

Answer Key

PHYSICS

1. b	2. d	3. b	4. c	5. d	6. d	7. a	8. c	9. a	10. a
11. c	12. c	13. b	14. b	15. b	16. b	17. b	18. a	19. c	20. c
21. a	22. a	23. c	24. a	25. a	26. b	27. a	28. a	29. a	30. b
31. c	32. c	33. b	34. b	35. c	36. d	37. a	38. a	39. c	40. a
41. c	42. b	43. a	44. c	45. c					

CHEMISTRY

1. d	2. a	3. d	4. d	5. a	6. d	7. d	8. c	9. d	10. d
11. c	12. b	13. a	14. a	15. a	16. a	17. a	18. c	19. b	20. d
21. b	22. b	23. c	24. a	25. c	26. b	27. a	28. d	29. a	30. d
31. d	32. a	33. c	34. b	35. b	36. c	37. c	38. d	39. b	40. b
41. d	42. c	43. b	44. c	45. d					

BIOLOGY

1. a	2. a	3. a	4. c	5. c	6. d	7. b	8. a	9. c	10. c
11. c	12. a	13. a	14. d	15. d	16. b	17. d	18. b	19. c	20. c
21. d	22. a	23. d	24. c	25. b	26. d	27. a	28. d	29. c	30. c
31. c	32. a	33. c	34. b	35. b	36. c	37. a	38. c	39. a	40. b
41. a	42. a	43. c	44. b	45. a	46. d	47. a	48. d	49. d	50. a
51. b	52. a	53. a	54. b	55. d	56. c	57. c	58. a	59. b	60. d
61. c	62. b	63. c	64. b	65. c	66. b	67. b	68. a	69. b	70. a
71. c	72. c	73. d	74. c	75. a	76. c	77. b	78. d	79. a	80. b
81. b	82. c	83. d	84. d	85. b	86. c	87. a	88. c	89. b	90. d

Question-wise Detailed Solution

1 A container with a liquid having area of free surface  $A$  has an orifice at a depth  $h$  with an area  $a$  below liquid surface, then the velocity  $v$  of flow through the orifice is -

 Solution

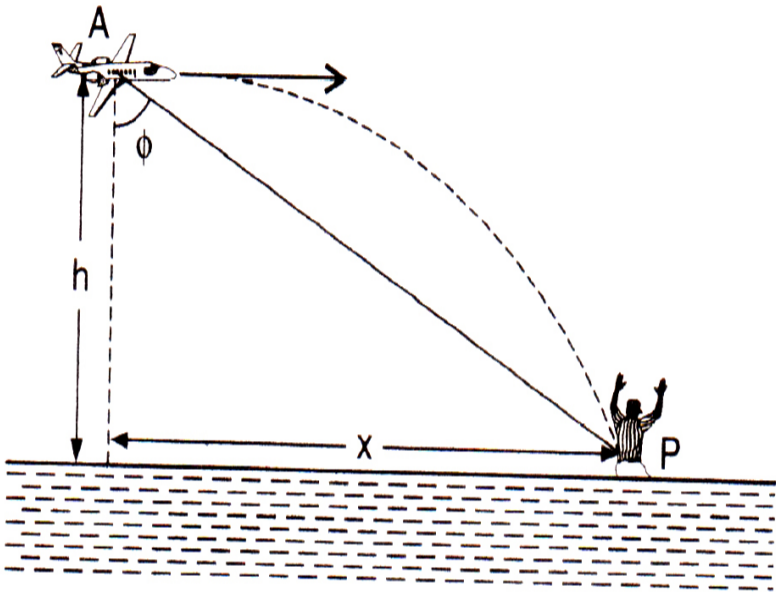
$$P + \frac{1}{2}\rho V^2 + \rho gh = P + \frac{1}{2}\rho v^2 + 0 \dots\dots\dots(i)$$

$$\text{also } AV = av\dots\dots\dots(ii)$$

From (i) and (ii)

$$v = \sqrt{2gh}\sqrt{\frac{A^2}{A^2-a^2}}$$

2 A relief aeroplane is flying at a constant height of 1960 m with speed 600 km/hr above the ground towards a point directly over a person struggling in flood water (see diagram). At what angle of sight, should the pilot release survival kit if it is to reach the person in water?  
( $g = 9.8 \text{ m/s}^2$ )



 Solution

As the plane is flying at a speed of  $600 \times (5/18)$ , i.e.,  $(500/3)$  m/s horizontally (at a height of 1960 m above the ground), the time taken by the kit to reach the ground

$$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 1960}{9.8}} = 20s$$

And in this time the kit will move horizontally by

$$x = ut = (500/3) \times 20 = (10,000/3)m$$

So the angle of sight

$$\tan\phi = \frac{x}{h} = \frac{10000}{3 \times 1960} = \frac{10}{5.88} = 1.7 \simeq \sqrt{3}$$

$$\text{i.e.,} \qquad \phi \simeq \tan^{-1}\left(\sqrt{3}\right) = 60^\circ$$

3 Two identical satellites are moving around the earth in circular orbits at heights  $3R$  and  $R$  respectively where  $R$  is the radius of the Earth. The ratio of their kinetic energies is

 Solution

The kinetic energy of satellites in a circular orbit is given as

$$E_k = \frac{GMm}{2r} \Rightarrow \frac{E_{k_1}}{E_{k_2}} = \frac{r_2}{r_1} = \frac{R+R}{R+3R} = \frac{2R}{4R} = \frac{1}{2}$$

4

If the length of rod  $A$  is  $(3.25 \pm 0.01)$  cm and that of  $B$  is  $(4.19 \pm 0.01)$  cm, then the rod  $B$  is longer than rod  $A$  by



Solution

Given, length of rod  $A$  is

$$L_A = 3.25 \pm 0.01$$

Of  $B$  is  $L_B = 4.19 \pm 0.01$

Then, the rod  $B$  is longer than rod  $A$  by a length

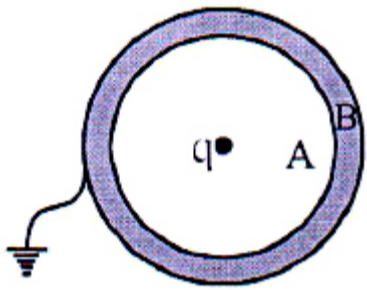
$$\Delta l = L_B - L_A$$

$$\Delta l = (4.19 \pm 0.01) - (3.25 \pm 0.01)$$

$$\Delta l = (0.94 \pm 0.02) \text{ cm}$$

5

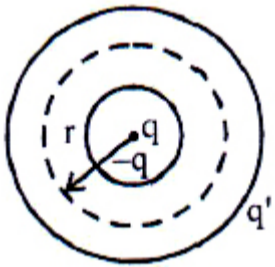
A positive point charge  $q$  is placed at the centre of an uncharged metal sphere insulated from the ground. The outside of the sphere is then grounded as shown. Then the ground wire is removed.  $A$  is the inner surface and  $B$  is the outer surface. Which statement is correct?



Solution

Potential on conductor must be zero

$$\Rightarrow \left( \frac{kq}{r} - \frac{kq}{r} + \frac{kq'}{r} \right) = 0 \Rightarrow q' = 0$$



6

A polarized light of intensity  $I_0$  is passed through another polarizer whose pass axis makes an angle of  $60^\circ$  with the pass axis of the former. What is the intensity of emerging polarized light from second polarizer?



Solution

By Malus law,  $I = I_0 \cos^2 \theta$

( $I$  = Intensity of emergent polarized light)

Where  $\theta = 60^\circ$ ,  $I = ?$

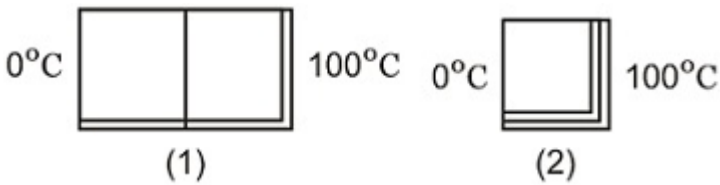
$$= I_0 \times \cos^2 60^\circ$$

( $I_0$  = Intensity passed through polarizer)

$$= I_0 \times \left( \frac{1}{2} \right)^2 = \frac{I_0}{4}$$

7

Two identical square rods of metal are welded end to end as shown in the figure (1), 20 cal of heat flows through it in 4 min. If the rods are welded as shown in the figure (2), the same amount of heat will flow through the rods in



 Solution

Figure (1) → series combination  
 Figure (2) → parallel combination  
 Thermal resistance for each block to be  $R$   
 Then  
 Thermal resistance for the case I  $R_1 = 2R$   
 Thermal resistance for the case II  $R_2 = R/2$

Thermal resistance for case II

$$I_1 = \frac{\Delta T}{R_1} \quad I_2 = \frac{\Delta T}{R_2}$$

$$\Rightarrow \quad 4I_1 = I_2$$

$$4\frac{\Delta Q_1}{\Delta t_1} = \frac{\Delta Q_2}{\Delta t_2} \quad \text{if } \Delta Q_1 = Q_2$$

then

$$4\Delta t_2 = \Delta t_1$$

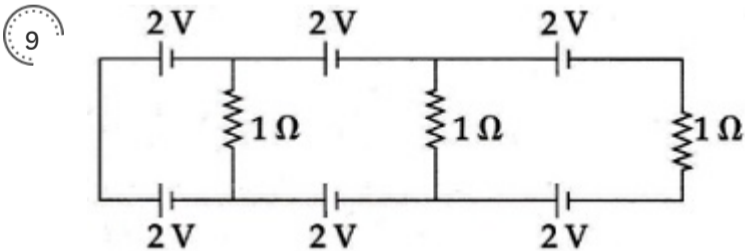
$$\Delta t_2 = \Delta t_1/4 = \frac{4}{4} = 1 \text{ min}$$

8 A sample of radioactive material has mass  $m$ , decay constant  $\lambda$  and molecular weight  $M$ . Avogadro's constant =  $N_A$ . The initial activity of the sample is

 Solution

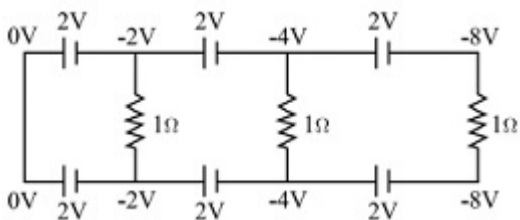
In a radioactive sample, activity is directly proportional to the number of active nuclei.  
 Activity =  $\lambda N$ , where  $N = \frac{N_A m}{M}$ .

$$\text{Activity} = \frac{\lambda m N_A}{M}$$



In the above circuit the current in each resistance is:

 Solution



p.d across each resistor is zero. Hence current is zero in each resistor.

10 The  $x$  and  $y$  components of a force are 2 N and  $-3\text{N}$ . The force is



Solution

$$\vec{F} = F_x \hat{i} + F_y \hat{j} \text{ or } \vec{F} = 2\hat{i} - 3\hat{j}.$$



11 The correct measure of magnetic hardness of a material is

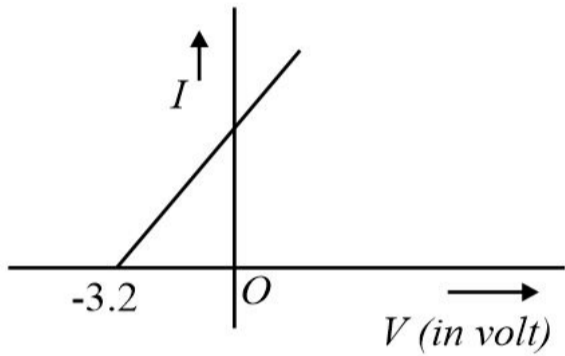


Solution

The correct measure of the hardness of a material is its coercivity, i.e., the field strength required to be applied in the opposite direction to reduce the residual magnetism of the specimen to zero.



