Physics

1. (c)

2. (d) Let; initial speed of car $\Rightarrow u = 20\ m/s$

Final speed of car; $V = 0\ m/s$

Retardation $= a$

Case $-I\ \Rightarrow V^2 = u^2 + 2as$

$\Rightarrow 0 = u^2 + 2as$

$\Rightarrow \frac{-400}{2 \times 40} = a$

$\Rightarrow [a = -5\ m/s^2]$

Case - II $u = 40\ m/s$

$v = 0\ m/s$

$a = -5\ m/s^2$

$S = ?$

$\Rightarrow\ V^2 = u^2 + 2as$

$\Rightarrow\ 0 = (40)^2 + 2(-5).S$

$\Rightarrow\ S = \frac{1600}{10}$

$\Rightarrow\ S = 160\ m$

3. (c) In circular motion, velocity is always tangential to the circular path. Also in uniform circular motion, tangential acceleration is zero. Hence, the net acceleration will be centripetal acceleration which always acts towards the centre of the circular path. Hence, velocity and acceleration of a particle describing uniform circular motion are at right angle to each other.

4. (b) When vectors are perpendicular to each other, then their dot product is zero.

$\Rightarrow\ \vec{A} \cdot \vec{B} = 0$

$\Rightarrow\ (2\hat{i} + 3\hat{j} + 8\hat{k}) \cdot (-4\hat{i} + 4\hat{j} + \alpha\hat{k}) = 0$

$\Rightarrow\ -8 + 12 + 8\alpha = 0$

$\Rightarrow\ 8\alpha = -4$

$\alpha = \frac{-1}{2}$

$\therefore$ (B)

5. (d) As the lift is falling freely, therefore its acceleration $= g$ (downwards)

Let, the force acting on body due to spring is " F "

$\therefore\ (50\ g) - F = (50)a$

$\Rightarrow 50\ g - F = 50\ g$

$\Rightarrow F = 0$

Thus, no force is acting on the body due to spring. So, the reading of spring balance is zero.

6. (a) Power $= \frac{\text{work done}}{\text{time taken}}$

$P = \frac{mgh}{t}$

$P = \left(\frac{m}{t}\right) gh$

$h = 25 + 35 = 60$ m.

Flow rate $= \left(\frac{m}{t}\right) = 6$ tones $/20$ min

$= \frac{6000}{20 \times 60} \frac{kg}{sec} = 5\ kg/sec$

$\therefore\ P = 5 \times 10 \times 60$

$= 3000\ W$

$= 3kw$

7. (c) As there is no force in horizontal direction, so there will be no acceleration of COM in horizontal direction. As for vertical direction only gravitational force acts on both the balls, hence acceleration of COM will be equal to acceleration due to gravity which is ' g '.

8. (d) Acceleration due to gravity at a depth "d":

$g_d = g\left(1 - \frac{d}{R_e}\right)$

$d \rightarrow 1600$ km
$Re \rightarrow 6400$ km
$g \rightarrow 9.8\ m/s^2$

$\Rightarrow g_d = 9.8\left(1 - \frac{1600}{6400}\right)$

$\Rightarrow g_d = 7.35\ m/s^2$

9. (a) Young's modulus is defined as the ratio of tensile stress to tensile strain or longitudinal strain

10. (c) Hydraulic lift works on the principle of equal transmission throughout a fluid i.e. pascal's law.

11. (b) Specific heat capacity: $S = \left(\frac{Q}{m\Delta T}\right)$

$Q \rightarrow$ Amount of heat absorbed

$M \rightarrow$ Mass of the substance

$\Delta T \rightarrow$ Change in temperature of the substance

$\therefore$ SI unit of $S \rightarrow JKg^{-1}\ K^{-1}$

12. (d) Efficiency of carnot's engine; $\eta = 1 - \frac{T_{Lower}}{T_{Higher}}$

Now, let's check options.

$\therefore$ (A) $\rightarrow \eta_A = 1 - \frac{40}{60} = 0.33$

(B) $\rightarrow \eta_B = 1 - \frac{20}{40} = 0.5$

(C) $\rightarrow \eta_c = 1 - \frac{60}{80} = 0.25$

(D) $\rightarrow \eta_d 1 - \frac{80}{100} = 0.2$

13. (b) Mean energy of a molecule of an ideal gas:

$E = \frac{1}{2} m V_{rms}^2$

Rms velocity of molecules: $V_{rms} = \sqrt{\frac{3KT}{m}}$

$\therefore \quad E = \frac{1}{2} \times m \times \left(\frac{3KT}{m}\right)$

$\therefore \quad E = \frac{3}{2} KT$

14. (b) Time period of simple pendulum: $T = 2\pi\sqrt{\frac{\ell}{g}}$

$\Rightarrow \frac{\ell_A}{\ell_B} = \left[\frac{T_A}{T_B}\right]^2$

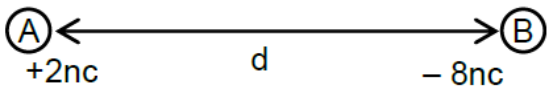
Time period of A: $T_A = \frac{20}{10} = 2sec$

Time period of B : $T_B = \frac{10}{8} = \frac{5}{4} sec$

$\therefore \frac{\ell_A}{\ell_B} = \frac{64}{25}$

15. (b) The waves set up in a closed pipe are longitudinal and stationary because of superposition of incident wave and reflected wave.

16. (b) CASE- I



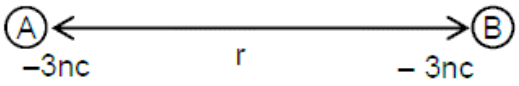
$F = \frac{Kq_A q_B}{r^2}$

$\Rightarrow F = \frac{K.2.8}{d^2}$

$\Rightarrow F = \frac{16\ K}{d^2}$

CASE – II (A)(B)

$q_A = q_B = \frac{2-8}{2} = \frac{-6}{2} = -3nc$



$q_A = q_B = \frac{2-8}{2} = \frac{-6}{2} = -3nc$

(A) $\underset{-3nc}{\leftarrow}$ (B)

$F' = \frac{K(3)(3)}{r^2}$

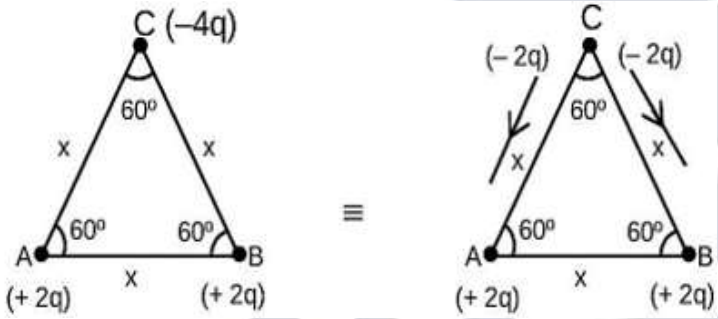
But $F = \frac{16k}{d^2}$

$\Rightarrow \frac{16k}{d^2} = \frac{9k}{r^2}$

$\Rightarrow r^2 = \frac{9}{16} d^2$

$\Rightarrow r = \frac{3}{4} d$

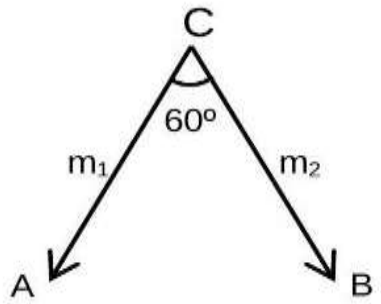
17. (b)



As evident from the diagram above, we can consider two dipoles one CA and CB.

M_1 : Dipole moment of CA $= 2q \times$ (from C to A)

M_2 : Dipole moment of CB $= 2qx$ (from C to B)



$\therefore$ Net dipole moment $= \sqrt{m_1^2 + m_2^2 + 2\, m_1\, m_2 \cos 60°}$

$= \sqrt{m_1^2 + m_2^2 + 2m_1m_2 \times \frac{1}{2}}$

$= \sqrt{m_1^2 + m_2^2 + m_1m_2}$

$= \sqrt{4q^2x^2 + 4q^2x^2 + 4q^2x^2}$

$= 2\sqrt{3}qx$

18. (b) Total charge removed from sphere = ne

$= (4 \times 10^{10}) \times (1.6 \times 10^{-19})$
$= 6.4 \times 10^{-9}\text{C}$

Distance of point from centre of sphere = 20 cm = 0.2 m

∴ Electric field: $E = \frac{kq}{r^2}$

$\Rightarrow E = \frac{9 \times 10^9 \times (6.4 \times 10^{-9})}{(0.2)^2}$

$= 1440\ \text{N/C}$

19. (a) Potential energy of system: $u = \frac{KQ_AQ_B}{d}$

Initial distance between charges → 5 cm = 0.05 m

$U_{initial} = \frac{(9 \times 10^9) \times (3 \times 10^{-9}) \times (1 \times 10^{-9})}{0.05}$
$= 5.4 \times 10^{-7}\ \text{J}$

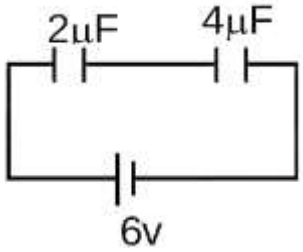
Final distance between charged → 5 − 1 = 4 cm = 0.04 m

∴ $U_{final} = \frac{(9 \times 10^9) \times (3 \times 10^{-9}) \times (1 \times 10^{-9})}{0.04}$
$= 6.75 \times 10^{-7}\ \text{J}$

Work done: $W = uf_f - u_i$

∴ $W = (6.75 - 5.4) \times 10^7$
$= 1.35 \times 10^7\ \text{J}$

20. (c) Equivalent capacitance: $C_{eq} = \frac{C_1C_2}{C_1+C_2} = \frac{2\times4}{2+4}$



$C_{eq} = \frac{4\mu F}{3}$

∴ Charge: q = cv

$\Rightarrow Q = \frac{4}{3} \times 6 = 8\mu C$

Energy stored: $E = \frac{1}{2}CV^2 = \frac{1}{2} \times \frac{4}{3}(6^2) = 24\mu J$

21. (a) Minimum capacitance can be obtained by connecting these three capacitors in series

$$\Rightarrow \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$
$$= \frac{1}{1} + \frac{1}{2} + \frac{1}{4}$$
$$= \frac{7}{4}$$
$$\Rightarrow C_{eq} = \frac{4}{7}\text{pF}$$

22. (a) Current density: $J = \frac{I}{A}$

Current: $I \longrightarrow 90\text{ mA} = 90 \times 10^{-3}\text{ A}$

Diameter of wire: $d = 0.1\text{ mm} = 10^{-4}\text{ m}^2$

Cross section area of wire; $A = \frac{\pi d^2}{4}$

$$A = \frac{3 \times (10^{-4})^2}{4} = 0.75 \times 10^{-8}\text{ m}^2$$
$$\therefore J = \frac{90 \times 10^{-3}}{0.75 \times 10^{-8}} = 1.2 \times 10^7\text{ A/m}^2$$

23. (d) Resistance of copper wire: $R = \frac{\rho L}{A}$

$\rho \rightarrow$ Resistivity of material and is constant

L → Length of wire

A → Cross sectional area of conductor

$$A = \frac{\pi d^2}{4}$$

D → diameter of wire

$$\Rightarrow R \propto \frac{L}{d^2}$$

Now, let's check the options

(A) $R_A \propto \frac{L}{d^2}$

(B) $RB_B \propto 2\frac{L}{d^2}$

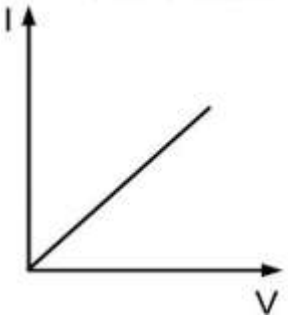
(C) $R_B \propto \frac{1}{8}\frac{L}{d^2}$

(D) $RD_D \propto 8\frac{L}{d^2}$

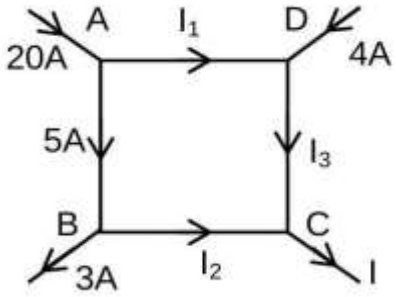
24. (c) Ohmic device, obey ohm's law, i.e.

$$V = IR$$
$$\Rightarrow \quad V \propto I \quad (R \rightarrow \text{constant})$$

