

PHYSICS

Section A

1. (c)

As we know, S.I unit of magnetic permeability is H/m.

$$\text{i.e., } [\mu] = \frac{[H]}{[L]} \dots (\because [H] = [ML^2T^{-2}A^{-2}])$$

$$\therefore [\mu] = [MLT^{-2}A^{-2}]$$

Thus, the dimensional formula of magnetic permeability is $[MLT^{-2}A^{-2}]$

2. (d)

Given that,

$$n_1 = 2$$

$$n_2 = 2$$

Now, as we know energy of electrons in n^{th} excited state will be.

$$E_n = \frac{E_0}{n^2}$$

Thus, for the given case the ratio of first excited state (T_1) and second excited state (T_2) is given as

$$\Rightarrow \frac{T_1}{T_2} = \frac{\frac{E_0}{4}}{\frac{E_0}{9}} = \frac{9}{4}$$

3. (c)

As we all know, as the temperature rises, so does the conductivity of the conductor, and thus the electrical resistance. The resistivity of a semiconductor, on the other hand, decreases with temperature. As a result, the electrical resistance of the semiconductor decreases.

4. (b)

Given that,

$$\text{Radius, } r = 1\text{mm} = 10^{-3}\text{ m}$$

$$\text{Number of turns, } N = 100$$

$$\text{Current, } I = 1\text{ A}$$

Now, the magnetic field at centre of solenoid will be

$$B = \mu_0 \frac{N}{l} I = \mu_0 n l \dots \left[\because n = \frac{N}{l} \right]$$

$$= 4\pi \times 10^{-7} \times \frac{100}{10^{-3}} \times 1$$

$$= 4\pi \times 10^{-2} T$$

$$B = 12.56 \times 10^{-2} T$$

5. (d)

Given that,

$$\text{Frequency of monochromatic light 1, } \nu_1 = \nu$$

$$\text{Stopping potential of metal 1, } V_1 = V_s/2$$

$$\text{Frequency of monochromatic light 2, } \nu_2 = \nu/2$$

$$\text{Stopping potential of metal 1, } V_2 = V_s$$

Now,

According to Einstein's equation of photoelectric effect.

$$K.E_{\text{max}} = eV_s = h\nu - \phi$$

$$\frac{eV_s}{2} = h\nu - h\nu_0 \dots (i)$$

$$eV_s = \frac{h\nu}{2} - h\nu_0 \dots (ii)$$

$$\frac{1}{2} \left[\frac{h\nu}{2} - h\nu_0 \right] = h\nu - h\nu_0$$

$$\Rightarrow h\nu_0 - \frac{h\nu_0}{2} = h\nu - \frac{h\nu}{4}$$

$$\Rightarrow \frac{h\nu_0}{2} = \frac{3h\nu}{4}$$

$$V_0 = \frac{3v}{2}$$

* Language of question is wrongly framed. The values of stopping potentials should be interchanged.

6. (d)

Waves	Wavelength
(a) AM radio waves	10^2 m
(b) Microwaves	10^{-2} m
(c) Infrared radiations	10^{-4} m
(d) X-rays	10^{-10} m

i.e., (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)

7. (b)

Given that,

$$R_1 = 100 \, \Omega$$

$$R_2 = 200 \text{ } \Omega$$

Now, as we know electric power is given as v^2

$$P = \frac{V^2}{R} \Rightarrow P \propto \frac{1}{R}$$

Thus, for the given case

$$\frac{P_1}{P_2} = \frac{R_2}{R_1}$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{200}{100} = \frac{2}{1}$$

8. (c)

Given that,

Mass on lift $m = 2000$

Friction force, $f = 3000 \text{ N}$

velocity, $v = 1.5 \text{ m/s}$

Now, minimum force needed to move lift upward

$$F_{up} = 2000g + 3000$$

$$= 23000 \text{ N}$$

Minimum power $P_{\min} = \vec{F} \cdot \vec{v}$

$$P_{\min} = Fv = 23000 \times \frac{3}{2} = 34500 \text{ W}$$

9. (c)

We know,

$$\text{RMS value of A.C. } E_{rms} = \frac{E_0}{\sqrt{2}}$$

$$E_0 = \sqrt{2}E_{rms}$$

10.(b)

As we know,

The moment of inertia of a solid disc rotating about the axis passing through its centre will be



$$I_1 = \frac{MR^2}{2}$$

$$k_1 = \sqrt{\frac{I_1}{M}}$$

$$= \frac{R}{\sqrt{2}} \dots (1)$$

Similarly, moment of inertia of solid disc rotating about its diameter will be.



$$I_2 = \frac{MR^2}{4}$$

$$K_2 = \sqrt{\frac{I_2}{M}}$$

$$= \frac{R}{2} \dots (2)$$

Thus, by dividing equation 1 and 2 we get

$$\frac{k_1}{k_2} = \frac{\frac{R}{\sqrt{2}}}{\frac{R}{2}}$$

$$= \sqrt{2} : 1$$

11. (c)

Given that,

Initial tension, $T_i = T$

Final tension, $T_f = 2T$

Now, as we know speed of transverse wave will be

$$v = \sqrt{\frac{T}{\mu}}$$

$$\therefore v_i = \sqrt{\frac{T}{\mu}} \text{ and } v_f = \sqrt{\frac{2T}{\mu}}$$

$$\therefore \frac{v_i}{v_f} = \frac{1}{\sqrt{2}}$$

12. (a)

$$\text{Plane angle} = \frac{\text{Arc}}{\text{Radius}} = \frac{[L]}{[L]} \rightarrow \text{Unit} = \text{Radian}$$

$$\text{Solid angle} = \frac{\text{Arc}}{(\text{Radius})^2} \rightarrow \text{Unit} = \text{Steradian}$$

$$= \frac{L^2}{L^2} = [M^0 L^0 T^0]$$

13. (c)

Given that,

Radii of curvature, $R_1 = R_2 = 20 \text{ cm} = 20 \times 10^{-2} \text{ m}$

Refractive index, $\mu = 1.5$

Now, as we know power of lens is given by

$$P = \frac{1}{f(m)}$$

$$\frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{f} = \left\{ \frac{3}{2} - 1 \right\} \left(\frac{1}{20} + \frac{1}{20} \right)$$

$$f = 20 \text{ cm}$$

$$P = \frac{1}{20 \times 10^{-2}}$$

$$= 5 \text{ D}$$

14. (d)

As we know, the relation between relative permittivity ϵ_r , relative permeability μ_r and the velocity of light v can be expressed as

$$v = \frac{1}{\sqrt{\epsilon_m \mu_m}}$$

$$v = \frac{1}{\sqrt{\epsilon_0 \epsilon_r \mu_0 \mu_r}}$$

$$\text{Since } c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

$$\Rightarrow v = \frac{c}{\sqrt{\epsilon_r \mu_r}}$$

15. (d)

Given that,

$$\theta_1 = 30^\circ$$

$$\theta_2 = 45^\circ$$

Now, as we know slope of displacement vs time curves gives the velocity

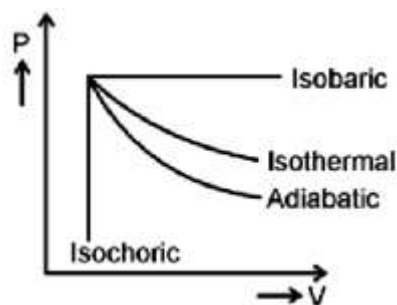
$$\Rightarrow \text{Ratio} = \frac{\tan 30^\circ}{\tan 45^\circ} = \frac{1}{\sqrt{3}} = 1 : \sqrt{3}$$

16. (b)

$$\left(\frac{dP}{dV} \right)_{\text{adiabatic}} = -\gamma P$$

$$\left(\frac{dP}{dV} \right)_{\text{isothermal}} = -P$$

$$\left(\frac{dP}{dV} \right)_{\text{adiabatic}} > \left(\frac{dP}{dV} \right)_{\text{isothermal}}$$



17. (c)

The following equation, which is applicable for infinitesimal elements, is used to determine the direction and magnitude of magnetic field according to Biot-law, Savart's

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{Idl \times \vec{r}}{r^3}$$

It is analogous to Coulomb's law, where $|\vec{d}|$ is a vector source and q is a scalar source.

Here statement I is correct and statement II is incorrect,

18. (b)

Potential of conducting hollow sphere = $\frac{KQ}{R}$

Now, Q = same

$$\Rightarrow V \propto \frac{1}{R} \Rightarrow \text{more the radius less will be the potential.}$$

$\Rightarrow$ Hence potential would be more on smaller sphere

19. (b)

Given that,

Mass of body, m = 60 g = 60/1000 kg

Gravitational force, F = 3 N

Now,

$$F = mE_G$$

$$3 = \frac{60}{1000} E_G$$

$$E_G = 50 \text{ N/kg}$$

20. (d)

$$\beta = \frac{\lambda D}{d}$$

Let length of segment of screen = l

$$\Rightarrow l = 8\beta_1 = \frac{8\lambda_1 D}{d} \dots\dots\dots(i)$$

$$\text{And } l = n\beta_2 = \frac{n\lambda_2 D}{d} \dots\dots\dots(2)$$

from (1) and (2)

$$8\lambda_1 = n\lambda_2$$

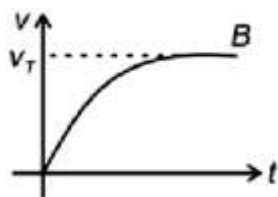
$$8(600\text{nm}) = n(400\text{nm})$$

$$n = 12$$

21. (b)

From the given condition we know that, the initial speed of ball is zero and it finally attains terminal speed.

Thus graph B is the correct representation of given case.



