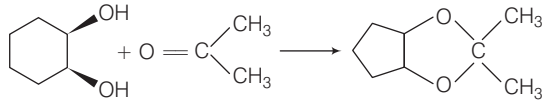
For option (c)

As we move down the group in alkali metal, metallic radius increases Li < Na < K < Rb.

For option (d)

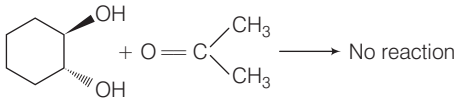
In case of isoelectronic species, as positive charge decreases or negative charge increases the ionic size of the species increases and *vice-versa* $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$.

**24.** *(d)* *cis*-cyclopenta-1, 2-diol when reacts with acetone, forms cyclic ketal whereas *trans*-isomer of cyclopenta-1, 2-diol can not form cyclic ketal.



*cis* – cyclopenta -1, 2-diol — Acetone — Cyclic ketal

But,



*Trans*-cyclopenta -1, 2-diol

**25.** *(d)* When calcium carbide ($CaC_2$) reacts with nitrogen ($N_2$) under high temperature, it forms calcium cyanamide which is also called nitrolim.

$$CaC_2 + N_2 \xrightarrow[\text{temperature}]{\text{High}} \underset{\text{Calcium cyanamide}}{CaCN_2} + C$$

Hence, option (d) should be $CaCN_2$ instead of $Ca(CN)_2$.

**26.** *(d)* Fog is a colloidal solution of liquid in a gas, in which liquid is the dispersed phase whereas gas is the dispersion medium. Examples of other options are as follows:

Gas in liquid : Shaving cream, soda water froth

Solid in gas : Dust in air

Gas in gas : Atmospheric air.

**27.** *(a)* As the size increases, bond dissociation enthalpy becomes lower. Also, as the size of atoms get smaller, ion pairs on the two atoms get close enough together to experience repulsion. In case of $F_2$, this repulsion is bigger and bond becomes weaker.

Hence, the correct order is $Cl_2 > Br_2 > F_2 > I_2$.

**28.** *(d)* Given, number of moles of hydrogen ($n_{H_2}$) and that of oxygen ($n_{O_2}$) are equal.

∴ We have, the relation between ratio of number of moles escaped and ratio of molecular mass.

$$\frac{n_{O_2}}{n_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}}$$

where, $M$ = Molecular mass of the molecule.

$$\Rightarrow \quad \frac{n_{O_2}}{n_{H_2}} = \sqrt{\frac{2}{32}}$$

$$\Rightarrow \quad \frac{n_{O_2}}{n_{H_2}} = \sqrt{\frac{1}{16}}$$

$$\Rightarrow \quad \frac{n_{O_2}}{0.5} = \frac{1}{4}$$

$$\Rightarrow \quad n_{O_2} = \frac{0.5}{4} = \frac{1}{8}$$

**29.** *(a)* Given, Li has a bcc structure.

Density ($\rho$) = 530 kg-m$^{-3}$

Atomic mass ($M$) = 6.94 g mol$^{-1}$

Avogadro's number ($N_A$) = $6.02 \times 10^{23}$ mol$^{-1}$

We know that, number of atoms per unit cell in bcc ($Z$) = 2.

∴ We have the formula for density,

$$\rho = \frac{ZM}{N_A a^3}$$

where $a$ = edge-length of a unit cell.

$$\text{or } a = \sqrt[3]{\frac{ZM}{\rho N_A}} = \sqrt[3]{\frac{2 \times 6.94 \text{ g mol}^{-1}}{0.53 \text{ g cm}^{-3} \times 6.02 \times 10^{23} \text{ mol}^{-1}}}$$

$$= \sqrt[3]{4.35 \times 10^{-23} \text{ cm}^{-3}}$$

$$= 3.52 \times 10^{-8} \text{ cm}$$

$$a = 352 \text{ pm}$$

**30.** *(d)* Since, component having higher vapour pressure will have higher percentage in vapour phase. Benzene has vapour pressure 12.8 kPa which is greater than toluene 3.85 kPa.