12 In a photoelectric experiment, the relation between the applied potential difference  $V$  and the photoelectric current  $I$  was found to be as shown in the graph below. If the work function of the cathode plate is 28.8 eV and  $h = 6.6 \times 10^{-34} \text{ J s}$ , the frequency of incident radiation would be nearly (in  $\text{s}^{-1}$ )



Solution

For the photoelectric effect,

$$hf = \phi + KE_{\max}$$

From the graph  $KE_{\max} = 3.2 \text{ eV}$

$$\therefore hf = (28.8 + 3.2) \text{ eV}$$

$$f = \frac{32}{h} \text{ eV} = \frac{32 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-34}} \text{ Hz}$$

$$= 0.775 \times 10^{16} \text{ Hz}$$



13 A whistle producing sound waves of frequency 9500 Hz above is approaching a stationary person with speed  $v \text{ ms}^{-1}$ . The velocity of sound in air is  $300 \text{ ms}^{-1}$ . If the person can hear frequency up to a maximum of 10,000 Hz, the maximum value of  $v$  up to which he can hear the whistle is



Solution

$$\text{Velocity of sound in air} = 300 \text{ ms}^{-1}$$

Let  $v$  be the maximum value of source velocity for which the person is able to hear the sound, then

$$10000 = f_{app} = \left( \frac{300}{300-v} \right) \times 9500$$

$$\implies v = 15 \text{ ms}^{-1}$$



14 If a cricketer catches a ball of mass 150 g moving with a velocity of  $20 \text{ m s}^{-1}$ , then he experiences a force of (Time taken to complete the catch is 0.1 s.)



Solution

$$\text{Net force experienced} = \frac{\text{Total Impulse}}{\text{Time taken}}$$

$$= \frac{m\Delta v}{t} = 0.15 \times \frac{20}{0.1} = 30 \text{ N}$$

**Alternate**

Given,

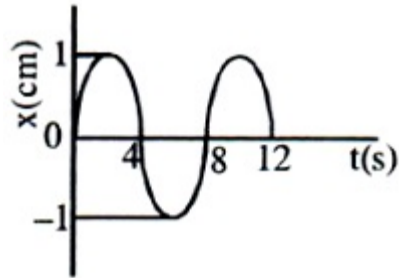
$$u = 20 \text{ m s}^{-1}$$
$$v = 0 \text{ m s}^{-1}$$
$$t = 0.1 \text{ s.}$$

Using,  $v = u + at$  we get

$$0 = 20 + a(0.1)$$
$$\Rightarrow a = -200 \text{ m s}^{-2}$$
$$\therefore F = \left(\frac{150}{1000}\right) \times (200) = 30N. \quad [\because F = ma]$$

15

The x-t graph of a particle undergoing simple harmonic motion is shown below. The acceleration of the particle at  $t = \frac{2}{3}$ s is



Solution

Using the general equation of SHM

$$x = A \sin \omega t$$

as per graph  $A = 1 \text{ cm}$ ,  $T = 8 \text{ sec}$

$$\Rightarrow \omega = \frac{2\pi}{T} = \frac{\pi}{4}$$
$$x = \sin \frac{\pi}{4} t$$
$$\text{acceleration } a = \frac{d^2x}{dt^2}$$
$$\Rightarrow a = \frac{-\pi^2}{16} \sin \frac{\pi}{4} t$$
$$\text{at } t = \frac{2}{3}, a = \frac{-\pi^2}{16} \sin \left( \frac{\pi}{4} \cdot \frac{2}{3} \right) = \frac{-\pi^2}{16} \cdot \sin \left( \frac{\pi}{6} \right)$$
$$\Rightarrow a = \frac{-\pi^2}{16} \times \frac{1}{2} = \frac{-\pi^2}{32} \text{ cm/s}^2$$

16

A particle of mass  $m$  is fixed to one end of a light spring of force constant  $k$  and unstretched length  $l$ . The system is rotated about the other end of the spring with an angular velocity  $\omega$ , in gravity-free space. Then increase in the length of the spring will be:



Solution

Let  $x$  be increase in length of the spring. The particle would move in a circular path of radius  $(l + x)$ . Centripetal force = force due to the spring

$$m(l + x)\omega^2 = kx$$
$$\therefore x = \frac{m\omega^2 l}{k - m\omega^2}$$

17

The dominant mechanisms for motion of charge carriers in forward and reverse biased silicon  $p$ - $n$  junctions are



Solution

For forward biased, majority charge carrier constitute current by diffusing to other side of junction. For reversed biased, minority charge carrier constitute small amount of leakage current by drifting due to externally applied electric field.

18

Two rods  $P$  and  $Q$  of equal lengths have thermal conductivities  $K_1$  and  $K_2$  and cross-sectional areas  $A_1$  and  $A_2$  respectively. If the temperature difference across the ends of each rod is the same, then the condition for which the rate of flow of heat through each of them will be equal, is



Solution

$$\left(\frac{\Delta Q}{\Delta t}\right)_P = \left(\frac{\Delta Q}{\Delta t}\right)_Q$$

$$K_1 A_1 \frac{(T_1 - T_2)}{l} = K_2 A_2 \frac{(T_1 - T_2)}{l}$$

$$\text{Or } K_1 A_1 = K_2 A_2 \text{ or } \frac{A_1}{A_2} = \frac{K_2}{K_1}$$

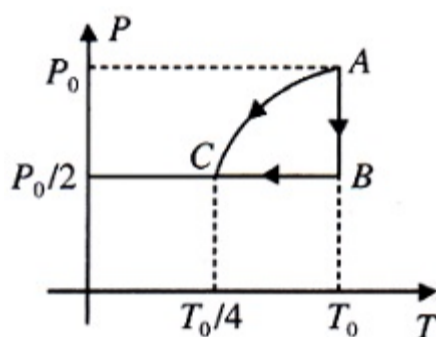
19

One mole of an ideal gas at pressure  $P_0$  and temperature  $T_0$  is expanded isothermally to twice its volume and then compressed at constant pressure to  $(V_0/2)$  and the gas is brought back to original state by a process in which  $P \propto V$  (pressure is directly proportional to volume). The correct temperature of the process is



Solution

Process AB is isothermal expansion, BC is isobaric compression and in process CA



$$P \propto \frac{nRT}{V} \Rightarrow P^2 \propto T$$

CA should be straight line PV diagram and parabolic in PT and can not be straight line VT diagram.

20

A 5 kg mass is projected at an angle of  $30^\circ$  to the horizontal. The curves (best) representing the variation of KE and PE as a function of time is



Solution

$$\text{Kinetic Energy} = \frac{1}{2}m(u^2 + gt^2 - 2ugt\sin\theta)$$

$$\text{Potential energy} = mg\left(u\sin\theta - \frac{1}{2}gt^2\right)$$

Kinetic energy is maximum at  $t = 0$  and kinetic energy varies with the time parabolically. For  $t = 0$ , potential energy is zero and potential energy varies parabolically with time.

21

Volume-temperature graph at atmospheric pressure for a monoatomic gas ( $V$  in  $\text{m}^3$ ,  $T$  in celcius) is



Solution

$$PV = nRt$$

$$V = \frac{nR}{P}(T_c + 273.15)$$

$$V = \left(\frac{nR}{P}\right)T_c + \frac{273.15nR}{P}$$

Positive slope positive intercept

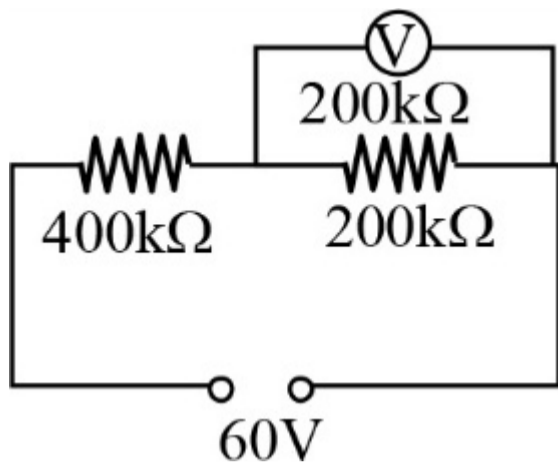
The volume of gas is zero at absolute zero temperature (0 K )

Thus, the volume has a positive value at  $0^\circ\text{C}$  since the volume is directly proportional to the absolute temperature and

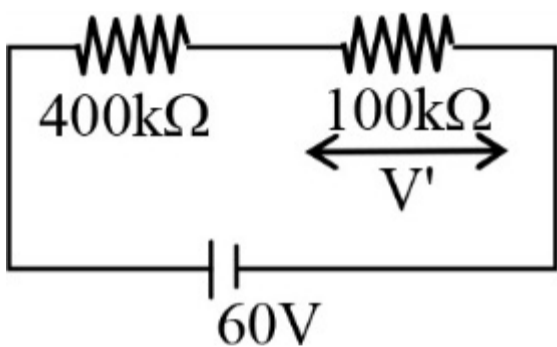
$$0\text{ K} = -273.15^\circ\text{C}$$

22

A constant 60 V supply is connected across the two resistors as shown in diagram. Calculate the reading of the voltmeter which has a resistance of 200 k $\Omega$



Solution



Voltmeter of resistance 200 k $\Omega$  and resistance 200 k $\Omega$  are in parallel combination

$$V' = \frac{60 \times 100}{500} = 12V$$

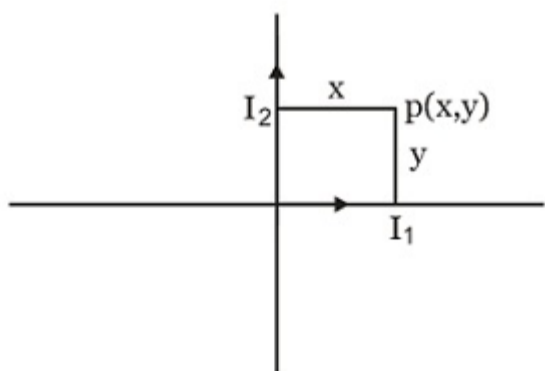
23

Two mutually perpendicular conductors carrying currents  $I_1$  and  $I_2$  lie in one plane. Locus of the point at which the magnetic induction is zero, is a



Solution

$$\vec{B}_p = \vec{B}_1 + \vec{B}_2$$



$$B_P = \frac{\mu_0}{4\pi} \frac{2I_1}{y} \odot + \frac{\mu_0}{4\pi} \frac{2I_2}{x} \otimes$$

$$0 = \left[ \frac{\mu_0}{4\pi} \frac{2I_1}{y} - \frac{\mu_0}{4\pi} \frac{2I_2}{x} \right] \odot$$

$$y = \frac{I_1}{I_2} x$$

24

An observer looks at a distant tree of height 10 m with a lens of magnifying power of 20. To the observer the tree appears as



Solution

Angular magnification of telescope is 20. so tree appears to the observer is 20 times taller

25

A cell of 2V,  $1\Omega$  is balanced at 1.9 m. Then what is balanced length for ideal cell of 2V ?



Solution

Balancing length is for emf of cell which does not depend on internal resistance.