22.(c)

As we know,

$$dV = -\vec{E} \cdot d\vec{r}$$

$$dV = -E dr \cos \theta$$

For equipotential surface,

$$dV = 0$$

$$\cos \theta = 0$$

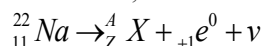
$$\Rightarrow \theta = 90^\circ$$

23.(c)

As we know, The negative half of an A.C cycle is removed from the sinusoidal pulse in a half wave rectifier, but the time lag between two positive pulses remains the same, so the frequency remains the same as the input (mains) frequency. As a result, the output frequency is the same as the input frequency

24.(c)

Given that,



From conservation of atomic number

$$11 = Z + 1 \Rightarrow Z = 10 \Rightarrow \text{Ne}$$

From conservation of mass number

$$22 = A + 0 \Rightarrow A = 22$$

$$\therefore {}_Z^A\text{X} = {}_{10}^{22}\text{Ne}$$

25.(a)

$$\text{Excess pressure inside the bubble} = \Delta P = \frac{4T}{R}$$

$$P_{in} = P_{out} + \frac{4T}{R}$$

as 'R' increases 'P' decreases

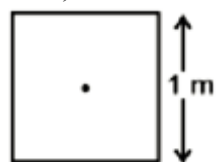
26.(b)

Given that, Area, $A = 1^2 \text{ m}^2$

Resistance, $R = 1 \Omega$

Magnetic field, $B = 0.5 \text{ T}$

Now,



$$\text{Magnetic flux } (\phi_B) = \vec{B} \cdot \vec{A}$$

$\vec{B}$ and $\vec{A}$ are in same direction, therefore

$$\phi_B = B \cdot A = 0.5 \times 1^2$$

$$= 0.5 \text{ Wb}$$

27.(c)

Given that,

Initial momentum = 0

Let the masses of 3 fragment be $2m$, $2m$, and m

$$\text{Momentum along x-direction} = 2mv \hat{i}$$

$$\text{Momentum along y-direction} = 2mv \hat{j}$$

$$= \sqrt{(2mv)^2 + (2mv)^2} = \sqrt{2} \cdot 2mv$$

Net momentum Now, $2\sqrt{2}mv = mv'$

$$v' = 2\sqrt{2}v$$

28.(d)

As we know, potential drops across p-n junctions will be the same if both junctions are forward biased or reverse biased.

Because both junctions in figures (a) and (c) are forward biased, they have the same potential. Because the first junction in figure (b) is forward biased and the second junction is reverse biased, their potential differences are different,

29.(a)

As we know,

$$\text{Power} = \frac{\text{Work}}{\text{time}} = \frac{\text{Energy}}{\text{time}}$$

$$\Rightarrow \text{Energy} = \text{Power} \times \text{time}$$

$$E = 100 \times 10^3 \times 3600$$

$$= 36 \times 10^7$$

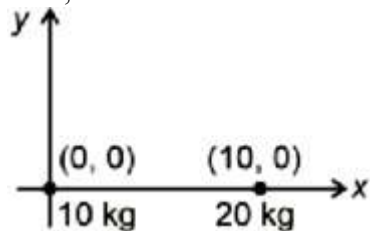
30. (b)

Given that,

Mass of object placed at x_1 , $m_1 = 10 \text{ kg}$

Mass of object placed at x_2 , $m_2 = 20 \text{ kg}$

Now,



$$X_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

$$= \frac{10 \times 0 + 20 \times 10}{10 + 20}$$

$$= \frac{200}{30}$$

$$= \frac{20}{3} m$$

31. (c)

Given $i = 60^\circ$ and $\mu = \sqrt{3}$

$\Rightarrow$ Here, angle of incidence $\Rightarrow i = \tan^{-1}(\mu)$

Hence, reflected and refracted rays would be perpendicular to each other.

32. (c)

$$S_{n^{th}} = u + \frac{1}{2} a (2n - 1)$$

$$S_{1^{st}} = \frac{1}{2} g (2 \times 1 - 1) = \frac{g}{2}$$

$$S_{2^{nd}} = \frac{1}{2} g (2 \times 2 - 1) = 3 \left(\frac{1}{2} g \right)$$

$$S_{3^{rd}} = \frac{1}{2} g (2 \times 3 - 1) = 5 \times \left(\frac{1}{2} g \right)$$

$$S_{4^{rd}} = \frac{1}{2} g (2 \times 4 - 1) = 7 \times \left(\frac{1}{2} g \right)$$

$$S_{1^{st}} : S_{2^{nd}} : S_{3^{rd}} : S_{4^{th}} \\ = 1:3:5:7$$

33.(d)

As we know, according to De Broglie equation for particle, the relation between wavelength and its linear momentum can be represented as shown below.



$$\lambda = \frac{h}{p}$$

$$\lambda \propto \frac{1}{p}$$

Thus, the correct option for the given case is D.

34.(d)

Given that,

Length, $l = 10 \text{ m}$

$$\text{Area, } \pi r^2 = \pi \left(\frac{10^{-2}}{\sqrt{\pi}} \right)^2$$

Now, as we know

$$R = \rho \frac{L}{A} = \frac{L}{\sigma A}$$

$$\Rightarrow \sigma = \frac{L}{RA}$$

$$\text{Current density, } j = \sigma E = \frac{LE}{RA}$$

$$j = \frac{10 \times 10}{10 \times \pi \left(\frac{10^{-2}}{\sqrt{\pi}} \right)^2} = \frac{100}{10 \times \pi \times \left(\frac{10^{-4}}{\pi} \right)}$$

$$= 10^5 \text{ A/m}^2$$

35.(b)

Given that,

$$\omega_i = 1200 \times \frac{2\pi}{60} \text{ rad / s}$$

$$\omega_f = 3120 \times \frac{2\pi}{60} \text{ rad / s}$$

Now, as we know

$$\text{Angular acceleration, } \alpha = \frac{\omega_f - \omega_i}{t}$$

$$\therefore \alpha = \frac{(3120 - 1200)}{16} \times \frac{2\pi}{60} = 4\pi$$

Section B

36.(c)

Given that,

Capacitance, $C = 900 \text{ pF} = 900 \times 10^{-12} \text{ F}$

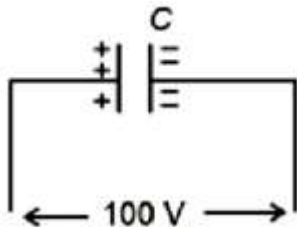
Voltage, $V = 100 \text{ V}$

Now,

We know that

$$C = \frac{Q}{V} \Rightarrow Q = CV$$

$$= 900 \times 10^{-12} \times 100 = 9 \times 10^{-8} \text{ C}$$



$$V = \frac{C_1 V_1 + C_2 V_2}{C_1 + C_2}$$

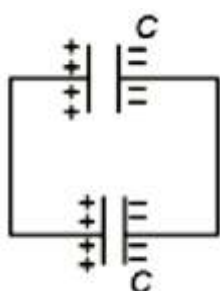
$$= \frac{9 \times 10^{-8} + 0}{1800 \times 10^{-12}} = \frac{100}{2} = 50 \text{ V}$$

$$U = \frac{1}{2} (C_1 + C_2) V^2$$

$$= \frac{1}{2} \times 1800 \times 10^{-12} \times 50 \times 50$$

$$= 225 \times 10^{-8}$$

$$U = 2.25 \times 10^{-6} \text{ J}$$



37. (c)

The Boolean equation for given logic gate is

$$C = (\overline{A.B}) . (\overline{\overline{A.B}})$$

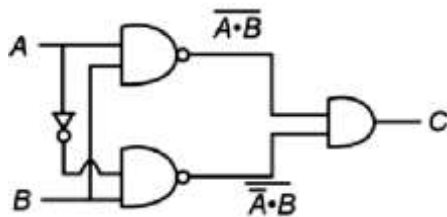
$$\Rightarrow C = \overline{A.B + \overline{A.B}}$$

$$\Rightarrow C = \overline{(A + \overline{A})B}$$

$$\Rightarrow C = \overline{B}$$

The truth table would be

A	B	C
0	0	1
0	1	0
1	0	1
1	1	0



38.(c)

As we know, It is true that stretching of spring is determined by shear modulus of the spring as when coil spring is stretched neither its length nor its volume changes, there is only change in its shape, Tensile strength of steel is more than that of copper. Hence Assertion is true and reason is false.

As we all know, stretching of string is determined by the shear modulus of the spring because when a coil spring is stretched, neither its length nor volume changes, only its shape changes. Also, we must note that, Steel has higher tensile strength than copper as a result, thus we can conclude that for the given case assertion is correct while reasoning is incorrect,

39.(b)

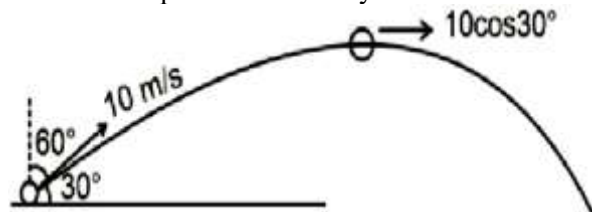
Given that,

Initial velocity, $u = 10 \text{ m/s}$

Angle of projection, $\theta = 60^\circ$

Now, as we know

Vertical component of velocity becomes zero at the highest point,



i.e., at highest point speed of object

$$= 10 \times \cos 30^\circ$$

$$= 5\sqrt{3} \text{ ms}^{-1}$$

40. (d)

Given that,

Mass of water, $m = 4.5 \text{ kg}$

$T = 273 \text{ K}$

$P = 10^5 \text{ N/m}^2$

Now,

As we know, from ideal gas equation

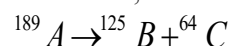
$$PV = nRT \dots \left[\because n = \frac{\text{mass of water}}{\text{mol.wt}} = \frac{4.5 \times 10^3}{18} \right]$$

$$V = \frac{nRT}{p}$$

$$V = \frac{4.5 \times 10^3}{18} \times \frac{8.3 \times 273}{10^5} = 5.66 \text{ m}^3$$

41. (c)

Given that,



As we know, the relation between radius of nuclei and its mass number A is given as

$$R = R_0 A^{1/3}$$

$$\frac{R_1}{R_2} = \left(\frac{125}{64} \right)^{1/3} = \frac{5}{4} = 5:4$$

42.(b)

Now, for the given case we know that, $R \gg L$,

Thus, given arrangement is an electric dipole

$$E = \frac{2p}{4\pi\epsilon_0 R^3} \dots (\because p = qL)$$

$$\text{i.e., } E \propto \frac{1}{R^3}$$

43.(b)

$$(a) [G] = \frac{Fr^2}{m_1 m_2}$$

$$[G] = \frac{Fr^2}{m_1 m_2} = \frac{[MLT^{-2}][L^2]}{[MM]} = [M^{-1}L^3T^{-2}]$$

$$(b) \text{ Gravitational potential energy } [ML^2T^{-2}]$$

$$(c) \text{ Gravitational potential } = \frac{PE}{m} = [L^2T^{-2}]$$

(d) Gravitational field intensity

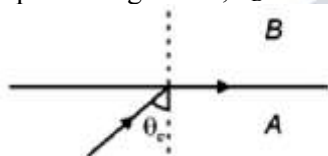
$$= \frac{F}{m} = [LT^{-2}]$$

44.(b)

Given that,

Speed of light in A, $v_A = 1.5 \times 10^8$ m/s

Speed of light in B, $v_B = 2 \times 10^8$ m/s



$$\mu_A = \frac{3 \times 10^8}{1.5 \times 10^8} = 2$$

$$\mu_B = \frac{3 \times 10^8}{2 \times 10^8} = 1.5$$

Now,

As we know for total internal reflection, ray of light should travel from denser to rarer medium

$$\mu_A \sin \theta_c = \mu_B \sin 90^\circ$$

$$2 \sin \theta_c = 1.5 \sin 90^\circ$$

$$\sin \theta_c = 0.75$$

$$\theta_c = \sin^{-1}(0.75)$$

45.(b)

We all know that a Wheatstone bridge is most precise when it is most sensitive.