Therefore, the vapour will contain a higher percentage of benzene.

**31.** *(b)* As negative charge on metal carbonyl complex increases, back $\pi$-bonding increases and hence bond length of C—O bond increases while bond length of metal-carbon bond decreases.

Hence, $[Fe(CO)_4]^{2-}$ has longest C—O bond length among the given complexes.

The correct order of bond length of the given complexes is

$$[Mn(CO)_6]^+ < [Ni(CO)_4] < [Co(CO)_4]^- < [Fe(CO)_4]^{2-}$$

**32.** *(a)* As the oxidation state of halogen i.e. —Cl in this case increases, acidity of oxyacid increases.

HClO : Oxidation state of Cl = +1

$HClO_2$ : Oxidation state of Cl = + 3

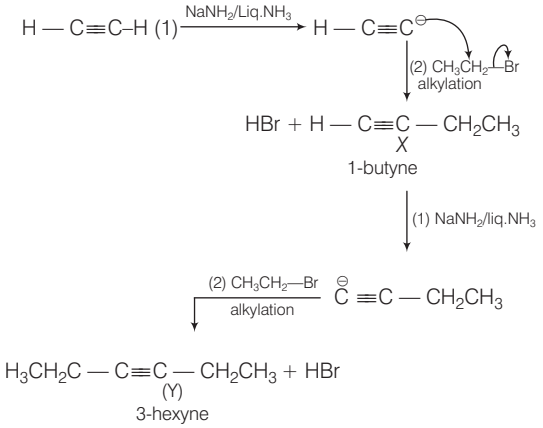
$HClO_3$ : Oxidation state of Cl = + 5

$HClO_4$ : Oxidation state of Cl = + 7

Therefore, the correct order of acidity would be

$$HClO < HClO_2 < HClO_3 < HClO_4$$

**33.** *(d)* Since, $NaNH_2$/liq.$NH_3$ behaves as a base, so it abstracts proton from acetylene to form acetylide anion followed by alkylation to give compound (*X*) i.e. 1-butyne. (*X*) further reacts with $NaNH_2$/liq. $NH_3$ followed by alkylation with ethyl bromide yields 3-hexyne (*Y*).




**34.** *(a)* For $MY$,

$$\underset{0}{MY} \rightleftharpoons \underset{s}{M^+} + \underset{s}{Y^-}$$

where, $s$ = solubility and $K_{sp}$ = solubility product.

$\therefore \quad K_{sp} = [M^+]\,[Y^-]$

$$K_{sp} = s^2$$

$$s = \sqrt{K_{sp}} = \sqrt{6.2 \times 10^{-13}}$$

$$= 7.874 \times 10^{-7}$$

Similarly, for $NY_3$,

$$\underset{0}{NY_3} \rightleftharpoons \underset{s}{N^+} + \underset{3s}{3Y^-}$$

$\therefore \quad K_{sp} = [N^+]\;[Y^-]^3$

$$= s \times (3s)^3$$

$$K_{sp} = 27s^4$$

$\therefore \quad s = \sqrt[4]{\frac{K_{sp}}{27}} = \sqrt[4]{\frac{6.2 \times 10^{-13}}{27}}$

$$= 3.89 \times 10^{-4}$$

Therefore, molar solubility of $MY$ in water is less than that of $NY_3$.

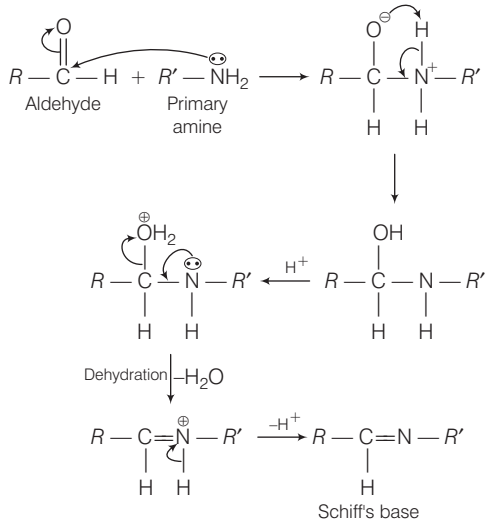
**35.** *(a)* In the nitration of benzene in the presence of conc. $H_2SO_4$ and $HNO_3$, nitrobenzene is formed.