$\therefore$ I – V characteristic will be straight line



25. (b) We will use concepts of KCL i.e. $I_{in} = I_{out}$ at a junction



Using KCL at A $\Rightarrow$ $20 = 5 + I_1$
$I_1 = 15$ A

Using KCL at B $5 = 3 + I_2$ $\Rightarrow$ $I_2 = 2$ A

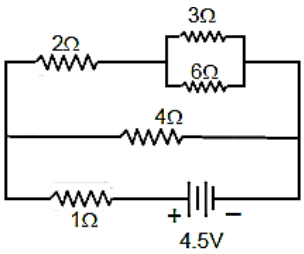
Using KCL at D $I_1 + 4 = I_3$

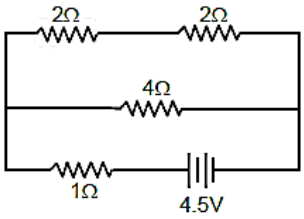
$I_3 = 15 + 4$

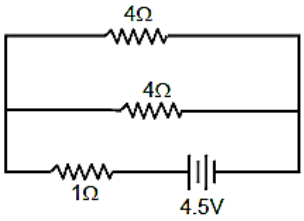
$\Rightarrow$ $I_3 = 19$ A

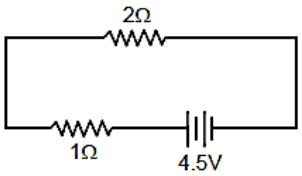
Using KCL at C $I = I_2 + I_3$ $\Rightarrow$ $I = 2 + 19$
$\Rightarrow$ $I = 21$ A

26. (a) The given circuit can be redrawn as



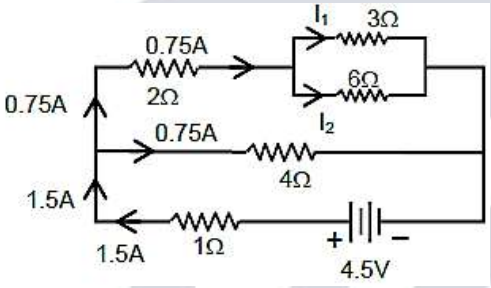
$\Rightarrow$ 

$\Rightarrow$ 

$\Rightarrow$ 

$\Rightarrow \quad I = \dfrac{V}{R} = \dfrac{4.5}{2+1}$

$\Rightarrow \quad I = \dfrac{4.5}{3} = 1.5A$

Again 

$I_1 = I \times \dfrac{6}{3+6} = 0.75 \times \dfrac{6}{9}$

$\Rightarrow I_1 = 0.5\ A$

Power in $3\Omega = I_1^2 R = (0.5)^2 \times 3 = 0.75\ W$

27. (a)

$$\frac{R_{unknown}}{R_{standard}} = \frac{\ell}{(1-\ell)}$$

As temperature increase P Resistance increases

$\Rightarrow \dfrac{R_{unknown}}{R_{standard}}$ Increases $\Rightarrow \dfrac{\ell}{(1-\ell)}$ Increases

$\Rightarrow (1-\ell)$ should decrease $\Rightarrow (\ell > 1)$

28. (a) $v = \dfrac{qBr}{m} \Rightarrow r = \dfrac{mV}{qB}$

$P = mV = \sqrt{2mE}$, E is same (kinetic energy)

$$r = \frac{\sqrt{2mE}}{qB}$$

$r \propto \frac{\sqrt{m}}{q}$

Or $r = \sqrt{\frac{m}{q^2}}$

$r_p : r_d : r_\alpha = \sqrt{\frac{m}{e^2}} : \sqrt{\frac{2\,m}{e^2}} : \sqrt{\frac{4\,m}{4e^2}}$

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

29. (b) Total internal resistance $= G + R$

$= 50 + 2950 = 3000\Omega$

Current; $I = \frac{3}{3000} = 10^{-3}$ A $= 1$ mA.

If the deflection is to be reduced to 20 divisions

$\Rightarrow I' = \frac{1 \text{ mA}}{30} \times 20 = \frac{2}{3}$ mA

Let x be the effective resistance of the circuit.

$\therefore\ 3 \text{ V} = 3000\Omega \times 1 \text{ mA} = x\Omega \times \frac{2}{3}$ mA

$\Rightarrow x = 4500\Omega$
$= 4450\Omega$
$\approx 4440\Omega$

30. (a) For a circular current carrying loop of radius R

$B_{centre} = \frac{\mu_0 i}{2R}$

$B_{axis} = \frac{\mu_0 i R^2}{2(R^2+x^2)^{3/2}}$ [at a distance x from the centre]

Given B centre $= 5\sqrt{5}$ Baxis

$$\frac{\mu_0 i}{2R} = 5\sqrt{5}\frac{\mu_0 i R^2}{2(R^2+x^2)^{3/2}}$$

$$\Rightarrow \frac{(R^2+x^2)^3}{R^6} = 125$$

$$\Rightarrow \frac{R^2+x^2}{R^2} = 5$$

$$\Rightarrow \frac{x^2}{R^2} = 4$$

$$\Rightarrow x = 2R$$

$$\Rightarrow x = 2 \times 10 = 20 \text{ cm} = 0.2 \text{ m}$$

31. (a) For equilibrium

$F_B = mg$

$Bil = mg$

$$\Rightarrow m = \frac{Bil}{g}$$

$$\Rightarrow m = \frac{(0.5) \times (2.5) \times (50 \times 10^{-2})}{10} = 62.5\ g$$

32. (d) A bar magnet can produce magnetic field. Option (d) is False

33. (c) Time period of oscillation

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$= 2\pi\sqrt{\frac{12 \times 10^{-6}}{(6 \times 10^{-2})(2 \times 10^{-2})}}$$

$$= 2\pi\sqrt{\frac{12 \times 10^{-6}}{12 \times 10^{-4}}}$$

$$= 2\pi \times 10^{-1}$$

$\therefore$ For 20 oscillations

$$T' = 20 \times 2\pi \times 10^{-1}$$

$$T' = 12sec$$

34. (a) Susceptibility of Ferromagnetic substance is $>>> 1$, because it is strongly attracted in an external magnetic field

35. (c) If the magnet is falling vertically down with its north pole towards the coil, then upper face of coil will become north pole, So that it can oppose the approaching north pole of the magnet. Here, the acceleration will be less than " g "

36. (b) Working of magnetic breaking in train is based on eddy current

37. (a) Voltage difference $= B\ell V\sin\theta$

$$= (4 \times 10^{-4}) \times (20) \times (400)\sin 30^\circ$$

$$= 1.6\ V$$

38. (b) When iron rod is inserted in the coil, then the inductive increases, hence the current flowing through the bulb decrease, therefore brightness decreases.

39. (c)

$$P = V.I.$$

$$\Rightarrow I = \frac{P}{V}$$

$$\Rightarrow I = \frac{12}{48} = 0.25\ A$$

$\therefore$ Peak current $= \sqrt{2}I$

$$= \sqrt{2} \times \frac{1}{4}$$

$$= \frac{1}{2\sqrt{2}}\ A$$

40. (b) $\omega = 2\pi f$

$$\omega = 2 \times 3.14 \times 50$$

$$\omega = 314$$

$$\tan\phi = \frac{xL}{R} = \frac{\omega L}{R} = \frac{1/\sqrt{3}}{1} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \phi = 30°$$

$$\Rightarrow \omega t = \frac{\pi}{6}$$

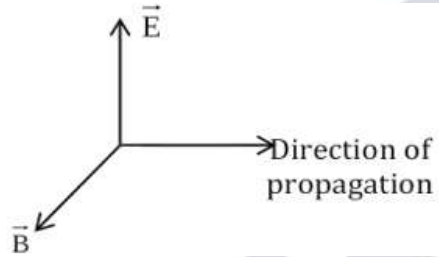
$$\Rightarrow t = \frac{\pi}{6 \times \omega}$$

$$\Rightarrow t = \frac{3.14}{6 \times 314}$$

$$t = \frac{1}{600}\text{sec}$$

41. (c) As we know, by property of electro-magnetic wave, the electric field, magnetic field & the direction of propagation, all the three are mutually perpendicular.

There by right hand thumb rule using the figure. $\vec{E} \times \vec{B}$



42. (c) In ray optics, all the directions in the direction of incident ray are taken as positive

43. (b) Using mirror formula

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{V}$$

$$\Rightarrow f = \frac{R}{2} = \frac{15}{2}$$

$$\Rightarrow \frac{1}{-15/2} = \frac{1}{-10} + \frac{1}{v}$$

$$\Rightarrow V = -30 \text{ cm}$$

$$\Rightarrow h_i = -3 \times 10$$

$$\Rightarrow h_i = -30$$

$\therefore$ Image will be magnified & inverted

44. (c) During scattering of light

Intensity: $I \propto \frac{1}{\lambda^4}$

45. (b) Fringe width: $w = \frac{D\lambda}{d}$

$$\Rightarrow w \propto \lambda$$

But $\lambda_{\text{yellow light}} > \lambda_{\text{Blue light}}$

$\Rightarrow$ Interference pattern will become narrower

46. (a) Refractive index of medium

$\mu = \frac{C}{V}$

$C \rightarrow$ speed of light in vacuum or air

$V \rightarrow$ speed of light in medium

Above equation implies that speed of light decrease when it goes from rarer medium (air) to denser medium

Also; $\lambda = \frac{v}{f}$

$\lambda =$ wave length, $f \rightarrow$ frequency

Frequency remains the same for all medium unless source of light is disturbed

$\Rightarrow \lambda \propto V$

$\Rightarrow$ Wave length decreases.

47. (a) From, Malus law

$I = I_0 \cos^2 \theta$

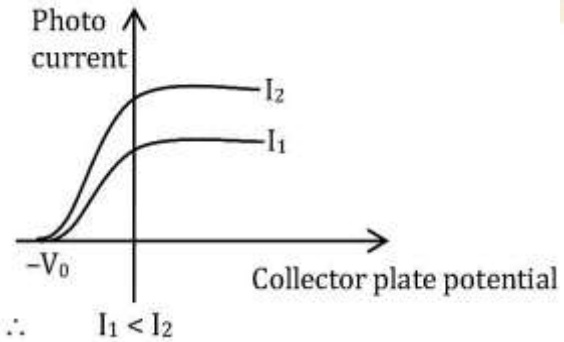
There; $I = \frac{I_0}{2}$

$\Rightarrow \frac{I_0}{2} = I_0 \cos^2 \theta$

$\text{Cos}\,\theta = \frac{1}{\sqrt{2}}$

$\Rightarrow \theta = 45^\circ$

48. (c) The value of photo current depends on intensity of incident light. So, when the intensity of incident light increases, then the value of photo current is increases. Intensity of light α photo current



$\therefore \quad I_1 < I_2$

49. (d) From de-broglie expression $\lambda = h/mv$

$\lambda = \frac{h}{m\sqrt{2gH}}$

$\Rightarrow \lambda \propto H^{-1/2}$

50. (b) Rutherford is credited with the discovery of nucleus in an atom.

51. (a) The expression of energy is

$$E_n = \frac{13.6}{n^2}$$

$\therefore$ required energy

$$\begin{aligned} E &= E_2 - E_4 \\ &= \frac{13.6}{(2)^2} - \frac{13.6}{(4)^2} \\ &= +2.55 \end{aligned}$$

52. (b) In a nuclear reactor, the function of moderator is to decrease the speed of neutrons.

53. (a)

$$^{238}_{92}U \xrightarrow{\alpha} {}^{234}_{90}U \xrightarrow{\beta} {}^{234}_{91}U \xrightarrow{\beta} {}^{234}_{92}U$$

$\therefore$ 1α and 2β particles

54. (b) Mass defect of ^4_2He; $\Delta M = 0.03u$

$\therefore$ Binding energy of helium: $E = \Delta M \times 931MeV$

$E = 0.03 \times 931.5 = 27.93MeV$

$\therefore$ Number of nucleons in helium; $n = 4$

Binding energy per nucleon $= \frac{E}{n} = \frac{27.93}{4} = 6.9825$

55. (d) In Germanium energy gap is less than 3eV

56. (c) Zener diode is used as a voltage regulated as in reverse biased condition it exhibits constant voltage

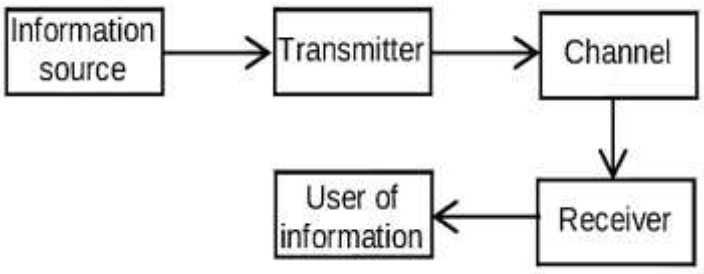
57. (a) In case of transistor, emitter is of moderate size and heavily doped so as to supply large number of majority charge carriers for current flow.

58. (b) The voltage drop across AB by using KVL is as follows:

$$\begin{aligned} V_{AB} &= (0.2 \times 10^{-3} \times 5 \times 10^3) + 0.2 + (0.2 \times 10^{-3} \times 5 \times 10^3) \\ &= 1 + 0.2 + 1 \\ &= 2.2\ V \end{aligned}$$

59. (d) NAND and NOR gate are considered as universal gates. Out of the given options, an option d is NAND gate.

