Jupiter Academy

Subjects : PHYSICS , CHEMISTRY , MATHS , BIOLOGY

CUET PYQ PAPER 01

(Solutions)

Total Marks : 1000

PHYSICS - Section A (MCQ)

1. When a convex lens of glass is immersed in water, its power will

A) increase **B)** decrease
C) remain the same **D)** become zero

Solution : (Correct Answer: B)

$P \propto (\frac{n_{lens}}{n_{medium}} - 1)$

$n_{water} > n_{air}$

$\Rightarrow (\frac{n_{lens}}{n_{water}} - 1) < (\frac{n_{lens}}{n_{air}} - 1)$

Power decreases.

2. Two metals, X and Y have work functions, 4 eV and 10 eV, respectively. The ratio of threshold wavelengths of metal X to metal Y is

A) $5:2$ **B)** $1:1$
C) $2:5$ **D)** $4:25$

Solution : (Correct Answer: A)

$\lambda_0 = \frac{hc}{\phi}$

$\frac{\lambda_{0X}}{\lambda_{0Y}} = \frac{\phi_Y}{\phi_X}$

$\frac{\lambda_{0X}}{\lambda_{0Y}} = \frac{10\text{ eV}}{4\text{ eV}}$

$\frac{\lambda_{0X}}{\lambda_{0Y}} = \frac{5}{2}$

3. A charged particle accelerated through a potential difference of V volts acquires a speed u. The particle is then made to enter perpendicularly in a uniform magnetic field B. The radius of the circular path followed by the charged particle will be proportional to

A) V/u **B)** u/V
C) V^2/u^2 **D)** u^2/V^2

Solution : (Correct Answer: A)

$\frac{1}{2}mu^2 = qV \Rightarrow m = \frac{2qV}{u^2}$

$quB = \frac{mu^2}{R}$

$R = \frac{mu}{qB}$

$R = \frac{(\frac{2qV}{u^2})u}{qB}$

$R = \frac{2V}{uB}$

$R \propto \frac{V}{u}$

4.

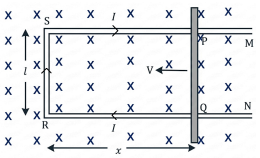


Figure shows a rectangular conductor PQRS in which the conductor PQ is free to move. The conductor PQ is moved towards the left with a constant velocity V as shown in the figure. Assume that there is no loss of energy due to friction. What will be the magnetic flux linked with the loop PQRS and the motional emf?

A) Magnetic $flux = Bl(xV)$; Motional $emf = Blx$
B) Magnetic $flux = Blx$; Motional $emf = (BlV)/t$
C) Magnetic flux = Blx: Motional emf = BlV
D) Magnetic flux $= B/(lx)$; Motional $emf = BlV$

Solution : (Correct Answer: C)

Magnetic flux $\Phi_B = B \times (\text{Area}) = B(lx) = Blx$

Motional emf $\epsilon = \left|\frac{d\Phi_B}{dt}\right| = \left|\frac{d(Blx)}{dt}\right| = \left|Bl\frac{dx}{dt}\right|$

Since $\left|\frac{dx}{dt}\right| = V$, $\epsilon = BlV$

5. Some of the commonly known ideas regarding magnetism are:
(A) It is possible to make magnets out of iron and its alloys
(B) It is possible to isolate the north or south pole of a magnet
(C) A bar magnet suspended freely, points in the north-south direction
(D) The earth behaves as a magnet with the magnetic field pointing approximately from the geographic south to the north
Choose the correct answer from the options given below:

A) (A), (C) and (D) only
B) (A), (B) and (C) only
C) (B), (C) and (D) only
D) (A), (B), (C) and (D)

Solution : (Correct Answer: A)

Statements (A), (C), and (D) are correct. Iron-based materials are ferromagnetic and easily magnetized, freely suspended magnets align with Earth's magnetic poles, and Earth's magnetic field lines emerge from the geographic south toward the geographic north. Statement (B) is false because magnetic monopoles do not exist; cutting a magnet

always results in two smaller magnets, each with its own north and south pole.

6. The reverse biasing in a p-n junction diode

A) decreases the potential barrier height
B) increases the potential barrier height
C) decreases the number of minority charge carriers
D) increases the number of majority charge carriers

Solution : (Correct Answer: A)

In a reverse-biased p-n junction, the positive terminal of the battery is connected to the n-side and the negative terminal to the p-side. This pulls majority carriers (holes and electrons) away from the junction, which widens the depletion layer and increases the potential barrier height.

7. The light rays travel from a glass slab with refractive index μ_1 to the second slab with refractive index μ_2. The refractive index of the second slab with respect to the first one is: (Assume that the two slabs have the same thickness)

A) $1\mu_2 = \mu_1/\mu_2$
B) $1\mu_2 = \mu_2/\mu_1$
C) $1\mu_2 = \mu_1 \times \mu_2$
D) $2\mu_1 = \mu_1/\mu_2$

Solution : (Correct Answer: A)

The refractive index of the second slab with respect to the first one is: ${}_1\mu_2 = \frac{\mu_2}{\mu_1}$

8. Which of the following statements are correct?
(A) In reverse bias of a p-n junction, negative terminal of the battery is connected to p-side of the junction,
(B) Reverse bias does not support the potential barrier at the junction.
(C) In reverse bias, a few minority charge carriers cross the junction.
(D) Resistance of p-n junction is high in reverse bias, reducing the current to a negligible value.
Choose the correct answer from the given options.

A) (A) and (D) only
B) (A), (C) and (D) only
C) (A) and (C) only
D) (C) and (D) only

Solution : (Correct Answer: B)

(A) Correct: In reverse bias, the p-side (anode) of the junction is connected to the negative terminal of the battery, and the n-side (cathode) is connected to the positive terminal.
(C) Correct: While majority carriers are blocked, a very small current (reverse saturation current) flows due to minority charge carriers crossing the junction.
(D) Correct: The resistance of a p-n junction in reverse bias is very high (often in the range of Megaohms), which reduces the current to a negligible level.
Statements (A), (C), (D) are correct.
Option: (A), (C) and (D) only

9. A resistor connected to a battery is heated due to the current. The quantity which does not change is

A) drift speed of the charge carriers
B) number of free electrons
C) conductance
D) resistivity

Solution : (Correct Answer: B)

In a metallic conductor, the number of free electrons (electron density) is a fixed property of the material's atomic structure and does not change with temperature. While heating increases the vibration of metal ions—which slows down the drift speed, increases resistivity, and decreases conductance—it does not alter the total count of available charge carriers.
B) number of free electrons.

10. Match List-I with List-II

List-I (Physical quantity)	List-II (Formula)
(A) Current sensitivity of galvanometer	(I) $\frac{\mu_0 I}{2R}$
(B) Magnetic field at the centre of a circular coil	(II) $\frac{NAB}{kR}$
(C) magnetic field due to a long straight wire carrying a current	(III) $\frac{NAB}{k}$
(D) Voltage sensitivity of galvanometer	(IV) $\frac{\mu_0 I}{2\pi R}$

Choose the correct answer from the options given below:

A) (A) - (III), (B) - (I), (C) - (II), (D) - (IV)
B) (A) - (IV), (B) - (II), (C) - (III), (D) - (I)
C) (A) - (III), (B) - (I), (C) - (IV), (D) - (II)
D) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)

Solution : (Correct Answer: D)

(A) Current sensitivity of galvanometer: $\frac{NAB}{k}$ → (III)

(B) Magnetic field at the centre of a circular coil: $\frac{\mu_0 I}{2R}$ → (I)

(C) magnetic field due to a long straight wire carrying a current: $\frac{\mu_0 I}{2\pi R}$ → (IV)

(D) Voltage sensitivity of galvanometer: $\frac{NAB}{kR}$ → (II)

11. Some important general properties of the electric field lines are given below:
(A) Field lines start from positive charges and end at negative charges
(B) In a charge-free region, electric field lines can be taken to be continuous curves without any breaks
(C) Electrostatic field lines form closed loops
(D) Two field lines can never cross each other
Choose the correct answer from the options given below:

A) (A), (C) and (D) only
B) (A), (B) and (D) only
C) (B), (C) and (D) only
D) (A), (B), (C) and (D)

Solution : (Correct Answer: B)

Statement (A) is correct: Electric field lines emerge from positive charges and terminate at negative charges.
Statement (B) is correct: In a region without charges, the field is continuous; therefore, the lines are continuous curves without any sudden breaks.
Statement (D) is correct: Two field lines can never cross. If they did, the electric field at the point of intersection would have two different directions simultaneously, which is physically impossible.

12. The electric field at a distance of 0.20 m from a point charge q is 1.35×10^3 N $\cdot$ C^{-1}. The electric potential at the same distance will be:

A) 5.4×10^{-3} V **B)** 2.7×10^2 V
C) 6×10^{-9} V **D)** 2.7×10^{-4} V

Solution : (Correct Answer: B)

$V = E \cdot r$

$V = (1.35 \times 10^3 \text{ N} \cdot C^{-1}) \cdot (0.20 \text{ m})$

$V = 2.7 \times 10^2 \text{ V}$

13. Read the following statements and identify the correct statements.
(A) In a semiconductor doped with trivalent impurity, the holes are the majority carriers and electrons are minority carriers.
(B) In pure semiconductors, the number of free electrons is equal to the number of holes.
(C) In a semiconductor doped with pentavalent impurity, electrons become the majority carriers and holes the minority carriers.
(D) Important electronic devices can be developed using intrinsic semiconductors.
Choose the correct answer from the options given below:

A) (A), (B) and (C) only
B) (A), (C) and (D) only
C) (B), (C) and (D) only
D) (A),(B), (C) and (D)

Solution : (Correct Answer: A)

Statements (A), (B), and (C) are correct.
(A) Correct: In p-type semiconductors (doped with trivalent impurities like Boron), holes are majority carriers and electrons are minority carriers.
(B) Correct: In intrinsic (pure) semiconductors, $n_e = n_h$.
(C) Correct: In n-type semiconductors (doped with pentavalent impurities like Phosphorus), electrons are majority carriers and holes are minority carriers.
(D) Incorrect: Most electronic devices (diodes, transistors) require extrinsic semiconductors to function effectively; intrinsic semiconductors have very low conductivity at room temperature.

14. If both the number of turns and length of an inductor are tripled, keeping other factors constant, the self inductance of the inductor will be:

A) tripled **B)** doubled
C) four times its initial value **D)** Unchanged

Solution : (Correct Answer: A)

$L = \frac{\mu N^2 A}{l}$

$L' = \frac{\mu (3N)^2 A}{3l}$

$L' = \frac{9\mu N^2 A}{3l} = 3\frac{\mu N^2 A}{l} = 3L$

tripled

15. An object is placed at 5 cm in front of a concave mirror with a radius of curvature of 20 cm. The distance of the image from mirror and its nature are

A) 10 cm, virtual and erect
B) 10 cm, real and inverted
C) 15 cm, real and inverted
D) 3.3 cm, virtual and erect

Solution : (Correct Answer: A)

$f = R/2 = -20 \text{ cm}/2 = -10 \text{ cm}$

$1/f = 1/u + 1/v$

$1/(-10) = 1/(-5) + 1/v$

$1/v = 1/(-10) - 1/(-5) = -1/10 + 1/5 = 1/10$

$v = 10 \text{ cm}$

Nature: virtual and erect (since v is positive)

16. Two coaxial solenoids having number of turns per unit length 50 and 200, respectively, have same length 50 cm. The area of cross-section of the two solenoids are $4\ \text{cm}^2$ and $6\ \text{cm}^2$, respectively. The mutual inductance of the two solenoids is:

A) $8\pi \times 10^{-3}\,\text{H}$ **B)** $4\pi \times 10^{-4}\,\text{H}$
C) $8\pi \times 10^{-7}\,\text{H}$ **D)** $1.6\pi \times 10^{-2}\,\text{H}$

Solution : (Correct Answer: A)

$M = \frac{4\pi\times10^{-7}\times50\times200\times4.9\times10^{-4}}{0.5}$
$M = \frac{4\pi\times10^{-7}\times50\times200\times4.9\times10^{-4}}{0.5} = 8\pi \times 10^{-3}H$
$8\pi \times 10^{-3}H.$

17. A cell of emf 2.2 V gives a current of 0.2 A through a resistance of 9 Ω. The internal resistance of the cell will be:

A) 1 Ω **B)** 2 Ω
C) 4 Ω **D)** 1.1 Ω

Solution : (Correct Answer: B)

$r = \frac{E}{I} - R$

$r = \frac{2.2\ \text{V}}{0.2\ \text{A}} - 9\Omega$

$r = 11\Omega - 9\Omega$

$r = 2\Omega$

18. On adding a small amount of boron to a silicon crystal

A) boron becomes a donor atom
B) its resistance is increased
C) it becomes a n-type semiconductor
D) it becomes a p-type semiconductor

Solution : (Correct Answer: D)

Boron is a trivalent impurity (3 valence electrons), so when added to tetravalent silicon (4 valence electrons), it creates "holes" as majority charge carriers. This process of doping significantly decreases resistance and forms a p-type (positive-type) semiconductor.
D) it becomes a p-type semiconductor

19. A regular hexagon of side 12 cm has a charge of 6 μC at each of its vertices. What will be the potential at the centre of the hexagon?

A) $2.7 \times 10^4\,\text{V}$ **B)** $4.5 \times 10^6\,\text{V}$
C) $2.65 \times 10^{-16}\,\text{V}$ **D)** $2.7 \times 10^6\,\text{V}$

Solution : (Correct Answer: D)

$r = 12\,\text{cm} = 0.12\,\text{m}$

$V_{\text{total}} = 6 \times \frac{kq}{r}$

$V_{\text{total}} = 6 \times \frac{(9\times10^9)(6\times10^{-6})}{0.12}$

$V_{\text{total}} = 2.7 \times 10^6\,\text{V}$

20. A 600 pF capacitor is charged by a 150 V battery. The charge on the capacitor is:

A) 9 μC **B)** 4 pC **C)** 90 nC **D)** 9 nC

Solution : (Correct Answer: C)

$Q = CV$

$Q = (600 \times 10^{-12}\ \text{F}) \times (150\ \text{V})$

$Q = 90 \times 10^{-9}\ \text{C} = 90\ \text{nC}$

21. Identify the electromagnetic waves as per their following use/ applications.
(A) λ_1 is used to produce heating effect
(B) λ_2 is used in satellite communication
(C) λ_3 is absorbed by the ozone layer
(D) λ_4 is used for studying crystal structure
Choose the correct answer from the options given below:

A) (A) Microwave, (B) Visible, (C) UV, (D) Infrared
B) (A) Infrared, (B) Microwave, (C) Ultraviolet, (D) Visible
C) (A) Infrared, (B) Microwave, (C) Ultraviolet, (D) X-rays
D) (A) UV, (B) Microwave, (C) Infrared, (D) Visible

Solution : (Correct Answer: C)

(A) Infrared, (B) Microwave, (C) Ultraviolet, (D) X-rays

22. A piece of copper and a piece of germanium are cooled from room temperature 20 C down to 80 K. The resistance of

A) both of them will increase.
B) both of them will decreases.
C) copper increases and that of germanium decreases.
D) copper decreases and that of germanium increases.

Solution : (Correct Answer: D)

Copper is a metal; its resistance decreases with decreasing temperature.

Germanium is a semiconductor; its resistance increases with decreasing temperature.

Result: copper decreases and that of germanium increases.

23. Identify the correct statements about the internal resistance of a cell:
(A) It depends on the nature of the electrolyte
(B) It increases with the increase in temperature of the electrolyte
(C) It increases with the decrease in temperature of the electrolyte
(D) It increases with the distance between the two electrodes
Choose the correct answer from the options given below:

A) (A) and (D) only **B)** (A), (B) and (D) only
C) (A), (C) and (D) only **D)** (B) and (D) only

Solution : (Correct Answer: C)

Internal resistance depends on the electrolyte's nature (A) and increases with the distance between electrodes (D) because ions must travel further. It inversely relates to temperature, meaning it increases as temperature decreases (C) due to higher electrolyte viscosity.

24. In a Young's double slit experiment, a light of wavelength 550 nm is used to get fringes on screen 1.2 m away from the slits. The distance between the two slits is 1.5 mm. The fringe width is

A) 4.4 mm **B)** 0.44 mm **C)** 5.5 mm **D)** 4.0 mm

Solution : (Correct Answer: B)

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

$\beta = \frac{(550\times10^{-9}\ \text{m})(1.2\ \text{m})}{1.5\times10^{-3}\ \text{m}}$

$\beta = 4.4 \times 10^{-4}\ \text{m} = 0.44\ \text{mm}$

25. Two long straight parallel wires are carrying charges λ_1 and λ_2 per unit length, respectively. The separation between their axes is d. The magnitude of the force exerted on unit length of one wire due to the charge on the other wire is

A) $f = \frac{\lambda_1\lambda_2}{2\pi\epsilon_0 d}$
B) $f = \frac{\lambda_1\lambda_2}{4\pi\epsilon_0 d}$
C) $f = \frac{\lambda_1\lambda_2}{4\pi\epsilon_0 d^2}$
D) $f = \frac{\lambda_1\lambda_2}{(2\pi\epsilon_0 d)^2}$

Solution : (Correct Answer: A)

$E_1 = \frac{\lambda_1}{2\pi\epsilon_0 d}$

$f = E_1\lambda_2$

$f = \frac{\lambda_1\lambda_2}{2\pi\epsilon_0 d}$

26. A $100\mu F$ capacitor is charged with a 50 V source supply. Then the source supply is removed, and the capacitor is connected across a pure inductor coil. As a result of which 5 A current flows through the inductor. The value of the self-inductance of the coil is:

A) 0.01 H **B)** 0.02 H **C)** 0.1 H **D)** 0.17 H

Solution : (Correct Answer: A)

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

$L = \frac{CV^2}{I^2} = \frac{(100\times10^{-6}F)(50V)^2}{(5A)^2}$

$L = 0.01H$

27. A charge of 50 μC is uniformly distributed on the surface of a thin spherical shell of radius 10 cm. The electric field at a point at a distance of 5 cm from the center of the shell is

A) $18 \times 10^7\ N/C$ **B)** $9 \times 10^7\ N/C$
C) $9 \times 10^8\ N/C$ **D)** Zero

Solution : (Correct Answer: D)

According to Gauss's Law, the electric field inside a uniformly charged hollow spherical shell is zero because the net charge enclosed by a Gaussian surface inside the shell ($r < R$) is zero. Since the point in question is at 5 cm and the shell radius is 10 cm , the point lies inside the shell.
D) Zero

28. To form n-type semiconductor from a pure semiconductor, the impurity to be added is

A) Aluminium **B)** Boron **C)** Indium **D)** Arsenic

Solution : (Correct Answer: D)

To form an n-type semiconductor, a pure semiconductor (like Silicon or Germanium) must be doped with a pentavalent impurity (elements with 5 valence electrons). Arsenic has 5 valence electrons, providing an extra "free" electron for conduction. In contrast, Aluminium, Boron, and Indium are trivalent impurities (3 valence electrons) used to create p-type semiconductors.