This can be accomplished by making the ratio arms equal,

$$\text{i.e., } \frac{Q}{Y} = \frac{P}{X}$$

46.(a)

Given that,

Length of 1st pendulum, $l_1 = 121$ cm = 1.21 m

Length of 2nd pendulum, $l_2 = 100$ cm = 1.00 m

Now,

The equation for time period of a simple pendulum is

$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$\text{i.e } T \propto \sqrt{L}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{L_1}{L_2}} = \sqrt{\frac{1.21}{1}}$$

$$\therefore \frac{T_1}{T_2} = 1.1 = \frac{11}{10}$$

As a result, we can conclude that after the 11th oscillation of the shorter pendulum, it will be in phase with the longer pendulum,

47.(c)

According to Ampere's law for a solid wire, the magnetic field intensity at some point inside

$$B = \frac{\mu_0 I r^2}{R^2 \times 2\pi r}$$

$$= \frac{\mu_0 I r}{R^2 \times 2\pi}$$

$$B \propto r$$

Whereas, magnetic field intensity at some point outside

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B \propto \frac{1}{r}$$

48. (d)

As we know,

Area of rectangle = Length x Breadth

$$= 55.3 \times 25 \text{ m}^2$$

$$= 1382.5 \text{ m}^2$$

$$\approx 14 \times 10^2 \text{ m}^2$$

49.(c)

Given that,

Number of turns, $N = 1000$

Radius, $r = 10 \text{ m}$

Area, $A = \pi r^2 = \pi \times (10)^2$

Earth's magnetic field strength, $B = 2 \times 10^{-5} \text{ T}$

Resistance, $R = 12.56 \Omega$

Now,

$$\phi_B = NBA \cos \omega t$$

$$\varepsilon = \frac{-d\phi_B}{dt} = -NBA\omega(-\sin \omega t)$$

$$\omega = NBA\omega \sin \omega t$$

$$i_{\max} = \frac{\varepsilon_{\max}}{R} = \frac{NBA\omega}{R}$$

$$= \frac{1000 \times 2 \times 10^{-5} \times \pi (10)^2 \times 2}{12.56} = 1 \text{ A}$$

50.(b)

Given that,

Inductance, $L = 10 \text{ H}$

Capacitance, $C = 10 \mu \text{ F}$

Resistance, $R = 50 \mu$

Peak voltage, $V = 200 \text{ V}$

$$\text{Frequency or A,C source, } v = \frac{\omega}{2\pi} = \frac{100}{2\pi} = \frac{50}{\pi}$$

As we know, at the resonating frequency

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10 \times 10 \times 10^{-6}}}$$

$$\omega = 100 \text{ rad/sec}$$

$$\omega = 2\pi f \Rightarrow f = \frac{\omega}{2\pi}$$

Now, the frequency of resonance for given LCR circuit is

$$\nu_0 = f_0 = \frac{100}{2\pi} = \frac{50}{\pi} \text{ Hz}, \omega = 100 \text{ rad/sec}$$

CHEMISTRY

Section A

51. (c)

Enzymes are complex nitrogenous organic compounds. They are produced by living plants and animals. They are protein molecules of high molecular mass and are not polysaccharides.

52. (d)

The IUPAC name of $[\text{Ag}(\text{H}_2\text{O})_2][\text{Ag}(\text{CN})_2]$ is diaquasilver (I) dicyanidoargentate(I)

53. (b)

Both (A) and (R) are correct but (R) is not the correct explanation of (A).

Assertion statement is the classic explanation of Schottky defect wherein cation and anion leaves their site, or impurity defect.

Reason statement is true but not correct explanation for assertion as it is defining Frenkel defect wherein ion does not leave crystal.

54. (b)

Gadolinium has a low value of third ionisation enthalpy because of high exchange enthalpy.

Electronic configuration of Gadolinium $[\text{Gd}] = [\text{Xe}] 4f^7 5d^1 6s^2$

For 3rd ionisation enthalpy, electron will be removed from 5d,

So the resultant configuration will be $[\text{Xe}]4f^7$ that is stable electronic configuration as it will have high exchange energy

Therefore, less energy will be required to remove 3rd electron

55. (d)

Thermoplastic polymers are the linear or slightly long chain molecules capable of repeatedly softening and hardening on cooling and can be reused.

Thermosetting polymers are cross-linked or heavily branched molecules, which on heating undergo extensive cross-linking in moulds and again become infusible.

The thermosetting polymer, often called a thermoset, is obtained by irreversibly hardening a soft solid or viscous liquid prepolymer. These cannot be reused

Elastomers have polymer chains held together by weak intermolecular forces and high elasticity. Fibres have high tensile strength

56. (d)

$$p_i = x_i p_i^0$$

where

p_i = partial pressure of i^{th} gas

x_i = mole fraction of i^{th} gas in gaseous mixture

x_i = mole fraction of i^{th} gas in gaseous mixture

p_i^0 = pressure of i^{th} gas in pure state

According to Dalton's law of partial pressure, the total pressure by the mixture of non-reactive gases is equal to the sum of the partial pressures of individual gases.

$$p_{\text{total}} = p_1 + p_2 + p_3$$

Also, $p_i = x_i p$; where p_i and x_i are the partial pressure and mole fraction of i^{th} gas respectively and p is the total pressure.

$$P_{\text{Total}} = p_1 + p_2 + p_3$$

$$= n_1 \frac{RT}{V} + n_2 \frac{RT}{V} + n_3 \frac{RT}{V}$$

$$= (n_1 + n_2 + n_3) \frac{RT}{V}$$

57. (b)

Consider mass of CaCO_3 required as 'm' gram.

$$\text{Pure CaCO}_3 \text{ in gram} = \frac{95}{100} \times m$$

$$\text{Mole of CaCO}_3 = \frac{95}{100} \times \frac{m}{100}$$

$$\text{Moles of HCl required} = 2 \times \text{moles of CaCO}_3 = 2 \times \frac{95}{100} \times \frac{m}{100}$$

$$2 \times \frac{95}{100} \times \frac{m}{100} = \frac{50}{1000} \times 0.5$$

$$m = 1.315 \text{ g} \approx 1.32 \text{ g}$$

58.(a)

IUPAC name of element with atomic number 119 is ununennium,

59.(c)

Statement I is correct but Statement II is incorrect.

According to hardy Schulze rule we know that,

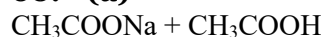
In negatively charged colloid, the flocculating power of cation increases with increase in charge on the cation of electrolyte.

Therefore, the order is $\text{Al}^{3+} > \text{Ba}^{2+} > \text{Na}^+$

In positively charged colloids, the flocculating power of anion increases with increases in charge on anion of electrolyte in case of positively charge colloids.

Therefore, order is $\text{NaCl} < \text{Na}_2\text{SO}_4 < \text{Na}_3\text{PO}_4$

60. (a)



$$0.1\text{M} \quad 0.01\text{M}$$

$$50 \text{ mL} \quad 50 \text{ mL}$$

$$\text{CH}_3\text{COOH}(\text{pK}_a) = 4.57$$

Since, it is a mixture of weak acid and salt of its conjugate base, so it is acidic buffer.

$$\text{pH} = \text{pK}_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

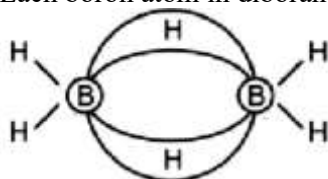
$$= 4.57 + \log \left(\frac{0.1}{0.01} \right)$$

$$= 4.57 + 1$$

$$= 5.57$$

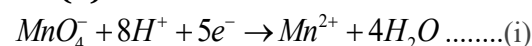
61. (d)

Each boron atom in diborane molecule uses sp^3 hybrid orbitals for bonding,

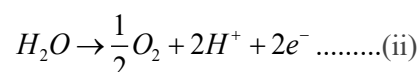


sp^3 hybridised boron

62.(a)

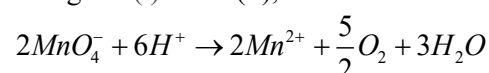


$$E_{\text{MnO}_4^-/\text{Mn}^{2+}}^0 = -E_{\text{Mn}^{2+}/\text{MnO}_4^-}^0 = 1.51\text{V}$$



$$E_{\text{O}_2/\text{H}_2\text{O}}^0 = 1.223\text{V}$$

Using $2 \times (\text{i}) + 5 \times (\text{ii})$, net cell reactions is



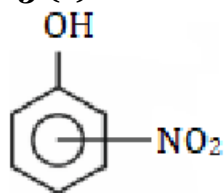
$$E_{\text{cell}}^0 = E_{\text{C}}^0 - E_{\text{A}}^0 = E_{\text{MnO}_4^-/\text{Mn}^{2+}}^0 - E_{\text{O}_2/\text{H}_2\text{O}}^0$$

$$= 1.51 - 1.223$$

$$= 0.287V$$

As cell $E_{cell}^0 > 0$, the net cell reaction is spontaneous and therefore, MnO_4^- liberate O_2 from H_2O in presence of an acid.

