DATE : 06/05/2018

Test Booklet Code

NN

HLAAC

Aakash
Medical | IIT-JEE | Foundations
(Divisions of Aakash Educational Services Pvt. Ltd.)

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Time : 3 hrs.

Answers & Solutions

Max. Marks : 720

for

NEET (UG) - 2018

Important Instructions :

1. The test is of **3 hours** duration and this Test Booklet contains **180** questions. Each question carries **4** marks. For each correct response, the candidate will get **4** marks. For each incorrect response, **one mark** will be deducted from the total scores. The maximum marks are **720**.
2. Use **Blue / Black Ball point Pen only** for writing particulars on this page/marking responses.
3. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
4. 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.**
5. The CODE for this Booklet is **NN**.
6. 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.
7. Each candidate must show on demand his/her Admission Card to the Invigilator.
8. No candidate, without special permission of the Superintendent or Invigilator, would leave his/her seat.
9. Use of Electronic/Manual Calculator is prohibited.
10. 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.
11. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.
12. The candidates will write the Correct Test Booklet Code as given in the Test Booklet / Answer Sheet in the Attendance Sheet.

1. The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA. This inductor is of inductance

(1) 13.89 H (2) 0.138 H

(3) 1.389 H (4) 138.88 H

Answer (1)

Sol. Energy stored in inductor

$$U = \frac{1}{2}LI^2$$

$$25\times10^{-3} = \frac{1}{2}\times L\times(60\times10^{-3})^2$$

$$L = \frac{25\times2\times10^{6}\times10^{-3}}{3600}$$

$$= \frac{500}{36}$$

$$= 13.89 \text{ H}$$

2. An object is placed at a distance of 40 cm from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, the displacement of the image will be

(1) 36 cm towards the mirror

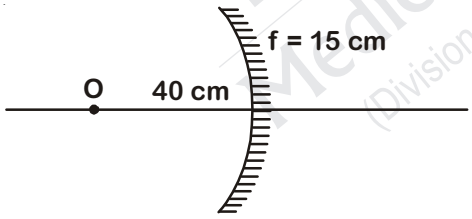
(2) 30 cm away from the mirror

(3) 30 cm towards the mirror

(4) 36 cm away from the mirror

Answer (4)

Sol.



$$\frac{1}{f} = \frac{1}{v_1} + \frac{1}{u}$$

$$-\frac{1}{15} = \frac{1}{v_1} - \frac{1}{40}$$

$$\Rightarrow \frac{1}{v_1} = \frac{1}{-15} + \frac{1}{40}$$

$v_1 = -24$ cm

When object is displaced by 20 cm towards mirror.

Now,

$u_2 = -20$

$$\frac{1}{f} = \frac{1}{v_2} + \frac{1}{u_2}$$

$$\frac{1}{-15} = \frac{1}{v_2} - \frac{1}{20}$$

$$\frac{1}{v_2} = \frac{1}{20} - \frac{1}{15}$$

$v_2 = -60$ cm

So, image shifts away from mirror by = 60 – 24 = 36 cm.

3. An em wave is propagating in a medium with a velocity $\vec{V} = V\hat{i}$. The instantaneous oscillating electric field of this em wave is along +y axis. Then the direction of oscillating magnetic field of the em wave will be along

(1) –x direction

(2) –z direction

(3) –y direction

(4) +z direction

Answer (4)

Sol. $\vec{E}\times\vec{B} = \vec{V}$

$$(E\hat{j})\times(\vec{B}) = V\hat{i}$$

So, $\vec{B} = B\hat{k}$

Direction of propagation is along +z direction.

4. The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30°. One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is

(1) Zero

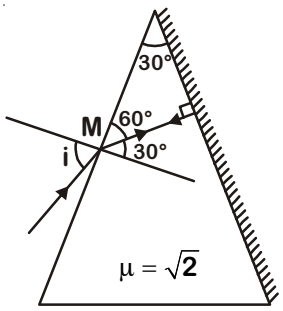
(2) 60°

(3) 30°

(4) 45°

Answer (4)

Sol. For retracing its path, light ray should be normally incident on silvered face.



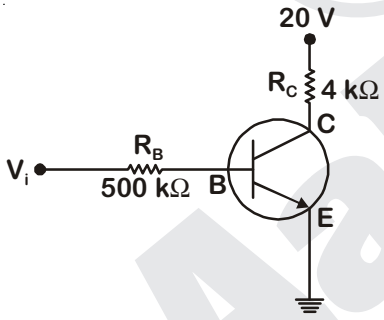
Applying Snell's law at M,

$$\frac{\sin i}{\sin 30^\circ} = \frac{\sqrt{2}}{1}$$

$$\Rightarrow \sin i = \sqrt{2} \times \frac{1}{2}$$

$$\sin i = \frac{1}{\sqrt{2}} \text{ i.e. } i = 45^\circ$$

5. In the circuit shown in the figure, the input voltage V_i is 20 V, V_{BE} = 0 and V_{CE} = 0. The values of I_B, I_C and β are given by



(1) I_B = 40 μA, I_C = 5 mA, β = 125

(2) I_B = 40 μA, I_C = 10 mA, β = 250

(3) I_B = 20 μA, I_C = 5 mA, β = 250

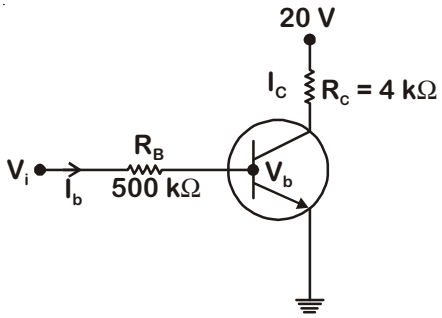
(4) I_B = 25 μA, I_C = 5 mA, β = 200

Answer (1)

Sol. $V_{BE} = 0$

$V_{CE} = 0$

$V_b = 0$



$$I_C = \frac{(20-0)}{4\times10^3}$$

$I_C = 5 \times 10^{-3} = 5$ mA

$V_i = V_{BE} + I_B R_B$

$V_i = 0 + I_B R_B$

$20 = I_B \times 500 \times 10^3$

$$I_B = \frac{20}{500\times10^3} = 40\ \mu A$$

$$\beta = \frac{I_C}{I_b} = \frac{25\times10^{-3}}{40\times10^{-6}} = 125$$

6. In a p-n junction diode, change in temperature due to heating

(1) Affects the overall V - I characteristics of p-n junction

(2) Affects only reverse resistance

(3) Does not affect resistance of p-n junction

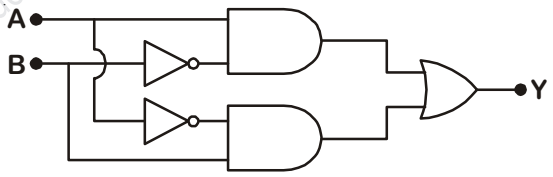
(4) Affects only forward resistance

Answer (1)

Sol. Due to heating, number of electron-hole pairs will increase, so overall resistance of diode will change.

Due to which forward biasing and reversed biasing both are changed.

7. In the combination of the following gates the output Y can be written in terms of inputs A and B as



(1) $\overline{A+B}$

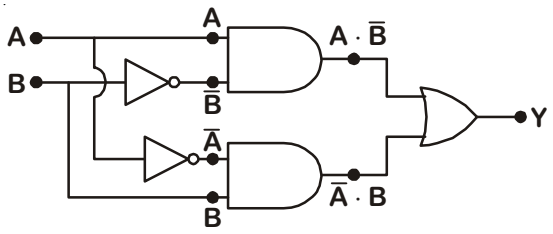
(2) $\overline{A \cdot B}$

(3) $\overline{A \cdot B} + A \cdot B$

(4) $A \cdot \bar{B} + \bar{A} \cdot B$

Answer (4)

Sol.



$Y = (A \cdot \bar{B} + \bar{A} \cdot B)$

8. The power radiated by a black body is P and it radiates maximum energy at wavelength, λ_0. If the temperature of the black body is now changed so that it radiates maximum energy at wavelength $\frac{3}{4}\lambda_0$, the power radiated by it becomes nP. The value of n is

(1) $\frac{81}{256}$ (2) $\frac{3}{4}$

(3) $\frac{256}{81}$ (4) $\frac{4}{3}$

Answer (3)

Sol. We know,

$\lambda_{max}\, T = \text{constant}$ (Wien's law)

So, $\lambda_{max_1}\, T_1 = \lambda_{max_2} T_2$

$\Rightarrow \lambda_0\, T = \frac{3\lambda_0}{4} T'$

$\Rightarrow T' = \frac{4}{3}T$

So, $\frac{P_2}{P_1} = \left(\frac{T'}{T}\right)^4 = \left(\frac{4}{3}\right)^4 = \frac{256}{81}$

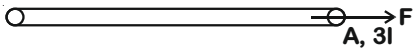
9. Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3A. If the length of the first wire is increased by Δl on applying a force F, how much force is needed to stretch the socond wire by the same amount?

(1) F (2) 9 F

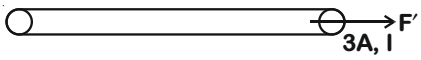
(3) 4 F (4) 6 F

Answer (2)

Sol. Wire 1 :



Wire 2 :



For wire 1,

$\Delta l = \left(\frac{F}{AY}\right) 3l$ ...(i)

For wire 2,

$\frac{F'}{3A} = Y\frac{\Delta l}{l}$

$\Rightarrow \Delta l = \left(\frac{F'}{3AY}\right) l$ ...(ii)

From equation (i) & (ii),

$\Delta l = \left(\frac{F}{AY}\right) 3l = \left(\frac{F'}{3AY}\right) l$

$\Rightarrow \boxed{F' = 9F}$

10. A sample of 0.1 g of water at 100°C and normal pressure (1.013×10^5 Nm^{-2}) requires 54 cal of heat energy to convert to steam at 100°C. If the volume of the steam produced is 167.1 cc, the change in internal energy of the sample, is

(1) 84.5 J (2) 104.3 J

(3) 42.2 J (4) 208.7 J

Answer (4)

Sol. $\Delta Q = \Delta U + \Delta W$

$\Rightarrow 54 \times 4.18 = \Delta U + 1.013 \times 10^5 (167.1 \times 10^{-6} - 0)$

$\Rightarrow \Delta U = 208.7$ J

11. A small sphere of radius 'r' falls from rest in a viscous liquid. As a result, heat is produced due to viscous force. The rate of production of heat when the sphere attains its terminal velocity, is proportional to

(1) r^4 (2) r^3

(3) r^5 (4) r^2

Answer (3)

Sol. Power = $6\pi\eta r V_T \cdot V_T = 6\pi\eta r V_T^2$

$V_T \propto r^2$

$\Rightarrow$ Power $\propto r^5$

12. When the light of frequency $2\nu_0$ (where ν_0 is threshold frequency), is incident on a metal plate, the maximum velocity of electrons emitted is v_1. When the frequency of the incident radiation is increased to $5\nu_0$, the maximum velocity of electrons emitted from the same plate is v_2. The ratio of v_1 to v_2 is

(1) 2 : 1

(2) 1 : 2

(3) 4 : 1

(4) 1 : 4

Answer (2)

Sol. $E = W_0 + \frac{1}{2}mv^2$

$h(2\nu_0) = h\nu_0 + \frac{1}{2}mv_1^2$

$h\nu_0 = \frac{1}{2}mv_1^2$ ...(i)

$h(5\nu_0) = h\nu_0 + \frac{1}{2}mv_2^2$

$4h\nu_0 = \frac{1}{2}mv_2^2$ ...(ii)

Divide (i) by (ii),

$\frac{1}{4} = \frac{v_1^2}{v_2^2}$

$\frac{v_1}{v_2} = \frac{1}{2}$

13. For a radioactive material, half-life is 10 minutes. If initially there are 600 number of nuclei, the time taken (in minutes) for the disintegration of 450 nuclei is

(1) 15 (2) 20

(3) 30 (4) 10

Answer (2)

Sol. Number of nuclei remaining = 600 – 450 = 150

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

$\frac{150}{600} = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$

$\left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$

$t = 2t_{1/2} = 2 \times 10$

$= 20$ minute

14. An electron of mass m with an initial velocity $\vec{V} = V_0\hat{i}$ ($V_0 > 0$) enters an electric field $\vec{E} = -E_0\hat{i}$ (E_0 = constant > 0) at t = 0. If λ_0 is its de-Broglie wavelength initially, then its de-Broglie wavelength at time t is

(1) λ_0

(2) $\frac{\lambda_0}{\left(1+\frac{eE_0}{mV_0}t\right)}$

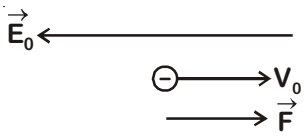
(3) $\lambda_0 t$

(4) $\lambda_0\left(1+\frac{eE_0}{mV_0}t\right)$

Answer (2)

Sol. Initial de-Broglie wavelength

$\lambda_0 = \frac{h}{mV_0}$



Acceleration of electron

$a = \frac{eE_0}{m}$

Velocity after time 't'

$V = \left(V_0 + \frac{eE_0}{m}t\right)$

So, $\lambda = \frac{h}{mV} = \frac{h}{m\left(V_0 + \frac{eE_0}{m}t\right)}$

$= \frac{h}{mV_0\left[1+\frac{eE_0}{mV_0}t\right]}$

$= \frac{\lambda_0}{\left[1+\frac{eE_0}{mV_0}t\right]}$

15. The ratio of kinetic energy to the total energy of an electron in a Bohr orbit of the hydrogen atom, is

(1) 1 : –2 (2) 1 : 1

(3) 2 : –1 (4) 1 : –1

Answer (4)

Sol. KE = –(total energy)

So, Kinetic energy : total energy = 1 : –1

16. A tuning fork is used to produce resonance in a glass tube. The length of the air column in this tube can be adjusted by a variable piston. At room temperature of 27°C two successive resonances are produced at 20 cm and 73 cm of column length. If the frequency of the tuning fork is 320 Hz, the velocity of sound in air at 27°C is

(1) 300 m/s (2) 330 m/s

(3) 350 m/s (4) 339 m/s

Answer (4)

Sol. $v = 2(\nu)[L_2 - L_1]$

$= 2 \times 320\,[73 - 20] \times 10^{-2}$

$= 339.2\ ms^{-1}$

$= 339$ m/s

17. The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is

(1) Inversely proportional to the distance between the plates

(2) Independent of the distance between the plates

(3) Proportional to the square root of the distance between the plates

(4) Linearly proportional to the distance between the plates

Answer (2)

Sol. For isolated capacitor Q = Constant

$$F_{plate} = \frac{Q^2}{2A\varepsilon_0}$$

F is Independent of the distance between plates.

