W6

Aakash
+ BYJU'S

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Answers & Solutions

Time : 3 hrs. 20 Min.

for

M.M. : 720

NEET (UG)-2022

Important Instructions :

1. The test is of **3.20 hours** duration and the Test Booklet contains **200** multiple choice questions (Four options with a single correct answer). There are two sections in each subject, i.e. Section-A & Section-B. You have to attempt all 35 questions from Section-A & only 10 questions from Section-B out of 15. (**Candidates are advised to read all 15 questions in each subject of Section-B** before they start attempting the question paper. In the event of a candidate attempting more than ten questions, **the first ten questions answered by the candidate shall be evaluated.**)

2. Each question carries **4 marks**. For each correct response, the candidate will get **4 marks**. For every wrong response **1 mark** shall be deducted from the total scores. The maximum marks are **720**.

3. Use **Blue / Black Ball point Pen only** for writing particulars on this page / marking responses on Answer Sheet.

4. Rough work is to be done in the space provided for this purpose in the Test Booklet only.

5. On completion of the test, the candidate must handover the Answer Sheet to the Invigilator before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.

6. The CODE for this Booklet is **W6**.

7. The candidates should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. Do not write your Roll No. anywhere else except in the specified space in the Test Booklet/Answer Sheet. Use of white fluid for correction is **NOT** permissible on the Answer Sheet.

8. Each candidate must show on-demand his/her Admission Card to the Invigilator.

9. No candidate, without special permission of the Centre Superintendent or Invigilator, would leave his/her seat.

10. Use of Electronic/Manual Calculator is prohibited.

11. The candidates are governed by all Rules and Regulations of the examination with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of this examination.

12. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.

13. The candidates will write the Correct Test Booklet Code as given in the Test Booklet / Answer Sheet in the Attendance Sheet.

PHYSICS

SECTION-A

1. An energy of 484 J is spent in increasing the speed of a flywheel from 60 rpm to 360 rpm. The moment of inertia of the flywheel is :

(1) 0.07 kg-m^2

(2) 0.7 kg-m^2

(3) 3.22 kg-m^2

(4) 30.8 kg-m^2

Answer (2)

Sol. From work - energy theorem

$W = \Delta k$ (change in Kinetic Energy)

In rotation, $\text{KE} = \dfrac{1}{2}I\omega^2$

$484 = \dfrac{1}{2}I(\omega_f^2 - \omega_i^2)$

$\Rightarrow \quad 484 = \dfrac{1}{2}I\left[\left(2\pi\dfrac{360}{60}\right)^2 - \left(2\pi \times \dfrac{60}{60}\right)^2\right]$

$\Rightarrow \quad 484 = \dfrac{1}{2}I4\pi^2(36 - 1)$

$\Rightarrow \quad I \simeq 0.7 \text{ kg-m}^2$

2. Let R_1 be the radius of the second stationary orbit and R_2 be the radius of the fourth stationary orbit of an electron in Bohr's model. The ratio $\dfrac{R_1}{R_2}$ is :

(1) 4

(2) 0.25

(3) 0.5

(4) 2

Answer (2)

Sol. Radius of Bohr's orbit depends on principal quantum number (*n*) as

$R \propto n^2$

Now $\dfrac{R_1}{R_2} = \dfrac{(2)^2}{(4)^2} = \dfrac{1}{4} = 0.25$

3. During a cloudy day, a primary and a secondary rainbow may be created, then the :

(1) secondary rainbow is due to single internal reflection and is formed above the primary one.

(2) primary rainbow is due to double internal reflection and is formed above the secondary one.

(3) primary rainbow is due to double internal reflection and is formed below the secondary one.

(4) secondary rainbow is due to double internal reflection and is formed above the primary one.

Answer (4)

Sol. Primary rainbow is result of three-step process, that is, refraction, internal reflection and refraction.

Secondary rainbow is result of four step process, that is, refraction, internal reflection, internal reflection and refraction.

Secondary rainbow appears above the primary rainbow.

4. The reciprocal of resistance is :

(1) conductance
(2) reactance
(3) mobility
(4) conductivity

Answer (1)

Sol. $R = \dfrac{1}{G}$

Thus reciprocal of resistance (*R*) is conductance (*G*)

5. Two copper vessels *A* and *B* have the same base area but of different shapes. *A* takes twice the volume of water as that *B* requires to fill upto a particular common height. Then the correct statement among the following is:

(1) Vessel *B* weighs twice that of *A*.
(2) Pressure on the base area of vessels *A* and *B* is same.
(3) Pressure on the base area of vessels *A* and *B* is not same.
(4) Both vessels *A* and *B* weigh the same.
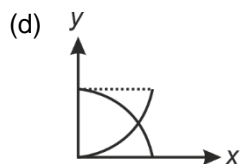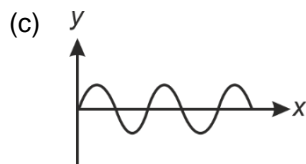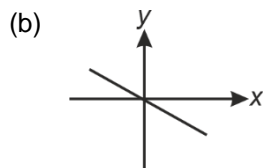
Answer (2)

Sol. In hydrostatic condition,

$P = P_0 + \rho g h$

Here, *P* : absolute pressure at depth *h*, P_0 is atmospheric pressure

Since, height of liquid in both vessel is same therefore pressure on the base of both vessel will be same.

6. Match List-I with List-II

| **List-I** (*x-y* graphs)	**List-II** (Situations)
(a)	(i) Total mechanical energy is conserved
(b)	(ii) Bob of a pendulum is oscillating under negligible air friction
(c)	(iii) Restoring force of a spring
(d)	(iv) Bob of a pendulum is oscillating along with air friction

Choose the **correct** answer from the options given below

(1) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)
(2) (a) - (iv), (b) - (ii), (c) - (iii), (d) - (i)
(3) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)
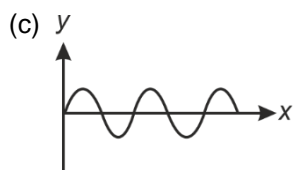(4) (a) - (i), (b) - (iv), (c) - (iii), (d) - (ii)
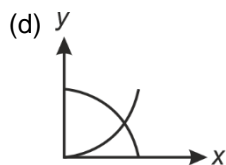
Answer (3)

Sol. (a)
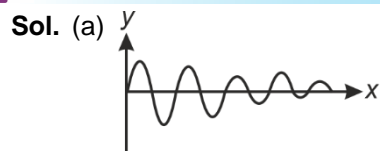
Amplitude of oscillation is continuously decreasing. It means bob of pendulum oscillate with air friction

(b)
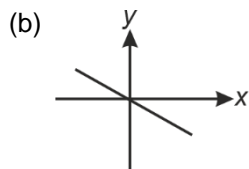
$F = -kx$ (restoring force of a spring)

(c)

Amplitude of oscillation is remains same. It means bob of pendulum is oscillating under negligible air resistance.

(d)

$P.E. = \frac{1}{2}kx^2, K.E. = \frac{1}{2}m\omega^2 A^2 - \frac{1}{2}kx^2$

$T.E. = \frac{1}{2}m\omega^2 A^2 = \text{constant}$

7. The distance covered by a body of mass 5 g having linear momentum 0.3 kg m/s in 5 s is

   (1)   0.3 m
   (2)   300 m
   (3)   30 m
   (4)   3 m

   Answer (2)

   Sol. $P = mv$

   $0.3 = 5 \times 10^{-3}v$

   $v = \frac{300}{2}$

   $v = 60$ m/s

   $S = v \times t$

   $= 60 \times 5$

   $= 300$ m

8. The distance between the two plates of a parallel plate capacitor is doubled and the area of each plate is halved. If C is its initial capacitance, its final capacitance is equal to

   (1) $\frac{C}{4}$
   (2)   2C

   (3) $\frac{C}{2}$
   (4)   4C

   Answer (1)

Sol. For a capacitor of area A and distance between the plates as d, the capacitance (C) is

$$C = \frac{A \in_0}{d}$$

On doubling the distance and reducing area to half.

$$C_1 = \frac{\frac{A}{2} \in_0}{2d}$$

$$\Rightarrow \quad C_1 = \frac{A \in_0}{4d}$$

$$\Rightarrow \quad C_1 = \frac{C}{4}$$

9. A closely packed coil having 1000 turns has an average radius of 62.8 cm. If current carried by the wire of the coil is 1 A, the value of magnetic field produced at the centre of the coil will be (permeability of free space = $4\pi \times 10^{-7}$ H/m) nearly

(1) 10^{-3} T
(2) 10^{-1} T
(3) 10^{-2} T
(4) 10^2 T

Answer (1)

Sol. Magnetic field at the centre of coil

$$B = \frac{\mu_0 NI}{2R}$$

On substituting the given values

$$\Rightarrow \quad B = \frac{4\pi \times 10^{-7} \times 10^3}{2 \times 62.8 \times 10^{-2}}$$

$$= 10^{-3} \text{ T}$$

10. The magnetic field of a plane electromagnetic wave is given by

$\vec{B} = 3 \times 10^{-8} \cos\left(1.6 \times 10^3 x + 48 \times 10^{10} t\right) \hat{j}$, then the associated electric field will be :

(1) $9 \cos\left(1.6 \times 10^3 x + 48 \times 10^{10} t\right) \hat{k}$ V/m
(2) $3 \times 10^{-8} \cos\left(1.6 \times 10^3 x + 48 \times 10^{10} t\right) \hat{i}$ V/m

(3) $3 \times 10^{-8} \sin\left(1.6 \times 10^3 x + 48 \times 10^{10} t\right) \hat{i}$ V/m
(4) $9 \sin\left(1.6 \times 10^3 x - 48 \times 10^{10} t\right) \hat{k}$ V/m

Answer (1)

Sol. For electromagnetic wave,

$$\left|\vec{B}\right| = \frac{\left|\vec{E}\right|}{c}$$

Here $\vec{B}$ is magnetic field associated with EM wave

$\vec{E}$ is electric field associated with EM wave

c is the speed of EM wave

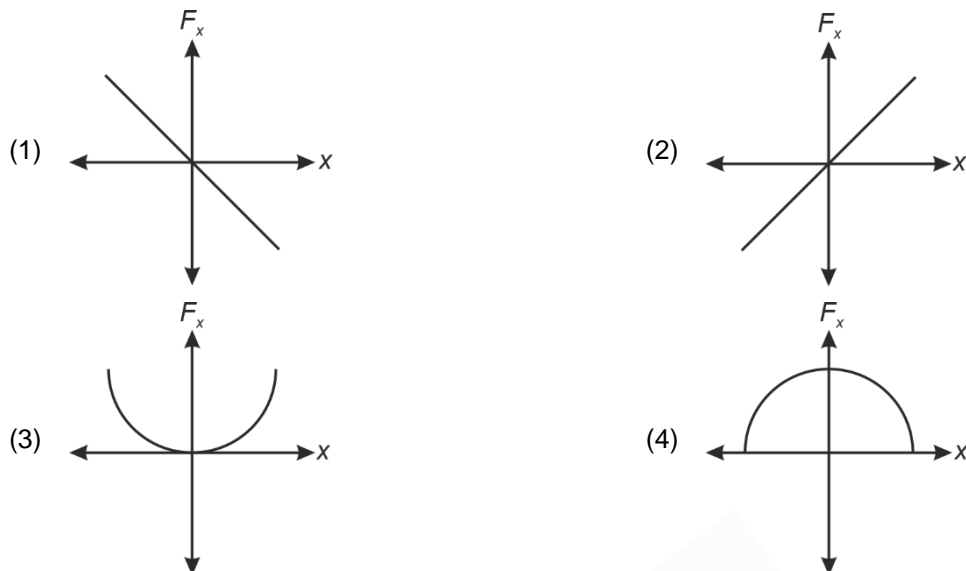$$\Rightarrow \quad \left|\vec{E}\right| = c\left|\vec{B}\right|$$

$$= 3 \times 10^8 \times 3 \times 10^{-8} \cos(1.6 \times 10^3 x + 48 \times 10^{10} t) \text{ V/m}$$

Direction can be determined from

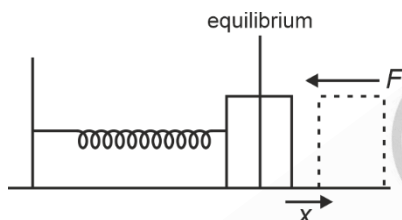Poynting vector $= \dfrac{\vec{E} \times \vec{B}}{\mu_0}$

$$\vec{E} = 9 \cos\left(1.6 \times 10^3 x + 48 \times 10^{10} t\right) \hat{k} \text{ V/m}$$

11. The restoring force of a spring with a block attached to the free end of the spring is represented by
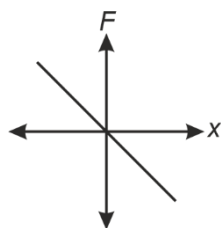
(1)

(2)

(3)

(4)

Answer (1)

Sol.

$F \propto -x$

$F = -kx$

Where F is restoring force

x is displacement of block from equilibrium position

12. Given below are two statements : One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): When a fire cracker (rocket) explodes in mid air, its fragments fly in such a way that they continue moving in the same path, which the fire cracker would have followed, had it not exploded.

Reason (R): Explosion of cracker (rocket) occurs due to internal force only and no external force acts for this explosion.

In the light of the above statements, choose the most appropriate answer from the option given below

(1) **(A)** is not correct but **(R)** is correct

(2) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

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

(4) **(A)** is correct but **(R)** is not correct

Answer (1)

Sol. As per Newton's II law for a system.

$$\vec{F}_{external} = \frac{d\vec{P}}{dt} = m\frac{d\vec{v}_{com}}{dt}$$

As explosion occurs due to internal forces only, the velocity of centre of mass would remain unchanged. This means that the centre of mass would continue to travel along same path as it was moving before explosion.

The fragments can however move individually along various directions.

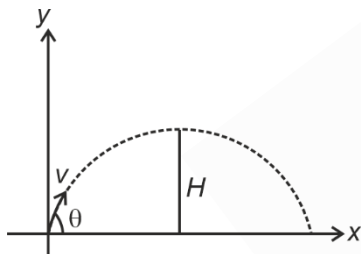Thus (A) is not correct and (R) is correct

13. A cricket ball is thrown by a player at a speed of 20 m/s in a direction 30° above the horizontal. The maximum height attained by the ball during its motion is

   (g = 10 m/s^2)

   (1)   25 m

   (2)   5 m

   (3)   10 m

   (4)   20 m

   Answer (2)

   Sol.

   Maximum height reached by the ball

   $$H = \frac{v^2 \sin^2 \theta}{2g}$$

   $$= \frac{(20)^2 \sin^2 30°}{2g}$$

   $$H = 5 \text{ m}$$

14. Given below are two statements

   Statement I: In an ac circuit, the current through a capacitor leads the voltage across it.

   Statement II: In a.c. circuit containing pure capacitance only, the phase difference between the current and the voltage is π.

   In the light of the above statements, choose the most appropriate answer from the options given below

   (1)   **Statement I** is incorrect but **Statement II** is correct

   (2)   Both **Statement I** and **Statement II** are correct

   (3)   Both **Statement I** and **Statement II** are incorrect

   (4)   **Statement I** is correct but **Statement II** is incorrect

   Answer (4)
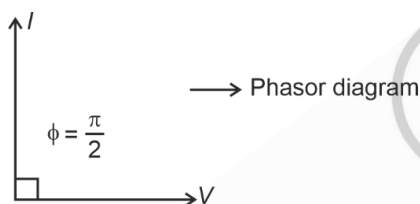
Sol.
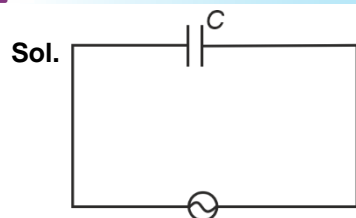
$V = V_0 \sin \omega t$

$V = \dfrac{q}{C}$

$q = CV \sin \omega t$

$\dfrac{dq}{dt} = CV \dfrac{d}{dt} \sin \omega t$

$i = CV\omega \cos \omega t$

$i = CV\omega \sin\left(\omega t + \dfrac{\pi}{2}\right)$

In a.c. circuit current lead by voltage by a phase $\dfrac{\pi}{2}$

Thus statement I is correct while II is incorrect

15. A cell of emf 4 V and internal resistance 0.5 Ω is connected to a 7.5 Ω external resistance. The terminal potential difference of the cell is
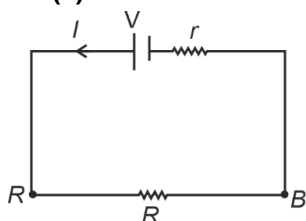   (1) 0.375 V
    (2) 3.75 V
    (3) 4.25 V
    (4) 4 V

Answer (2)

Sol.

From Kirchhoff's loop law :

$V - Ir - IR = 0$

$\Rightarrow \quad I = \left(\dfrac{V}{r+R}\right)$

Terminal potential difference across cell,

$V_{AB} = IR$

$V_{AB} = \dfrac{RV}{r+R}$

$= \dfrac{7.5 \times 4}{0.5 + 7.5}$

$= 3.75$ V

16. An ideal gas follows a process described by the equation $PV^2 = C$ from the initial (P_1, V_1, T_1) to final (P_2, V_2, T_2) thermodynamic states, where C is a constant. Then

    (1) If $P_1 > P_2$ then $V_1 > V_2$

    (2) If $P_1 > P_2$ then $T_1 < T_2$

    (3) If $V_2 > V_1$ then $T_2 > T_1$

    (4) If $V_2 > V_1$ then $T_2 < T_1$

    Answer (4)

    Sol. We know,

    $PV = nRT$

    Given, $PV^2 = $ constant

    $\Rightarrow$ If $P_1 > P_2 \Rightarrow V_1 < V_2$

    $$P\left(\frac{nRT}{P}\right)^2 = \text{constant}$$

    $$P^{-1}T^2 = \text{constant}$$

    $\Rightarrow P \propto T^2$

    i.e., if $P_1 > P_2 \Rightarrow T_1 > T_2$

    Also, $\left(\dfrac{nRT}{V}\right)V^2 = \text{constant}$
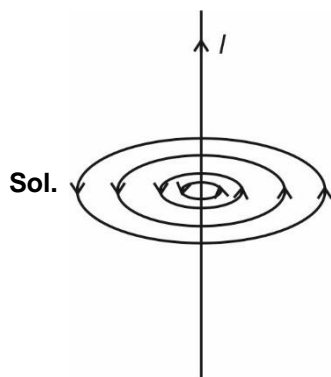
    $TV = \text{constant}$

    $\Rightarrow$ If $V_2 > V_1$ then $T_2 < T_1$

17. The shape of the magnetic field lines due to an infinite long, straight current carrying conductor is

    (1) a plane

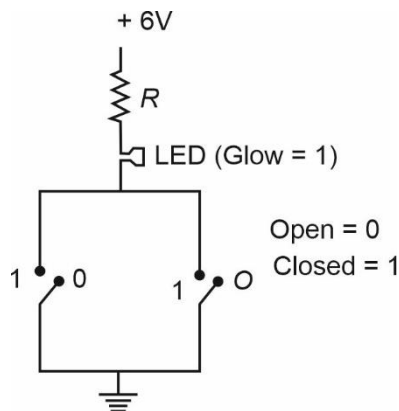   (2) a straight line

    (3) circular

    (4) elliptical

    Answer (3)

    Sol.

    From the right hand curl rule,

    the shape of magnetic field lines due to long current carrying wire is circular (concentric circles)

18.

+ 6V

R

LED (Glow = 1)

Open = 0
Closed = 1

1 ● ● 0   1 ● ● O

Identify the equivalent logic gate represented by the given circuit

(1) NAND

(2) OR

(3) NOR

(4) AND

Answer (2)

Sol. The given circuit clearly indicates that the bulb will glow when either of the switches are closed.