$$HNO_3 + H_2SO_4 \rightleftharpoons \underset{\text{Electrophile}}{NO_2^+} + \underset{\text{Nucleophile}}{HSO_4^-} + H_2O$$

If large amount of $KHSO_4$ is added to this mixture, more $HSO_4^-$ ion furnishes and hence the concentration of $NO_2^+$, i.e. electrophile decreases.

As concentration of electrophile decreases, rate of electrophilic aromatic reaction slows down.

**36.** *(d)*




**37.** *(d)* From the question, we have an equation

$$2H^+ + 2e^- \longrightarrow H_2(g)$$

According to Nernst equation,

$$E = E^\circ - \frac{0.0591}{2} \log \frac{p_{H_2}}{[H^+]^2}$$

$$= 0 - \frac{0.0591}{2} \log \frac{p_{H_2}}{(10^{-7})^2}$$

$$[\because\; [H^+] = 10^{-7}]$$

$\therefore$ For potential of $H_2$ electrode to be zero, $p_{H_2}$ should be equal to $[H^+]^2$, i.e. $10^{-14}$ atm.

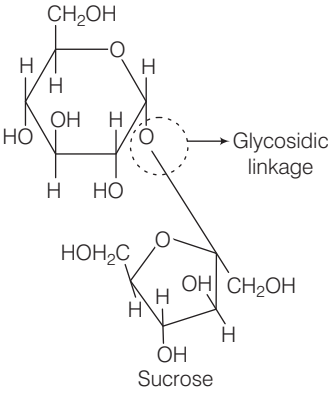
$$\therefore \qquad \log \frac{10^{-14}}{(10^{-7})^2} = 0$$

**38.** *(a)* In DNA, two helically twisted strands connected together by steps. Each strand consists of alternating molecules of deoxyribose at 2′-position and phosphate groups.

On the other hand, in RNA, the pentose sugar has an identical structure with deoxyribose sugar except that there is an —OH group instead of —H on carbon atom 2′.

Hence, it is only called ribose.

**39.** *(c)* Sucrose is non-reducing sugar because reducing part of glucose ($-\overset{\overset{O}{\|}}{C}-H$) and fructose ($>C=O$) are involved in glycosidic linkage.




While, lactose, glucose and maltose are reducing sugars.

**40.** *(c,d)*

- For ionic salts, hydrogen never behaves as cation, but behaves as anion ($H^-$).
- $H_3O^+$ exists freely in solution.
- Dihydrogen acts as a reducing agent.
- Hydrogen has three isotopes.

  Protium ($^1_1H$)

  Deuterium ($^2_1H$)

  Tritium ($^3_1H$)

  Protium is the most common isotopes of hydrogen with an abundance of 99.98%.

**41.** *(c)* The given phase equilibria is

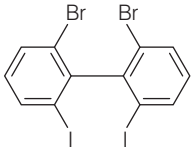
$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

This equilibrium states that, when liquid is heated, it converts into vapour but on cooling, it further converts into liquid, which is derived by Clausius Clapeyron and the relationship is written as,

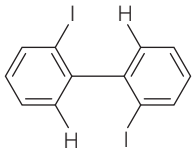
$$\frac{d\ln p}{dT} = -\frac{\Delta H_v}{RT^2}$$

where, $\Delta H_v$ = Heat of vaporisation

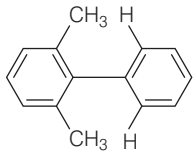
**42.** *(a)* The biphenyl compounds having proper substitution at *ortho*-position of benzene rings resulting steric hindrance. This steric hindrance makes the biphenyl system non-planar and hence optically active compounds.