18. A pendulum is hung from the roof of a sufficiently high building and is moving freely to and fro like a simple harmonic oscillator. The acceleration of the bob of the pendulum is 20 m/s^2 at a distance of 5 m from the mean position. The time period of oscillation is

(1) 1 s (2) 2π s

(3) 2 s (4) π s

Answer (4)

Sol. $|a| = \omega^2 y$

$\Rightarrow 20 = \omega^2(5)$

$\Rightarrow \omega = 2$ rad/s

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = \pi \text{ s}$$

19. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is

(1) Equal (2) Smaller

(3) 10 times greater (4) 5 times greater

Answer (2)

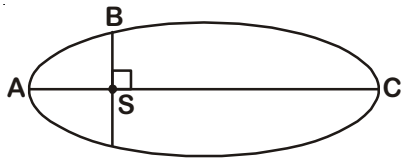
Sol. $h = \frac{1}{2}\frac{eE}{m}t^2$

$\therefore t = \sqrt{\frac{2hm}{eE}}$

$\therefore t \propto \sqrt{m}$ as 'e' is same for electron and proton.

$\because$ Electron has smaller mass so it will take smaller time.

20. The kinetic energies of a planet in an elliptical orbit about the Sun, at positions A, B and C are K_A, K_B and K_C, respectively. AC is the major axis and SB is perpendicular to AC at the position of the Sun S as shown in the figure. Then



(1) $K_B > K_A > K_C$

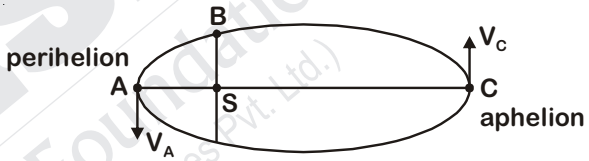
(2) $K_A < K_B < K_C$

(3) $K_B < K_A < K_C$

(4) $K_A > K_B > K_C$

Answer (4)

Sol.



Point A is perihelion and C is aphelion.

So, $V_A > V_B > V_C$

So, $K_A > K_B > K_C$

21. A solid sphere is in rolling motion. In rolling motion a body possesses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simultaneously. The ratio $K_t : (K_t + K_r)$ for the sphere is

(1) 2 : 5 (2) 7 : 10

(3) 10 : 7 (4) 5 : 7

Answer (4)

Sol. $K_t = \frac{1}{2}mv^2$

$$K_t + K_r = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mr^2\right)\left(\frac{v}{r}\right)^2$$

$$= \frac{7}{10}mv^2$$

So, $\boxed{\frac{K_t}{K_t + K_r} = \frac{5}{7}}$

22. If the mass of the Sun were ten times smaller and the universal gravitational constant were ten times larger in magnitude, which of the following is not correct?

(1) 'g' on the Earth will not change

(2) Raindrops will fall faster

(3) Time period of a simple pendulum on the Earth would decrease

(4) Walking on the ground would become more difficult

Answer (1)

Sol. If Universal Gravitational constant becomes ten times, then $G' = 10\ G$

So, acceleration due to gravity increases.

i.e. (1) is wrong option.

23. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere?

(1) Angular momentum

(2) Angular velocity

(3) Rotational kinetic energy

(4) Moment of inertia

Answer (1)

Sol. $\tau_{ex} = 0$

So, $\frac{dL}{dt} = 0$

i.e. L = constant

So angular momentum remains constant.

24. A metallic rod of mass per unit length 0.5 kg m^{-1} is lying horizontally on a smooth inclined plane which makes an angle of 30° with the horizontal. The rod is not allowed to slide down by flowing a current through it when a magnetic field of induction 0.25 T is acting on it in the vertical direction. The current flowing in the rod to keep it stationary is

(1) 11.32 A (2) 7.14 A

(3) 14.76 A (4) 5.98 A

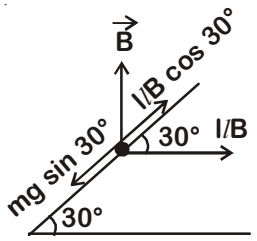
Answer (1)

Sol. For equilibrium,

$$mg\sin 30^\circ = IlB\cos 30^\circ$$

$$I = \frac{mg}{lB}\tan 30^\circ$$

$$= \frac{0.5\times 9.8}{0.25\times\sqrt{3}} = 11.32\ A$$



25. An inductor 20 mH, a capacitor 100 μF and a resistor 50 Ω are connected in series across a source of emf, V = 10 sin 314 t. The power loss in the circuit is

(1) 1.13 W (2) 0.79 W

(3) 2.74 W (4) 0.43 W

Answer (2)

Sol. $P_{av} = \left(\frac{V_{RMS}}{Z}\right)^2 R$

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = 56\ \Omega$$

$$\therefore\quad P_{av} = \left(\frac{10}{(\sqrt{2})56}\right)^2 \times 50 = 0.79\ W$$

26. A thin diamagnetic rod is placed vertically between the poles of an electromagnet. When the current in the electromagnet is switched on, then the diamagnetic rod is pushed up, out of the horizontal magnetic field. Hence the rod gains gravitational potential energy. The work required to do this comes from

(1) The induced electric field due to the changing magnetic field

(2) The current source

(3) The lattice structure of the material of the rod

(4) The magnetic field

Answer (2)

Sol. Energy of current source will be converted into potential energy of the rod.

27. Current sensitivity of a moving coil galvanometer is 5 div/mA and its voltage sensitivity (angular deflection per unit voltage applied) is 20 div/V. The resistance of the galvanometer is

(1) 500 Ω (2) 40 Ω

(3) 250 Ω (4) 25 Ω

Answer (3)

Sol. Current sensitivity

$$I_S = \frac{NBA}{C}$$

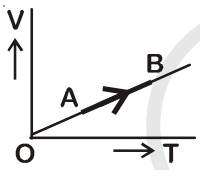
Voltage sensitivity

$$V_S = \frac{NBA}{CR_G}$$

So, resistance of galvanometer

$$R_G = \frac{I_S}{V_S} = \frac{5\times1}{20\times10^{-3}} = \frac{5000}{20} = 250\ \Omega$$

28. The volume (V) of a monatomic gas varies with its temperature (T), as shown in the graph. The ratio of work done by the gas, to the heat absorbed by it, when it undergoes a change from state A to state B, is



(1) $\frac{2}{7}$ (2) $\frac{2}{5}$

(3) $\frac{1}{3}$ (4) $\frac{2}{3}$

Answer (2)

Sol. Given process is isobaric

$$dQ = n\,C_p\,dT$$

$$dQ = n\left(\frac{5}{2}R\right)dT$$

$$dW = P\,dV = n\,RdT$$

Required ratio $= \frac{dW}{dQ} = \frac{nRdT}{n\left(\frac{5}{2}R\right)dT} = \frac{2}{5}$

29. The fundamental frequency in an open organ pipe is equal to the third harmonic of a closed organ pipe. If the length of the closed organ pipe is 20 cm, the length of the open organ pipe is

(1) 16 cm

(2) 13.2 cm

(3) 12.5 cm

(4) 8 cm

Answer (2)

Sol. For closed organ pipe, third harmonic

$$= \frac{3v}{4l}$$

For open organ pipe, fundamental frequency

$$= \frac{v}{2l'}$$

Given,

$$\frac{3v}{4l} = \frac{v}{2l'}$$

$$\Rightarrow\ l' = \frac{4l}{3\times2} = \frac{2l}{3}$$

$$= \frac{2\times20}{3} = 13.33\ \text{cm}$$

30. The efficiency of an ideal heat engine working between the freezing point and boiling point of water, is

(1) 12.5%

(2) 26.8%

(3) 6.25%

(4) 20%

Answer (2)

Sol. Efficiency of ideal heat engine, $\eta = \left(1-\frac{T_2}{T_1}\right)$

T_2 : Sink temperature

T_1 : Source temperature

$$\%\eta = \left(1-\frac{T_2}{T_1}\right)\times100$$

$$= \left(1-\frac{273}{373}\right)\times100$$

$$= \left(\frac{100}{373}\right)\times100 = 26.8\%$$

31. At what temperature will the rms speed of oxygen molecules become just sufficient for escaping from the Earth's atmosphere?

(Given :

Mass of oxygen molecule (m) = 2.76×10^{-26} kg

Boltzmann's constant $k_B = 1.38 \times 10^{-23}\ JK^{-1}$)

(1) 1.254×10^4 K (2) 2.508×10^4 K

(3) 5.016×10^4 K (4) 8.360×10^4 K

Answer (4)

Sol. $V_{escape} = 11200$ m/s

Say at temperature T it attains V_{escape}

$$\text{So, } \sqrt{\frac{3k_BT}{m_{O_2}}} = 11200 \text{ m/s}$$

On solving,

$$T = 8.360 \times 10^4 \text{ K}$$

32. Unpolarised light is incident from air on a plane surface of a material of refractive index 'μ'. At a particular angle of incidence 'i', it is found that the reflected and refracted rays are perpendicular to each other. Which of the following options is correct for this situation?

(1) $i = \tan^{-1}\left(\frac{1}{\mu}\right)$

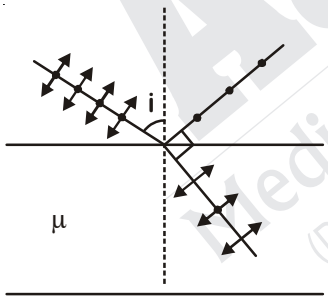
(2) Reflected light is polarised with its electric vector parallel to the plane of incidence

(3) $i = \sin^{-1}\left(\frac{1}{\mu}\right)$

(4) Reflected light is polarised with its electric vector perpendicular to the plane of incidence

Answer (4)

Sol. When reflected light rays and refracted rays are perpendicular, reflected light is polarised with electric field vector perpendicular to the plane of incidence.



Also, tan i = μ (Brewster angle)

33. In Young's double slit experiment the separation d between the slits is 2 mm, the wavelength λ of the light used is 5896 Å and distance D between the screen and slits is 100 cm. It is found that the angular width of the fringes is 0.20°. To increase the fringe angular width to 0.21° (with same λ and D) the separation between the slits needs to be changed to

(1) 1.7 mm (2) 1.8 mm

(3) 2.1 mm (4) 1.9 mm

Answer (4)

Sol. Angular width $= \frac{\lambda}{d}$

$$0.20° = \frac{\lambda}{2 \text{ mm}} \quad \text{...(i)}$$

$$0.21° = \frac{\lambda}{d} \quad \text{...(ii)}$$

Dividing we get, $\frac{0.20}{0.21} = \frac{d}{2 \text{ mm}}$

$\therefore$ d = 1.9 mm

34. An astronomical refracting telescope will have large angular magnification and high angular resolution, when it has an objective lens of

(1) Small focal length and small diameter

(2) Small focal length and large diameter

(3) Large focal length and large diameter

(4) Large focal length and small diameter

Answer (3)

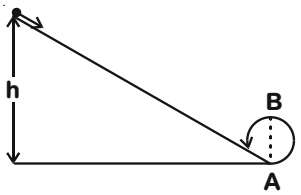
Sol. For telescope, angular magnification = $\frac{f_0}{f_E}$

So, focal length of objective lens should be large.

Angular resolution = $\frac{D}{1.22\lambda}$ should be large.

So, objective should have large focal length (f_0) and large diameter D.

35. A body initially at rest and sliding along a frictionless track from a height h (as shown in the figure) just completes a vertical circle of diameter AB = D. The height h is equal to

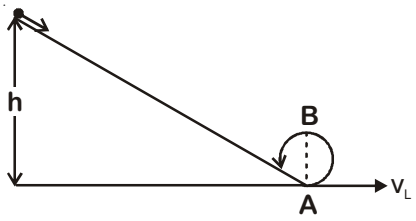


(1) $\frac{5}{4}$D (2) $\frac{3}{2}$D

(3) $\frac{7}{5}$D (4) D

Answer (1)

Sol.