26

A body is projected at an angle of  $60^\circ$  with the horizontal. If its kinetic energy at its maximum height is 10 J, then the height at which its potential energy and kinetic energy have equal values is (consider potential energy at the point of projection to be zero)



Solution

KE at maximum height

$$\frac{1}{2}mu^2\cos^2 60^\circ = 10 \text{ J}$$

$$\frac{1}{2}mu^2 = 40 \text{ J}$$

$$Mg H_{\max} = 30 \text{ J} \quad \dots(i)$$

When PE = KE

$$\Rightarrow mgh = 20 = \dots(ii)$$

from (i) and (ii)

$$\frac{h}{H_{\max}} = \frac{2}{3}$$

27

Two white points are 1 mm apart on a black paper. They are viewed by eye of pupil diameter 3 mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye?

[Take wavelength of light = 500 nm]



Solution

We know,

$$\frac{y}{D} \geq 1.22 \frac{\lambda}{d}$$

$$\Rightarrow D \leq \frac{yd}{1.22\lambda}$$

$$= \frac{10^{-3} \times 3 \times 10^{-3}}{1.22 \times 5 \times 10^{-7}}$$

$$= \frac{30}{6.1} = 5 \text{ m}$$

$$\therefore D_{\max} = 5 \text{ m}$$

28

At a temperature of  $30^\circ\text{C}$ , the susceptibility of a paramagnetic material is found to be  $X$ . Its susceptibility at  $333^\circ\text{C}$  is



Solution

Susceptibility of ferromagnetic material is inversely proportional to temperature

$$X \propto \frac{1}{T}$$

$$\frac{X_1}{X_2} = \frac{T_2}{T_1}$$

$$\text{Given, } T_1 = 30^\circ\text{C}, T_2 = 333^\circ\text{C}, X_1 = X$$

$$\therefore X_2 = \frac{T_1}{T_2} X = \frac{303 K}{606 K} X = 0.5 X$$

29

Given  $\theta$  is the angle between  $\vec{A}$  and  $\vec{B}$  which are unit vectors. Then  $\left| \vec{A} \times \vec{B} \right|$  is equal to



Solution

$$\left| \vec{A} \times \vec{B} \right| = (1) \cdot (1) \sin \theta = \sin \theta$$

30

A negative test charge is moving near a long straight wire carrying a current. The force acting on the test charge is parallel to the direction of the current. The motion of the charge is:



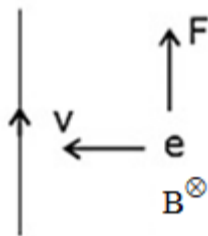
Solution

$$\vec{F} = q \left( \vec{v} \times \vec{B} \right)$$

$$\therefore q = -ve$$

$$\Rightarrow \vec{f} = -q \left( \vec{V} \times \vec{B} \right)$$

$\therefore$  motion of  $-q$  is towards the wire



31

The efficiency of a Carnot engine working between 800 K and 500 K is -



Solution

$$\begin{aligned} \text{Efficiency, } \eta &= 1 - \frac{T_2}{T_1} = 1 - \frac{500}{800} \\ &= \frac{3}{8} = 0.375 \end{aligned}$$

32

A particle of charge equal to that of an electron,  $-e$ , and mass 208 times the mass of electron (called  $\mu$  - meson) moves in a circular orbit around a nucleus of charge  $+3e$ . (Take the mass of the nucleus to be infinite). Assuming that Bohr model of the atom is applicable to this system:

Derive an expression for the radius of the  $n^{\text{th}}$  Bohr orbit



Solution

Electrostatic force will provide required centripetal force for circular motion in Bohr orbit.

$$r_n = \frac{n^2 h^2 \epsilon_0}{\pi m e^2 Z}$$

Put  $Z = 3$ ;  $m = 208 m_e$

33

Consider a car moving along a straight horizontal road with a speed of  $72 \frac{km}{h}$ . If the coefficient of static friction between the tyres and the road is 0.5, the shortest distance in which the car can be stopped is (taking  $g = 10 \frac{m}{s^2}$ )



Solution

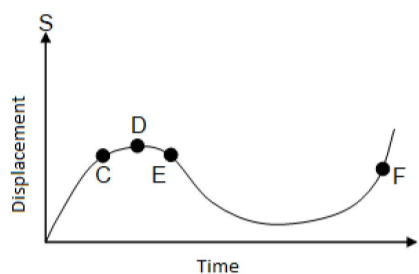
Here  $u = 72 \frac{km}{h} = 20 \frac{m}{s}; v = 0;$

$$a = -\mu g = -0.5 \times 10 = -5 \frac{m}{s^2}$$

As  $v^2 = u^2 + 2as,$

$$\therefore s = \frac{(v^2 - u^2)}{2a} = \frac{(0 - (20)^2)}{2 \times (-5)} = 40m$$

34 The displacement time graph of a moving particle is shown below



The instantaneous velocity of the particle is negative at the point



Solution

At E, the slope of the curve is negative, *i.e.* for a displacement-time graph the slope represents the velocity and at E, the velocity is  $-ve$  as the slope is  $-ve$ .

35 A body falls from a height  $h = 200m$ . The ratio of distance travelled in each 2s, during  $t = 0$  to  $t = 6s$  of the journey is



Solution

From equation of motion, we have

$$s = ut + \frac{1}{2}gt^2$$

where  $u$  is initial velocity,  $g$  the gravity and  $t$  the time.

Since,  $u = 0$ .

$$\therefore s_2 = \frac{1}{2}g(2)^2 = 2g; s_4 = \frac{1}{2}g(4)^2 = 8g$$

$$s_6 = \frac{1}{2}g(6)^2 = 18g$$

Distances travelled in first two seconds during  $t = 0$  to  $t = 6s$  are

$$(s_i)_2 = s_2 - s_0 = 2g$$

$$(s_m)_2 = s_4 - s_2 = 8g - 2g = 6g$$

$$(s_f)_2 = s_6 - s_4 = 18g - 8g = 10g$$

Hence, ratio obtained  $= 2g : 6g : 10g = 1 : 3 : 5$

36 Temperature at which the kinetic energy of gas molecule is half of the value of kinetic energy at  $27^\circ C$  is



Solution

Kinetic energy of a gas molecule

$$E = \frac{3}{2}kT$$

where  $k$  is Boltzmann's constant.

$$\therefore E \propto T$$

$$\text{or } \frac{E_1}{E_2} = \frac{T_1}{T_2} \quad \text{or} \quad \frac{E}{(E/2)} = \frac{300}{T_2}$$

$$\text{or } T_2 = 150 \text{ K}$$

$$T_2 = 150 - 273 = -123^\circ\text{C}$$

37 The dimensional formula for the magnetic field is

 Solution

$$\text{Magnetic field} = \frac{\text{Force}}{\text{Charge} \times \text{velocity}}$$

$$= \frac{[\text{MLT}^{-2}]}{[\text{AT}][\text{LT}^{-1}]} = [\text{MA}^{-1}\text{T}^{-2}]$$

38 A truck of mass 10 metric ton runs at  $3 \text{ m s}^{-1}$  along a level track and collides with a loaded truck of mass 20 metric ton, standing at rest. If the trucks couple together, the common speed after the collision is

 Solution

By the conservation of linear momentum

$$v = \frac{m_1 u_1 + m_2 u_2}{m_1 + m_2}$$

$$v = \frac{10 \times 3 + 20 \times 0}{10 + 20} = 1 \text{ m s}^{-1}$$

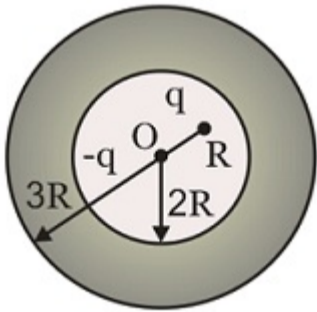
39 A point charge  $q$  is placed at a distance of  $R$  from the centre of a conducting shell of inner radius  $2R$  and outer radius  $3R$ . The electric potential at the centre of the shell will be

 Solution

The induced charges will be  $-q$  and  $+q$  as shown in the figure.

The potential at the centre O will be

$$V_0 = \frac{1}{4\pi\epsilon_0} \left[ \frac{q}{R} - \frac{q}{2R} + \frac{q}{3R} \right] = \frac{1}{4\pi\epsilon_0} \left( \frac{5q}{6R} \right)$$



40 The natural frequency ( $f_0$ ) of oscillations in L - C circuit is given by

 Solution

Natural frequency is nothing but resonant frequency.

In this case  $X_L = X_C$

$$\Rightarrow \omega_0 L = \frac{1}{\omega_0 C}$$

$$\Rightarrow \omega_0^2 = \frac{1}{LC}$$

$$\Rightarrow \omega_0 = \frac{1}{\sqrt{LC}}$$

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

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

41

When an unpolarized light of intensity  $I_0$  is incident on a polarizing sheet, the intensity of the light which gets absorbed is



Solution

If Intensity of incident light =  $I_0$

then, Intensity of polarized light =  $I_0/2$

$\therefore$  Intensity of light not transmitted

$$= I_0 - \frac{I_0}{2} = \frac{I_0}{2}$$

42

Two coils are at fixed locations. When coil 1 has no current and the current in the coil 2 increases at the rate  $15.0 \text{ As}^{-1}$ , the emf in coil 1 is  $25.0 \text{ mV}$ . When coil 2 has current of  $3.6 \text{ A}$  the flux linkage in coil 2 is



Solution

$$\text{As } e = M \frac{di}{dt}$$

$$\therefore M = \frac{e}{di/dt} = \frac{25 \times 10^{-3}}{15.0} = 1.67 \times 10^{-3} H$$

$$\text{As } \phi = Mi$$

$$\therefore \phi = 1.67 \times 10^{-3} \times 3.6 = 6 \times 10^{-3} \text{ Wb}$$

$$= 6 \text{ m Wb}$$

43

A body of mass  $5 \text{ kg}$  under the action of constant force  $\vec{F} = F_x \hat{i} + F_y \hat{j}$  has velocity at  $t = 0 \text{ s}$  as  $\vec{u} = (6\hat{i} - 2\hat{j}) \text{ m/s}$  and at  $t = 10 \text{ s}$  as  $\vec{v} = +6\hat{j} \text{ m/s}$ . The force  $\vec{F}$  is :



Solution

$$\vec{F} = F_x \hat{i} + F_y \hat{j}$$

$$\vec{u} = 6 \hat{i} - 2 \hat{j} \text{ m/s, } t = 0 \text{ sec}$$

$$\vec{v} = 6 \hat{j} \text{ m/s, } t = 10 \text{ sec}$$

$$\vec{a} = \frac{F_x}{5} \hat{i} + \frac{F_y}{5} \hat{j}$$

$$\therefore \vec{v} = \vec{u} + \vec{a} \cdot t$$

$$= (6\hat{i} - 2\hat{j}) + \left( \frac{F_x}{5} \hat{i} + \frac{F_y}{5} \hat{j} \right) \times 10$$

$$= (6\hat{i} - 2\hat{j}) + (2F_x \hat{i} + 2F_y \hat{j})$$

$$= (6 + 2F_x) \hat{i} + (2F_y - 2) \hat{j}$$

$$\text{Final velocity } \vec{v} = 0 \hat{i} + 6 \hat{j}$$

$$6 + 2F_x = 0$$

$$\therefore F_x = -3$$

$$2F_y - 2 = 6$$

$$\therefore F_y = 4$$

$$\therefore \vec{F} = -3\hat{i} + 4\hat{j}$$

44

An earth orbiting satellite has solar energy collecting panel with total area  $5 \text{ m}^2$ . If solar radiations are perpendicular and completely absorbed, the average force associated with the radiation pressure is

(Solar constant =  $1.4 \text{ kWm}^{-2}$ )



Solution

We know that, Power =  $I \times \text{area} = (1.4 \times 10^3) \times 5$

$$\text{Force } F = \frac{\text{Power}}{c} = \frac{1.4 \times 10^3 \times 5}{3 \times 10^8}$$

$$= 2.33 \times 10^{-5} \text{ N}$$

45

A ballet dancer is rotating about his own vertical axis on smooth horizontal floor with a time period 0.5 sec. The dancer folds himself close to his axis of rotation due to which his radius of gyration decreases by 20%, then his time period is



Solution

$$I_1 \omega_1 = I_2 \omega_2$$

$$MK_1^2 \frac{2\pi}{T_1} = MK_2^2 \frac{2\pi}{T_2}$$

$$\frac{T_2}{T_1} = \left( \frac{K_2}{K_1} \right)^2$$

$$T_2 = 0.64 \times 0.5$$

$$= 0.32 \text{ sec}$$

## CHEMISTRY

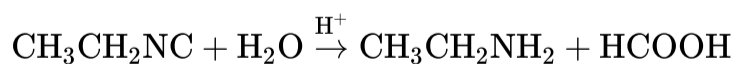
1

Ethyl isocyanide on hydrolysis in acidic medium generates



Solution

Ethyl isocyanide on hydrolysis form primary amines.