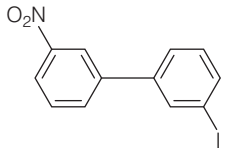

- Proper substitution
- Restricted rotation about single bond




- Improper substitution




- Improper substitution




- No bulkier group present at *ortho* position arising improper substitution

**43.** *(b)*

- $Ca^{2+}$ ions are very important factor in blood clotting.
- $Ca^{2+}$ ions are very important for maintaining the regular heart beating.
- $Mg^{2+}$ ions is present in the green parts of plants i.e., chlorophyll.
- $Mg^{2+}$ can form a complex with ATP.

**44.** *(d)*

Given, ionic radius of cation $(A^+) = 0.98 \times 10^{-10}$ m

Ionic radius of anion $(B^-) = 1.81 \times 10^{-10}$ m

$\therefore$ Coordination number of each ion in $AB$ = ?

Now, we have

$$\text{Radius ratio} = \frac{\text{Radius of cation}}{\text{Radius of anion}} = \frac{0.98 \times 10^{-10}\ \text{m}}{1.81 \times 10^{-10}\ \text{m}}$$

$= 0.541$

If radius ratio range is in between 0.441 – 0.732, ion would have octahedral structure with coordination number 'six'.

**45.** *(d)* Given, order of reaction = 1

Rate of reaction at 10 s = 0.04 mol $L^{-1}$ $s^{-1}$

Rate of reaction at 20 s = 0.03 mol $L^{-1}$ $s^{-1}$

$\therefore$ Half-life period $(t_{1/2})$ = ?

We have the equation for rate-constant '$k$' in first order reaction.

$$k = \frac{2.303}{t} \log \frac{A_t}{A_0}$$

$$= \frac{2.303}{105} \log \frac{0.04}{0.03}$$

$$= \frac{2.303}{105} \times 0.124$$

$$k = 0.028\ s^{-1}$$

We know that,

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

$$= \frac{0.693}{0.028773391\ s^{-1}} = 24.14\ s \approx 24.1\ s$$

# Biology

**1.** *(d)* Reptiles have 3-chambered heart except crocodiles. Mammals are viviparous except prototherian mammals; chordates have jaws except protochordates and cyclostomes.

**2.** *(d)* High levels of estrogen and progesterone give negative feedback to hypothalamus for the release of GnRH. Thus, inhibiting the gonadotropin release.

**3.** *(a)* Microtubules are structures present in cilia, flagella, centrioles and spindle fibres. They are also the part of fibres found in cytoskeleton.

**4.** *(b)* Mitochondria and chloroplast are semi-autonomous organelles which contains DNA, ribosomes (70s), etc. They are capable of self-replication so called semi-autonomous.

**5.** *(a)* Photosensitive pigment rhodopsin in human eye is made up of opsin protein and retinal [aldehyde form of vitamin-A (Retinol)]. These pigments are present in the rod cells of retina layer of eye.

**6.** *(a)* All single celled eukaryotic organisms-like chrysophytes [diatoms and desmids], euglenoids *[Euglena]*, dinoflagellates and slime moulds are included in kingdom–Protista.

**7.** *(b)* Methanogens are group of obligate anaerobic ancient and primitive bacteria. They are involved in methanogenesis and produce methane gas in ruminant of cattles.

**8.** *(a)* Inhibin is produced by granulosa cells of ovarian follicles in the ovary and has negative feedback effect on the secretion of FSH.

**9.** *(a)* Basal metabolic rate is inversely proportional to body size. So smaller animals have a higher metabolic rate, thus have quick and more energy required to go up the hills.

**10.** *(d)* Parents – TT × tt
(Tall) (Dwarf)
$F_1$-generation Tt (Heterozygous tall)
On selfing

| Pollen → T | | t |
|---|---|---|
| Egg T | TT (Tall) | Tt (Tall) |
| t | Tt (Tall) | tt (dwarf) |

$F_2$-generation

**Phenotypic ratio** = 3 : 1 [Tall : Dwarf]

**Genotypic ratio** ⇒ 1 : 2 : 1

[Homozygous tall : Heterozygous tall : Dwarf]

**11.** *(a)* Ozone is found in the upper part of the atmosphere called stratosphere and it acts as a shield absorbing ultraviolet radiation from sun. So its depletion can lead to incidence of skin cancers caused by harmful solar radiations which will reach earth in the absence of $O_3$ layer.