As track is frictionless, so total mechanical energy will remain constant

$T.M.E_I = T.M.E_F$

$$0 + mgh = \frac{1}{2}mv_L^2 + 0$$

$$h = \frac{v_L^2}{2g}$$

For completing the vertical circle, $v_L \geq \sqrt{5gR}$

$$h = \frac{5gR}{2g} = \frac{5}{2}R = \frac{5}{4}D$$

36. Three objects, A : (a solid sphere), B : (a thin circular disk) and C : (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation

(1) $W_A > W_C > W_B$

(2) $W_C > W_B > W_A$

(3) $W_B > W_A > W_C$

(4) $W_A > W_B > W_C$

Answer (2)

Sol. Work done required to bring them rest

$\Delta W = \Delta KE$

$$\Delta W = \frac{1}{2}I\omega^2$$

$\Delta W \propto I$ for same ω

$$W_A : W_B : W_C = \frac{2}{5}MR^2 : \frac{1}{2}MR^2 : MR^2$$

$$= \frac{2}{5} : \frac{1}{2} : 1$$

$$= 4 : 5 : 10$$

$\Rightarrow W_C > W_B > W_A$

37. Which one of the following statements is incorrect?

(1) Coefficient of sliding friction has dimensions of length.

(2) Rolling friction is smaller than sliding friction.

(3) Frictional force opposes the relative motion.

(4) Limiting value of static friction is directly proportional to normal reaction.

Answer (1)

Sol. Coefficient of sliding friction has no dimension.

$f = \mu_s N$

$$\Rightarrow \mu_s = \frac{f}{N}$$

38. A moving block having mass m, collides with another stationary block having mass 4m. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v, then the value of coefficient of restitution (e) will be

(1) 0.4 (2) 0.5

(3) 0.8 (4) 0.25

Answer (4)

Sol. According to law of conservation of linear momentum,

$$mv + 4m \times 0 = 4mv' + 0$$

$$v' = \frac{v}{4}$$

$$e = \frac{\text{Relative velocity of separation}}{\text{Relative velocity of approach}} = \frac{\frac{v}{4}}{v}$$

$$e = \frac{1}{4} = 0.25$$

39. A carbon resistor of (47 ± 4.7) kΩ is to be marked with rings of different colours for its identification. The colour code sequence will be

(1) Green – Orange – Violet – Gold

(2) Violet – Yellow – Orange – Silver

(3) Yellow – Green – Violet – Gold

(4) Yellow – Violet – Orange – Silver

Answer (4)

Sol. $(47 \pm 4.7)\ k\Omega = 47 \times 10^3 \pm 10\%$

$\therefore$ Yellow – Violet – Orange – Silver

40. A set of 'n' equal resistors, of value 'R' each, are connected in series to a battery of emf 'E' and internal resistance 'R'. The current drawn is I. Now, the 'n' resistors are connected in parallel to the same battery. Then the current drawn from battery becomes 10 I. The value of 'n' is

(1) 9 (2) 10

(3) 20 (4) 11

Answer (2)

Sol. $I = \frac{E}{nR + R}$ ...(i)

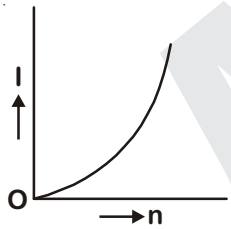
$10I = \frac{E}{\frac{R}{n} + R}$ ...(ii)

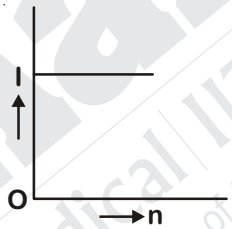
Dividing (ii) by (i),

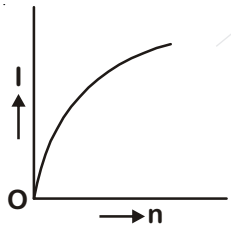
$$10 = \frac{(n+1)R}{\left(\frac{1}{n}+1\right)R}$$

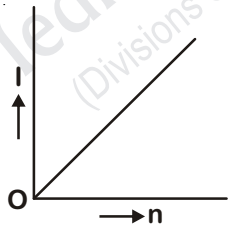
After solving the equation, n = 10

41. A battery consists of a variable number 'n' of identical cells (having internal resistance 'r' each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and n?

(1) 

(2) 

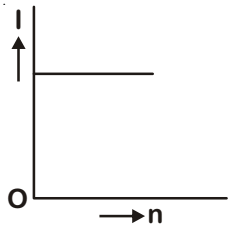
(3) 

(4) 

Answer (2)

Sol. $I = \frac{n\varepsilon}{nr} = \frac{\varepsilon}{r}$

So, I is independent of n and I is constant.

$\therefore$ 

42. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively

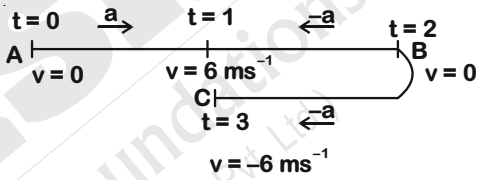
(1) 1.5 m/s, 3 m/s

(2) 2 m/s, 4 m/s

(3) 1 m/s, 3.5 m/s

(4) 1 m/s, 3 m/s

Answer (4)

Sol. 

Acceleration $a = \frac{6-0}{1} = 6\ ms^{-2}$

For t = 0 to t = 1 s,

$S_1 = \frac{1}{2} \times 6(1)^2 = 3\ m$ ...(i)

For t = 1 s to t = 2 s,

$S_2 = 6.1 - \frac{1}{2} \times 6(1)^2 = 3\ m$ ...(ii)

For t = 2 s to t = 3 s,

$S_3 = 0 - \frac{1}{2} \times 6(1)^2 = -3\ m$ ...(iii)

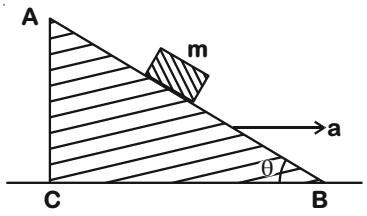
Total displacement $S = S_1 + S_2 + S_3 = 3\ m$

Average velocity $= \frac{3}{3} = 1\ ms^{-1}$

Total distance travelled = 9 m

Average speed $= \frac{9}{3} = 3\ ms^{-1}$

43. A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure. The wedge is given an acceleration 'a' towards the right. The relation between a and θ for the block to remain stationary on the wedge is



(1) $a = g \tan\theta$

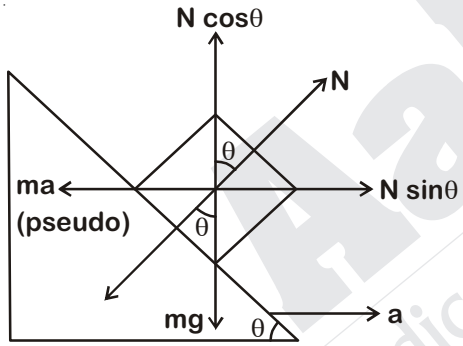
(2) $a = \frac{g}{\text{cosec}\,\theta}$

(3) $a = g\cos\theta$

(4) $a = \frac{g}{\sin\theta}$

Answer (1)

Sol.



In non-inertial frame,

$N \sin\theta = ma$ ...(i)

$N \cos\theta = mg$ ...(ii)

$\tan\theta = \frac{a}{g}$

$a = g \tan\theta$

44. A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and zero of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of –0.004 cm, the correct diameter of the ball is

(1) 0.529 cm

(2) 0.521 cm

(3) 0.053 cm

(4) 0.525 cm

Answer (1)

Sol. Diameter of the ball

= MSR + CSR × (Least count) – Zero error

= 0.5 cm + 25 × 0.001 – (–0.004)

= 0.5 + 0.025 + 0.004

= 0.529 cm

45. The moment of the force, $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at (2, 0, –3), about the point (2, –2, –2), is given by

(1) $-7\hat{i} - 4\hat{j} - 8\hat{k}$

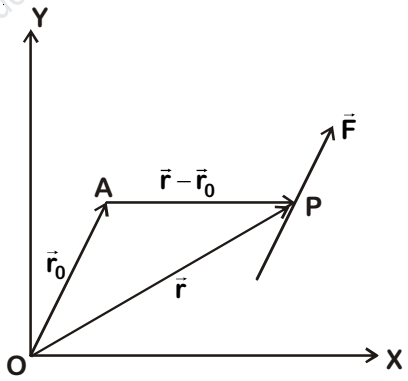
(2) $-8\hat{i} - 4\hat{j} - 7\hat{k}$

(3) $-7\hat{i} - 8\hat{j} - 4\hat{k}$

(4) $-4\hat{i} - \hat{j} - 8\hat{k}$

Answer (1)

Sol.



$\vec{\tau} = (\vec{r} - \vec{r}_0) \times \vec{F}$ ...(i)

$\vec{r} - \vec{r}_0 = (2\hat{i} + 0\hat{j} - 3\hat{k}) - (2\hat{i} - 2\hat{j} - 2\hat{k})$

$= 0\hat{i} + 2\hat{j} - \hat{k}$

$$\vec{\tau} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 2 & -1 \\ 4 & 5 & -6 \end{vmatrix} = -7\hat{i} - 4\hat{j} - 8\hat{k}$$

46. Which of the following hormones can play a significant role in osteoporosis?

(1) Parathyroid hormone and Prolactin

(2) Aldosterone and Prolactin

(3) Estrogen and Parathyroid hormone

(4) Progesterone and Aldosterone

Answer (3)

Sol. Estrogen promotes the activity of osteoblast and inhibits osteoclast. In an ageing female osteoporosis occurs due to deficiency of estrogen. Parathormone promotes mobilisation of calcium from bone into blood. Excessive activity of parathormone causes demineralisation leading to osteoporosis.

47. Which of the following is an amino acid derived hormone?

(1) Estriol

(2) Epinephrine

(3) Estradiol

(4) Ecdysone

Answer (2)

Sol. Epinephrine is derived from tyrosine amino acid by the removal of carboxyl group. It is a catecholamine.

48. Which of the following structures or regions is incorrectly paired with its functions?

(1) Corpus callosum : band of fibers connecting left and right cerebral hemispheres.

(2) Medulla oblongata : controls respiration and cardiovascular reflexes.

(3) Hypothalamus : production of releasing hormones and regulation of temperature, hunger and thirst.

(4) Limbic system : consists of fibre tracts that interconnect different regions of brain; controls movement.

Answer (4)

Sol. Limbic system is emotional brain. It controls all emotions in our body but not movements.

49. The transparent lens in the human eye is held in its place by

(1) smooth muscles attached to the ciliary body

(2) ligaments attached to the ciliary body

(3) smooth muscles attached to the iris

(4) ligaments attached to the iris

Answer (2)

Sol. Lens in the human eye is held in its place by suspensory ligaments attached to the ciliary body.

50. The amnion of mammalian embryo is derived from

(1) ectoderm and endoderm

(2) ectoderm and mesoderm

(3) mesoderm and trophoblast

(4) endoderm and mesoderm

Answer (2)

Sol. The extraembryonic or foetal membranes are amnion, chorion, allantois and Yolk sac.

Amnion is formed from mesoderm on outer side and ectoderm on inner side.

Chorion is formed from trophoectoderm and mesoderm whereas allantois and Yolk sac membrane have mesoderm on outerside and endoderm in inner side.

51. Hormones secreted by the placenta to maintain pregnancy are

(1) hCG, progestogens, estrogens, glucocorticoids

(2) hCG, hPL, progestogens, prolactin

(3) hCG, hPL, progestogens, estrogens

(4) hCG, hPL, estrogens, relaxin, oxytocin

Answer (3)

Sol. Placenta releases human chorionic gonadotropic hormone (hCG) which stimulates the Corpus luteum during pregnancy to release estrogen and progesterone and also rescues corpus luteum from regression. Human placental lactogen (hPL) is involved in growth of body of mother and breast. Progesterone maintains pregnancy, keeps the uterus silent by increasing uterine threshold to contractile stimuli.

52. The contraceptive 'SAHELI'

(1) is a post-coital contraceptive.

(2) blocks estrogen receptors in the uterus, preventing eggs from getting implanted.

(3) is an IUD.

(4) increases the concentration of estrogen and prevents ovulation in females.

Answer (2)

Sol. Saheli is the first non-steroidal, once a week pill. It contains centchroman and its functioning is based upon selective Estrogen Receptor modulation.

53. The difference between spermiogenesis and spermiation is

(1) In spermiogenesis spermatozoa are formed, while in spermiation spermatozoa are released from sertoli cells into the cavity of seminiferous tubules.

(2) In spermiogenesis spermatids are formed, while in spermiation spermatozoa are formed.

(3) In spermiogenesis spermatozoa from sertoli cells are released into the cavity of seminiferous tubules, while in spermiation spermatozoa are formed.

(4) In spermiogenesis spermatozoa are formed, while in spermiation spermatids are formed.

Answer (1)

Sol. Spermiogenesis is transformation of spermatids into spermatozoa whereas spermiation is the release of the sperms from sertoli cells into the lumen of seminiferous tubule.

54. A woman has an X-linked condition on one of her X chromosomes. This chromosome can be inherited by

(1) Both sons and daughters

(2) Only daughters

(3) Only grandchildren

(4) Only sons

Answer (1)

Sol.
- Woman is a carrier
- Both son & daughter inherit X–chromosome
- Although only son be the diseased

55. According to Hugo de Vries, the mechanism of evolution is

(1) Minor mutations

(2) Multiple step mutations

(3) Phenotypic variations

(4) Saltation

Answer (4)

Sol. As per mutation theory given by Hugo de Vries, the evolution is a discontinuous phenomenon or saltatory phenomenon/ saltation.