2

An ore like zinc blende is concentrated by



Solution

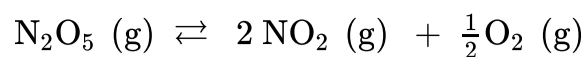
Froth floatation because it is sulphide ore ( $\text{ZnS}$ )

3

The reaction,  $\text{N}_2\text{O}_5 (\text{g}) \rightleftharpoons 2 \text{NO}_2 (\text{g}) + \frac{1}{2} \text{O}_2 (\text{g})$ , is started with initial pressure of  $\text{N}_2\text{O}_5 (\text{g})$  equal to 600 torr. What fraction of  $\text{N}_2\text{O}_5 (\text{g})$  decomposed when total pressure of the system is 960 torr ?



Solution



Initially : 600 torr - -

At equilibrium:  $(600 - p)$  torr     $2p$  torr     $\frac{p}{2}$  torr

Total press is  $\left(600 + \frac{3p}{2}\right)$  torr

$$\therefore 600 + \frac{3p}{2} = 960$$

$$\text{or } \frac{3p}{2} = 360$$

or  $p = 240$  torr

$$\therefore \square \text{fraction of } \text{N}_2\text{O}_5 (\text{g}) \text{ decomposed} = \frac{240}{600} = 0.4$$

4

Equal volumes of monoatomic and diatomic gases are taken at same temperature and pressure. The ratio of adiabatic exponents of the gases will be-



Solution

For monoatomic gas,  $\gamma_1 = \frac{C_p}{C_v} = 1.67$

For diatomic gas,  $\gamma_2 = \frac{C_p}{C_v} = 1.40$

$$\therefore \gamma_1 : \gamma_2 = \frac{1.67}{1.40} = 1.19 : 1$$

5

What will be the volume of  $\text{O}_2$  Liberated at NTP by passing 5A current For 193 Sec. through acidified water.



Solution

$$W = \frac{C \times t \times E}{F}$$

$$= \frac{5 \times 193 \times 8}{96500}$$

$\therefore$  At NTP, volume of 32 g  $\text{O}_2 = 22400$  mL

$$\therefore \text{Volume of } 0.08 \text{ g } \text{O}_2 = \frac{22400 \times 0.08}{32}$$

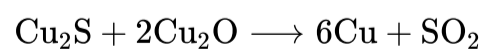
$$= 56 \text{ mL}$$

6

Heating mixture of  $\text{Cu}_2\text{O}$  and  $\text{Cu}_2\text{S}$  will give



Solution



This is an example of auto - reduction.

7

The sequence of ionic mobility in aqueous solution is



Solution

Smaller the size of cation, higher will be the hydration and its effective size will increase and hence mobility in aqueous solution will decrease. Larger size ions have more ionic mobility due to less hydration. Thus the degree of hydration of  $\text{M}^+$  ions decreases from  $\text{Li}^+$  to  $\text{Cs}^+$ . Consequently the radii of the hydrated ion decreases from  $\text{Li}^+$  to  $\text{Cs}^+$ . Hence the ionic conductance of these hydrated ions increases from  $\text{Li}^+$  to  $\text{Cs}^+$ .

8 In which of the following salts only cationic hydrolysis is involved?

 Solution

Cationic hydrolysis

Strong Acid + Weak Base

$\therefore \text{NH}_4\text{Cl}$

$\text{NH}_3 + \text{HCl}$

Weak Base + Strong Acid

9 If  $\text{H}_2\text{SO}_4$  ionises as  $\text{H}_2\text{SO}_4 + 2\text{H}_2\text{O} \rightarrow 2\text{H}_3\text{O}^+ + \text{SO}_4^{2-}$ , then total number of ions produced by 0.1 Molar and 1 L aqueous  $\text{H}_2\text{SO}_4$  will be:

 Solution

1 mole of  $\text{H}_2\text{SO}_4$  gives = 3 moles of ions or  $3 \times 6.023 \times 10^{23}$  ions

$\therefore$  0.1 mole of  $\text{H}_2\text{SO}_4$  will give =  $0.1 \times 3 \times 6.023 \times 10^{23}$  ions =  $1.8 \times 10^{23}$  ions

10 The energy of an electron in the first orbit of H- atom is  $-13.6$  eV. The possible energy values of the excited state for electrons in Bohr orbits of  $\text{Li}^{2+}$  ions is/are-

 Solution

$$E_n = -\frac{13.6 Z^2}{n^2} \text{ for } \text{Li}^{2+}, E_n = -\frac{13.6 \times 9}{n^2}$$

$$= \frac{-122.4}{n^2} \text{ eV}$$

If  $n = 1$ ,  $E_n = -122.4$  eV

If  $n = 2$ ,  $E_n = -30.6$  eV

If  $n = 3$ ,  $E_n = -13.6$  eV

11 pH of a 1000 cc solution is 2. It will not change if

 Solution

If two solutions of same pH are mixed, no change in pH is observed. pH of water will be 7, that of 100 cc of 0.1 M HCl and 1 cc of 0.1 M HCl will be 1 (as  $\text{H}^+$  concentration is 0.1 )

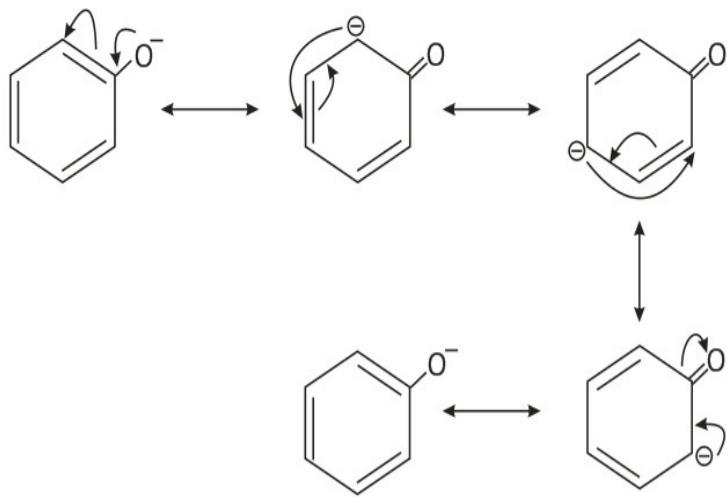
0.01 N HCl has also pH = 2.

So adding this to a 1000 cc solution of pH 2 will not make any difference in pH

12 Which of the following is acidic

 Solution

Due to the resonance stabilisation of phenoxide ion. Conjugate Base



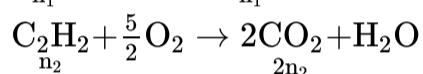
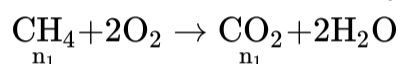
13 A mixture of  $\text{CH}_4$  and  $\text{C}_2\text{H}_2$  occupied a certain volume at a total pressure equal to 63 torr. The same gas mixture was burnt to  $\text{CO}_2$  and  $\text{H}_2\text{O}(l)$ .  $\text{CO}_2(g)$  alone was collected in the same volume and at the same temperature, the pressure was found to be 69 torr.

What was the mole fraction of  $\text{CH}_4$  in the original gas mixture?

Solution

Let no. of moles of  $\text{CH}_4$  present =  $n_1$  mole

Let no. of moles of  $\text{C}_2\text{H}_2$  present =  $n_2$  mole



Total no. of moles at initial =  $n_1 + n_2$

Total no. of moles at final =  $n_1 + 2n_2$

At constant V & T

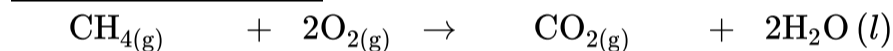
$$\frac{P_1}{P_2} = \frac{\text{No. of moles at initial}}{\text{No. of moles at final}}$$

$$\frac{63}{69} = \frac{n_1 + n_2}{n_1 + 2n_2} \Rightarrow \frac{21}{23} = \frac{n_1 + n_2}{n_1 + 2n_2}$$

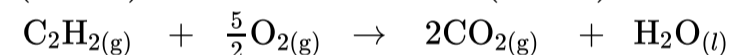
$$\Rightarrow \frac{n_2}{n_1} = \frac{2}{19} \Rightarrow \frac{n_1 + n_2}{n_1} = \frac{21}{19}$$

$$\therefore \frac{n_1}{n_1 + n_2} = \frac{19}{21}$$

**Alternative solutions**



$$(63 - x) \text{ Torr} \qquad (63 - x) \text{ Torr}$$



$$(x) \text{ Torr} \qquad (2x) \text{ Torr}$$

$$\sum P_{\text{CO}_2} = 63 - x + 2x = 63 + x = 69 \text{ Torr}$$

$$\therefore x = 6 \text{ Torr}$$

$$X_{\text{CH}_4} = \frac{63-6}{63} = \frac{57}{63} = \frac{19}{21}$$

14 Which one of the following is not the representative element ?

Solution

Group 1,2,13,14,15,16 and 17 are representative elements.

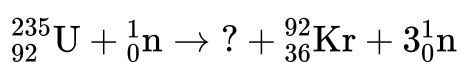
15 Which of the following compounds will not undergo Friedel Craft's reaction with benzene?

Solution

Formation of carbocation is not possible in case of  $\text{CH}_2 = \text{CHCl}$

Because +ve charge at  $\text{Csp}^2$  is highly unstable.

16 Fill in the blank :



Solution

$$92 + 0 = Z + 36 + 0 \Rightarrow Z = 56 \text{ (Sum total atomic numbers)}$$

$$235 + 1 = A + 92 + 3 \text{ (Sum total mass numbers)}$$

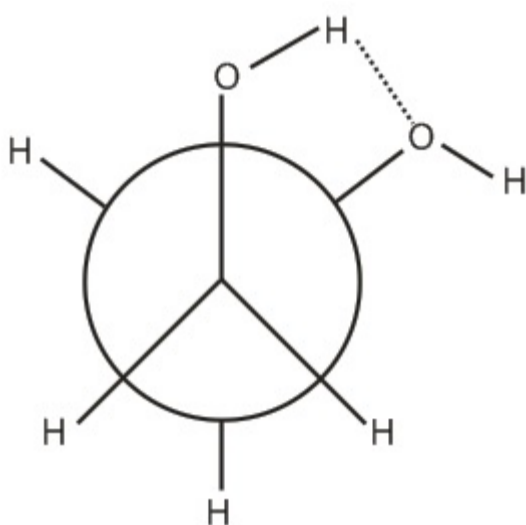
$$\therefore A = 141$$

Missing nuclide is  ${}_{56}^{141}\text{Ba}$

17 Which of the following conformers for ethylene glycol is most stable ?

 Solution

Due to hydrogen bonding between the two OH groups, gauche conformation of ethylene glycol (a) is the most stable conformation.