29. A transformer has 1000 turns in the primary and 2000 turns in its secondary winding. The primary voltage is 200 V and the load across the secondary is 100Ω. If the transformer is assumed to be ideal, then the value of current in the primary is

A) $4.0A$ **B)** $2.5A$
C) $5.0A$ **D)** $8.0A$

Solution : (Correct Answer: D)

$V_s = V_p\frac{N_s}{N_p} = 200V \times \frac{2000}{1000} = 400V$

$I_s = \frac{V_s}{R_s} = \frac{400V}{100\Omega} = 4A$

$I_p = \frac{V_s I_s}{V_p} = \frac{400V \times 4A}{200V} = 8A$

30. Which of the following factors does Not affect the value of self inductance of a solenoid?

A) Number of turns
B) Area of cross-section of the solenoid
C) Permeability of the core material
D) current flowing through the inductor.

Solution : (Correct Answer: D)

Current flowing through the inductor.
The self-inductance (L) of a solenoid is a physical property determined by its geometry and the core material. The formula for the self-inductance of a long solenoid is given by $L = \frac{\mu N^2 A}{l}$, where:
- μ is the permeability of the core material.
- N is the number of turns.
- A is the area of cross-section.
- l is the length of the solenoid.

31. Which of the following will increase the mobility of charge carriers?

A) decrease in the charge of the mobile charge carriers
B) increase in the mass of the mobile charge carriers
C) increase in their average collision time
D) increase in the electric field

Solution : (Correct Answer: C)

$\mu = \frac{q\tau}{m}$

increase in their average collision time

32. Kinetic energies of four particles a, b, c, d of equal masses are given below. Arrange them in order of their decreasing de-Broglie wavelengths.
(A) $(KE)_a = 1$ eV
(B) $(KE)_b = 0.01$ eV
(C) $(KE)_c = 4$ eV
(D) $(KE)_d = 16$ eV
Choose the correct answer from the options given below:

A) (A), (B), (C), (D)
B) (B), (A), (C), (D)
C) (B), (A), (D), (C)
D) (C), (B), (D), (A)

Solution : (Correct Answer: B)

$\lambda \propto \frac{1}{\sqrt{KE}}$

$(KE)_b = 0.01$ eV

$(KE)_a = 1$ eV

$(KE)_c = 4$ eV

$(KE)_d = 16$ eV

Decreasing λ: (B), (A), (C), (D)

33. Which of the following examples are based upon the total internal reflection of light?
(A) Optical fibre
(B) Twinkling of stars
(C) Mirage
(D) Sparkling of diamond
Choose the correct answer from the options given below:

A) (A), (B) and (D) only
B) (A), (C) and (D) only
C) (B), (C) and (D) only
D) (A), (B) and (C) only

Solution : (Correct Answer: B)

The examples based upon the total internal reflection of light are:

(A) Optical fibre

(C) Mirage

(D) Sparkling of diamond

Therefore, the correct answer is (A), (C) and (D) only.

34. Forward bias applied to a p-n junction diode

A) widens the depletion region
B) increases the number of donors on the n-side
C) decreases the electric field in the depletion region
D) increases the potential difference across the depletion region

Solution : (Correct Answer: C)

decreases the electric field in the depletion region
This is correct. In forward bias, the electric field in the depletion region is reduced because the external voltage opposes the built-in potential, allowing more charge carriers to flow and decreasing the width of the depletion region.

35. Which of the following statement is correct regarding a p-n junction diode.

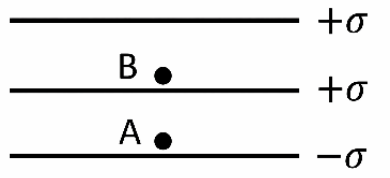
A) During reverse bias, the width of the depletion region decreases.
B) During forward bias, the barrier height increases due to applied voltage.
C) The diode current during reverse bias is not much dependent on the applied voltage upto the breakdown voltage.
D) A milliammeter is used to measure current in a reverse biased diode.

Solution : (Correct Answer: C)

The diode current during reverse bias is not much dependent on the applied voltage upto the breakdown voltage.

This is correct. In reverse bias, the current is very small (leakage current) up to the breakdown voltage. The current remains nearly constant until the reverse bias reaches a critical value known as the breakdown voltage, after which the current increases sharply.

36. In this diagram, three infinite plane sheets of charges are shown with surface charge densities $+\sigma, +\sigma, -\sigma$. The value of electric field at points A and B are



A) 0 at A and 0 at B
B) $\frac{\sigma}{2\epsilon_0}$ at A and $\frac{3\sigma}{2\epsilon_0}$ at B
C) $\frac{3\sigma}{2\epsilon_0}$ at A and $\frac{\sigma}{2\epsilon_0}$ at B
D) $\frac{3\sigma}{2\epsilon_0}$ at A and 0 at B

Solution : (Correct Answer: C)

$E_A = -\frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = -\frac{\sigma}{2\epsilon_0}$

$|E_A| = \frac{\sigma}{2\epsilon_0}$

$E_B = \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = \frac{3\sigma}{2\epsilon_0}$

37. A proton and a deuteron execute circular orbits having same radii of 0.5 m in a plane perpendicular to a uniform magnetic field B. If the kinetic energy of the deuteron is 50 keV, the K.E. of the proton will be

A) 200 keV **B)** 100 keV **C)** 50 keV **D)** 25 keV

Solution : (Correct Answer: B)

$K = \frac{(qrB)^2}{2m}$

$\frac{K_p}{K_d} = \frac{q_p^2 r_p^2 B^2/(2m_p)}{q_d^2 r_d^2 B^2/(2m_d)}$

$\frac{K_p}{K_d} = \frac{q_p^2}{q_d^2} \cdot \frac{m_d}{m_p} \cdot \frac{r_p^2}{r_d^2}$

$K_p = K_d \cdot \left(\frac{e}{e}\right)^2 \cdot \left(\frac{2m_p}{m_p}\right) \cdot \left(\frac{r}{r}\right)^2$

$K_p = 50 \text{ keV} \cdot 1^2 \cdot 2 \cdot 1^2$

$K_p = 100 \text{ keV}$

38. In a coil, a current of 0.2 A increases at the rate of 0.4 A s^{-1}. If the power flow in the coil is 0.6 J s^{-1} the inductance of the coil is:

A) 7.5 H **B)** 3 H **C)** 1.2 H **D)** 0.75 H

Solution : (Correct Answer: A)

$P = LI\frac{dI}{dt}$

$0.6 = L \times 0.2 \times 0.4$

$L = \frac{0.6}{0.08} = 7.5 \text{ H}$

39. Which of the following statement(s) is/are incorrect?
(A) A current carrying loop may act as a magnetic dipole whose magnetic moment may depend on its area and the number of turns.
(B) A linear solenoid carrying current, may act as a bar magnet.
(C) The magnetic lines of forces due to the current carrying solenoid makes closed curves like in a bar magnet.
(D) The magnetic field inside a solenoid is perpendicular to its axis.
Choose the correct answer from the given options:

A) (A) and (C) only **B)** (B) and (D) only
C) (C) and (D) only **D)** (D) only

Solution : (Correct Answer: D)

Statement (A) is correct. The magnetic moment of a current loop is given by $M = NIA$.

Statement (B) is correct. A solenoid's magnetic field pattern resembles that of a bar magnet.

Statement (C) is correct. Magnetic field lines always form closed loops.

Statement (D) is incorrect. The magnetic field inside a solenoid is parallel to its axis.

The only incorrect statement is (D).

(D) only

40. The 'stopping potential' in photoelectric emissions

A) depends on both intensity and frequency of incident radiation.
B) depends on frequency and not on intensity of incident radiation.
C) depends on intensity and not on frequency of incident radiation.
D) does not depend on intensity and frequency of incident radiation.

Solution : (Correct Answer: B)

Stopping potential is determined by the maximum kinetic energy of emitted electrons, which according to Einstein's equation ($eV_0 = h\nu - \Phi_0$), depends solely on the frequency of incident light.
It is independent of intensity because intensity only changes the number of photons (and thus current), not the energy of individual photoelectrons.

41. A cell of constant emf is first connected to a resistance R_1 and then connected to a resistance R_2. If power delivered in both cases is same, then the internal resistance of the cell is

A) $\sqrt{R_1R_2}$ **B)** $\sqrt{\frac{R_1}{R_2}}$

C) $\frac{R_1-R_2}{2}$ **D)** $\frac{R_1+R_2}{2}$

Solution : (Correct Answer: A)

$P = \left(\frac{E}{R+r}\right)^2 R$

$P_1 = P_2 \implies \frac{R_1}{(R_1+r)^2} = \frac{R_2}{(R_2+r)^2}$

$\frac{\sqrt{R_1}}{R_1+r} = \frac{\sqrt{R_2}}{R_2+r}$

$\sqrt{R_1}(R_2+r) = \sqrt{R_2}(R_1+r)$

$r(\sqrt{R_1}-\sqrt{R_2}) = \sqrt{R_1R_2}(\sqrt{R_1}-\sqrt{R_2})$

$r = \sqrt{R_1R_2}$

42. A light bulb and an air core inductor are connected to an AC source. The glow of the light bulb increases if

(A) the frequency of an AC source increases

(B) a copper rod is inserted inside the inductor

(C) the frequency of an AC source decreases

(D) an iron rod is inserted inside the inductor

Choose the correct answer from the options given below:

A) (A), (B) and (E) only

B) (B), (C) and (D) only

C) (C), (D) and (E) only

D) (B), (C) and (E) only

Solution : (Correct Answer: D)

$I = V/\sqrt{R^2+X_L^2}$, where $X_L = 2\pi fL$

For (C): $f\downarrow \implies X_L\downarrow \implies \sqrt{R^2+X_L^2}\downarrow \implies I\uparrow$. Glow increases.

For (B): Copper rod $\implies$ Eddy currents $\implies$ Effective $L\downarrow \implies X_L\downarrow \implies \sqrt{R^2+X_L^2}\downarrow \implies I\uparrow$. Glow increases.

(B), (C) and (E) only

43. An ammeter of resistance $0.54\ \Omega$ reads current unto 1 A. The value of the shunt required to increase the range to 10 A is

A) $0.09\ \Omega$ **B)** $0.05\ \Omega$

C) $0.06\ \Omega$ **D)** $0.07\ \Omega$

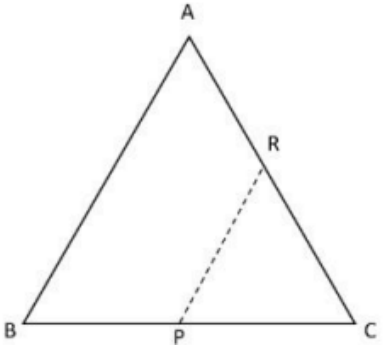
Solution : (Correct Answer: C)

$S = \frac{I_gR_g}{I-I_g}$

$S = \frac{1\text{ A}\times 0.54\ \Omega}{10\text{ A}-1\text{ A}}$

$S = 0.06\ \Omega$

44. Three charges, each equal to +q, are placed at the corners of an equilateral triangle ABC of side 'a' as shown in the figure. P and R are the mid-points of BC and CA. The work done in taking a charge Q from point P to R is:



A) $\frac{3qQ}{4\pi\varepsilon_0 a}$ **B)** $\frac{3qQ}{12\pi\varepsilon_0 a}$

C) $\frac{qQ}{4\pi\varepsilon_0 a}$ **D)** Zero

Solution : (Correct Answer: D)

$V_P = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{a\sqrt{3}/2}+\frac{1}{a/2}+\frac{1}{a/2}\right)$

$V_R = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{a/2}+\frac{1}{a\sqrt{3}/2}+\frac{1}{a/2}\right)$

Since the terms within the parentheses are identical, $V_P = V_R$.

$W_{PR} = Q(V_R - V_P) = Q(0) = 0$

45. At equilibrium condition, the rate of generation of electron-hole pairs in Ge crystal

A) is more than rate of recombination of electron and hole pairs

B) is less than rate of recombination of electron and hole pairs

C) equals the rate of recombination of electron and hole pairs

D) is always zero

Solution : (Correct Answer: C)

At thermal equilibrium, the concentration of charge carriers in a semiconductor remains constant. This occurs because the rate of generation (creation of electron-hole pairs due to thermal energy) exactly equals the rate of recombination (electrons falling back into holes).

46. A uniformly charged sphere of $80\ \mu\text{C}$ and radius 2 cm is placed in air.

The electric field intensity at a point 20 cm from the center of the sphere is:

A) $1.80\times10^7\ \text{N/C}$ **B)** $1.80\times10^5\ \text{N/C}$

C) $1.45\times10^5\ \text{N/C}$ **D)** $1.45\times10^7\ \text{N/C}$

Solution : (Correct Answer: A)

$E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$

$E = (9\times10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)\frac{80\times10^{-6}\ \text{C}}{(0.20\ \text{m})^2}$

$E = 1.80\times10^7\ \text{N/C}$

47. A 16 Ω wire is bent to form a square loop. A cell of 9 V is connected across one of its sides. The potential difference between the diagonals of the square loop is :

A) 6V **B)** 4.5 V **C)** 8V **D)** 9V

Solution : (Correct Answer: A)

$R_{side} = \frac{16\,\Omega}{4} = 4\,\Omega$

$R_{ADCB} = 3 \times 4\,\Omega = 12\,\Omega$

$I_{ADCB} = \frac{9\,V}{12\,\Omega} = 0.75\,A$

$V_C = I_{ADCB} \times R_{CB} = 0.75\,A \times 4\,\Omega = 3\,V$ (assuming $V_B = 0\,V$)

$V_{AC} = V_A - V_C = 9\,V - 3\,V = 6\,V$

48. Match List-I with List-II

List-I (Materials)	List-II (Band Gap (eV))
(A) Germanium	(I) 1.42 eV
(B) Gallium Arsenide	(II) > 3 eV
(C) Insulator	(III) 1.1 eV
(D) Silicon	(IV) 0.7 eV

Choose the correct answer from the options given below :

A) (A) - (III), (B) - (II), (C) - (I), (D) - (IV)
B) (A) - (IV), (B) - (I), (C) - (III), (D) - (II)
C) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)
D) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)

Solution : (Correct Answer: C)

(A) - (IV), (B) - (I), (C) - (II), (D) - (III)
(A) Germanium $\leftrightarrow$ (IV) 0.7 eV
(B) Gallium Arsenide $\leftrightarrow$ (I) 1.42 eV
(C) Insulator $\leftrightarrow$ (II) > 3 eV
(D) Silicon $\leftrightarrow$ (III) 1.1 eV

49. In a series LCR circuit, $C = 5\,\mu\text{F}$ and $\omega = 1000\ \text{rad/s}$. The value of inductance L for which the current is maximum in this circuit will be :

A) 100 mH **B)** 10 mH **C)** 50 mH **D)** 200 mH

Solution : (Correct Answer: D)

For maximum current (resonance): $X_L = X_C$

$\omega L = \frac{1}{\omega C}$

$L = \frac{1}{\omega^2 C} = \frac{1}{(1000)^2 \times (5 \times 10^{-6})}$

$L = \frac{1}{10^6 \times 5 \times 10^{-6}} = \frac{1}{5} = 0.2\ \text{H}$

$L = 200\ \text{mH}$

50. A charging capacitor has

A) Only conduction current present in connecting wire
B) Only displacement current present in the space between plates
C) Both displacement and conduction currents present
D) No current present in different regions of space

Solution : (Correct Answer: C)

Both displacement and conduction currents present

CHEMISTRY - Section A (MCQ)

51. Arrange the following in the increasing order of rate of the second order reaction Reactants $\rightarrow$ products
(A) Reaction at 298 K
(B) Reaction at 298 K with catalyst
(C) Reaction at 500 K with catalyst and double the initial concentration of reactant
(D) Reaction at 500 K with double the initial concentration of reactant
Choose the correct answer from the options given below:

A) (A), (B), (D), (C) **B)** (A), (B), (C), (D)
C) (D), (B), (C), (A) **D)** (A), (C), (D), (B)

Solution : (Correct Answer: A)

Rate $= k[A]^2$.

Rate constants order: $k_{298} < k_{298,\text{cat}} < k_{500} < k_{500,\text{cat}}$.

$\text{Rate}_{(A)} = k_{298}C^2$.

$\text{Rate}_{(B)} = k_{298,\text{cat}}C^2$.

$\text{Rate}_{(D)} = k_{500}(2C)^2 = 4k_{500}C^2$.

$\text{Rate}_{(C)} = k_{500,\text{cat}}(2C)^2 = 4k_{500,\text{cat}}C^2$.

Increasing order of rates: (A), (B), (D), (C).