The corresponding truth table will be

Input A	Input B	Output Y
0	0	0
0	1	1
1	0	1
1	1	1

This suggests that it will correspond to OR gate

19. The light rays having photons of energy 4.2 eV are falling on a metal surface having a work function of 2.2 eV. The stopping potential of the surface is

(1) 6.4 V

(2) 2 eV

(3) 2 V

(4) 1.1 V

Answer (3)

Sol. We know, $KE_{max} = h\nu - h\nu_0$

$eV_0 = h\nu - h\nu_0$ $(\because KE_{max} = eV_0)$

$eV_0 = 4.2$ eV $- 2.2$ eV

$\therefore$ $V_0 = 2$ V

20. Identify the function which represents a non-periodic motion.

(1) $\sin(\omega t + \pi/4)$

(2) $e^{-\omega t}$

(3) $\sin\omega t$

(4) $\sin\omega t + \cos\omega t$

Answer (2)

Sol. Here,

$\sin\omega t$ and $\sin\left(\omega t + \dfrac{\pi}{4}\right)$ clearly suggest a periodic sinusoidal function (SHM)

And $\sin\omega t + \cos\omega t = \sqrt{2}\sin\left(\omega t + \dfrac{\pi}{4}\right)$ is also a periodic sinusoidal function (SHM)

While, $y = e^{-\omega t}$ is an exponentially decreasing function and thus does not have periodicity

21. An inductor of inductance 2 mH is connected to a 220 V, 50 Hz a.c. source. Let the inductive reactance in the circuit is X_1. If a 220 V dc source replace the ac source in the circuit, then the inductive reactance in the circuit is X_2. X_1 and X_2 respectively are :

    (1) 0.628 Ω, infinity

    (2) 6.28 Ω, zero

    (3) 6.28 Ω, infinity

    (4) 0.628 Ω, zero

Answer (4)

Sol. We know, for A.C. source

$X_L = \omega L$

$= 2\pi f(L)$

$= 100\pi(2 \times 10^{-3})$

$= 0.2\pi \ \Omega = 0.628 \ \Omega$

For D.C source

The inductor behaves as a closed circuit offering no resistance at all (at steady state)

as $\omega = 0$ (For D.C)

$\therefore \quad X_L = 0 \ \Omega$

22. The ratio of the magnitude of the magnetic field and electric field intensity of a plane electromagnetic wave in free space of permeability μ_0 and permittivity ε_0 is (Given that c - velocity) of light in free space)

    (1) $\dfrac{\sqrt{\mu_0\varepsilon_0}}{c}$

    (2) c

    (3) $\dfrac{1}{c}$

    (4) $\dfrac{c}{\sqrt{\mu_0\varepsilon_0}}$

Answer (3)

Sol. We know,

$\dfrac{E_0}{B_0}(\text{in vacuum}) = c$

$\therefore \quad \dfrac{B_0}{E_0} = \dfrac{1}{c}$

or $\dfrac{B_0}{E_0} = \sqrt{\mu_0\varepsilon_0}$

23. The threshold frequency of a photelectric metal is v_0. If light of frequency $4v_0$ is incident on this metal, then the maximum kinetic energy of emitted electrons will be :

(1) $4 hv_0$

(2) hv_0

(3) $2 hv_0$

(4) $3 hv_0$

Answer (4)

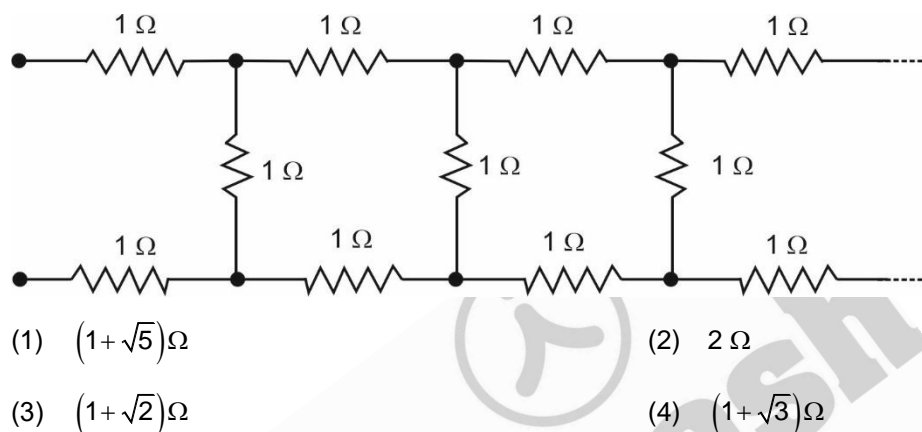**Sol.** According to Einstein's photoelectric equation

$(K. E)_{max} = hv - hv_0$

$(K. E)_{max} = h(4v_0) - hv_0$

$(K. E)_{max} = 3hv_0$

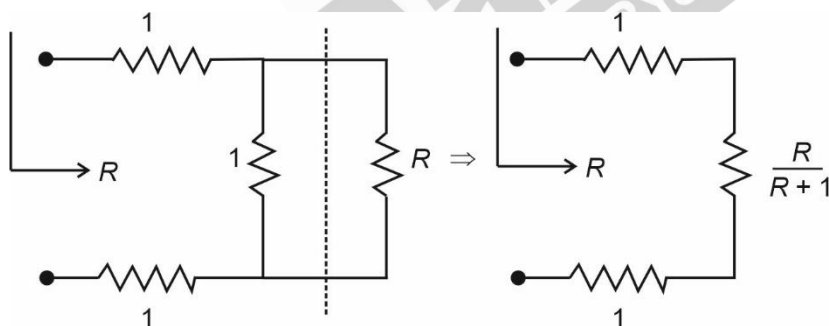24. The equivalent resistance of the infinite network given below is :

(1) $\left(1+\sqrt{5}\right)\Omega$

(2) 2Ω

(3) $\left(1+\sqrt{2}\right)\Omega$

(4) $\left(1+\sqrt{3}\right)\Omega$

Answer (4)

Sol. Let net resistance of the given infinite network be 'R'

Now, the circuit can be modified as

Now, $R_{net} = R = 1+1+\dfrac{R}{R+1}$

$\therefore \quad R = 2+\dfrac{R}{R+1}$

$R^2 + R = 2R + 2 + R$

$R^2 - 2R - 2 = 0$

$R = \left(\dfrac{2 \pm \sqrt{4+8}}{2}\right)$

$R = \left(1+\sqrt{3}\right)\Omega$

25. If the screen is moved away from the plane of the slits in a Young's double slit experiment, then the :

    (1) linear separation of the fringes decreases
    (2) angular separation of the fringes increases
    (3) angular separation of the fringes decreases
    (4) linear separation of the fringes increase

    Answer (4)

    Sol. In YDSE,

    Separation between fringes is

    Related to fringe width $\beta = \dfrac{D\lambda}{d}$

    If D is increased β increases while

    Angular separation is independent of distance between slits and screen (D)

    As angular separation $= \dfrac{\beta}{D} = \dfrac{\lambda}{d}$

26. If $\vec{F} = 2\hat{i} + \hat{j} - \hat{k}$ and $\vec{r} = 3\hat{i} + 2\hat{j} - 2\hat{k}$, then the scalar and vector products of $\vec{F}$ and $\vec{r}$ have the magnitudes respectively as

    (1) 10, 2
    (2) $5, \sqrt{3}$
    (3) $4, \sqrt{5}$
    (4) $10, \sqrt{2}$

    Answer (4)

    Sol. Given $\vec{F} = 2\hat{i} + \hat{j} - \hat{k}$ and $\vec{r} = 3\hat{i} + 2\hat{j} - 2\hat{k}$

    $\vec{F} \cdot \vec{r} = 2(3) + 2(1) + (-2)(-1)$

    $\qquad = 6 + 2 + 2 = 10$

    $\vec{F} \times \vec{r} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & -1 \\ 3 & 2 & -2 \end{vmatrix}$

    $\qquad = \hat{i}(-2+2) - \hat{j}(-4+3) + \hat{k}(4-3)$

    $\Rightarrow \quad \vec{F} \times \vec{r} = \hat{j} + \hat{k}$

    $|\vec{F} \times \vec{r}| = \sqrt{1^2 + 1^2} = \sqrt{2}$

27. Given below are two statements

    Statement I :

    The law of radioactive decay states that the number of nuclei undergoing the decay per unit time is inversely proportional to the total number of nuclei in the sample.

    Statement II :

    The half of a radionuclide is the sum of the life time of all nuclei, divided by the initial concentration of the nuclei at time $t = 0$.

    In the light of the above statements, choose the **most appropriate** answer from the options given below :

    (1) **Statement I** is incorrect but **statement II** is correct

    (2) Both **statement I** and **statement II** are correct

    (3) Both **statement I** and **statement II** are incorrect

    (4) **Statement I** is correct but **statement II** is incorrect

    Answer (3)

Sol. According to law of radioactive decay

Rate of decay $\left(-\dfrac{dN}{dt}\right) \propto N$ (No. of undecayed nuclei)

Half life is the time in which half of the radioactive sample decays

∴ Both statements are incorrect.

28. The physical quantity that has the same dimensional formula as pressure is

   (1) Coefficient of viscosity

   (2) Force

   (3) Momentum

   (4) Young's modulus of elasticity

   Answer (4)

   Sol. Pressure $[P] = \left[\dfrac{F}{A}\right] = \left[\dfrac{MLT^{-2}}{L^2}\right] = [ML^{-1}T^{-2}]$

   And, dimensions of Young's modulus $[Y] = \left[\dfrac{\text{Stress}}{\text{Strain}}\right] = [ML^{-1}T^{-2}]$

   $[\text{Force}] = [MLT^{-2}]$

   $[\text{Momentum}] = [MLT^{-1}]$

   $[\text{Coefficient of viscosity}] = [ML^{-1}T^{-1}]$

29. The effective capacitances of two capacitors are 3 μF and 16 μF, when they are connected in series and parallel respectively. The capacitance of two capacitors are :

   (1) 1.2 μF, 1.8 μF

   (2) 10 μF, 6 μF

   (3) 8 μF, 8 μF

   (4) 12 μF, 4 μF

   Answer (4)

   Sol. Here, $\dfrac{1}{C_1} + \dfrac{1}{C_2} = \dfrac{1}{3}$ (Series combination)

   While, $C_1 + C_2 = 16$ (Parallel combination)

   Solving the above equations we get

   $C_1 = 12$ μF

   and $C_2 = 4$ μF

30. After passing through a polariser a linearly polarised light of intensity I is incident on an analyser making an angle of 30° with that of the polariser. The intensity of light emitted from the analyser will be

   (1) $\dfrac{2I}{3}$

   (2) $\dfrac{I}{2}$

   (3) $\dfrac{I}{3}$

   (4) $\dfrac{3I}{4}$
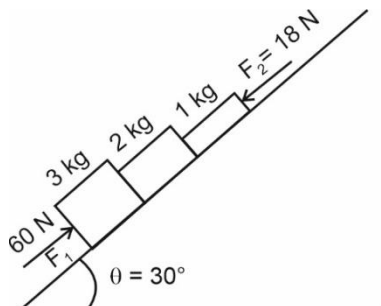
   Answer (4)

Sol. According to Malu's Law

$I_{out} = I_{in} \cos^2\theta$

$I_{out} = I \cos^2 (30°)$

$I_{out} = \dfrac{3I}{4}$

31. In the diagram shown, the normal reaction force between 2 kg and 1 kg is (Consider the surface, to be smooth):

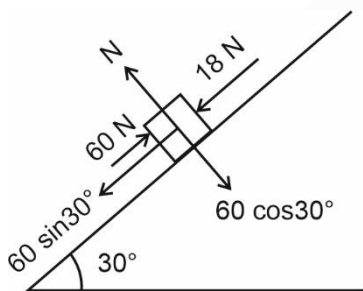Given $g = 10$ ms^{-2}

(1) 10 N   (2) 25 N

(3) 39 N   (4) 6 N

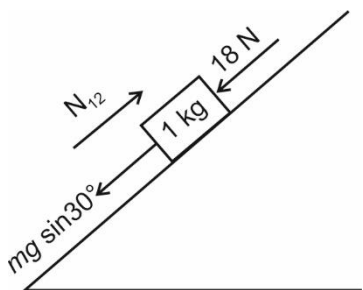**Answer (2)**

Sol. Assuming all three blocks as system

Hence, acceleration of system

$a = \dfrac{60-30-18}{6} = \dfrac{12}{6} = 2 \text{ m/s}^2$

$a = 2$ m/s^2, upward along the incline.

Now, for 1 kg block

$\Rightarrow N_{12} - 18 - 5 = 1 \times 2$

$\Rightarrow N_{12} - 23 = 2$

$\Rightarrow N_{12} = 25$ N

32. The incorrect statement about the property of a Zener diode is:

    (1) p and n regions of zener diode are heavily doped

    (2) Zener voltage remains constant at breakdown

    (3) It is designed to operate under reverse bias

    (4) Depletion region formed is very wide

    Answer (4)

    Sol. Zener diode is special purpose p-n junction diode, which is generally operated in reverse bias for its operation of voltage regulation. It is a heavily doped p-n junction. Due to large doping concentration depletion width is narrower.

33. A gravitational field is present in a region and a mass is shifted from *A* to *B* through different paths as shown. If W_1, W_2 and W_3 represent the work done by the gravitational force along the respective paths, then:
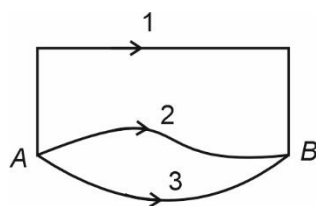
    (1) $W_1 < W_2 < W_3$

    (2) $W_1 = W_2 = W_3$

    (3) $W_1 > W_2 > W_3$

    (4) $W_1 > W_3 > W_2$

    Answer (2)

    Sol. Since the gravitational field is conservative in nature hence the work done would depend only on the initial and final positions and not on the path followed by the mass.

    Hence, $W_1 = W_2 = W_3$

34. A standard filament lamp consumes 100 W when connected to 200 V ac mains supply. The peak current through the bulb will be:

    (1) 2 A

    (2) 0.707 A

    (3) 1 A

    (4) 1.414 A

    Answer (2)

    Sol. $P_{avg} = V_{rms} \times I_{rms} \times \cos\phi$

    Here, $\phi = 0°$ as current and voltage are in same phase in a resistor.

    $\Rightarrow 100 = 200 \times I_{rms} \Rightarrow I_{rms} = \dfrac{1}{2} \Rightarrow \dfrac{I_0}{\sqrt{2}} = \dfrac{1}{2} \Rightarrow I_0 = \dfrac{1}{\sqrt{2}} = 0.707$ A

35. The terminal velocity of a copper ball of radius 5 mm falling through a tank of oil at room temperature is 10 cm s^{-1}. If the viscosity of oil at room temperature is 0.9 kg m^{-1} s^{-1}, the viscous drag force is:

    (1) 4.23×10^{-6} N

    (2) 8.48×10^{-3} N

    (3) 8.48×10^{-5} N

    (4) 4.23×10^{-3} N

    Answer (2)

    Sol. $F_{viscous} = -6\pi\eta av$

    $F_{viscous} = 6 \times 3.14 \times 0.9 \times 5 \times 10^{-3} \times 10 \times 10^{-2}$

    $= 84.78 \times 10^{-4}$

    $= 8.478 \times 10^{-3}$ N

SECTION-B

36. In a gravitational field, the gravitational potential is given by, $V = -\dfrac{K}{x}$ (J/Kg). The gravitational field intensity at point (2, 0, 3) m is

    (1) $+\dfrac{K}{4}$

    (2) $+\dfrac{K}{2}$

    (3) $-\dfrac{K}{2}$

    (4) $-\dfrac{K}{4}$

    Answer (4)

    Sol. Gravitational field intensity $= \dfrac{-\partial V}{\partial x}\hat{i} + \dfrac{-\partial V}{\partial y}\hat{j} + \dfrac{-\partial V}{\partial x}\hat{k}$

    where V is gravitational potential

    $\Rightarrow$ Gravitational field intensity $= \dfrac{-\partial}{\partial x}\left[\dfrac{-K}{x}\right] = \dfrac{-K}{x^2}\hat{i}$

    at (2, 0, 3)

    $\overrightarrow{E_G} = \dfrac{-K}{2^2} = \dfrac{-K}{4}\hat{i}$

37. The percentage error in the measurement of g is : (Given that $g = \dfrac{4\pi^2 L}{T^2}$, $L = (10 \pm 0.1)$ cm, $T = (100 \pm 1)$ s)

    (1) 7%

    (2) 2%

    (3) 5%

    (4) 3%

    Answer (4)

Sol. Given $g = \dfrac{4p^2 L}{T^2}$

Fractional error in value of g

$$\frac{\Delta g}{g} = \frac{\Delta L}{L} + 2\frac{\Delta T}{T}$$

$$\Rightarrow \quad \frac{\Delta g}{g} \times 100 = \frac{\Delta L}{L} \times 100 + 2\frac{\Delta T}{T} \times 100$$

$$\Rightarrow \quad \frac{\Delta g}{g} \times 100 = \frac{0.1}{10} \times 100 + 2 \times \frac{1}{100} \times 100 = 3\%$$

Hence percentage error in measurement of g is 3%

38. Two very long, straight, parallel conductors *A* and *B* carry current of 5 *A* and 10 *A* respectively and are at a distance of 10 cm from each other. The direction of current in two conductors is same. The force acting per unit length between two conductors is : ($\mu_0 = 4\pi \times 10^{-7}$ SI unit)

   (1) 1×10^{-4} Nm^{-1} and is repulsive

   (2) 2×10^{-4} Nm^{-1} and is attractive

   (3) 2×10^{-4} Nm^{-1} and is repulsive

   (4) 1×10^{-4} Nm^{-1} and is attractive

Answer (4)

Sol. Force per unit length between two long current carrying wires $= \dfrac{\mu_0\, I_1\, I2}{2\,\pi\, d}$

$$F = \frac{4\pi \times 10^{-7} \times 5 \times 10}{2\,\pi \times 10 \times 10^{-2}} = 10^{-4} \text{ Nm}^{-1}$$

$\Rightarrow$ The force is attractive as direction of current in two conductors is same

Hence, required force is 1×10^{-4} Nm^{-1} and it is attractive

39. The magnetic field on the axis of a circular loop of radius 100 cm carrying current $I = \sqrt{2}$ A , at point 1 m away from the centre of the loop is given by :

   (1) 6.28×10^{-4} T

   (2) 3.14×10^{-7} T

   (3) 6.28×10^{-7} T

   (4) 3.14×10^{-4} T

Answer (2)

Sol. Magnetic field at the axis of a current carrying circular loop

$$|B| = \frac{\mu_0 i a^2}{2\left[a^2 + d^2\right]^{3/2}} \Rightarrow |B| = \frac{4\pi \times 10^{-7} \times \sqrt{2} \times 1}{2[1+1]^{3/2}}$$

$$|B| = \frac{4\pi \times 10^{-7} \times \sqrt{2}}{2.(2)^{3/2}} = \frac{4\pi \times 10^{-7}}{(2)^{3/2} \times (2)^{1/2}} = 3.14 \times 10^{-7} \text{ T}$$

40. At any instant, two elements X_1 and X_2 have same number of radioactive atoms. If the decay constant of X_1 and X_2 are 10 λ and λ respectively, then the time when the ratio of their atoms becomes $\dfrac{1}{e}$ respectively will be :

(1) $\dfrac{1}{5\lambda}$

(2) $\dfrac{1}{11\lambda}$

(3) $\dfrac{1}{9\lambda}$

(4) $\dfrac{1}{6\lambda}$

Answer (3)

Sol. Number of radioactive nuclei at any time is

$N = N_0 e^{-\lambda t}$

Initial number of nuclei is same for sample X_1 & X_2.

Let after time 't' the ratio of their atoms become $\dfrac{1}{e}$

$\Rightarrow \dfrac{N_0 e^{-10\lambda \times t}}{N_0 e^{-\lambda \times t}} = \dfrac{1}{e} \Rightarrow e^{-9\lambda t} = e^{-1} \Rightarrow t = \dfrac{1}{9\lambda}$

Hence $t = \dfrac{1}{9\lambda}$

41. Two rods one made of copper and other made of steel of same length and same cross sectional area are joined together. The thermal conductivity of copper and steel are 385 J s^{-1} K^{-1} m^{-1} and 50 J s^{-1} K^{-1} m^{-1} respectively. The free ends of copper and steel are held at 100°C and 0°C respectively. The temperature at the junction is, nearly :

(1) 88.5°C

(2) 12°C

(3) 50°C

(4) 73°C

Answer (1)

Sol. We know in conduction, rate of flow of heat $q = \dfrac{-K.A.\Delta T}{\Delta x}$

As it is a case of steady state heat transfer

$\Rightarrow \dfrac{-K_{cu} \times A \times \left[100 - T_j\right]}{\ell} = \dfrac{-K_{steel} \times A \times \left[T_j - 0\right]}{\ell}$

Where T_j is temperature of the junction

$\Rightarrow 385(100 - T_j) = 50(T_j)$

$\Rightarrow \dfrac{100}{T_j} - 1 = \dfrac{50}{385} \Rightarrow \dfrac{100}{T_j} = 1 + \dfrac{50}{385} \Rightarrow \dfrac{100}{T_j} = 1.1298$

$\Rightarrow T_j = 88.5°C$

42. The ratio of Coulomb's electrostatic force to the gravitational force between an electron and a proton separated by some distance is 2.4×10^{39}. The ratio of the proportionality constant, $K = \dfrac{1}{4\pi\varepsilon_0}$ to the Gravitational constant G is nearly (Given that the charge of the proton and electron each = 1.6×10^{-19} C, the mass of the electron = 9.11×10^{-31} kg, the mass of the proton = 1.67×10^{-27} kg) :

   (1) 10

   (2) 10^{20}

   (3) 10^{30}

   (4) 10^{40}

   Answer (2)

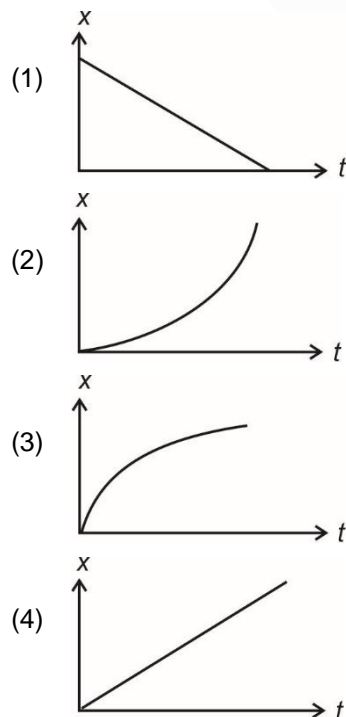   **Sol.** Ratio of magnitude of Coulomb's electrostatic force to the Gravitational force

   $$\frac{F_E}{F_G} = \frac{\left(\dfrac{Kq_1q_2}{r^2}\right)}{\left(\dfrac{Gm_1m_2}{r^2}\right)} = \frac{Kq_1q_2}{Gm_1m_2}$$

   $$\Rightarrow\ 2.4\times10^{39} = \frac{K}{G}\times\frac{1.6\times10^{-19}\times1.6\times10^{-19}}{9.11\times10^{-31}\times1.67\times10^{-27}}$$

   $$\Rightarrow\ 2.4\times10^{39} = \frac{K}{G}\times\frac{2.56}{15.21}\times10^{20} \Rightarrow \frac{K}{G} = 14.26\times10^{19}$$

   $$\Rightarrow\ \frac{K}{G} = 1.426\times10^{20} \Rightarrow \text{Ratio} \approx 10^{20}$$

43. The position-time (x - t) graph for positive acceleration is

   (1)

   (2)

   (3)

   (4)

   Answer (2)

   Sol. Slope of position-time (x - t) graph represents velocity.