60. (b) The block diagram of communication system is as follows:



Chemistry

61. (b) Number of moles of H_2SO_4 left $= N/Na$

Now, finding N

For 98gm of H_2SO_4 the molecules are 6.02×10^{20}

H_2SO_4 left $= 6.02 \times 10^{20} - 3.01 \times 10^{20} = 3.01 \times 10^{20}$

Number of moles of H_2SO_4 left $= N/NA$

$= 3.01 \times 10^{20}/6.02 \times 10^{23} = 0.5 \times 10^{-3}$ mol

62. (c) For finding out unpaired electron of chlorine atom we have to find electronic configuration

$Cl = 1\ S^2 2\ S^2 2P^6 3\ S^2 3P^5$

$n = 3, l = 1, m = 1, s = \pm\frac{1}{2}$

63. (c) As we move down the group, the electro negativity increase $Si < P < C < N$

64. (c) It is given that there are total three bond pairs and one lone pair

$\therefore$ Total electron pair is 4 which shows sp^3 hybridization

$\because$ It is given that one lone pair is also present than geometry will be pyramidal

65. (b, c) The structure of $\cdot\cdot N \equiv \overset{+}{N} - \overset{-}{\circ}: [NO_2]$

Positive charge is on N atom due to its less electro negativity than oxygen. The structure in option C is also a stable configuration since octets of nitrogen and oxygen are fulfilled and no charge separation is there.

66. (a) The intermolecular attraction between the particles of real gas in much less hence the pressure of real gas is less than that of ideal gas. Their energy is less $\because$ they do not collide with each other at an impact. The pressure of real gases is less than that of ideal gas because of intermolecular attraction.

67. (b) We know, $\Delta G = \Delta H - T\Delta S$

Given ΔH and ΔS are negative.

Therefore, expression will be

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

By seeing the above equation for negative ΔG the value of ΔS must be less than ΔH.

$\Delta H > T\Delta S$

So, the reaction will be exothermic If the reaction is exothermic then, it's rate will increase with decrease in temperature.

68. (d) Equilibrium constant does not depend on catalyst.

So, value of constant is same that is 4×10^{-4}

69. (d) If the reaction is in reverse direction then reaction quotient is greater than equilibrium constant $Q_c > K_c$

If the reaction is in equilibrium then reaction quotient is equal to equilibrium constant $Q_c > K_c$

$\therefore$ If $Q_c > K_c$. Reaction is forward

70. (b) $3ClO^-_{((aq)} \longrightarrow ClO^- + 2Cl^-$

The oxidation state of chlorine changes from +1 to -1

∴ This reaction is an example of reduction reaction.

71. (a) $ACO(g) + H_2O(g) \overset{670\ K}{\rightarrow} CO_2(g) + H_2(g)$

The reaction shown above is reaction of manufacturing of hydrogen from water gas. Here, CO is oxidized to CO_2 with steam in the presence of catalyst. Then absorption of CO_2 in alkali takes place.

So answer is CO is oxidized to CO_2.

72. (a) The formula for plaster of paris is $CaSO_4 \cdot \frac{1}{2}H_2O$

73. (b) The reaction involved for addition of mineral acid to aqueous solution of borax is

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \rightarrow Na_2SO_4 + 4H_3BO_3$$

(Borane) (Acid) (orthoboric acid)

So, orthoboric acid is formed as a product.

74. (c) Position isomers are those in which both compounds have different position of a substituent but have same parent chain and functional group.

$$CH_3-CH_2-CH_2-OH \;\&\; CH_3-\underset{\underset{OH}{|}}{CH_2}-CH_3$$

∴ Propan-l-ol and propan-2-ol are position isomers.

75. (c) Homolytic bond fission takes place when the bonded molecules are of same or almost equal electro negativity or where bonding pair of electrons move independently. So, in free radical chlorination of methane homolytic fission takes place.

The mechanism is shown below.

$$Cl_2 \xrightarrow{light} 2Cl^{\bullet}$$

$$Cl + CH_4 \longrightarrow HCl + CH_3^{\bullet}$$

$$Cl_2 + CH_3 \longrightarrow CH_3Cl + Cl^{\bullet}$$

At termination the reactions are

$$2Cl^{\bullet} \longrightarrow Cl_2$$

$$Cl^{\bullet} + CH_3^{\bullet} \longrightarrow CH_3 - Cl$$

$$2\,CH_3^{\bullet} \longrightarrow CH_3 - CH_3$$

So, answer is "free radical chlorination of Methane".

76. (d) In electrolysis of salts new bond is created

The reaction is

$RCOO^{-}\overset{\oplus}{Na} \xrightarrow{\text{electrolysis}} \text{alkenes}$

Or $-CO_2$

$RCOO^{-}\ K^{+}$ $-NaOH$

$-H_2$

So, aqueous solutions of sodium and potassium salts of carboxylic acid undergo electrolysis for preparation of alkenes.

77. (d) Ozone, nitrogen, PAN, oxygen and some organic compounds are the pollutants in photochemical smog. Photochemical smog does not include chloro flouro carbons.

78. (a) Given that $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90$

Then the unit cell must be triclinic

$\because$ $K_2Cr_2O_7$ has triclinic unit cell then.

$\alpha \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90$

79. (b) Since, in Frenkel defect, the smallest ion gets dislocated to its interstitial site hence, Frenkel defect is termed as dislocation defect as well.

80. (a) Given that it is face centered cubic cell and A atoms are at the corners of unit cell

$\because$ One of A atom is missing from one corner in unit cell then, there are 7A atoms with total contribution.

$7 \times \frac{1}{8} = \frac{7}{8}$

B atoms are at face centers.

$\because$ There are 6 face centers. Each contributes $\frac{1}{2}$. So, total contribution will be $6 \times \frac{1}{2} = 3$

$A: B = \frac{7}{8} : 3 \Rightarrow 7:24$

The simplest formula of compound is $A_7\ B_{24}$

81. (d) NH_4Cl dissociation in aqueous solution is as follows:

$NH_4Cl \rightarrow NH_4^+ + Cl^-$

Lesser the number of particles available higher will be the freezing point.

Here $i = 2$ which is least among all so it has highest freezing point.

82. (b) Vant-Hoff's factor 'i' accounts for extent of dissociation of solute

83. (b) Reverse osmosis is the process in which pure solvent diffuses out of the solution through the semi-permeable membrane.

84. (a) The reducing agent will be stronger when its reduction potential is more negative.

$\therefore$ zinc is strongest reducing agent as its value of reducing potential is highly negative (0.762 v)

85. (c) The reaction is

$NaClO_3 + H_2O \rightarrow NaClO_4 + H_2$

Here, the oxidation number changes from +5 to +7 so, two electrons are involved in the reaction.

Thus, 2 Faraday of charge will form one mole of $NaClO_4$.

$\therefore$ 3 Faraday of charge will form $\frac{1}{2} \times 3 = 1.5$ mole of $NaClO_4$.

86. (d) Half- cell reduction reaction at cathode is

$$H_2O(l) + e^- \longrightarrow \frac{1}{2}H_2 + OH^-$$

The standard reduction potential of above reaction is 0 volts. The half- cell oxidation reaction at anode is shown below.

$$Cl^-(aq) \rightarrow \frac{1}{2}Cl_2 + e^-$$

The standard reduction potential of above reaction is 1.36 volts

87. (a, b)

$\because$ The expression for Arrhenius equation is $k = Ae^{-\epsilon a/RT}$

By seeing above equation, we can conclude that the rate of reaction depends upon activation energy and temperature. It is clear that the rate of reaction will increase as the activation energy decreases and temperature increases. The rate of reaction depends upon activation energy and temperature, increases with increase in temperature & decrease in activation energy.

88. (a) The rate law for chemical reaction is equation that links the initial reaction rate with concentration of reactants. For many reactions the initial rate is given by $V_0 = k[A]^x[B]^y$ hence, rate law for any reaction can be determined experimentally.

89. (b) The given equation is $\frac{1}{2}$ A $\rightarrow$ 2 B

The rate of reaction is

Rate of disappearance of products = Rate of formation of products.

$$\text{Rate} = -2\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}$$

$\therefore$ Rate of disappearance of A is

$$-\frac{d[A]}{dt} = \frac{1}{4}\frac{d[B]}{dt}$$

90. (a) When river meets the sea the colloidal particles are coagulated by electrolyte available in sea, due to which the colloidal particles settle down during meet time. So, coagulation occurs.

91. (a) For finding solution we have to write the equation of hydrogenation of vegetable oils $oil(l) + H_2(g) \xrightarrow[\Delta]{Ni(s)}$ vegetable ghee (s).

Here, we can see that the phases of reactant and catalyst are different so, the reaction is heterogeneous catalysis.

92. (a) Since physical adsorption is an exothermic process so it is favored at low temperature. Further Le chatelier's principle states that with the increase in temperature, the extend of adsorption decreases. So, high temperature is not favorable for physical adsorption.

93. (b) The reactions involved in process of leaching of cyanides are

$Ag_2S + 4NaCN \rightleftharpoons 2Na[Ag(CN)_2] + Na_2S$
$2Na[Ag(CN)_2] + Zn \rightarrow Na_2[2n(CN)_4] + 2Ag \downarrow$

So, silver is obtained by leaching with cyanide

94. (a) The reaction involved in extraction of chlorine from brine is

$2Cl^- + 2H_2O \rightarrow 2OH^- + H_2 + Cl_2$

So here oxidation of Cl^-ion to chlorine gas occurs.

95. (a) Since, size of nitrogen atom is very small

So, it is able to form $P\pi^- P\pi$ bond with itself and can accommodate other atoms of itself.

So, answer is nitrogen ' N '.

96. (d) Amphoteric oxides are those that can act as acid as well as base. When we move down the ' s ' group the acidic character of element decreases and basic character increases.

So, Al_2O_3 is amphoteric in nature.

97. (c) In reaction

$2NaOH + Cl_2 \rightarrow 2NaCl + H_2 + O_2$

The products formed are wrong the correct products will be

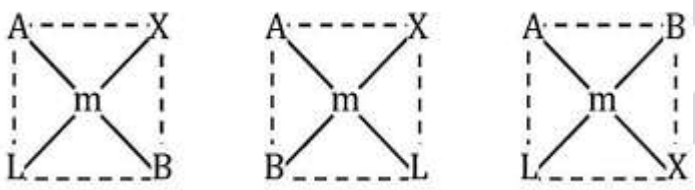
$2NaOH + Cl_2 \rightarrow 2NaCl + +NaOCl + H_2O$

98. (d) Helium is used for filling balloons and air ships since it is light in weight. It has property of diffusing through the materials such as rubber, glasses or plastid

99. (b) Magnetic character depends on number of unpaired electrons. 3 d^5 has five unpaired electrons. Therefore, its magnetic moment is highest.

100. (a) Lanthanoids are generally colourful since, vacant orbital's transition of electrons take place.

101. (a) MAXBL complex is shown below.



So, it can show two cis and one trans isomerism.

102. (a) $M - LM$ is metal and L is ligand According to crystal field theory M-L bond is purely ionic in nature, because there is electrostatic interaction among metal ions and ligands.

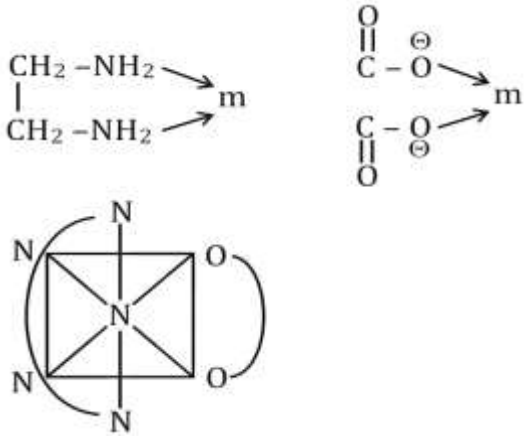
103. (a) $[M(en)(C_2O_4)]NO_2$

The general oxidation state for en $\rightarrow$ 2 for

$C_2O_4 = 0$ So, oxidation state of M will be

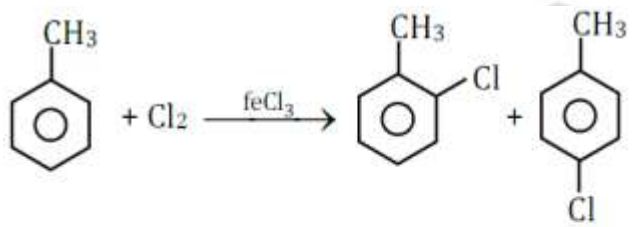
$x + 0 + 2x(-2) = 0 - 1x = 3$

Now finding coordination number



So, total coordination number is 6

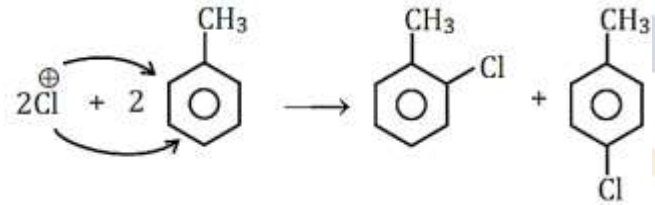
104. (b)



Mechanism

Step-(1)

Step-(2)



From step (1) we concluded that $Cl^+$is formed

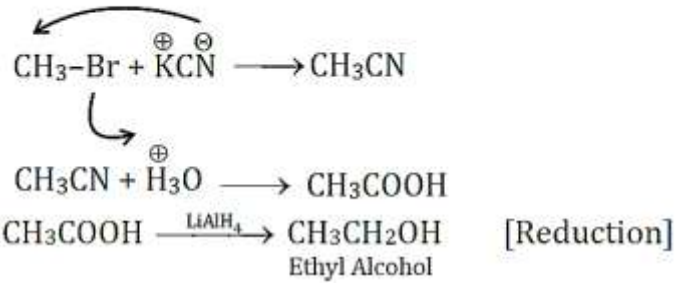
$\because$ Cl_2 has lone pair and $FeCl_3$ has vacant d-orbital so, lone pairs are transferred to its vacant orbital and $Cl^+$is create(d)

$\because$ $Cl^+$is electrophile substitutes with H^+so reaction is electrophilic substitution reaction.