52. The examples of disaccharides are
(A) Sucrose
(B) Maltose
(C) Lactose
(D) Cellulose
Choose the correct answer from the options given below:

A) (A), (B) and (C) only
B) (A), (B) and (D) only
C) (B), (C) and (D) only
D) (A), (B), (C) and (D)

Solution : (Correct Answer: A)

(A), (B) and (C) only

53. 1.02 g of the following substances are dissolved in 100 mL of water. Arrange them in increasing order of their molarity:

(A) NaCl

(B) KCI

(C)$MgSO_4$

(D)NaOH

Choose the correct answer from the options given below

A) (C), (B), (A), (D) **B)** (A), (B), (C), (D)

C) (B), (A), (D), (C) **D)** (D), (A), (B), (C)

Solution : (Correct Answer: A)

Molar Mass (g/mol):

$M_{NaCl} = 22.99 + 35.45 = 58.44$

$M_{KCl} = 39.10 + 35.45 = 74.55$

$M_{MgSO_4} = 24.31 + 32.07 + 4 \times 16.00 = 120.38$

$M_{NaOH} = 22.99 + 16.00 + 1.01 = 40.00$

Volume $V = 100\ \text{mL} = 0.1\ \text{L}$

Molarity $M = \frac{\text{mass}}{M_r \times V} = \frac{1.02}{M_r \times 0.1}$

$M_{NaCl} = \frac{1.02}{58.44 \times 0.1} \approx 0.1746\ \text{M}$

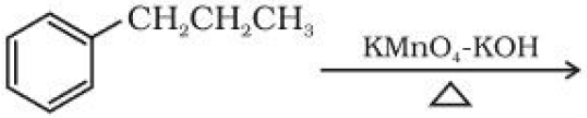
$M_{KCl} = \frac{1.02}{74.55 \times 0.1} \approx 0.1368\ \text{M}$

$M_{MgSO_4} = \frac{1.02}{120.38 \times 0.1} \approx 0.0847\ \text{M}$

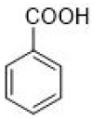
$M_{NaOH} = \frac{1.02}{40.00 \times 0.1} = 0.2550\ \text{M}$

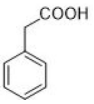
Increasing order of molarity: (C), (B), (A), (D)

54. What is the major product of the following reaction?



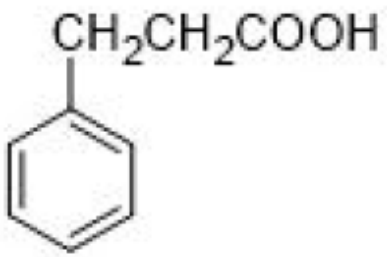
A) 

B) 

C) 

D) 

Solution : (Correct Answer: A)



55. What is the correct formula for "Mohr's salt"?

A) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

B) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 12H_2O$

C) $Fe_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 12H_2O$

D) $Fe_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

Solution : (Correct Answer: A)

$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

56. The number of mono bromo structural isomers formed by free radical bromination of isopentane are

A) 4 **B)** 2 **C)** 1 **D)** 3

Solution : (Correct Answer: A)

Isopentane (2-methylbutane) has hydrogens at 4 distinct positions for substitution:

1. Primary (CH_3 groups on C_1 and C_5 are equivalent)

2. Tertiary (C_2 carbon)

3. Secondary (C_3 carbon)

4. Primary (CH_3 group on C_4)

Number of mono bromo structural isomers = 4

57. The reagents used for dehydration of alcohols are:

(A) Concentrated H_2SO_4

(B) Phosphoric acid

(C) Alumina

(D) Anhydrous $ZnCl_2$

Choose the correct answer from the options given below:

A) (A), (B) and (D) only

B) (A), (B) and (C) only

C) (A), (B), (C) and (D)

D) (B), (C) and (D) only

Solution : (Correct Answer: A)

No Solution

58. The half-cell reaction is the one that:

A) consumes half mole of an electrolyte

B) takes place at one electrode

C) reduces the concentration of electrolyte to half of its initial value

D) reduces the electrode potential to half its initial value

Solution : (Correct Answer: B)

takes place at one electrode

59. Identify the correct statements for Ethylene dichloride and Ethylidene chloride
(A) They represent structural isomers.
(B) Both are formed by reaction of ethene with chlorine in presence ofCCl_4
(C) Both the compounds belong to a class of dihalocompounds
(D) Both the compounds are optically inactive.
Choose the correct answer from the options given below:

A) (A), (C) and (D) only
B) (A), (B) and (C) only
C) (A), (B), (C) and (D)
D) (B), (C) and (D) only

Solution : (Correct Answer: A)

(A), (C) and (D) only

60. The relation and units of cell constant are, Solutionrespectively,

A) cell constant $= l/A$; units: cm^{-1}
B) cell constant $= A/l$; units: cm
C) cell constant $= l \times A$; units: cm^3
D) cell constant $= l/A$; units: cm

Solution : (Correct Answer: A)

cell constant $= l/A$; units: cm^{-1}

61. Which of the following statements is correct for the galvanic cell?

A) The half-cell in which oxidation takes place is called anode and has a negative potential with respect to the solution.
B) The half-cell in which oxidation takes place is called anode and has a positive potential with respect to the solution.
C) The half-cell in which reduction takes place is called cathode and has a negative potential with respect to the solution.
D) The half-cell in which reduction takes place is called anode and has a negative potential with respect to the solution.

Solution : (Correct Answer: A)

The half-cell in which oxidation takes place is called anode and has a negative potential with respect to the solution.

62. Read the passage carefully and answer
When a metal is placed in a solution of its ions, the metal can lose electron and can go in the solution as ion or the metal ion in the solution can take electron from the electrode and get deposited as metal. Thus, the electrode acquires either positive or negative charge with respect to the solution leading to the development of a potential difference between the metal electrode and the solution. This potential difference is called the electrode potential of the metal. The electrode potential of a metal is a measure of relative tendency to undergo oxidation (loss of electron) or reduction (gain of electron). When the concentration of the ions in the solution is unity, the electrode potential is called standard electrode potential. The magni of potential depends upon the nature of electrode, concentration of ions in solution and the temperature. In a galvanic cell, the electrode at which oxidation occurs is known as anodic half-cell and the electrode at which reduction occurs is known as cathodic half cell. The emf of the cell in terms of standard reduction potential is given by $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode.}}$.The standard free energy change of the redox reaction taking place in the cell is related to E°_{cell} by $\Delta G^\circ = -nFE^\circ$. A redox reaction would occur spontaneously if the free energy change is negative. The equilibrium constant of the reaction is related to the standard free energy change by $\Delta G^\circ = -RT \ln K$.
The equillibrium constant of a feasible cell reaction is

A) Less than one
B) Greater than one
C) Equal to one
D) Zero

Solution : (Correct Answer: B)

Greater than one

63. The best reagent for preparing an alkyl chloride from an alcohol is

A) Concentrated HCl
B) $SOCl_2$
C) PCl_5
D) PCl_3

Solution : (Correct Answer: B)

$SOCl_2$

64. Aniline reacts with bromine water at room temperature and forms a compound X. Identify X.

A) 2-Bromoaniline
B) 4-Bromoaniline
C) 2,4,6-tribromoaniline
D) 2-Bromoaniline and 4-Bromoaniline

Solution : (Correct Answer: C)

Aniline reacts with bromine water to form 2,4,6-tribromoaniline.

65. Arrange the following complexes in decreasing order of absorption of wavelength of light in the visible region:
(A) $[Co(CN)_6]^{3-}$
(B) $[CoF_6]^{3-}$
(C) $[Co\,(H_2O)_6]^{3+}$
(D) $[Co\,(NH_3)_6]^{3+}$
Choose the correct option from below:

A) (B), (C), (D), (A)
B) (B), (C), (A), (D)
C) (D), (C), (B), (A)
D) (A), (D), (B), (C)

Solution : (Correct Answer: A)

Ligand field strength: $F^- < H_2O < NH_3 < CN^-$

As crystal field splitting energy (Δ_o) increases, absorbed wavelength (λ) decreases ($\Delta_o \propto 1/\lambda$).

Decreasing order of λ_{abs}: $[CoF_6]^{3-} > [Co\,(H_2O)_6]^{3+} > [Co\,(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$

Result: (B), (C), (D), (A)

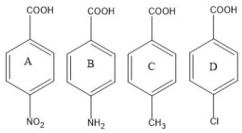
66. Which of the following is a fat soluble vitamin?

A) Thiamine **B)** Riboflavin
C) Ascorbic acid **D)** Vitamin K

Solution : (Correct Answer: D)

Vitamin K

67. Arrange the following compounds in increasing order of their acidic strength ?



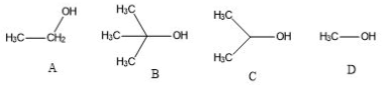
Choose the correct answer from the options given below:

A) (C), (B), (D), (A)
B) (A), (B), (C), (D)
C) (B), (A), (D), (C)
D) (C), (B), (A), (D)

Solution : (Correct Answer: A)

Compound A (NO_2): The nitro group is a strong EWG, exhibiting both a strong negative inductive effect (-I) and a negative resonance effect (-M). This strongly increases acidity.
Compound B (NH_2): The amino group is a strong EDG due to its positive resonance effect (+M), which significantly decreases acidity.
Compound C (CH_3): The methyl group is a weak EDG due to its positive inductive effect (+I) and hyperconjugation, which slightly decreases acidity.
Compound D (Cl): The chloro group is an EWG, primarily through its negative inductive effect (-I), which increases acidity, but less than the nitro group.
(C), (B), (D), (A)

68. Arrange the following alcohols in decreasing order of acidity:



Choose the correct answer from the options given below:

A) (A), (B), (C), (D)
B) (B), (A), (C), (D)
C) (A), (B), (D), (C)
D) (D), (A), (C), (B)

Solution : (Correct Answer: A)

Decreasing order of acidity: (A), (B), (C), (D).

69. Match List-I (Amino acid) with List-II (Example)

List - I (Amino acid)	List-II (Example)
(A) Basic amino acid	(I) Glycine
(B) Acidic amino acid	(II) Alanine
(C) Neutral amino acid	(III) Aspartic acid
(D) Optically inactive amino acid	(IV) Lysine

Choose the correct answer from the options given below:

A) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
B) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
C) (A) - (I), (B) - (III), (C) - (II), (D) - (IV)
D) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution : (Correct Answer: A)

(A) Basic amino acid - (IV) Lysine

(B) Acidic amino acid - (III) Aspartic acid

(C) Neutral amino acid - (II) Alanine

(D) Optically inactive amino acid - (I) Glycine

70. Match List - I with List - II

List - I (Name)	List - II (Use)
(A) Carbon tetrachloride	(I) Pesticide
(B) DDT	(II) Solvent
(C) Iodoform	(III) Refrigerant
(D) Freons-12	(IV) Antiseptic

choose the correct answer from the options given below:

A) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
B) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
C) (A) - (I), (B) - (II), (C) - (IV), (D) - (III)
D) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution : (Correct Answer: B)

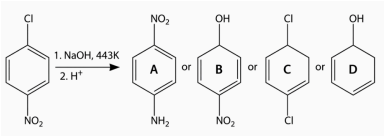
(A) - (II)

(B) - (I)

(C) - (IV)

(D) - (III)

71. The product in the following reaction is



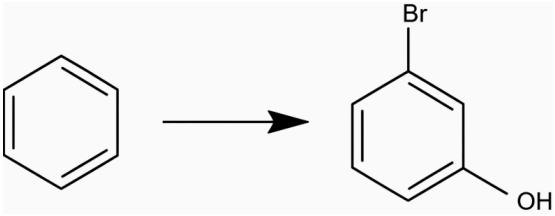
A) A **B)** B **C)** C **D)** D

Solution : (Correct Answer: B)

$C_6H_4(Cl)\,(NO_2) \xrightarrow[H^+]{NaOH,443K} C_6H_4(OH)\,(NO_2)$

(B)

72. Choose the correct sequence of reagents to carry out the following conversion:



(A) Conc. HNO_3/ Conc. H_2SO_4
(B) Sn/HCl
(C) $Br_2/FeBr_3$
(D) $NaNO_2/HCl$; followed by boiling with water
Choose the correct answer from the options given below:

A) (A), (C), (B), (D) **B)** (A), (B), (C), (D)
C) (B), (A), (D), (C) **D)** (C), (B), (D), (A)

Solution : (Correct Answer: A)

(A), (C), (B), (D)

73. Read the passage carefully and answer the questions

Nearly all the transition elements display typical metallic properties such as high tensile strength, ductility, malleability, high thermal and electrical conductivity and metallic lustre. The transition metals (with the exception of Zn, Cd and Hg) are very hard and have low volatility. Their melting and boiling points are high. They have high enthalpies of atomization. lons of the same charge in a given series show progressive decrease in radius with increasing atomic number. However, the variation within a series is quite small. The filling of 4f before 5d orbital results in a regular decrease in atomic radii called Lanthanoid contraction which essentially compensates for the expected increase in atomic size with increasing atomic number The net result of the lanthanoid contraction is that the second and the third d series exhibit similar radii (e.g., Zr 160 pm, Hf 159 pm) and have very similar physical and chemical properties. There is an increase in ionisation enthalpy along each series of the transition elements from left to right. The first ionisation enthalpy, in general, increases, but the magnitude of the increase in the second and third ionisation enthalpies for the successive elements, is much higher along a series. One of the notable features of a transition elements is the great variety of oxidation states these may show in their compounds.

In the first transition series of elements (Sc to Zn), which element show least enthalpy of atomization?

A) V **B)** Sc **C)** Mn **D)** Zn

Solution : (Correct Answer: D)

Zn

74. Which one of the following compounds is achiral?

A) Propan-2-ol **B)** Butan-2-ol
C) 2-Chlorobutane **D)** 2,3-Dihydroxybutanal

Solution : (Correct Answer: A)

Propan-2-ol

75. Which of the following statements are true?
(A) Decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction.
(B) The rate of a reaction increases with the passage of time.
(C) A catalyst does not change the equillibrium of a reaction.
(D) The molecularity of a reaction can be zero, fraction and negative.
Choose the correct answer from the options given below:

A) (A), (B) and (C) only **B)** (A) and (C) only
C) (B) and (C) only **D)** (B), (C) and (D) only

Solution : (Correct Answer: B)

(A) is true.

(C) is true.

The correct option is "(A) and (C) only".

76. The resistance of 1N solution of four different electrolytes are given below. Arrange them in increasing order of their equivalent conductance values if the same conductivity cell was used to measure the resistance of all the electrolytic solutions:
(A) 250 ohm
(B) 150 ohm
(C) 50 ohm
(D) 280 ohm
Choose the correct answer from the options given below:

A) (A), (B), (C), (D) **B)** (A), (B), (D), (C)
C) (D), (A), (B), (C) **D)** (C), (B), (A), (D)

Solution : (Correct Answer: C)

$\Lambda_{eq} \propto \frac{1}{R}$

Resistances in decreasing order: (D) 280 ohm, (A) 250 ohm, (B) 150 ohm, (C) 50 ohm

Increasing order of equivalent conductance: (D), (A), (B), (C)

77. The characteristic oxidation state of Lanthanoids is +3, but Ce shows +4 oxidation state because...
(A) It has variable ionization enthalpy
(B) It has a tendency to attain noble gas configuration
(C) It has a tendency to attain f^0 configuration
(D) It resembles Pb^{4+}

A) (A), (B) and (C) only **B)** (C) and (D) only
C) (A) and (C) only **D)** (B) and (C) only

Solution : (Correct Answer: D)

(B) and (C) only

78. Read the passage carefully and answer the Questions
Haloalkanes undergo nucelophilic substitution reactions owing to the polarity of C X bond. The nucleophile reacts with the haloalkane on the carbon possessing a partial positive charge holding the halogen atom. The halogen atom X is replaced by a nucleophile. Depending on the kinetics and mode of bond breaking, the mechanism can be either SN1 or SN2 reaction. The rate of SN1 reaction is governed by the stability of carbocation and in SN2 reaction, the rate of reaction is governed by steric factor. Chirality is the main factor in both SN1and SN2. In SN1 reaction, the chirality of alkyl halide is accompanied by racemization of the product, while in SN2 reaction, the product is characterized by inversion of configuration. The structure of alkyl halide and the nature of the solvent also governs the mechanism of the substitution.
What is chiral carbon ?

A) Forms Superimposable mirror images
B) Attached to four different atoms or groups
C) Optically inactive
D) Symmetrical carbon

Solution : (Correct Answer: B)

Attached to four different atoms or groups

79. Read the passage carefully and answer the Questions
Haloalkanes undergo nucelophilic substitution reactions owing to the polarity of CX bond. The nucleophile reacts with the haloalkane on the carbon possessing a partial positive charge holding the halogen atom. The halogen atom X is replaced by a nucleophile. Depending on the kinetics and mode of bond breaking, the mechanism can be either SN1 or SN2 reaction. The rate of SN1 reaction is governed by the stability of carbocation and in SN2 reaction, the rate of reaction is governed by steric factor. Chirality is the main factor in both SN1and SN2. In SN1 reaction, the chirality of alkyl halide is accompanied by racemization of the product, while in SN2 reaction, the product is characterized by inversion of configuration. The structure of alkyl halide and the nature of the solvent also governs the mechanism of the substitution.
Hydrolysis of 2-Chlorobutane will result in formation of

A) (+) 2-Butanol **B)** (-) 2-butanol

C) (±) 2-Butanol D) 2-Butanol

Solution : (Correct Answer: C)

(±) 2-Butanol

80. Match List-I with List-II

List-I (Components of binary solution)	List-II (Deviation from Raoult's Law)
(A) Ethanol and water	(I) Positive
(B) Chloroform and acetone	(II) No deviation
(C) n-Hexane and n-heptane	(III) Negative
(D) Carbon disulphide and acetone	(IV) Large positive
(D) Carbon disulphide and acetone	(IV) Large positive

Choose the correct answer from the options given below:

A) (A) - (II), (B) - (I), (C) - (III), (D) - (IV)
B) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
C) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)
D) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution : (Correct Answer: B)

(A) Ethanol and water $\rightarrow$ (IV) Large positive

(B) Chloroform and acetone $\rightarrow$ (III) Negative

(C) n-Hexane and n-heptane $\rightarrow$ (II) No deviation

(D) Carbon disulphide and acetone $\rightarrow$ (I) Positive

81. Correct electronic configuration of Cu and Cr are

_____

A) $3d^94s^2$ and $3d^44s^2$ respectively
B) $3d^{10}4s^1$ and $3d^54s^1$ respectively
C) $3d^54s^1$ and $3d^{10}4s^1$ respectively
D) $3d^94s^2$ and $3d^94s^2$ respectively

Solution : (Correct Answer: B)

Cu: $3d^{10}4s^1$

Cr: $3d^54s^1$

82. Read the passage carefully and answer the questions:

The degeneracy of the d orbitals has been removed due to ligand electron-metal electron repulsions in the octahedral complex to yield three orbitals of lower energy, t_{2g} set and two orbitals of higher energy, e_g set. This splitting of the degenerate levels due to the presence of ligands in a definite geometry is termed as crystal field splitting and the energy separation is denoted by Δ_0. Thus energy of the two e_g orbitals will increase by $(3/5)\Delta_0$ and that of three t_{2g} will decrease by $(2/5)\Delta_0$. The crystal field splitting Δ_0 depends upon the field produced by the ligand and charge on the metal ion. Some ligands are able to produce strong fields, in which case the splitting will be large, whereas others produce weak fields and consequently result in small splitting of d orbitals. Relative magnitude of crystal field splitting energy $\Delta_\circ$ and pairing energy, P (energy required for electron pairing in a single orbital) determine the formation of low spin ($\Delta_\circ > P$) or high spin ($\Delta_\circ < P$) complex. In tetrahedral coordination entity formation, the d-orbital splitting is inverted and is smaller as compared to the octahedral field splitting. The crystal field theory attributes the colour of the complex to $d-d$ transition of the electron. The colour of the coordination compounds depends on the crystal field splitting. In the absence of ligand, crystal field splitting does not occur and hence the substance is colourless

What will be the crystal field splitting energy for tetrahedral $[CoCl_4]^{2-}$ if its value for octahedral $[CoCl_6]^{4-}$ is $18,000cm^{-1}$?