**12.** *(a)* Cropland ecosystem is largest anthropogenic ecosystem characterised by less diversity and high productivity.

**13.** *(d)* Liliaceae represents $G_{(3)}$. This family includes plants-like garlic, onion, tulip, *indigo*, etc.

**14.** *(c)* None of the option is correct w.r.t. question. The option (a) seems to be more appropriate.

None of the option consist of all three macronutrients, But option (c) have nitrogen and phosphorus which are macronutrients, but nickel is a micronutrients.

**15.** *(b)* Reduction in pH of blood i.e., increase in acidity favours the dissociation of oxyhemoglobin thereby giving upmore $O_2$. When this

phenomenon occurs due to increase in $CO_2$ concentration then it is called Bohr effect.

**16.** *(b)* Sustained muscle contraction due to repeated stimulus is known as tetanus. This results due to muscle fatigue.

**17.** *(b)* *Eubacteria* are true bacteria which exhibit all true characteristic features of group *Eubacteria*.

**18.** *(d)* *Hind* II is a restriction endonuclease. Restriction endonucleases are enzymes used for cutting of DNA at specific locations.

*Hind* II was the first restriction endonuclease isolated by Smith Wilcox and Kelley in 1968. It was found that it always cut DNA molecules at a particular point by recognising a specific sequence of six base pairs.

**19.** *(d)* In primary succession on rocks, lichens secrete acids to dissolve rock, helps in weathering and soil formation. So, lichens are pioneer species to colonize the bare rock.

**20.** *(a)* Diffusion of water vapour and $CO_2$ are independent process. Their diffusion depends on the difference in their partial pressure in the atmosphere as well as inside the leaves.

**21.** *(c)* Large, shield shaped cotyledon of grass family is called scutellum. Coleorhiza is a sheath protecting the root of germinating grass.

Coleoptile is a sheath covering emerging shoot. Plumule is rudimentary shoot of an embryo plant.

**22.** *(c)* Sphincter of Oddi guards the opening of hepatopancreatic duct into the duodenum. Hepatopancreatic duct brings secretion of liver as well as pancreas to the duodenum.

**23.** *(a)* In stomach, gastric acid (HCl) is secreted by parietal cells of gastric gland. It makes the medium of food in stomach acidic for stimulation of proteolytic enzymes of stomach.

**24.** *(b)* Urea is synthesised in liver. So, maximum amount of urea is present in hepatic vein and minimum in renal vein.

**25.** *(a)* The term ecosystem was coined by AG Tansley in 1935. Ecosystem is a self regulated and self sustaining structural and functional unit of nature. It consists of living beings and their physical environment.

**26.** *(b)* *Lac* operon is an inducible operon. Lactose is the substrate for the enzyme β-galactosidase and it also regulates switching on and off of the operon. Hence, it is termed as inducer.

**27.** *(c)* Butyric acid is produced by fermentive activity of the bacteria called *Clostridium butylicum*. It does not produce lipase. Lipase is obtained from *Candida albicans*.

**28.** *(d)* In logistic growth model population growth equation is described as

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

where, $N$ = Population density at time $t$

$r$ = Intrinsic rate of natural increase

$K$ = Carrying capacity

when, $\frac{N}{K} = 1$ then $\frac{K-N}{K} = 0$

Therefore, $\frac{dN}{dt} = 0$

**29.** *(d)* Tapetum is the inner layer of microsporangium (anther) which provides nourishment to developing pollen grain after meiotic cell division.

**30.** *(c)* In several primitive simple plants–like algae, bryophytes and pteridophytes, water is the medium through which male gametes are transferred to the female reproductive organ orgamete to bring about fertilisation.

**31.** *(d)* Pitcher of *Nepenthes* is modified leaf. It helps to trap insects, in insectivorous plants.

**32.** *(b)* Nuclei, mitochondria and chloroplasts are all double membrane bound organelles. Lysosomes are single membrane bound organelle.