   In graph-2, the slope is increasing hence the velocity is increasing hence acceleration is positive.

44. Six charges $+q$, $-q$, $+q$, $-q$, $+q$, and $-q$ are fixed at the corners of a hexagon of side d as shown in the figure. The work done in bringing a charge q_0 to the centre of the hexagon from infinity is
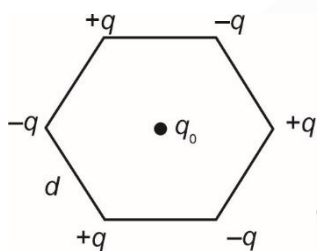
(ε_0 – permittivity of free space)
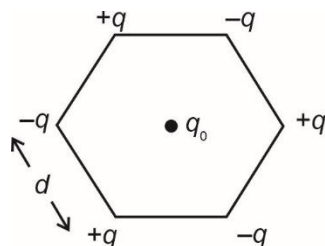
(1) $\dfrac{-q^2}{4\pi\varepsilon_0 d}\left(6 - \dfrac{1}{\sqrt{2}}\right)$

(2) Zero

(3) $\dfrac{-q^2}{4\pi\varepsilon_0 d}$

(4) $\dfrac{-q^2}{4\pi\varepsilon_0 d}\left(3 - \dfrac{1}{\sqrt{2}}\right)$

Answer (2)

Sol.

Work done $= q_0 \cdot (V_0 - V_\infty)$

$$= \left\{\frac{3kq}{d} + \left(\frac{-3kq}{d}\right)\right\} q_0$$

$$= \text{Zero}$$

45. An astronomical refracting telescope is being used by an observer to observe planets in normal adjustment. The focal lengths of the objective and eye piece used in the construction of the telescope are 20 m and 2 cm respectively. Consider the following statements about the telescope :

(a) The distance between the objective and eye piece is 20.02 m

(b) The magnification of the telescope is (–) 1000

(c) The image of the planet is erect and diminished

(d) The aperture of eye piece is smaller than that of objective

The correct statements are :

(1) (a), (b) and (d) (2) (a), (b) and (c)

(3) (b), (c) and (d) (4) (c), (d) and (a)

Answer (1)

Sol. Given f_0 = 20 m = 2000 cm, f_e = 2 cm

- Distance between objective and eye piece

$I = f_0 + f_e$

= 20 m + 2 cm = 20.02 m

- Magnification of telescope

$m = -\dfrac{f_0}{f_e} = -\dfrac{2000 \text{ cm}}{2 \text{ cm}} = -1000$

- Image formed by telescope is inverted.

- Aperture of eye piece is smaller than that of objective.

So, statements (a), (b) and (d) are correct

46. The magnetic flux linked to a circular coil of radius R is

$\phi = 2t^3 + 4t^2 + 2t + 5$ Wb

The magnitude of induced emf in the coil at t = 5 s is

(1) 192 V

(2) 108 V

(3) 197 V

(4) 150 V

Answer (1)

Sol. Given magnetic flux is

$\phi = 2t^3 + 4t^2 + 2t + 5$

Induced emf is given by

$\varepsilon = \dfrac{-d\phi}{dt} = \dfrac{-d}{dt}\left(2t^3 + 4t^2 + 2t + 5\right)$

$|\varepsilon| = 6t^2 + 8t + 2$

At t = 5 s,

$|\varepsilon| = 6 \times 25 + 8 \times 5 + 2$

= 150 + 40 + 2

= 192 V

47. Three vessels of equal capacity have gases at the same temperature and pressure. The first vessel contains helium (monoatomic), the second contains fluorine (diatomic) and the third contains sulfur hexafluoride (polyatomic). The correct statement, among the following is :

(1) The root mean square speed of sulfur hexafluoride is the largest

(2) All vessels contain unequal number of respective molecules

(3) The root mean square speed of molecules is same in all three cases

(4) The root mean square speed of helium is the largest

Answer (4)

Sol. All three vessels have equal volume and same temperature and pressure.

From ideal gas equation

$PV = nRT$

$nR = \dfrac{PV}{T}$

$n = \dfrac{PV}{RT} = \text{constant}$

So, here all three vessels contains equal number of moles and number of gas molecules.

Now, $v_{rms} = \sqrt{\dfrac{3RT}{M}} \Rightarrow v_{rms} \propto \dfrac{1}{\sqrt{M}}$

Here, rms speed of helium is the largest.

48. An organ pipe filled with a gas at 27°C resonates at 400 Hz in its fundamental mode. If it is filled with the same gas at 90°C, the resonance frequency at the same mode will be

(1) 512 Hz

(2) 420 Hz

(3) 440 Hz

(4) 484 Hz

Answer (3)

**Sol.** $f_0 = \dfrac{v}{2L} = \dfrac{\sqrt{\dfrac{\gamma RT}{M}}}{2L}$

$\dfrac{f_{0_1}}{f_{0_2}} = \sqrt{\dfrac{T_1}{T_2}} = \sqrt{\dfrac{300}{363}} = \dfrac{1}{1.1}$

$f_{0_2} = 1.1 f_{0_1} = 1.1(400)$

$= 440 \text{ Hz}$

49. The collector current in a common base amplifier using n-p-n transistor is 24 mA. If 80% of the electrons released by the emitter is accepted by the collector, then the base current is numerically :

(1) 3 mA and entering the base

(2) 6 mA and leaving the base

(3) 3 mA and leaving the base
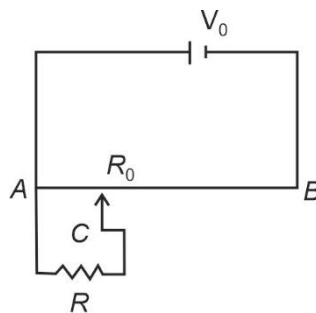
(4) 6 mA and entering the base

Answer (4)

Sol.
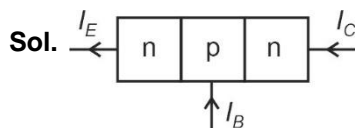
Given $I_C = 24$ mA

$\alpha = 0.8 = \dfrac{I_C}{I_E}$
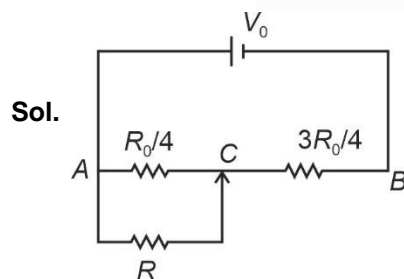
$I_E = \dfrac{24}{0.8} \text{ mA} = 30 \text{ mA}$

$I_B = I_E - I_C = 30 - 24$

$= 6 \text{ mA, entering the base}$

50. The sliding contact *C* is at one fourth of the length of the potentiometer wire (*AB*) from *A* as shown in the circuit diagram. If the resistance of the wire *AB* is R_0, then the potential drop (V) across the resistor *R* is

(1) $\dfrac{2V_0R}{2R_0 + 3R}$

(2) $\dfrac{4V_0R}{3R_0 + 16R}$

(3) $\dfrac{4V_0R}{3R_0 + R}$

(4) $\dfrac{2V_0R}{4R_0 + R}$

Answer (2)

Sol.

Equivalent resistance across point *AC*

$$R_{AC} = \dfrac{\dfrac{R_0}{4} \times R}{\dfrac{R_0}{4} + R} = \dfrac{RR_0}{R_0 + 4R}$$

From voltage divider rule

$$V_{AC} = \dfrac{R_{AC}}{R_{AC} + R_{CB}} V_0 = \dfrac{\dfrac{RR_0}{R_0 + 4R} V_0}{\dfrac{RR_0}{R_0 + 4R} + \dfrac{3R_0}{4}}$$

$$= \dfrac{4RR_0V_0}{4RR_0 + 3R_0^2 + 12RR_0} = \dfrac{4RV_0}{3R_0 + 16R}$$

CHEMISTRY

SECTION-A

51. Match **List - I** with **List - II** :

	List - I		**List - II**
	(quantum number)		**(orbital)**
(a)	$n = 2, l = 1$	(i)	3s
(b)	$n = 3, l = 2$	(ii)	3s
(c)	$n = 3, l = 0$	(iii)	2p
(d)	$n = 2, l = 0$	(iv)	3d

Choose the **correct answer** from the options given below :

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

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

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

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

Answer (1)

Sol.

n	l	Subshell notation
2	0	2s
2	1	2p
3	0	3s
3	1	3p
3	2	3d

52. The density of the solution is 2.15 g mL^{-1}, then mass of 2.5 mL solution in **correct** significant figures is :

(1) 53.75 g

(2) 5375×10^{-3} g

(3) 5.4 g

(4) 5.38 g

Answer (3)

Sol. Mass = Volume × Density

$= 2.5 \times 2.15$

$= 5.375$ g

Since 2.5 has two significant figures, so the mass of solution in correct significant figures will be 5.4 g.
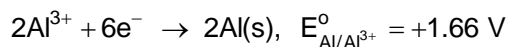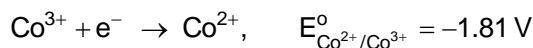
53. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : Chlorine is an electron withdrawing group but it is ortho, para directing in electrophilic aromatic substitution.

Reason (R) : Inductive effect of chlorine destabilises the intermediate carbocation formed during the electrophilic substitution, however due to the more pronounced resonance effect, the halogen stabilises the carbocation at ortho and para positions.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) **(A)** is not correct but **(R)** is correct

(2) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

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

(4) **(A)** is correct but **(R)** is not correct

Answer (4)

Sol. Cl has pronounced –I effect than +R effect due to large size difference between carbon and chlorine, also due to high electronegativity of chlorine.

54. Two half cell reactions are given below.

$$Co^{3+} + e^- \rightarrow Co^{2+}, \quad E^o_{Co^{2+}/Co^{3+}} = -1.81 \text{ V}$$

$$2Al^{3+} + 6e^- \rightarrow 2Al(s), \quad E^o_{Al/Al^{3+}} = +1.66 \text{ V}$$

The standard EMF of a cell with feasible redox reaction will be :

(1) –3.47 V
(2) +7.09 V
(3) +0.15 V
(4) +3.47 V

Answer (4)

Sol. Since E^o_{OP} of Al is more than Co^{2+}, so at anode Al will oxidise and at cathode Co^{3+} will reduce.

$$E^o_{Cell} = (E^o_{Cathode})_{RP} - (E^o_{Anode})_{RP}$$

$$= E^o_{Co^{3+}/Co^{2+}} - E^o_{Al^{3+}/Al}$$

$$= (1.81) - (-1.66)$$

$$= +3.47 \text{ V}$$

55. Match **List - I** with **List - II** :

List - I (Compounds)	List - II (Molecular formula)
(a) Borax	(i) $NaBO_2$
(b) Kernite	(ii) $Na_2B_4O_7 \cdot 4H_2O$
(c) Orthoboric acid	(iii) H_3BO_3
(d) Borax bead	(iv) $Na_2B_4O_7 \cdot 10H_2O$

Choose the **correct answer** from the options given below :

(1) (a) - (i), (b) - (iii), (c) - (iv), (d) - (ii)
(2) (a) - (iv), (b) - (ii), (c) - (iii), (d) - (i)
(3) (a) - (ii), (b) - (iv), (c) - (iii), (d) - (i)
(4) (a) - (iii), (b) - (i), (c) - (iv), (d) - (ii)

Answer (2)

Sol.
- Borax : $Na_2B_4O_7 \cdot 10H_2O = Na_2[B_4O_5(OH)_4] \cdot 8H_2O$
- Kernite : $Na_2B_4O_7 \cdot 4H_2O$
- Orthoboric acid : $H_3BO_3 = B(OH)_3$
- Borax bead : $NaBO_2$ (Sodium metaborate)

56. The correct order of first ionization enthalpy for the given four elements is :

    (1) C < F < N < O

    (2) C < N < F < O

    (3) C < N < O < F

    (4) C < O < N < F

    Answer (4)

    Sol. • Generally, on moving left to right in a period. First ionisation enthalpy of elements increases due to increase in effective nuclear charge.

    • Due to more stable half-filled outer electronic configuration ($2s^2 2p^3$) of N, its first ionisation enthalpy is more than O.

      So, correct order of IP is : C < O < N < F

57. Match List-I with List-II :

List-I (Defects)		**List-II** (Shown by)
(a) Frenkel defect	(i)	Non-ionic solids and density of the solid decreases
(b) Schottky defect	(ii)	Non-ionic solids and density of the solid increases
(c) Vacancy defect	(iii)	Ionic solids and density of the solid decreases
(d) Interstitial defect	(iv)	Ionic solids and density of the solid remains constant

    Chose the **correct answer** from the options given below :

    (1) (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)   (2) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)

    (3) (a) – (i), (b) – (iii), (c) – (ii), (d) – (iv)   (4) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

    Answer (1)

    Sol. • **Frenkel defect :** It is shown by ionic solids. The smaller ion (usually cation) is dislocated from its normal site to an interstitial site. It does not change the density of the solid.

    • **Schottky defect :** It is a vacancy defect in ionic solids. It decreases the density of substance.

    • **Vacancy defect :** When some of the lattice sites are vacant, the crystal is said to have vacancy defect. This results in decrease in density of the substance.

    • **Interstitial defect :** When some constituent particles occupy an interstitial site, the crystal is said to have interstitial defect. This defect increases the density of the substance.

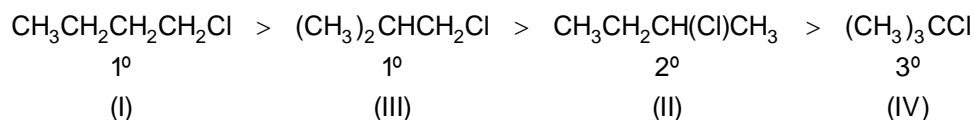58. Predict the order of reactivity of the following four isomers towards S_N2 reaction.

    (I) $CH_3CH_2CH_2CH_2Cl$

    (II) $CH_3CH_2CH(Cl)CH_3$

    (III) $(CH_3)_2CHCH_2Cl$

    (IV) $(CH_3)_3CCl$

    (1) (IV) > (II) > (III) > (I)   (2) (IV) > (III) > (II) > (I)

    (3) (I) > (II) > (III) > (IV)   (4) (I) > (III) > (II) > (IV)

Answer (4)

Sol. ● Lesser the steric hinderance on halide carbon, more will be the reactivity of alkyl halide towards S_N2 reaction.

● So correct order towards S_N2 reactivity is :

$$CH_3CH_2CH_2CH_2Cl \quad > \quad (CH_3)_2CHCH_2Cl \quad > \quad CH_3CH_2CH(Cl)CH_3 \quad > \quad (CH_3)_3CCl$$
$$1^0 \qquad\qquad\qquad 1^0 \qquad\qquad\qquad\qquad 2^0 \qquad\qquad\qquad 3^0$$
$$(I) \qquad\qquad\qquad (III) \qquad\qquad\qquad\qquad (II) \qquad\qquad\qquad (IV)$$

59. Match List-I with List-II :

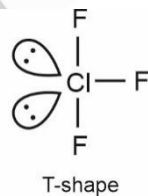| List-I	List-II
(Molecules)	**(Shape)**
(a) NH_3	(i) Square pyramidal
(b) ClF_3	(ii) Trigonal bipyramidal
(c) PCl_5	(iii) Trigonal pyramidal
(d) BrF_5	(iv) T-shape

Chose the **correct answer** from the options given below :

(1) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

(2) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)

(3) (a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)

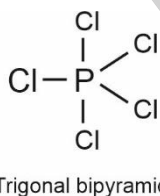(4) (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)
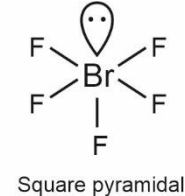
Answer (3)

Sol. (a) NH_3 :

Trigonal pyramidal

(b) ClF_3 :

T-shape

(c) PCl_5 :

Trigonal bipyramidal

(d) BrF_5 :

Square pyramidal
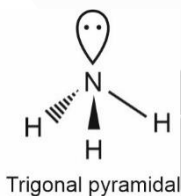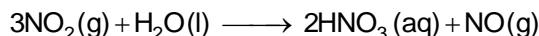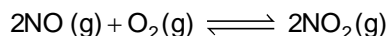
(a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)

60. Which of the following reactions is a part of the large scale industrial preparation of nitric acid?

(1) $Cu(NO_3)_2 + 2NO_2 + 2H_2O \xrightarrow[\text{500 K, 9 bar}]{\text{Pt}} 4HNO_3 + Cu$

(2) $NaNO_3 + H_2SO_4 \xrightarrow[\text{500 K, 9 bar}]{\text{Pt}} NaHSO_4 + HNO_3$

(3) $4NH_3 + 5O_2 \text{ (from air)} \xrightarrow[\text{500 K, 9 bar}]{\text{Pt}} 4NO + 6H_2O$

(4) $4HPO_3 + 2N_2O_5 \xrightarrow[\text{500 K, 9 bar}]{\text{Pt}} 4HNO_3 + P_4O_{10}$

Answer (3)

Sol. $4NH_3 + 5O_2$ (from air) $\xrightarrow[\text{500 K, 9 bar}]{\text{Pt}}$ $4NO + 6H_2O$

$2NO\ (g) + O_2(g) \rightleftharpoons 2NO_2(g)$

$3NO_2(g) + H_2O(l) \longrightarrow 2HNO_3\ (aq) + NO(g)$
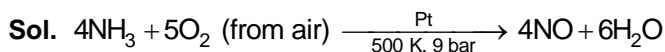
This is industrial method of preparation of nitric acid.

61. Match **List-I** with **List-II**:

	List-I		**List-II**
(a)	Sodium laurylsulphate	(i)	Toilet soap
(b)	Cetyltrimethyl ammonium chloride	(ii)	Non-ionic detergent
(c)	Sodium stearate	(iii)	Anionic detergent
(d)	Polyethyleneglycyl stearate	(iv)	Cationic detergent

Choose the **correct answer** from the options given below:

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

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

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

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

Answer (4)

Sol. (a) Sodium laurylsulphate → Anionic detergent

(b) Cetyltrimethyl ammonium chloride → Cationic detergent

(c) Sodium stearate → Toilet soap

(d) Polyethyleneglycyl stearate → Non-ionic detergent
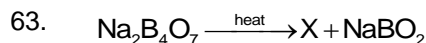
(a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

62 Which among the following is a thermoplastic polymer?

(1) Melamine polymer

(2) Bakelite

(3) Polythene

(4) Urea-formaldehyde resin

Answer (3)

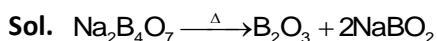**Sol.** • Polythene is an example of thermoplastic polymer.

Melamine polymer, Bakelite and Urea-formaldehyde resin are thermosetting polymers

63. $Na_2B_4O_7 \xrightarrow{\text{heat}} X + NaBO_2$

in the above reaction the product "X" is:

(1) NaB_3O_5

(2) H_3BO_3

(3) B_2O_3

(4) $Na_2B_2O_5$

Answer (3)

Sol. $Na_2B_4O_7 \xrightarrow{\Delta} B_2O_3 + 2NaBO_2$

Product X is B_2O_3

64. One mole of an ideal gas at 300 K is expanded isothermally from 1 L to 10 L volume. ΔU for this process is:

(Use R = 8.314 J k^{-1} mol^{-1})

(1) 0 J

(2) 1260 J

(3) 2520 J

(4) 5040 J

Answer (1)

Sol. $\Delta U = nC_v\Delta T$

For isothermal condition; $\Delta T = 0$

$\therefore \Delta U = O$

65. Match **List-I** with **List-II**:

List-I		**List-II**	
(Complexes)		**(Types)**	
(a)	[Co(NH$_3$)$_5$NO$_2$]Cl$_2$ and [Co(NH$_3$)$_5$ONO]Cl$_2$	(i)	ionisation isomerism
(b)	[Cr(NH$_3$)$_6$][Co(CN)$_6$] and [Cr(CN)$_6$][Co(NH$_3$)$_6$]	(ii)	coordination isomerism
(c)	[Co(NH$_3$)$_5$(SO$_4$)]Br and [Co(NH$_3$)$_5$Br]SO$_4$	(iii)	linkage isomerism
(d)	[Cr(H$_2$O)$_6$]Cl$_3$ and [Cr(H$_2$O)$_5$Cl]Cl$_2$·H$_2$O	(iv)	solvate isomerism

Choose the **correct answer** from the options given below:

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

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

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

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

Answer (4)

Sol. (a) [Co(NH$_3$)$_5$NO$_2$]Cl$_2$

and [Co(NH$_3$)$_5$ONO]Cl$_2$ $\longrightarrow$ linkage isomerism

(b) [Cr(NH$_3$)$_6$][Co(CN)$_6$]

and [Cr(CN)$_6$][Co(NH$_3$)$_6$] $\longrightarrow$ coordination isomerism

(c) [Co(NH$_3$)$_5$(SO$_4$)]Br

and [Co(NH$_3$)$_5$Br]SO$_4$ $\longrightarrow$ ionisation isomerism

(d) [Cr(H$_2$O)$_6$]Cl$_3$ and

[Cr(H$_2$O)$_5$Cl]Cl$_2$·H$_2$O $\longrightarrow$ solvate isomerism

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

66. Shown below are adsorption isotherms for a gas 'X' at temperatures T_1, T_2 and T_3 :
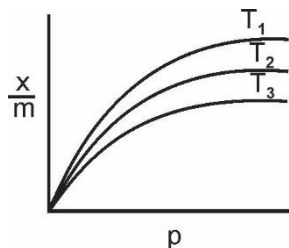
p and $\dfrac{x}{m}$ represent pressure and extent of adsorption, respectively. The correct order of temperatures for the given adsorption is :

(1) $T_1 = T_2 > T_3$ (2) $T_1 > T_2 > T_3$

(3) $T_3 > T_2 > T_1$ (4) $T_1 = T_2 = T_3$

Answer (3)

Sol. With **i**ncrease in temperature, extent of adsorption $\left(i.e. \dfrac{x}{m} \right)$ decreases so correct order of temperatures will be $T_3 > T_2 > T_1$

67. 0.01 M acetic acid solution is 1% ionised, then pH of this acetic acid solution is :

(1) 1   (2) 3

(3) 2   (4) 4

Answer (4)

Sol. For weak acid (i.e. CH_3COOH)

$[H^+] = C\alpha$

$= 0.01 \times \dfrac{1}{100} = 10^{-4} M$

$pH = -\log H^+ = -\log 10^{-4} = 4$

68. The half life of a first order reaction is 2000 years. If the concentration after 8000 years is 0.02 M, then the initial concentration was :

(1) 0.04 M   (2) 0.16 M
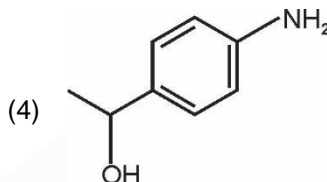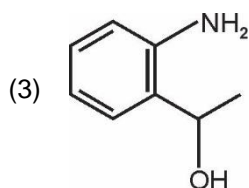
(3) 0.32 M   (4) 0.08 M

Answer (3)

Sol. Let the initial concentration is A molar.