63.(c)



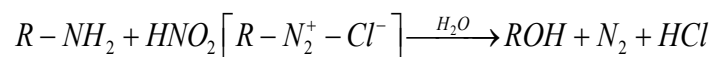
Nitro group has electron withdrawing property as it can withdraw electrons both by -I effect and -R effect. Hence, the acidic strength of monosubstituted nitrophenol is higher than phenol.

Nitro group present at o- and p-positions will have strong -R effect while nitro group present at m-position will influence only -I effect hence acidity of ortho and para isomers will be more meta isomer.

The acidic nature of nitrophenols increases in the order: meta < ortho < para.

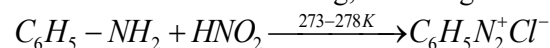
64.(c)

Primary aliphatic amines react with HNO_2 and give unstable diazonium salt which turns into alcohol.

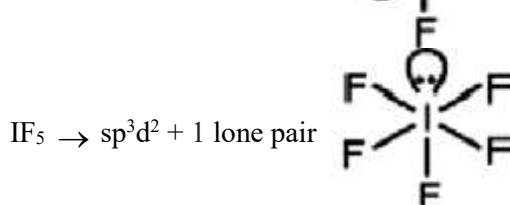
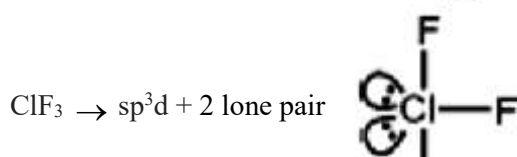
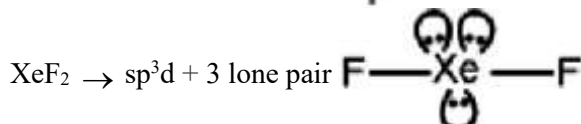
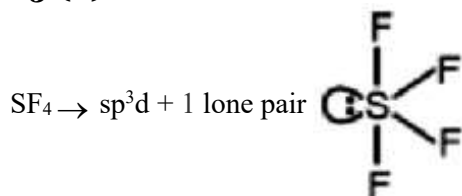


Primary aromatic amines react with HNO_2 and yields stable diazonium salt which are stable at 273 to 278 K due to resonance

stabilisation of aromatic ring, but at higher temperature, they are unstable.



65.(d)

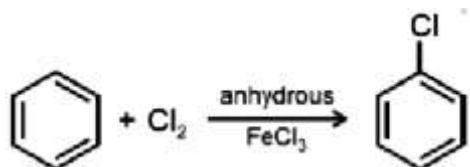


As, XeF_2 consists of maximum lone pairs, it has maximum 'lone pair-lone pair' electron repulsions.

66.(c)

The stereoisomers which are non-superimposable mirror image of each other are called enantiomers.

67.(a)



Benzene reacts with chlorine in presence of anhydrous FeCl_3 to yield chlorobenzene.

68. (b)

- (a) - (iii) Cimetidine is an antacid
- (b) - (iv) Seldane is an antihistamine
- (c) - (ii) Morphine is an analgesic
- (d) - (i) Salvarsan is an antimicrobial drug

69.(c)

• For zero order reaction, rate is independent of concentration of reactants.

$$r = k[A]^0$$

$$r = k \text{ (constant)}$$

Therefore, 'y' as 'rate' and 'x' as concentration will give desired graph,

• For first order reaction, $t_{1/2}$ is dependent only on K, hence no change with respect to concentration.

$$t_{1/2} = \frac{0.693}{k} \text{ (k is constant)}$$

Therefore, 'y' as ' $t_{1/2}$ ' and 'x' as concentration will give desired graph.

70.(a)

Interhalogen compounds are more reactive than halogens (except fluorine). This is because X – X' bond in interhalogens is weaker than X - X bond in halogens except F - F bond. Hence, I -Cl is more reactive than h because of weaker I - Cl bond than I - I bond.

71. (c)

Diamond:

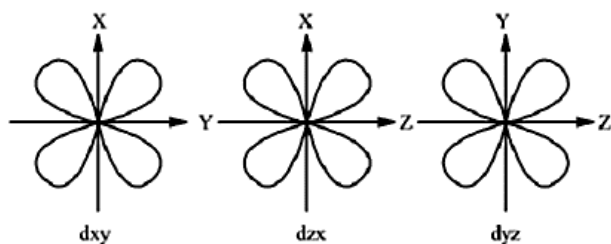
(sp^3 hybridised C atoms, Covalent, 3-D structure, Cannot be used as dry lubricant)

Graphite:

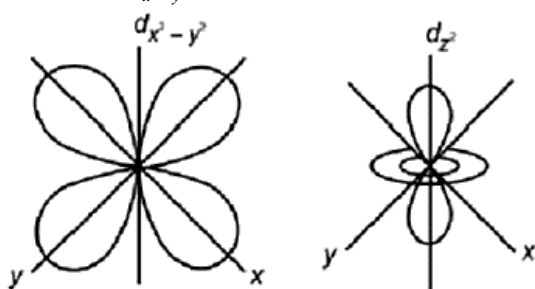
(sp^2 hybridised C atoms, Covalent, Planar structure, Used as dry lubricant)

72. (d)

In an atom, the shapes of 3d orbital are same as respective 4d and 5d orbitals, only the size of the orbital changes, when the respective shell number increases. All the d orbitals are degenerate [equal in energy] in free state.



The shape of $d_{x^2-y^2}$ is different than shape of d_{z^2} .



The size of orbital depends on principal quantum number 'n', hence all the five 3d orbitals are different in size when compared to the respective 4d orbitals.

Shape of orbitals depends on azimuthal quantum number 'l', hence shapes of 4d orbitals are similar to the respective 3d orbitals.

73. (b)

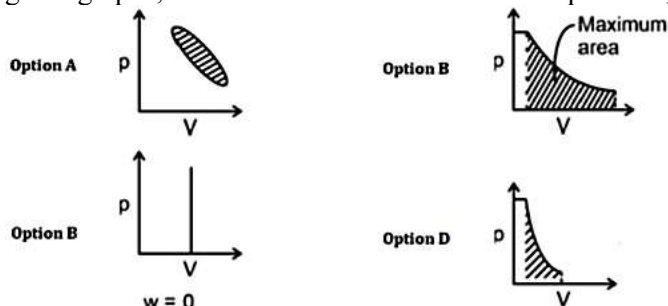
Alkali metals like potassium show only '+1' oxidation state in all of their compounds.

KO_2 is a super-oxide in which O_2^- is anion and K^+ is cation.

The oxidation state of K is +1 in KO_2 .

74. (b)

Work done under any thermodynamic process can be determined by area under the 'p-V' graph. From the given graphs, the maximum area is covered in option 'B',



75. (c)

Kjeldahl method cannot be used for the nitrogen content determination of compounds having nitro group, azo groups and nitrogen present in the ring (e.g., pyridine) as nitrogen of these compounds does not change to ammonium sulphate under these conditions.

Hence, nitrogen content of aniline can be determined by Kjeldahl's method,

76. (a)

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

List - I (Hydrides)

List - II (Nature)

MgH_2

Ionic

GeH_4 Electron precise

B_2H_6 Electron deficient

HF Electron rich

• Ionic hydrides are compounds formed between hydrogen and the most active metals, especially with the alkali and alkaline-earth metals.

• Covalent hydrides are formed when hydrogen reacts group 13 to group 17 elements.

• All the group 13 elements form electron deficient compounds with hydrogen.

• All group 14 elements form electron precise compounds.

• Elements from groups 15 through 17 form bonds which have excess electrons present as lone pairs.

Therefore,

• MgH_2 is an ionic compound.

• GeH_4 has sufficient number of electrons required for forming covalent bonds, hence it is electron precise compound.

• B_2H_6 is electron deficient compound due to incomplete octet.

• HF is electron rich compound due to pair of unpaired electrons on fluorine.

77. (b)

Compound

Boiling point (K)

H_2O 373

H_2S 213

H_2Se 232

H_2Te 269

• The boiling points of these hydrides not exactly increases with increase in molar mass.

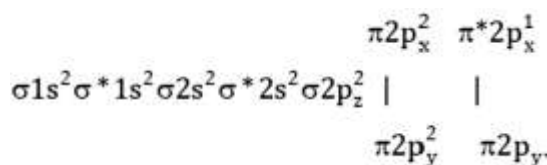
• H_2O has maximum boiling point due to intermolecular hydrogen bonding.

• Boiling point increases with molar mass of the compound, but it is also get affected by hydrogen bonding.

• By considering both the factors, the correct order of boiling points of 16th group hydrides is

$\text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te} < \text{H}_2\text{O}$

78. (d)

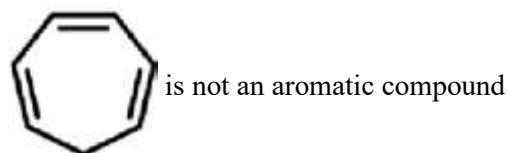
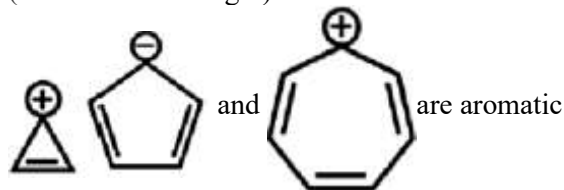


Due to one unpaired electron in $\pi^* 2p$ molecular orbital, O_2^+ is a paramagnetic ion and not diamagnetic.

79. (d)

80. (d)

Planar, cyclic, conjugated species consisting of $(4n + 2)$ π electrons are aromatic in nature (where n is an integer).



81. (d)

For a reaction to be spontaneous, E_{cell}^0 must be positive.