56. All of the following are part of an operon except

(1) a promoter (2) an operator

(3) an enhancer (4) structural genes

Answer (3)

Sol.
- Enhancer sequences are present in eukaryotes.
- Operon concept is for prokaryotes.

57. AGGTATCGCAT is a sequence from the coding strand of a gene. What will be the corresponding sequence of the transcribed mRNA?

(1) UCCAUAGCGUA

(2) AGGUAUCGCAU

(3) ACCUAUGCGAU

(4) UGGTUTCGCAT

Answer (2)

Sol. Coding strand and mRNA has same nucleotide sequence except, 'T' – Thymine is replaced by 'U'–Uracil in mRNA.

58. Match the items given in Column I with those in Column II and select the **correct** option given below :

	Column I		Column II
a.	Proliferative Phase	i.	Breakdown of endometrial lining
b.	Secretory Phase	ii.	Follicular Phase
c.	Menstruation	iii.	Luteal Phase

	a	b	c
(1)	iii	i	ii
(2)	iii	ii	i
(3)	ii	iii	i
(4)	i	iii	ii

Answer (3)

Sol. During proliferative phase, the follicles start developing, hence, called follicular phase.

Secretory phase is also called as luteal phase mainly controlled by progesterone secreted by corpus luteum. Estrogen further thickens the endometrium maintained by progesterone.

Menstruation occurs due to decline in progesterone level and involves breakdown of overgrown endometrial lining.

59. In which disease does mosquito transmitted pathogen cause chronic inflammation of lymphatic vessels?

(1) Amoebiasis

(2) Elephantiasis

(3) Ringworm disease

(4) Ascariasis

Answer (2)

Sol. Elephantiasis is caused by roundworm, *Wuchereria bancrofti* and it is transmitted by Culex mosquito.

60. Among the following sets of examples for divergent evolution, select the **incorrect** option :

(1) Eye of octopus, bat and man

(2) Forelimbs of man, bat and cheetah

(3) Brain of bat, man and cheetah

(4) Heart of bat, man and cheetah

Answer (1)

Sol. Divergent evolution occurs in the same structure, example - forelimbs, heart, brain of vertebrates which have developed along different directions due to adaptation to different needs whereas eye of octopus, bat and man are examples of analogous organs showing convergent evolution.

61. The similarity of bone structure in the forelimbs of many vertebrates is an example of

(1) Adaptive radiation

(2) Homology

(3) Convergent evolution

(4) Analogy

Answer (2)

Sol. In different vertebrates, bones of forelimbs are similar but their forelimbs are adapted in different way as per their adaptation, hence example of homology.

62. Which of the following is **not** an autoimmune disease?

(1) Vitiligo

(2) Psoriasis

(3) Alzheimer's disease

(4) Rheumatoid arthritis

Answer (3)

Sol. Rheumatoid arthritis is an autoimmune disorder in which antibodies are produced against the synovial membrane and cartilage.

Vitiligo causes white patches on skin also characterised as autoimmune disorder.

Psoriasis is a skin disease that causes itchy or sore patches of thick red skin and is also autoimmune whereas Alzheimer's disease is due to deficiency of neurotransmitter acetylcholine.

63. Which of the following characteristics represent 'Inheritance of blood groups' in humans?

a. Dominance

b. Co-dominance

c. Multiple allele

d. Incomplete dominance

e. Polygenic inheritance

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

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

Answer (4)

Sol.
- I^AI^O, I^BI^O - Dominant–recessive relationship
- I^AI^B - Codominance
- I^A, I^B & I^O - 3-different allelic forms of a gene (multiple allelism)

64. Conversion of milk to curd improves its nutritional value by increasing the amount of

(1) Vitamin E

(2) Vitamin D

(3) Vitamin B_{12}

(4) Vitamin A

Answer (3)

Sol.
- Curd is more nourishing than milk.
- It has enriched presence of vitamins specially Vit-B_{12}.

65. Match the items given in **Column I** with those in **Column II** and select the **correct** option given below :

	Column-I		Column-II
a.	Eutrophication	i.	UV-B radiation
b.	Sanitary landfill	ii.	Deforestation
c.	Snow blindness	iii.	Nutrient enrichment
d.	Jhum cultivation	iv.	Waste disposal

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

Answer (3)

Sol.

a.	Eutrophication	iii.	Nutrient enrichment
b.	Sanitary landfill	iv.	Waste disposal
c.	Snow blindness	i.	UV-B radiation
d.	Jhum cultivation	ii.	Deforestation

66. Which one of the following population interactions is widely used in medical science for the production of antibiotics?

(1) Amensalism
(2) Commensalism
(3) Parasitism
(4) Mutualism

Answer (1)

Sol. Amensalism/Antibiosis (0, –)

- Antibiotics are chemicals secreted by one microbial group (eg : *Penicillium*) which harm other microbes (eg : *Staphylococcus*)
- It has no effect on *Penicillium* or the organism which produces it.

67. All of the following are included in '*ex-situ* conservation' except

(1) Seed banks
(2) Wildlife safari parks
(3) Botanical gardens
(4) Sacred groves

Answer (4)

Sol.
- Sacred groves – *in-situ* conservation.
- Represent pristine forest patch as protected by Tribal groups.

68. In a growing population of a country,

(1) pre-reproductive individuals are less than the reproductive individuals.
(2) pre-reproductive individuals are more than the reproductive individuals.
(3) reproductive and pre-reproductive individuals are equal in number.
(4) reproductive individuals are less than the post-reproductive individuals.

Answer (2)

Sol. Whenever the pre-reproductive individuals or the younger population size is larger than the reproductive group, the population will be an increasing population.

69. Which part of poppy plant is used to obtain the drug "Smack"?

(1) Leaves (2) Flowers
(3) Roots (4) Latex

Answer (4)

Sol. 'Smack' also called as brown sugar/Heroin is formed by acetylation of morphine. It is obtained from the latex of unripe capsule of Poppy plant.

70. Which of the following gastric cells indirectly help in erythropoiesis?

(1) Parietal cells (2) Chief cells
(3) Goblet cells (4) Mucous cells

Answer (1)

Sol. Parietal or oxyntic cell is a source of HCl and intrinsic factor. HCl converts iron present in diet from ferric to ferrous form so that it can be absorbed easily and used during erythropoiesis.

Intrinsic factor is essential for the absorption of vitamin B_{12} and its deficiency causes pernicious anaemia.

71. Match the items given in Column I with those in Column II and select the correct option given below :

	Column I	Column II
a.	Fibrinogen	(i) Osmotic balance
b.	Globulin	(ii) Blood clotting
c.	Albumin	(iii) Defence mechanism

	a	b	c
(1)	(ii)	(iii)	(i)
(2)	(iii)	(ii)	(i)
(3)	(i)	(iii)	(ii)
(4)	(i)	(ii)	(iii)

Answer (1)

Sol. Fibrinogen forms fibrin strands during coagulation. These strands forms a network and the meshes of which are occupied by blood cells, this structure finally forms a clot.

Antibodies are derived from γ-Globulin fraction of plasma proteins which means globulins are involved in defence mechanisms.

Albumin is a plasma protein mainly responsible for BCOP.

72. Which of the following is an occupational respiratory disorder?

(1) Emphysema

(2) Anthracis

(3) Botulism

(4) Silicosis

Answer (4)

Sol. Silicosis is due to excess inhalation of silica dust in the workers involved grinding or stone breaking industries.

Long exposure can give rise to inflammation leading to fibrosis and thus causing serious lung damage.

Anthrax is a serious infectious disease caused by *Bacillus anthracis*. It commonly affects domestic and wild animals. Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased.

Botulism is a form of food poisoning caused by *Clostridium botulinum*.

73. Calcium is important in skeletal muscle contraction because it

(1) Prevents the formation of bonds between the myosin cross bridges and the actin filament.

(2) Binds to troponin to remove the masking of active sites on actin for myosin.

(3) Detaches the myosin head from the actin filament.

(4) Activates the myosin ATPase by binding to it.

Answer (2)

Sol.
- Signal for contraction increase Ca^{++} level many folds in the sarcoplasm.
- Ca^{++} now binds with sub-unit of troponin (troponin "C") which is masking the active site on actin filament and displaces the sub-unit of troponin.
- Once the active site is exposed, head of the myosin attaches and initiate contraction by sliding the actin over myosin.

74. Nissl bodies are mainly composed of

(1) Free ribosomes and RER

(2) Proteins and lipids

(3) Nucleic acids and SER

(4) DNA and RNA

Answer (1)

Sol. Nissl granules are present in the cyton and even extend into the dendrite but absent in axon and rest of the neuron.

Nissl granules are in fact composed of free ribosomes and RER. They are responsible for protein synthesis.

75. Which of these statements is **incorrect**?

(1) Oxidative phosphorylation takes place in outer mitochondrial membrane

(2) Enzymes of TCA cycle are present in mitochondrial matrix

(3) Glycolysis operates as long as it is supplied with NAD that can pick up hydrogen atoms

(4) Glycolysis occurs in cytosol

Answer (1)

Sol. Oxidative phosphorylation takes place in inner mitochondrial membrane.

76. Select the **incorrect** match :

(1) Polytene chromosomes – Oocytes of amphibians

(2) Lampbrush chromosomes – Diplotene bivalents

(3) Submetacentric chromosomes – L-shaped chromosomes

(4) Allosomes – Sex chromosomes

Answer (1)

Sol. Polytene chromosomes are found in salivary glands of insects of order Diptera.

77. Which of the following terms describe human dentition?

(1) Pleurodont, Diphyodont, Heterodont

(2) Thecodont, Diphyodont, Homodont

(3) Pleurodont, Monophyodont, Homodont

(4) Thecodont, Diphyodont, Heterodont

Answer (4)

Sol. In humans, dentition is

- Thecodont : Teeth are present in the sockets of the jaw bone called alveoli.
- Diphyodont : Teeth erupts twice, temporary milk or deciduous teeth are replaced by a set of permanent or adult teeth.
- Heterodont dentition : Dentition consists of different types of teeth namely incisors, canine, premolars and molars.

78. Which of the following events does not occur in rough endoplasmic reticulum?

(1) Phospholipid synthesis

(2) Protein folding

(3) Cleavage of signal peptide

(4) Protein glycosylation

Answer (1)

Sol. Phospholipid synthesis does not take place in RER. Smooth endoplasmic reticulum are involved in lipid synthesis.

79. Many ribosomes may associate with a single mRNA to form multiple copies of a polypeptide simultaneously. Such strings of ribosomes are termed as

(1) Nucleosome (2) Polysome

(3) Plastidome (4) Polyhedral bodies

Answer (2)

Sol. The phenomenon of association of many ribosomes with single m-RNA leads to formation of polyribosomes or polysomes or ergasomes.

80. Ciliates differ from all other protozoans in

(1) having two types of nuclei

(2) using flagella for locomotion

(3) using pseudopodia for capturing prey

(4) having a contractile vacuole for removing excess water

Answer (1)

Sol. Ciliates differs from other protozoans in having two types of nuclei.

eg. *Paramoecium* have two types of nuclei i.e. macronucleus & micronucleus.

81. Identify the vertebrate group of animals characterized by crop and gizzard in its digestive system

(1) Osteichthyes

(2) Amphibia

(3) Aves

(4) Reptilia

Answer (3)

Sol. The digestive tract of Aves has additional chambers in their digestive system as crop and Gizzard.

Crop is concerned with storage of food grains.

Gizzard is a masticatory organ in birds used to crush food grain.

82. Which one of these animals is not a homeotherm?

(1) Psittacula

(2) Macropus

(3) Camelus

(4) Chelone

Answer (4)

Sol. Homeotherm are animals that maintain constant body temperature, irrespective of surrounding temperature.

Birds and mammals are homeotherm.

Chelone (Turtle) belongs to class reptilia which is Poikilotherm or cold blood.

83. Which of the following features is used to identify a male cockroach from a female cockroach?

(1) Presence of anal cerci

(2) Presence of a boat shaped sternum on the 9^{th} abdominal segment

(3) Forewings with darker tegmina

(4) Presence of caudal styles

Answer (4)

Sol. Males bear a pair of short, thread like anal styles which are absent in females.

Anal/caudal styles arise from 9^{th} abdominal segment in male cockroach.

84. Which of the following animals does not undergo metamorphosis?

(1) Starfish (2) Earthworm

(3) Moth (4) Tunicate

Answer (2)

Sol. Metamorphosis refers to transformation of larva into adult.

Animal that perform metamorphosis are said to have indirect development.

In earthworm development is direct which means no larval stage and hence no metamorphosis.

85. Which of the following organisms are known as chief producers in the oceans?

(1) Euglenoids (2) Dinoflagellates

(3) Cyanobacteria (4) Diatoms

Answer (4)

Sol. Diatoms are chief producers of the ocean.

86. Which of the following options correctly represents the lung conditions in asthma and emphysema, respectively?

(1) Decreased respiratory surface; Inflammation of bronchioles

(2) Inflammation of bronchioles; Decreased respiratory surface

(3) Increased respiratory surface; Inflammation of bronchioles

(4) Increased number of bronchioles; Increased respiratory surface

Answer (2)

Sol. Asthma is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles. Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased.