Number of half lives in 8000 years $= \dfrac{8000}{2000} = 4$

$0.02 = \dfrac{[A]}{(2)^4}$

$[A] = 0.02 \times 2^4 = 0.32$ M

69.   The product formed from the following reaction sequence is :

(i) (CH₃CO)₂O, pyridine
(ii) LiAlH₄
(iii) H₂O

(1)

(2)

(3)

(4)
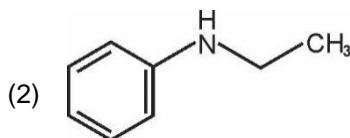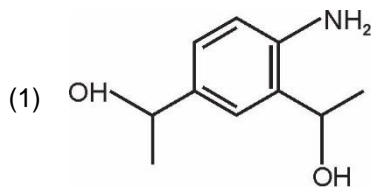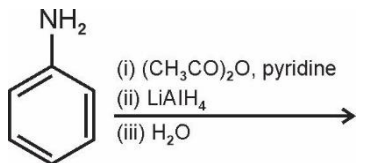
Answer (2)

Sol.
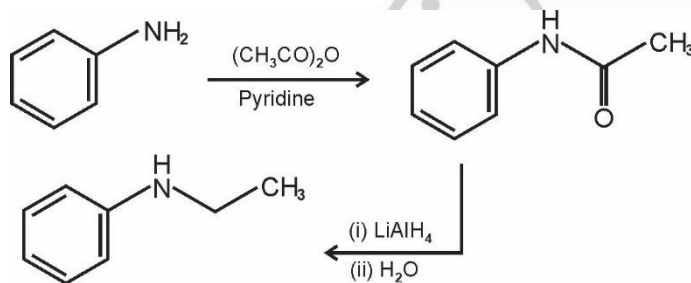
70.   The decreasing order of boiling points of the following alkanes is :

(a)   heptane

(b)   butane

(c)   2-methylbutane

(d)   2-methylpropane

(e)   hexane

Choose the correct answer from the options given below :

(1)   (a) > (e) > (c) > (b) > (d)   (2)   (a) > (c) > (e) > (d) > (b)

(3)   (c) > (d) > (a) > (e) > (b)   (4)   (a) > (e) > (b) > (c) > (d)

Answer (1)

Sol. ● With increase in number of carbons in alkane, boiling point increases

● In case of isomeric alkanes, greater is the number of branches, lesser is the boiling point.

Boiling point order : $\underset{(a)}{Heptane} > \underset{(e)}{Hexane} > \underset{(c)}{2\text{-methylbutane}} > \underset{(b)}{butane} > \underset{(d)}{2\text{-methylpropane}}$

71. The element used for welding metals with high melting points is

(1) He
(2) Cl_2
(3) H_2
(4) Ne

Answer (3)

Sol. Atomic hydrogen atoms produced by dissociation of dihydrogen with the help of electric arc use for cutting and welding metals with high melting points.

72. Decrease in size from left to right in actinoid series is greater and gradual than that in lanthanoid series due to

(1) 5f orbitals have greater shielding effect
(2) 4f orbitals are penultimate
(3) 4f orbitals have greater shielding effect
(4) 5f orbitals have poor shielding effect

Answer (4)

Sol. Due to more diffused nature of 5f orbitals as compared to 4f orbitals the shielding effect of 5f is poor, resulting in the decrease in size from left to right in actinoid series which is greater and gradual than that in lanthanoid series.

73. Which of the following reactions is not an example for nucleophilic addition-elimination reaction?

(1) $CH_3CHO + NH_3 \rightleftharpoons CH_3CH = NH + H_2O$

(2) $CH_3CHO + NaHSO_3 \rightleftharpoons CH_3 - \underset{\underset{H}{|}}{\overset{\overset{OH}{|}}{C}} - OSO_2Na$

(3) $CH_3CHO + NH_2OH \rightleftharpoons CH_3CH = N - OH + H_2O$

(4) $CH_3CHO + C_6H_5NHNH_2 \rightleftharpoons CH_3CH = N - NHC_6H_5 + H_2O$

Answer (2)

Sol. It is an example of nucleophilic addition reaction
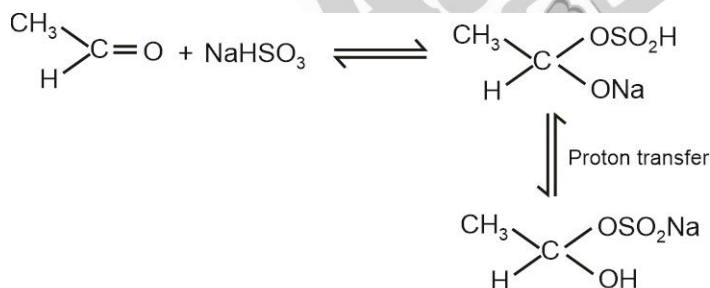
Bisulphite addition product

74. $CaCl_2$ and $Ca(OCl)_2$ are components of

(1) Lime water
(2) Gypsum
(3) Portland cement
(4) Bleaching power

Answer (4)

Sol. Milk of lime reacts with chlorine to form hypochlorite, a constituent of bleaching powder
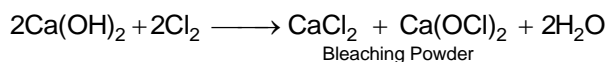
$$2Ca(OH)_2 + 2Cl_2 \longrightarrow \underset{\text{Bleaching Powder}}{CaCl_2 + Ca(OCl)_2} + 2H_2O$$

75. The product formed from the following reaction sequence is

(i) HCN
(ii) H₃O⁺
(iii) NaOH and CaO, Δ
(3 : 1)

(1)

(2)

(3)

(4)

Answer (3)

Sol.

(i) HCN
(ii) H₃O⁺

Cyanohydrin

H_3O^+

NaOH and CaO, Δ
Decarboxylation
$-CO_2$
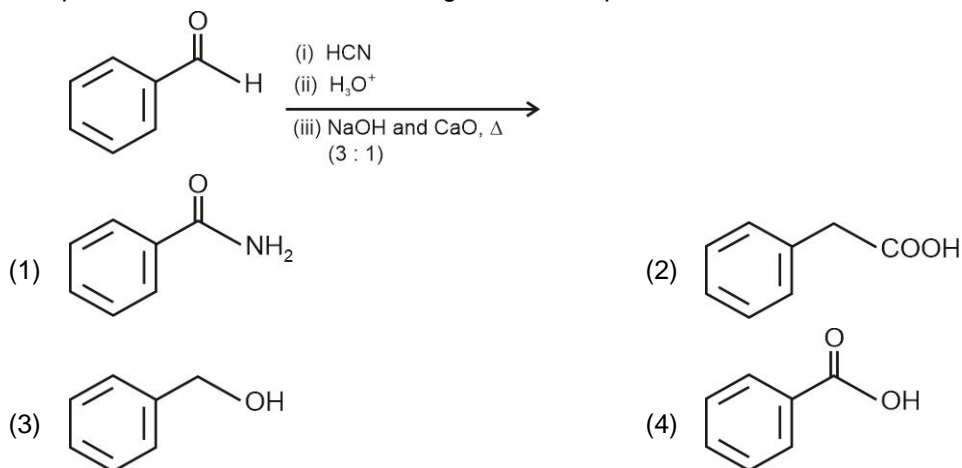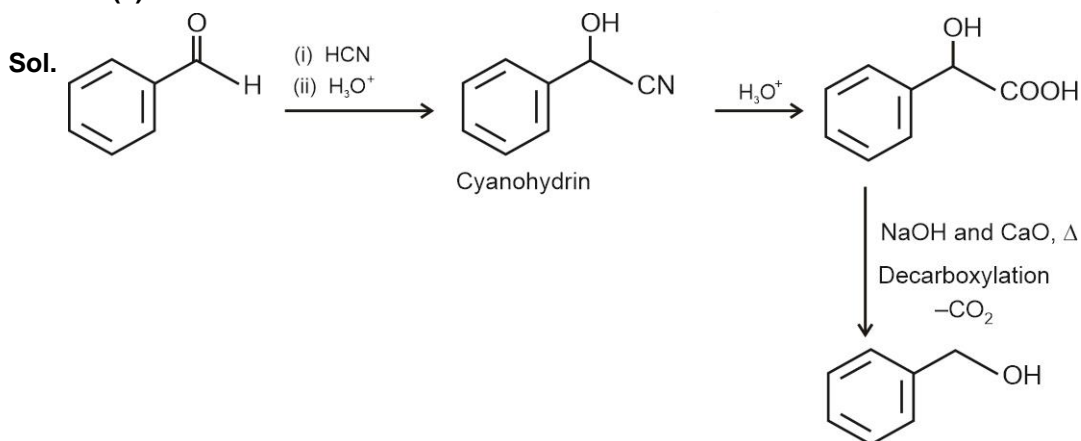
76. Flourine is a stronger oxidising agent than chlorine because:
    (a) F-F bond has a low enthalpy of dissociation.
    (b) Flouride ion (F⁻) has high hydration enthalpy.
    (c) Electron gain enthalpy of flourine is less negative than chlorine.
    (d) Flourine has a very small size.
    Choose the **most appropriate** answer from the options given:
    (1) (b) and (c) only
    (2) (a) and (b) only
    (3) (a) and (c) only
    (4) (a) and (d) only

    Answer (2)

    Sol. Flourine is a stronger oxidising agent than chlorine due to
    (i) low dissociation enthalpy of F – F bond
    (ii) High hydration enthalpy of F⁻ ion

77. K_H value for some gases at the same temperature 'T' are given:

Gas	K_H/k bar
Ar	40.3
CO₂	1.67
HCHO	1.83×10^{-5}
CH₄	0.413

    where K_H is Henry's Law constant in water. The order of their solubility in water is:

(1) $HCHO < CH_4 < CO_2 < Ar$

(2) $Ar < CO_2 < CH_4 < HCHO$

(3) $Ar < CH_4 < CO_2 < HCHO$

(4) $HCHO < CO_2 < CH_4 < Ar$
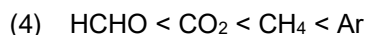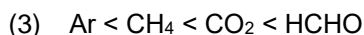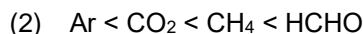
Answer (2)

Sol. According to Henry's law,

$p = K_H x$

Where 'p' is partial pressure of gas in vapour phase.

K_H is Henry's law constant.

'x' is mole fraction of gas in liquid.

Higher the value of K_H at a given pressure, lower is the solubility of the gas in the liquid.

∴ Solubility: $Ar < CO_2 < CH_4 < HCHO$

78.   Which of the following reactions is a decomposition redox reaction?

(1) $P_4(s) + 3OH^- (aq) + 3H_2O(l) \rightarrow PH_3(g) + 3H_2PO_2^- (aq)$

(2) $2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$

(3) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

(4) $Cl_2(g) + 2OH^-(aq) \rightarrow ClO^-(aq) + Cl^-(aq) + 4H_2O(l)$
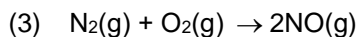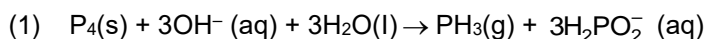
Answer (2)

Sol. Decomposition redox reaction leads to breakdown of a compound into two or more compounds at least one of which must be in the elemental state with change in oxidation number.

$$2Pb\left(N\overset{2-}{O_3}\right)_2 (s) \rightarrow 2PbO(s) + 4NO_2(g) + \overset{0}{O_2}(g)$$
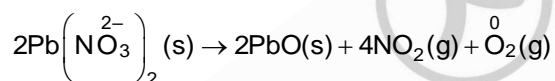
79.   What is the hybridization shown by C_1 and C_2 carbons, respectively in the given compound?

$OHC - CH = CH - CH_2COOCH_3$

(1) sp^3 and sp^3

(2) sp^2 and sp^3

(3) sp^2 and sp^2

(4) sp^3 and sp^2
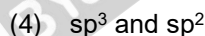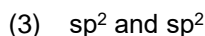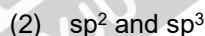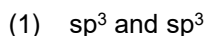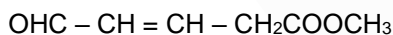
Answer (2)

Sol. $-COOCH_3$ has higher priority than $- C = C -$ and $- CHO$ in IUPAC nomenclature.

$$\underset{5}{OHC} - \underset{4}{CH} = \underset{3}{CH} - \underset{2}{CH_2} - \underset{1}{\overset{\overset{O}{\|}}{C}} - O - CH_3$$

$C_1 = sp^2$

$C_2 = sp^3$
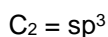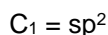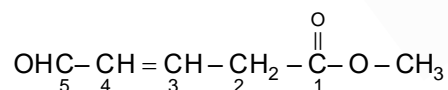
80.   Match the reagents **(List - I)** with the product **(List - II)** obtained from phenol.

List - I		List - II	
(a)	(i) NaOH (ii) CO_2 (iii) H^+	(i)	Benzoquinone
(b)	(i) Aqueous NaOH + $CHCl_3$ (ii) H^+	(ii)	Benzene
(c)	Zn dust, Δ	(iii)	Salicyl aldehyde
(d)	$Na_2Cr_2O_7$, H_2SO_4	(iv)	Salicylic acid
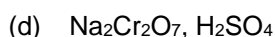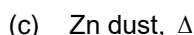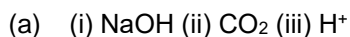
Choose the correct answer from the options given below:

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

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

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

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

Answer (4)

Sol.

Salicylic acid

Salicyl aldehyde

Benzene

Benzoquinone
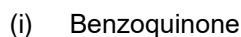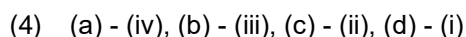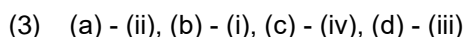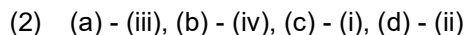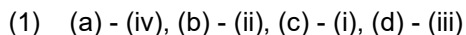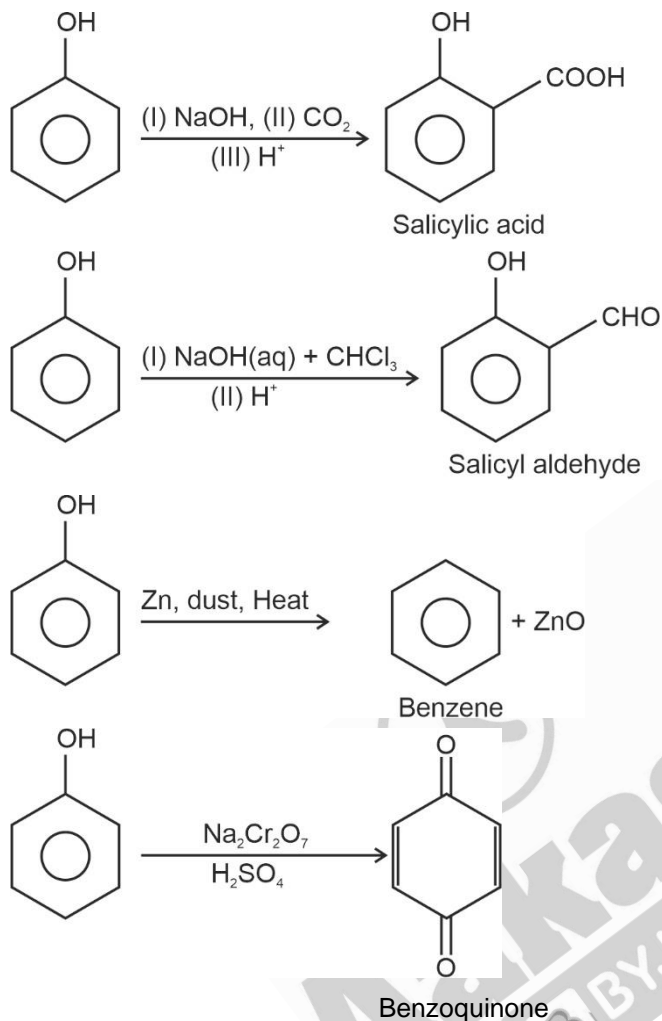
81. The correct order of bond angles in the following compounds/species is :

(1) $CO_2 < NH_3 < H_2O < \overset{+}{N}H_4$

(2) $H_2O < NH_3 < \overset{+}{N}H_4 < CO_2$

(3) $H_2O < \overset{+}{N}H_4 < NH_3 < CO_2$

(4) $H_2O < \overset{+}{N}H_4 = NH_3 < CO_2$

Answer (2)

Sol. $CO_2 \Rightarrow sp^2$ hybridisation, bond angle = 180°

$NH_4^+ \Rightarrow sp^3$ hybridisation, bond angle = 109° 28′

$NH_3 \Rightarrow sp^3$ hybridisation with one lone pair on central atom, bond angle ≃ 107°

$H_2O \Rightarrow sp^3$ hybridisation with two lone pairs on central atom, bond angle ≃ 104.5°

82. Match **List-I** with **List-II** :

List-I	**List-II**
(Reaction)	**(Product formed)**
(a) Gabriel synthesis	(i) Benzaldehyde
(b) Kolbe synthesis	(ii) Ethers
(c) Williamson synthesis	(iii) Primary amines
(d) Etard reaction	(iv) Salicylic acid

Choose the **correct answer** from the options given below:

(1)　(a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)

(2)　(a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)

(3)　(a) – (ii), (b) – (iii), (c) – (i), (d) – (iv)

(4)　(a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)

Answer (1)

Sol.

- Gabriel phthalimide synthesis is used for preparation of aliphatic primary amines.
- Kolbe synthesis with phenol gives salicylic acid
- Williamson synthesis gives ether on reaction of alkyl halide and alcoxide
- Etard reaction gives benzaldehyde from benzene

83.　If first ionization enthalpies of elements X and Y are 419 kJ mol^{-1} and 590 kJ mol^{-1}, respectively and second ionization enthalpies of X and Y are 3069 kJ mol^{-1} and 1145 kJ mol^{-1}, respectively. Then **correct** statement is :

(1)　Both X and Y are alkaline earth metals

(2)　X is an alkali metal and Y is an alkaline earth metal

(3)　X is an alkaline earth metal and Y is an alkali metal

(4)　Both X and Y are alkali metals

Answer (2)

Sol. As it can be observed from given data of question, in case of element 'X' there is huge difference between IP_1 and IP_2 hence it will have one electron in outermost shell and will be alkali metal.

While for 'Y' difference is not that high hence it will be alkaline earth metal.

84.　The **incorrect** statement about denaturation of proteins is :

(1)　Uncoiling of the helical structure takes place

(2)　It results due to change of temperature and/or pH

(3)　It results in loss of biological activity of proteins

(4)　A protein is formed from amino acids linked by peptide bonds

Answer (4)

Sol.

- Proteins are polymers of α-amino acids and they are connected to each other by peptide bond, but this is not denaturation process.
- Due to denaturation globules unfold and helix get uncoiled and protein loses its biological activity.

Denaturation can be caused if protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH

85.　Four gas cylinders containing He, N_2, CO_2 and NH_3 gases separately are gradually cooled from a temperature of 500 K. Which gas will liquify first?

(Given T_C in K – He : 5.3, N_2 : 126, CO_2 : 304.1 and NH_3 : 405.5)

(1)　NH_3　　　　　　　　　　　　(2)　He

(3)　N_2　　　　　　　　　　　　　(4)　CO_2

Answer (1)

Sol. As from the given data NH_3 has highest critical temperature which suggests maximum attractive forces hence NH_3 will get liquified first

SECTION-B

86. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

    Assertion (A): The metal carbon bond in metal carbonyls possesses both σ and π character.

    Reason (R): The ligand to metal bond is a π bond and metal to ligand bond is a σ bond.

    In the light of the above statements, choose the **most appropriate** answer from the options given below.

    (1) **(A)** is not correct but **(R)** is correct

    (2) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

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

    (4) **(A)** is correct but **(R)** is not correct

    Answer (4)

    Sol.
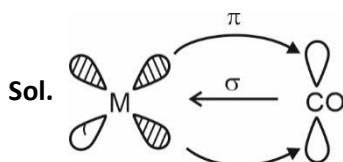
    In case of metal carbonyls, the bonding has both σ and π nature, where ligand to metal bond is 'σ' (coordinate) bond and metal to ligand bond is π (synergic) bond.