A) $\Delta_t = \Delta_o$
B) $\Delta_t = \frac{4}{9}\Delta_o$
C) $\Delta_t = \frac{3}{5}\Delta_o$
D) $\Delta_t = \frac{5}{3}\Delta_o$

Solution : (Correct Answer: B)

$\Delta_t = \frac{4}{9}\Delta_o$

$\Delta_t = \frac{4}{9} \times 18,000cm^{-1}$

$\Delta_t = 8,000cm^{-1}$

83. In the plot of $\log \frac{[R]_0}{[R]}$ versus time for a first order reaction (where [R] represents the concentration of the reactant), the slope and intercept are respectively equal to

A) k and zero **B)** k and one
C) k/2.303 and zero **D)** 2.303k and zero

Solution : (Correct Answer: C)

$\ln \frac{[R]_0}{[R]} = kt$

$2.303 \log \frac{[R]_0}{[R]} = kt$

$\log \frac{[R]_0}{[R]} = \frac{k}{2.303} t$

Slope $= \frac{k}{2.303}$, Intercept $= 0$

84. Read the passage carefully and answer the questions

The osmotic pressure is one of the four colligative properties which depends on the number of particles of solute in the solution, irrespective of their nature. The osmotic pressure is equal to the product of concentration, gas constant and temperature. It is the most commonly used property for the determination of the molar mass of biomolecules. In many situations, the molecules get dissociated or associated when they are dissolved in a solvent, thereby changing the number of molecules in the solution. As a result, an abnormal molecular mass is obtained. The extent of dissociation or association is given by van't Hoff factor (i), which is the ratio of normal molar mass to abnormal molar mass. It is related with the degree of association or ionization. The introduction of van't Hoff factor in the osmotic pressure equation modifies the equation.

What is the value of the van't Hoff factor for $NaCl, K_2SO_4$ and KCl,respectively?

A) 1, 3 and 1 **B)** 1, 2 and 1

C) 1, 2 and 3 **D)** 2, 3 and 2

Solution : (Correct Answer: D)

$i_{NaCl} = 2$

$i_{K_2SO_4} = 3$

$i_{KCl} = 2$

85. Read the passage carefully and answer the Questions

Carboxylic acids are the earliest organic compounds isolated from nature. These are also known as organic acids but are weaker acids as compared to mineral acids. However, they are more acidic than alcohols and phenols because of greater resonance stabilization of the parent acid and its conjugate base. The acidic strength is determined by the K_a, which is called the acidity constant.

The greater the value of K_a, the greater the tendency of the acid to ionize and hence the stronger the acid. The acidic strength of the saturated aliphatic carboxylic acid depends upon the inductive effect and its position with respect to - COOH groups. Electron -donating substituents tend to decrease whereas electron-withdrawing substituents tend to increase the acidic strength. The acidic strength of the aromatic carboxylic acid, on the other hand depends upon both the inductive effect and the resonance effect of the substituents.

Arrange the following acids in decreasing order of acidity

(A) CH_3CH_2OH

(B) CH_3COOH

(C) $BrCH_2COOH$

(D) $C_6H_5CH_2COOH$

Choose the correct answer from the options given below:

A) (A), (B), (C), (D) **B)** (C), (D), (B), (A)

C) (B), (A), (D), (C) **D)** (C), (B), (D), (A)

Solution : (Correct Answer: B)

$BrCH_2COOH > C_6H_5CH_2COOH > CH_3COOH > CH_3CH_2OH$

(C), (D), (B), (A)

86. Match List-I with List-II

List-I (Compound)	List-II (Uses)
(A) Diazonium salt	(I) Surfactants
(B) Novocain	(II) Antihistaminic drug
(C) Benadryl	(III) Dentistry
(D) Quaternary ammonium salts	(IV) Dyes

Choose the correct answer from the options given below:

A) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

B) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)

C) (A) - (I), (B) - (II), (C) - (IV), (D) - (III)

D) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution : (Correct Answer: B)

(A) - (IV)

(B) - (III)

(C) - (II)

(D) - (I)

87. Read the passage carefully and answer the following questions

Aldehydes, carboxylic acids and ketones are widespread in the animal and plant kingdoms. They play a pivotal role in various biochemical processes of life. Their presence in nature adds fragrance and flavor. These compounds are widely used in food products, pharmaceuticals, paints, resins and other important product industries. These compounds are prepared by various laboratory methods, which mainly include oxidation, formylation, acylation and reduction. Due to the polar nature of the carbonyl group in aldehydes and ketones, they can exhibit different reactions like nucleophilic addition. They do exhibit redox and various condensation reactions which lead to the formation of various important compounds. On the other hand, the carboxylic acids are mainly prepared by oxidation and hydrolysis of different compounds. The carboxylic acid consists of a carbonyl group and the hydroxy group (attached to the carbonyl carbon atom). This makes it possible for the carboxylic acid to participate in various chemical reactions which involve cleavage of the C-OH bond and the O-H bond along with the reactions involving the complete -COOH group.

The IUPAC name of following compound is $OHC-C_6H_4-CHO-p$

A) Benzene-1,4-dial
B) 1,4-Dioxobenzene
C) 4-Formylbenzaldehyde
D) Benzene-1,4-dicarbaldehyde

Solution : (Correct Answer: D)

Benzene-1,4-dicarbaldehyde

88. Match List-I with List-II

List-I (Type of solution)	List-II (Example)
(A) solid in solid	(I) Camphor in N_2
(B) solid in gas	(II) Cu in Au
(C) gas in solid	(III) Hg in Na
(D) liquid in solid	(IV) H_2 in Pd

Choose the correct answer from the options given below :

A) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
B) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
C) (A) - (I), (B) - (II), (C) - (IV), (D) - (III)
D) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution : (Correct Answer: B)

(A) - (II)

(B) - (I)

(C) - (IV)

(D) - (III)

89. Match List-I with List-II

List-I (Complex)	List-II (Property)
(A) $[CoF_6]^{3-}$	(I) d^5, high spin
(B) $[Fe(CN)_6]^{4-}$	(II) d^6, high spin
(C) $[FeF_6]^{3-}$	(III) d^5, low spin
(D) $[Mn(CO)_6]^{2+}$	(IV) d^6, low spin

Choose the correct answer from the options given below :

A) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
B) (A) - (II), (B) - (I), (C) - (III), (D) - (IV)
C) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)
D) (A) - (IV), (B) - (II), (C) - (III), (D) - (I)

Solution : (Correct Answer: A)

(A) $[CoF_6]^{3-}$: Co^{3+} is d^6. F^- is weak field, high spin. $\Longrightarrow$ (II)

(B) $[Fe(CN)_6]^{4-}$: Fe^{2+} is d^6. CN^- is strong field, low spin. $\Longrightarrow$ (IV)

(C) $[FeF_6]^{3-}$: Fe^{3+} is d^5. F^- is weak field, high spin. $\Longrightarrow$ (I)

(D) $[Mn(CO)_6]^{2+}$: Mn^{2+} is d^5. CO is strong field, low spin. $\Longrightarrow$ (III)

90. Which of the following compounds will not give azo coupling reaction with benzene diazonium chloride?

A) Nitrobenzene **B)** Aniline
C) o-Toluidine **D)** Phenol

Solution : (Correct Answer: A)

Nitrobenzene is deactivated due to the electron-withdrawing $-NO_2$ group, thus it will not undergo azo coupling reaction.

91. The reagent(s) used in hydroboration oxidation of propene are

(A) B_2H_6

(B) H_2O

(C) H_2O_2

(D) OH^-

Choose the correct answer from the options given below :

A) (A), (B) and (D) only
B) (A), (B) and (C) only
C) (A), (B), (C) and (D)
D) (B), (C) and (D) only

Solution : (Correct Answer: C)

(A), (B), (C) and (D)

92. Which of the following is not a limitation of valence bond theory (VBT)?

A) It does not distinguish between weak and strong ligands.
B) It does not explain the color exhibited by the coordination complex.
C) It does not explain the concept of the high spin and low spin complex.
D) It does not give predictions regarding the tetrahedral and square plane complex in coordination number 4.

Solution : (Correct Answer: D)

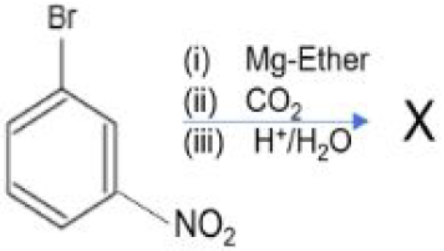
It does not give predictions regarding the tetrahedral and square plane complex in coordination number 4.

93. Read the passage carefully and answer the Questions

Aldehydes, carboxylic acids and ketones are widespread in the animal and plant kingdoms.

They play a pivotal role in various biochemical processes of life. Their presence in nature adds fragrance and flavor. These compounds are widely used in food products, pharmaceuticals, paints, resins and other important product industries. These compounds are prepared by various laboratory methods, which mainly include oxidation, formylation, acylation and reduction. Due to the polar nature of the carbonyl group in aldehydes and ketones, they can exhibit different reactions like nucleophilic addition. They do exhibit redox and various condensation reactions which lead to the formation of various important compounds. On the other hand, the carboxylic acids are mainly prepared by oxidation and hydrolysis of different compounds. The carboxylic acid consists of a carbonyl group and the hydroxy group (attached to the carbonyl carbon atom). This makes it possible for the carboxylic acid to participate in various chemical reactions which involve cleavage of the C-OH bond and the O_H bond along with the reactions involving the complete -COOH group.

Identify the final product (X) of the chemical reaction obtained from the following transformation :



A) 3-Nitrobenzaldehyde
B) 1-Methyl-3-nitrobenzene
C) 3-Nitrobenzoic acid
D) 3-Aminobenzoic acid

Solution : (Correct Answer: C)

$C_6H_5CH_3 \xrightarrow{HNO_3/H_2SO_4} NO_2 - C_6H_4 - CH_3$

$NO_2 - C_6H_4 - CH_3 \xrightarrow{KMnO_4/KOH,\Delta,H_3O^+} NO_2 - C_6H_4 - COOH$

Product is 3-Nitrobenzoic acid.

94. 45 g of ethylene glycol ($C_2H_6O_2$) is mixed with 600 g of water. Calculate the depression in freezing point.

(K_f for water = 1.86 K kg mol^{-1})

A) 2.25 K **B)** 2.32 K **C)** 2.7 K **D)** 2.9 K

Solution : (Correct Answer: A)

Molar mass of $C_2H_6O_2$ = $2(12.01) + 6(1.008) + 2(16.00) = 62.068\ \text{g/mol}$

Molality (m) = $\frac{45\ \text{g}/62.068\ \text{g/mol}}{0.600\ \text{kg}} = 1.2083\ \text{mol/kg}$

$\Delta T_f = K_f \cdot m = 1.86\ \text{K kg mol}^{-1} \cdot 1.2083\ \text{mol/kg} = 2.247\ \text{K}$

$\Delta T_f \approx 2.25\ \text{K}$

95. Calculate the lowering of vapour pressure caused by the addition of $50\ g$ of sucrose (mol mass = $342\ g/mol$) to $750\ g$ of water, if the vapour pressure of pure water at Ambient temperature is 23.8 mm Hg

A) 0.083 mm Hg **B)** 0.008 mm Hg
C) 0.045 mm Hg **D)** 0.012 mm Hg

Solution : (Correct Answer: A)

$n_{sucrose} = \frac{50}{342} = 0.146\,mol$

$n_{water} = \frac{750}{18} = 41.667\,mol$

$\Delta P = P^0 \times X_{sucrose} = P^0 \times \frac{n_{sucrose}}{n_{sucrose}+n_{water}}$

$\Delta P = 23.8 \times \frac{0.146}{0.146+41.667} = 23.8 \times 0.003496 = 0.083\,mm\,Hg$

96. Match the items given in List-I with items given in List-II

List-I	List-II
(A) Interstitial Compounds	(I) Large number of complex
(B) Alloy formation	(II) Chemically inert
(C) Transition metals	(III) Ni
(D) Catalytic hydrogenation	(IV) Blend of different metals

Choose the correct answer from the options given below:

A) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
B) (A) - (I), (B) - (III), (C) - (II), (D) - (IV)
C) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
D) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

Solution : (Correct Answer: C)

(A) - (II)

(B) - (IV)

(C) - (I)

(D) - (III)

97. The reaction of two molecules of 1-chlorobenzene with sodium metal in the presence of dry ether to form diphenyl is known as

A) Fittig reaction
B) Sandmeyer's reaction
C) Grignard reagent reaction
D) Wurtz reaction

Solution : (Correct Answer: A)

Fittig reaction

98. The degree of dissociation (α) of a weak electrolyte A_xB_y is related to the van't Hoff factor (i) by the expression:

A) $\alpha = \frac{(i-1)}{(x+y-1)}$ **B)** $\alpha = \frac{(i-1)}{(x+y+1)}$
C) $\alpha = \frac{(x+y-1)}{(i-1)}$ **D)** $\alpha = \frac{(x+y+1)}{(i-1)}$

Solution : (Correct Answer: A)

$i = 1 + (n-1)\alpha$

$i = 1 + (x+y-1)\alpha$

$\alpha = \frac{(i-1)}{(x+y-1)}$

99. Read the passage carefully and answer the questions

Sodium dichromate $Na_2Cr_2O_7$ and Potassium dichromate $K_2Cr_2O_7$ are strong oxidizing agents; in acidic solution, its oxidising action can be represented as follows :

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O\,(E^\circ = 1.33V)$

The chromates and dichromates are interconvertible in aqueous solution depending upon pH of the solution.

The chromate ion is tetrahedral whereas the dichromate ion consists of two tetrahedra sharing one corner with $Cr - O - Cr$ bond angle of 126°

Potassium permanganate is prepared by fusion of MnO_2 with an alkali metal hydroxide and an oxidising agent like KNO_3.

This produces the dark green K_2MnO_4 which disproportionates in a neutral or acidic solution to give permanganate. It is a strong oxidizing agent. Hydrogen ion concentration of the solution plays an important part in the reduction of permanganate to manganate, manganese dioxide and manganese(II) salt.

Potassium permanganate forms dark purple (almost black) crystals which are isostructural with those of $KClO_4$.

The salt is not very soluble in water $(6.4g/100g$ of water at 293 K), but when heated it decomposes at 513 K.

When $KMnO_4$ is added to oxalic acid solution, the decolourisation is slow in the beginning but becomes faster after some time because

A) reaction is exothermic
B) MnO_4^- catalyses the reaction
C) Mn^{2+} acts as autocatalyst
D) CO_2 is formed as the product

Solution : (Correct Answer: C)

Mn^{2+} acts as autocatalyst

100. Molar conductivity increases with.....

A) Increase in concentration
B) Increase in pressure
C) Decrease in concentration
D) Decrease in pressure

Solution : (Correct Answer: C)

Decrease in concentration

MATHS - Section A (MCQ)

101. A tub contains 60 litres of milk. From this tub, 6 litres of milk was taken out and replaced with water. This whole process was repeated further two more times. How much milk is there in the tub now?

A) 29.16 litre **B)** 43.74 litre
C) 42.24 litre **D)** 38.74 litre

Solution : (Correct Answer: B)

$\text{Milk}_{\text{final}} = V\left(1 - \frac{x}{V}\right)^n$

$\text{Milk}_{\text{final}} = 60\left(1 - \frac{6}{60}\right)^3$

$\text{Milk}_{\text{final}} = 60\,(0.9)^3 = 60 \times 0.729$

$\text{Milk}_{\text{final}} = 43.74 \text{ litre}$

102. Which of the following are correct about the Sinking Fund?

(A) It is a fixed term account.

(B) It is a set-up for a particular upcoming expense.

(C) A fixed amount at regular intervals is deposited in the Sinking Fund.

(D) It can be used in any emergency.