87. Match the items given in Column I with those in Column II and select the correct option given below :

	Column I		Column II
a.	Tricuspid valve	i.	Between left atrium and left ventricle
b.	Bicuspid valve	ii.	Between right ventricle and pulmonary artery
c.	Semilunar valve	iii.	Between right atrium and right ventricle

	a	b	c
(1)	ii	i	iii
(2)	iii	i	ii
(3)	i	ii	iii
(4)	i	iii	ii

Answer (2)

Sol. Tricuspid valves are AV valve present between right atrium and right ventricle. Bicuspid valves are AV valve present between left atrium and left ventricle. Semilunar valves are present at the openings of aortic and pulmonary aorta.

88. Match the items given in Column I with those in Column II and select the correct option given below:

	Column I		Column II
a.	Tidal volume	i.	2500 – 3000 mL
b.	Inspiratory Reserve volume	ii.	1100 – 1200 mL
c.	Expiratory Reserve volume	iii.	500 – 550 mL
d.	Residual volume	iv.	1000 – 1100 mL

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

Answer (4)

Sol. Tidal volume is volume of air inspired or expired during normal respiration. It is approximately 500 mL. Inspiratory reserve volume is additional volume of air a person can inspire by a forceful inspiration. It is around 2500 – 3000 mL. Expiratory reserve volume is additional volume of air a person can be expired by a forceful expiration. This averages 1000 – 1100 mL.

Residual volume is volume of air remaining in lungs even after forceful expiration. This averages 1100 – 1200 mL.

89. Match the items given in Column I with those in Column II and select the correct option given below :

	Column I		Column II
a.	Glycosuria	i.	Accumulation of uric acid in joints
b.	Gout	ii.	Mass of crystallised salts within the kidney
c.	Renal calculi	iii.	Inflammation in glomeruli
d.	Glomerular nephritis	iv.	Presence of in glucose urine

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

Answer (1)

Sol. Glycosuria denotes presence of glucose in the urine. This is observed when blood glucose level rises above 180 mg/100 ml of blood, this is called renal threshold value for glucose. Gout is due to deposition of uric acid crystals in the joint.

Renal calculi are precipitates of calcium phosphate produced in the pelvis of the kidney.

Glomerular nephritis is the inflammatory condition of glomerulus characterised by proteinuria and haematuria.

90. Match the items given in Column I with those in Column II and select the correct option given below:

	Column I (Function)		Column II (Part of Excretory system)
a.	Ultrafiltration	i.	Henle's loop
b.	Concentration of urine	ii.	Ureter
c.	Transport of urine	iii.	Urinary bladder
d.	Storage of urine	iv.	Malpighian corpuscle
		v.	Proximal convoluted tubule

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

Answer (4)

Sol. Ultrafiltration refers to filtration of very fine particles having molecular weight less than 68,000 daltons through malpighian corpuscle.

Concentration of urine refers to water absorption from glomerular filtrate as a result of hyperosmolarity in the medulla created by counter-current mechanism in Henle's loop.

Urine is carried from kidney to bladder through ureter.

Urinary bladder is concerned with storage of urine.

91. Secondary xylem and phloem in dicot stem are produced by

(1) Axillary meristems

(2) Apical meristems

(3) Phellogen

(4) Vascular cambium

Answer (4)

Sol.
- Vascular cambium is partially secondary
- Form secondary xylem towards its inside and secondary phloem towards outsides.
- 4 – 10 times more secondary xylem is produced than secondary phloem.

92. Pneumatophores occur in

(1) Submerged hydrophytes

(2) Halophytes

(3) Carnivorous plants

(4) Free-floating hydrophytes

Answer (2)

Sol.
- Halophytes like mangrooves have pneumatophores.
- Apogeotropic (–vely geotropic) roots having lenticels called pneumathodes to uptake O_2.

93. Plants having little or no secondary growth are

(1) Cycads

(2) Grasses

(3) Conifers

(4) Deciduous angiosperms

Answer (2)

Sol. Grasses are monocots and monocots usually do not have secondary growth.

Palm like monocots have anomalous secondary growth.

94. Select the wrong statement :

(1) Mitochondria are the powerhouse of the cell in all kingdoms except Monera

(2) Cell wall is present in members of Fungi and Plantae

(3) Pseudopodia are locomotory and feeding structures in Sporozoans

(4) Mushrooms belong to Basidiomycetes

Answer (3)

Sol. Pseudopodia are locomotory structures in sarcodines (Amoeboid)

95. Casparian strips occur in

(1) Endodermis

(2) Epidermis

(3) Cortex

(4) Pericycle

Answer (1)

Sol.
- Endodermis have casparian strip on radial and inner tangential wall.
- It is suberin rich.

96. Sweet potato is a modified

(1) Rhizome

(2) Stem

(3) Tap root

(4) Adventitious root

Answer (4)

Sol. Sweet potato is a modified adventitious root for storage of food

- Rhizomes are underground modified stem
- Tap root is primary root directly elongated from the redicle

97. Which of the following statements is correct?

(1) Stems are usually unbranched in both *Cycas* and *Cedrus*

(2) Ovules are not enclosed by ovary wall in gymnosperms

(3) Horsetails are gymnosperms

(4) *Selaginella* is heterosporous, while *Salvinia* is homosporous

Answer (2)

Sol.
- Gymnosperms have naked ovule.
- Called phanerogams without womb/ovary

98. What type of ecological pyramid would be obtained with the following data?

Secondary consumer : 120 g

Primary consumer : 60 g

Primary producer : 10 g

(1) Upright pyramid of biomass

(2) Inverted pyramid of biomass

(3) Upright pyramid of numbers

(4) Pyramid of energy

Answer (2)

Sol.
- The given data depicts the inverted pyramid of biomass, usually found in aquatic ecosystem.
- Pyramid of energy is always upright
- Upright pyramid of biomass and numbers are not possible, as the data depicts primary producer is less than primary consumer and this is less than secondary consumers.

99. World Ozone Day is celebrated on

(1) 22nd April

(2) 5th June

(3) 16th September

(4) 21st April

Answer (3)

Sol. World Ozone day is celebrated on 16th September.

5th June - World Environment Day

21st April - National Yellow Bat Day

22nd April - National Earth Day

100. In stratosphere, which of the following elements acts as a catalyst in degradation of ozone and release of molecular oxygen?

(1) Oxygen (2) Carbon

(3) Fe (4) Cl

Answer (4)

Sol. UV rays act on CFCs, releasing Cl atoms, chlorine reacts with ozone in sequential method converting into oxygen

Carbon, oxygen and Fe are not related to ozone layer depletion

101. Natality refers to

(1) Number of individuals entering a habitat

(2) Death rate

(3) Number of individuals leaving the habitat

(4) Birth rate

Answer (4)

Sol. Natality refers to birth rate.

- Death rate – Mortality
- Number of individual entering a habitat is – Immigration
- Number of individual leaving the habital – Emigration

102. Niche is

(1) the functional role played by the organism where it lives

(2) all the biological factors in the organism's environment

(3) the range of temperature that the organism needs to live

(4) the physical space where an organism lives

Answer (1)

Sol. Ecological niche was termed by J. Grinnel. It refers the functional role played by the organism where it lives.

103. Which of the following is a secondary pollutant?

(1) O_3

(2) CO

(3) SO_2

(4) CO_2

Answer (1)

Sol. O_3 (ozone) is a secondary pollutant. These are formed by the reaction of primary pollutant.

CO – Quantitative pollutant

CO_2 – Primary pollutant

SO_2 – Primary pollutant

104. Winged pollen grains are present in

(1) *Pinus*

(2) Mustard

(3) Mango

(4) *Cycas*

Answer (1)

Sol. In *Pinus*, winged pollen grains are present. It is extended outer exine on two lateral sides to form the wings of pollen. It is the characteristic feature, only in *Pinus*.

Pollen grains of Mustard, *Cycas* & Mango are not winged shaped.

105. After karyogamy followed by meiosis, spores are produced exogenously in

(1) *Saccharomyces*

(2) *Neurospora*

(3) *Agaricus*

(4) *Alternaria*

Answer (3)

Sol.
- In *Agaricus* (a genus of basidiomycetes), basidiospores or meiospores are produced exogenously.
- *Neurospora* (a genus of ascomycetes) produces ascospores as meiospores but endogenously inside the ascus.)
- *Alternaria* (a genus of deuteromycetes) does not produce sexual spores.
- *Saccharomyces* (Unicellular ascomycetes) produces ascospores, endogenously.

106. Which one is wrongly matched?

(1) Unicellular organism – *Chlorella*

(2) Uniflagellate gametes – *Polysiphonia*

(3) Gemma cups – *Marchantia*

(4) Biflagellate zoospores – Brown algae

Answer (2)

Sol. • *Polysiphonia* is a genus of red algae, where asexual spores and gametes are non-motile or non-flagellated.

• Other options (1, 3 & 4) are correctly matched

107. Match the items given in Column I with those in Column II and select the correct option given below:

	Column I		Column II
a.	Herbarium	(i)	It is a place having a collection of preserved plants and animals
b.	Key	(ii)	A list that enumerates methodically all the species found in an area with brief description aiding identification
c.	Museum	(iii)	Is a place where dried and pressed plant specimens mounted on sheets are kept
d.	Catalogue	(iv)	A booklet containing a list of characters and their alternates which are helpful in identification of various taxa.

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

Answer (1)

Sol. • Herbarium – Dried and pressed plant specimen

• Key – Identification of various taxa

• Museum – Plant and animal specimen are preserved

• Catalogue – Alphabetical listing of species

108. Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete its life cycle without the other?

(1) *Viola* (2) *Hydrilla*

(3) Banana (4) *Yucca*

Answer (4)

Sol. *Yucca* have an obligate mutualism with a species of moth i.e. *Pronuba*.

109. Pollen grains can be stored for several years in liquid nitrogen having a temperature of

(1) –160°C

(2) –120°C

(3) –196°C

(4) –80°C

Answer (3)

Sol. Pollen grains can be stored for several years in liquid nitrogen at –196°C (Cryopreservation)

110. In which of the following forms is iron absorbed by plants?

(1) Both ferric and ferrous

(2) Ferric

(3) Free element

(4) Ferrous

Answer (2*)

Sol. Iron is absorbed by plants in the form of ferric ions. (According to NCERT)

*Plants absorb iron in both form i.e. Fe^{++} and Fe^{+++}. (Preferably Fe^{++})

111. Which of the following elements is responsible for maintaining turgor in cells?

(1) Calcium (2) Magnesium

(3) Potassium (4) Sodium

Answer (3)

Sol. Potassium helps in maintaining turgidity of cells.

112. Double fertilization is

(1) Syngamy and triple fusion

(2) Fusion of two male gametes of a pollen tube with two different eggs

(3) Fusion of two male gametes with one egg

(4) Fusion of one male gamete with two polar nuclei

Answer (1)

Sol. Double fertilization is a unique phenomenon that occur in angiosperms only.

Syngamy + Triple fusion = Double fertilization

113. What is the role of NAD^+ in cellular respiration?

(1) It is the final electron acceptor for anaerobic respiration.

(2) It functions as an enzyme.

(3) It is a nucleotide source for ATP synthesis.

(4) It functions as an electron carrier.

Answer (4)

Sol. In cellular respiration, NAD^+ act as an electron carrier.

114. Oxygen is not produced during photosynthesis by

(1) *Chara*

(2) Green sulphur bacteria

(3) *Cycas*

(4) *Nostoc*

Answer (2)

Sol. Green sulphur bacteria do not use H_2O as source of proton, therefore they do not evolve O_2.

115. The Golgi complex participates in

(1) Activation of amino acid

(2) Fatty acid breakdown

(3) Respiration in bacteria

(4) Formation of secretory vesicles

Answer (4)

Sol. Golgi complex, after processing releases secretory vesicles from their trans-face.

116. Stomatal movement is not affected by

(1) CO_2 concentration

(2) Temperature

(3) O_2 concentration

(4) Light

Answer (3)

Sol. Light, temperature and concentration of CO_2 affect opening and closing of stomata while they are not affected by O_2 concentration.

117. Stomata in grass leaf are

(1) Barrel shaped

(2) Dumb-bell shaped

(3) Rectangular

(4) Kidney shaped

Answer (2)

Sol. Grass being a monocot, has Dumb-bell shaped stomata in their leaves.

118. Which of the following is true for nucleolus?

(1) It is a site for active ribosomal RNA synthesis

(2) Larger nucleoli are present in dividing cells

(3) It takes part in spindle formation

(4) It is a membrane-bound structure

Answer (1)

Sol. Nucleolus is a non membranous structure and is a site of r-RNA synthesis.

119. Which of the following is not a product of light reaction of photosynthesis?

(1) Oxygen (2) ATP

(3) NADPH (4) NADH

Answer (4)

Sol. ATP, NADPH and oxygen are products of light reaction, while NADH is a product of respiration process.

120. The stage during which separation of the paired homologous chromosomes begins is

(1) Zygotene (2) Pachytene

(3) Diakinesis (4) Diplotene

Answer (4)

Sol. Synaptonemal complex disintegrates. Terminalisation begins at diplotene stage i.e. chiasmata start to shift towards end.

121. The two functional groups characteristic of sugars are

(1) Carbonyl and hydroxyl

(2) Hydroxyl and methyl

(3) Carbonyl and phosphate

(4) Carbonyl and methyl

Answer (1)

Sol. Sugar is a common term used to denote carbohydrate.

Carbohydrates are polyhydroxy aldehyde, ketone or their derivatives, which means they have carbonyl and hydroxyl groups.