**33.** *(a)* Analogous structures are a result of convergent evolution. When organisms with completely different organisation, living in the same habitat come to possess superficial resemblance, this is known as convergent evolution.

**34.** *(c)* Glycine is the simplest amino acid in which functional group '*R*' is replaced by hydrogen atom (H).

**35.** *(c)* A typical stamen consist of anther and filament. The proximal end of filament is attached to thalamus or petal of the flower whereas distal end bears anther.

**36.** *(a)* A zinc finger is a small protein structural motif that is characterised by the co-ordination of one or more Zn ions in order to stabilise the folds.

**37.** *(b)* Mammals are viviparous while birds are oviparous. Viviparous means giving birth to offspring that develops within the mother's body. Oviparous means producing eggs that hatch outside the body of mother.

**38.** *(b)* In follicular phase of menstrual cycle, LH and FSH increase gradually and stimulate follicular development as well as secretion of estrogens by the growing follicles.

**39.** *(d)* Melatonin and serotonin are derivatives of tryptophan amino acid while thyroxine and tri-iodothyronine are iodinated tyrosine amino acid derivatives.

**40.** *(b)* Joint Forest Management Concept was introduced in India during 1980s by the Government of India to work closely with the local communities for protection and management of forests.

**41.** *(d)* Cell wall of most fungi is made up of chitin. Chemically it is N-acetyl glucosamine. It is also found in the exoskeleton of insects.

**42.** *(d)* In prokaryotes, several ribosomes may attach to single *m*RNA and form a chain called polyribosomes or polysomes.

**43.** *(b)* Parapodia are present in aquatic annelids like *Nereis,* which help them in swimming. Other three features i.e. metameric segmentation, jointed appendages and chitinous exo-skeleton are present in Phylum Arthropoda. Out of these Metameric segmentation is visible as Tagmetization.

**44.** *(a)* Asthma is an allergic reaction characterised by spasm of bronchi muscles because of effect of histamine released by mast cells.

**45.** *(c)* Sickle cell anaemia is an autosomal recessive gene disorder in which sickle celled RBCs are formed instead of normal ones. They carry very less content of $O_2$ as their haemoglobin is malformed. The person suffering from this disease show symptoms of anaemia.

**46.** *(c)* In humans, insulin is produced by β-cells of pancreas. It is synthesised as prohormone in which two polypeptides are synthesised with an extra stretch of 'C' polypeptide. During maturation extra stretch of 'C' polypeptide is separated and two polypeptide chains (A and B) are linked together by disulphide linkages (bridges).

**47.** *(c)* Coconut milk represents free-nuclear endosperm where the division of primary endosperm nucleus is not followed by formation of cell walls (cytokinesis) thus all nucleus remain free in liquid form. It is rich in plant hormone cytokinin.

**48.** *(c)* Plasmid is extrachromosomal, double stranded, circular DNA, found in bacterial cells and some yeasts. Discovery of plasmid has led to the revolution in biotechnological research.

**49.** *(a)* River dolphin is the National Aquatic Animal of India. This mammal exclusively reside in freshwater or brackish water.

**50.** *(b) Bioassay* is a quantitative and qualitative test used to determine the nature and function of a biochemical by using living material e.g., *Avena* curvature test is used as bioassay usually for auxins (Indole Acetic Acid).

**51.** *(b)* There are four major causes of biodiversity loss in which most important cause driving animals and plants to extinction is habitat loss and fragmentation.

**52.** *(c)* In vasectomy, a small part of the vas-deferens is removed or tied up through a small incision on the scrotum in males. Vasectomy blocks the gamete transport and does not affect spermatogenesis.

**53.** *(b)* When two genes in a dihybrid cross are situated on the same chromosome, the proportion of parental gene combinations are much higher than the non-parental or recombinant type as linked genes are inherited together in offspring.

**54.** *(a)* A typical fat molecule is triglyceride formed by esterification of one glycerol and three fatty acid molecules. The three fatty acids can be of same type or different depending on the type of the fat molecules.