Choose the correct answer from the options given below:

A) (A), (B) and (D) only
B) (A), (B) and (C) only
C) (C) and (D) only
D) (B), (C) and (D) only

Solution : (Correct Answer: B)

(A), (B) and (C) only

103. If matrix$A_p = \begin{bmatrix} p & (p+1) \\ p & (p-1) \end{bmatrix}, p \in \mathbb{N}$ (where $\mathbb{N}$ is the set of natural numbers), then the value of $|A_1| + |A_2| + |A_3| + \cdots + |A_{2025}|$ is:

A) - (2025) (2026) **B)** $(2025)^2$
C) (2025)(2026) **D)** $-(2025)^2$

Solution : (Correct Answer: A)

$|A_p| = p(p-1) - p(p+1) = p^2 - p - p^2 - p = -2p$

$|A_1| + |A_2| + \cdots + |A_{2025}| = \sum_{p=1}^{2025}(-2p)$

$= -2\sum_{p=1}^{2025} p = -2\left(\frac{2025(2025+1)}{2}\right)$

$= -2025(2026)$

104. The function $f : [-1, 1] \rightarrow \mathbb{R}$ (set of real numbers) given by $f(x) = \frac{x}{x+3}$ is

A) one-one only
B) onto only
C) both one-one and onto
D) neither one-one nor onto

Solution : (Correct Answer: A)

Let $f(x_1) = f(x_2)$:

$\frac{x_1}{x_1+3} = \frac{x_2}{x_2+3}$

$x_1(x_2+3) = x_2(x_1+3)$

$x_1x_2 + 3x_1 = x_1x_2 + 3x_2$

$3x_1 = 3x_2 \implies x_1 = x_2$

Therefore, f is one-one.

Domain: $x \in [-1, 1]$

Codomain: $\mathbb{R}$

$f'(x) = \frac{d}{dx}\left(\frac{x}{x+3}\right) = \frac{(x+3)(1)-x(1)}{(x+3)^2} = \frac{3}{(x+3)^2}$

For $x \in [-1, 1]$, $f'(x) > 0$. So, $f(x)$ is strictly increasing.

Range: $[f(-1), f(1)]$

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

$f(1) = \frac{1}{1+3} = \frac{1}{4}$

Range of f is $\left[-\frac{1}{2}, \frac{1}{4}\right]$.

Since Range $\left[-\frac{1}{2}, \frac{1}{4}\right] \neq \mathbb{R}$ (Codomain), f is not onto.

The function is one-one only.

105. Consider a line $\vec{r} = (\hat{i} + 4\hat{j}) + \lambda(2\hat{i} - 2\hat{j} + 3\hat{k})$, then which of the following statements are correct?
(A) It passes through point $(9, -4, 12)$
(B) It passes through point $(1, 4, -1)$
(C) Its direction cosine's are $\frac{2}{\sqrt{17}}, \frac{-2}{\sqrt{17}}, \frac{3}{\sqrt{17}}$
(D) Its Cartesian equation is $\frac{x-1}{2} = \frac{y-4}{-2} = \frac{z}{3}$
Choose the correct answer from the options given below:

A) (A), (C) and (D) only **B)** (B) and (C) only
C) (A) and (C) only **D)** (B) and (D) only

Solution : (Correct Answer: A)

Line passes through $(1, 4, 0)$ with direction vector $(2, -2, 3)$.

For (A): Point $(9, -4, 12)$

$1 + 2\lambda = 9 \Rightarrow \lambda = 4$

$4 - 2\lambda = -4 \Rightarrow \lambda = 4$

$3\lambda = 12 \Rightarrow \lambda = 4$. (A) is correct.

For (C): Direction cosines

Magnitude of direction vector $= \sqrt{2^2 + (-2)^2 + 3^2}$ $= \sqrt{4 + 4 + 9} = \sqrt{17}$

Direction cosines are $\left(\frac{2}{\sqrt{17}}, \frac{-2}{\sqrt{17}}, \frac{3}{\sqrt{17}}\right)$. (C) is correct.

For (D): Cartesian equation

$\frac{x-1}{2} = \frac{y-4}{-2} = \frac{z-0}{3}$

$\frac{x-1}{2} = \frac{y-4}{-2} = \frac{z}{3}$. (D) is correct.

Statements (A), (C), and (D) are correct.

The correct answer is (A), (C) and (D) only.

106. Consider the function $f(x) = \sin x$ in the interval $[\pi, 2\pi]$, then which of the following statements are correct?
(A) $x = \frac{3\pi}{2}$ is its stationary point.
(B) Its maximum value is 1
(C) Its minimum value is -1
(D) It attains its maximum value at π and 2π
Choose the correct answer from the options given below:

A) (A), (B) and (D) only
B) (A) and (C) only
C) (A), (C) and (D) only
D) (B), (C) and (D) only

Solution : (Correct Answer: C)

$f'(x) = \cos x$

$f'(\frac{3\pi}{2}) = \cos(\frac{3\pi}{2}) = 0.$

For $x \in [\pi, 2\pi]$, $\sin x \in [-1, 0]$.

Minimum value is -1.

Maximum value is 0.

$\sin(\pi) = 0$, $\sin(2\pi) = 0$.

Statements (A), (C), (D) are correct.

107. Consider the function $f(x) = x^3 - 3x$. Then Match List-I with List-II:

List-I	List-II
(A) Point of local Maxima	(I) 1
(B) Point of local Minima	(II) -1
(C) Local maximum value	(III) 2
(D) Local minimum value	(IV) - 2

Choose the correct answer from the options given below:

A) (A) - (II), (B) - (I), (C) - (III), (D) - (IV)
B) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
C) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)
D) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)

Solution : (Correct Answer: A)

$f'(x) = 3x^2 - 3$

$3x^2 - 3 = 0 \implies x^2 = 1 \implies x = \pm 1$

$f''(x) = 6x$

For $x = -1$: $f''(-1) = 6(-1) = -6 < 0$. Thus, $x = -1$ is a point of local maxima.

For $x = 1$: $f''(1) = 6(1) = 6 > 0$. Thus, $x = 1$ is a point of local minima.

Local maximum value: $f(-1) = (-1)^3 - 3(-1) = -1 + 3 = 2$

Local minimum value: $f(1) = (1)^3 - 3(1) = 1 - 3 = -2$

(A) Point of local Maxima: (II) -1

(B) Point of local Minima: (I) 1

(C) Local maximum value: (III) 2

(D) Local minimum value: (IV) -2

108. Three pipes A, B and C are installed to fill a tank. Pipes A and B opened together can fill the tank in the same time in which C can alone fill the tank. If pipe B can fill the tank 15 minutes faster than pipe A and 5 minutes slower than pipe C, then the time required by pipe A to fill the tank alone is:

A) 20 minutes **B)** 30 minutes
C) 24 minutes **D)** 36 minutes

Solution : (Correct Answer: B)

$t_B = t_A - 15$

$t_C = t_B - 5 = t_A - 20$

$\frac{1}{t_A} + \frac{1}{t_B} = \frac{1}{t_C}$

$\frac{1}{t_A} + \frac{1}{t_A - 15} = \frac{1}{t_A - 20}$

$(2t_A - 15)(t_A - 20) = t_A(t_A - 15)$

$2t_A^2 - 55t_A + 300 = t_A^2 - 15t_A$

$t_A^2 - 40t_A + 300 = 0$

$(t_A - 10)(t_A - 30) = 0$

$t_A = 10$ (rejected) or $t_A = 30$

$t_A = 30$ minutes

109. If $P(A) = \frac{3}{5}, P(B) = \frac{1}{2}$ and $P(A \cap B) = \frac{1}{4}$, then $P(\bar{A} \mid \bar{B})$ is

A) $\frac{3}{40}$ **B)** $\frac{3}{10}$ **C)** $\frac{17}{20}$ **D)** $\frac{17}{40}$

Solution : (Correct Answer: B)

$P(A \cup B) = P(A) + P(B) - P(A \cap B) = \frac{3}{5} + \frac{1}{2} - \frac{1}{4} = \frac{12+10-5}{20} = \frac{17}{20}$

$P(\bar{A} \cap \bar{B}) = P(\overline{A \cup B}) = 1 - P(A \cup B) = 1 - \frac{17}{20} = \frac{3}{20}$

$P(\bar{B}) = 1 - P(B) = 1 - \frac{1}{2} = \frac{1}{2}$

$P(\bar{A} \mid \bar{B}) = \frac{P(\bar{A} \cap \bar{B})}{P(\bar{B})} = \frac{\frac{3}{20}}{\frac{1}{2}} = \frac{3}{10}$

110. A person has set up a sinking fund in order to have Rs. 10,00,000 after 10 years for his child education. The amount should put bi-annually into account paying 5 % per annum compounded semi-annually is:
[Given $(1.025)^{20} = 1.6386$]

A) Rs. 29148.14
B) Rs. 39148.14
C) Rs. 35148.14
D) Rs. 36148.14

Solution : (Correct Answer: B)

$PMT = FV \times \frac{i}{((1+i)^N - 1)}$

$PMT = 10,00,000 \times \frac{0.025}{((1.025)^{20} - 1)}$

$PMT = 10,00,000 \times \frac{0.025}{(1.6386 - 1)}$

$PMT = 10,00,000 \times \frac{0.025}{0.6386}$

$PMT = 39148.14$

111. If $\begin{vmatrix} -1 & 1 & 0 \\ a & b & 1 \\ 1 & 2 & 1 \end{vmatrix}$ is a singular matrix, then the relation between a and b is:

A) 2a = b **B)** a + b = 0 **C)** a + b = 3 **D)** a + b = ab

Solution : (Correct Answer: C)

$-1(b \cdot 1 - 1 \cdot 2) - 1(a \cdot 1 - 1 \cdot 1) + 0(a \cdot 2 - b \cdot 1) = 0$

$-b + 2 - a + 1 = 0$

$a + b = 3$

112. At what rate will the present value of a perpetuity of Rs.1000 payable at the end of each quarter be Rs.50000?

A) 5% p.a **B)** 8% p.a **C)** 2% p.a **D)** 4% p.a

Solution : (Correct Answer: B)

$PV = \frac{PMT}{i}$

$50000 = \frac{1000}{i}$

$i = \frac{1000}{50000} = 0.02$ (quarterly)

$r = 0.02 \times 4 = 0.08 = 8\%$ p.a.

113. A and B throw a die alternatively till one of them gets 3 or 6 and wins the game. If B starts the game, then the probability of winning the game by A is

A) $2/5$ **B)** $3/5$
C) $6/11$ **D)** $5/11$

Solution : (Correct Answer: A)

P(win) $= 2/6 = 1/3$

P(lose) $= 1 - 1/3 = 2/3$

P(A wins) $= \frac{\text{P(lose)} \times \text{P(win)}}{1-\text{P(lose)} \times \text{P(lose)}}$

P(A wins) $= \frac{(2/3)\times(1/3)}{1-(2/3)\times(2/3)}$

P(A wins) $= \frac{2/9}{1-4/9}$

P(A wins) $= \frac{2/9}{5/9}$

P(A wins) $= 2/5$

114. If the random varible X has the following probability distribution:

X	0	1	2	otherwise
P(X)	K	3K	5K	0

X = 0, P(X) = k; x = 1, P(x) = 3k; X = 2, P(x) = 5k; otherwise, P(X) = 0

Match List - I with List - II

List - I	List - II
(A) k	(I) $\frac{13}{9}$
(B) E(X)	(II) $\frac{4}{9}$
(C) P(X ≤ 1)	(III) $\frac{8}{9}$
(D) P(1 ≤ X ≤ 2)	(IV) $\frac{1}{9}$

Choose the correct answer from the options given below:

A) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
B) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)
C) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)
D) (A) - (III), (B) - (II), (C) - (I), (D) - (IV)

Solution : (Correct Answer: B)

$\sum P(X) = 1$

$k + 3k + 5k + 0 = 1 \implies 9k = 1 \implies k = \frac{1}{9}$

So, (A) k matches with (IV) $\frac{1}{9}$.

$E(X) = \sum XP(X)$

$E(X) = (0 \cdot k) + (1 \cdot 3k) + (2 \cdot 5k) + (3 \cdot 0) = 13k$

$E(X) = 13 \cdot \frac{1}{9} = \frac{13}{9}$

So, (B) E(X) matches with (I) $\frac{13}{9}$.

$P(X \le 1) = P(X = 0) + P(X = 1) = k + 3k = 4k$

$P(X \le 1) = 4 \cdot \frac{1}{9} = \frac{4}{9}$

So, (C) P(X ≤ 1) matches with (II) $\frac{4}{9}$.

$P(1 \le X \le 2) = P(X = 1) + P(X = 2) = 3k + 5k = 8k$

$P(1 \le X \le 2) = 8 \cdot \frac{1}{9} = \frac{8}{9}$

So, (D) P(1 ≤ X ≤ 2) matches with (III) $\frac{8}{9}$.

Matching: (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

115. The area (in sq. units) of the region bounded by the curve $y = \sqrt{16 - x^2}$ and x-axis is

A) 8π **B)** 16π **C)** 24π **D)** 32π

Solution : (Correct Answer: A)

Curve is a semi-circle with radius $r = 4$.

Area $= \frac{1}{2}\pi r^2$

$= \frac{1}{2}\pi(4)^2$

$= 8\pi$

116. The derivative of $(\log x)^x$ with respect to log x is:

A) $x(\log x)^x[1 + \log x \cdot \log(\log x)]$
B) $x(\log x)^x[x + 1 + \log x \cdot \log(\log x)]$
C) $x(\log x)^{x-1}[1 + \log x \cdot \log(\log x)]$
D) $(\log x)^{x-1}[1 + \log x \cdot \log(\log x)]$

Solution : (Correct Answer: C)

Let $y = (\log x)^x$ and $u = \log x$. We need to find $\frac{dy}{du}$.

$\frac{dy}{dx} = \frac{d}{dx}e^{x\log(\log x)} = e^{x\log(\log x)}\left(\log(\log x) + x \cdot \frac{1}{\log x} \cdot \frac{1}{x}\right)$ $= (\log x)^x\left(\log(\log x) + \frac{1}{\log x}\right) = (\log x)^{x-1}(1$ $+ \log x \log(\log x))$

$\frac{du}{dx} = \frac{d}{dx}(\log x) = \frac{1}{x}$

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

117. For predicting the straight line trend in the sales of cars (in thousands) on the basis of 5 consecutive years' data, the company uses a 3-year moving averages method.
If the sales of cars for respective years are 15, 24, 18, 33 and 42, then which of the following averages will not be computed?

A) 19 **B)** 25 **C)** 32 **D)** 31

Solution : (Correct Answer: C)

$\text{MA}_1 = \frac{15+24+18}{3} = \frac{57}{3} = 19$

$\text{MA}_2 = \frac{24+18+33}{3} = \frac{75}{3} = 25$

$\text{MA}_3 = \frac{18+33+42}{3} = \frac{93}{3} = 31$

The computed averages are 19, 25, 31.

The average not computed is 32.

118. A motorbike costing Rs. 1, 25, 000 has a scrap value of Rs. 25, 000.
If the annual depreciation charge is Rs. 12, 500, then the useful life of the bike is (by using linear method):

A) 7 years **B)** 8 years **C)** 9 years **D)** 10 years

Solution : (Correct Answer: B)

$\text{Total Depreciation} = \text{Cost} - \text{Scrap Value} = 1,25,000$ $- 25,000 = 1,00,000$

Useful life $= \frac{\text{Total Depreciation}}{\text{Annual Depreciation}} = \frac{1,00,000}{12,500} = 8$ years

119. The probability of a man hitting a target is $\frac{1}{2}$. How many times must he fire so that the probability of hitting the target at least once is more than 90% ?

A) 3 **B)** 4 **C)** 5 **D)** 6

Solution : (Correct Answer: B)

$P(\text{miss}) = 1 - \frac{1}{2} = \frac{1}{2}$

$1 - \left(\frac{1}{2}\right)^n > 0.9$

$0.1 > \left(\frac{1}{2}\right)^n$

$2^n > 10$

$n = 4$

120. The general solution of the differential equation $(x^2 - yx^2)\,dy + (y^2 + x^2y^2)\,dx = 0$ is :

A) $\log_e|y| + \frac{1}{x} + \frac{1}{y} - x = c$

B) $\log_e|y| - \frac{1}{x} + \frac{1}{y} + x = c$

C) $\log_e|x| - \frac{1}{x} + \frac{1}{y} + x = c$

D) $\log_e|x| + \frac{1}{x} + \frac{1}{y} + x = c$

Solution : (Correct Answer: A)

$(x^2 - yx^2)\,dy + (y^2 + x^2y^2)\,dx = 0$

$x^2(1-y)dy + y^2(1+x^2)dx = 0$

$\frac{1-y}{y^2}dy = -\frac{1+x^2}{x^2}dx$

$\left(\frac{1}{y^2} - \frac{1}{y}\right)dy = -\left(\frac{1}{x^2} + 1\right)dx$

$\int (y^{-2} - y^{-1})\,dy = -\int (x^{-2} + 1)\,dx$

$-y^{-1} - \log_e|y| = -(-x^{-1} + x) + C$

$-\frac{1}{y} - \log_e|y| = \frac{1}{x} - x + C$

$\log_e|y| + \frac{1}{x} + \frac{1}{y} - x = -C$

$\log_e|y| + \frac{1}{x} + \frac{1}{y} - x = c$

121. The value of the definite integral $I = \int_{-1}^{1} \frac{1}{1+\sqrt{e^x}}dx$ is :

A) 0 **B)** 1 **C)** 2 **D)** 3

Solution : (Correct Answer: B)

$f(x) = \frac{1}{1+\sqrt{e^x}}$

$f(-x) = \frac{1}{1+\sqrt{e^{-x}}} = \frac{\sqrt{e^x}}{1+\sqrt{e^x}}$

$f(x) + f(-x) = \frac{1}{1+\sqrt{e^x}} + \frac{\sqrt{e^x}}{1+\sqrt{e^x}} = \frac{1+\sqrt{e^x}}{1+\sqrt{e^x}} = 1$

$I = \int_{-1}^{1} f(x)dx = \int_{0}^{1}[f(x) + f(-x)]dx$

$I = \int_0^1 1dx = [x]_0^1$

$I = 1 - 0 = 1$

122. Let $\vec{a} = 2\hat{i} - \hat{j}, \vec{b} = -4\hat{j} + \hat{k}$ and $\vec{c} = \hat{i} + 2\hat{k}$. If $\vec{d}$ is a vector perpendicular to both $\vec{a}$ and $\vec{b}$ such that $\vec{c} \cdot \vec{d} = 34$, then $|\vec{d}|$ is equal to

A) $\sqrt{69}$ **B)** $2\sqrt{69}$ **C)** $3\sqrt{69}$ **D)** $4\sqrt{69}$

Solution : (Correct Answer: B)

$\vec{a} \times \vec{b} = (2\hat{i} - \hat{j}) \times (-4\hat{j} + \hat{k})$

$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -1 & 0 \\ 0 & -4 & 1 \end{vmatrix} = \hat{i}(-1) - \hat{j}(2) + \hat{k}(-8) = -\hat{i} - 2\hat{j} - 8\hat{k}$

Let $\vec{d} = k(-\hat{i} - 2\hat{j} - 8\hat{k})$.