• For, $CuSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Cu(s)$

$$E_{cell}^0 = 0.34V - (-0.76V)$$

$$= 1.1V$$

• For, $CuSO_4(aq) + Fe(s) \rightarrow FeSO_4(aq) + Cu(s)$

$$E_{cell}^0 = 0.80V - (-0.44V)$$

$$= 1.24V$$

• For, $FeSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Fe(s)$

$$E_{cell}^0 = E_{cathode}^0 - E_{anode}^0$$

$$= -0.44V - (-0.76V)$$

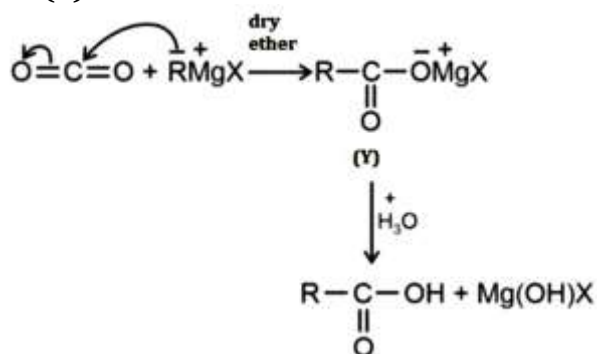
$$= 0.32V$$

• For, $2CuSO_4(aq) + 2Ag(s) \rightarrow 2Cu(s) + Ag_2SO_4(aq)$

$$E_{cell}^0 = 0.34V - 0.80V$$

$$= -0.46V \quad (E_{cell}^0 \text{ is negative hence reaction cannot occur.})$$

82. (a)



Thus, Y is $RCOO^-Mg^+X$.

83. (b)

Molality is the moles of solute dissolved per kg of solvent.

As given 1 molal solution contains 0.5 moles of solute.

$$m = \frac{\text{Moles of solute}}{\text{Mass of solvent (in kg)}}$$

Therefore, mass of solvent = 0.5 kg = 500 g

84. (d)

- Lithium is used in many electrochemical cells.
- Liquid sodium metal is used as a coolant in fast breeder nuclear reactor.
- KOH used to adsorb CO₂ which changes into K₂CO₃.
- Cs is used in photoelectric cell due to its low ionisation enthalpy.

85. (a)

- The boiling points of aldehydes and ketones are higher than hydrocarbons of comparable molecular masses. It is due to weak molecular association in aldehydes and ketones arising out of the dipole - dipole interaction.
- The boiling point of aldehydes and ketones are lower than the alcohols of similar molecular masses because alcohols involve intermolecular hydrogen bonding.

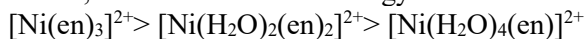
Section B

86. (c)

Stronger the field strength of ligand, higher will be the energy absorbed by the complex.

Ethylene diamine (en) is a strong field ligand than 'H₂O' according to spectrochemical series.

Hence, the correct order of energy absorbed is:



i.e. (C) > (A) > (B)

87. (c)

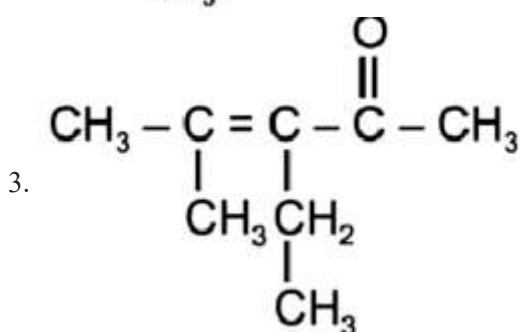
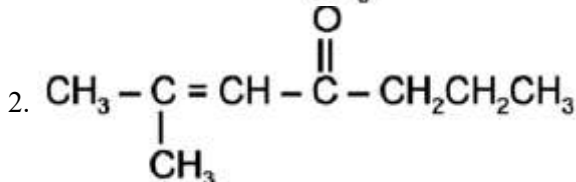
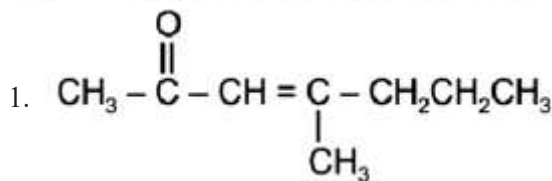
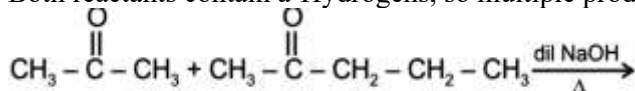
Primary, secondary and tertiary alcohols can be differentiated by their reaction with Lucas reagent (anhyd. ZnCl₂ + conc. HCl).

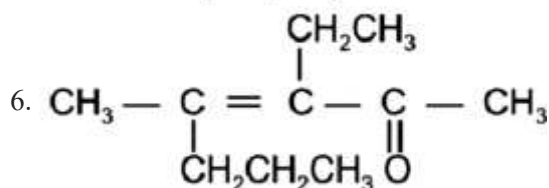
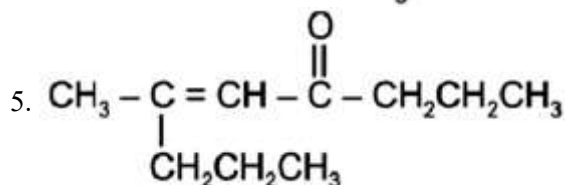
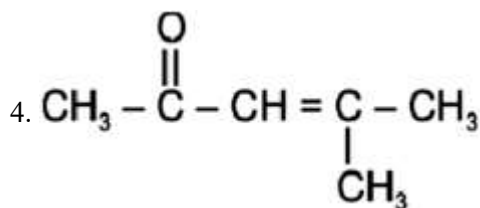
- 3° alcohol $\xrightarrow{\text{Anhyd. ZnCl}_2 + \text{conc. HCl}}$ Turbidity appears immediately at room temperature
- 2° alcohol $\xrightarrow{\text{Anhyd. ZnCl}_2 + \text{conc. HCl}}$ Turbidity appears after 5 minutes at room temperature
- 1° alcohol $\xrightarrow{\text{Anhyd. ZnCl}_2 + \text{conc. HCl}}$ Do not give turbidity at room temperature

88. (b)

Cross Aldol condensation reaction:

Both reactants contain α-Hydrogens, so multiple products are possible which are as follows:





Hence, option (B) is not possible.

89. (d)

For ideal gas,

$$PV = nRT$$

$$P = n \frac{RT}{V}$$

$$P = \frac{64}{32} \times \frac{0.0831 \times 300}{10}$$

$$P = 4.9 \text{ bar}$$

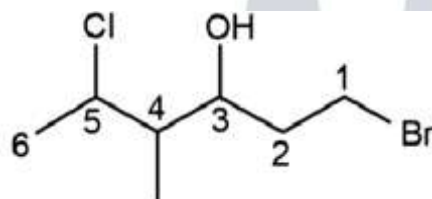
Therefore, pressure of O_2 gas inside the flask is 4.9 bar.

90. (a)

The root word in the given structure is hex and alcoholic group forms the suffix.

According to the least sum rule of the substituents the position of the substituents that is Bromo, chloro and methyl groups should be 1, 5 and 4 respectively.

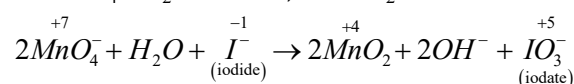
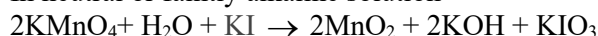
Also, the functional group with highest priority should be getting least possible number in position.



1-bromo-5-chloro-4-methylhexan-3-ol

91. (a)

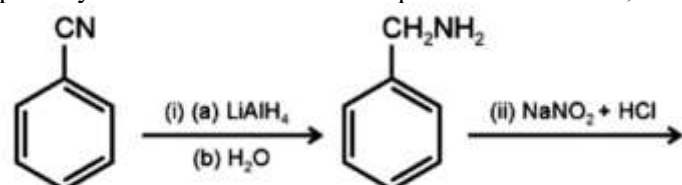
In neutral or faintly alkaline solution

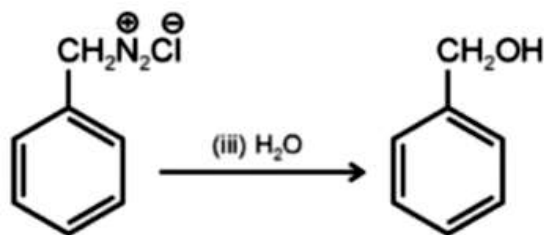


Oxidation state of Manganese (Mn) changes from +7 to +4.

92. (d)

In the presence of LiAlH_4 and H_2O , phenyl cyanide is converted into primary amine followed by conversion of this primary amine into alcohol in the presence of NaNO_2 , HCl and H_2O .

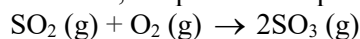




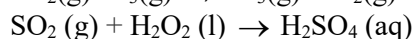
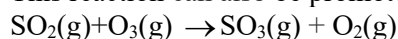
93.(b)

Uncatalysed oxidation of sulphur dioxide is slow.

However, the presence of particulate matter in polluted air catalyzes the oxidation of SO_2 to SO_3 .



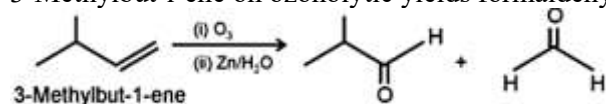
This reaction can also be promoted by O_3 and H_2O_2 , as,



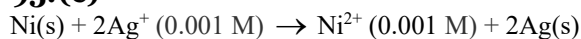
94.(a)

Reductive ozonolysis of alkenes yields aldehydes and ketones.

3-Methylbut-1-ene on ozonolytic yields formaldehyde and 2-methyl propanal.