**55.** *(a)* Dominance – Expression of only one allele in a heterozygous organism.

– Side by side full expression of both alleles. $F_1$ resembles both parents.

– Single gene can exhibit multiple phenotypic expression e.g. Phenylketonuria.

Polygenic

**56.** *(d)* Pollen grains of different species are incompatible, so they fail to germinate. Only the pollen of the same species germinate and can form pollen tube which grows and finally dispatches male gamete to embryo sac.

**57.** *(a)* Cockroach has determinate cleavage during embryonic development and it develops into nymph, which is a fully developed cockroach except its size as it is much smaller than the adult one.

**58.** *(c)* Anthocyanins are water soluble vacuolar pigments that may appear red, purple or blue depending on pH. It is impermeable to cell membranes of plants and can leak out only when membrane is damaged or dead.

**59.** *(a)* Polyploid cells have a chromosome number that is more than double the haploid number e.g. *Triticum aestivum* (wheat) is a hexaploid ($6n$)).

**60.** *(a)* This plant is a $C_4$ plant as these group of plants shows little photorespiration, efficient in binding to $CO_2$ even at low concentrations, better utilisation of water as well as high rates of photosynthesis even at high temperatures, i.e. tropical region. Besides, they can also tolerate excess of salts due to presence of organic acids.

**61.** *(b)* In auto-immune disease, the immune cells are unable to distinguish between self-cells and non-self cells and attack self-cells which may lead to auto-immune disorders like interstitial lung disease in humans.

**62.** *(a)* Emerson performed photosynthetic experiment on *Chlorella*. He provided monochromatic light of more than 680 nm and observed decrease in rate of photosynthesis known as red drop.

Later, he provided synchronised light of 680 nm and 700 nm and observed increase in rate of photosynthesis, known as enhancement effect. This experiment led to discovery of two photosystems –PS-I and PS-II operating in photosynthesis.

**63.** *(b) Sequoia* is one of the tallest tree species, known as red wood tree. It is a gymnospermic plant.

*Salvinia* is an angiosperm, but *Ginkgo* and *Pinus* are gymnosperms. Gymnosperms are well adapted to extremes of climate and are heterosporous.

**64.** *(c)* Synapsis is pairing of homologous chromosomes. It occurs during zygotene stage of meiosis. The homologous chromosomes come closer leading to cross over in the next stage called pachytene. These are not observed during mitosis.

**65.** *(b)* Blood pressure in different blood vessels :
Artery > Arteriole > Capillary > Venule > Vein (vena cava)

The pulmonary arteries have thicker smooth muscle and connective tissue then the pulmonary veins to accomodate the higher pressure and speed of blood.

**66.** *(c)* Wings of bird and flipper of whale are modified fore limbs of the two organisms so have same origin wings help in flying and flippers help in swimming, but thus perform the different functions.

**67.** *(c)* Apomixis is a special mechanism found in flowering plants to produce seeds without fertilisation. It is a type of asexual reproduction which mimics the sexual reproduction and is commonly found in *citrus* varieties.

**68.** *(d)* Emphysema is characterised by inflation or distension of alveoli by dissolution of wall of the two adjacent lung alveoli. It generally occurs due to chronic cigarette smoking.

**69.** *(a)* Spindle fibres attach to kinetochores of chromosomes during cell division. They help the chromosomes/chromatids to get separated to the two daughter cells, towards opposite poles.

**70.** *(c)* Cleft palate is a developmental abnormality which may occur in the developing faetus and so it can be detected by sonography, not by amniocentesis.

Amniocentesis is being misused for foetal sex determination test so it is banned in India.

**71.** *(b)* Phylloclades are aerial modified stem, in which stem becomes thick, fleshy succulent, green and perform the function of photosynthesis. The leaves are reduced to spines in this.

**72.** *(a)* Proton concentration is higher in the lumen of thylakoid due to photolysis of water, $H^+$ pumping and NADP reductase activity which occurs in stroma of the chloroplast.