105. (d)

$CH_3Br \xrightarrow{KCN} CH_3CN\ (A) \xrightarrow{H_3O^{\oplus}} CH_3COOH\ (B)$

$CH_3COOH \xrightarrow{LiAlH_4} CH_3CH_2OH$
(C)



106. **(b)** When the conjugate base is more stable then the compound is more acidi(c) The EWG makes conjugate base more stable.

So, correct order is

O-cresol< phenol< O-nitrophenol

107. **(b)** $KMnO_4$ is strong oxidizing agent so they convert alcohols to carboxylic acid

108. **(c)**

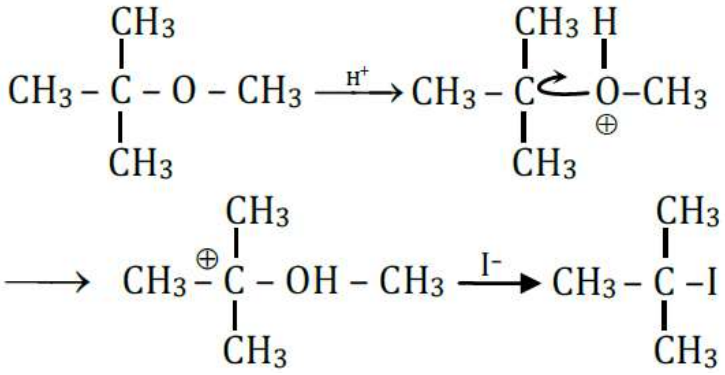
109. **(a)** Condition for H-Bonding are the compound have high electronegative atom linked to hydrogen atom. Further, the adjacent atom on us has lone pair of electrons. These conditions are fulfilled by lower carboxylic acids so here formation of H-Bond takes place.

110. **(c)** More the methyl groups, more the positive effect and more will be the availability of lone pair, hence compound will have more basic nature.

$NH_3 < CH_3NH_2 < (CH_3)_2NH$

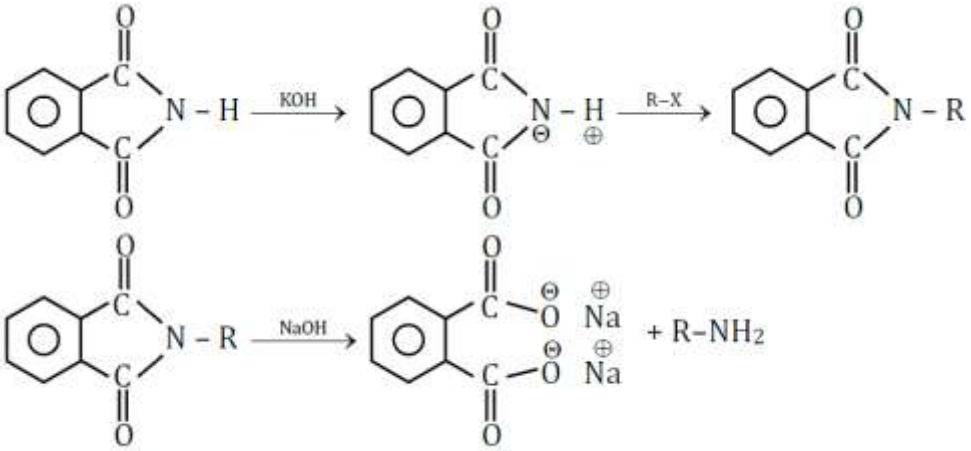
111. **(a)**

The reaction is



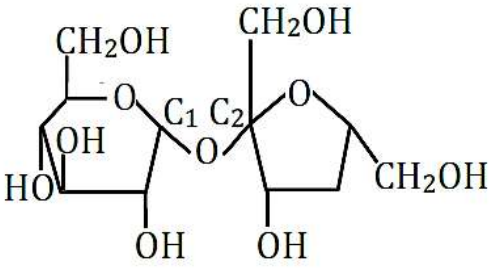
112. **(d)** Reduction of ketones cannot be carried out with hydrogen in presence of palladium in Barium Sulphate since this reagent is lindlar's catalyst and is used for selective reduction of alkynes to trans alkenes.

113. **(c)** Gabriel phthalimide synthesis: -



∴ HCl is not used

114. (a)

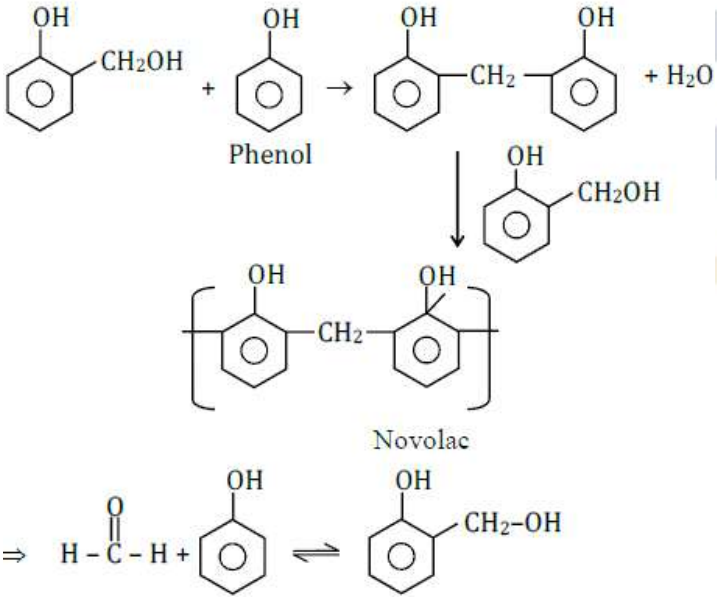


C_1 of α-glucose and C_2 of B-fructose

115. (b) Thyroxine is iodine containing hormone.

116. (d) Due to the deficiency of vitamin D, rickets is caused Deficiency of vitamin A, causes xerophthalmia Vitamin A is also known as retinol.

117. (a)



Formaldehyde phenol

So, monomers are phenol and formaldehyde.

118. (d) Glyptol is non-biodegradable polymer.

119. **(a)** Bacterial antibiotics can kill bacteria and inhibits their growth. Ofloxacin is fluoro quinolone carboxylic acid It's antibacterial. So, answer is ofloxacin.

120. **(d)**

Mathematics

121. **(c)** Consider the function $A \subset B$

$A \cap B = A$

$N(A \cap B) = n(A)$

Also,

$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$
$$= n(A) + n(B) - n(A)$$
$$= n(B)$$

122. **(b)**

$$\cos^2 45^\circ - \sin^2 15^\circ$$
$$\Rightarrow \cos(45^\circ + 15^\circ)\cos(45^\circ - 15^\circ) \{\because \cos^2 A - \sin^2 B = \cos(A+B)\cos(A-B)\}$$
$$= \cos 60^\circ \cos 30^\circ$$
$$= \left(\frac{1}{2}\right)\left(\frac{\sqrt{3}}{2}\right)$$
$$= \frac{\sqrt{3}}{4}$$

123. **(a)**

$3 + 5 + 7 + \ldots\ldots\ldots\ldots + n$

$(a = 3, d = 2)$

$$S_n = \frac{n}{2}[2a + (n-1)d]$$
$$S_n = \frac{n}{2}[2(3) + (n-1)(2)]$$
$$S_n = \frac{n}{2}[6 + 2n - 2]$$
$$S_n = \frac{n}{2}[4 + 2n]$$
$$S_n = n(n+2)$$

124. **(c)** Consider the equation

$\left(\frac{1+i}{1-i}\right)^m = 1$

$\Rightarrow \left(\frac{1+i}{1-i} \times \frac{1+i}{1+i}\right)^m = 1$

$\Rightarrow \left(\frac{(1+i)^2}{1-i^2}\right)^m = 1 \{\because i^2 = -1\}$

$\Rightarrow \left(\frac{1+2i-1}{1+1}\right)^m = 1$

$\Rightarrow \left(\frac{2i}{2}\right)^m = 1$

$\Rightarrow (i)^m = 1$

$\Rightarrow (i)^m = 1^4$

$\Rightarrow m = 4$

125. (a)

$|x-2| \leq 1$

$-1 \leq x-2 \leq 1$

$-1+2 \leq x \leq 1+2$

$-1 \leq x \leq 3$

Thus, $x \in [1,3]$

126. (d)

It is known that if,

${}^nC_x = {}^nC_y$

Then $x + y = n$
Now ${}^nC_{12} = n_8$
So $12 + 8 = n$
$n = 20$

127. (a) Consider the expansion $(x+a)^{47} - (x-a)^{47}$

Here, $n = 47$ which is odd

The total number of term in the expansion is,

$$\text{Total term} = \frac{n+1}{2}$$
$$= \frac{47+1}{2} = \frac{48}{2} = 24$$

128. (a) The equation of line $y = 3x - 1$

Slope of the line is $m = 3$

The slope of the line perpendicular to the given line $m_1 = -\frac{1}{m}$

$m_1 = -\frac{1}{3}$

The equation of required line is

$$(y - y_1) = m_1(x - x_1)$$
$$\Rightarrow (y - 2) = -\frac{1}{3}(x - 1)$$
$$\Rightarrow 3y - 6 = -x + 1$$
$$x + 3y - 7 = 0$$

129. (**a**)

The equation of ellipse

$$\Rightarrow \frac{x^2}{36} + \frac{y^2}{16} = 1$$

$$\Rightarrow \frac{x^2}{(6)^2} + \frac{y^2}{(4)^2} = 1$$

So, $a = 6$

$b = 4$

Eccentricity $(e) = \sqrt{1 - \frac{b^2}{a^2}}$

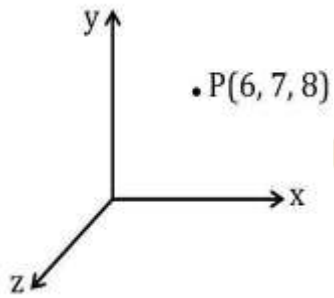
$$= \sqrt{1 - \frac{4^2}{6^2}} = \sqrt{1 - \frac{16}{36}} = \sqrt{\frac{20}{36}} = \frac{2\sqrt{5}}{6}$$

130. **(a)** The given point is P(6,7,8)

Distance of any point from xy-plane $= |z|$

$D = |z|$

$D = |8|$



$D = 8$

131. **(a)**

$$L = \lim_{\theta \to 0} \frac{1 - \cos 4\theta}{1 - \cos 6\theta}$$

$$= \lim_{\theta \to 0} \frac{1 - 1 + 2\sin^2 2\theta}{1 - 1 + 2\sin^2 3\theta} \{\because \cos 2A = 1 - 2\sin^2 A\}$$

Let

$$= \lim_{\theta \to 0} \frac{2\sin^2 2\theta}{2\sin^2 3\theta}$$

$$= \lim_{\theta \to 0} \left(\frac{\sin 2\theta}{2\theta}\right)^2 \left(\frac{3\theta}{\sin 3\theta}\right)^2 \left(\frac{4}{9}\right)$$

$$= (1) \cdot (1) \cdot \left(\frac{4}{9}\right) = \frac{4}{9}$$

132. **(d)** The contrapositive statement of the statement "If x is a prime number then x is odd" is "If x is not odd then x is not a prime number.