95.(c)



$$E^\circ_{\text{cell}} = 1.05\text{V}$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{n} \log \frac{[\text{Ni}^{2+}]}{[\text{Ag}^+]^2}$$

$$= 1.05 - \frac{0.059}{2} \log \frac{(10^{-3})}{(10^{-3})^2}$$

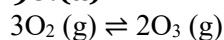
$$= 1.05 - \frac{0.059}{2} \log(10)^3$$

$$= 1.05 - 0.0295 \times 3$$

$$= 1.05 - 0.0885$$

$$= 0.9615\text{V}$$

96.(a)



$$K_c = \frac{[\text{O}_3]^2}{[\text{O}_2]^3}$$

$$[\text{O}_3]^2 = K_c [\text{O}_2]^3 = 3 \times 10^{-59} \times (0.04)^3$$

$$[\text{O}_3]^2 = 1.9 \times 10^{-63} = 19 \times 10^{-64}$$

$$[\text{O}_3] = 4.38 \times 10^{-32}$$

Therefore, concentration of O_3 at equilibrium = $4.38 \times 10^{-32}\text{ M}$

97.(a)

$$r_n \propto \frac{n^2}{Z}$$

$$\frac{r_3(\text{Li}^{2+})}{r_2(\text{He}^+)} = \frac{(n_3)^3}{Z(\text{Li}^{2+})} \times \frac{Z(\text{He}^+)}{(n_2)^2}$$

$$\frac{r_3(\text{Li}^{2+})}{105.8} = \frac{(3)^2}{3} \times \frac{2}{(2)^2}$$

$$= 105.8 \times \frac{3}{2}$$

$$r_3(Li^{2+}) = 158.7 \text{ pm}$$

98. (b)

List - I (Ores)

Haematite

Magnetite

Calamine

Kaolinite

List - II (Composition)

Fe_2O_3

Fe_3O_4

$ZnCO_3$

$[Al_2(OH)_4Si_2O_5]$

99. (a)

$$d = \frac{ZM}{N_A(a)^3}$$

$Z = 4$ (for FCC)

$d = 8.92 \text{ g cm}^{-3}$

$N_A = 6.023 \times 10^{23}$

$a = 3.608 \times 10^{-8} \text{ cm}$

$$= \frac{8.92 \times 6.023 \times 10^{23} \times (3.608 \times 10^{-8})^3}{4}$$

$$= \frac{8.92 \times 6.023 \times 10^{23} \times 46.97 \times 10^{-24}}{4}$$

$$= \frac{2523.47 \times 10^{-1}}{4}$$

$$= 630.8 \times 10^{-1} = 63.08 \approx 63.1 \text{ u}$$

100. (b)

For first order reaction,

$$K = \frac{2.303}{t} \log \frac{[R_0]}{[R]}$$

Where R_0 is the initial concentration of reactant A

$R_0 = 0.1 \text{ M}$

$R = 0.001 \text{ M}$

$t = 5 \text{ minute}$

$$K = \frac{2.303}{5} \log \frac{0.1}{0.001}$$

$$= \frac{2.303}{5} \log 10^2$$

$$= \frac{2.303}{5} \times 2$$

$$K = 0.9212 \text{ min}^{-1}$$

BIOLOGY

Section A

101. (c)

Arthropod bodies are supported by chitin-composed external bones or hardened exoskeletons.

It is formed by their skin to form a protective outer covering that hardens.

102. (c)

Decomposition is a process in which the detritus is broken down into smaller, simpler substances by microbes, Decomposition rate is slower if the detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water - soluble substances like sugars.

103. (a)

Cleistogamous flowers are invariably autogamous because the anther and stigma lie close to each other. They are bisexual and cannot open even at maturity and hence self-pollination is mandatory. This makes cleistogamy disadvantageous as there is no scope for cross-pollination.

104. (a)

The process of translation of mRNA to protein begins when the small subunit of ribosome encounters an mRNA. This process is followed by the binding of bigger or larger subunit, t-RNA is activated by the addition of amino acid prior to the attachment of ribosome, in the first phase.

105. (d)

In lactic acid fermentation, less than 7% of the energy in glucose is released because only two ATPs are produced at this stage compared to the total number of 32 ATPs in aerobic

respiration. Thus, energy produced is $\frac{2}{32} \times 100 = 6.25\%$.

106. (b)

The girdling experiment shows that phloem is the tissue responsible for the translocation of food; and that transport takes place in one direction i.e. towards the root.

107. (c)

The symplastic system is system of interconnected protoplasts, Neighbouring cells are connected through cytoplasmic strands that extend through the plasmodesmata. The water travels through cell cytoplasm and plasmodesmata, hence the movement is relatively slower. Symplastic movement is aided by cytoplasmic streaming.

108. (a)

In old trees, the greater part of secondary xylem is dark brown due to the deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils in the central or innermost layers of the stem. These substances make this layer hard, durable and resistant to the attack of micro-organisms and insects.

109. (c)

Hydrocolloids such as carrageen are water holding substances obtained from red algae (Rhodophyceae).

110. (d)

Among the animals, insects, particularly bees are the most dominant biotic pollinating agents.

111. (c)

Polymorphism in DNA sequence is the basis of genetic mapping of human genome as well as of DNA fingerprinting.

112. (b)

In-situ conservation means on site conservation i.e, when we conserve and protect the whole ecosystem, its biodiversity at all levels is protected.

National parks are a type of in-situ conservation whereas, micropropagation, cryopreservation and in-vitro fertilization are methods of ex-situ conservation.

113. (b)

Chemiosmosis requires a membrane, a proton pump, a proton gradient and ATP synthase. Energy is used to pump protons across a membrane to create a gradient or a high concentration of protons within the thylakoid lumen.

The enzyme, NADP reductase is located on the stroma side of the membrane. Along with the electrons that come from the acceptor of electrons of PS I, protons are necessary for the reduction of NADP⁺ to NADPH and H⁺. The process does not involve breakdown of electron gradient.

114. (c)

During glycolysis, total 4 ATPs are produced from one glucose molecule with a net gain of 2 ATPs.

115. (b)

When a flower can be divided into two similar halves only in one particular vertical plane, it is zygomorphic, e.g, pea, gulmohar, bean

Cassia. Rest of the flowers i.e., mustard, Datura and chilli are actinomorphic.

116. (a)

Gregor J, Mendel, conducted hybridisation experiments on garden pea and selected 14 true breeding pea plant varieties (seven contrasting traits). Contrasting traits studied were smooth or wrinkled seeds, yellow or green seeds, inflated or constricted pods, green or yellow pods, tall or dwarf plants, violet or white flowers and axial or terminal flower positions.

117. (b)

Ulothrix is a member of Chlorophyceae (green algae), with reserve food material as starch.

Mannitol is a stored food material of Phaeophyceae (brown algae)

118. (c)

Ethylene increases the number of female flowers and fruits in certain plants such as cucumber. Gibberellins are used to increase the size of fruits in some plants.

119. (b)

The microbe, Frankia, produces nitrogen fixing nodules on the roots of non-leguminous plants such as Alnus.

120. (b)

Manganese plays a major role in the splitting of water during photolysis to liberate oxygen during photosynthesis.

Magnesium activates several enzymes involved in photosynthesis and respiration.

Boron is involved in pollen germination.

Iron activates the enzyme catalase along with some other enzymes.

121. (b)

Ethylene is a gaseous plant hormone. It induces development of adventitious roots on various types of cuttings. It promotes the development of lateral roots and growth of root hairs.

Cytokinin helps to overcome apical dominance.

Auxin is used to kill dicotyledonous weeds.

Gibberellin speeds up the malting process

122. (c)

Axillary buds of stems and not leaflets get modified into woody, straight and pointed thorns. Thorns are found in many plants such as Citrus and Bougainvillea

123. (d)

All the given statements are correct regarding vascular bundles, but none of the options with such combination is given.

124. (c)

Grasshopper is an example of XO type of sex determination in which the males have only one X- chromosome besides the autosomes, whereas females have a pair of X-chromosomes.

125. (c)

Habitat loss and fragmentation, over exploitation, alien species invasion and co-extinction are causes for biodiversity loss.

126. (d)

Plants follow different pathways in response to environment or phases of life to form different kinds of structures. This ability is called plasticity, e.g, heterophylly in cotton, coriander and larkspur. In such plants, leaves of the juvenile plant have a shape which is different from that in mature plants.

Maize plant does not show plasticity.

127. (a)

The primary CO_2 acceptor in C_4 plants is a 3-carbon molecule, phosphoenol pyruvate (PEP) and is present in the mesophyll cells.

Mesophyll cells of C_4 plants lack RuBisCO enzyme. Instead, this enzyme is found in the bundle sheath cells in C_4 plants.

128. (c)

Bright colored bands of DNA can be observed in the gel when EtBr (Ethidium bromide) treated DNA is exposed to UV light.

129. (c)

Electrostatic precipitator can remove over 99% particulate matter present in the exhaust from a thermal power plant.

Catalytic converters are fitted into automobiles for reducing emission of poisonous gases.

STPs are associated with sewage treatment.

130. (c)

Pachytene stage of meiosis is characterised by the appearance of recombination nodules, the sites at which crossing over occurs between non-sister chromatids of homologous chromosomes.

131. (b)

Euchromatin is the loosely packed chromatin region.

Heterochromatin is transcriptionally inactive.

The negatively charged DNA is wrapped around the positively charged histone octamer to form a structure called nucleosome.

Histones are rich in basic amino acid residues lysine and arginine.

A typical nucleosome contains 200 bp of DNA helix.

132. (c)

Pairing of homologous chromosomes occurs during prophase 1 of meiosis.

Coiling and condensation of chromatids, attachment of spindle fibers to the kinetochores and

movement of centrioles towards opposite poles occur in both mitosis and meiosis

133. (c)

One of the species in predation gains benefit at the expense of the other, Predators help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species. If a predator is too efficient and overexploits its prey, then the prey might become extinct

134. (b)

Vexillary aestivation and diadelphous stamens are the characteristic features of family Fabaceae.

Pisum sativum (garden pea) belongs to family Fabaceae.

Allium cepa (onion) and *Colchicum autumnale* (colchicine) belong to family Liliaceae.

Solanum nigrum belongs to family Solanaceae.

135. (b)

Polymerase chain reaction is used in DNA amplification because this technique allows to take a very small sample of DNA and amplify it [or a part of it] to a large enough amount to study in detail.

Ampicillin resistance gene is a selectable marker that helps to check transformation by selection of transformants.

Section B

136. (b)

Myotonic dystrophy is an autosomal dominant disorder i.e. it occurs due to the presence of an autosomal linked dominant trait.

Haemophilia is an X-linked recessive disorder.