122. Which among the following is not a prokaryote?

(1) *Oscillatoria*

(2) *Saccharomyces*

(3) *Nostoc*

(4) *Mycobacterium*

Answer (2)

Sol. *Saccharomyces* i.e. yeast is an eukaryote (unicellular fungi)

Mycobacterium – a bacterium

Oscillatoria and *Nostoc* are cyanobacteria.

123. Offsets are produced by

(1) Parthenogenesis (2) Meiotic divisions

(3) Parthenocarpy (4) Mitotic divisions

Answer (4)

Sol. Offset is a vegetative part of a plant, formed by mitosis.

– Meiotic divisions do not occur in somatic cells.

– Parthenogenesis is the formation of embryo from ovum or egg without fertilisation.

– Parthenocarpy is the fruit formed without fertilisation, (generally seedless)

124. Select the correct statement

(1) Transduction was discovered by S. Altman

(2) Franklin Stahl coined the term ''linkage''

(3) Spliceosomes take part in translation

(4) Punnett square was developed by a British scientist

Answer (4)

Sol. Punnett square was developed by a British geneticist, Reginald C. Punnett.

– Franklin Stahl proved semi-conservative mode of replication.

– Transduction was discovered by Zinder and Laderberg.

– Spliceosome formation is part of post-transcriptional change in Eukaryotes

125. Which of the following has proved helpful in preserving pollen as fossils?

(1) Sporopollenin (2) Pollenkitt

(3) Oil content (4) Cellulosic intine

Answer (1)

Sol. Sporopollenin cannot be degraded by enzyme; strong acids and alkali, therefore it is helpful in preserving pollen as fossil.

Pollenkitt – Help in insect pollination.

Cellulosic Intine – Inner sporoderm layer of pollen grain known as intine made up cellulose & pectin.

Oil content – No role is pollen preservation.

126. Which of the following pairs is wrongly matched?

(1) T.H. Morgan : Linkage

(2) Starch synthesis in pea : Multiple alleles

(3) XO type sex determination : Grasshopper

(4) ABO blood grouping : Co-dominance

Answer (2)

Sol. Starch synthesis in pea is controlled by pleiotropic gene.

Other options (1, 3 & 4) are correctly matched.

127. Select the correct match

(1) Francois Jacob and Jacques Monod - Lac operon

(2) Alec Jeffreys - *Streptococcus pneumoniae*

(3) Matthew Meselson and F. Stahl - *Pisum sativum*

(4) Alfred Hershey and Martha Chase - TMV

Answer (1)

Sol. Francois Jacob and Jacque Monod proposed model of gene regulation known as operon model/lac operon.

– Alec Jeffreys – DNA fingerprinting technique.

– Matthew Meselson and F. Stahl – Semi-conservative DNA replication in E. coli.

– Alfred Hershey and Martha Chase – Proved DNA as genetic material not protein

128. Which of the following flowers only once in its life-time?

(1) Papaya (2) Bamboo species

(3) Mango (4) Jackfruit

Answer (2)

Sol. Bamboo species are monocarpic i.e., flower generally only once in its life-time after 50-100 years.

Jackfruit, papaya and mango are polycarpic i.e., produce flowers and fruits many times in their life-time.

129. The experimental proof for semiconservative replication of DNA was first shown in a

(1) Virus (2) Fungus

(3) Plant (4) Bacterium

Answer (4)

Sol. Semi-conservative DNA replication was first shown in Bacterium *Escherichia coli* by Matthew Meselson and Franklin Stahl.

130. Which of the following is commonly used as a vector for introducing a DNA fragment in human lymphocytes?

(1) pBR 322 (2) Retrovirus

(3) λ phage (4) Ti plasmid

Answer (2)

Sol. Retrovirus is commonly used as vector for introducing a DNA fragment in human lymphocyte.

Gene therapy : Lymphocyte from blood of patient are grown in culture outside the body, a functional gene is introduced by using a retroviral vector, into these lymphocyte.

131. Select the correct match

(1) G. Mendel - Transformation

(2) Ribozyme - Nucleic acid

(3) T.H. Morgan - Transduction

(4) F_2 × Recessive parent - Dihybrid cross

Answer (2)

Sol. Ribozyme is a catalytic RNA, which is nucleic acid.

132. Use of bioresources by multinational companies and organisations without authorisation from the concerned country and its people is called

(1) Bioexploitation (2) Bio-infringement

(3) Biodegradation (4) Biopiracy

Answer (4)

Sol. Biopiracy is term used for or refer to the use of bioresources by multinational companies and other organisation without proper authorisation from the countries and people concerned with compensatory payment (definition of biopiracy given in NCERT).

133. A 'new' variety of rice was patented by a foreign company, though such varieties have been present in India for a long time. This is related to

(1) Basmati (2) Co-667

(3) Lerma Rojo (4) Sharbati Sonora

Answer (1)

Sol. In 1997, an American company got patent rights on Basmati rice through the US patent and trademark office that was actually been derived from Indian farmer's varieties.

The diversity of rice in India is one of the richest in the world, 27 documented varieties of Basmati are grown in India.

Indian basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty.

Sharbati Sonora and Lerma Rojo are varieties of wheat.

134. In India, the organisation responsible for assessing the safety of introducing genetically modified organisms for public use is

(1) Genetic Engineering Appraisal Committee (GEAC)

(2) Indian Council of Medical Research (ICMR)

(3) Research Committee on Genetic Manipulation (RCGM)

(4) Council for Scientific and Industrial Research (CSIR)

Answer (1)

Sol. Indian Government has setup organisation such as GEAC (Genetic Engineering Appraisal Committee) which will make decisions regarding the validity of GM research and safety of introducing GM-organism for public services. (Direct from NCERT).

135. The correct order of steps in Polymerase Chain Reaction (PCR) is

(1) Denaturation, Annealing, Extension

(2) Extension, Denaturation, Annealing

(3) Denaturation, Extension, Annealing

(4) Annealing, Extension, Denaturation

Answer (1)

Sol. This technique is used for making multiple copies of gene (or DNA) of interest in vitro.

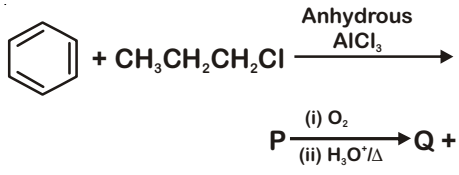
Each cycle has three steps

(i) Denaturation

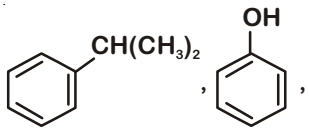
(ii) Primer annealing

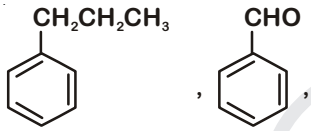
(iii) Extension of primer

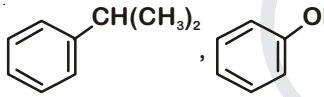
136. Identify the major products P, Q and R in the following sequence of reactions:

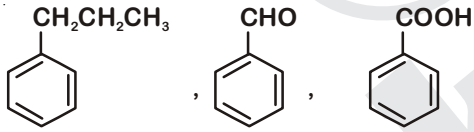


P Q R

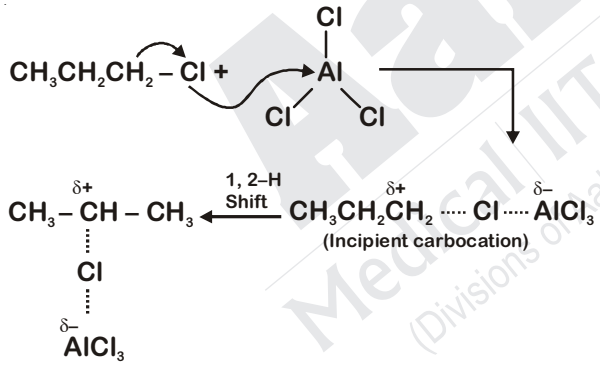
(1)  $CH_3 - CO - CH_3$

(2)  $CH_3CH_2 - OH$

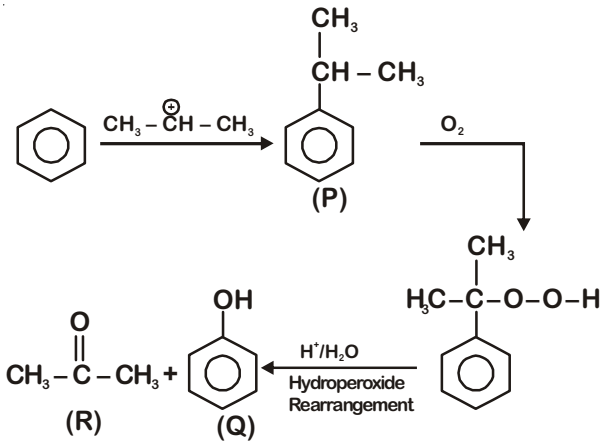
(3)  $CH_3CH(OH)CH_3$

(4) 

Answer (1)

Sol. 

Now,



137. Which of the following compounds can form a zwitterion?

(1) Glycine (2) Aniline

(3) Benzoic acid (4) Acetanilide

Answer (1)

Sol. $H_3\overset{\oplus}{N} - CH_2 - COOH \rightleftharpoons H_3\overset{\oplus}{N} - CH_2 - COO^-$ (Zwitterion form)

$pK_a = 9.60$ $pK_a = 2.34$

$\rightleftharpoons H_2N - CH_2 - COO^-$

138. The geometry and magnetic behaviour of the complex $[Ni(CO)_4]$ are

(1) Tetrahedral geometry and paramagnetic

(2) Square planar geometry and diamagnetic

(3) Square planar geometry and paramagnetic

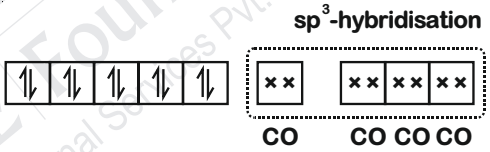
(4) Tetrahedral geometry and diamagnetic

Answer (4)

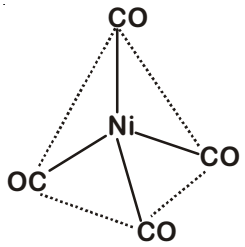
Sol. Ni(28) : $[Ar]3d^8\ 4s^2$

$\because$ CO is a strong field ligand

Configuration would be :



For, four 'CO'-ligands hybridisation would be sp^3 and thus the complex would be diamagnetic and of tetrahedral geometry.



139. Iron carbonyl, $Fe(CO)_5$ is

(1) Dinuclear (2) Tetranuclear

(3) Trinuclear (4) Mononuclear

Answer (4)

Sol. • Based on the number of metal atoms present in a complex, they are classified into mononuclear, dinuclear, trinuclear and so on.

eg: $Fe(CO)_5$: mononuclear

$Co_2(CO)_8$: dinuclear

$Fe_3(CO)_{12}$: trinuclear

140. Match the metal ions given in Column I with the spin magnetic moments of the ions given in Column II and assign the correct code :

Column I	Column II
a. Co^{3+}	i. $\sqrt{8}$ BM
b. Cr^{3+}	ii. $\sqrt{35}$ BM
c. Fe^{3+}	iii. $\sqrt{3}$ BM
d. Ni^{2+}	iv. $\sqrt{24}$ BM
	v. $\sqrt{15}$ BM

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

Answer (2)

Sol. Co^{3+} = [Ar] $3d^6$, Unpaired $e^-(n) = 4$

Spin magnetic moment = $\sqrt{4(4+2)} = \sqrt{24}$ BM

Cr^{3+} = [Ar] $3d^3$, Unpaired $e^-(n) = 3$

Spin magnetic moment = $\sqrt{3(3+2)} = \sqrt{15}$ BM

Fe^{3+} = [Ar] $3d^5$, Unpaired $e^-(n) = 5$

Spin magnetic moment = $\sqrt{5(5+2)} = \sqrt{35}$ BM

Ni^{2+} = [Ar] $3d^8$, Unpaired $e^-(n) = 2$

Spin magnetic moment = $\sqrt{2(2+2)} = \sqrt{8}$ BM

141. The type of isomerism shown by the complex $[CoCl_2(en)_2]$ is

(1) Linkage isomerism

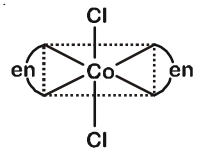
(2) Geometrical isomerism

(3) Ionization isomerism

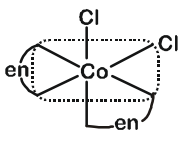
(4) Coordination isomerism

Answer (2)

Sol. In $[CoCl_2(en)_2]$, Coordination number of Co is 6 and this compound has octahedral geometry.



Trans-form
(optically inactive)



cis-form
(optically active)

- As per given option, type of isomerism is geometrical isomerism.