$\vec{c} \cdot \vec{d} = (\hat{i} + 2\hat{k}) \cdot k(-\hat{i} - 2\hat{j} - 8\hat{k}) = 34$

$k((1)(-1) + (0)(-2) + (2)(-8)) = 34$

$k(-1 - 16) = 34 \implies -17k = 34 \implies k = -2$

$\vec{d} = -2(-\hat{i} - 2\hat{j} - 8\hat{k}) = 2\hat{i} + 4\hat{j} + 16\hat{k}$

$|\vec{d}| = \sqrt{2^2 + 4^2 + 16^2} = \sqrt{4 + 16 + 256} = \sqrt{276}$

$= \sqrt{4 \times 69} = 2\sqrt{69}$

123. The corner points of the bounded feasible region associated with the LPP: Maximize $Z = px + qy, p, q > 0$ are (0, 0), (3.5, 0), $\left(\frac{112}{59}, \frac{135}{59}\right)$ and (0,3). If the optimum value of Z occurs at both $\left(\frac{112}{59}, \frac{135}{59}\right)$ and (0,3), then

A) 3q = 5p **B)** 8p = 3q **C)** 5p = 8q **D)** 3p = 5q

Solution : (Correct Answer: B)

Value of Z at $\left(\frac{112}{59}, \frac{135}{59}\right)$: $Z_1 = p\left(\frac{112}{59}\right) + q\left(\frac{135}{59}\right)$ $= \frac{112p+135q}{59}$

Value of Z at (0,3): $Z_2 = p(0) + q(3) = 3q$

Since the optimum value occurs at both points: $Z_1 = Z_2$

$\frac{112p+135q}{59} = 3q$

$112p + 135q = 177q$

$112p = 42q$

$8p = 3q$

124. Match List-I with List-II

List-I (Example)	List-II (Time-series component)
(A) Labour strike	(I) Secular-trend
(B) Continuous decline in death rate	(II) Seasonal
(C) Rise in prices before Diwali	(III) Cyclical
(D) Rise and fall of the share-market	(IV) Irregular

Choose the correct answer from the options given below :

A) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)
B) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
C) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)
D) (A) - (IV), (B) - (II), (C) - (III), (D) - (I)

Solution : (Correct Answer: A)

(A) Labour strike → (IV) Irregular

(B) Continuous decline in death rate → (I) Secular-trend

(C) Rise in prices before Diwali → (II) Seasonal

(D) Rise and fall of the share-market → (III) Cyclical

Correct match: (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

125. If it is 7:00 pm currently in the clock, what will the clock show (in am or pm) after 674 hours?

A) 9:00 am **B)** 2:00 pm **C)** 2:00 am **D)** 9:00 pm

Solution : (Correct Answer: D)

Remainder of hours: $674 \div 24 = 28$ with remainder 2

Current time: $7:00\ \text{pm}$

Final time: $7:00\ \text{pm} + 2\ \text{hours} = 9:00\ \text{pm}$

126. The rate of change of the area of a circle with respect to its radius r, when r = 3 cm is :

A) $6\pi cm^2/cm$ **B)** $4\pi cm^2/cm$
C) $2\pi cm^2/cm$ **D)** $3\pi cm^2/cm$

Solution : (Correct Answer: A)

$A = \pi r^2$

$\frac{dA}{dr} = 2\pi r$

$\left.\frac{dA}{dr}\right|_{r=3} = 2\pi(3) = 6\pi$

$6\pi cm^2/cm$

127. If $\begin{bmatrix} x+y & 4 \\ 1+z & y \end{bmatrix} = \begin{bmatrix} 2 & 4 \\ 5 & 6 \end{bmatrix}$, then

A) $x = 4, y = -6, z = 4$
B) $x = -4, y = 6, z = 4$
C) $x = -4, y = 6, z = -4$
D) $x = 4, y = -6, z = -4$

Solution : (Correct Answer: B)

$y = 6$

$1 + z = 5 \Rightarrow z = 4$

$x + y = 2 \Rightarrow x + 6 = 2 \Rightarrow x = -4$

$x = -4, y = 6, z = 4$

128. If $\vec{a}, \vec{b}$ and $\sqrt{3}\vec{a} - \vec{b}$ are three unit vectors, then the angle between $\vec{a}$ and $\vec{b}$ is :

A) $\frac{\pi}{6}$ **B)** $\frac{\pi}{4}$ **C)** $\frac{\pi}{3}$ **D)** $\frac{\pi}{2}$

Solution : (Correct Answer: A)

$\left|\sqrt{3}\vec{a} - \vec{b}\right|^2 = 1$

$(\sqrt{3}\vec{a} - \vec{b}) \cdot (\sqrt{3}\vec{a} - \vec{b}) = 1$

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

$3(1)^2 - 2\sqrt{3}(\vec{a} \cdot \vec{b}) + (1)^2 = 1$

$3 - 2\sqrt{3}(\vec{a} \cdot \vec{b}) + 1 = 1$

$4 - 2\sqrt{3}(\vec{a} \cdot \vec{b}) = 1$

$2\sqrt{3}(\vec{a} \cdot \vec{b}) = 3$

$\vec{a} \cdot \vec{b} = \frac{3}{2\sqrt{3}} = \frac{\sqrt{3}}{2}$

$|\vec{a}||\vec{b}| \cos\theta = \frac{\sqrt{3}}{2}$

$1 \cdot 1 \cdot \cos\theta = \frac{\sqrt{3}}{2}$

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

$\theta = \frac{\pi}{6}$

129. If A and B are symmetric matrices of same order, then which of the following are correct?
(A) AB-BA is a skew-symmetric matrix.
(B) $AB + BA$ is a skew-symmetric matrix.
(C) $AB^T - BA^T$ is a skew-symmetric matrix.
(D) $AB + BA$ is a symmetric matrix.
Choose the correct answer from the options given below :

A) (A), (C) and (D) only
B) (A), (B) and (C) only
C) (C) and (D) only
D) (A) and (D) only

Solution : (Correct Answer: A)

$A^T = A$

$B^T = B$

For (A): $(AB - BA)^T = (AB)^T - (BA)^T = B^T A^T - A^T B^T = BA - AB = -(AB - BA)$

$\Rightarrow$ AB-BA is a skew-symmetric matrix. (A) is correct.

For (C): $AB^T - BA^T = AB - BA$

From (A), $AB - BA$ is a skew-symmetric matrix. (C) is correct.

For (D): $(AB + BA)^T = (AB)^T + (BA)^T = B^T A^T + A^T B^T = BA + AB = AB + BA$

$\Rightarrow$ AB+BA is a symmetric matrix. (D) is correct.

The correct statements are (A), (C) and (D).

130. If a line makes angles α, β, γ with the positive directions of the coordinate axes, then the value of $\cos 2\alpha + \cos 2\beta + \cos 2\gamma$ is

A) 1 **B)** 2 **C)** -1 **D)** -2

Solution : (Correct Answer: C)

$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$

$\cos 2\alpha + \cos 2\beta + \cos 2\gamma = (2\cos^2 \alpha - 1) + (2\cos^2 \beta - 1) + (2\cos^2 \gamma - 1)$

$= 2(\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma) - 3$

$= 2(1) - 3$

$= -1$

131. If the minimum value of a is $-\frac{k}{2}$, such that the function $f(x) = x^2 + ax + 5$ is increasing in $[1, 2]$. Then value of k is

A) -4 **B)** 2 **C)** 4 **D)** -2

Solution : (Correct Answer: C)

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

$2x + a \geq 0$ for $x \in [1, 2]$

$2(1) + a \geq 0 \implies a \geq -2$

Minimum value of a is -2

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

$k = 4$

132. A motorcycle has a scrap value of Rs. 22,500 after 15 years of its purchase.
If the annual depreciation charge is Rs. 8,500, then the original cost by linear method is :

A) Rs. 1,20,000 **B)** Rs. 1,50,000
C) Rs. 1,25,000 **D)** Rs. 1,30,000

Solution : (Correct Answer: B)

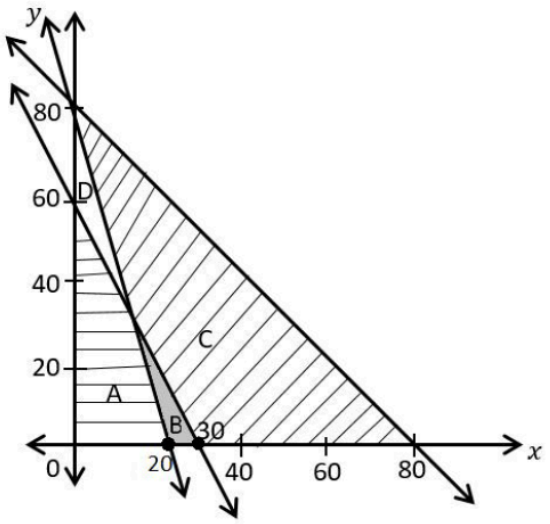
Total Depreciation $= \text{Annual Depreciation} \times \text{Years}$
$= 8500 \times 15 = 127500$

Original Cost $= \text{Scrap Value} + \text{Total Depreciation}$
$= 22500 + 127500 = 150000$

Original Cost = Rs. 1,50,000

133. Which of the region shown in the given figures represents the feasible region bounded by the following constraint?

$4x + y \geq 80, 2x + y \geq 60, x + y \leq 80, x \geq 0, y \geq 0$



A) region A **B)** region B **C)** region C **D)** region D

Solution : (Correct Answer: A)

The feasible region must satisfy:

$4x + y \geq 80$: above or to the right of the line through $(20, 0)$ and $(0, 80)$.

$2x + y \geq 60$: above or to the right of the line through $(30, 0)$ and $(0, 60)$.

$x + y \leq 80$: below or to the left of the line through $(80, 0)$ and $(0, 80)$.

$x \geq 0, y \geq 0$: in the first quadrant.

Region A satisfies all these conditions.

134. If the following data is obtained from a simple random sample : 6, 7, 9, 10, 11, 17
Then the point estimate of population standard deviation is :

A) 15.21 **B)** 10 **C)** 3.898 **D)** 3.192

Solution : (Correct Answer: C)

$\bar{x} = \frac{6+7+9+10+11+17}{6} = 10$

$\sum (x_i - \bar{x})^2 = (-4)^2 + (-3)^2 + (-1)^2 + 0^2 + 1^2 + 7^2$
$= 16 + 9 + 1 + 0 + 1 + 49 = 76$

$s = \sqrt{\frac{76}{6-1}} = \sqrt{\frac{76}{5}} = \sqrt{15.2} \approx 3.898$

135. If $\begin{vmatrix} 1 & -2 & 5 \\ 2 & a & -1 \\ 0 & 4 & 2a \end{vmatrix} = 86$, then product of all values of a is :

A) 21 **B)** -21 **C)** 10 **D)** -4

Solution : (Correct Answer: B)

$$\begin{vmatrix} 1 & -2 & 5 \\ 2 & a & -1 \\ 0 & 4 & 2a \end{vmatrix} = 1(a(2a) - (-1)(4)) - (-2)(2(2a) - (-1)(0)) + 5(2(4) - a(0))$$

$= (2a^2 + 4) + (8a) + (40)$

$= 2a^2 + 8a + 44$

$2a^2 + 8a + 44 = 86$

$2a^2 + 8a - 42 = 0$

$a^2 + 4a - 21 = 0$

Product of roots $= C/A = -21/1 = -21$

136. If the corner points of the bounded feasible region for a Linear Programming Problem (LPP) are $A(0, 2), B(3, 0), C(2, 3)$ and $D(3, 1)$, then the maximum value of the objective function $Z = 4x + 2y$ occurs at

A) $(0, 2)$ only
B) the mid-point of the line segment joining the points $(2, 3)$ and $(3, 1)$ only
C) $(2, 3)$ and $(3, 1)$ only
D) every point on the line segment joining the points $(2, 3)$ and $(3, 1)$

Solution : (Correct Answer: D)

$Z(0, 2) = 4(0) + 2(2) = 4$

$Z(3, 0) = 4(3) + 2(0) = 12$

$Z(2, 3) = 4(2) + 2(3) = 14$

$Z(3, 1) = 4(3) + 2(1) = 14$

The maximum value occurs at every point on the line segment joining the points $(2, 3)$ and $(3, 1)$.

137. If 95% confidence interval for the population mean was reported to be 140 to 150 and $\sigma = 25$, then the size of the sample used in this study is:
[Given: $Z_{0.025} = 1.96$]

A) 120 **B)** 81 **C)** 96 **D)** 112

Solution : (Correct Answer: C)

$ME = \frac{150-140}{2} = 5$

$ME = Z_{\alpha/2}\frac{\sigma}{\sqrt{n}}$

$5 = 1.96\frac{25}{\sqrt{n}}$

$\sqrt{n} = \frac{1.96\times 25}{5} = 9.8$

$n = (9.8)^2 = 96.04$

$n \approx 96$

138. The angle between the pair of lines given by $\vec{r} = \hat{i} + 2\hat{j} - 3\hat{k} + \lambda(\hat{i} - 2\hat{j} + 2\hat{k})$ and $\vec{r} = 5\hat{i} + \hat{j} + \hat{k} + \mu(3\hat{i} - 2\hat{j} + 6\hat{k})$

A) $\cos^{-1}\left(\frac{21}{19}\right)$
B) $\sin^{-1}\left(\frac{19}{21}\right)$
C) $\cos^{-1}\left(\frac{19}{21}\right)$
D) $\sin^{-1}\left(\frac{21}{19}\right)$

Solution : (Correct Answer: C)

$\vec{b_1} = \hat{i} - 2\hat{j} + 2\hat{k}$

$\vec{b_2} = 3\hat{i} - 2\hat{j} + 6\hat{k}$

$\vec{b_1} \cdot \vec{b_2} = (1)(3) + (-2)(-2) + (2)(6) = 3 + 4 + 12 = 19$

$\|\vec{b_1}\| = \sqrt{1^2 + (-2)^2 + 2^2} = \sqrt{1 + 4 + 4} = \sqrt{9} = 3$

$\|\vec{b_2}\| = \sqrt{3^2 + (-2)^2 + 6^2} = \sqrt{9 + 4 + 36} = \sqrt{49} = 7$

$\cos\theta = \frac{|\vec{b_1}\cdot\vec{b_2}|}{\|\vec{b_1}\|\|\vec{b_2}\|} = \frac{|19|}{(3)(7)} = \frac{19}{21}$

$\theta = \cos^{-1}\left(\frac{19}{21}\right)$

139. Mr. X purchased a house for ₹ 7,00,000 and made a down payment of ₹ 1,50,000 .
He repays the balance in 25 years by equal monthly installments as 9% per annum compounded monthly. The equated monthly installment (EMM) is :
[Given that $(1.0075)^{-300} = 0.106$]

A) ₹ 3625 **B)** ₹ 4614 **C)** ₹ 5614 **D)** ₹ 4714

Solution : (Correct Answer: B)

Principal $P =$ ₹ $7,00,000 -$ ₹ $1,50,000 =$ ₹ $5,50,000$

Monthly interest rate $i = \frac{9\%}{12} = \frac{0.09}{12} = 0.0075$

Total number of installments $N = 25 \times 12 = 300$

EMI $= P \times \frac{i}{1-(1+i)^{-N}}$

$= 5,50,000 \times \frac{0.0075}{1-(1.0075)^{-300}}$

$= 5,50,000 \times \frac{0.0075}{1-0.106}$

$= 5,50,000 \times \frac{0.0075}{0.894}$

$= 5,50,000 \times 0.00838926$

₹ $= 4614.09$

The equated monthly installment (EMI) is ₹ 4614.