Thalassemia and sickle cell anaemia are autosomal recessive disorders.

137. (a)

Sequencing the whole set of genome that contained all the coding and non-coding sequences and later assigning different regions in the sequence with functions is called sequence annotation.

138. (b)

Mobile genetic elements (transposons) that replicate via an RNA intermediate can act as the source of the complementary RNA for the

technique of gene silencing or RNA interference (RNAi).

Autoradiography usually follows the technique of hybridisation.

Polymerase chain reaction is used to make copies of the DNA sample and does not need transposons.

Transposons are not required during gene sequencing.

139. (a)

In predation, one species is benefitted whereas the other is harmed. It is (+/-) type of population interaction.

140. (c)

Lecithin is a type of phospholipid found in the plasma membrane.

Saturated fatty acids are without C = C double bond.

Oils have lower melting point and hence remain as oil in winters.

Lipids are generally insoluble in water but soluble in some organic solvents.

Monoglycerides are formed when a fatty acid is esterified with a glycerol.

141. (b)

If some solute is dissolved in pure water, the solution has lower free water and the concentration of water decreases, reducing its water potential. The magnitude of this lowering due to dissolution of a solute is called solute potential.

142. (c)

Closely located genes do not show independent assortment. Mendel's law of independent assortment holds good for those genes which are located on different chromosomes.

143. (c)

The given figure is of a false fruit. False fruit develops from other floral parts and thalamus along with the development of ovary wall,

144. (c)

Phosphorus cycle is a sedimentary cycle, Reservoir pool of phosphorus in the ecosystem is the Earth's crust or lithosphere. Therefore, weathering of rocks will accelerate the phosphorus cycle.

145. (b)

Palindromic DNA sequence is a DNA sequence of base pairs that reads same on the two strands when the orientation of reading is kept the same, Out of the given base sequences, the below sequence is the only palindromic sequence-

5'GAATTC3'
3'CTTAAG5'

146. (b)

CNG is cheaper than petrol and it burns more efficiently unlike petrol or diesel. It also cannot be adulterated like diesel and petrol. The same diesel engine cannot be used in CNG buses for making the cost conversion low.

147. (b)

The vessels are produced with the wider lumens to transport more water to meet the requirement by increased transpiring surface in spring season.
Spring wood is also called early wood. It is lighter in colour and has a lower density.
The springwood and autumn wood appear as alternate concentric rings of light and dark colour forming annual rings.

148. (b)

The large cells around the vascular bundles of C_4 plants form bundle sheath. These cells have large number of chloroplasts to carry out the Calvin cycle.

149. (b)

Spirogyra is an alga. It shows haplontic life-cycle.
Fern is a pteridophyte. The dominant phase of its life-cycle is a diploid sporophyte. Its gametophyte is called prothallus.
Funaria is a bryophyte. Its gametophyte is a leafy stage.
Cycas is a gymnosperm. The main plant body in gymnosperm is a sporophyte. They have highly reduced gametophyte stage.

150. (a)

In metacentric chromosome, centromere is in the middle of the chromosome.
Acrocentric chromosome has centromere close to the end of the chromosome.
In sub-metacentric chromosome, centromere is slightly away from the middle of the chromosome. Telocentric chromosome has a terminal centromere.

ZOOLOGY

Section A

151. (c)

An autoimmune disorder occurs when the body's immune system attacks and destroys healthy body tissue by mistake. Sometimes, due to genetic and other unknown reasons, the body attacks self-cells. Rheumatoid arthritis is an autoimmune disorder and is the result of the body's immune system attacking healthy body tissues, usually the joints (synovial membrane). So, Statement I is correct but Statement II is incorrect.

152. (d)

Coagulum or clot is formed mainly of a network of threads called fibrins
RBCs are destroyed in the spleen so spleen is known as the graveyard of erythrocytes. Hence, Statement II is correct.

153. (a)

Bioactive molecule, cyclosporin A, that is used as an immunosuppressive agent in organ transplant patients, is produced by the fungus, *Trichoderma polysporum*.

154. (d)

- Haploid gametes are formed in spermatogenesis and oogenesis. So (a) is true for both.
- The spermatids are transformed into spermatozoa (sperms) by the process called spermiogenesis. Hence, (b) is true for spermatogenesis only.
- Spermatogenesis and oogenesis both are controlled by LH and FSH secreted by the anterior pituitary. Hence (d) is true for both.
- Spermatogenesis is a continuous process that begins at puberty. Oogenesis on the other hand begins during embryonic development of the female. So (e) is true for spermatogenesis.

155. (c)

The intrauterine device (IUD) presently available as the nonmedicated IUDs, is Lippe's loop.
Option (4) is incorrect as copper releasing IUDs are CuT, Cu7 and multiload 375.
Option (1) and (2) are incorrect as diaphragms, cervical caps and vaults are included in barrier method of contraception.

156. (b)

Oogenesis is the process of formation of functional haploid ova from the diploid germinal cells in the ovary. Oogenesis begins during embryonic development but is completed only after fertilisation of the secondary oocyte with the sperm.

157. (a)

Hierarchical classification in animals starts from species and ends in kingdom. So, the correct ascending order of taxonomic categories in case of animals is

Species → genus → family → order → class → phylum → kingdom

158. (c)

Mycoplasma refers to a genus of bacteria which lack a cell wall and it is currently considered the smallest known cell at about 0.1 micron (μm) in diameter. So, it can pass through less than 1 μm filter size

159. (a)

Option (A) is the correct answer because Arthritis is inflammation of joints.

Option (B) is incorrect because tetany is rapid spasms in muscle due to low Ca^{++} in body fluid.

Option (C) is incorrect because myasthenia gravis is an immune disorder affecting neuro muscular junction leading to fatigue, weakening and paralysis of skeletal muscle.

Option (D) is incorrect because muscular dystrophy is progressive degeneration of skeletal muscle mostly due to genetic disorder.

160. (c)

As the product of 'I' gene binds with the operator region and blocks the transcription and translation of z, y and a gene, its product is prevented from binding to the operator by attaching it with the inducer. As the inducer is no more capable of binding with the repressor, thus, in all the cases, operator always gets attached with the repressor thereby preventing the transcription and transmission of z, y and a. Even in the presence of lactose, transcription and translation of z, y and a would not occur.

161. (d)

The conducting part of the respiratory system starts with the external nostrils up to the terminal bronchioles whereas the alveoli and their ducts form the respiratory or exchange part of the respiratory system. The conducting part transports the atmospheric air to the alveoli, clears it from foreign particles, humidifies and also brings the air to body temperature.

Exchange part is the site of actual diffusion of O_2/CO_2 between blood and atmospheric air.

162. (c)

Bio fortification is the process of increasing the micronutrient content of staple crops such as rice, wheat, beans, and other cereals and legumes to improve the nutrition.

Biomagnification refers to increase in concentration of the toxicant at successive trophic levels.

Bioremediation is the phenomenon of using biological organisms to handle pollution,

163. (d)

Option (D) is the correct answer because digestion of polysaccharides like starch occurs in mouth and digestion of disaccharides occurs in small intestine.

Option (C) is incorrect because saliva contains mucus which helps in the lubrication of oral cavity.

Option (A) is incorrect because saliva contains lysozyme (antibacterial agent) so that it controls bacterial population in mouth.

164. (b)

Tegmina or forewings (the first pair of wings) in cockroach arise from mesothorax which is narrow, thick and opaque and helps in protection.

Others are incorrect because no wing arises from prothorax and hindwings arise from metathorax because metathorax is broad, delicate and thin and helps in flight

165. (c)

Unlike eukaryotes, membrane bound organelles such as nucleus, mitochondria, endoplasmic reticulum are absent in prokaryotes and RER and SER belongs to endoplasmic reticulum.

166. (c)

The transformation of spermatids into spermatozoa (sperms) are called spermiogenesis. After this, sperm head becomes embedded in the Sertoli cells and are finally released from the seminiferous tubules by the process called spermiation whereas spermatogenesis is the process of formation of sperms from spermatogonia.

Hence, Statement I is a correct statement.

167. (b)

Cartilage which forms the intervertebral disc, is present between the adjacent bones of the vertebral column and it is a type of cartilaginous joint.

Option (C) is incorrect because areolar tissue present beneath the skin is a type of loose connective tissue.

Option (D) is incorrect because smooth muscles are present in the visceral organs.

Option (A) is incorrect because intercalated discs are characteristic feature of cardiac muscles present in heart.

168. (d)

Additional chambers like crop and gizzard in alimentary canal are present in birds, Pavo (Peacock), Psittacula (Parrot), Corvus (Crow) and Columba (Pigeon) are birds.

Option (A), (B) and (C) are incorrect because Catla is a bony fish, Crocodilus, Chameleon and Bangarus are reptiles, Bufo is an amphibian and Balaenoptera is an aquatic mammal,

169. (b)

Cornelia are the asexual reproductive structures produced in Penicillium.

Gemmules are produced in sponge.

Buds are produced in Hydra.

Zoospores are produced in Chlamydomonas.

170. (a)

Since fatty acids and glycerol are not soluble in water, they cannot enter the bloodstream. They first become part of micelles, which are tiny droplets that travel to the intestinal mucosa. They are transformed into chylomicrons, which are incredibly tiny protein-coated fat globules that are carried into the lymph vessels (lacteals) in the villi, The ingested chemicals are eventually released into the blood stream by these lymph veins, So, both the statements are correct.

171. (a)

The biodiversity of the ecosystem is safeguarded on all scales when the entire system is conserved and preserved. This is a site-specific or in-situ conservation technique.

172. (a)

If 8 Drosophila in a laboratory population of 80 died during a week, the death rate in the population $\frac{8}{80} =$

0.1 individuals per Drosophila per week.

173. (d)

Neuroglia is a part of nervous tissue.

The supporting cells of nerve tissue are called neuroglia. They account for more than 50% of the total amount of neural tissue, The building block of the nervous system, neurons, are excitable cells.

Blood and cartilage are specific types of connective tissues

A type of loose connective tissue is adipose tissue

174. (a)

The DNA contains a unique palindromic nucleotide sequence that each restriction endonuclease can recognize. It will bind to the DNA and cut the double helix's two strands at particular locations. The DNA strand is cut by restriction enzymes between the same two bases on the opposing strands, but just outside of the palindrome location. As a result, statement I and II are both true.