133. **(a)** The coefficient of variation is $CV = 60$ and the standard deviation is $\sigma = 24$

Coefficient of variation $= \frac{\sigma}{\bar{x}} \times 100$

$$60 = \frac{24}{\bar{x}} \times 100$$

$$\bar{x} = \frac{24}{60} \times 100$$

$$\bar{x} = 40$$

134. **(b)**

Let $y = f(x) = \sqrt{9 - x^2}$

Squaring both side

$y^2 = 9 - x^2$

$x = \sqrt{9 - y^2}$

Now,

$9 - y^2 \geq 0$

$\Rightarrow (3 - y)(3 + y) \geq 0$

$\Rightarrow (y - 3)(y + 3) \leq 0$

$y \in [0,3]$

So $f(x) \in [0,3]$

135. **(d)** Given function $f(x) = x^4$

Let $f(x_1) = x_1^4$

And

$F(x_2) = x_2^4$

So, $f(x_1) = f(x_2)$

$x_1^4 = x_2^4$

$x_1 = \pm X2$

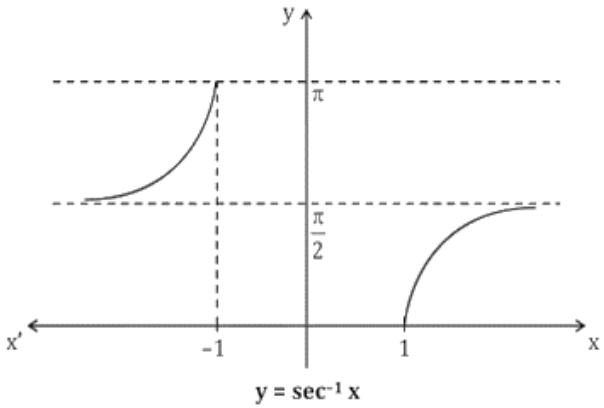
So f(x) is not one-one.

The co-domain of f(x) is R and the range is $f(x) \in [0, \infty)$

Since co-domain is not equal to the range of the function.

Thus, the function is not onto.

136. **(d)** The graph of $\sec^{-1} x$



The range of the $\sec^{-1} x$ is $[0, \pi] - \left\{\frac{\pi}{2}\right\}$

137. **(b)** Given function

$$\tan^{-1} x + \tan^{-1} y = \frac{4\pi}{5}$$

$$\Rightarrow \frac{\pi}{2} - \cot^{-1} x + \frac{\pi}{2} - \cot^{-1} y = \frac{4\pi}{5} \quad \left\{Q \tan^{-1} x + \cot^{-1} x = \frac{\pi}{2}\right\}$$

$$\Rightarrow \cot^{-1} x + \cot^{-1} y = \pi - \frac{4\pi}{5}$$

$$\cot^{-1} x + \cot^{-1} y = \frac{\pi}{5}$$

138. **(a)** Given function

Given function

$f(x) = 8x^3$

And $g(x) = x^{1/3}$

Now, $fog(x) = f[g(x)]$

$= f[x^{1/3}]$

$= 8(x^{1/3})^3$

$= 8x$

139. **(d)**

140. **(b)** Let A be a matrix that is both symmetric and skew symmetric Therefore,

$A' = A$

And $A' = -A$

This case is only possible when A is a zero matrix.

141. (a)

$$2\begin{bmatrix}1 & 3\\ 0 & x\end{bmatrix}+\begin{bmatrix}y & 0\\ 1 & 2\end{bmatrix}=\begin{bmatrix}5 & 6\\ 1 & 8\end{bmatrix}$$
$$\begin{bmatrix}2 & 6\\ 0 & 2x\end{bmatrix}+\begin{bmatrix}y & 0\\ 1 & 2\end{bmatrix}=\begin{bmatrix}5 & 6\\ 1 & 8\end{bmatrix}$$
$$\begin{bmatrix}2+y & 6\\ 1 & 2x+2\end{bmatrix}=\begin{bmatrix}5 & 6\\ 1 & 8\end{bmatrix}$$

So

$$2+y=5 \qquad 2x+2=8$$
$$y=3$$
$$2x=6$$
$$x=3$$

142. (c) Given that

$$a*b=\frac{a}{b+1} \quad \ldots\ldots\ldots (1)$$

So

$$b^{*}a=\frac{b}{a+1} \ldots\ldots\ldots (2)$$

Thus

$$a*b\neq b*a$$

Hence, the operation is not commutative.

Now,

$$a*(b*c)=a*\left(\frac{b}{c+1}\right)$$
$$=\frac{a}{\left(\frac{b}{c+1}\right)+1}$$
$$=\frac{a(c+1)}{b+c+1}$$

and

$$(a*b)*c=\left(\frac{a}{b+1}\right)*c$$
$$=\frac{\frac{a}{b+1}}{c+1}$$
$$=\frac{a}{(b+1)(c+1)}$$

So $a*(b*c)=(a*b)*c$

Hence, the operation is not associative.

143. (d)

$$\begin{vmatrix}3 & x\\ x & 1\end{vmatrix} = \begin{vmatrix}3 & 2\\ 4 & 1\end{vmatrix}$$

$\Rightarrow 3 - x^2 = 3 - 8$

$\Rightarrow -x^2 = -8$

$\Rightarrow x^2 = 8$

$\Rightarrow x = \pm 2\sqrt{2}$

144. **(c)** For a n × n order matrix of degree 2.

$|KA| = K^n|A|$

Here n is the order of the matrix.

Since the matrix of the 3×3

$|KA| = K^3|A|$

145. **(a)** The vertices of the triangle are $(K, 0), (4,0), (0,2)$

The area of the triangle is 4 sq. units.

$$\Rightarrow \Delta = \frac{1}{2}\begin{vmatrix}K & 0 & 1\\ 4 & 0 & 1\\ 0 & 2 & 1\end{vmatrix}$$

$$\Rightarrow 4 = \frac{1}{2}|[K(0-2) - 0(4-0) + 1(8-0)]|$$

$$\Rightarrow 4 = \frac{1}{2}|[-2K + 8]| \Rightarrow 8 = |-2K + 8|$$

$-2K + 8 = \pm 8$

Now,

$-2K + 8 = 8$
$-2K = 0$
$K = 0$

And

$-2K + 8 = -8$
$-2K = -16;\ K = 8$

146. **(b)**

$$\Delta = \begin{vmatrix}Ax & x^2 & 1\\ By & y^2 & 1\\ Cz & z^2 & 1\end{vmatrix}$$

And

$$\Delta_1 = \begin{vmatrix}A & B & C\\ x & y & z\\ zy & zx & xy\end{vmatrix}$$

Apply $C_1 \to xC_1, C_2 \to yC_2$ and $C_3 \to zC_3$

$$\Delta_1 = \frac{1}{xyz}\begin{vmatrix} Ax & By & Cz \\ x^2 & y^2 & z^2 \\ xyz & xyz & xyz \end{vmatrix}$$

$$\Delta_1 = \frac{xyz}{xyz}\begin{vmatrix} Ax & By & Cz \\ x^2 & y^2 & z^2 \\ 1 & 1 & 1 \end{vmatrix}$$

$$\Delta_1 = \begin{vmatrix} Ax & By & Cz \\ x^2 & y^2 & z^2 \\ 1 & 1 & 1 \end{vmatrix}$$

Since

$|A'| = |A|$

So,

$$\Delta_1 = \begin{vmatrix} Ax & x^2 & 1 \\ By & y^2 & 1 \\ Cz & z^2 & 1 \end{vmatrix}$$

$\Delta_1 = \Delta$

147. **(c)** $f(x) = \begin{cases} kx^2 & ; x \leq 2 \\ 3 & ; x > 2 \end{cases}$

The function is continuous at $x = 2$. So,

$\lim_{x\to 2} Kx^2 = \lim_{x\to 2} 3$

$K(2)^2 = 3$

$K = \frac{3}{4}$

148. **(a)** The mean value theorem is given as

$f'(c) = \frac{f(b) - f(a)}{b - a}$

Now,

$f(x) = x^2$
$f'(x) = 2x$

Therefore

$f'(c) = \frac{f(4) - f(2)}{4 - 2}$

$\Rightarrow 2c = \frac{16 - 4}{2}$

$\Rightarrow c = \frac{12}{4}$

$c = 3$

149. **(b)** The curve $y^2 = x$

Differentiate with respect to x

$$2y\frac{dy}{dx} = 1$$
$$\Rightarrow \frac{dy}{dx} = \frac{1}{2y}$$
$$\Rightarrow \tan\theta = \frac{1}{2y} \left\{Q\theta = \frac{\pi}{4}\right\}$$
$$\Rightarrow \tan\frac{\pi}{4} = \frac{1}{2y}$$
$$\Rightarrow 1 = 2y$$
$$\Rightarrow y = \frac{1}{2}$$

Thus,

$$\left(\frac{1}{2}\right)^2 = x \left\{Qy^2 = x \text{ and } y = \frac{1}{2}\right\}$$
$$x = \frac{1}{4}$$

The required point is $\left(\frac{1}{4}, \frac{1}{2}\right)$

150. **(a)**

$f(x) = x^2 + 2x - 5$

Differentiate with respect to x

$f'(x) = 2x + 2$

Now, function is strictly increasing

$$f(x) > 0$$
$$2(x + 1) > 0$$
$$x + 1 > 0$$
$$x > -1$$

The function is increasing in $(-1, \infty)$

151. **(b)** The volume of the sphere is

$$v = \frac{4}{3}\pi a^3$$

Differentiate with respect to a

$$\frac{dv}{da} = \frac{4}{3}\pi(3a^2)$$
$$\frac{dv}{da} = 4\pi a^2$$

The surface area of the sphere is

$s = 4\pi a^2$

Differentiate with respect to a

$$\frac{ds}{da} = 4\pi(2a)$$
$$\frac{ds}{da} = 8\pi a$$

Now, divide eq (1) by eq (2)

$$\frac{dv}{ds} = \frac{dv}{da} \times \frac{da}{ds}$$
$$\Rightarrow \frac{dv}{ds} = \frac{4\pi a^2}{8\pi a}$$
$$\Rightarrow \frac{dv}{ds} = \frac{a}{2}$$
$$\Rightarrow \frac{dv}{ds} = \frac{4}{2} \{\because \text{ radius } (a) = 4\}$$
$$\Rightarrow \frac{dv}{ds} = 2 \text{ cm}^3/\text{cm}^2$$

152. **(d)** $y = \tan^{-1}\left(\frac{\sin x + \cos x}{\cos x - \sin x}\right)$

$$y = \tan^{-1}\left(\frac{1 + \tan x}{1 - \tan x}\right)$$

$$y = \tan^{-1}\left[\tan\left(\frac{\pi}{4} + x\right)\right]$$

$$y = \frac{\pi}{4} + x$$

Differentiate with respect to x

$$\frac{dy}{dx} = 1$$

153. **(a, c, d)**

$$y = \begin{vmatrix} f(x) & g(x) & h(x) \\ l & m & n \\ a & b & c \end{vmatrix}$$

Differentiate with respect to x

$$\frac{dy}{dx} = \begin{vmatrix} f'(x) & g'(x) & h'(x) \\ l & m & n \\ a & b & c \end{vmatrix} + \begin{vmatrix} f(x) & g(x) & h(x) \\ \frac{d(l)}{dx} & \frac{d(m)}{dx} & \frac{d(n)}{dx} \\ a & b & c \end{vmatrix} + \begin{vmatrix} f(x) & g(x) & h(x) \\ l & m & n \\ \frac{d(a)}{dx} & \frac{d(b)}{dx} & \frac{d(c)}{dx} \end{vmatrix}$$

$$\frac{dy}{dx} = \begin{vmatrix} f'(x) & g'(x) & h'(x) \\ l & m & n \\ a & b & c \end{vmatrix} + \begin{vmatrix} f(x) & g(x) & h(x) \\ 0 & 0 & 0 \\ a & b & c \end{vmatrix} + \begin{vmatrix} f(x) & g(x) & h(x) \\ l & m & n \\ 0 & 0 & 0 \end{vmatrix}$$

$$\frac{dy}{dx} = \begin{vmatrix} f'(x) & g'(x) & h'(x) \\ l & m & n \\ a & b & c \end{vmatrix} = \begin{vmatrix} l & m & n \\ a & b & c \\ f'(x) & g'(x) & h'(x) \end{vmatrix}$$

$$\frac{dy}{dx} = \begin{vmatrix} f'(x) & l & a \\ g'(x) & m & b \\ h'(x) & n & c \end{vmatrix}$$

154. (a)

$$\sin x = \frac{2t}{1+t^2}$$
$$x = \sin^{-1}\left(\frac{2t}{1+t^2}\right)$$
$$x = 2\tan^{-1} t \ldots\ldots (1)$$

And

$$\tan y = \frac{2t}{1-t^2}$$
$$y = \tan^{-1}\left(\frac{2t}{1-t^2}\right)$$
$$y = 2\tan^{-1} t \ldots (2)$$

From equation (1) and (2)

$$y = x$$
$$\frac{dy}{dx} = 1$$

155. (a)