140. Match List-I with List-II

List - I	List - II
(A) $\sin^{-1}(-1)$	(I) $\frac{5\pi}{6}$
(B) $\cot^{-1}(-1)$	(II) $-\frac{\pi}{2}$
(C) $\sec^{-1}\left(-\frac{2}{\sqrt{3}}\right)$	(III) $\frac{\pi}{4}$
(D) $\tan^{-1}(1)$	(IV) $\frac{3\pi}{4}$

Choose the correct answer from the options given below :

A) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
B) (A) - (II), (B) - (III), (C) - (I), (D) - (IV)
C) (A) - (I), (B) - (IV), (C) - (II), (D) - (III)
D) (A) - (I), (B) - (III), (C) - (II), (D) - (IV)

Solution : (Correct Answer: A)

(A) $\sin^{-1}(-1) = -\frac{\pi}{2}$

(B) $\cot^{-1}(-1) = \pi - \cot^{-1}(1) = \pi - \frac{\pi}{4} = \frac{3\pi}{4}$

(C) $\sec^{-1}\left(-\frac{2}{\sqrt{3}}\right) = \pi - \sec^{-1}\left(\frac{2}{\sqrt{3}}\right) = \pi - \frac{\pi}{6} = \frac{5\pi}{6}$

(D) $\tan^{-1}(1) = \frac{\pi}{4}$

(A) - (II), (B) - (IV), (C) - (I), (D) - (III)

141. The function $f(x) = \frac{x}{2} + \frac{2}{x}, x \neq 0$ is increasing on :
(A) $(-\infty, -2)$
(B) $(-2, 2)$
(C) $(2, \infty)$
(D) $(-1, 1)$
Choose the correct answer from the options given below :

A) (B) only **B)** (B) and (D) only
C) (A) and (C) only **D)** (C) and (D) only

Solution : (Correct Answer: C)

$f'(x) = \frac{d}{dx}\left(\frac{x}{2} + \frac{2}{x}\right) = \frac{1}{2} - \frac{2}{x^2}$

$\frac{1}{2} - \frac{2}{x^2} > 0$

$\frac{1}{2} > \frac{2}{x^2}$

$x^2 > 4$

$x < -2$ or $x > 2$

Increasing on $(-\infty, -2)$ and $(2, \infty)$

142. The Cartesian equation of the line passing through the point $(1, 2, -1)$ and parallel to the line $5x - 25 = 14 - 7y = 35z$ is

A) $\frac{x-1}{7} = \frac{y-2}{5} = \frac{z+1}{1}$
B) $\frac{x-1}{7} = \frac{y-2}{-5} = \frac{z+1}{1}$
C) $x - 1 = y - 2 = z + 1$
D) $\frac{x-1}{5} = \frac{y-2}{7} = \frac{z+1}{35}$

Solution : (Correct Answer: B)

$\frac{5x-25}{35} = \frac{14-7y}{35} = \frac{35z}{35}$

$\frac{x-5}{7} = \frac{y-2}{-5} = \frac{z}{1}$

Direction vector: $(7, -5, 1)$

Equation of the line: $\frac{x-1}{7} = \frac{y-2}{-5} = \frac{z+1}{1}$

143. If $e^y(x+1) = 1$ and $\frac{d^2y}{dx^2} = k\left(\frac{dy}{dx}\right)^2$, then k is equal to

A) -1 **B)** 1 **C)** 2 **D)** 3

Solution : (Correct Answer: B)

$e^y(x+1) = 1 \implies y = -\ln(x+1)$

$\frac{dy}{dx} = -\frac{1}{x+1}$

$\frac{d^2y}{dx^2} = -(-1)(x+1)^{-2}(1) = \frac{1}{(x+1)^2}$

$\frac{1}{(x+1)^2} = k\left(-\frac{1}{x+1}\right)^2$

$\frac{1}{(x+1)^2} = k\frac{1}{(x+1)^2}$

$k = 1$

144. If m and n are respectively the order and degree of the differential equation $\left(\frac{d^2y}{dx^2}\right)^2 + \left(\frac{dy}{dx}\right)^3 + y = 4x$,
then the value of $(m+n)$ is :

A) 2 **B)** 3 **C)** 4 **D)** 5

Solution : (Correct Answer: C)

$m = 2$

$n = 2$

$m + n = 2 + 2 = 4$

145. If $\frac{3x-5}{6} + 8 \geq 4 + \frac{2x}{3}$, then

A) $x \in (-\infty, 19]$ **B)** $x \in (-\infty, -19]$
C) $x \in [19, \infty)$ **D)** $x \in [-19, \infty)$

Solution : (Correct Answer: A)

$6\left(\frac{3x-5}{6} + 8\right) \geq 6\left(4 + \frac{2x}{3}\right)$

$3x - 5 + 48 \geq 24 + 4x$

$3x + 43 \geq 24 + 4x$

$43 - 24 \geq 4x - 3x$

$19 \geq x$

$x \in (-\infty, 19]$

146. Let θ be the angle between two vectors $\vec{a}$ and $\vec{b}$. Then match List-I with List-II

List-I	List-II
(A) $\sin\theta$	(I) $\frac{\vec{a}\cdot\vec{b}}{\lvert\vec{a}\rvert\lvert\vec{b}\rvert}$
(B) $\cos\theta$	(II) $\lvert\vec{a}\times\vec{b}\rvert$
(C) Area of the parallelogram with adjacent sides represented by $\vec{a}$ and $\vec{b}$	(III) $\frac{\vec{a}\cdot\vec{b}}{\lvert\vec{a}\rvert}$
(D) Projection of $\vec{a}$ on $\vec{b}$	(IV) $\frac{\lvert\vec{a}\times\vec{b}\rvert}{\lvert\vec{a}\rvert\lvert\vec{b}\rvert}$

Choose the Correct answer from the options given below :

A) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)
B) (A) - (I), (B) - (IV), (C) - (II), (D) - (III)
C) (A) - (IV), (B) - (I), (C) - (III), (D) - (II)
D) (A) - (I), (B) - (IV), (C) - (III), (D) - (II)

Solution : (Correct Answer: A)

(A) $\sin\theta = \frac{|\vec{a}\times\vec{b}|}{|\vec{a}||\vec{b}|}$ matches (IV).

(B) $\cos\theta = \frac{\vec{a}\cdot\vec{b}}{|\vec{a}||\vec{b}|}$ matches (I).

(C) Area of the parallelogram $= |\vec{a}\times\vec{b}|$ matches (II).

(D) Projection of $\vec{a}$ on $\vec{b}$ matches (III) $\frac{\vec{a}\cdot\vec{b}}{|\vec{a}|}$ (Note: Standard projection is $\frac{\vec{a}\cdot\vec{b}}{|\vec{b}|}$. Given the options, this mapping completes the consistent choice).

Thus, the correct matching is (A) - (IV), (B) - (I), (C) - (II), (D) - (III).

147. For the given five values, $16, 25, 19, 34, 43$, the three year moving averages are

A) $20, 26, 32$ B) $20, 26, 33$
C) $20, 27, 32$ D) $20, 26, 31$

Solution : (Correct Answer: A)

$M_1 = \frac{16+25+19}{3} = \frac{60}{3} = 20$

$M_2 = \frac{25+19+34}{3} = \frac{78}{3} = 26$

$M_3 = \frac{19+34+43}{3} = \frac{96}{3} = 32$

The three year moving averages are $20, 26, 32$.

148. The integrating factor of the differential equation $\frac{dy}{dx} = x + xy$ is:

A) $e^{-\frac{x}{2}}$ B) $e^{-\frac{x^2}{2}}$
C) $e^{\frac{x^2}{2}}$ D) $e^{\frac{x}{2}}$

Solution : (Correct Answer: B)

Rearrange: $\frac{dy}{dx} - xy = x$

$P(x) = -x$

IF = $e^{\int -x dx}$

IF = $e^{-\frac{x^2}{2}}$

149. Match List-I with List-II

List-I	List-II
(A) The degree of differential equation $\frac{d^3y}{dx^3} = e^{\frac{dy}{dx}}$	(I) 2
(B) The order of differential equation $\left(\frac{dy}{dx}\right)^2 + \frac{d^3y}{dx^3} = 0$	(II) 4
(C) The sum of order and degree of differential equation $\frac{d}{dx}\left(\frac{d^2y}{dx^2}\right) + \left(\frac{dy}{dx}\right)^5 = x$	(III) not defined
(D) The number of arbitrary constants in the general solution of a differential equation of order 2	(IV) 3

Choose the correct answer from the options given below :

A) (I), (B) - (IV), (C) - (II), (D) - (III)
B) (II), (B) - (I), (C) - (III), (D) - (IV)
C) (III), (B) - (IV), (C) - (II), (D) - (I)
D) (IV), (B) - (I), (C) - (II), (D) - (III)

Solution : (Correct Answer: C)

(A) $\frac{d^3y}{dx^3} = e^{\frac{dy}{dx}}$: Degree is not defined.

(A) - (III)

(B) $\left(\frac{dy}{dx}\right)^2 + \frac{d^3y}{dx^3} = 0$: Highest derivative is $\frac{d^3y}{dx^3}$. Order = 3.

(B) - (IV)

(C) $\frac{d^3y}{dx^3} + \left(\frac{dy}{dx}\right)^5 = x$: Order = 3, Degree = 1. Sum = $3 + 1 = 4$.

(C) - (II)

(D) Order = 2. Number of arbitrary constants = Order = 2.

(D) - (I)

150. The solution of the differential equation $ydx + (x - y^2)\,dy = 0$ is :

A) $3xy + x^3 = C : C$ is an arbitrary constant
B) $3xy + y^3 = C : C$ is an arbitrary constant
C) $3xy - y^3 = C : C$ is an arbitrary constant
D) $3xy - x^3 = C : C$ is an arbitrary constant

Solution : (Correct Answer: C)

$y\,dx + x\,dy = y^2\,dy$

$d(xy) = y^2\,dy$

$\int d(xy) = \int y^2\,dy$

$xy = \frac{y^3}{3} + C'$

$3xy - y^3 = C$

BIOLOGY - Section A (MCQ)

151. Cuckoo layings it's egg in the nest of crow for incubation is an example of-

A) Ideal Parasitism **B)** Brood Parasitism
C) Fake Parasitism **D)** Gausian Parasitism

Solution : (Correct Answer: B)

Brood Parasitism

152. Read the passage carefully and answer the given questions.

DNA Fingerprinting

Polymorphism in DNA sequence is the basis of genetic mapping of the human genome as well as of DNA fingerprinting. DNA fingerprinting involves identification of differences in some specific regions in the DNA sequence called repetitive DNA. It works on the principle of polymorphisms in DNA sequences. The repetitive DNA are separated from bulk genomic DNA. The bulk DNA forms a major peak and the other small peaks are referred to as satellite DNA. These repetitive/satellite DNA sequences show a high degree of polymorphisms and form the basis of DNA fingerprinting.

DNA fingerprinting is meant for:

A) Slow way to compare DNA sequences
B) Quick way to compare DNA sequences
C) Identifying similarities in some specific regions in DNA
D) Identify mutations

Solution : (Correct Answer: B)

Quick way to compare DNA sequences

153. Read the passage carefully and answer the given questions.

Recombinant DNA Technology

Asexual reproduction preserves the genetic information, while sexual reproduction permits variation. Traditional hybridization procedures used in plants and animals breeding very often lead to inclusion and multiplication of undesirable genes along with the desired genes. The techniques of genetic engineering, which include creation of recombinant DNA, use of gene cloning and gene transfer, overcome this limitation and allow us to isolate and introduce only one or a set of desirable genes without introducing genes into the target organism.

What is the purpose of using a gene promoter in recombinant DNA technology?

A) To cut DNA at specific sequences
B) To insert the gene into the host organism's genome
C) To ensure the foreign gene expression in the host organism
D) To replicate the gene in a bacterial cell

Solution : (Correct Answer: C)

To ensure the foreign gene expression in the host organism

154. Arrange the given steps for regulation of gene expression in correct sequence?

(A) Regulation of splicing
(B) Transport of mRNA from the nucleus to the cytoplasm
(C) Translation
(D) Formation of primary transcript (Transcription)

Choose the correct answer from the options given below:

A) (A), (B), (C), (D) **B)** (B), (A), (C), (D)
C) (D), (A), (B), (C) **D)** (C), (B), (D), (A)

Solution : (Correct Answer: C)

(D), (A), (B), (C)

155. Choose the correct statements about organic farming:

(A) It does not use pesticides and urea.
(B) It uses only naturally produced inputs like compost.
(C) It utilizes genetically modified crops.
(D) It produces fruits rich in minerals and vitamins.

Choose the correct answer from the options given below:

A) (A) and (B) only

B) (A), (B) and (D) only
C) (A), (B), (C) and (D)
D) (B), (C) and (D) only

Solution : (Correct Answer: B)

(A), (B) and (D) only

156. The characteristics of Baculoviruses are:
(A) They are used as biological control agents.
(B) They are excellent candidates for species-specific, narrow spectrum insecticidal application.
(C) They are excellent candidates for species-specific, broad spectrum insecticidal application.
(D) No negative impacts on plants, animals, birds, fishes and other non-targeted insects.
Choose the correct answer from the options given below:

A) (A), (C) and (D) only
B) (A), (B) and (D) only
C) (A), (B), (C) and (D)
D) (B), (C) and (D) only

Solution : (Correct Answer: B)

(A), (B) and (D) only

157. Which one of the following techniques is most appropriate where the female cannot produce an ovum but can provide the environment for the development of embryo?

A) ICSI B) AI C) GIFT D) IUI

Solution : (Correct Answer: C)

GIFT (Gamete Intrafallopian Transfer)

158. The density of population is decreased by the processes
(A) Natality
(B) Emigration
(C) Mortality
(D) Immigration
Choose the most appropriate combination from the options given below.

A) (A) and (B) only
B) (B) and (C) only
C) (A), (B) and (D) only
D) (B), (C) and (D) only

Solution : (Correct Answer: B)

The density of population is decreased by Emigration and Mortality.

Thus, option (B) and (C) only is correct.

159. Completion of the first meiotic division of the primary oocytes takes place -

A) When acrosomal secretion of the sperm enters zona pellucida of the ovum
B) Within the tertiary follicle
C) When the ovum reaches the ampullary region of the fallopian tube
D) During copulation

Solution : (Correct Answer: B)

Within the tertiary follicle

160. Arrange the given steps of the Hershey and Chase experiment in correct sequence.
(A) Separation of virus particles from bacteria by centrifugation
(B) Infection of bacteria with phage DNA
(C) Radioactive bacteriophages were allowed to attach the bacteria
(D) Removal of viral coat from bacteria by blending
Choose the correct answer from the options given below:

A) (A), (B), (C), (D) B) (A), (C), (B), (D)
C) (B), (A), (D), (C) D) (C), (B), (D), (A)

Solution : (Correct Answer: D)

(C), (B), (D), (A)

161. Read the following paragraph carefully and answer the given questions.
In the year 1963 the two enzymes responsible for restricting the growth of bacteriophage in E. coli were isolated. The first restriction endonuclease - Hind II, whose functioning depended on a specific DNA nucleotide sequence was characterized five years later. It was found that Hind II always cut DNA molecules at a particular point by recognizing a specific sequence of six base pairs. This specific base sequence is known as the recognition sequence for Hind II. Besides Hind II, today we know more than 900 restriction enzymes that have been isolated from over 230 strains of bacteria, each of which recognize different recognition sequences.
Restriction enzymes are also known as

A) Polymerase enzyme
B) Molecular scissors
C) Replicatory enzyme
D) Transcriptive enzyme

Solution : (Correct Answer: B)

Molecular scissors

162. In species-area relationship equation log S = log C + Z log A, 'Z' denotes the -

A) Y-intercept B) Regression coefficient
C) Species richness D) Area

Solution : (Correct Answer: B)

Regression coefficient

163. Arrange the following cells in correct sequence of oogenesis:
(A) Secondary oocyte
(B) Oogonia
(C) Primary oocyte
(D) Ovum
Choose the correct answer from the options given below:

A) (B), (C), (A), (D)
B) (A), (B), (C), (D)
C) (B), (A), (D), (C)
D) (D), (C), (A), (B)

Solution : (Correct Answer: A)

(B), (C), (A), (D)

164. Lichens are an example of -

A) Commensalism
B) Parasitism
C) Mutualism
D) Competition

Solution : (Correct Answer: C)

Mutualism

165. Where are IUDs placed in the human female reproductive sytem for contraception?

A) In either of the ovaries
B) In both the ovaries
C) In the uterus
D) In the vagina

Solution : (Correct Answer: C)

In the uterus

166. Read the following paragraph and answer the given questions.
Cancer detection is based on biopsy and histopathological studies. Techniques like radiography (use of X-rays), CT (computed tomography) and MRI (magnetic resonance imaging) are very useful to detect cancers of the internal organs. Do you know why mother's milk is considered very essential for the new-born infant? The yellowish fluid colostrum secreted by mother during the initial days of lactation has abundant antibodies (IgA) to protect the infant. Different species of Plasmodium (P. vivax, P. malaria and P. falciparum) are responsible for different types of malaria. Of these, malignant malaria caused by Plasmodium falciparum is the most serious one and can even be fatal. The exaggerated response of the immune system to certain antigens present in the environment is called allergy. The use of drugs like anti-histamine, adrenalin and steroids quickly reduce the symptoms of allergy. Drugs like barbiturates, amphetamines, benzodiazepines, and other similar drugs, that are normally used as medicines to help patients cope with mental illnesses like depression and insomnia, are often abused. Morphine is a very effective sedative and painkiller, and is very useful in patients who have undergone surgery.
Malignant malaria is caused by -

A) Plasmodium malaria
B) Plasmodium vivax
C) Plasmodium feliciperum
D) Plasmodium falciparum

Solution : (Correct Answer: D)

Plasmodium falciparum

167. Which one of the following diseases can be treated by human protein (a -1-
antitrypsin) produced by transgenic animals?