175. (b)

In directional natural selection more individuals acquire value other than the mean character value. Hence (b) is correct.

Option (C) is incorrect because in disruptive change, more individuals acquire peripheral character value at both ends of the distribution curve.

Option (D) is incorrect because there is no random change in natural selection.

Option (A) is incorrect because natural selection leads to stabilisation when more individuals acquire mean character value

176. (d)

Option (D) is the correct answer because birds (Pavo) excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water.

Option (3) and (2) are incorrect because many bony fishes (like Hippocampus) and aquatic amphibians (like Saianandra) are ammonotelic in nature.

Option (1) is incorrect because mammals (like Ornithorhynchus) mainly excrete urea and are called ureotelic animals.

177. (c)

Osteoporosis is due to decreased levels of oestrogen. Osteoporosis is an age-related disorder characterised by decreased bone mass hence, the chances of fractures increase

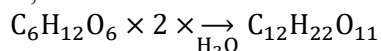
178. (b)

Under typical circumstances, the amount of oxygen delivered to the tissues in 100% oxygenated blood is about 5%, For instance, 100 ml of oxygenated blood can provide 5 ml of oxygen to the tissues.

Option (3), (4) and (1) are incorrect because every 100 mL of deoxygenated blood delivers approximately 4 mL of CO₂ to the alveoli.

179. (c)

Maltose is a disaccharide formed by dehydration process i.e., synthesis by elimination of one water molecule to form a glycosidic bond in between two glucose molecules. So, its molecular formula is,



180. (a)

Number of base pairs $\times$ distance between 2 consecutive base pairs = Length of DNA molecule
 $x \cdot 0.34 \times 10^{-9} \text{ m} = 1.1 \text{ m}$

$$x = \frac{1.1}{0.3 \times 10^{-9}}$$

$$= 3.6 \times 10^9$$

$$\approx 3.3 \times 10^9 \text{ bp}$$

181. (b)

Spindle fibres attach to the kinetochores of chromosomes, Kinetochores are the disc shaped structures present on sides of primary constriction or centromere of chromosomes.

182. (a)

Urochordata, Cephalochordate, and Vertebrata are the three subphyla of chordates. In adults, the notochord is replaced by a bony or cartilaginous vertebral column in the subphylum Vertebrata. As a result, all vertebrates are chordates, but not all chordates are vertebrates.

183. (b)

Meiosis is the process through which cells divide into two successive nuclear and cellular cycles known as meiosis-I and meiosis-II, but only one DNA replication cycle. Interkinesis, which is often brief and devoid of DNA replication, occurs between two meiotic divisions.

184. (d)

A normal functional copy of the human gene coding for ADA is inserted into these cells using a retroviral vector after being removed from the patient's bone marrow. The patient's bone marrow is then given the cells that have undergone this treatment. These cells create functioning ADA genes in their lymphocytes, which reactivate the immune system of the victim. Though these cells are not immortal, the patient needs regular infusions of these genetically modified lymphocytes, Hence, Option (B) is correct.

Option (C) is not the correct answer as the lymphocytes from patient's blood are grown in culture, outside the body but it is not the correct reason.

In option (B), if the gene isolated from bone marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure

Option (A) is just a process in periodic infusion but not the reason

185. (b)

Detritivores (eg, earthworm) break down detritus into smaller particles. This process is called fragmentation.

186. (b)

- Barrier methods of contraception include diaphragms. They protect the cervix and prevent sperm from entering,
- Progestogen-alone or progestogen-and-oestrogen-combined formulations are used as contraceptive pills. They modify the quality of cervical mucus to stop sperm entry, hinder ovulation and implantation, and other processes.
- Intra uterine devices increase the phagocytosis of sperms within the uterus.

• Lactational amenorrhoea is a natural method of contraception that is based on the observation that the menstrual cycle and ovulation do not coincide during the period of strong lactation that occurs after delivery.

187. (d)

Homologous organs have the same structure but have different functions according to the needs of the organisms. Hence, homology indicates common ancestry.

Analogous structures have developed for the same function but do not show a similarity in structure. Hence, they are a result of convergent evolution.

Option (D) is the correct answer because flippers of penguins and dolphins are analogous organs as they help in swimming but do not have the same structure.

Sweet potato is a root modification for food storage whereas potato is an underground stem modification for storage. Hence, they are analogous.

188. (d)

Option (D) is the correct answer as acquired immunity is a specific type of defence which is not present at the time of birth.

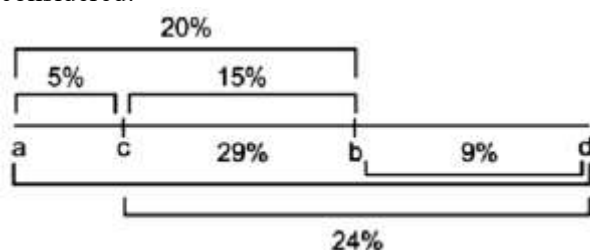
Option (A), (B) and (C) are true statements and hence cannot be the answer.

Anamnestic response or secondary immune response is a highly intensified response due to memory of first encounter. When our body encounters a pathogen for the first time then the body elicits the primary immune response. When there is a subsequent encounter with the same pathogen, secondary or anamnestic immune response is elicited.

189. (d)

1% recombination frequency = 1 centi Morgan

To place the genes on a linear chromosome, decreasing order of recombination frequency will be considered.



190. (d)

- Glycogen is a polysaccharide and is a storage product in animals.
- Globulins form antibodies which are also known as immunoglobulins.
- Steroids form hormones like testosterone.
- Thrombin is a biocatalyst which converts soluble fibrinogen to insoluble fibrin

191. (d)

Impulse transmission across an electrical synapse is always faster than that across a chemical synapse.

Chemical synapses use chemicals for transmission which are known as neurotransmitters. The membranes of

presynaptic and postsynaptic neurons are in close proximity in an electrical synapse.

An electrical current is used to transmit an impulse from one neuron to the following neuron in an electrical synapse.

192. (b)

Genetically engineered insulin contains A-peptide and B-peptide chains of insulin that are produced separately in E.coli before being extracted and combined via a disulphide bond.

Hence, (b) is the appropriate answer.

Statement (a) is incorrect as genetically engineered insulin does not have an extra stretch of C-peptide.

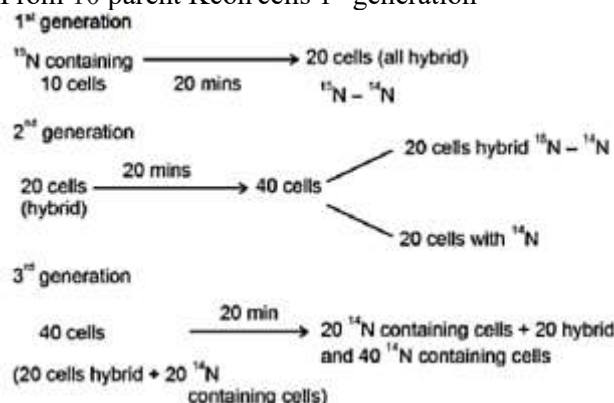
Statement (c) is incorrect as insulin obtained from cattle and pigs is not genetically engineered insulin.

Statement (d) is incorrect because conversion of pro-insulin to insulin is not required during production of insulin by genetic engineering as A-peptide and B-peptide chains are produced separately.

Statement (e) is incorrect as allergic reactions to insulin are mostly seen when the insulin is obtained from animals.

193. (c)

From 10 parent KcoH'cells 1st generation



Therefore, after 60 minutes, 60 K.coli cells will have DNA totally free from ¹⁵N

194. (c)

Option (C) is the correct answer because during joint diastole, blood moves freely from atrium to ventricle as atrioventricular valve remain open during joint diastole.

Option (D) is incorrect because decrease in ventricular pressure, during ventricular diastole closes semilunar valves to produce 'dub' heart sound.

Option (A) is incorrect because SA node generates action potential to stimulate atrial contraction.

Option (B) is incorrect because bicuspid and tricuspid valves open due to pressure exerted by blood present in atria and decrease in pressure in ventricles during ventricular diastole,

195. (d)

Cloning vectors are the carriers of the desired gene in the host cell.

The features desirable in a cloning vector are: -

- Presence of origin of replication
- Presence of marker genes
- Presence of very few, preferably single recognition site for the commonly used restriction enzymes

196. (d)

Scrubber is used by the industries which produce SO₂ as a by-product. The limestone present in slurry of scrubber remove SO₂ from the exhaust. Electrostatic precipitator is the most effective device to remove 99% of particulate matter, 'even PM 2,5' present in the exhaust.

197. (b)

Option (B) is the correct answer because parathyroid hormone is a hypercalcemic hormone, which means it raises blood calcium levels. It also improves calcium absorption from digested food. Glucocorticoids regulate the carbohydrate metabolism.

Option (C) is not true because parathyroid hormone stimulates the process of bone resorption,

Option (A) and (D) are not true because reabsorption of Ca²⁺ by renal tubules is a function of PTH.

198. (a)

Kingdom Monera is classified into three sub-kingdoms- Archaeobacteria, Eubacteria, and Cyanobacteria, Monerans are the group of organisms that show the maximum number of modes of nutrition. Some of the monerans like Cyanobacteria are autotrophs and can produce their own food Slime moulds are classified under kingdom Protista, Mycoplasma lack cell wall, Bacteria can be autotrophic as well as heterotrophic

199. (a)

The inner surface of hollow organs like bronchioles and fallopian tubes are where ciliated epithelium is primarily found. The purpose is to move particles or mucus over the epithelium in a particular direction. Some columnar or cuboidal cells become specialised for secretion and are referred to as glandular epithelium, Goblet cells are single-celled glands.

Tendons are dense regular connective tissues. They attach skeletal muscles to bones.

A form of loose connective tissue called adipose tissue is primarily found beneath the skin. This tissue's cells have been specifically designed to store fat.

200. (d)

If mother of man is colourblind, then man will also be colourblind as colour blindness is an X-linked recessive trait and shows criss-cross inheritance.