**73.** *(d)* Biological names originate from latin language and are printed in italics.

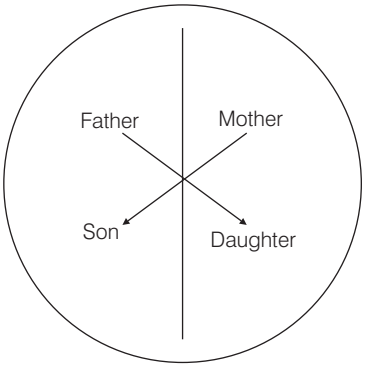
**74.** *(d)*

| | | |
|---|---|---|
| Leptotene | — | Condensation of chromatin |
| Zygotene | — | Synapsis of homologous chromosomes |
| Pachytene | — | Crossing over |
| Diplotene | — | Dissolution of synaptonemal complex and appearance of chiasmata |
| Diakinesis | — | Terminalisation of chiasmata |

**75.** *(c)* Oral polio vaccine consists of attenuated pathogens. Attenuated pathogens are living micro-organisms or viruses cultured under adverse condition, leading to loss of their virulance. But these organisms have the ability to induce protective immunity. The oral vaccine of polio contains three live polio strains in attenuated forms.

**76.** *(d)* *Taq* polymerase is a thermostable DNA polymerase obtained from *Thermus aquaticus*. *Thermus aquaticus* is a bacterium that lives in hot springs and hydrothermal vents.

**77.** *(a)* Haemophilia is X-linked recessive gene disorder. It is a blood clotting disorder and shows criss-cross inheritance. In this, characters from father are transmitted to daughter and from mother to son.




**78.** *(b)* The standard or large upper petal of a papilionaceous corolla is also called vexillum.

**79.** *(c)* *Meloidegyne incognitia* is a nematode, which infects roots of tobacco plant and results in root knot disease.

**80.** (c) Viroids are infectious, non-protein-coding, highly structured with small circular RNA's, which have the ability to replicate autonomously. These contain RNA of low molecular weight and induce diseases in higher plants.

**81.** *(c)* Cancerous cells have high telomerase activity. The maintenance of telomere stability is required for the long term proliferation of tumors. This makes telomerase a target not only for cancer diagnosis but also for the development of novel anti-cancer therapeutic agents, e.g. telomerase inhibitors are used in cancer treatment.

**82.** *(d)* Columnar epithelium is present in the lining of stomach.

Tendon is dense connective tissue and connects muscle to bone. Tip of nose consists of elastic cartilage.

**83.** *(c)* Relaxin hormone which is secreted by posterior pituitary gland relaxes the pubic symphysis during parturition while inhibin decreases the secretion of FSH from anterior pituitary.

**84.** *(a)* Few epidermal cells, in the vicinity of the guard cells become specialised in their shape and size and are known as subsidiary cells. These cells are devoid of chloroplasts.

The stomatal aperture, guard cells and the surrounding subsidiary cells are together called

**85.** *(a)* Fertilisation in humans, is practically feasible only if the sperms and ovum are transported simultaneously at ampullary-isthmic junction of Fallopian tube.

**86.** *(d)* AUG is the start codon. It also codes for amino acid called methionine which is the first amino acid in a polypeptide chain. UAA, UAG and UGA are stop codons and are meant for termination of polypeptide chain during protein synthesis.

**87.** *(c)* A river with an inflow of domestic sewage rich in organic waste will reduce the dissolved oxygen (DO). The organic waste will increase biological oxygen demand of the river thus depleting the $O_2$ content and may result in death of fish due to lack of oxygen.

**88.** *(b)* The earliest organisms that appeared on earth were anaerobic chemoautotrophs.

Chemoautotrophs were the first autotrophic organisms They were unable to perform photolysis of water and never released oxygen, e.g. sulphur bacteria.

**89.** *(d)* Ley farming is a system of rotating crops with legumes or grass pasture in order to improve soil structure and fertility and also to disrupt pest and disease life cycles.

**90.** *(b)* Gause's principle of competitive exclusion states that no two species can occupy the same niche indefinitely for the same limiting resources.