87. Match **List - I** with **List - II** :

List - I		List - II	
(a)	Biochemical oxygen demand	(i)	oxidising mixture
(b)	Photochemical smog	(ii)	polar stratospheric cloud
(c)	Classical smog	(iii)	organic matter in water
(d)	Ozone layer depletion	(iv)	reducing mixture

    Choose the **correct answer** from the options given below:

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

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

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

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

    Answer (4)

    Sol.

List - I		List - II	
(a) Biochemical oxygen demand		(iii)	organic matter in water
(b) Photochemical smog		(i)	oxidising mixture
(c) Classical smog		(iv)	reducing mixture
(d) Ozone layer depletion		(ii)	polar stratospheric cloud

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

88. Which of the following is the most stable carbocation?

(1)

(2)

(3)

(4)

Answer (1)

Sol. (1) $\longrightarrow$ Cross conjugation and 3α - H [Hyperconjugation]
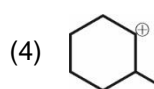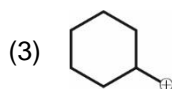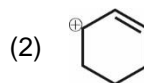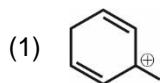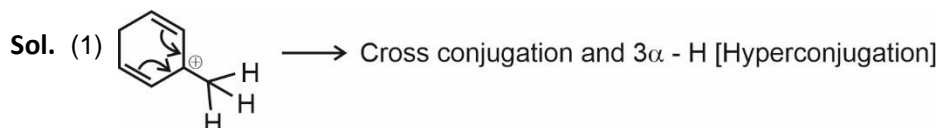
Due to cross-conjugation and 3α-H [Hyperconjugation], (1) is most stable.

(2) $\longrightarrow$ Resonance and 2α - H [Hyperconjugation]

(3) $\longrightarrow$ 1α - H [Hyperconjugation]

(4) $\longrightarrow$ 3α - H [Hyperconjugation]
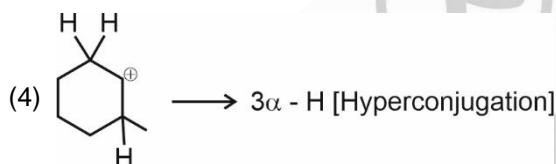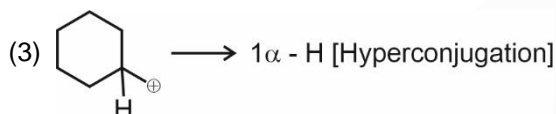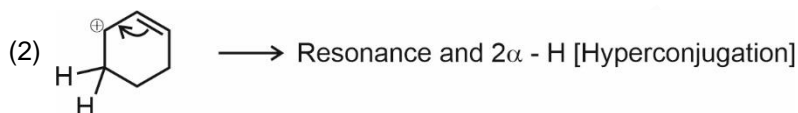
89. Given below are two statements :

Statement I : Cr^{2+} is oxidising and Mn^{3+} is reducing in nature.

Statement II : Sc^{3+} compounds are repelled by the applied magnetic field.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) **Statement I** is incorrect but **Statement II** is correct

(2) Both **Statement I** and **Statement II** are correct

(3) Both **Statement I** and **Statement II** are incorrect

(4) **Statement I** is correct but **Statement II** is incorrect

Answer (1)

Sol. Statement I : Cr^{2+} is reducing as its configuration changes from d^4 to d^3, the latter having a half-filled t_{2g} level. On the other hand, the change from Mn^{3+} to Mn^{2+} results in the half-filled (d^5) configuration which has extra stability.

Statement II : Sc^{3+} has zero unpaired electron, so magnetic moment is also zero. Hence, Sc^{3+} will repelled by the applied magnetic field.

90. K_p for the following reaction is 3.0 at 1000 K.

$$CO_2(g) + C(s) \rightleftharpoons 2CO(g)$$
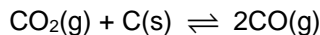
What will be the value of K_C for the reaction at the same temperature?

(Given - R = 0.083 L bar K^{-1} mol^{-1})

(1) 3.6

(2) 0.36

(3) 3.6×10^{-2}

(4) 3.6×10^{-3}

Answer (3)

Sol. $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$
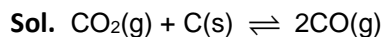
$\Delta n_g = 2 - 1 = 1$

$K_p = K_c(RT)^{\Delta n_g}$

$K_p = K_c(RT)$ $\qquad\qquad [\therefore K_p = 3]$

$K_c = \dfrac{K_p}{RT} = \dfrac{3}{0.083 \times 1000}$

$= 0.036$

$= 3.6 \times 10^{-2}$

91. A vessel contains 3.2 g of dioxygen gas at STP (273.15 K and 1 atm pressure). The gas is now transferred to another vessel at constant temperature, where pressure becomes one third of the original pressure. The volume of new vessel in L is: (Given-molar volume at STP is 22.4 L)

(1) 67.2

(2) 6.72

(3) 2.24

(4) 22.4

Answer (2)

Sol. At constant temperature and amount

$P_1V_1 = P_2V_2$

$P_1 V_1 = \dfrac{P_1}{3} V_2 \qquad [\therefore P_2 = \dfrac{P_1}{3}]$

$V_2 = 3V_1$

mole of $O_2(g) = \dfrac{3.2}{32} = 0.1$ mole

Volume of $O_2(g) = (0.1 \times 22.4)$ L = 2.24 L
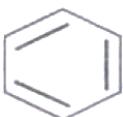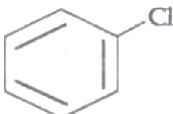
At STP (V_1)

$V_2 = 3V_1 = 3 \times 2.24$

$= 6.72$ L

92. Which one of the following reaction sequence is **incorrect** method to prepare phenol?

(1) , oleum, NaOH, H_3O^+

(2) Aniline, $NaNO_2$ + HCl, H_2O, heating

(3) Cumene, O_2, H_3O^+

(4) , NaOH, STP condition

Answer (4)

Sol.
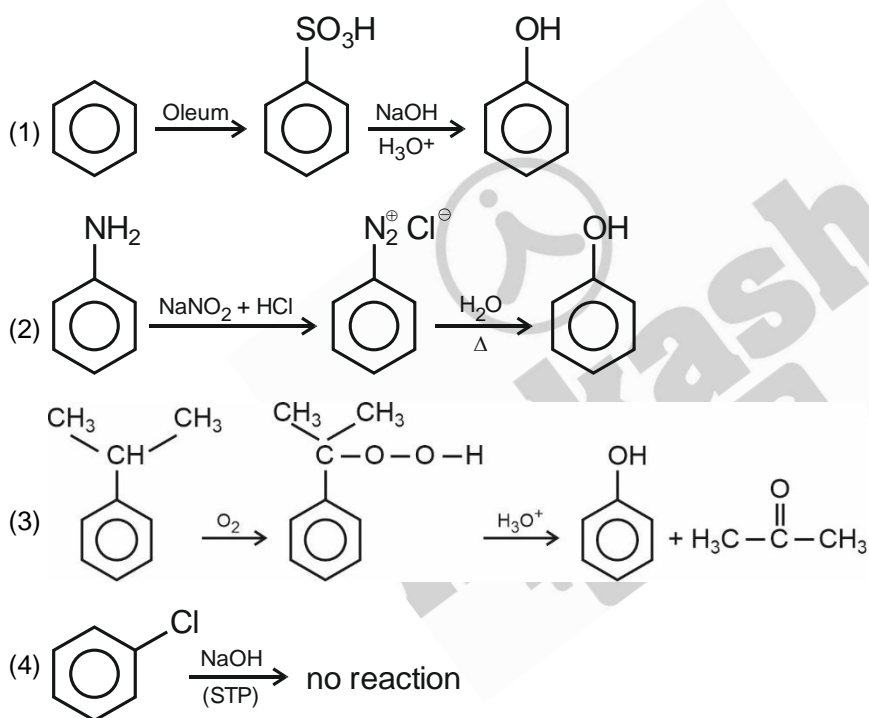
At STP condition substitution at sp^2 carbon atom is not feasible

93. For a chemical reaction

$4A + 3B \rightarrow 6C + 9D$
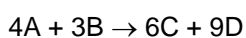
Rate of formation of C is 6×10^{-2} mol L^{-1} s^{-1} and rate of disappearance of A is 4×10^{-2} mol L^{-1} s^{-1}.

The rate of reaction and amount of B consumed in interval of 10 seconds, respectively will be:

(1) 10×10^{-2} mol L^{-1} s^{-1} and 30×10^{-2} mol L^{-1}

(2) 1×10^{-2} mol L^{-1} s^{-1} and 30×10^{-2} mol L^{-1}

(3) 10×10^{-2} mol L^{-1} s^{-1} and 10×10^{-2} mol L^{-1}

(4) 1×10^{-2} mol L^{-1} s^{-1} and 10×10^{-2} mol L^{-1}

Answer (2)

Sol. $4A + 3B \rightarrow 6C + 9D$

Rate of reaction = $\dfrac{-d[A]}{dt} \times \dfrac{1}{4} = \dfrac{-d[B]}{dt} \times \dfrac{1}{3} = \dfrac{+d[C]}{dt} \times \dfrac{1}{6} = \dfrac{+d[D]}{dt} \times \dfrac{1}{9}$

Rate of reaction = $\dfrac{+d[C]}{dt} \times \dfrac{1}{6} = \dfrac{6 \times 10^{-2}}{6} = 10^{-2} \, \text{mol L}^{-1} \text{s}^{-1}$

Rate of reaction = $\dfrac{-1}{3} \dfrac{d[B]}{dt}$

$\dfrac{-d[B]}{dt} = 3 \times$ rate of reaction = $3 \times 10^{-2} \, \text{mol L}^{-1} \text{s}^{-1}$

After interval of 10 sec. = $3 \times 10^{-2} \times 10$

$= 30 \times 10^{-2} \, \text{mol L}^{-1}$

94. Standard electrode potential for the cell with cell reaction

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
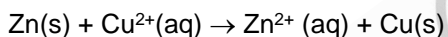
is 1.1 V. Calculate the standard Gibbs energy change for the cell reaction. (Given F = 96487 C mol^{-1})

(1) −200.27 J mol^{-1}

(2) −200.27 kJ mol^{-1}

(3) −212.27 kJ mol^{-1}

(4) −212.27 J mol^{-1}

Answer (3)

Sol. $Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$
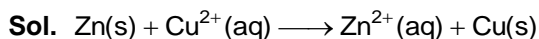
$E^{\circ}_{cell} = 1.1 \, V$

$\Delta G^{\circ} = -nFE^{\circ}_{cell}, \qquad \therefore n = 2$

$\Delta G^{\circ} = -2 \times 96487 \times 1.1$

$\Delta G^{\circ} = -212271.4 \, J \, mol^{-1}$

$\Delta G^{0} = -212.27 \, kJ \, mol^{-1}$

95. The products A and B in the following reaction sequence are:

$$Ph\underset{\text{(iii) CO}_2, \text{H}_3\text{O}^+}{\overset{\text{(i) HBr}}{\xrightarrow{\hspace{1.5cm}}}} A \underset{\text{(ii) CH}_3\text{NH}_2}{\overset{\text{(i) SOCl}_2}{\xrightarrow{\hspace{1cm}}}} B$$

(1) A = [benzene ring with CH(CH₃)–OH group];

B = [benzene ring with CH(CH₃)–NH–CH₃ group]

(2) A = [benzene ring with CH₂CH₂–C(=O)–OH group];

B = [benzene ring with CH₂CH₂–C(=O)–NH–CH₃ group]

(3) A = [benzene ring with CH(CH₃)–C(=O)–OH group];

B = [benzene ring with CH(CH₃)–C(=O)–N(H)–CH₃ group]

(4) A = [benzene ring with CH₂CH₂–OH group];

B = [benzene ring with CH₂CH₂–N(H)–CH₃ group]
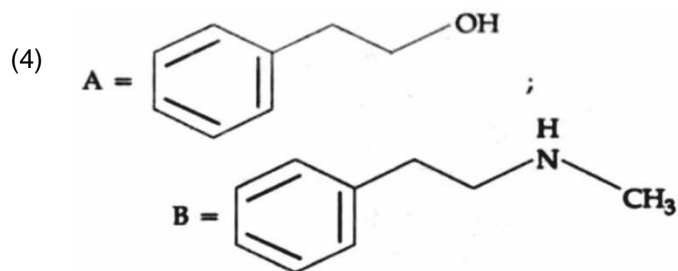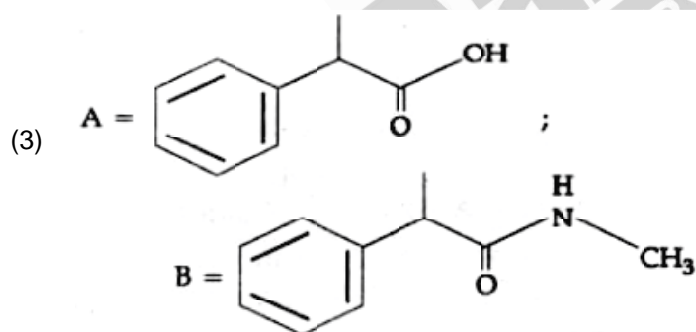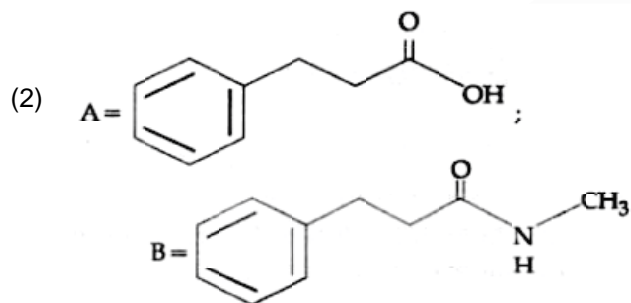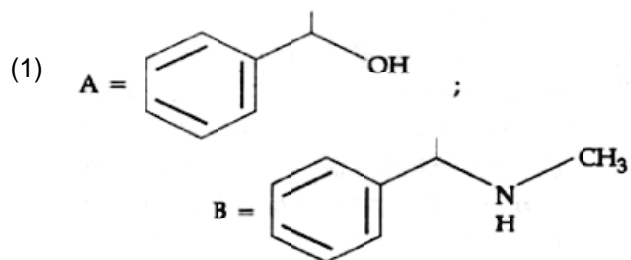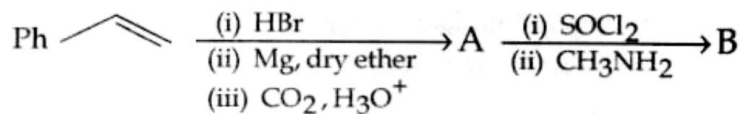
Answer (3)

Sol.
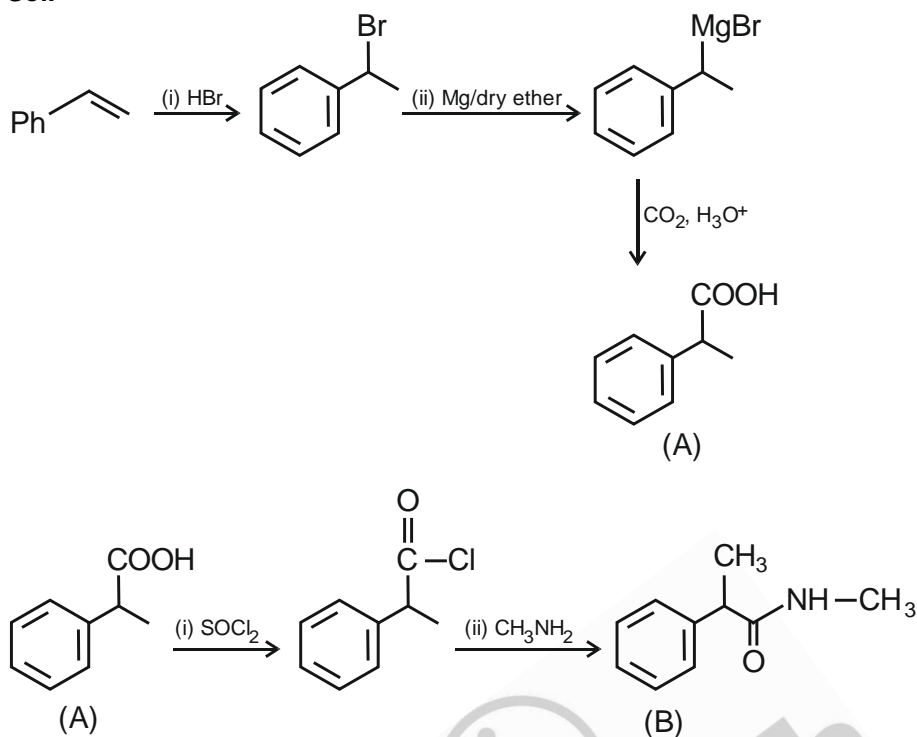
96. Which one of the following is not a calcination reaction?

(1) $CaCO_3 + 2HCl \xrightarrow{\Delta} CaCl_2 + H_2O + CO_2$ (2) $ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$

(3) $Fe_2O_3 \cdot xH_2O \xrightarrow{\Delta} Fe_2O_3 + xH_2O$ (4) $CaCO_3 \cdot MgCO_3 \xrightarrow{\Delta} CaO + MgO + 2CO_2$

Answer (1)

Sol. Calcination involves heating when the volatile matter escapes leaving behind the metal oxide.

$Fe_2O_3 \cdot xH_2O(s) \xrightarrow{\Delta} Fe_2O_3(s) + xH_2O(g)$

$ZnCO_3(s) \longrightarrow ZnO(s) + CO_2(g)$

$CaCO_3 \cdot MgCO_3(s) \longrightarrow CaO(s) + MgO(s) + 2CO_2(g)$

$CaCO_3 + 2HCl \xrightarrow{\Delta} CaCl_2 + H_2O + CO_2$ Not calcination
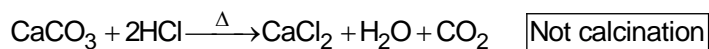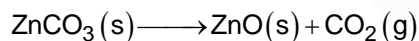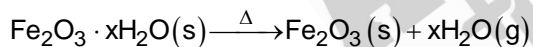
It is a neutralization reaction.

97. The incorrect method for the synthesis of alkenes is

(1) Treating vicinal dihalides with Zn metal

(2) Treating of alkynes with Na in liquid NH₃

(3) Heating alkyl halides with alcoholic KOH

(4) Treating alkyl halides in aqueous KOH solution

Answer (4)

Sol. Alkenes can be prepared

(1) From vicinal dihalides

$$\underset{\substack{| \quad\quad | \\ CH_2 - CH_2}}{\overset{Br \quad Br}{}} + Zn \longrightarrow \underset{\text{alkene}}{CH_2 = CH_2} + ZnBr_2$$

(2) From alkynes

$$RC \equiv CR' + H_2 \xrightarrow{Na/liq.\ NH_3} \underset{\text{trans-alkene}}{\overset{R}{\underset{H}{>}} C = C \overset{H}{\underset{R'}{<}}}$$
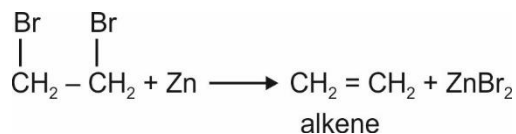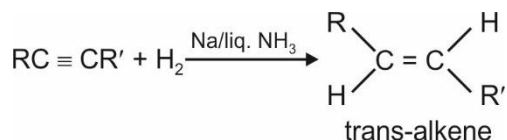
(3) From alkyl halide

$$\underset{\substack{| \quad | \\ H \quad X}}{\overset{\substack{H \quad H \\ | \quad |}}{H - C - C - H}} \xrightarrow[\Delta]{alc.\ KOH} \overset{H}{\underset{H}{>}} C = C \overset{H}{\underset{H}{<}}$$
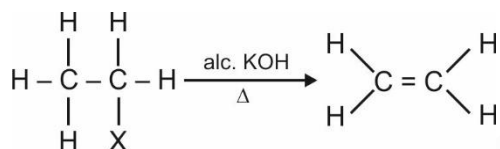
(4) $\underset{\text{alkyl halide}}{CH_3 - CH_2 - X} \xrightarrow{KOH\ (aq.)} \underset{\text{alcohol}}{CH_3 - CH_2 - OH}$

98. When electromagnetic radiation of wavelength 300 nm falls on the surface of a metal, electrons are emitted with the kinetic energy of 1.68×10^5 J mol^{-1}. What is the minimum energy needed to remove an electron from the metal?

($h = 6.626 \times 10^{-34}$ Js, $c = 3 \times 10^8$ ms^{-1}, $N_A = 6.022 \times 10^{23}$ mol^{-1})

(1) 2.31×10^5 J mol^{-1}

(2) 2.31×10^6 J mol^{-1}

(3) 3.84×10^4 J mol^{-1}

(4) 3.84×10^{-19} J mol^{-1}

Answer (1)

Sol. Energy of one photon $= \dfrac{hc}{\lambda}$ $(\lambda = 300$ nm$)$

For one mole photons, $E = \dfrac{hc}{\lambda} \times N_A$

$E = \dfrac{6.626 \times 10^{-34} \times 3 \times 10^8 \times 6.023 \times 10^{23}}{300 \times 10^{-9}}$

$E = 3.99 \times 10^5$ J mol^{-1}

Kinetic energy $= 1.68 \times 10^5$ J mol^{-1}

$W_0 = E - K.E.$

$= 3.99 \times 10^5 - 1.68 \times 10^5$

$= 2.31 \times 10^5$ J mol^{-1}

99. What fraction of Fe exists as Fe(III) in Fe$_{0.96}$O?

(Consider Fe$_{0.96}$O to be made up of Fe(II) and Fe(III) only)

(1) $\dfrac{1}{20}$

(2) $\dfrac{1}{12}$

(3) 0.08

(4) $\dfrac{1}{16}$

Answer (2)

Sol. $Fe_{0.96}O$

Let Fe(II) present in $Fe_{0.96}O$ = x

Fe(III) present = (0.96 − x)

Total charge on Fe = 2x + (0.96 − x)3

Total charge on O = −2

2x + (0.96 −x)3 = 2

2x + 2.88 − 3x = 2
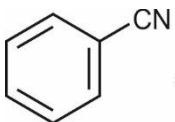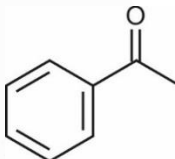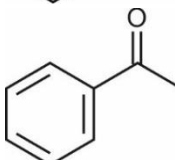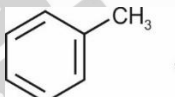
−x = −0.88

$\boxed{x = 0.88}$

Fe^{2+} = 0.88, Fe^{3+} = 0.08

Fraction of $Fe^{3+} = \dfrac{0.08}{0.96} = \dfrac{1}{12}$

100. The incorrect method to synthesize benzaldehyde is

(1) , CH_3MgBr, followed by H_3O^+

(2) Cl, H_2, Pd-BaSO$_4$

(3) OC_2H_5, DIBAL-H, followed by H_2O

(4) ,CrO_2Cl_2, followed by H_3O^+ in CS_2

Answer (1)

Sol.