18 In the Rosenmund's reaction  
 $\text{BaSO}_4$  :

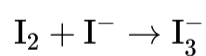
 Solution

In the Rosenmund's reaction, acid chlorides are converted to corresponding aldehydes by catalytic reduction. The reaction is carried out by passing through a hot solution of the acid chloride in the presence of Pd deposited over  $\text{BaSO}_4$ . Here, barium sulphate decreases the activity of palladium.

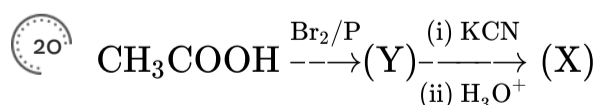
19 The correct statement for the molecule  $\text{CsI}_3$ , is :

 Solution

$\text{I}_3^-$  ion is made by the addition of excess iodine to iodide solution.



Cs will always be in +1 oxidation state.

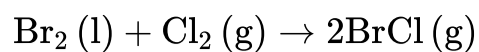


Here (X) is:

 Solution

[Math Processing Error]

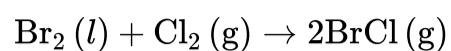
21 The enthalpy and entropy change for the reaction :



are  $30 \text{ kJ mol}^{-1}$  and  $105 \text{ J K}^{-1} \text{ mol}^{-1}$  respectively. The temperature at which the reaction will be in equilibrium is



Solution



$$\Delta H = 30 \text{ kJ mol}^{-1}, \Delta S = 105 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta S = \frac{\Delta H}{T} \text{ i.e., } 105 = \frac{30}{T} \times 1000$$

$$\therefore T = \frac{30 \times 1000}{105} = 285.7 \text{ K}$$

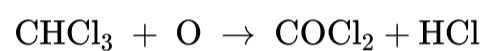


Chloroform, when kept open, is oxidised to



Solution

Chloroform is oxidised to a poisonous gas, phosgene ( $\text{COCl}_2$ ) by atmospheric oxidation.



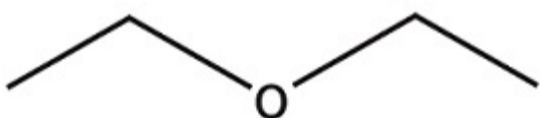
The number of metamers possible for  $\text{C}_4\text{H}_{10}\text{O}$  is



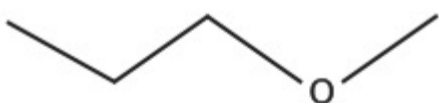
Solution

Compound with molecular formula  $\text{C}_4\text{H}_{10}\text{O}$  has the following metamers:

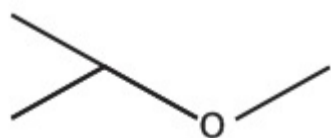
i)



ii)



iii)



Which of the following is a hypnotic drug



Solution

These drugs produce sleep and are habit forming common example of hypnotic drugs are Luminal and Saconal.



A compound contains 1.08 mol of Na, 0.539 mol of Cu and 2.16 mol of F. Its aqueous solution shows osmotic pressure which is three times that of urea having same molar concentration. The formula of the compound is :



Solution

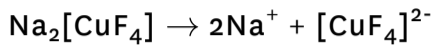
Mol ratio of Na, Cu and F

$$= \frac{1.08}{0.539} : \frac{0.539}{0.539} : \frac{2.16}{0.539} = 2:1:4$$

Empirical formula = Na<sub>2</sub>CuF<sub>4</sub> : Van't Hoff factor (i)

$$= 3 \text{ (given)}$$

Hence, formula of the compound :



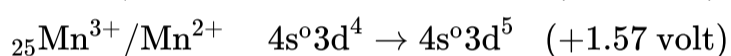
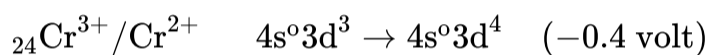
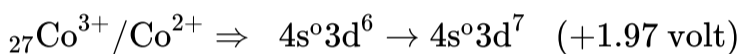
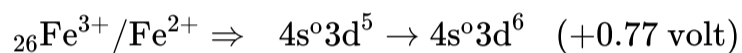
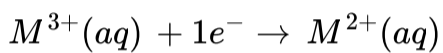
26

Four successive members of the first row transition elements are listed below with atomic numbers. Which one of them is expected to have the highest  $E_{\text{M}^{3+}/\text{M}^{2+}}^0$  value ?



Solution

Species having highest reduction potential ie. tendency to undergo reduction by gain of electron  
SRP value increases from left to right in the period for the d-block elements.



Highest reduction potential means strong oxidising agent ie. undergoing reduction  $\text{Co}^{3+} + 1\text{e}^- \rightarrow \text{Co}^{+2}$

27

Root mean square velocity of O<sub>2</sub> at STP is (in  $\frac{\text{cm}}{\text{s}}$ )



Solution

$$u_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

$$= \sqrt{\frac{3 \times 8.31 \times 10^7 \times 273}{32}} = 4.61 \times 10^4 \text{ cm/sec}$$

(at STP, T = 273 K, R = 8.314 × 10<sup>7</sup> ergs K<sup>-1</sup>mol<sup>-1</sup>)

28

The radial probability distribution curve for 2s electron appears like -



Solution

Radial Probability =  $4\pi r^2 \varphi^2$  vs r for 2 s orbital

29

At solution containing 12.5 g of non-electrolyte substance in 175 of water gave boiling point elevation of 0.70 K. Calculate the molar mass of the substance. Molal elevation constant (K<sub>b</sub>) for water 0.52 K kg mol<sup>-1</sup> ?



Solution

$$\Delta T_b = k_b \times \frac{w}{M} \times \frac{1000}{W}$$

$$M = \frac{K_b \times w \times 1000}{\Delta T_b \times W}$$

$$M_B = \frac{K_b \times W_B \times 1000}{\Delta T_b \times W_A}$$

According to available data

$$\text{Mass of solute (W}_B) = 12.5 \text{ g}$$

$$\text{Mass of solute (W}_A) = 175 \text{ g}$$

$$\text{Molal elevation constant (K}_b) = 0.52 \text{ K kg mol}^{-1}$$

$$\text{Elevation in boiling point temperature } (\Delta T_b) = 0.70 \text{ K}$$

$$\therefore M = \frac{(0.52 \text{ K kg mol}^{-1}) \times (12.5 \text{ g}) \times 1000}{(0.70 \text{ K}) \times (175 \text{ g})}$$

$$= 53 \text{ g mol}^{-1}$$



The number of atoms in 100 g of an FCC crystal with density  $d = 10 \text{ g/cm}^3$  and cell edge equal to 100 pm, is equal to



Solution

$$M = \frac{\rho \times a^3 N_A}{Z}$$

$$= \frac{10 \times (100)^3 \times 6.02 \times 10^{23} \times 10^{-30}}{4} = 1.505$$

$$\therefore \text{number of atoms in 100 g} = \frac{6.02 \times 10^{23}}{1.505} \times 100$$

$$= 4 \times 10^{25}$$



99% of a first order reaction was completed in 32 min. When will 99.9% of the reaction complete?



Solution

$$k = \frac{2.303}{32} \log \frac{100}{1}$$

$$\therefore t = \frac{2.303}{\frac{2.303}{32} \log 100} \log \frac{100}{0.1}$$

$$t = 48 \text{ min}$$



How many nitrogen atoms are in 0.25 mole of  $\text{Ca}(\text{NO}_3)_2$  ?



Solution

1 mole of  $\text{Ca}(\text{NO}_3)_2$  has = 2 N atoms of nitrogen

0.25 mole of  $\text{Ca}(\text{NO}_3)_2$  has =  $2 \times 0.25 \times 6.023 \times 10^{23}$  atoms of N

$$= 3.0 \times 10^{23}$$



Bleeding is stopped by the application of ferric chloride. This is because:



Solution

Blood is a colloidal solution and  $\text{FeCl}_3$  is a strong coagulant. Blood contains colloidal impurities and  $\text{FeCl}_3$  neutralizes the charge on these colloidal impurities and clotting of blood begins which blocks the vessels and prevents any further flow of blood.



Given the equilibrium system

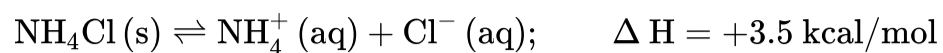


( $\Delta H = +3.5 \text{ kcal/mol}$ ).

What change will shift the equilibrium to the right?



Solution



This is the endothermic reaction hence, increasing the temperature will shift the equilibrium to the right.



35 For which order reaction half-life period is independent of initial concentration of reactant?



Solution

For first order reaction half-life period is independent of initial concentration of reactant.

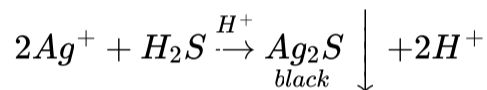
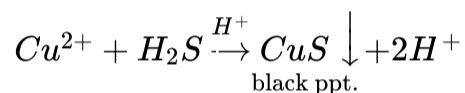


36  $H_2S$  is passed through an acidified solution of  $Ag$ ,  $Cu$  and  $Zn$ . Which forms precipitate



Solution

Sulphides of  $Ag^{2+}$  and  $Cu^{2+}$  have low value of their solubility product, whereas sulphide of  $Zn^{2+}$  has higher value. So, only AgS and CuS precipitate out while ZnS remains in the solution.



37 Nylon-6,6 and polythene are examples of



Solution

**Condensation polymerisation:** In this type polymerisation, two or more bifunctional molecules undergo a series of independent condensation reactions with the elimination of simple molecules such as water, alcohol, hydrogen chloride, etc. to form a macromolecule.

For Example, nylon 6, 6.

**Additional Polymerisation:** In this type of polymerisation, the polymers are formed by the repeated addition of monomer molecules possessing double or triple bonds. For example, formation of polythene from ethane.



38 A body centre cubic lattice is made up of two different types of atoms A and B. Atom A occupies the body centre and B occupying the corner positions. One of the corners is left unoccupied per unit cell. Empirical formula of such a solid is



Solution

There is one A per unit cell

$$\text{Number of B per unit cell} = \frac{1}{8} \times 7 = \frac{7}{8}$$

$$\text{Empirical formula} = A_1 B_{\frac{7}{8}}$$

$$= A_8 B_7$$



39 Sodium chloride is an ionic compound, whereas hydrogen chloride is mainly covalent because

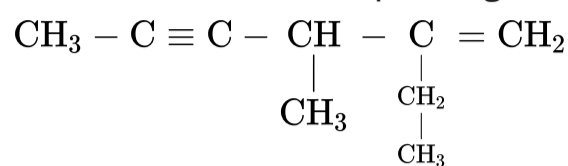


Solution

Hydrogen is non metal and non metal atoms form covalent bond

The nature of a bond formed between two elements mainly depends on the difference of electronegativity. If difference of electronegativity of two atoms is more than 1.90, they form an ionic bond. And when this difference is less than 1.9, they form a covalent bond.