Let $v = \cos^{-1}(2x^2 - 1)$ and $u = \cos^{-1} x$

$$v = \cos^{-1}(2x^2 - 1)$$
$$v = 2\cos^{-1} x$$

Differentiate with respect to x

$$\frac{dv}{dx} = \frac{-2}{\sqrt{1-x^2}}$$

And

$$u = \cos^{-1} x$$
$$\frac{du}{dx} = \frac{-1}{\sqrt{1-x^2}}$$

Now,

$$\frac{dv}{du} = \frac{du}{dx} \times \frac{dx}{dv}$$
$$= \frac{(-2)}{\sqrt{1-x^2}} \times \frac{\sqrt{1-x^2}}{(-1)}$$
$$= 2$$

156. (a) $y = \log(\log x)$

Differentiate with respect to x

$$\frac{dy}{dx} = \frac{1}{x} \times \left(\frac{1}{\log x}\right)$$

$$\frac{dy}{dx} = (x\log x)^{-1}$$

Differentiate with respect to x

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

157. **(c)** Let $I = \int \frac{(x+3)e^x}{(x+4)^2} dx$

$$I = \int e^x \left[\frac{x+4-1}{(x+4)^2}\right] dx$$
$$I = \int e^x \left[\frac{1}{x+4} - \frac{1}{(x+4)^2}\right] dx$$
$$I = \int e^x \left(\frac{1}{x+4}\right) dx - \int e^x \left(\frac{1}{x+4}\right)^2 dx$$
$$I = \frac{e^x}{x+4} - \int e^x \left[\frac{-1}{(x+4)^2}\right] dx - \int e^x \left[\frac{1}{(x+4)^2}\right] dx$$
$$I = \frac{e^x}{x+4} + \int \frac{e^x}{(x+4)^2} dx - \int \frac{e^x}{(x+4)^2} dx$$
$$I = \frac{e^x}{x+4} + C$$

158. **(a)**

$$I = \int \frac{\cos 2x - \cos 2\theta}{\cos x - \cos \theta} dx$$

$$I = \int \frac{(2\cos^2 x - 1) - (2\cos^2 \theta - 1)}{\cos x - \cos \theta} dx \{\because \cos 2A = 2\cos^2 A - 1\}$$

$$I = \int \frac{2\cos^2 x - 2\cos^2 \theta}{\cos x - \cos \theta} dx$$

$$I = 2\int \frac{(\cos x - \cos \theta)(\cos x + \cos \theta)}{\cos x - \cos \theta} dx$$

$$I = 2\int (\cos x + \cos \theta) dx$$

$$I = 2[\sin x + x\cos \theta] + C$$

159. **(a)**

Let $I = \int \sqrt{x^2 + 2x + 5} dx$

$$I = \int \sqrt{(x+1)^2+4}dx$$

$$I = \frac{x+1}{2}\sqrt{(x+1)^2+4} + \frac{(2)^2}{2}\log\left|x+1+\sqrt{(x+1)^2+4}\right| + C$$

$$I = \frac{x+1}{2}\sqrt{x^2+2x+5} + 2\log\left|x+1+\sqrt{x^2+2x+5}\right| + C$$

160. **(b)** Let

$$I = \int_0^{\frac{\pi}{2}} \frac{\tan^7 x}{\cot^7 x + \tan^7 x}dx \ldots\ldots(1)$$

$$I = \int_0^{\frac{\pi}{2}} \frac{\tan^7\left(\frac{\pi}{2}-x\right)}{\cot^7\left(\frac{\pi}{2}-x\right)+\tan^7\left(\frac{\pi}{2}-x\right)}dx$$

$$I = \int_0^{\frac{\pi}{2}} \frac{\cot^7 x}{\tan^7 x + \cot^7 x}dx \ldots\ldots(2)$$

Add equation (1) + (2)

$$2I = \int_0^{\frac{\pi}{2}} \frac{\tan^7 x + \cot^7 x}{\tan^7 x + \cot^7 x}dx$$

$$2I = \int_0^{\frac{\pi}{2}} 1dx$$

$$2I = [x]_0^{\pi/2}$$

$$I = \frac{\pi}{4}$$

161. **(a)**

$$I = \int_{-5}^{5} |x+2|dx$$

$$I = -\int_{-5}^{-2}(x+2)dx + \int_{-2}^{5}(x+2)dx$$

$$= -\left[\frac{x^2}{2}+2x\right]_{-5}^{-2} + \left[\frac{x^2}{2}+2x\right]_{-2}^{5}$$

$$= \left[-\left\{\frac{4}{2}-4\right\} - \left\{\frac{25}{2}-10\right\}\right] + \left[\left\{\frac{25}{2}+10\right\} - \left\{\frac{4}{2}-4\right\}\right]$$

$$= 29$$

162. **(d)** $I = \int_{-\pi/2}^{\pi/2} \frac{1}{e^{\sin x}+1}$

Using property

$$\Rightarrow \int_{-a}^{a} f(x)dx = \int_0^a [f(x)+f(-x)]dx$$

$$\Rightarrow I = \int_0^{\pi/2}\left[\frac{1}{e^{\sin x}+1} + \frac{1}{e^{\sin(x)}+1}\right]dx$$

$$I = \int_0^{\pi/2}\left[\frac{1}{e^{\sin x}+1} + \frac{e^{\sin x}}{e^{\sin x}+1}\right]dx$$

$$I = \int_0^{\pi/2} \frac{e^{\sin x} + 1}{e^{\sin x} + 1} dx$$

$$I = \int_0^{\pi/2} 1 dx$$

$$I = [x]_0^{\pi/2}$$

$$I = \frac{\pi}{2}$$

163. (d)

$$I = \int_0^{\pi/2} \frac{1}{a^2 \sin^2 x + b^2 \cos^2 x} dx$$

$$I = \int_0^{\pi/2} \frac{\sec^2 x}{a^2 \tan^2 x + b^2} dx$$

Let $\tan x = t$

$$\sec^2 x = \frac{dt}{dx}$$

$$\sec^2 x dx = dt$$

Now,

$$I = \int_0^{\infty} \frac{1}{a^2 t^2 + b^2} dt$$

$$I = \frac{1}{a^2} \int_0^{\infty} \frac{1}{t^2 + \frac{b^2}{a^2}} dt$$

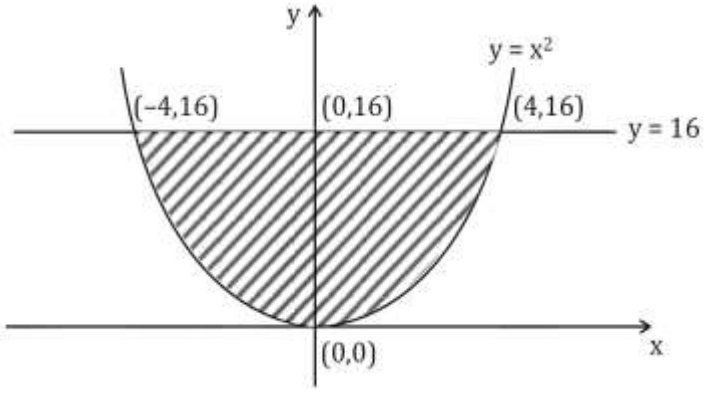
$$I = \frac{1}{a^2} \times \frac{1}{b/a} \left[\tan^{-1} \frac{t}{b/a} \right]_0^{\infty}$$

$$I = \frac{1}{ab} [\tan^{-1} \infty - \tan^{-1} 0]$$

$$I = \frac{1}{ab} \times \frac{\pi}{2}$$

$$I = \frac{\pi}{2ab}$$

164. (b) Curve $y = x^2$ and line $y = 16$



$$\text{Area} = 2\int_0^{16} x\,dy$$

$$A = 2\int_0^{16} \sqrt{y}\,dy$$

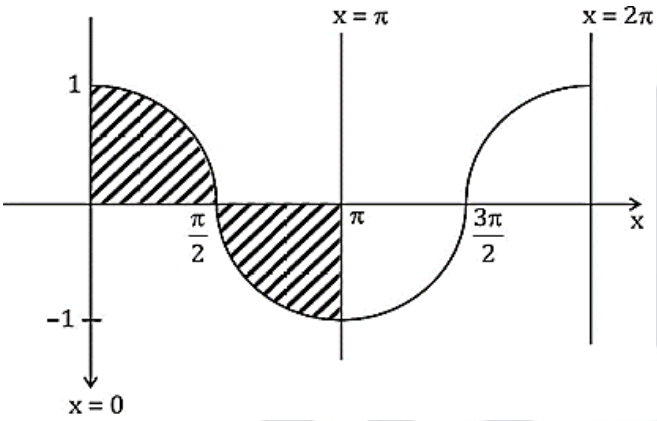
$$A = 2\left[\frac{y^{3/2}}{3/2}\right]_0^{16}$$

$$A = 2\left[\frac{(16)^{3/2}}{3/2}\right]$$

$$A = \frac{4}{3}(64)$$

$$A = \frac{256}{3} \text{ sq.units}$$

165. (a)



$y = \cos x, x = 0$ and $x = \pi$ is shaded area

$$\text{Area} = \int_0^{\pi/2} \cos x\,dx + \int_{\pi/2}^{\pi} (-\cos x)\,dx$$

$$= [\sin x]_0^{\pi/2} - [\sin x]_{\pi/2}^{\pi}$$

$$= [1-0] - [0-1] = 2 \text{ sq. units}$$

166. (a)

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

The power of the term $\frac{d^2y}{dx^2}$ is 1.

Therefore, the degree of the given differential equation is 1.

167. (a)

$$\frac{dy}{dx} + y = 1$$

$$\Rightarrow \frac{dy}{dx} = 1 - y$$

$$\Rightarrow \frac{dy}{1-y} = dx$$

Integrate both side of the equation

$$\Rightarrow \int \frac{dy}{1-y} = \int dx$$

$$\Rightarrow -\log|1-y| = x + C$$

$$\Rightarrow \log\left|\frac{1}{1-y}\right| = x + C$$

168. (a)

$$x\frac{dy}{dx} + 2y = x^2$$
$$\Rightarrow \frac{dy}{dx} + \frac{2}{x}y = x$$

The integrating factor is calculated as

$$\text{IF} = e^{\int \frac{2}{x}dx}$$
$$= e^{2\log x}$$
$$= e^{\log x^2}$$
$$= x^2$$

169. (d) Given vectors are

$$\vec{a} = 2\hat{i} + \lambda\hat{j} + \hat{k}$$
And $\vec{b} = \hat{i} + 2\hat{j} + 3\hat{k}$

Since, condition of orthogonal

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

$$\Rightarrow (2\hat{i} + \lambda\hat{j} + \hat{k})(\hat{i} + 2\hat{j} + 3\hat{k})$$

$$\Rightarrow 2 + 2\lambda + 3 = 0$$

$$2\lambda = -5$$

$$\lambda = -\frac{5}{2}$$

170. (c) Because $\vec{a}, \vec{b}, \vec{c}$ are units vectors, therefore,

$$\left|\vec{a}\right| = 1, \left|\vec{b}\right| = 1 \text{ and } |\vec{c}| = 1 \ldots\ldots (1)$$

Again given $\vec{a} + \vec{b} + \vec{c} = \vec{0}$

Squaring both side

$$\left(\vec{a} + \vec{b} + \vec{c}\right)^2 = 0$$

$$|\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 + 2\left(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\frac{1}{a}\right) = 0$$

$1+1+1+2(\hat{a}\cdot\hat{b}+\hat{b}\cdot\hat{c}+\hat{c}\cdot\hat{a})=0$

$2(\hat{a}\cdot\hat{b}+\hat{b}\cdot\hat{c}+\hat{c}\cdot\hat{a})=-3$

$\hat{a}\cdot\hat{b}+\hat{b}\cdot\hat{c}+\hat{c}\cdot\frac{1}{a}=-\frac{3}{2}$

171. **(a)** Consider the unit vectors a, b and $(\sqrt{3}a-b)$

So, $(\sqrt{3}a-b)=1$

Squaring both side

$\Rightarrow(\sqrt{3}a-b)^2=1$

$\Rightarrow 3|a|^2+|b|^2-2\sqrt{3}a\cdot b=1$

$\Rightarrow 3(1)+(1)-2\sqrt{3}|a||b|\cos\theta=1$

$\Rightarrow 4-2\sqrt{3}\cos\theta=1$

$\Rightarrow 2\sqrt{3}\cos\theta=3$

$\Rightarrow \cos\theta=\frac{\sqrt{3}}{2}$

$\Rightarrow \theta=\cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$

$\Rightarrow \theta=\frac{\pi}{6}=30^\circ$

172. **(d)** The reflection of any point (x,y,z) in xy-plane is $(x,y,-z)$.