142. Which one of the following ions exhibits d-d transition and paramagnetism as well?

(1) MnO_4^{2-} (2) CrO_4^{2-}

(3) MnO_4^- (4) $Cr_2O_7^{2-}$

Answer (1)

Sol. $CrO_4^{2-} \Rightarrow Cr^{6+}$ = [Ar]

Unpaired electron (n) = 0; Diamagnetic

$Cr_2O_7^{2-} \Rightarrow Cr^{6+}$ = [Ar]

Unpaired electron (n) = 0; Diamagnetic

$MnO_4^{2-} = Mn^{6+}$ = [Ar] $3d^1$

Unpaired electron (n) = 1; Paramagnetic

$MnO_4^- = Mn^{7+}$ = [Ar]

Unpaired electron (n) = 0; Diamagnetic

143. Which of the following molecules represents the order of hybridisation sp^2, sp^2, sp, sp from left to right atoms?

(1) $CH_3 - CH = CH - CH_3$

(2) $HC \equiv C - C \equiv CH$

(3) $CH_2 = CH - CH = CH_2$

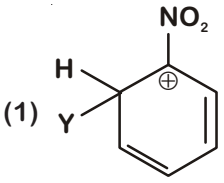
(4) $CH_2 = CH - C \equiv CH$

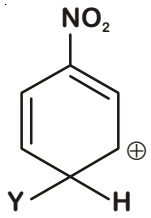
Answer (4)

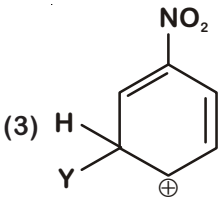
Sol. $\overset{sp^2}{CH_2} = \overset{sp^2}{CH} - \overset{sp}{C} \equiv \overset{sp}{C}H$

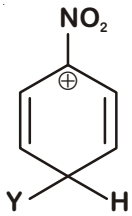
Number of orbital require in hybridization = Number of σ-bonds around each carbon atom.

144. Which of the following carbocations is expected to be most stable?

(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. $-NO_2$ group exhibit –I effect and it decreases with increase in distance. In option (3) positive charge present on C-atom at maximum distance so –I effect reaching to it is minimum and stability is maximum.

145. Which of the following is correct with respect to – I effect of the substituents? (R = alkyl)

(1) $-NR_2 > -OR > -F$

(2) $-NH_2 < -OR < -F$

(3) $-NH_2 > -OR > -F$

(4) $-NR_2 < -OR < -F$

Answer (2*)

Sol. –I effect increases on increasing electronegativity of atom. So, correct order of –I effect is $-NH_2 < -OR < -F$.

*Most appropriate Answer is option (2), however option (4) may also be correct answer.

146. The solubility of $BaSO_4$ in water is 2.42×10^{-3} gL^{-1} at 298 K. The value of its solubility product (K_{sp}) will be

(Given molar mass of $BaSO_4$ = 233 g mol^{-1})

(1) 1.08×10^{-8} mol^2L^{-2}

(2) 1.08×10^{-10} mol^2L^{-2}

(3) 1.08×10^{-14} mol^2L^{-2}

(4) 1.08×10^{-12} mol^2L^{-2}

Answer (2)

Sol. Solubility of $BaSO_4$, $s = \frac{2.42\times10^{-3}}{233}$ (mol L^{-1})

$= 1.04 \times 10^{-5}$ (mol L^{-1})

$$BaSO_4(s) \rightleftharpoons \underset{s}{Ba^{2+}}(aq) + \underset{s}{SO_4^{2-}}(aq)$$

$K_{sp} = [Ba^{2+}][SO_4^{2-}] = s^2$

$= (1.04 \times 10^{-5})^2$

$= 1.08 \times 10^{-10}$ $mol^2 L^{-2}$

147. Given van der Waals constant for NH_3, H_2, O_2 and CO_2 are respectively 4.17, 0.244, 1.36 and 3.59, which one of the following gases is most easily liquefied?

(1) CO_2

(2) NH_3

(3) O_2

(4) H_2

Answer (2)

Sol.
- van der waal constant 'a', signifies intermolecular forces of attraction.
- Higher is the value of 'a', easier will be the liquefaction of gas.

148. Following solutions were prepared by mixing different volumes of NaOH and HCl of different concentrations :

a. 60 mL $\frac{M}{10}$ HCl + 40 mL $\frac{M}{10}$ NaOH

b. 55 mL $\frac{M}{10}$ HCl + 45 mL $\frac{M}{10}$ NaOH

c. 75 mL $\frac{M}{5}$ HCl + 25 mL $\frac{M}{5}$ NaOH

d. 100 mL $\frac{M}{10}$ HCl + 100 mL $\frac{M}{10}$ NaOH

pH of which one of them will be equal to 1?

(1) c (2) b

(3) d (4) a

Answer (1)

Sol.
- Meq of HCl = $75\times\frac{1}{5}\times1 = 15$
- Meq of NaOH = $25\times\frac{1}{5}\times1 = 5$
- Meq of HCl in resulting solution = 10
- Molarity of $[H^+]$ in resulting mixture

$= \frac{10}{100} = \frac{1}{10}$

$pH = -\log[H^+] = -\log\left[\frac{1}{10}\right] = 1.0$

149. On which of the following properties does the coagulating power of an ion depend?

(1) The sign of charge on the ion alone

(2) The magnitude of the charge on the ion alone

(3) Both magnitude and sign of the charge on the ion

(4) Size of the ion alone

Answer (3)

Sol.
- Coagulation of colloidal solution by using an electrolyte depends on the charge present (positive or negative) on colloidal particles as well as on its size.
- Coagulating power of an electrolyte depends on the magnitude of charge present on effective ion of electrolyte.

150. Which of the following statements is not true for halogens?

(1) Chlorine has the highest electron-gain enthalpy

(2) All form monobasic oxyacids

(3) All but fluorine show positive oxidation states

(4) All are oxidizing agents

Answer (3)

Sol. Due to high electronegativity and small size, F forms only one oxoacid, HOF known as Fluoric (I) acid. Oxidation number of F is +1 in HOF.

151. Considering Ellingham diagram, which of the following metals can be used to reduce alumina?

(1) Cu (2) Fe

(3) Mg (4) Zn

Answer (3)

Sol. The metal which is more reactive than 'Al' can reduce alumina i.e. 'Mg' should be the correct option.

152. The correct order of atomic radii in group 13 elements is

(1) B < Ga < Al < In < Tl

(2) B < Al < In < Ga < Tl

(3) B < Ga < Al < Tl < In

(4) B < Al < Ga < In < Tl

Answer (1)

Sol.

Elements	B	Ga	Al	In	Tl
Atomic radii (pm)	85	135	143	167	170

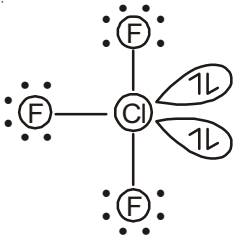
153. In the structure of ClF_3, the number of lone pairs of electrons on central atom 'Cl' is

(1) Three (2) One

(3) Four (4) Two

Answer (4)

Sol. The structure of ClF_3 is



The number of lone pair of electrons on central Cl is 2.

154. The correct order of N-compounds in its decreasing order of oxidation states is

(1) NH_4Cl, N_2, NO, HNO_3

(2) HNO_3, NO, N_2, NH_4Cl

(3) HNO_3, NH_4Cl, NO, N_2

(4) HNO_3, NO, NH_4Cl, N_2

Answer (2)

Sol. $\overset{+5}{H}\overset{}{N}\overset{}{O_3}$, $\overset{+2}{N}O$, $\overset{0}{N_2}$, $\overset{-3}{N}H_4Cl$

155. Which one of the following elements is unable to form MF_6^{3-} ion?

(1) In

(2) Ga

(3) B

(4) Al

Answer (3)

Sol. ∵ 'B' has no vacant d-orbitals in its valence shell, so it can't extend its covalency beyond 4. i.e. 'B' cannot form the ion like $MF_6^{3(-)}$ i.e. $BF_6^{3(-)}$.

156. The compound A on treatment with Na gives B, and with PCl_5 gives C. B and C react together to give diethyl ether. A, B and C are in the order

(1) C_2H_5OH, C_2H_5ONa, C_2H_5Cl

(2) C_2H_5OH, C_2H_6, C_2H_5Cl

(3) C_2H_5Cl, C_2H_6, C_2H_5OH

(4) C_2H_5OH, C_2H_5Cl, C_2H_5ONa

Answer (1)

Sol.

$$\underset{(A)}{C_2H_5OH} \xrightarrow{Na} \underset{(B)}{C_2H_5O^-Na^+}$$

$$\downarrow PCl_5$$

$$\underset{(C)}{C_2H_5Cl}$$

$$\underset{(B)}{C_2H_5O^-Na^+} + \underset{(C)}{C_2H_5Cl} \xrightarrow{S_N2} C_2H_5OC_2H_5$$

157. Hydrocarbon (A) reacts with bromine by substitution to form an alkyl bromide which by Wurtz reaction is converted to gaseous hydrocarbon containing less than four carbon atoms. (A) is

(1) CH_4 (2) $CH \equiv CH$

(3) $CH_3 - CH_3$ (4) $CH_2 = CH_2$

Answer (1)

Sol. $CH_4 \xrightarrow[(A)]{Br_2/h\nu} CH_3Br \xrightarrow[\text{Wurtz reaction}]{\text{Na/dry ether}} CH_3 — CH_3$

158. The compound C_7H_8 undergoes the following reactions:

$$C_7H_8 \xrightarrow{3Cl_2/\Delta} A \xrightarrow{Br_2/Fe} B \xrightarrow{Zn/HCl} C$$

The product 'C' is

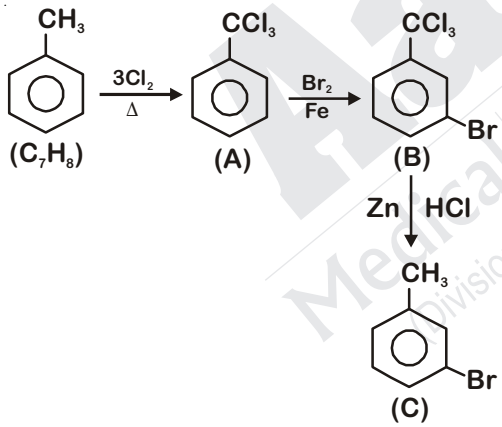
(1) p-bromotoluene

(2) m-bromotoluene

(3) 3-bromo-2,4,6-trichlorotoluene

(4) o-bromotoluene

Answer (2)

Sol. 

(C_7H_8) (A) (B) (C)

159. Which oxide of nitrogen is not a common pollutant introduced into the atmosphere both due to natural and human activity?

(1) NO

(2) N_2O_5

(3) N_2O

(4) NO_2

Answer (2)

Sol. Fact

160. The correct difference between first and second order reactions is that

(1) The rate of a first-order reaction does depend on reactant concentrations; the rate of a second-order reaction does not depend on reactant concentrations

(2) The rate of a first-order reaction does not depend on reactant concentrations; the rate of a second-order reaction does depend on reactant concentrations

(3) A first-order reaction can catalyzed; a second-order reaction cannot be catalyzed

(4) The half-life of a first-order reaction does not depend on $[A]_0$; the half-life of a second-order reaction does depend on $[A]_0$

Answer (4)

Sol. ♦ For first order reaction, $t_{1/2} = \frac{0.693}{k}$, which is independent of initial concentration of reactant.

♦ For second order reaction, $t_{1/2} = \frac{1}{k[A_0]}$, which depends on initial concentration of reactant.

161. Among CaH_2, BeH_2, BaH_2, the order of ionic character is

(1) $BaH_2 < BeH_2 < CaH_2$

(2) $BeH_2 < CaH_2 < BaH_2$

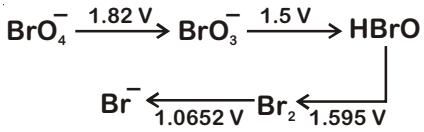
(3) $BeH_2 < BaH_2 < CaH_2$

(4) $CaH_2 < BeH_2 < BaH_2$

Answer (2)

Sol. For 2nd group hydrides, on moving down the group metallic character of metals increases so ionic character of metal hydride increases.

162. Consider the change in oxidation state of Bromine corresponding to different emf values as shown in the diagram below :



Then the species undergoing disproportionation is

(1) HBrO (2) BrO_3^-

(3) Br_2 (4) BrO_4^-

Answer (1)

Sol. $\overset{+1}{HBrO} \longrightarrow \overset{0}{Br_2}$, $E^o_{HBrO/Br_2} = 1.595\ V$

$\overset{+1}{HBrO} \longrightarrow \overset{+5}{BrO_3^-}$, $E^o_{BrO_3^-/HBrO} = 1.5\ V$

E^o_{cell} for the disproportionation of HBrO,

$E^o_{cell} = E^o_{HBrO/Br_2} - E^o_{BrO_3^-/HBrO}$

$= 1.595 - 1.5$

$= 0.095\ V = +ve$

163. In which case is number of molecules of water maximum?

(1) 10^{-3} mol of water

(2) 18 mL of water

(3) 0.00224 L of water vapours at 1 atm and 273 K

(4) 0.18 g of water

Answer (2)

Sol. (1) Molecules of water = mole × N_A = $10^{-3}\ N_A$

(2) Mass of water = 18 × 1 = 18 g

Molecules of water = mole × $N_A = \frac{18}{18} N_A$

$= N_A$

(3) Moles of water = $\frac{0.00224}{22.4} = 10^{-4}$

Molecules of water = mole × $N_A = 10^{-4}\ N_A$

(4) Molecules of water = mole × $N_A = \frac{0.18}{18} N_A$

$= 10^{-2}\ N_A$

164. Carboxylic acids have higher boiling points than aldehydes, ketones and even alcohols of comparable molecular mass. It is due to their

(1) Formation of intermolecular H-bonding

(2) Formation of intramolecular H-bonding

(3) More extensive association of carboxylic acid via van der Waals force of attraction

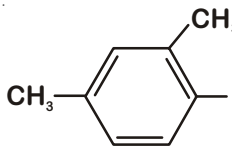
(4) Formation of carboxylate ion

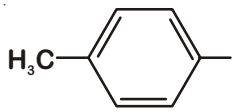
Answer (1)

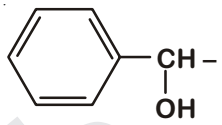
Sol. Due to formation of intermolecular H-bonding in carboxylic acid, association occurs. Hence boiling point increases and become more than the boiling point of aldehydes, ketones and alcohols of comparable molecular masses.