40 IUPAC name of the compound given below is-

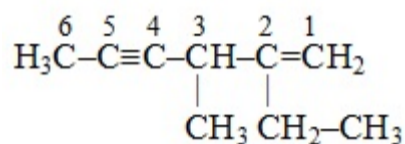


 Solution

The first step for naming a compound is identifying the longest carbon chain. But while doing this, care must be taken to ensure that the double and triple bonds are present in the parent chain.

Now we need to number the chain such that the most important functional group gets the lowest number possible. A double bond is given higher priority and hence, the compound is numbered from right to left.

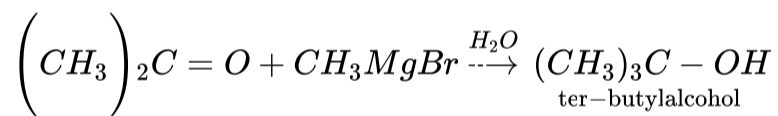
In substituents, ethyl is written before methyl to maintain alphabetical order. Hence, the name will be 2-ethyl-3-methyl-hex-1-en-4-yne.



41 Acetone on treatment with  $\text{CH}_3 - \text{Mg} - \text{I}$  and on further hydrolysis gives

 Solution

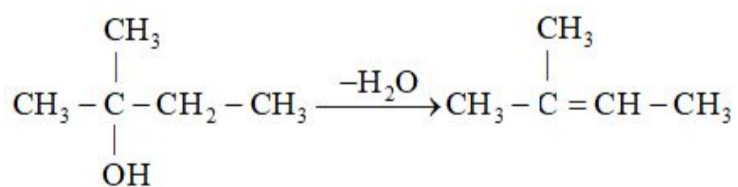
Acetone reacts with Grignard's reagent to give tertiary alcohol.



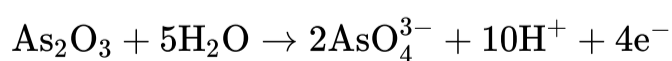
42 2-Methylbutan-2-ol can be obtained by the acid catalyzed hydration of

 Solution

Proceed backward i.e., remove a molecule of water to get the alkene.



43 Evaluate equivalent weight of  $\text{As}_2\text{O}_3$  :



 Solution

$$E_{\text{red/oxi}} = \frac{\text{Mol. weight of reductant or oxidant}}{\text{Number of electrons gained or lost by one molecule reductant or oxidant or valence factor}}$$

$$E_{\text{As}_2\text{O}_3} = \frac{M_{\text{As}_2\text{O}_3}}{4} \left( \text{As}_2^{6+} \longrightarrow 2\text{As}^{5+} + 4e^- \right)$$

Per mole  $4e^-$  lose so 'n' factor = 4

Equivalent weight of  $As_2O_3 = \frac{M \text{ wt. of } As_2O_3}{4}$

44

If in a solvent, n simple molecules of solute combine to form an associated molecule,  $\alpha$  is the degree of association, the van't Hoff's factor is equal to



Solution

$$\frac{nA}{(1-\alpha)} \rightleftharpoons \frac{An}{\frac{\alpha}{n}}$$

$$i = 1 - \alpha + \frac{\alpha}{n}$$

45

Which of the following statements is false?



Solution

Oil slick causes water pollution, thus it decreases DO value (dissolved oxygen value) of sea water

## BIOLOGY

1

Which of the following show pulmonary respiration



Solution

Pulmonary respiration is the process by which oxygen enters and carbon dioxide exits the alveoli

2

The two chromatids of a metaphase chromosome represent



Solution

The two chromatids of a metaphase chromosome represent replicated chromosomes, arranged at the equatorial plane of the cell, to be separated at anaphase.

3

When an organ is transplanted and is rejected by the body, the lymphocytes involved are



Solution

T cell, also called T lymphocyte, type of leukocyte (white blood cell) that is an essential part of the immune system. T cells are one of two primary types of lymphocytes—B cells being the second type—that determine the specificity of immune response to antigens (foreign substances) in the body.

T cells originate in the bone marrow and mature in the thymus. In the thymus, T cells multiply and differentiate into helper, regulatory, or cytotoxic T cells or become memory T cells. They are then sent to peripheral tissues or circulate in the blood or lymphatic system. Once stimulated by the appropriate antigen, helper T cells secrete chemical messengers called cytokines, which stimulate the differentiation of B cells into plasma cells (antibody-producing cells). Regulatory T cells act to control immune reactions, hence their name.

4

Select the correct option related to placentation seen in sweet pea?



Solution

In sweet pea the gynoecium is monocarpellary and bears a single placenta along the junction of two fused margins, this is called marginal placentation.

5

Statement I: Biolistics method of gene transfer is an example of direct gene transfer.

Statement II: In the biolistics method, PBR<sup>322</sup> is used.



Solution

Biolistics is a commonly used method for genetic transformation of plants and other organisms. Millions of DNA-coated metal particles are shot at target cells or tissues using a biolistic device or gene gun.

6

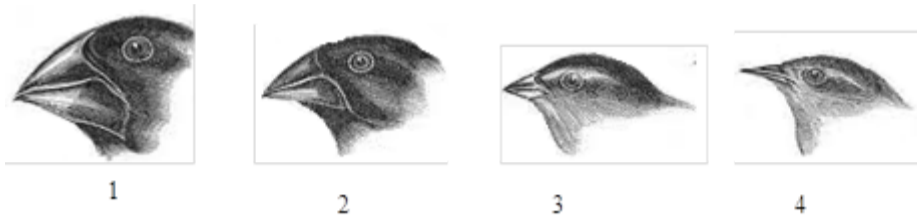
An undifferentiated layer, mesoglea, is present in



Solution

Animals in which the cells are arranged in two embryonic layers, external ectoderm, and internal endoderm, are called diploblastic animals, e.g., coelenterates. An undifferentiated layer, mesoglea, is present in between the ectoderm and the endoderm.

7



Darwin noticed this changing pattern of finches on which of the following Islands:



Solution

Darwin's noticed a variety of finches on the Galapagos Island. In the original seed-eating birds altered beaks arose, enabling them to become insectivorous and vegetarian Ancher. This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography is called adaptive radiation.

8

*cryIIAb* and *cryIAb* produce toxins that control



Solution

Bt toxin is coded by a gene named Cry. There are a number of them, e.g., the proteins encoded by the genes Cry I Ac and Cry II Ab control the cotton bollworms, that of Cry I Ab controls corn borer.

9

For transformation with recombinant DNA, the bacterial cells must first be made competent which means



Solution

As DNA is a hydrophilic molecule, it can not pass through cell membrane as it is hydrophobic in nature. Therefore, the bacterial cells should be made capable of uptaking DNA, i.e., they should be competent.

10

Which of the following is the main factor of desertification



Solution

Desertification is the process leading to the formation of desert.The main factor of desertification of land is over-grazing by herbivorous animals.

11

Corpus luteum in mammals is present in



Solution

The hormone-secreting structure that develops in an ovary after an ovum has been discharged but degenerates after a few days unless pregnancy has begun.

12

Number of death and birth in the last stage of plateau growth curve of a population will be



Solution

In middle stage growth rate is very high due to lack of environmental resistance, but in last stage growth rate is very low due to high environmental resistance. In this phase both natality and mortality is equal to each other.

13

Transgenic plants are the one that is



Solution

Transgenic plants contain a gene or genes which have been artificially inserted of the plants acquiring them through pollination. Inserted gene sequences (transgene) may come from other unrelated plants, or from a completely different species.

14

In which one of the following techniques blastomeres up to 8 cell stage is introduced into the fallopian tube?



Solution

In this technique fusion of ovum and sperm is done outside the body of a woman to form a zygote which is allowed to divide forming 8 blastomeres, then it is transferred into the fallopian tube of the woman.

15

Which of the following blood cells engulf pathogens rapidly?



Solution

Monocytes are the largest of W.B.C. Macrophages or monocytes that digest cells and pathogens by engulfing them in a process called Phagocytosis.

16

How many ATP molecules could maximally be generated from one molecule of glucose, if the complete oxidation of one mole of glucose to  $\text{CO}_2$  and  $\text{H}_2\text{O}$  yields 686 kcal and the useful chemical energy available and the high energy phosphate bond of one mole of ATP is 12 kcal?



Solution

12 kcal of energy present in one molecule of ATP & on oxidation of one mole of glucose into  $\text{CO}_2$  and  $\text{H}_2\text{O}$  energy released is 686 kcal. So no. of ATP which can store this energy would be  $= 57.1 = 57$  ATPs.

17

Certain genetic disorders show a higher proportion of males to be affected as compared to females that are affected. Such genetic disorders can arise due to



Solution

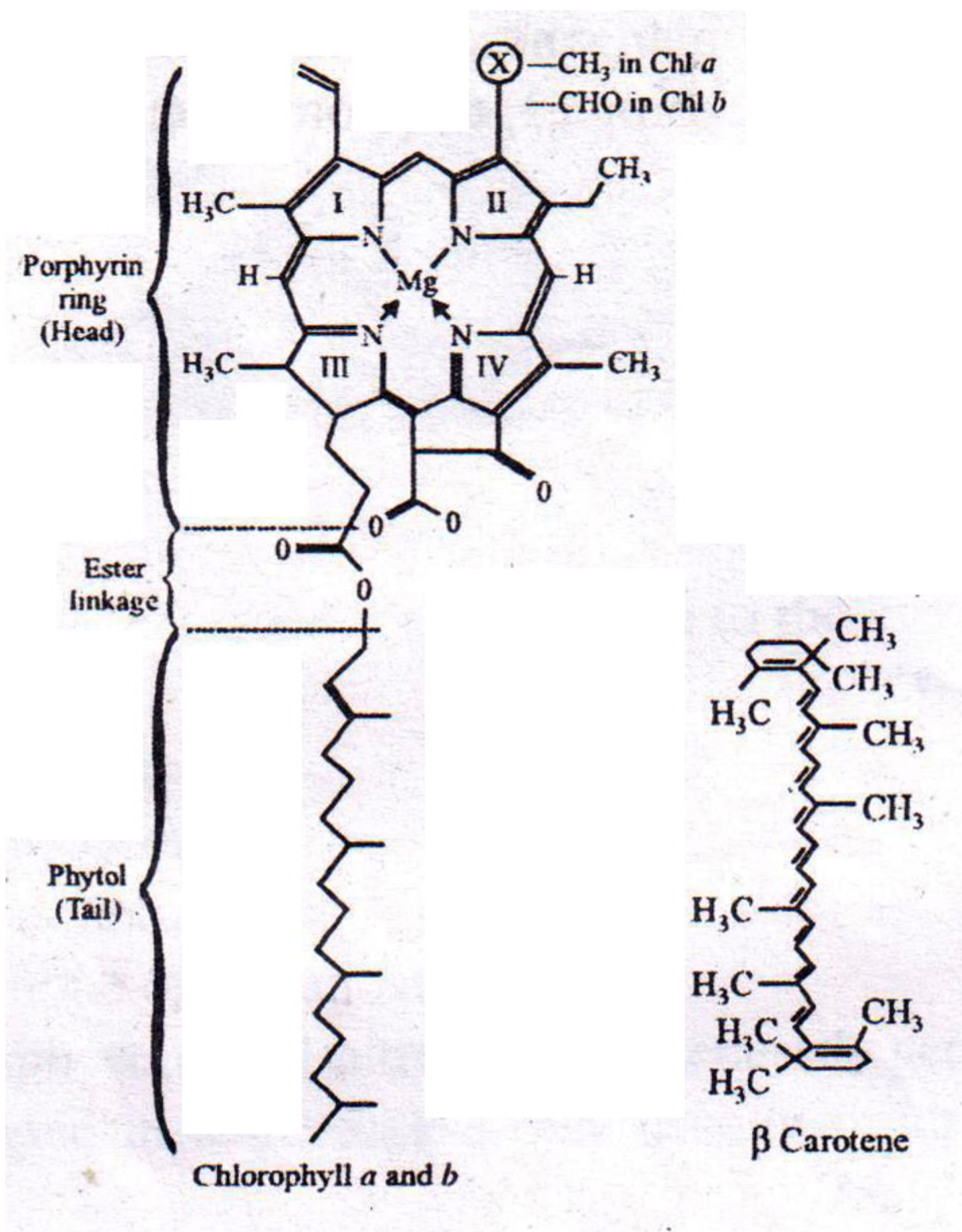
Genetic disorders due to recessive genes present on the X-chromosome are more prevalent in males as compared to females because of the homozygous condition of males. In males, a single recessive allele present on X-chromosome can cause the disease, while it requires both the alleles to be recessive in females for the symptoms to be visible.