Therefore, the reflection of (α,β,γ) in xy-plane $(\alpha,\beta,-\gamma)$

173. **(b)** Plane equation: $2x-3y+6z-11=0$

Plane: $\hat{n}=2\hat{i}-3\hat{j}+6\hat{k}$

Line: $\hat{b}=\hat{i}$

Angle between line & plane $=\frac{\vec{r}\cdot\hat{b}}{|\vec{r}||b|}$

$\Rightarrow \sin\theta=\frac{(2\hat{i}-3\hat{j}+6\hat{k})\cdot\hat{i}}{\left|\sqrt{(2)^2+(-3)^2+(6)^2}\right|\left|\sqrt{(1)^2}\right|}$

$\Rightarrow \sin\theta=\frac{2+0+0}{\sqrt{49}\sqrt{1}}$

$\Rightarrow \sin\theta=\frac{2}{7}$

$\Rightarrow \theta = \sin^{-1}\frac{2}{7}$

$\Rightarrow \sin^{-1}\alpha = \sin^{-1}\frac{2}{7}$

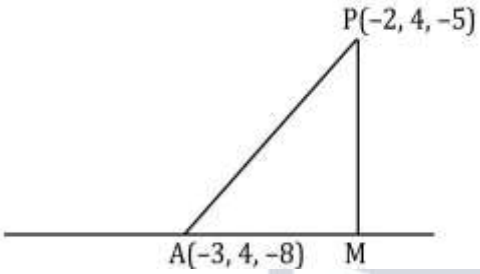
$\Rightarrow \alpha = \frac{2}{7}$

174. **(b)** A line that passes through $A(-3,4,-8)$ and is parallel to the vector $b = 3\hat{i} + 5\hat{j} + 6\hat{k}$ Let M be the foot of the perpendicular from $P(-2,4,-5)$

Then

$AP = -\hat{i} - 3\hat{k}$
$|AP| = \sqrt{1+9} = \sqrt{10}$

So



Therefore, AM is equal to the projection of AP on b

$$AM = \left|\frac{AP \cdot b}{|b|}\right|$$
$$= \left|\frac{(-\hat{i} - 3\hat{k}) \cdot (3\hat{i} + 5\hat{j} + 6\hat{k})}{|(3\hat{i} + 5\hat{j} + 6\hat{k})|}\right| = \left|\frac{-3 - 18}{\sqrt{9+25+36}}\right| = \frac{21}{\sqrt{70}}$$

Therefore

$$PM = \sqrt{AP^2 - AM^2}$$
$$= \sqrt{10 - \frac{441}{70}}$$
$$= \sqrt{\frac{259}{70}}$$
$$= \sqrt{\frac{37}{10}}$$

175. **(c)** The probability of the defective ball is, $P = \frac{10}{100} = \frac{1}{10}$

The probability that the ball is not defective is,

$$Q = 1 - \frac{1}{10} = \frac{9}{10}$$

The probability the out of a sample of 5 pens drawn one by one without replacement and almost one is defective calculated as,

$$\text{Probability} = {}^5C_0\left(\frac{1}{10}\right)^0\left(\frac{9}{10}\right)^5 + {}^5C_1\left(\frac{1}{10}\right)^1\left(\frac{9}{10}\right)^4$$

$$= (1)\left(\frac{9}{10}\right)^5 + \left(\frac{5}{10}\right)\left(\frac{9}{10}\right)^4$$
$$= \left(\frac{9}{10}\right)^5 + \frac{1}{2}\left(\frac{9}{10}\right)^4$$

176. **(b)** Two events A & B are said to be independent if,

$P(A' \cap B') = P(A') \cdot P(B')$

If A and B are independent then A' and B' are also independent.

Therefore,

$$P(A' \cap B') = P(A') \cdot P(B')$$
$$= (1 - P(A))(1 - P(B))$$

If A and B are mutually exclusive then, $P(A \cap B) = 0$

177. **(a)** The sum of all probabilities is always equal to 1.

So,

$$0.3 + K + 2K + 2K = 1$$
$$0.3 + 5K = 1$$
$$5K = 0.7$$
$$K = \frac{0.7}{5}$$
$$K = 0.14$$

178. **(c)** (1) Since, region (shaded) lies above x-axis.

$\therefore\ y \geq 0$

(2) Shaded region is on left of $x = 6$

$\therefore\ x \leq 6$

(3) Shaded region is below $y = 3$

$\therefore\ y \leq 3$

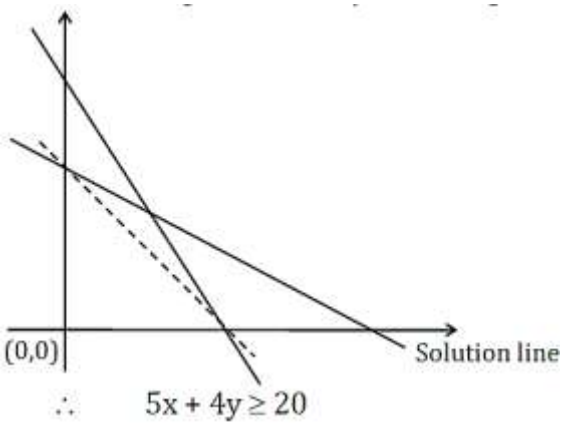
(4) Equation of line passing through $(4,0)\&(0,5)$ is

$$y - 0 = \frac{5}{-4}(x - 4)$$

$$5x + 4y - 20 = 0$$

If $5x + 4y \geq 20$, put $(0,0)$ we get $0 \geq 20$

False



(5) Shaded region lies on right side of y-axis

$\therefore\ x \geq 0$

$\therefore\ 5x + 4y \geq 20, x \leq 6, y \leq 3, x \geq 0, y \geq 0$

179. **(b)** When a LPP admits an optimal solution at two consecutive vertices of a feasible region.

Then the optimal solution occurs at every point on the line joining these two points.

180. **(b)** Let $I = \int_{0.2}^{3.5} [x]dx$

$$I = \int_{0.2}^{1} [x]dx + \int_{1}^{2} [x]dx + \int_{2}^{3} [x]dx + \int_{3}^{3.5} [x]dx$$

$$I = \int_{0.2}^{1} 0dx + \int_{1}^{2} 1dx + \int_{2}^{3} 2dx + \int_{3}^{3.5} 3dx$$

$$I = 0 + [x]_1^2 + 2[x]_2^3 + 3[x]_3^{3.5}$$

$$I = (2-1) + 2(3-2) + 3(3.5-3)$$

$$I = 1 + 2 + 1.5$$

$$I = 4.5$$

Biology

181. **(a)** Carnivora is the order of eutherian mammals, which refer to any meat-eating organism. Example- Dogs, Cats, Wolves etc.

Muscidae are a family of flies found in the superfamily Muscoidea. Example- House fly, Musca.

Insects are a class of hexapod invertebrates within the arthropod phylum. Example- Ant, Bugs etc.

Panthera is a genus within the Felidae family. Example- Tiger, Lion etc.

182. **(c)** Mycoplasma is the smallest cell which does not possess cell wall as an outer covering but has cell membrane as an outer covering. As they do not have cell wall they do not get affected by the antibiotics and causes severe diseases to the plants and animals. They can even survive without oxygen and respire anaerobically.

183. **(a)** The algae which belong to the group Rhodophyceae can reproduce sexually as well as asexually. In asexual reproduction, the non-motile spores are produced which form the new cell body. The sexual reproduction is the fusion of the non-motile gametes to form the embryo which develops to form the new algal body. In phaeophyceae reproduction takes place both asexually and sexually. Asexual reproduction takes place by zoospores. Sexual reproduction takes place by both isogamy and anisogamy. In Chlorophyceae, sexual

reproduction occurs by isogamy, anisogamy or oogamy. The blue green algae (Cyanophyceae) reproduce by both vegetative and asexual means. They vegetative reproduction performs through fission.

184. **(c)** Zygomorphic flowers have the symmetry in which the flowers can be divided into halves only through the division in one plane.

A flower when cut in two equal halves through any vertical plane passing through the axis then its symmetry remains undisturbed. Such flower is called as an actinomorphic flower.

The flowers of the plant Gulmohar are zygomorphic in nature.

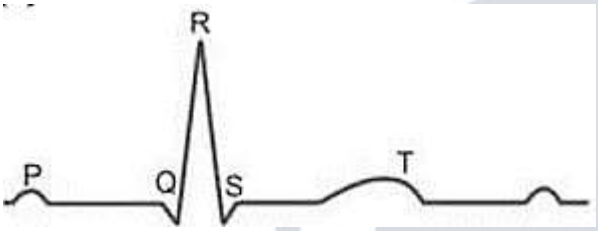
Canna, mustard, and hibiscus plants have flowers which are actinomorphic.

185. **(b)** Suberin is a fatty material which is deposited on the certain cells of the plants. The material is deposited on the phellem cells in the stem and the endodermal cells of the root. On the endodermis, the suberin deposition results in the formation of the Casparian strips which prevents the flow of water.

186. **(c)** The internal lining of the tube-like structures possesses the ciliated epithelium. The cells bear shorter hair like projections called as cilia which beat and allow the movement of the particles. Their function is to move particles or mucus in a specific direction over the epithelium organs like bronchioles and fallopian tubules.

187. **(b)** The endomembrane system is composed of the membranous structures in the cell. The common structures which are included are the lysosome, vesicles, vacuoles, cell membrane, endoplasmic reticulum, nuclear membrane, etc. Mitochondria, peroxisomes and chloroplast are not included under endomembrane system.

188. **(d)**



Each peak in the ECG is identified with a letter from P to T that corresponds to a specific electrical activity of the heart.

The P- wave represents the electrical excitation (or depolarization) of the atria, which leads to the contraction of both the atria.

The QRS complex represents the depolarization of the ventricles which initiates the ventricular contraction. The contraction starts shortly after Q and marks the beginning of the systole.

The T-wave represents the return of the ventricles from excited to normal state (repolarisation). The end of the T-wave marks the end of systole.

189. **(a)** Facilitated transport is the selective transport of the ions or the molecules through special membrane proteins called as channel proteins. The transport depends on the concentration gradient or the saturation limit. The movement is in accordance with the concentration gradient and hence a downhill transport. Transport proteins provide high selectivity and transport only certain molecules. The uphill transport is an example of the active transport in which there is transport opposite to the concentration gradient.

190. **(a)** The plant requires the elements for the growth and developmental processes. The deficiency of the element causes adverse effects on the growth of the plant. The deficiency of the elements Mg and K result in the necrosis and chlorosis. Necrosis is the death of the living tissue and chlorosis is the decolorization of the pigment of the leaves.

191. **(d)**

192. **(b)** Glycolysis is the process in which there is partial oxidation of the glucose molecule carried out. The glucose molecule is broken down to give two molecules of pyruvate. There are 4 ATPs produced but 2 are used up, so the net yield of glycolysis is 2 ATP.

193. **(a)** A trypsinogen is a precursor form of trypsin which cleaves the peptide bond of a polypeptide to yield amino acids. The inactivated form trypsinogen is activated by enterokinase.

Rennin is the enzyme which is secreted in the gut of the infants which helps in the digestion of the milk proteins.

Amylase is the enzyme that acts on the carbohydrates and results in the breakdown of starch to sugar by digesting the glycosidic bonds.

Lipase is involved in the digestion of the fats into fatty acids.

194. **(c)** Tidal volume is the lung volume representing the normal volume of air displaced between normal inhalation and exhalation when extra effort is not applied. In a healthy, young human adult, tidal volume is approximately 500 mL per inspiration. The breathing rate for a normal person is 12-15 breaths per minutes. So, a normal person inhale or exhale around 6000 to 8000 ml air per minute.

195. **(d)** Basophils are a type of white blood cell, which contains granulated cytoplasm. They are the largest type of granulocyte. They are responsible for inflammatory reactions during an immune response, as well as in the formation of acute and chronic allergic diseases, including anaphylaxis, asthma, atopic dermatitis, and hay fever. The granules in the cytoplasm contain the molecules histamine, heparin and serotonin which are released during the allergic reactions. Heparin is the anticoagulant; histamine is allergic agent and serotonin affects the motor activities.

196. **(a)** There are two hormones which are secreted in the human body involved in the calcium metabolism. The parathormone (PTH) is secreted by the cells of the parathyroid glands and are involved in increasing the level of blood calcium. The hormone thyrocalcitonin (TCT) is secreted by the C cells of the thyroid gland is responsible for increasing the uptake of calcium by the cells.

197. **(d)** The protozoans like the Amoeba are considered as immortal because they divide by binary fission. During this type of asexual reproduction, there is distribution of the parent body into two daughter cells. The parental identity gets lost in the case of binary fission.

198. **(d)** Meiosis in gamete mother cells forms the gametes during the process of gametogenesis. This is followed by transfer of male gametes to the female reproductive tract to facilitate fertilization. Fertilization forms zygote which then undergoes cleavage to form morula. So, gametogenesis, gamete transfer and meiosis are the events that occur before fertilization but cleavage occurs after fertilization.

199. **(b)** The plant is tetraploid (4n) and there are 48 chromosomes in the nucleus. The egg cell and the synergid are produced by meiotic division and are haploid in nature. So, 48/2=24 chromosomes in the egg and synergid.

200. **(a)** The pollen grain is the male gametophyte which contains the male gametes. The pollen grain is spherical and measures about $25-50$ micrometers. It is surrounded by two layers as exine which forms the outer layer and intine which forms the inner layer. The generative cell divides to form the two male gametes.