Benzaldehyde

Benzaldehyde

Benzaldehyde
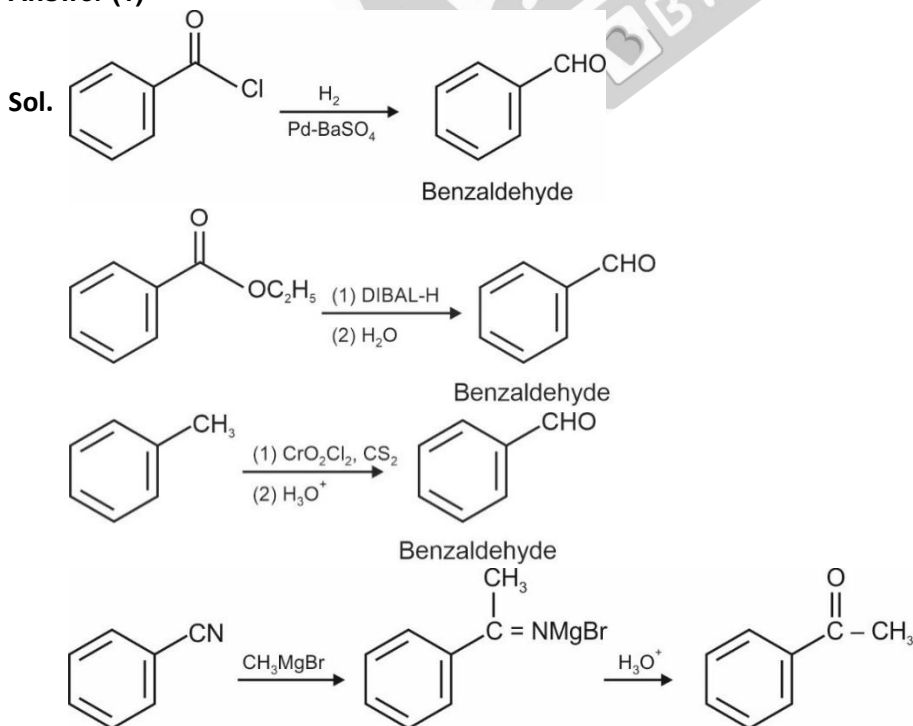
BOTANY

SECTION-A

101. Given below are two statements :

    Statement I : Sickle cell anaemia and Haemophilia are autosomal dominant traits.

    Statement II : Sickle cell anaemia and Haemophilia are disorders of the blood.

    In the light of the above statements, choose the **correct** answer from the options given below :

    (1) **Statement I** is incorrect but **Statement II** is correct

    (2) Both **Statement I** and **Statement II** are correct

    (3) Both **Statement I** and **Statement II** are incorrect

    (4) **Statement I** is correct but **Statement II** is incorrect

    Answer (1)

    Sol. Sickle cell anaemia is autosomal recessive disorder, whereas, haemophilia is sex linked recessive disorder.

    Both sickle cell anaemia and haemophilia are the genetic disorders related to blood.

102. Which stage of meiosis can last for months or years in the oocytes of some verterbrates?

    (1) Diakinesis

    (2) Leptotene

    (3) Pachytene

    (4) Diplotene

    Answer (4)

    Sol. In oocytes of some vertebrates, diplotene lasts for months or years. This stage is referred as dictyotene stage.

103. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

    Assertion (A): When a particular restriction enzyme cuts strand of DNA, overhanging stretches or sticky ends are formed.

    Reason (R): Some restriction enzymes cut the strand of DNA a little away from the centre of palindromic site.

    In the light of the above statements, choose the **correct** answer from the options given below:

    (1) **(A)** is not correct but **(R)** is correct

    (2) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

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

    (4) **(A)** is correct but **(R)** is not correct

    Answer (2)

    Sol. Option (2) is the correct answer because when restriction enzymes cut the strand of DNA a little away from the centre of the palindrome sites, but between the same two bases on the opposite strands, then single stranded portions are left at the ends. These overhanging stretches on each strand are called sticky ends.

104. Give the **correct** descending order of organisms with reference to their estimated number found in Amazon forest.

     (a) Plants

     (b) Invertebrates

     (c) Fishes

     (d) Mammals

     (e) Birds

     Choose the **correct** answer from the options given below :

     (1) (b) > (a) > (c) > (e) > (d)

     (2) (a) > (b) > (e) > (d) > (c)

     (3) (a) > (c) > (d) > (b) > (e)

     (4) (b) > (a) > (e) > (d) > (c)

     Answer (1)

     Sol. The numbers of species related to different taxa in Amazonian rain forest are as follows:

Taxa	Number of species
Plants	> 40, 000
Mammals	427
Birds	1,300
Fishes	3,000
Invertebrates	> 1,25,000

105. In *lac* operon, *z* gene codes for

     (1) Transacetylase

     (2) β-galactosidase

     (3) Permease

     (4) Repressor

     Answer (2)

     Sol. In *lac* operon, *z* gene codes for β-galactosidase.

     Transacetylase, permease and repressor protein are coded by genes '*a*', '*y*' and '*i*' respectively.

106. The 5-C compound formed during TCA cycle is

     (1) Fumaric acid

     (2) α-ketoglutaric acid

     (3) Oxalo succinic acid

     (4) Succinic acid

     Answer (2)

     Sol. In TCA cycle, the intermediate which is a 5-C compound is α-ketoglutaric acid.

     Oxalosuccinic acid is a 6-C compound, whereas succinic acid and fumaric are and 4-C compounds.

107. In meiosis, crossing over and exchange of genetic material between homologous chromosomes are catalyzed by the enzyme

     (1) Polymerase

     (2) Phosphorylase

     (3) Recombinase

     (4) Transferase

     Answer (3)

     Sol. Crossing over and exchange of genetic material between homologous chromosomes occurs during pachytene stage of meiosis. The enzyme involved in this process is recombinase.

108. All successions irrespective of the habitat proceed to which type of climax community?

    (1) Edaphic

    (2) Xeric

    (3) Mesic

    (4) Hydrophytic

    Answer (3)

    Sol. Both hydrarch and xerarch succession lead to medium water condition called mesic condition. This condition is neither too dry nor too wet.

109. When a carrier protein facilitates the movement of two molecules across the membrane in same direction, it is called

    (1) Symport

    (2) Uniport

    (3) Transport

    (4) Antiport

    Answer (1)

    Sol. A symport is the transport of two types of molecules across the membrane in same direction.

    Antiport is the transport of two different molecules in opposite directions.

    Uniport is transport of a molecule across the membrane independent of other molecule.

110. When one CO_2 molecule is fixed as one molecule of triose phosphate, which of the following photochemically made, high energy chemical intermediates are used in the reduction phase?

    (1) 2 ATP + 2 NADPH

    (2) 1 ATP + 1 NADPH

    (3) 1 ATP + 2 NADPH

    (4) 2 ATP + 1 NADPH

    Answer (1)

    Sol. The reduction step of Calvin cycle involves utilisation of two molecules of ATP for phosphorylation and two molecules of NADPH for reduction per molecule of CO_2 fixed.

111. The ability of plants to follow different pathways in response to environment leading to formation of different kinds of structures is called

    (1) Differentiation

    (2) Redifferentiation

    (3) Development

    (4) Plasticity

    Answer (4)

    Sol. The ability of plant to follow different pathways and produce different structures in response to environment is called plasticity.

    During differentiation, cells lose their ability to divide and form permanent cell.

    The process where the differentiated cells again lose the ability to divide and form permanent cells is called redifferentiation.

112. Match **List-I** with **List-II**

	List-I		**List-II**
(a)	*Chlamydomonas*	(i)	Moss
(b)	*Cycas*	(ii)	Pteridophyte
(c)	*Selaginella*	(iii)	Alga
(d)	*Sphagnum*	(iv)	Gymnosperm

Choose the **correct** answer from the options given below

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

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

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

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

Answer (3)

Sol. *Chlamydomonas* is a unicellular alga. *Cycas* is a gymnosperm. *Selaginella* is a heterosporous pteridophyte and *Sphagnum* is a moss.

113. Interfascicular cambium is present between

(1) Secondary xylem and secondary phloem

(2) Primary xylem and primary phloem

(3) Pericycle and endodermis

(4) Two vascular bundles

Answer (4)

Sol. During secondary growth in dicot stem, the cells of medullary rays lie between the vascular bundles become dedifferentiated and give rise to new cambium called interfascicular cambium.

114. Which of the following growth regulators is an adenine derivative?

(1) Abscisic acid

(2) Auxin

(3) Cytokinin

(4) Ethylene

Answer (3)

Sol. • Cytokinins are derived from adenine.
• Auxins are derivatives of indole compounds.
• Abscisic acid is derived from carotenoids.

Ethylene is derived from methionine.

115. The chromosomal theory of inheritance was proposed by

(1) Robert Brown

(2) Thomas Morgan

(3) Sutton and Boveri

(4) Gregor Mendel

Answer (3)

Sol. Sutton and Boveri proposed chromosomal theory of inheritance. Thomas Morgan experimentally verified the chromosomal theory of inheritance. Gregor Mendel proposed laws of inheritance.

116. Which of the following statement is **not** correct?

    (1) The rhizome is thick, prostrate and branched

    (2) Rhizome is a condensed form of stem

    (3) The apical bud in rhizome always remains above the ground

    (4) The rhizome is aerial with no distinct nodes and internodes

    Answer (4)

    Sol. Rhizome is an underground (sub-aerial) stem. It bears distinct nodes and internodes.

117. The Phenomenon by which the undividing parenchyma cells start to divide mitotically during plant tissue culture is called as

    (1) Secondary growth

    (2) Differentiation

    (3) Dedifferentiation

    (4) Redifferentiation

    Answer (3)

    Sol. The phenomenon where certain living differentiated cells regain or attain their ability to divide and form new cells is known as dedifferentiation.

118. Match **List-I** with **List-II**

	List-I		List-II
(a)	Adenine	(i)	Pigment
(b)	Anthocyanin	(ii)	Polysaccharide
(c)	Chitin	(iii)	Alkaloid
(d)	Codeine	(iv)	Purine

    Choose the **correct answer** from the options given below

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

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

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

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

    Answer (2)

    Sol. Option (2) is the correct answer as adenine is a purine, anthocyanin is a pigment, chitin is a homopolysaccharide and codeine is an alkaloid.

119. The residual persistent part which forms the perisperm in the seeds of beet is

    (1) Integument

    (2) Calyx

    (3) Endosperm

    (4) Nucellus

    Answer (4)

    Sol. Mostly nucellus is consumed after fertilisation due to absorption of food by developing embryo in a seed. Sometimes, the nucellus remains persistent in the seed and is called perisperm.

120. The World Summit on sustainable development held in 2002 in Johannesburg, South Africa pledged for

    (1) Collection and preservation of seeds of different genetic strains of commercially important plants.

    (2) A significant reduction in the current rate of biodiversity loss.

    (3) Declaration of more biodiversity hotspots.

    (4) Increase in agricultural production.

    Answer (2)

    Sol. In the World Summit on sustainable development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local levels.

121. The type of tissue commonly found in the fruit wall of nuts is :

    (1) Sclereid

    (2) Parenchyma

    (3) Collenchyma

    (4) Sclerenchyma

    Answer (1)

    Sol. The sclereids are the spherical, oval or cylindrical, highly thickened dead cells with very narrow cavities (lumen). These are found commonly in the fruit wall of nuts.

122. The pioneer species in a hydrarch succession are

    (1) Filamentous algae

    (2) Free-floating angiosperms

    (3) Submerged rooted plants

    (4) Phytoplanktons

    Answer (4)

    Sol. In primary succession in water, the pioneers are the small phytoplanktons, which are replaced with time by rooted-submerged plants, rooted floating angiosperms followed by free-floating plants, then reed-swamp, marsh-meadow, scrub and finally trees.

123. Which of the following protects nitrogenase inside the root nodule of a leguminous plant?

    (1) Glutamate dehydrogenase

    (2) Catalase

    (3) *leg* haemoglobin

    (4) Transaminase

    Answer (3)

    Sol. The enzyme nitrogenase functions under anaerobic conditions as it is highly sensitive to molecular oxygen. In order to protect these enzymes, the nodules contain a red or pink-coloured pigment called *leg* haemoglobin. It is an O_2 scavenger.

124. Given below are two statements

    Statement I:

    DNA polymerases catalyse polymerisation only in one direction, that is 5′ → 3′.

    Statement II:

    During replication of DNA, on one strand the replication is continuous while on other strand it is discontinuous.

    In the light of the above statements, choose the correct answer from the options given below:

    (1) Statement I is incorrect but Statement II is correct

    (2) Both Statement I and Statement II are correct

    (3) Both Statement I and Statement II are incorrect

    (4) Statement I is correct but Statement II is incorrect

    Answer (2)

    Sol. The DNA-dependent DNA polymerases catalyse polymerisation only in one direction, that is 5′ → 3′. This creates some additional complications at the replicating fork. Consequently, on one strand (the template with polarity 3′ → 5′), the replication is continuous, while on the other (the template with polarity 5′ → 3′), it is discontinuous.

125. The species that come to appear in bare area are called

    (1) Species of seral community

    (2) Pioneer species

    (3) Invasive species

    (4) Competitive species

    Answer (2)

    Sol. The species that invade a bare area are called pioneer species.

    The individual transitional communities in an ecological succession are termed as seral stages or seral communities.

126. Initiation of lateral roots and vascular cambium during secondary growth takes place in cells of

    (1) Pericycle

    (2) Epiblema

    (3) Cortex

    (4) Endodermis

    Answer (1)

    Sol. Initiation of lateral roots and vascular cambium during secondary growth takes place in pericycle cells of dicot roots. Epiblema, endodermis and cortex do not dedifferentiate.

127. Match **List - I** with **List - II.**

	List - I		List – II
(a)	In *lac* operon *i* gene codes for	(i)	transacetylase
(b)	In *lac* operon *z* gene codes for	(ii)	permease
(c)	In *lac* operon *y* gene codes for	(iii)	β-galactosidase
(d)	In *lac* operon *a* gene codes for	(iv)	Repressor

Choose the **correct answer** from the options given below

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

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

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

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

Answer (3)

Sol. In *lac* operon,

The *i* gene codes for repressor protein.

The *z* gene codes for β-galactosidase.

The *y* gene codes for permease and the *a* gene codes for transacetylase.

128.   To ensure that only the desired pollens fall on the stigma in artificial hybridization process

(a)   the female flower buds of plant producing unisexual flowers need not be bagged.

(b)   there is no need to emasculate unisexual flowers of selected female parent

(c)   emasculated flowers are to be bagged immediately after cross pollination

(d)   emasculated flowers are to be bagged after removal of anthers

(e)   bisexual flowers, showing protogyny are never selected for cross

Choose the **correct answer** from the options given belows

(1)   (a), (d) and (e) only

(2)   (a), (b) and (c) only

(3)   (b), (c) and (d) only

(4)   (b), (c) and (e) only

Answer (3)

Sol. In artificial cross hybridisation, if female parent is bisexual then emasculation is done i.e., removal of anthers, before it dehisce.

If female parent is unisexual, there is no need of emasculation.

After emasculation, flowers are bagged to prevent contamination of stigma.

Desired pollen grains are dusted on stigma and it is rebagged after cross pollination.

Bisexual flowers which show protogynous condition can also be used for artificial hybridisation.

129.   The ascent of xylem sap is plants in mainly accomplished by the

(1)   root pressure

(2)   size of the stomatal aperture

(3)   distribution of stomata on the upper and lower epidermis

(4)   cohesion and adhesion between water molecules

Answer (4)

Sol. The ascent of xylem sap in plants is mainly due to negative hydrostatic pressure i.e. transpirational pull, which is accomplished by three physical properties of water i.e., cohesion, adhesion and surface tension.

130. Match **List - I** with **List – II.**

	List - I		List - II
(a)	Imbricate	(i)	*Calotropis*
(b)	Valvate	(ii)	*Cassia*
(c)	Vexillary	(iii)	Cotton
(d)	Twisted	(iv)	Bean

Choose the **correct answer** from the options given below

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

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

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

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

Answer (3)

Sol. Imbricate aestivation is found in *Cassia*

Valvate aestivation is found in *Calotropis*

Vexillary aestivation is found in Bean

Twisted aestivation is found in cotton

131. The number of time(s) decarboxylation of isocitrate occurs during single TCA cycle is

(1) Four

(2) One

(3) Two

(4) Three

Answer (3)

Sol. During TCA cycle, 6-C compound isocitrate is converted into succinyl CoA, a 4-C compound by removing two CO_2 molecules.

The steps are as follows -
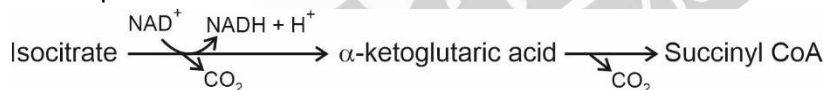
132. Match List-I with List-II

	List-I		List-II
(a)	Porins	(i)	Pink coloured nodules
(b)	*leg* haemoglobin	(ii)	Lumen of thylakoid
(c)	H^+ accumulation	(iii)	Amphibolic pathway
(d)	Respiration	(iv)	Huge pores in outer membrane of mitochondria

Choose the **correct** answer from the options given below.

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

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

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

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

Answer (3)

Sol. Porins are huge pores in outer membrane of mitochondria.

Leg haemoglobin turns the nodules pink in colour.

H^+ accumulation in lumen of thylakoid occurs during photosynthetic electron transport.

Respiration is an amphibolic pathway.

133. Separation of DNA fragments is done by a technique known as

    (1) Gel electrophoresis

    (2) Polymerase Chain Reaction

    (3) Recombinant technology

    (4) Southern blotting

    Answer (1)

    Sol. Option (1) is the correct answer because separation of DNA fragments which is carried out after restriction enzyme digestion, is done by a technique known as gel electrophoresis.

    Option (2) is not the correct answer because polymerase chain reaction (PCR) is a technique used for amplification of gene of interest.

    Option (3) is not the correct answer because recombinant DNA technology comprises altering genetic material outside an organism to obtain enhanced and desired characteristics in living organisms or as their products.

    Option (4) is not the answer because Southern blotting is a method used for detection of specific DNA sequences in samples.

134. In general the egg apparatus of embryo sac in angiosperm consists of

    (1) One egg cell, two synergids, two antipodal cells, two Polar nuclei

    (2) One egg cell, two synergids, three antipodal cells, two Polar nuclei

    (3) One egg cell, two synergids, two antipodal cells, three Polar nuclei

    (4) One egg cell, three synergids, two antipodal cells, two Polar nuclei

    Answer (2)

    Sol. The egg apparatus of an embryo sac consists of one egg cell and two synergids.

    Whereas the embryo sac consists of one egg cell, two synergies, three antipodals and two polar nuclei.

    As per the question none of the option is correct however considering the composition of embryo sac the correct option should be 2.

135. The Floral Diagram represents which one of the following families?

    (1) Liliaceae (2) Fabaceae

    (3) Brassicaceae (4) Solanaceae

    Answer (3)

    Sol. The floral diagram given in the question represents Brassicaceae family. It can be easily identified by looking on its parietal placentation.

SECTION-B

136. Primary proteins are also called as polypeptides because:

    (1) They can assume many conformations

    (2) They are linear chains

    (3) They are polymers of peptide monomers

    (4) Successive amino acids are joined by peptide bonds

    Answer (4)

    Sol. Option (4) is the correct answer because primary proteins are heteropolymers containing strings of amino acids linked by peptide bonds.

    Option (1) and (2) are incorrect as primary proteins are called polypeptides due to the presence of many monomers linked via peptide bonds, not due to the presence of many conformations.

    Option (3) is incorrect because proteins are polymers of amino acid monomers.

137. Match List-I with List-II:

	List-I			List-II
(a)	Bacteriophage $\phi \times 174$	(i)	48502 base pairs
(b)	Bacteriophage lambda	(ii)	5386 nucleotides
(c)	*Escherichia coli*	(iii)	3.3×10^9 base pairs
(d)	Haploid content of human DNA	(iv)	4.6×10^6 base pairs

    Choose the **correct** answer from the options given below:

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

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

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

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

    Answer (4)

    Sol. Genetic material of –

    • Bacteriophage $\phi \times 174$ contains 5386 nucleotides

    • Bacteriophage lambda contains 48502 basepairs

    • *Escherichia coli* contains 4.6×10^6 basepairs

    • Haploid content of human DNA contains 3.3×10^9 basepairs

138. Which type of substance would face difficulty to pass through the cell membrane?

    (1) Substance soluble in lipids

    (2) Substance with hydrophobic moiety

    (3) Substance with hydrophilic moiety

    (4) All substance irrespective of hydrophobic and hydrophilic moiety

    Answer (3)

    Sol. Substances that have a hydrophilic moiety find it difficult to pass through the plasma membrane; thus, their movement has to be facilitated.