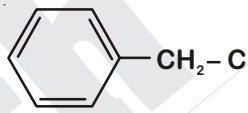
165. Compound A, $C_8H_{10}O$, is found to react with NaOI (produced by reacting Y with NaOH) and yields a yellow precipitate with characteristic smell.

A and Y are respectively

(1)  OH and I_2

(2)  CH_2 – OH and I_2

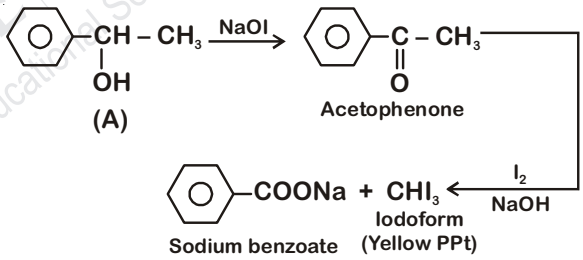
(3)  $CH - CH_3$ and I_2

(4)  $CH_2 - CH_2 - OH$ and I_2

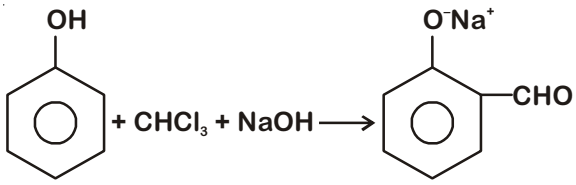
Answer (3)

Sol. Option (3) is secondary alcohol which on oxidation gives phenylmethyl ketone (Acetophenone). This on reaction with I_2 and NaOH form iodoform and sodium benzoate.

$2NaOH + I_2 \rightarrow NaOI + NaI + H_2O$



166. In the reaction



The electrophile involved is

(1) Dichlorocarbene $(:CCl_2)$

(2) Dichloromethyl cation $(\overset{\oplus}{C}HCl_2)$

(3) Dichloromethyl anion $(\overset{\ominus}{C}HCl_2)$

(4) Formyl cation $(\overset{\oplus}{C}HO)$

Answer (1)

Sol. It is Reimer-Tiemann reaction. The electrophile formed is :CCl_2 (Dichlorocarbene) according to the following reaction

$$CHCl_3 + OH^- \rightleftharpoons \overset{\ominus}{C}Cl_3 + H_2O$$

$$\overset{\ominus}{C}Cl_3 \longrightarrow \underset{\text{Electrophile}}{:CCl_2} + Cl^-$$

167. The bond dissociation energies of X_2, Y_2 and XY are in the ratio of 1 : 0.5 : 1. ΔH for the formation of XY is –200 kJ mol^{-1}. The bond dissociation energy of X_2 will be

(1) 400 kJ mol^{-1}

(2) 200 kJ mol^{-1}

(3) 800 kJ mol^{-1}

(4) 100 kJ mol^{-1}

Answer (3)

Sol. The reaction for $\Delta_f H°(XY)$

$$\frac{1}{2}X_2(g) + \frac{1}{2}Y_2(g) \longrightarrow XY(g)$$

Bond energies of X_2, Y_2 and XY are X, $\frac{X}{2}$, X respectively

$$\therefore \quad \Delta H = \left(\frac{X}{2} + \frac{X}{4}\right) - X = -200$$

On solving, we get

$$\Rightarrow -\frac{X}{2} + \frac{X}{4} = -200$$

$\Rightarrow$ X = 800 kJ/mole

168. When initial concentration of the reactant is doubled, the half-life period of a zero order reaction

(1) Remains unchanged

(2) Is halved

(3) Is tripled

(4) Is doubled

Answer (4)

Sol. Half life of zero order

$$t_{1/2} = \frac{[A_0]}{2K}$$

$t_{1/2}$ will be doubled on doubling the initial concentration.

169. The correction factor 'a' to the ideal gas equation corresponds to

(1) Forces of attraction between the gas molecules

(2) Density of the gas molecules

(3) Electric field present between the gas molecules

(4) Volume of the gas molecules

Answer (1)

Sol. In real gas equation, $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$

van der Waal's constant, 'a' signifies intermolecular forces of attraction.

170. Which one of the following conditions will favour maximum formation of the product in the reaction,

$$A_2(g) + B_2(g) \rightleftharpoons X_2(g)\ \Delta_r H = -X\ kJ?$$

(1) High temperature and low pressure

(2) Low temperature and high pressure

(3) High temperature and high pressure

(4) Low temperature and low pressure

Answer (2)

Sol. $A_2(g) + B_2(g) \rightleftharpoons X_2(g);\ \Delta H = -x\ kJ$

On increasing pressure equilibrium shifts in a direction where pressure decreases i.e. forward direction.

On decreasing temperature, equilibrium shifts in exothermic direction i.e., forward direction.

So, high pressure and low temperature favours maximum formation of product.

171. For the redox reaction

$$MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$$

The correct coefficients of the reactants for the balanced equation are

	MnO_4^-	$C_2O_4^{2-}$	H^+
(1)	5	16	2
(2)	16	5	2
(3)	2	16	5
(4)	2	5	16

Answer (4)

Sol. $\overset{+7}{MnO_4^-} + \overset{+3}{C_2O_4^{2-}} + H^+ \longrightarrow \overset{+2}{Mn^{2+}} + \overset{+4}{CO_2} + H_2O$

Reduction

Oxidation

n-factor of MnO_4^- $\Rightarrow 5$

n-factor of $C_2O_4^{2-}$ $\Rightarrow 2$

Ratio of n-factors of MnO_4^- and $C_2O_4^{2-}$ is 5 : 2

So, molar ratio in balanced reaction is 2 : 5

$\therefore$ The balanced equation is

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

172. Regarding cross-linked or network polymers, which of the following statements is incorrect?

(1) They contain strong covalents bonds in their polymer chains.

(2) They contain covalent bonds between various linear polymer chains.

(3) Examples are bakelite and melamine.

(4) They are formed from bi- and tri-functional monomers.

Answer (1)

Sol. Cross linked or network polymers are formed from bi-functional and tri-functional monomers and contain strong covalent bonds between various linear polymer chains, e.g. bakelite, melamine etc. Option (1) is not related to cross-linking.

173. Nitration of aniline in strong acidic medium also gives m-nitroaniline because

(1) In acidic (strong) medium aniline is present as anilinium ion.

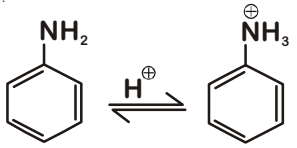
(2) Inspite of substituents nitro group always goes to only m-position.

(3) In absence of substituents nitro group always goes to m-position.

(4) In electrophilic substitution reactions amino group is meta directive.

Answer (1)

Sol.



Anilinium ion

$-\overset{\oplus}{N}H_3$ is m-directing, hence besides para (51%) and ortho (2%), meta product (47%) is also formed in significant yield.

174. Which of the following oxides is most acidic in nature?

(1) CaO (2) MgO

(3) BaO (4) BeO

Answer (4)

Sol. BeO < MgO < CaO < BaO

$\longrightarrow$

Basic character increases.

So, the most acidic should be BeO. In fact, BeO is amphoteric oxide while other given oxides are basic.

175. The difference between amylose and amylopectin is

(1) Amylose is made up of glucose and galactose

(2) Amylopectin have 1 $\rightarrow$ 4 α-linkage and 1 $\rightarrow$ 6 α-linkage

(3) Amylopectin have 1 $\rightarrow$ 4 α-linkage and 1 $\rightarrow$ 6 β-linkage

(4) Amylose have 1 $\rightarrow$ 4 α-linkage and 1 $\rightarrow$ 6 β-linkage

Answer (2)

Sol. Amylose and Amylopectin are polymers of α-D-glucose, so β-link is not possible. Amylose is linear with 1 $\rightarrow$ 4 α-linkage whereas Amylopectin is branched and has both 1 $\rightarrow$ 4 and 1 $\rightarrow$ 6 α-linkages.

176. A mixture of 2.3 g formic acid and 4.5 g oxalic acid is treated with conc. H_2SO_4. The evolved gaseous mixture is passed through KOH pellets. Weight (in g) of the remaining product at STP will be

(1) 4.4 (2) 1.4

(3) 2.8 (4) 3.0

Answer (3)

Sol. $\underset{2.3\,g\ or\ \left(\frac{1}{20}\,mol\right)}{HCOOH} \xrightarrow{Conc.H_2SO_4} \underset{\frac{1}{20}\,mol}{CO(g)} + H_2O(l)$

$\underset{\underset{4.5\,g\ or\ \left(\frac{1}{20}\,mol\right)}{COOH}}{\overset{COOH}{|}} \xrightarrow{Conc.H_2SO_4} \underset{\frac{1}{20}\,mol}{CO(g)} + \underset{\frac{1}{20}\,mol}{CO_2(g)} + H_2O(l)$

Gaseous mixture formed is CO and CO_2 when it is passed through KOH, only CO_2 is absorbed. So the remaining gas is CO.

So, weight of remaining gaseous product CO is

$$\frac{2}{20} \times 28 = 2.8\,g$$

177. Which one is a **wrong** statement?

(1) The value of m for d_z2 is zero

(2) Total orbital angular momentum of electron in 's' orbital is equal to zero

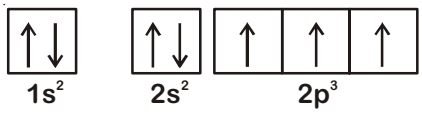
(3) The electronic configuration of N atom is



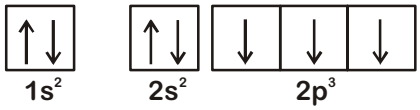
(4) An orbital is designated by three quantum numbers while an electron in an atom is designated by four quantum numbers

Answer (3)

Sol. According to Hund's Rule of maximum multiplicity, the correct electronic configuration of N-atom is



OR



∴ Option (3) violates Hund's Rule.

178. Consider the following species :

CN^+, CN^-, NO and CN

Which one of these will have the highest bond order?

(1) CN

(2) NO

(3) CN^+

(4) CN^-

Answer (4)

Sol. NO : $(\sigma1s)^2$, $(\sigma^*1s)^2$, $(\sigma2s)^2$,$(\sigma^*2s)^2$,$(\sigma2p_z)^2$, $(\pi2p_x)^2 = (\pi2p_y)^2$,$(\pi^*2p_x)^1 = (\pi^*2p_y)^0$

$$BO = \frac{10-5}{2} = 2.5$$

CN^- : $(\sigma1s)^2$, $(\sigma^*1s)^2$, $(\sigma2s)^2$,$(\sigma^*2s)^2$, $(\pi2p_x)^2$ $= (\pi2p_y)^2$,$(\sigma2p_z)^2$

$$BO = \frac{10-4}{2} = 3$$

CN : $(\sigma1s)^2$, $(\sigma^*1s)^2$, $(\sigma2s)^2$,$(\sigma^*2s)^2$, $(\pi2p_x)^2$ $= (\pi2p_y)^2$,$(\sigma2p_z)^1$

$$BO = \frac{9-4}{2} = 2.5$$

CN^+ : $(\sigma1s)^2$, $(\sigma^*1s)^2$, $(\sigma2s)^2$,$(\sigma^*2s)^2$, $(\pi2p_x)^2$ $= (\pi2p_y)^2$

$$BO = \frac{8-4}{2} = 2$$

179. Magnesium reacts with an element (X) to form an ionic compound. If the ground state electronic configuration of (X) is $1s^2\ 2s^2\ 2p^3$, the simplest formula for this compound is

(1) Mg_3X_2

(2) Mg_2X_3

(3) Mg_2X

(4) MgX_2

Answer (1)

Sol. Element (X) electronic configuration

$1s^2\ 2s^2\ 2p^3$

So, valency of X will be 3.

Valency of Mg is 2.

Formula of compound formed by Mg and X will be Mg_3X_2.

180. Iron exhibits bcc structure at room temperature. Above 900°C, it transforms to fcc structure. The ratio of density of iron at room temperature to that at 900°C (assuming molar mass and atomic radii of iron remains constant with temperature) is

(1) $\frac{1}{2}$ (2) $\frac{\sqrt{3}}{\sqrt{2}}$

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

Answer (3)

Sol. For BCC lattice : Z = 2, $a = \frac{4r}{\sqrt{3}}$

For FCC lattice : Z = 4, $a = 2\sqrt{2}\,r$

$$\therefore \frac{d_{25^\circ C}}{d_{900^\circ C}} = \frac{\left(\frac{ZM}{N_A a^3}\right)_{BCC}}{\left(\frac{ZM}{N_A a^3}\right)_{FCC}} = \frac{2}{4}\left(\frac{2\sqrt{2}\,r}{\frac{4r}{\sqrt{3}}}\right)^3 = \left(\frac{3\sqrt{3}}{4\sqrt{2}}\right)$$

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