18

A plant requires magnesium for



Solution



Plants require magnesium for chlorophyll synthesis. All four tetrapyrrole rings bind with magnesium ( $Mg^{++}$ ) ion at the center of chlorophyll molecule.

19 Heterocysts are found in certain

💡 Solution

Some cyanobacteria possess heterocyst, e.g., *Nostoc*, *Scytonema*, *Anabaena*. Heterocyst is a site of  $N_2$  fixation.

20 Long fibres of cotton seed are known as

💡 Solution

Long fibres of cotton is called lint and small fibres is called fuzz. Lint is extractable and fuzz are non extractable.

21 Which of the following meristems is responsible for extrastelar secondary growth in dicotyledonous stem ?

💡 Solution

Intrafascicular cambium occurs inside the vascular bundles in between xylem and phloem. Interfascicular cambium develops in the form of strips at the level of intrafascicular cambium of vascular bundles. Intercalary meristem lie in between areas of permanent

tissues.

22 The most abundant, harmful and universal waste product of metabolism is

 Solution

$CO_2$  and  $H_2O$  are the end product of complete aerobic oxidation of food through kerb's cycle and electron transport chain (E.T.C.)  
 $CO_2$  is most abundant, harmful and universal waste product of metabolism.

23 Which one among the following is the richest source of protein?

 Solution

Soyabean is the richest source of protein. The chief form of proteins is globulin accounting for nearly 80-90% of total seed protein.

24 The specific characteristic of  $C_4$ -plants is

 Solution

Anatomy of leaves of  $C_4$ -plant is called kranz anatomy. In the mesophyll cells of these plants palisade tissue is absent.

25 Kingdom Plantae includes

 Solution

The Kingdom Plantae includes algae, bryophytes, pteridophytes, gymnosperms and flowering plants (angiosperms). They are common on land, on sea shore and in freshwater.

26 Which of the following set of examples is correct with respect to escaping time as a response to abiotic factors?

 Solution

Bears going into hibernation during winter is an example of escape in time. Some snails and fish go into aestivation to avoid summer-related problems-heat and desiccation. Under unfavourable conditions, many zooplankton species in lakes and ponds are known to enter diapause, a stage of suspended development.

27 Chipko movement was launched for the protection of

 Solution

Chipko movement was launched for the protection of forests. The Chipko movement refers to the unique form of protest adopted by the rural people in the Himalayan region of India in the 1970s and 80s, against the indiscriminate logging and felling of trees that spelt the destruction of their environment. The first Chipko action occurred in April 1973. Over the next five years, the movement spread to several hill districts in Uttar Pradesh. In 1980, Chipko activists won a fifteen-year ban on green felling in the Himalayan forests.

28 Who discovered "ribosomes" in animal cells?

 Solution

Ribosomes were discovered by George Emil Palade and hence are also called as the Palade particles. The ribosome is a complex molecular machine, found within all living cells, that serves as the site of biological protein synthesis (translation). Ribosomes link amino acids together in the order specified by messenger RNA(mRNA) molecules. Ribosomes consist of two major components: the small ribosomal subunits, which read the RNA, and the large subunits, which join amino acids to form a polypeptide chain.

29

What is antisense technology?



Solution

The antisense RNA technology simply involves the synthesis of RNA molecules that are complementary to the mRNA molecules produced by transcription of a given gene.

30

Statement I: According to the 2001 census report, the population growth rate was still around 1.7%.

Statement I: At this rate if population increases then our population could double in 33 years.



Solution

According to the 2001 census report, the population growth rate was still around 1.7%, i.e., 17/1000/year, a rate at which our population could double in 33 years. Such an alarming growth rate could lead to an absolute scarcity of even the basic requirements, i.e., food, shelter and clothing, in spite of significant progress made in those areas.

31

Which one of the following immune system components does not correctly match with its respective role?



Solution

Macrophages are phagocytic cells that can ingest pathogenic micro-organisms. Macrophages are among the first cells that respond to the infection.

32

Which of the following organisms are correctly paired with its life span?



Solution

Butterfly - 1-2 weeks; Parrot - 140 years; Crocodile - 60 years.

33

In how many steps,  $\text{CO}_2$  is released in aerobic respiration of pyruvic acid



Solution

In aerobic respiration,  $\text{CO}_2$  is produced at 3 step :

(i) During acetyl Co-A formation.

(ii) During formation of  $\alpha$ -ketoglutaric acid in kreb's cycle.

(iii) During succinic acid formation in kreb's cycle.

34

Movements of leaves of sensitive plant, *Mimosa pudica* are due to



Solution

*Mimosa pudica* (touch me not family Mimosaceae) shows both nyctinasty and seismonasty movements in response to shock.

35

Given below are four statements (I–IV) regarding the human blood circulatory system.

(I) In the treatment of angina pectoris, nitrous oxide and nitroglycerine are used.

(II) Veins have thinner walls and broader lumen than arteries.

(III) Artificial pacemakers are used in arrhythmia.

How many of the above are correct statements?



Solution

In the treatment of angina pectoris, nitrous oxide and nitroglycerine are recommended, and they are proved to be very effective. Veins have a thinner wall and larger lumen, while arteries have thicker walls and a smaller lumen. Pacemaker is a small artificial

device placed in the chest or abdomen for controlling abnormal heart rhythms. This device is used to treat arrhythmias and uses electrical pulses to prompt the heart to beat at a normal rate.

36 What are flocs?

 Solution

Flocs are masses of bacteria associated with fungal filaments to form mesh-like structures.

37 Category among following is

 Solution

Linnaeus introduced five categories in the taxonomic hierarchy, i.e., class, order, species and variety. Later on, three more categories, i.e., kingdom, division or phylum and family were added and variety was discarded to make a hierarchy of seven obligate categories.

**Kingdom** - highest taxonomy category

**Phylum/ Division** - largest category including closely allied classes.

**Class** - group of related order /cohort

**Order/ Cohort** - group of related families

**Family** - group of related genera

**Genus** - group of related species

**Species** - basic unit of classification

38 In which of the following tissue preparations, signet ring appearance is obtained?

 Solution

Signet ring appearance is obtained with tissue preparation of adipose tissue. The thin peripheral ring of cytoplasm and the flattened peripheral nucleus, coupled with the large central vacuole result in the signet ring appearance of fat cells.

39 FAD is a coenzyme derived from

 Solution

Flavin adenine dinucleotide (FAD) is a coenzyme derived from riboflavin or vitamin-B<sub>2</sub>

40 Which one is correct sequence in glycolysis?

 Solution

The correct sequence in glycolysis is

Glucose-6-phosphate → 3-phosphoglyceraldehyde

Phosphoenol ← 3-phosphoglyceric acid ↓

Pyruvate

↓

Pyruvic acid.

41 Which of the following feature of vector is required to identify the transformed cell?

 Solution

A selectable marker is essential in a cloning vector because it helps in identifying and eliminating non-transformants and selectively permitting the growth of the transformants.

42

Given below is an incomplete table about hormones, their source glands and one major effect of each on the body in humans. Identify the correct option for the three blanks A, B, and C.

Source gland	Hormone	Function
A	Oestrogen	Maintenance of secondary sexual characters
Alpha cells of islets of Langerhans	B	Raises blood sugar level
Anterior pituitary	C	Over secretion leads to gigantism



Solution

Ovary secretes estrogen hormone, which maintains the secondary sexual character in humans. Alpha cells of Islets of Langerhans secrete glucagon, which acts antagonist to insulin in raising the blood sugar level. Anterior pituitary secretes growth hormone and it's over secretion leads to a condition known as gigantism.

43

Arrange the following options in the ascending order of their BOD value.

- I. Sample of highly polluted pond water.
- II. Sample from unpolluted pond water.
- III. Distilled water.

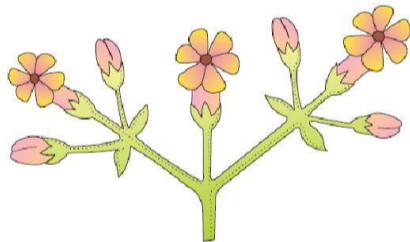


Solution

Biochemical oxygen demand is the oxygen in milligrams required for five days in one litre of water at 20°C for the microorganisms to metabolize organic waste. BOD increases with an increase in pollution.

44

Identify the given diagram.



Solution

The cymose inflorescence is a type of flowering shoot in which the first-formed flower develops from the growing region at the top of the flower stalk. E.g. - Red campion.

45

During photorespiration, the oxygen-consuming reaction(s) occur in



Solution

Photorespiration is the process that occurs in C<sub>3</sub> plants. In this process, peroxisomes, chloroplast, and mitochondria take part. The oxygen-consuming reactions occur in peroxisomes and stroma of chloroplast while CO<sub>2</sub> releasing reaction occurs in mitochondria.

46

Which are exclusively viviparous



Solution

Among animals, viviparity is development of the embryo inside the body of the parent, eventually leading to live birth, as opposed to reproduction by laying eggs that complete their incubation outside the parental body.

47

Which of the following is used as bio-fertiliser



Solution

Nostoc possess special type of cells called heterocyst for free  $N_2$  fixation that why nostoc is biofertiliser.



Plasmodium is inoculated in humans by



Solution

Plasmodium is inoculated in human by female Anopheles because female Anopheles injects saliva while puncturing human skin for obtaining a meal of blood. The infected mosquito possesses a large number of sporozoites in its salivary glands. The same are passed into human blood.



One celled suspensor is found in



Solution

One celled suspensor is found in embryo of *Triticum* (wheat) and *Satittaria*.



Sperm cells are produced in



Solution

Seminiferous tubules are highly coiled tubules found in testicular lobule of testis. It consists of spermatogonium which divide mitotically to give rise to spermatocytes. These spermatocytes on meiosis give rise to sperm cells.



Hydrolytic enzymes which act on low pH are called as



Solution

Proteases catalyze breakdown of proteins and amylases act upon carbohydrates. Hydrolases catalyse hydrolysis.



Which one of the following is the correct matching of three items and their grouping category?



Solution

The pelvic girdle is formed by two innominate bones consisting of three separate bones: ilium, ischium and pubis. Actin and myosin are the motor proteins that form the spindle apparatus during cell division. Malleus, incus and stapes are the ear ossicles. Cytosine, thymine and uracil are the pyrimidines.



Which bacteria are utilized in the biogas plant?



Solution

*Methanobacillus* (methanogen) occurs in marshes and also in dung. It produced  $CH_4$  gas under anaerobic conditions and is utilized in gobar gas plants.