139. What is the expected percentage of F_2 progeny with yellow and inflated pod in dihybrid cross experiment involving pea plants with green coloured, inflated pod and yellow coloured constricted pod?

(1) 9%

(2) 100%

(3) 56.25%

(4) 18.75%

Answer (4)

Sol. (G) Green pod colour is dominant over yellow pod colour (g)

(I) Inflated pod is dominant over constricted pod (i)

GGII
(Dominant parent) ✕ ggii (Recessive parent)
Green coloured, inflated pod   Yellow coloured and constricted pod
↓
Ggli → F_1 progeny
(Green coloured, Inflated pod)
Ggli × Ggli → selfing
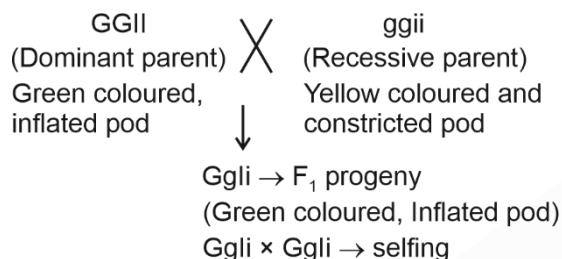
Expected percentage of F_2 progeny with yellow – inflated pod in this cross is

$$\frac{1}{4} \times \frac{3}{4} \times 100 = 18.75\%$$

140. Match List-I with List-II:

	List-I		**List-II**
(a)	Carbon dissolved in oceans	(i)	55 billion tons
(b)	Annual fixation of carbon through photosynthesis	(ii)	71%
(c)	PAR captured by plants	(iii)	4×10^3 kg
(d)	Productivity of oceans	(iv)	2 to 10%

Choose the **correct** answer from the options given below:

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

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

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

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

Answer (4)

Sol. About 71% of total carbon is found dissolved in oceans.

Annual fixation of carbon through photosynthesis is 4×10^{13} kg.

PAR captured by plants is 2 to 10% of total sunlight.

Productivity of oceans is approximately 55 billion tons.

141. If a female individual is with small round head, furrowed tongue, partially open mouth and broad palm with characteristic palm crease. Also the physical, psychomotor and mental development is retarded. The karyotype analysis of such an individual will show :

    (1) Trisomy of chromosome 21

    (2) 47 chromosomes with XXY sex chromosomes

    (3) 45 chromosomes with XO sex chromosomes

    (4) 47 chromosomes with XYY sex chromosomes

    Answer (1)

    Sol. If a female individual is with small head, furrowed tongue, partially open mouth and broad palm with characteristic palm crease and also the physical psychomotor and mental development is retarded, the individual is suffering from Down's syndrome, an autosomal trisomy. Karyotype analysis of such an individual will show trisomy of chromosome 21.

142. Read the following statements and identify the characters related to the alga shown in the diagram :

    (a) It is a member of Chlorophyceae

    (b) Food is stored in the form of starch

    (c) It is monoecious plant showing oogonium and antheridium

    (d) Food is stored in the form of laminarin or mannitol

    (e) It shows dominance of pigments Chlorophyll a, c and Fucoxanthin

    Choose the **correct answer** from the options given below :

    (1) (c), (d) and (e) only

    (2) (a), and (b) only

    (3) (a), (b) and (c) only

    (4) (a), (c) and (d) only

    Answer (3)

    Sol. Alga shown in the diagram is *Chara*. It is a member of Chlorophyceae. Food is stored in the form of starch.

    Chara is monecious plant showing oogonium and antheridium on the same plant body.

143. Match the **List-I** with **List-II** :

	List-I		List-II
(a)	Sacred groves	(i)	Alien species
(b)	Zoological park	(ii)	Release of large quantity of oxygen
(c)	Nile perch	(iii)	*Ex-situ* conservation
(d)	Amazon forest	(iv)	Khasi Hills in Meghalaya

Choose the **correct answer** from the options given below :

(1)   (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

(2)   (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)

(3)   (a) – (ii), (b) – (iv), (c) – (i), (d) – (iii)

(4)   (a) – (iv), (b) – (i), (c) – (ii), (d) – (iii)

Answer (2)

Sol. Khasi Hills in Meghalaya are sacred groves. Zoological park is an *ex-situ* conservation strategy.

Nile perch is an alien species.

Amazon forest releases large quantity of O_2.

144.   The enzyme (a) is needed for isolating genetic material from plant cells and enzyme (b) for isolating genetic material from fungus. Choose the **correct** pair of options from the following :

(1)   (a) Cellulase (b) Lipase

(2)   (a) Cellulase (b) Protease

(3)   (a) Cellulase (b) Chitinase

(4)   (a) Chitinase (b) Lipase

Answer (3)

Sol. Option (3) is the correct answer because cellulase is used to isolate genetic material from plant cells and chitinase is used to isolate genetic material from fungal cells.

Option (2) is incorrect because protease is used for digestion of proteins.

Option (1) and (4) are incorrect because lipase is used for the breakdown of lipids.

145.   Identify the **correct** sequence of events during Prophase I of meiosis:

(a)   Synapsis of homologous chromosomes

(b)   Chromosomes become gradually visible under microscope

(c)   Crossing over between non-sister chromatids of homologous chromosomes

(d)   Terminalisation of chiasmata

(e)   Dissolution of synaptonemal complex

Choose the **correct answer** from the options given below:

(1)   (a), (c), (d), (e), (b)

(2)   (a), (b), (c), (d), (e)

(3)   (b), (c), (d), (e), (a)

(4)   (b), (a), (c), (e), (d)

Answer (4)

Sol. Correct sequence of events during Prophase I of meiosis is : (b) $\rightarrow$ (a) $\rightarrow$ (c) $\rightarrow$ (e) $\rightarrow$ (d)

(b)   Chromosomes become gradually visible under microscope.

(a)   Synapsis of homologues chromosomes.

(c)   Crossing over between non-sister chromatids of homologous chromosomes.

(e)   Dissolution of synaptonemal complex.

(d)   Terminalisation of chiasmata.

146. Which of the following pair represents free living nitrogen fixing aerobic bacteria?

    (1) *Pseudomonas* and *Thiobacillus*

    (2) *Rhizobium* and *Frankia*

    (3) *Azotobacter* and *Beijernickia*

    (4) *Anabaena* and *Rhodospirillum*

    Answer (3)

    Sol. The free living nitrogen fixing aerobic microbes are *Azotobacter* and *Beijernickia*

    Rhizobium and *Frankia* are symbiotic nitrogen fixers.

    Rhodospirillum is anaerobic nitrogen fixer.

    Pseudomonas and *Thiobacillus* are denitrifying bacteria.

147. Frugivorous birds are found in large numbers in tropical forests mainly because of :

    (1) Temperature conducive for their breeding

    (2) Lack of niche specialisation

    (3) Higher annual rainfall

    (4) Availability of fruits throughout the year

    Answer (4)

    Sol. Frugivorous birds are fruit eating birds found in large number in tropical forest mainly because of availability of fruits throughout the year.

148. Identify the **correct** statements regarding chemiosmotic hypothesis:

    (a) Splitting of the water molecule takes place on the inner side of the membrane.

    (b) Protons accumulate within the lumen of the thylakoids.

    (c) Primary acceptor of electron transfers the electrons to an electron carrier.

    (d) NADP reductase enzyme is located on the stroma side of the membrane.

    (e) Protons increase in number in stroma.

    Choose the **correct answer** from the options given below:

    (1) (b), (c) and (e)

    (2) (a), (b) and (e)

    (3) (a), (b) and (d)

    (4) (b), (c) and (d)

    Answer (3)

    Sol.

    • Primary acceptor of electron transfers its electron not to an electron carrier but to an H carrier.

    • Protons increase in number in lumen of the thylakoid not in stroma.

149. Match **List-I** with **List-II**:

	List-I		List-II
(a)	Gene gun	(i)	Replacement of a faulty gene by a normal healthy gene
(b)	Gene therapy	(ii)	Used for transfer of gene
(c)	Gene cloning	(iii)	Total DNA in the cells of an organism
(d)	Genome	(iv)	To obtain identical copies of a particular DNA molecule

Choose the correct answer from the options given below:

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

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

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

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

Answer (2)

Sol. Option (2) is the correct answer because

• Gene gun or biolistics is a direct gene transfer method suitable for plant cell.

• Gene therapy involves replacement of a faulty gene by a normal healthy gene.

• Gene cloning is done to make identical copies of a particular DNA molecule.

• Genome is the total DNA in the cells of an organism.

150. Which of the following can be expected if scientists succeed in introducing apomictic gene into hybrid varieties of crops?

(1) There will be segregation of the desired characters only in the progeny

(2) Polyembryony will be seen and each seed will produce many plantlets

(3) Seeds of hybrid plants will show longer dormancy

(4) Farmers can keep on using the seeds produced by the hybrids to raise new crop year after year

Answer (4)

Sol. If hybrid seeds are made into apomicts, there is no segregation of characters in the hybrid progeny

Then the farmers can keep on using the hybrid seeds to raise new crop year after year and he does not have to buy hybrid seeds every year.

ZOOLOGY

SECTION-A

151. Which of the following animals has three chambered heart?
     (1) *Pteropus*
     (2) *Scoliodon*
     (3) *Hippocampus*
     (4) *Chelone*

     Answer (4)

     Sol. Option (4) is the correct answer because *Chelone* (turtle) is a reptile and the heart of reptiles are usually three-chambered except crododiles.

     Option (1) is incorrect as *Pteropus* (flying fox) possess four -chambered heart.

     Option (2) and (3) are incorrect as *Scoliodon* (dog fish) and *Hippocampus* (sea horse) possess two - chambered heart.

152. Which of the following types of epithelium is present in the bronchioles and Fallopian tubes?
     (1) Stratified squamous epithelium
     (2) Simple squamous epithelium
     (3) Simple columnar epithelium
     (4) Ciliated epithelium

     Answer (4)

     Sol. Option (4) is the correct answer as ciliated epithelium is mainly present in the inner lining of hollow organs like bronchioles and fallopian tubes.

     Option (1) is incorrect as stratified squamous epithelium covers moist surfaces such as those of buccal cavity, pharynx and oesophagus.

     Option (2) is incorrect as simple squamous epithelium is found in the walls of blood vessels and air sacs of lungs.

     Option (3) is incorrect as simple columnar epithelium is found in the lining of stomach and intestine.

153. Which of the following is **not** an Intra Uterine Device?
     (1) Progestasert
     (2) Progestogens
     (3) Multiload 375
     (4) Lippes loop

     Answer (2)

     Sol. Option (2) is the correct answer as progestogens are the synthetic forms of progesterone.

     Option (1) is not the answer as progestasert is an hormone releasing IUD.

     Option (3) is not the answer as Multiload-375 is a copper releasing IUD.

     Option (4) is not the answer as Lippes loop is an inert IUD.

154. Match **List-I** with **List-II**

List-I		List-II	
(a)	*Chlamydomonas*	(i)	Conidia
(b)	*Penicillium*	(ii)	Zoospores
(c)	*Hydra*	(iii)	Gemmules
(d)	Sponge	(iv)	Buds

     Choose the **correct answer** from the options given below
     (1) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)
     (2) (a) - (i), (b) - (iv), (c) - (iii), (d) - (ii)
     (3) (a) - (ii), (b) - (i), (c) - (iv), (d) - (iii)
     (4) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)

     Answer (3)

Sol. ● *Penicillium* asexually reproduces by conidia formation

● *Chlamydomonas* asexually reproduces by zoospores

Hydra reproduces by budding whereas sponges produce gemmules for asexual reproduction

155. Which of the following reasons is mainly responsible for graft rejection in transplantation of organs?

(1) Cell-mediated response

(2) Inability of recipient to differentiate between 'self' and 'non-self' tissues/cells

(3) Humoral immune response only

(4) Auto-immune response

Answer (1)

Sol. Option (1) is the correct answer as the body is able to differentiate between 'self' and 'non-self' and the cell-mediated immune response is responsible for the graft rejection.

Option (2) is incorrect as body of higher vertebrates have the ability to differentiate foreign organisms from self cells.

Option (4) is incorrect as the autoimmune response occur when the body's immune system fails to recognize 'self' from 'non-self' and starts destroying the body's own cells.

156. Bivalent or Tetrad formation is a characteristic feature observed during

(1) Chiasmata in zygotene stage

(2) Synaptonemal complex in zygotene stage

(3) Chiasmata in Diplotene stage

(4) Synaptonemal complex in Pachytene stage

Answer (2)

Sol. Bivalent or tetrad formation is called synapsis which is accompanied by the formation of complex structure called synaptonemal complex.

157. Give below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): FSH which interacts with membrane bound receptors does not enter the target cell.

Reason (R): Binding of FSH to its receptors generates second messenger (cyclic AMP) for its biochemical and physiological responses.

In the light of the above statements, choose the most appropriate answer from the options given below

(1) **(A)** is not correct but **(R)** is correct

(2) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

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

(4) **(A)** is correct but **(R)** is not correct

Answer (3)

Sol. Option (3) is the correct answer as FSH is a peptide hormone, which is a lipid insoluble hormone. Lipid insoluble hormones cannot directly pass through the membranes and usually require intracellular (membrane bound) receptors for carrying out their activity.

Binding of hormones to membrane bound receptors generate second messenger for its biochemical and physiological responses.

158. Choose the correct statement about a muscular tissue

(1) Smooth muscles are multinucleated and involuntary.

(2) Skeletal muscle fibres are uninucleated and found in parallel bundles.

(3) Intercalated discs allow the cardiac muscle cells to contract as a unit.

(4) The walls of blood vessels are made up of columnar epithelium.

Answer (3)

Sol. Option (3) is the correct answer as cardiac muscle fibres possess communication junctions (intercalated discs) at some fusion points that allow the cells to contract as unit, *i.e.*, when one cell receives a signal to contract, its neighbours are also stimulated to contract.

Option (1) is incorrect as smooth muscle fibres are uninucleated.

Option (2) is incorrect as skeletal muscle fibres are multinucleated.

Option (4) is incorrect as the wall of blood vessels are made up of simple squamous epithelium.

159. Identify the region of human brain which has pneumotaxic centre that alters respiratory rate by reducing the duration of inspiration.

   (1) Cerebrum   (2) Medulla

   (3) Pons   (4) Thalamus

   Answer (3)

   Sol. Option (3) is the correct answer as pneumotaxic centre is present in the pons region of the brain, that can moderate the functions of the respiratory rhythm centre.

   Option (2) is incorrect as medulla oblongata possesses respiratory rhythm centre and a chemosensitive area.

   Option (1) and (4) are incorrect as cerebrum and thalamus does not possess any specialised centre to moderate the respiratory rhythm to suit the demands of the body tissues.

160. The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis is called

   (1) Net primary production   (2) Secondary production
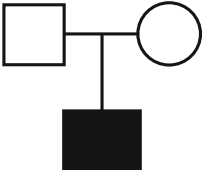
   (3) Primary production   (4) Gross primary production

   Answer (4)
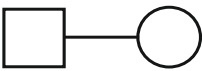
   Sol. The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis is called gross primary productivity.

161. Select the **incorrect** match regarding the symbols used in Pedigree analysis:
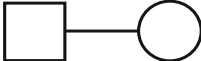
   (1)   –   Parent with male child affected with disease

   (2)   –   Sex unspecified

   (3)   –   Affected individual

   (4)   –   Consanguineous mating

   Answer (4)

   Sol. Symbol,   in pedigree shows mating between male and female.

   Symbol   shows consanguineous mating.

162. If the pH in lysosomes is increased to alkaline, what will be the outcome?

(1) Lysosomal enzymes will be more active

(2) Hydrolytic enzymes will function more efficiently

(3) Hydrolytic enzymes will become inactive

(4) Lysosomal enzymes will be released into the cytoplasm

Answer (3)

Sol. Lysosomes contain hydrolytic enzymes which become active at acidic pH.

If pH in lysosomes is increased to alkaline or basic then hydrolytic enzymes will become inactive.

163. According to the sliding filament theory:

(1) The actin filaments slide away from A-band resulting in shortening of sarcomere.

(2) Actin and myosin filaments slide over each other to increase the length of the sarcomere.

(3) Length of A-band does not change

(4) I-band increases in length.

Answer (3)

Sol. Option (3) is the correct answer because length of A band remains unchanged during muscle contraction.

Option (1) is incorrect because actin filaments slide towards A-band.

Option (2) is incorrect because length of sarcomere decreases during muscle contraction.

Option (4) is incorrect because length of I-band decreases during muscle contraction.

164. Pathogenic bacteria gain resistance to antibiotics due to changes in their:

(1) Nucleoid

(2) Cosmids

(3) Plasmids

(4) Nucleus

Answer (3)

Sol. Plasmid is small circular DNA outside the genomic DNA. The plasmid DNA confers certain unique phenotypic characters to the bacteria such as resistance to antibiotics.

165. Panspermia, an idea that is still a favourite for some astronomers, means:

(1) Transfer of spores as unit of life from other planets to Earth

(2) Creation of life from dead and decaying matter

(3) Creation of life from chemicals

(4) Origin of sperm in human testes

Answer (1)

Sol. Option (1) is the correct answer because some scientists believe that life came from outside. Early Greek thinkers thought units of life called spores were transferred to different planets including earth. This transfer of spores was termed Panspermia.

Option (2) is not the correct answer because theory of spontaneous generation gave the idea for creation of life from dead and decaying matter.

Option (3) is not the correct answer because creation of life from chemicals was the basis for chemical evolution.

Option (4) is not the correct answer as formation of sperm in testes is known as spermatogenesis.

166. Why CNG is considered better fuel than diesel?

    (a) It can not be adulterated.

    (b) It takes less time to fill the fuel tank

    (c) It burns more efficiently.

    (d) It is cheaper.

    (e) It is less inflammable.

    Choose the **most appropriate** answer from the options given below :

    (1) (c), (d), (e) only   (2) (a), (b), (c), (e) only

    (3) (a), (c), (d) only   (4) (a), (b), (d), (e) only

    Answer (3)

    Sol. CNG is better fuel than diesel and petrol because

       (1) It burns more efficiently than diesel or petrol

       (2) It is cheaper

       (3) It can not be adulterated

167. Which of the following statements are correct with respect to vital capacity?

    (a) It includes ERV, TV and IRV

    (b) Total volume of air a person can inspire after a normal expiration.

    (c) The maximum volume of air a person can breathe in after forced expiration.

    (d) It includes ERV, RV and IRV.

    (e) The maximum volume of air a person can breath out after a forced inspiration.

    Choose the **most appropriate** answer from the options given below :

    (1) (a) and (e)   (2) (b), (d) and (e)

    (3) (a), (c) and (d)   (4) (a), (c) and (e)

    Answer (4)

    Sol. Option (4) is the correct answer because statements (a), (c) and (e) are correct.

    Vital capacity includes ERV, TV and IRV.

    Vital capacity is the maximum volume of air a person can breathe in after a forced expiration or the maximum volume of air a person can breathe out after a forced inspiration.

    Statement (b) is incorrect as total volume of air a person can inspire after a normal expiration is termed as inspiratory capacity (IC).

    Statement (d) is incorrect as ERV, RV, IRV and TV comprise total lung capacity.

168. How many secondary spermatocytes are required to form 400 million spermatozoa?

    (1) 400 million   (2) 50 million

    (3) 100 million   (4) 200 million

    Answer (4)

    Sol. Option (4) is the correct answer because one primary spermatocyte produces two secondary spermatocytes by meiosis I and one secondary spermatocyte produces two spermatozoa via meiosis 2. So, 200 million secondary spermatocytes will produce 400 million spermatozoa.

169. Mad cow disease in cattle and Cr Jacob disease in humans are due to infection by _____.

    (1) Prion   (2) Bacterium

    (3) Virus   (4) Viroid

    Answer (1)

    Sol. Prions are abnormally folded proteins. They cause mad cow disease in cattle and Cr Jacob disease in humans.

170. Arrange the components of mammary gland. (from proximal to distal).

    (a) Mammary duct   (b) Lactiferous duct

    (c) Alveoli   (d) Mammary ampulla

    (e) Mammary tubules

    Choose the **most appropriate** answer from the options given below :

    (1) (e) → (c) → (d) → (b) → (a)   (2) (c) → (a) → (d) → (e) → (b)

    (3) (b) → (c) → (e) → (d) → (a)   (4) (c) → (e) → (a) → (d) → (b)

    Answer (4)

    Sol. Option (4) is the correct answer because the components of mammary gland (from proximal to distal) is:

    (c) ⟶ (e) ⟶ (a) ⟶ (d) ⟶ (b)
    Alveoli → Mammary → Mammary → Mammary → Lactiferous
              tubules   duct   ampulla   duct

    Each mammary lobule is composed of a number of alveoli which open into mammary tubules. The tubules of each lobule join to form a mammary duct. Near the nipple, mammary ducts expand to form mammary ampullae where some milk is stored before going to lactiferous duct which is present at distal end through which milk is sucked out.

171. Western Ghats have a large number of plants and animal species that are not found anywhere else. Which of the following term is used to notify such species?

    (1) Vulnerable species   (2) Threatened species

    (3) Keystone species   (4) Endemic species

    Answer (4)

    Sol. Endemic species are those species which are confined to a particular area, such as, species found in Western Ghats are not found anywhere else.