201. **(d)** In autogamy, the flowers are bisexual and anther and stigma are close to each other. The flowers are synchronized in the release of the pollen and the maturation of the stigma to allow successful autogamy. Pollinating agents are not required for the autogamy which is self-fertilization but they are involved in the transfer of the pollen grain by cross pollination.

202. **(a)** The sperms are produced in the testes in which the process of spermatogenesis takes place. The temperature of the scrotum is $2-3^{\circ}C$ less as compared to the body temperature which is necessary for the maintenance of the optimum temperature for spermatogenesis. So, it is necessary that the testes must descend down into the scrotum.

203. **(a)** The female reproductive system is composed of the reproductive organs and accessory ducts and glands. The oviduct, uterus, and vagina are the accessory ducts which are involved in the process of reproduction. The oviduct is the site for fertilization of the egg and the sperm. The uterus is the site for implantation and the vagina acts as the birth canal.

204. **(c)** There are about a million follicles which divide to form the primary follicles in the ovary of the foetus. Many primary follicles degenerate and at puberty, there is only $60,000-80,000$ primary follicles present which is formed by the mitotic division of the germ cells.

205. **(c)** Progesterone is secreted by the corpus luteum. It prepares the uterus for the implantation of fertilized eggs and controls the development of the foetus in the uterus. The hormone is responsible for the increase in the cell lining of the uterus leading to implantation and maintenance of pregnancy.

206. **(c)** India was amongst the first countries in the world to initiate action plans and programs at a national level to attain total reproductive health as a social goal. These programs called family planning were initiated in 1951 and were periodically assessed over the past decades.

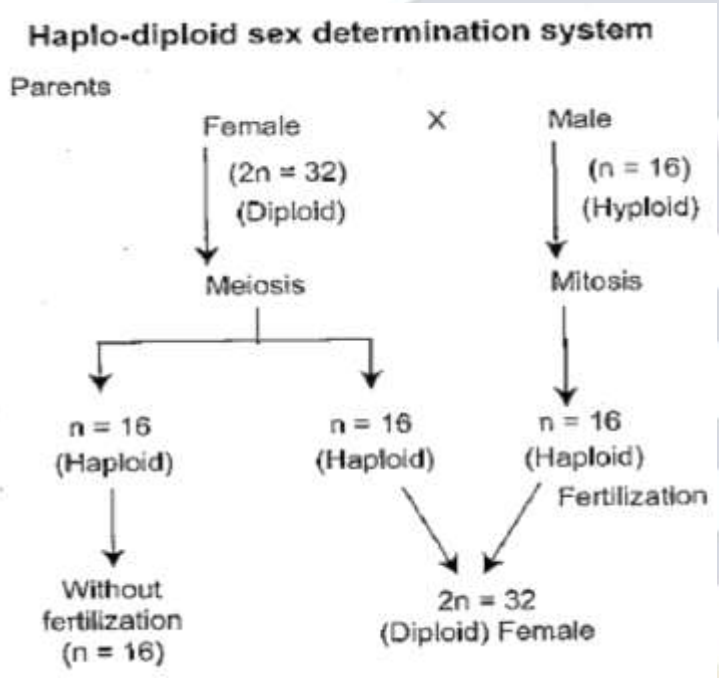
207. **(b)** The blastocyst is composed of the outer cell layer called as the trophoblast and the inner cell mass. The inner cell mass will form all the tissues of the embryo and differentiate into embryo proper. The trophoblast will form the placental structures.

208. **(a)** Aneuploidy means an organism does not have the normal number of chromosomes. Down's syndrome is mainly caused due to an extra copy of chromosome 21 which is hyper aneuploidy of the autosomal chromosome. The extra copy is formed due to non-disjunction of chromosomes during meiosis.

209. **(b)** In dihybrid cross, when pea plant with round shaped seeds with yellow colour seed (RRYY) is crossed with pea plant showing wrinkled shape with green cotyledons (rryy), the F_1 generation will have round shaped seeds with yellow colour seed (RrYy) progeny. When F1 plants (RrYy) are self hybridised, 12 yellow and 4 green seeds are produced. Therefore, the ratio of segregation of yellow and green in F_2 is 3:1.

210. **(b)** This is an autosome linked recessive trait that can be transmitted from parents to the offspring when both the partners are carrier for the gene. The mutation causing sickle cell anaemia is a single nucleotide substitution (A to T) in the codon for amino acid 6. The change converts a glutamic acid codon (GAG) to a valine codon (GTG). The form of hemoglobin in persons with sickle-celled anaemia is referred to as HbS.

211. **(a)** In honey bees, the male is haploid while the female is diploid. Haplodiploidy occurs in some insects like bees, ants and wasps. Male insects are haploid because they develop parthenogenetically from unfertilized eggs. Meiosis does not occur during the formation of sperms. Females grow from fertilized eggs and are hence diploid. Queen bee picks up all the sperms from the drone during nuptial flight and stores the same in her seminal vesicle. Formation of worker bees (diploid females) and drones (haploid males) depends upon the brood cells visited by the queen. While visiting the smaller brood cells, the queen emits sperms from its seminal receptacle after laying the eggs. Males are normally fertile haploids due to development from unfertilized eggs. Occasionally, diploid infertile males are also produced from heterozygous females through fertilization.



212. **(c)** The genomes of the $\Pi \times 174$ bacteriophage whose genome was sequenced and there are 5386 nucleotides. The genome of the bacteriophage lambda is 48502bp. The genome of the bacterium Escherichia coli contains 4.6×10^6bp. The genome of man contains 3.3×10^9bp.

213. **(a)** The average length of the hnRNA in humans is about 3000 bases. The hnRNA is spliced and posttranscriptional modifications are carried out in order to synthesize the mature mRNA which measures about $1800 - 2000$ bases.

214. **(a)** The experiment performed by Messelson and Stahl proves that the replication pattern of the DNA is semi-conservative. The DNA helix is composed of two strands. During replication, the strands separate and the new strands are formed on the original template strands. One of the strand remains the older and one new strand is synthesized and the process is known as semi-conservative. Since, the cells are grown in medium containing N^{15} so there will be no strand with N^{14}/N^{14} i.e. E. coli is allowed to grow for 40 minutes in a medium containing N^{15} then the number of N^{14}/N^{14} containing DNA would be zero.

215. **(b)** DNA replication is the process which the DNA is replicated and two copies are synthesized. The two strands of the DNA helix separate and the new strands are formed on the original strands, known as the template

strands. The strand which is synthesized in 3'-5' direction is the leading strand and the strand which is synthesized in the opposite 5'-3' direction is the lagging strand which contains the Okazaki fragments.

216. **(b)** The lac operon is the inducible cluster of genes in the prokaryotes involved in the lactose metabolism. When the cell is placed in a Lactose rich medium, Lactose is transported through the membrane with the help of permease into the cell which is then converted to allolactose that binds to the repressor protein, and prevents it from binding to the operator, thereby inducing the expression of the Lac operon.

217. **(a)** Each tRNA contains a set of three nucleotides called an anticodon. The anticodon of a given tRNA can bind to one or a few specific mRNA codons. The codon on the mRNA which codes for amino acid tryptophan is 5'-UGG-3'. The anticodon on the tRNA will be 3'-ACC-5' which will code for the amino acid tryptophan.

218. **(d)** Neanderthal man is the early species of modern man and was known as Homo sapiens neanderthalensis. The lower jaw was strong with strong jaw muscles and did not have a chin. The cranial capacity of this species was 1450 cc. They buried the dead persons and perform the rituals after the death of the similar ones.

219. **(c)** The Jurassic period started 213 million years ago and lasted until 240 million years ago. The Jurassic period is the period of the large mammals like dinosaurs. This was the period in which the plants like the ferns, conifers, and cycades dominated.

220. **(c)** The rhinovirus is the most common viral infectious agent in humans and is the predominant cause of the common cold. Rhinovirus infection proliferates in temperatures of $33 - 35°C$, the temperatures found in the nose.

221. **(c)** Dengue and chikungunya are the viral diseases which are caused in the humans. The diseases are transmitted by the bite of the Aedes mosquito and carrying of the blood from the infected person to the healthy person. Only the female mosquitoes are involved in the transmission of the disease.

222. **(c)** Heroine commonly called smack is chemically diacetylmorphine which is a white, odourless, bitter crystalline compound. This is obtained by acetylation of morphine which is extracted from the latex of poppy plant papaver somniferum. Generally, taken by snorting and injection, heroine is depressant and slows down body functions.

223. **(a)** Intrabreeding is the process in which the organisms of the same species do breed with each other. This causes inbreeding depression in which the progeny becomes weaker due to the continuous breeding of the animals within the same species. Inbreeding depression can be reduced by cross-breeding.

224. **(a)** Pusa gaurav variety of brassica is resistant to aphids. Pusa Sem 2 and Pusa Sem 3 of flat beans are resistant to jassids, aphids and fruit borer. Pusa Sawani and Pusa A-4 varieties of okra are resistant to shoot and fruit borer.

225. **(d)** Breeding techniques helped in the development of new resistant varieties of the plants. The mutation techniques help in the production of the mung bean varieties which are resistant to the yellow vein mosaic virus and the powdery mildew. The generation of these varieties helped in increasing the yield.

226. **(c)** Statins are the molecules that act as inhibitors of certain enzymes. The statins help to lower the level of cholesterol in the blood by acting as inhibitors of the enzymes which are involved in the formation of cholesterol. This prevents the formation of cholesterol and the level of cholesterol in the blood is reduced. The common example of the organism which is used for the production of statin is Monascus purpureus.

227. **(a)** BOD is the amount of oxygen required by microbes to break down the organic matter present in a certain volume of a sample of water. In polluted water, BOD is high as it contains a large number of organisms. High BOD values in the water of a river mean that the water is highly polluted.

228. **(a)** The restriction enzymes are the enzymes which cleave the DNA at specific recognition sites. These enzymes are isolated from the bacteria which produce the enzymes to cleave the viral genome and provide protection against the viral infection.

229. **(d)** The restriction enzymes are isolated from the bacterial sources and are named according to the name of the bacterial species. The enzyme Sal I is isolated from the bacterium Streptomyces albus. This is the first enzyme which is isolated from the bacterium.

230. **(a)** Human genes have introns, the intervening non coding sequences which are removed by post transcriptional modification of hnRNA. Bacterial genes do not have introns and bacteria lack the intron splicing machinery. The transformed bacterium with human gene, fails to produce desired protein due to inability of splicing the introns to produce the matured mRNA from the hnRNA.

231. **(a)** RNAi method involves the use of the single-stranded complementary RNA segment to silence the gene of the parasite. This is the common method for defense in the eukaryotic organisms. This is a pre-translational process in which the ssRNA binds to the mRNA and forms the hybrid structure which cannot be read by the polymerase.

232. **(b)** Transgenic sheep is genetically modified animal, so that her milk produces a human protein called alpha antitrypsin, a potential treatment for the disease cystic fibrosis.

233. **(b)** Psammophyte are the plants that grow in sands, primarily in deserts. These plants are marked by a number of adaptations, this property enable them to exist on wind-blown sands. Psammophytic trees and shrubs form strong adventitious roots on those parts of their trunks buried in the sand.

234. **(b)** The modification (morphological/anatomical) of plant to prevent excessive heat is:

• Leaves covered with dense hairs.

• Leaf surface shiny or glabrous.

• Leaf blade lamina rolled during day.

235. **(b)** Resource partitioning is the phenomenon when there are many species living in the same region but have adapted to different resources. This causes a reduction in the fight for the same resource. When there are five closely related species of the warblers on the same tree without any competition, this type of behavioral difference is due to resource partitioning.

236. **(b)** Climax community is an ecological community in which the species composition remains stable and exists in balance with each other and their environment. It is an ecological community that has reached the final stage of ecological succession. It is a state of near equilibrium in which population remains relatively unchanged until destroyed by an event such as fire or human interference.

237. **(d)** The process of decomposition involves the breaking of the complex inorganic compounds into smaller organic nutrients. The detritus rich in the lignin and chitin are decomposed slowly. The reason is that the lignin and chitin are hard polymeric substances which are not easily destroyed by the action of the enzymes secreted by the bacteria.

238. **(a)** The difference in the genetic composition of the organism within a species is known as the genetic diversity. The variety of the indigenous cows belongs to the same species but have certain different characters. This is the reason they are an example of genetic diversity.

239. **(b)** The estimated number of species of the fungi is about 2 to 4 million. This is the global estimated richness of the fungal species. This number is more than the combined total of the species of the fishes, amphibians, reptiles and mammals.

240. **(a)** The e-waste refers to the electronic waste which is increasing in the amount every day. There are sources of metals and plastic in the electronic waste and so, it is necessary to dispose off the waste properly. The safe method considered for the disposal of this form of waste is incineration in which the waste is burned at very high temperature in a furnace.