Write one of the following correctly matched Sexually Transmitted Disease (STD) with its pathogen?



Solution

Syphilis is a sexually Transmitted Disease caused by *Treponema pallidum*. It is a member of the family *Spirochaeticea* and is related to other spirochete genera which have the capacity to infect man, namely *Borrelia* and *Leptospira*.



IARI, New Delhi developed which variety of beans which is protein enriched :-



Solution

Lablab is a summer-growing annual or occasionally short-lived perennial forage legume (*Lablab purpureus* is a species of bean in the family Fabaceae). It is a twining, climbing, trailing or upright herbaceous plant that can be up to 3-6 m in length.

56 Which of the following does not match?

 Solution

Monocyte is the largest WBC, which involves in phagocytosis of pathogen like bacteria.

57 6 -furfuryl adenine is

 Solution

The furfuryl substituent attached with adenine at 9<sup>th</sup> position.

58 The information about the plant specimens, the herbarium compiled and published in a book form is known as

 Solution

A flora is a reference book that compiles and describes all the species of vascular plants of different regions. Published flora enables botanists, students and other interested parties to identify plants in an area of question.

59 The most significant value of vegetative propagation is that

 Solution

Vegetative reproduction (vegetative propagation) is a form of asexual reproduction in plants. It is a mean of production of genetic of individuals genetically identical to the parent

60 Which of the following is incorrect about Klinefelter's syndrome?

 Solution

Klinefelter syndrome is a chromosomal disorder cause by nondisjunction of chromosome during meiosis. Klinefelter male are generally infertile and show enlargement of breast tissues called as gynaecomastia due to one extra X chromosome.

61 Which of the following step of translation does not consume a high energy phosphate bond

 Solution

Protein synthesis or translation consists of ribosomes, amino acids, mRNA, tRNAs and aminoacyl tRNA synthetases. The ribosomes have two binding sites namely aminoacyl site or A-site and peptide site or P-site. The starting amino acid methionine lies at the P-site of the ribosome. The next incoming tRNA is called amino acyl tRNA, it is bound to A-site. A peptide bond is formed between COOH group of the t-RNA at P-site and NH, group of aminoacyl t-RNA. This is facilitated by the enzyme peptidyl transferase and does not require high energy phosphate bonds.

62 In the following which one is the example of Bryophyta that has elaborate mechanism of spore dispersal?

 Solution

The sporophyte in mosses is more elaborate than that in liverworts. The capsule contains spores. Spores are formed after meiosis. The mosses have an elaborate mechanism of spore dispersal. Common examples of mosses are *Funaria*, *Polytrichum*, and *Sphagnum*. *Polytrichum* is a genus of mosses - commonly called haircap moss.

63

Passive absorption of water is related to all, except



Solution

Passive absorption of water is related to development of a positive pressure in roots. The whole root acts as a cell and the multicellular radicular tissue behaves as an osmotic membrane, establishing a positive hydrostatic pressure in the xylem responding to the accumulation of solutes.

64

During mitosis, number of chromosomes



Solution

Mitosis was first observed by Strasburger and termed by W Flemming. During mitosis, chromosome number remains same in the daughter cells. During meiosis (reduction division), the chromosome number gets reduced to half in the daughter cells.

65

The retina of mammalian eye is composed of



Solution

Ratina of mammalian eye is consists of three concentric layers viz., outer layer of rods and cones, middle layer of bipolar nerve cells and inner of large ganglionic nerve cells.

66

The hyphae of *Aspergillus* are:



Solution

The mycelium of *Aspergillus* consists of branched septate hyphae. Cells of hyphae are multinucleate.

67

Which one is polymer?



Solution

Glycogen is the main storage polysaccharide in animals. Hence, it is commonly called 'animal starch'. Blue-green algae and fungi also store glycogen as 'fuel reserve'. Like those of amylopectin, glycogen molecules are also large and highly branched (branch points are  $\alpha$  1-6 linkages) polymers of thousands of D-glucose residues linked by  $\alpha$  1-4 glycosidic bonds. In comparison to amylopectin molecules, however, glycogen molecules are much larger, more extensively branched, and more compactly coiled concentrically.

68

Chlorosis is caused due to the deficiency of



Solution

Magnesium is a component of chlorophyll and an important binding substance for ribosomal sub-units. Its deficiency causes inter-veinal chlorosis, development of anthocyanin and depression of internal phloem.

69

Selective permeability identifies the process of transmission through the semipermeable membrane is called



Solution

Osmosis is a special type of diffusion or diffusion through the semipermeable membrane.

70

Organisms, attached to substratum generally possess



Solution

The organisms attached to substratum generally possess radial symmetry.

Radial animals are usually sessile, freely floating or weakly swimming.

71

Match the source gland with its respective hormone and function and select the correct option.



Solution

Oxytocin is released by the posterior pituitary. Vasopressin decreases the amount of urine by increasing reabsorption of water from DCT and collecting tubules. It also stimulates the contraction of walls of blood vessels, thereby raising the blood pressure. Glucagon stimulates the liver to convert stored glycogen into glucose and thus raises the blood sugar level. Thymus releases thymosin which aids in the proliferation of T-lymphocytes.

72

Bulliform cells are found in



Solution

In grasses, certain adaxial epidermal cells along the veins modify themselves into large, empty, colourless cells. These are called bulliform cells. When the bulliform cells in the leaves have absorbed water and are turgid, the leaf surface is exposed. When they are flaccid due to water stress, they make the leaves curl inwards to minimise water loss.

73

Water stress in plants causes decrease in photosynthesis because :-

- (A) it reduces the CO<sub>2</sub> availability
- (B) it reduces the surface area of the leaves
- (C) it reduces the metabolic activities of leaves

Choose the correct option from the following :-



Solution

Water stress in plants causes decrease in photosynthesis because it reduces the CO availability, also reduces the surface area of the leaves and reduces the metabolic activities of leaves. Water stress substantially alters plant metabolism, decreasing plant growth and photosynthesis and profoundly affecting ecosystems and agriculture, and thus human societies. Mild water stress, on the order of –1.0 megapascals xylem water potential, can reduce the rate of photosynthesis and eliminate the inhibition of photosynthesis caused by O<sub>2</sub> in water-stress-sensitive plants.

74

Which of the following technique is employed for the separation and identification of phytohormones



Solution

Hormones were originally measured with bioassays but now-a-days most hormones are measured with gas chromatography and immunoassay techniques.

75

Majority of proteins (of intracellular use) are not synthesized on:

- A - Ribosomes produced in the nucleolus
- B - Ribosomes attached with ER and nuclear membrane
- C - Ribosomes present in the chloroplast
- D - Free ribosomes of eukaryotic cells
- E - Ribosomal sub-units forming polyribosomes which are found in peri-mitochondrial space of prokaryotic cells



Solution

All ribosomes are synthesized and assemble in nucleolus. Most of the protein are synthesized in cytosol of the cell. Some proteins that are produced in secretory cells are synthesized by ribosomes attach to rough endoplasmic reticulum and nuclear membranes. These include the digestive enzymes produced in the stomach and the protein hormones like insulin produced in the pancreas.

76

Which of the following animal has a network of neurons but does not comprise the brain?



Solution

The neural organisation is very simple in lower invertebrates. For example, in *Hydra* it is composed of a network of neurons. The neural system is better organised in insects, where a brain is present along with a number of ganglia and neural tissues. The vertebrates have a more developed neural system.



The end product of ornithine cycle is



Solution

The entire process of this **cycle** converts two amino groups, one from  $\text{NH}_4^-$  and one from Asp, and a carbon atom from  $\text{HCO}_3^-$ , to the relatively nontoxic excretion **product urea** at the cost of four "high-energy" phosphate bonds. To enter the **cycle**, ammonia is converted to carbomyl phosphate.



During ionic flux, uptake of ions into inner space is



Solution

The movement of ions is called flux. The movement of ions into the cell is called influx and outward migration of ions is known as efflux. The energy is considered to be involved in the transport of such free ions across the membrane. The absorption of ions, involving the use of metabolic energy, is called active absorption. Energy used in these mechanisms comes from metabolic activities. Mineral absorption is mainly an active process.



A cell swells up when kept in



Solution

A cell swells up when kept in a hypotonic solution due to the process of endosmosis. Endosmosis is the movement of water into the cell and such a plant cell is referred to as turgid.



An ecosystem resist change because it is in a state of



Solution

An ecosystem resist changes because it is in a state of greater stability. It is called as homeostasis or an ecosystem maintains a functional balance or relatively stable state of equilibrium amongst its different components. This phenomenon is called balance of nature or homeostasis.



The speed of migration of ions in an electric field during gel electrophoresis depends on



Solution

Electrophoresis is a technique of separation of charged molecules under the influence of an electrical field so that they migrate in the direction of electrode bearing the opposite charge, viz., positively charged molecules move towards cathode (-ve electrode) and negatively charged molecules travel towards anode (+ve electrode) through a medium/matrix. This technique was developed by A. Tiselius in 1937. Any charged ion or molecule migrates when placed in an electric field. The rate of migration depend upon its net charge, size, shape and the applied electric current.



Which one of the following is wrongly matched?



Solution

Most prokaryotic cells, particularly the bacterial cells, have a chemically complex cell envelope. The cell envelope consists of a tightly bound three-layered structure i.e., the outermost glycocalyx followed by the cell wall and then the plasma membrane.

83

When a person is suffering from poor renal reabsorption then which of the following will not help in the maintenance of blood volume ?



Solution

Increased arterial pressure in kidney will promote the filtration but the person is suffering from poor renal reabsorption, so the volume of glomerular filtrate and urine will increase and person would be unable to maintain the volume of blood.

84

The sensation of fatigue in the muscles after prolonged strenuous physical work, is caused by



Solution

The reduction in force of contraction of a muscle after prolonged stimulation is called muscle fatigue. The accumulation of lactic acid leads to muscle fatigue. Lactic acid is produced by glycolysis in absence of  $O_2$ .

85

The situation where indigenous knowledge of nature, originating with indigenous people, is used by others for profit, without taking proper permission from them and with little or no compensation or recognition to the indigenous people themselves is known as



Solution

Biopiracy is the term used to refer to the use of bio-resources by multinational companies and other organizations without proper authorization from the countries and people concerned without compensatory payment.

86

*Peripatus* is a connecting link between



Solution

*Peripatus* is a connecting link between Annelida and Arthropoda. Like annelids, it has continuous muscle layers in the body wall, unjointed legs like parapodia, nephridia for excretion and simple gut. Main arthropod characters are claws on the legs, haemocoel, tracheae for respiration, dorsal heart with ostia, etc.

87

After ovulation the graafian follicle becomes an endocrine organ called



Solution

Interstitial organ

Corpus luteum, yellow hormone-secreting body in the female reproductive system. It is formed in an ovary at the site of a follicle, or sac, that has matured and released its ovum, or egg, in the process known as ovulation.

88

Mature male gametophyte is made up of



Solution

At maturity, the male gametophyte consists of three cells, the vegetative cell and the two sperm cells, which lie within the cytoplasm of the vegetative cell

89

Endemic plants are those, which are



Solution

Endemic plants are restricted to grow in limited or confined areas, i.e., these grow in geographically limited areas. These are adapted to grow in particular regions only.

90

Bananas are seedless because they



Solution

Banana is a naturally parthenocarpic fruit formed without fertilization of ova.

160, 4th Floor, Rajgarh Road, Guwahati, Kamrup Metropolitan, Assam -781003

 **EMBIBE**  
www.embibe.com