172. Match **List-I** with **List-II** regarding the organs of Cockroach:

List-I	List-II
(a) Crop	(i) Grinding the food particles
(b) Proventriculus	(ii) Secretion of digestive juice
(c) Hepatic caecae	(iii) Removal of nitrogenous waste
(d) Malpighian tubules	(iv) Storage of food

    Choose the **correct answer** from the options given below :

    (1) (a) - (i), (b) - (iv), (c) - (iii), (d) - (ii)   (2) (a) - (iv), (b) - (i), (c) - (ii), (d) - (iii)

    (3) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)   (4) (a) - (ii), (b) - (iv), (c) - (i), (d) - (iii)

    Answer (2)

    Sol. Option (2) is the correct answer because

    (a) Crop – Responsible for storage of food

    (b) Proventriculus – Grinding the food particles

    (c) Hepatic caecae – Secretion of digestive juice

    (d) Malpighian tubules – Removal of nitrogenous waste

173. Two butterfly species are competing for the same nectar of a flower in a garden. To survive and coexist together, they may avoid competition in the same garden by :

    (1) Predating on each other
    (2) Feeding at the same time
    (3) Choosing different foraging patterns
    (4) Increasing time spent on attacking each other

    Answer (3)

    Sol. Two individuals that are competing for same resource can avoid competition by choosing different times for feeding or different foraging patterns.

174. Role of enamel is to

    (1) Give basic shape to the teeth
    (2) Connect crown of tooth with its root
    (3) Masticate the food
    (4) Form bolus

    Answer (3)

    Sol. Option (3) is the correct answer because enamel is the hardest substance of the body which covers the exposed part of tooth called crown and helps in mastication of food.

    Option (1) is incorrect because basic shape of teeth is provided by dentine which is present in crown, root and neck.

    Option (2) is incorrect because neck of tooth connects crown with root.

    Option (4) is incorrect because bolus is masticated food mixed with saliva which is ready for swallowing.

175. Choose the **incorrect** enzymatic rection:

    (1) $\text{Dipeptides} \xrightarrow{\text{Dipeptidases}} \text{Amino acids}$

    (2) $\text{Maltose} \xrightarrow{\text{Maltase}} \text{Glucose + Fructose}$

    (3) $\text{Sucrose} \xrightarrow{\text{Sucrase}} \text{Glucose + Fructose}$

    (4) $\text{Lactose} \xrightarrow{\text{Lactase}} \text{Glucose + Galactose}$

    Answer (2)

    Sol. Option (2) is the correct answer because maltose is a disaccharide which on hydrolysis gives two molecules of glucose.

    $\text{Maltose} \xrightarrow{\text{Maltase}} \text{Glucose + Glucose}$
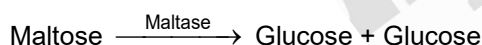
    Options (1), (3) and (4) represent correct enzymatic reactions so they are not the answer.

176. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

    Assertion (A): During pregnancy the level of thyroxine is increased in the maternal blood.

    Reason (R): Pregnancy is characterised by metabolic changes in the mother.

    In the light of the above statements, choose the most appropriate answer from the options given below:

    (1) **(A)** is not correct but **(R)** is correct
    (2) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**
    (3) Both **(A)** and **(R)** are correct but **(R)** is not the correct explanation of **(A)**
    (4) **(A)** is correct but **(R)** is not correct

    Answer (2)

    Sol. Option (2) is the correct answer because thyroxine is the main hormone that increases the basal metabolic rate in our body. A high metabolic rate is required during pregnancy, so levels of thyroxine increase in pregnant females along with other hormones such as cortisol, progesterone, *etc.*

177. Choose the **correct** statements:

(a) Bones support and protect softer tissues and organs

(b) Weight bearing function is served by limb bones

(c) Ligament is the site of production of blood cells.

(d) Adipose tissue is specialised to store fats.

(e) Tendons attach one bone to another.

Choose the most appropriate answer from the options given below:

(1) (a), (b) and (e) only

(2) (a), (b) and (d) only

(3) (b), (c) and (e) only

(4) (a), (c) and (d) only

Answer (2)

Sol. Option (2) is the correct answer because statements (a), (b) and (d) are correct.

- Bones are the hardest tissue of our body that support and protect softer tissues and organs.

- Limb bones serve weight bearing function.

- Adipose tissue is a type of loose connective tissue specialised to store fats.

- Option (1) is incorrect because statement (e) is false as tendons attach bones to muscles.

- Option (3) is incorrect because statement (c) is false as bone marrow in some bones is the site of production of blood cells.

- Option (4) is incorrect because this option includes statement (c) which is false.

178. If DNA contained sulfur instead of phosphorus and proteins contained phosphorus instead of sulfur, what would have been the outcome of Hershey and Chase experiment?

(1) Radioactive phosphorus in bacterial cells

(2) No radioactive sulfur in bacterial cells

(3) Both radioactive sulfur and phosphorus in bacterial cells

(4) Radioactive sulfur in bacterial cells

Answer (4)

Sol. In Hershey-chase experiment when radioactive sulphur was in protein capsule and radioactive phosphorus was in DNA then, no sulphur radioactivity detected in the cells as protein coat remains outside the bacterial cell after infection.

In the given question, sulphur is shown in the DNA and phosphorus in the protein coat. Hence radioactive sulphur will be seen in bacterial cells.

179. Select the **incorrect** statements with respect to Cyclostomes:

(a) They lack scales and paired fins.

(b) They have circular mouth with jaws.

(c) They bear 6-15 pairs of gills.

(d) They migrate to deep sea for spawning.

Choose the most appropriate answer from the options given below:

(1) (a) and (d) only

(2) (a) and (b) only

(3) (b) and (c) only

(4) (b) and (d) only

Answer (4)

Sol. Option (4) is the correct answer because statement (b) is false as cyclostomes have a circular mouth without jaws and statement (d) is false as they migrate from marine water to fresh water for spawning.

Statements (a) and (c) are correct for cyclostomes as they have 6-15 pairs of gills and body is divoid of scales and paired fins.

180. A unique vascular connection between the digestive tract and liver is called_____.

(1) Hepato-cystic system

(2) Hepato-pancreatic system

(3) Hepatic portal system

(4) Renal portal system

Answer (3)

Sol. Option (3) is the correct answer because hepatic portal system is a unique vascular connection between digestive tract and liver.

Option (1) is not correct because hepato-cystic system is part of biliary pathway where common hepatic duct joins cystic duct of gall bladder.

Option (2) is incorrect because hepato-pancreatic system is a part of biliary pathway where common bile duct fuses with pancreatic duct.

Option (4) is incorrect because renal portal system is a unique vascular connection between lower parts of the body and kidney.

181. Milk of transgenic 'Cow Rosie' was nutritionally more balanced product for human babies than natural cow milk because it contained:

(1) Human enzyme Adenosine Deaminase (ADA)

(2) Human protein α-1-antitrypsin

(3) Human alpha-lactalbumin

(4) Human insulin-like growth factor

Answer (3)

Sol. Option (3) is the correct answer because the first transgenic cow Rosie produced human protein-enriched milk. The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow milk.

Option (1) is not the correct answer because ADA deficiency in humans can be cured by gene therapy.

Option (2) is not the correct answer because transgenic sheep produced human α-1-antitrypsin that is used to treat emphysema.

Option (4) is not the correct answer because insulin-like growth factor was not present in Rosie's milk.

182. Gout is a type of disorder which leads to:

(1) Weakening of bones due to low calcium level

(2) Inflammation of joints due to accumulation of uric acid crystals

(3) Weakening of bones due to decreased bone mass

(4) Inflammation of joints due to cartilage degeneration

Answer (2)

Sol. Option (2) is the correct answer as inflammation of joints due to accumulation of uric acid crystals is known as gout.

Options (1) and (3) are incorrect because weakening of bones due to decreased bones mass, calcium deficiency, decreased levels of estrogen, *etc.*, is termed as osteoporosis.

Option (4) is incorrect because inflammation of joints due to cartilage degeneration is known as osteoarthritis.

183. Which of the following methods is not commonly used for introducing foreign DNA into the plant cell?

(1) Bacteriophages

(2) Agrobacterium mediated transformation

(3) Gene gun

(4) 'Disarmed pathogen' vectors

Answer (1)

Sol. Option (1) is the correct answer because bacteriophages act as a cloning vector for bacterial cells, not the plant cells.

Options (2), (3) and (4) are not the correct answers because *Agrobacterium*, gene gun and disarmed pathogens as vectors are used for introducing foreign DNA into the plant cells.

184. Given below are two statements:

Statement I : Amino acids have a property of ionizable nature of $-NH_2$ and $-COOH$ groups, hence have different structures at different pH.

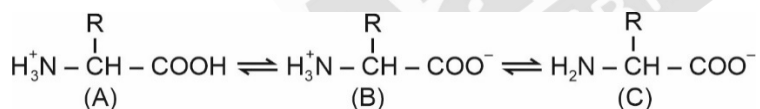**Statement-II** : Amino acids can exist as Zwitterionic form at acidic and basic pH.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) **Statement I** is incorrect but **Statement II** is correct

(2) Both **Statement I** and **Statement II** are correct

(3) Both **Statement I** and **Statement II** are incorrect

(4) **Statement I** is correct but **Statement II** is incorrect

Answer (4)

Sol. Option (4) is the correct answer as statement I is correct but statement II is incorrect.

A particular property of amino acids is the ionizable nature of $-NH_2$ and $-COOH$ groups. Hence, in solutions of different pH, the structure of amino acid changes. Amino acid exists as a dipolar ion called a zwitterion at a particular pH called isoelectric point.

$$H_3^+N - \underset{\underset{(A)}{|}}{\overset{\overset{R}{|}}{CH}} - COOH \rightleftharpoons H_3^+N - \underset{\underset{(B)}{|}}{\overset{\overset{R}{|}}{CH}} - COO^- \rightleftharpoons H_2N - \underset{\underset{(C)}{|}}{\overset{\overset{R}{|}}{CH}} - COO^-$$

(B) is called zwitterionic form.

185. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : *Spirulina* is a microbe that can be used for reducing environmental pollution.

Reason (R) : *Spirulina* is a rich source of protein, carbohydrates, fats, minerals and vitamins.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) **(A)** is not correct but **(R)** is correct

(2) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

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

(4) **(A)** is correct but **(R)** is not correct

Answer (3)

Sol. *Spirulina* can be grown easily on materials like waste water from potato processing plants, so it can reduce environmental pollution. It can serve as food rich in protein, minerals, fats, carbohydrates and vitamins.

Hence, option (3) is correct as both (A) & (R) are correct but (R) is not correct explanation of (A).

SECTION-B

186. With respect to metaphase, which of the following statements is incorrect?
(1) Chromosomes lie at the equator of the cell
(2) Complete disintegration of nuclear envelope takes place
(3) Chromosomes are highly condensed
(4) Metaphase chromosomes are made up of four sister chromatids held together by centromere

Answer (4)

Sol. During metaphase, each chromosome has two chromatids which are held together by a centromere.

A chromosome never has four chromatids during any stage of cell cycle.

187. Against the codon 5' UAC 3', what would be the sequence of anticodon on tRNA?
(1) 5' GUA 3'
(2) 5' AUG 3'
(3) 5' ATG 3'
(4) 5' GTA 3'

Answer (1)

Sol. The codons on mRNA are complimentary to anticodons of tRNA.

Against the codon 5'-UAC-3', the anticodon will be 3'-AUG-5'.

So, the correct option is 1.

188. Arrange the following formed elements in the decreasing order of their abundance in blood in humans:
(a) Platelets
(b) Neutrophils
(c) Erythrocytes
(d) Eosinophils
(e) Monocytes

Choose the **most appropriate** answer from the options given below:
(1) (a), (c), (b), (d), (e)
(2) (c), (a), (b), (e), (d)
(3) (c), (b), (a), (e), (d)
(4) (d), (e), (b), (a), (c)

Answer (2)

Sol. Option (2) is the correct answer as a healthy adult man has, on an average, 5 millions to 5.5 millions of RBCs (erythrocytes) mm^{-3} of blood.

Blood normally contains 1,50,000 – 3,50,000 platelets mm^{-3}.

Neutrophils form 60-65 percent of the total WBCs, monocytes form 6-8 percent of the total WBCs and eosinophils form 2-3 percent of the total WBCs. The total WBCs are approximately 6000-8000 mm^{-3} of blood.

Thus, the formed elements in the decreasing order of their abundance in blood in humans: -
Erythrocytes – Platelets – Neutrophils – Monocytes – Eosinophils

189. Which of the following are true about the taxonomical aid 'key'?
(a) Keys are based on the similarities and dissimilarities.
(b) Key is analytical in nature.
(c) Keys are based on the contrasting characters in pair called couplet.
(d) Same key can be used for all taxonomic categories.
(e) Each statement in the key is called Lead.

Choose the most appropriate answer from the options given below:
(1) (a), (c), (d) and (e) only
(2) (a), (b) and (c) only
(3) (b), (c), and (d) only
(4) (a), (b), (c) and (e) only

Answer (4)

Sol. Key is taxonomical aid used for identification of plants and animals based on the similarities and dissimilarities. The keys are based on the contrasting characters generally in a pair called couplet. Each statement in the key is called a lead. Separate taxonomic keys are required for each taxonomic category such as family, genus and species for identification purposes. Keys are generally analytical in nature.

190. A normal girl, whose mother is haemophilic marries a male with no ancestral history of haemophilia. What will be the possible phenotypes of the offspring?

(a) Haemophilic son and haemophilic daughter.

(b) Haemophilic son and carrier daughter.

(c) Normal daughter and normal son.

(d) Normal son and haemophilic daughter.

Choose the **most appropriate** answer from the options given below:

(1) (b) and (d) only

(2) (a) and (b) only
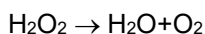
(3) (b) and (c) only

(4) (a) and (d) only

Answer (3)

Sol. Girl's Mother $X^h X^h$
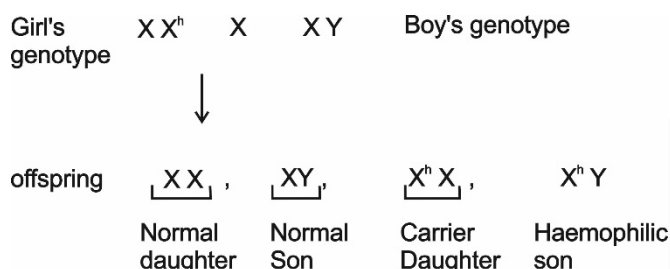
Hence (b) & (c) are correct which makes option (3) as correct option.

191. In the enzyme which catalyses the breakdown of:

$H_2O_2 \rightarrow H_2O + O_2$

the prosthetic group is:

(1) Niacin

(2) Nicotinamide adenine dinucleotide

(3) Haem

(4) Zinc

Answer (3)

Sol. Option (3) is the correct answer because peroxidase is the enzyme that catalyzes the breakdown of hydrogen peroxide to water and oxygen; haem is the prosthetic group of this enzyme.

Option (1) and (2) are incorrect because co-enzyme nicotinamide adenine dinucleotide (NAD) and NADP contain the vitamin niacin.

Option (4) is incorrect because zinc is a co-factor for the proteolytic enzyme carboxypeptidase.

192. Select the **incorrect** statement with respect to inbreeding of animals.

(1) It exposes harmful recessive genes that are eliminated by selection.

(2) It is used for evolving pure lines in cattle.

(3) It helps in accumulation of superior genes and elimination of less desirable genes.

(4) It decreases homozygosity.

Answer (4)

Sol. Option (4) is the correct answer because inbreeding increases homozygosity.

Option (1) is not the correct answer because inbreeding exposes harmful recessive genes that are eliminated by selection.

Option (2) is not the correct answer because inbreeding refers to the mating of more closely related individuals within the same breed for 4-6 generations. This strategy was used for developing pure lines in cattle.

Option (3) is not the correct answer because inbreeding helps in accumulation of superior genes and elimination of less desirable genes.

193. IUDs are small objects made up of plastic or copper that are inserted in the uterine cavity. Which of the following statements are correct about IUDs ?

    (a) IUDs decrease phagocytosis of sperm within the uterus.

    (b) The released copper ions suppress the sperm motility.

    (c) IUDs do not make the cervix hostile to the sperm.

    (d) IUDs suppress the fertilization capacity of sperm.

    (e) The IUDs require surgical intervention for their insertion in the uterine cavity.

    Choose the **most appropriate** answer from the options given below:

    (1) (d) only

    (2) (a), (d) and (e) only

    (3) (b) and (c) only

    (4) (b) and (d) only

    Answer (4)

    Sol. Option (4) is the correct answer as only statements (b) and (d) are correct because the Cu ions which are released suppress the sperm motility and the fertilising capacity of sperms.

    Option (1) is incorrect as statement (b) is also a correct statement.

    Option (2) is incorrect as IUDs increase the phagocytosis of sperms and IUD's insertion does not require surgical intervention.

    Option (3) is incorrect as hormonal IUDs suppress endometrial changes and changes in cervical mucus, thereby making the cervix hostile to the sperms.

194. Select the correct statement regarding mutation theory of evolution.

    (1) Large differences due to mutations arise gradually in a population

    (2) This theory was proposed by Alfred Wallace

    (3) Variations are small directional changes

    (4) Single step large mutation is a cause of speciation

    Answer (4)

    Sol. Correct answer is option no. 4 because

    Hugo de Vries, based on his work on evening primrose brought forth the idea of mutations. He believed that mutation caused speciation and hence called it saltation (Single step large mutation).

    Option (1) is incorrect because mutations are sudden (random) and directionless.

    Option (2) is incorrect because mutation theory was proposed by Hugo deVries.

    Option (3) is incorrect because Darwinian variations are small and directional changes, but they are not related to mutation theory of evolution.

195. Excretion in cockroach is performed by all, EXCEPT:

    (1) Hepatic caeca

    (2) Urecose glands

    (3) Malpighian tubules

    (4) Fat body

    Answer (1)

    Sol. Option (1) is correct answer because hepatic caeca are responsible for secretion of digestive juices in cockroach and it does not participate in excretion. Urecose glands in male cockroach, Malpighian tubules and fat bodies in both male and female cockroach are considered as excretory structures.

196. Select the **correct** statements.

(a) Angiotensin II activates the cortex of adrenal gland to release aldosterone.

(b) Aldosterone leads to increase in blood pressure.

(c) ANF acts as a check on renin-angiotensin mechanism.

(d) ADH causes vasodilation.

(e) Vasopressin is released from adenohypophysis.

Choose the **most appropriate** answer from the options given below :

(1) (a), (b) and (c) only   (2) (a), (b) and (e) only

(3) (c), (d) and (e) only   (4) (b), (c) and (d) only

Answer (1)

Sol. Option (1) is the correct answer because statements (a), (b) and (c) are correct.

Angiotensin II activates the adrenal cortex of adrenal gland to release aldosterone. Aldosterone increases blood volume and thus blood pressure by increasing reabsorption of water and electrolytes from distal parts of nephron. ANF causes vasodilation and decreases blood pressure and thus GFR.

Statements (d) and (e) are incorrect as ADH/vasopressin is a potent vasoconstrictor which is released from neurohypophysis.

197. If A and C make 30% and 20% of DNA, respectively, what will be the percentage composition of T and G?

(1) T : 20%, G : 20%   (2) T : 20%, G : 30%

(3) T : 30%, G : 20%   (4) T : 30%, G : 30%

Answer (3)

Sol. According to Chargaff's rule, amount of Adenine (A) is equal to thymine and amount of cytosine (c) will be equal to that of Guanine.

So,

A = T = 30% + 30% = 60%

C = G = 20% + 20% = 40%

So, T and G will be 30% and 20% respectively.

198. Refer to the following statements for agarose-gel electrophoresis:

(a) Agarose is a natural polymer obtained from sea-weed.

(b) The separation of DNA molecules in agarose-gel electrophoresis depends on the size of DNA.

(c) The DNA migrates from negatively-charged electrode to the positively-charged electrode

(d) The DNA migrates from positively-charged electrode to the negatively-charged electrode.

Choose the **most appropriate** answer from the options given below :

(1) (b), (c) and (d) only   (2) (a) and (b) only

(3) (a), (b) and (c) only   (4) (a), (b) and (d) only

Answer (3)

Sol. Option (3) is the correct answer as the most commonly used matrix in gel electrophoresis is agarose which is a natural polymer extracted from sea weeds.

In agarose gel electrophoresis, the DNA fragments separate (resolve) according to their size through sieving effect provided by the agarose gel.

Since, DNA fragments are negatively charged molecules, they migrate towards the anode (positively-charged electrode) under an electric field through a medium/martix.

199. Match **List-I** with **List - II** :

	List - I		List - II
(a)	Multipolar neuron	(i)	Somatic neural system
(b)	Bipolar neuron	(ii)	Cerebral cortex
(c)	Myelinated nerve fibre	(iii)	Retina of Eye
(d)	Unmyelinated nerve fibre	(iv)	Spinal nerves

Choose the **correct answer** from the options given below :

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

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

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

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

Answer (1)

Sol. Option (1) is the correct answer because

(a) Multipolar neurons are present in cerebral cortex.

(b) Bipolar neurons are found in the retina of the eye.

(c) Myelinated nerve fibres are found in spinal and cranial nerves

(d) Unmyelinated nerve fibres are commonly found in autonomous and somatic neural systems.

200. Match **List-I** with **List - II** :

	List - I		List - II
(a)	Cellular barrier	(i)	Interferons
(b)	Cytokine barrier	(ii)	Mucus
(c)	Physical barrier	(iii)	Neutrophils
(d)	Physiological barrier	(iv)	HCl in gastric juice

Choose the **correct answer** from the options given below :

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

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

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

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

Answer (1)

Sol. Option (1) is the correct answer because cellular barriers include NK cells, macrophages (monocytes) and neutrophils (PMNL).

Cytokine barriers include interferons.

Physical barriers include mucus membranes and skin.

Physiological barriers include HCl in gastric juice, saliva and tears etc.

❑   ❑   ❑