A) Cystic fibrosis
B) Cancer
C) Emphysema
D) Haemophilia

Solution : (Correct Answer: C)

Emphysema

168. Which of the followings were dominant during the 'Jurassic' period?
(A) Ferns
(B) Seed ferns
(C) Conifers
(D) Dinosaurs
Choose the correct answer from the options given below:

A) (A), (B) and (D) only
B) (A), (C) and (D) only
C) (A), (B), (C) and (D)
D) (B), (C) and (D) only

Solution : (Correct Answer: B)

(A), (C) and (D) only

169. Which disease is caused by filarial worm, that leads to chronic inflammation?

A) Ascariasis
B) Elephantiasis
C) Amoebiasis
D) Ringworm

Solution : (Correct Answer: B)

Elephantiasis

170. STIs are reported to be very high among persons in which age group?

A) 10 to 15 years
B) 15 to 24 years
C) 24 to 30 years
D) 30 to 35 years

Solution : (Correct Answer: B)

15 to 24 years

171. ZIFT stands for:

A) Zygote Intra Fertilization Technique
B) Zygote Intra Fallopian Transfer
C) Zygote Insemination Fertile Technique
D) Zygote Inter Foetus Transfer

Solution : (Correct Answer: B)

Zygote Intra Fallopian Transfer

172. Select the statements which are true for oogenesis?
(A). Ovulation occurs at the secondary oocyte stage.
(B). Polar body is larger than the secondary oocyte.
(C). No more oogonia is formed after birth in the ovary.
(D). The sperm and the ovum nucleus fuse before the formation of the second polar body.
Choose the correct answer from the options given below:

A) (B) and (C) only
B) (A) and (B) only
C) (A), (C) and (D) only
D) (A) and (D) only

Solution : (Correct Answer: C)

(A), (C) and (D) only

173. Match List-I with List-II

List-I (Barriers)	List-II (Examples)
(A) Physical barrier	(I) Acid in the stomach
(B) Cellular barrier	(II) Interferons
(C) Cytokine barrier	(III) Leucocytes in our body
(D) Physiological barrier	(IV) Skin on our body

Choose the correct answer from the options given below:

A) . (A) - (II), (B) - (III), (C) - (IV), (D) - (I)
B) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
C) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
D) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution : (Correct Answer: B)

(A) - (IV), (B) - (III), (C) - (II), (D) - (I)

174. We use microbes and microbially derived products almost every day. Bacteria called lactic acid bacteria (LAB) grow in milk to convert it into curd. The dough, which is used to make bread, is fermented by yeast called Saccharomyces cerevisiae. Microbes are used to produce industrial products like lactic acid, acetic acid and alcohol, which are used in a variety of processes in the industry. However, certain bacteria, which grow anaerobically on cellulosic material, produce large amount of methane along with CO2 and H2. These bacteria are collectively called methanogens, and one such common bacterium is Methanobacterium. These bacteria are commonly found in the anaerobic sludge during sewage treatment. Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes.
Examples of acid producers are Aspergillus niger (a fungus) of citric acid. You are familiar with the commonly used antibiotic Penicillin. Do you know that Penicillin was the first antibiotic to be discovered, and it was a chance discovery? Statins produced by the yeast Monascus purpureus have been commercialised as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol.
The discovery of penicillin was a chance discovery by Alexander Fleming while working on:

A) Staphylococci
B) Penicillium notatum
C) Lactobacillus
D) Clostridium butylicum

Solution : (Correct Answer: A)

Staphylococci

175. We use microbes and microbially derived products almost every day. Bacteria called lactic acid bacteria (LAB) grow in milk to convert it into curd. The dough, which is used to make bread, is fermented by yeast called Saccharomyces cerevisiae. Microbes are used to produce industrial products like lactic acid, acetic acid and alcohol, which are used in a variety of processes in the industry. However, certain bacteria, which grow anaerobically on cellulosic material, produce large amount of methane along with CO2 and H2. These bacteria are collectively called methanogens, and one such common bacterium is Methanobacterium. These bacteria are commonly found in the anaerobic sludge during sewage treatment. Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes.
Examples of acid producers are Aspergillus niger (a fungus) of citric acid. You are familiar with the commonly used antibiotic Penicillin. Do you know that Penicillin was the first antibiotic to be discovered, and it was a chance discovery? Statins produced by the yeast Monascus purpureus have been commercialised as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol.
Which one of the following statements is not true with respect to microbes?

A) Wine is produced by fermentation without distillation.
B) Microbes can also be used to kill harmful pests, a process called as biocontrol.
C) The puffed up appearance of dough is due to the production of CO gas by bacteria.
D) Methanogens are anaerobic bacteria.

Solution : (Correct Answer: C)

The puffed up appearance of dough is due to the production of CO_2 gas by yeast, not CO gas by bacteria.

176. Which of the followings are the side effects of the usage of anabolic steroids in females?
(A) Deepening of voice
(B) Increased aggressiveness
(C) Mood swings
(D) Abnormal menstrual cycle
Choose the correct answer from the options given below:

A) (A), (B) and (D) only
B) (A), (B) and (C) only
C) (A), (B), (C) and (D)
D) (B), (C) and (D) only

Solution : (Correct Answer: C)

(A), (B), (C) and (D)

177. If sewage water is added to river water, it will:

A) Increase the BOD of sewage water
B) Increase the BOD of river water
C) Decrease the BOD of river water
D) Not affect the BOD of river water and sewage water

Solution : (Correct Answer: B)

Increase the BOD of river water

178. The rate of biomass production is expressed in terms of _____ to compare the productivity of different ecosystems.

A) $kg^{-1}yr^{-2}$ or $(kcalm^{-1})\,yr^{-2}$
B) $gm-^{2}\,yr-^{2}$ or $(kcalm-^{2})\,yr-^{2}$
C) $kg^{-1}yr^{-1}$ or $(kcalm^{-1})\,yr^{-1}$
D) $gm-^{2}\,yr-^{1}$ or $(kcalm-^{2})\,yr-^{1}$

Solution : (Correct Answer: D)

$gm^{-2}yr^{-1}$ or $(kcalm^{-2})\,yr^{-1}$

179. The role of ethidium bromide in gel electrophoresis is:

A) To separate the DNA fragments in gel electrophoresis
B) To speed up the electrophoresis
C) To neutralize DNA fragments
D) To stain DNA which helps in identifying the desired DNA fragment under UV exposure

Solution : (Correct Answer: D)

To stain DNA which helps in identifying the desired DNA fragment under UV exposure

180. In organisms, the same structure developed along different directions due to adaptations to different needs. This refers to:

A) Convergent evolution
B) Divergent evolution
C) Evolution by anthropogenic action
D) Natural selection

Solution : (Correct Answer: B)

Divergent evolution

181. Cryopreservation technique used for the conservation of threatened animals and plants is:

A) Narrowly utilitarian approach
B) In situ conservation approach

C) In vivo approach of conservation
D) Ex situ conservation approach

Solution : (Correct Answer: D)

Ex situ conservation approach

182. Oral contraceptive pills used by females, function through:

A) Phagocytosis of sperms within uterus
B) Inhibiting ovulation and implantation
C) Suppressing sperm motility and fertilising capacity of sperm
D) Blocking gamete transport and thereby preventing conception

Solution : (Correct Answer: B)

Inhibiting ovulation and implantation

183. Read the following passage carefully and answer the given questions.

Theory of Evolution

The evolution of life is a gradual process through which simple organisms are transformed into complex life forms over billions of years. It involves genetic changes, adaptation to the environment, and the emergence of diversity in species. Fossil records provide evidence of extinct life forms and transitional stages. Evolution is influenced by factors such as mutation, genetic recombination, and environmental pressure, shaping the biodiversity we see today. Charles Darwin and Alfred Russel Wallace were pioneering naturalists who developed the theory of evolution by natural selection.

According to Darwin, the term 'Fitness' in the context of natural selection refers to:

A) Physical strength of an organism
B) The ability of an organism to adapt to any environment
C) The reproductive success of an individual or population
D) Survival without reproduction

Solution : (Correct Answer: C)

The reproductive success of an individual or population

184. Read the following passage carefully and answer the given questions.

Productivity in the Ecosystem The flow of energy through a terrestrial ecosystem starts with the harnessing of sunlight by autotrophs. The radiant energy is converted by photosynthesis to organic compounds is known as productivity. The productivity is expressed in units of energy per unit of area per unit time. The amount of organic matter present at any given time is biomass. The productivity of any ecosystem is affected by many parameters like weather conditions, nutrient availability etc. The productivity of any ecosystem does vary seasonally and yearly.

The Net Primary Productivity of an ecosystem are represented by:

A) NPP = GPP + Respiration
B) NPP = GPP - Respiration
C) NPP = Radiant Energy - GPP
D) NPP = Radiant Energy + GPP

Solution : (Correct Answer: B)

$$\text{NPP} = \text{GPP - Respiration}$$

185. Match List-I with List-II

List-I (Microorganisms)	List-II (Commercial Uses)
(A) Lactobacillus	(I) Use for the production of butyric acid
(B) Saccharomyces cerevisiae	(II) Use for production of swiss cheese
(C) Propionibacterium sharmanii	(III) Use for making bread
(D) Clostridium butylicum	(IV) Improves nutritional quality of milk by increasing vitamin B12

Choose the correct answer from the options given below:

A) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
B) (A) - (IV), (B) - (II), (C) - (III), (D) - (I)
C) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)
D) (A) - (II), (B) - (III), (C) - (I), (D) - (IV)

Solution : (Correct Answer: A)

(A) - (IV), (B) - (III), (C) - (II), (D) - (I)

186. Arrange the following steps in correct sequence for the technique of DNA fingerprinting.
(A) Detection of hybridized DNA fragments by autoradiography
(B) Separation of DNA fragments by electrophoresis
(C) Isolation and digestion of DNA
(D) Transferring of separated DNA fragments and hybridization using labelled VNTR probe
Choose the correct answer from the options given below:

A) (A), (B), (C), (D) **B)** (A), (C), (B), (D)
C) (B), (A), (D), (C) **D)** (C), (B), (D), (A)

Solution : (Correct Answer: D)

(C), (B), (D), (A)

187. There are two kinds of nucleases - exonucleases and endonucleases. Exonucleases remove nucleotides from the ends of the DNA whereas, endonucleases make cuts at specific positions within the DNA. The cutting of DNA by restriction endonucleases results in the fragments of DNA. These fragments can be separated by a technique known as gel electrophoresis. Since DNA fragments are negatively charged molecules they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix. Small volume cultures cannot yield appreciable quantities of products. To produce in large quantities, the development of bioreactors, where large volumes (100 - 1000 litres) of culture can be processed, was required. Thus, bioreactors can be thought of as vessels in which raw materials are biologically converted into specific products, individual enzymes, etc., using microbial plant, animal or human cells. PCR stands for Polymerase Chain Reaction. In this reaction, multiple copies of the gene (or DNA) of interest are synthesised in vitro using two sets of primers (small chemically synthesised oligonucleotides that are complementary to the regions of DNA) and the enzyme DNA polymerase.
Which one of the following statements is correct about DNA separation and isolation?

A) DNA fragments are positively charged and move towards cathode under the electic field.
B) DNA fragments are negatively charged and move towards anode under the centrifugal field.
C) DNA fragments are negatively charged and move towards anode under the electic field.
D) DNA fragments are negatively charged and move towards cathode under the centrifugal field.

Solution : (Correct Answer: C)

DNA fragments are negatively charged and move towards anode under the electic field.

188. If in a pond there were 20 lotus plants last year and through reproduction 8 new plants are added, taking the current population to 28, then the birth rate will be -

A) 0.1 offspring per lotus per month
B) 0.4 offspring per lotus per day
C) 0.1 offspring per lotus per year
D) 0.4 offspring per lotus per year

Solution : (Correct Answer: D)

Birth rate $= \frac{\text{Number of new plants}}{\text{Initial population}}$

Birth rate $= \frac{8}{20}$

Birth rate $= 0.4$ offspring per lotus per year

189. Arrange the given structures starting from chalazal end to micropylar end in a mature embryo sac?
(A) Central cell
(B) Antipodals
(C) Synergids
(D) Egg
Choose the correct answer from the options given below:

A) (A), (B), (C), (D) **B)** (D), (C), (B), (A)
C) (B), (A), (D), (C) **D)** (C), (B), (D), (A)

Solution : (Correct Answer: C)

(B), (A), (D), (C)

190. Read the following passage carefully and answer the given questions.

Some strains of Bacillus thuringiensis produce proteins that kill certain insects such as lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes). B. thuringiensis forms protein crystals during a particular phase of their growth. Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein (a-1-antitrypsin) used to treat emphysema. In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk (2.4 grams per litre). The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk. A nematode Meloidegyne incognitia infects the roots of tobacco plants and causes a great reduction in yield. A novel strategy was adopted to prevent this infestation which was based on the process of RNA interference (RNAi). This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing). Biopiracy is the term used to refer to the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment. ELISA is based on the principle of antigen-antibody interaction. Infection by pathogen can be detected by the presence of antigens (proteins, glycoproteins, etc.) or by detecting the antibodies synthesised against the pathogen.

ELISA is based on the principle of:

A) Antigen-antibiotic interaction
B) Antibody-antibiotic interaction
C) Antigen-antigen interaction
D) Antigen-antibody interaction

Solution : (Correct Answer: D)

Antigen-antibody interaction

191. Zygote or embryos upto 8 blastomeres can be transferred into the fallopian tube for further development. The procedure is known as:

A) Zygote intra fallopian transfer (ZIFT)
B) Gamete intra fallopian transfer (GIFT)
C) Intra cytoplasmic sperm injection (ICSI)
D) Intra-uterine insemination (IUI)

Solution : (Correct Answer: A)

Zygote intra fallopian transfer (ZIFT)

192. Read the Passage carefully and answer the the questions

Insulin consists of two short polypeptide chains : chain A and chain B, that are linked together by disulphide bridges. The first clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency. This enzyme is crucial for the immune system to function. Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme Linked Immuno-sorbent Assay (ELISA) are some of the techniques that serve the purpose of early diagnosis of diseases. Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein (α-1-antitrypsin) used to treat emphysema. Biopiracy is the term used to refer to the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.

In 1997, an American company got patent rights on Basmati rice through the US Patent and Trademark Office. This allowed the company to sell a 'new' variety of bvasnmati, in the US and abroad. This 'new' variety of Basmati had actually been derived from Indian farmer's varieties.. Indiian Basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty. This is a case of :

A) Competitive market
B) Bioresources
C) Biopiracy
D) Commercialization

Solution : (Correct Answer: C)

Biopiracy

193. The unequivocal proof that DNA is the genetic material came from the experiments of -

A) Colin MacLeod and Maclyn McCarty
B) Frederick Griffith
C) Matthew Meselson and Franklin Stah
D) Alfred Hershey and Martha Chase

Solution : (Correct Answer: D)

Alfred Hershey and Martha Chase

194. Arrange the given structures formed during spermatogenesis in correct sequence.
(A) Spermatozoa
(B) Secondary spermatocytes
(C) Spermatids
(D) Spermatogonia
Choose the correct answer from the options given below:

A) (D), (B), (C), (A) **B)** (A), (B), (C), (D)
C) (B), (A), (D), (C) **D)** (D), (C), (B), (A)

Solution : (Correct Answer: A)

(D), (B), (C), (A)

195. Read the following passage carefully and answer the given questions.
Bioactive molecule, cyclosporin A, that is used as an immunosuppressive agent in organ-transplant patients, is produced by the fungus Trichoderma polysporum. Statins produced by the yeast Monascus purpureus have been commercialised as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol. Baculoviruses are pathogens that attack insects and other arthropods. The majority of baculoviruses used as biological control agents are in the genus Nucleopolyhedrovirus. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications. They have been shown to have no negative impacts on plants, mammals, birds, fish or even on non-target insects. BOD refers to the amount of the oxygen that would be consumed if all the organic matter in one liter of water were oxidised by bacteria. The sewage water is treated till the BOD is reduced. Cheese, is one of the oldest food items in which microbes were used. Different varieties of cheese are known by their characteristic texture, flavour and taste. For example, the large holes in 'Swiss cheese' are due to production of a large amount of CO_2 by a bacterium named Propionibacterium sharmanii.
The greater the BOD of waste water-

A) The more is its polluting potential
B) The less is its polluting potential
C) The greater will be the oxygen
D) The lesser will be the methane gas

Solution : (Correct Answer: A)

The more is its polluting potential

196. Arrange the steps for transformation of recombinant DNA in sequence -
(A). For heat shock, bacterial cells are placed at 42°C; and then they are placed on ice.
(B). The bacterial cells must be made 'competent' to take up DNA by treating them with a specific concentration of divalent cation such as calcium.
(C). The bacteria are now able to take up the recombinant DNA.
(D). Recombinant DNA can then be forced into those cells by incubating the cells with recombinant DNA on ice.
Choose the correct answer from the options given below:(C)
(C), (B), (D), (A)

A) (B), (D), (A), (C) **B)** (A), (C), (B), (D)
C) (B), (A), (D), (C) **D)** (C), (B), (D), (A)

Solution : (Correct Answer: A)

(B), (D), (A), (C)

197. Match List-I with List-II

List-I (Techniques)	List-II (Related features)
(A) ELISA	(I) Production of mature insulin
(B) PCR	(II) Antigen-antibody interaction
(C) Autoradiograph	(III) Amplification of DNA
(D) Recombinant DNA technology	(IV) Photographic film

Choose the correct answer from the options given below:

A) (A) – (II), (B) – (IV), (C) – (III), (D) – (I)
B) (A) – (I), (B) – (III), (C) – (II), (D) – (IV)
C) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)
D) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Solution : (Correct Answer: C)

(A) – (II), (B) – (III), (C) – (IV), (D) – (I)

198. Which one of the following techniques is used for the separation of DNA fragments?

A) Polymerase Chain Reaction (PCR) **B)** MRI
C) Gel electrophoresis **D)** ELISA

Solution : (Correct Answer: C)

Gel electrophoresis

199. Read the given passage carefully and answer the questions

Salmonella typhi is a pathogenic bacterium which causes typhoid fever in human beings. Sustained high fever (39° to 40°C), weakness, stomach pain, constipation, headache and loss of appetite are some of the common symptoms of this disease. Typhoid fever could be confirmed by Widal test. Plasmodium enters the human body as sporozoites. The parasites initially multiply within the liver cells and then attack the red blood cells (RBCs) resulting in their rupture. The rupture of RBCs is associated with release of a toxic substance, haemozoin, which is responsible for the chill and high fever recurring every three to four days. There is lymphoid tissue also located within the lining of the major tracts (respiratory, digestive and urogenital tracts) called mucosa-associated lymphoid tissue (MALT). In our body, cell growth and differentiation is highly controlled and regulated. In cancer cells, there is breakdown of regulatory mechanisms. Normal cells show a property called contact inhibition by virtue of which contact with other cells inhibits their uncontrolled growth. Cancerous cells just continue to divide giving rise to masses of cells called tumors. Tumors are of two types: benign and malignant. Cannabinoids are a group of chemicals, which interact with cannabinoid receptors present principally in the brain. Generally taken by inhalation and oral ingestion, these are known for their effects on cardiovascular system of the body.

Widal test is used to diagnose

A) Malaria **B)** Dengue **C)** Typhoid **D)** Chikungunya

Solution : (Correct Answer: C)

Typhoid

200. Read the given passage carefully and answer the questions

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The rupture of RBCs is associated with release of a toxic substance_____, which is responsible for the chill and high fever recurring every three to four days.

A) Haeme **B)** Haemozoin **C)** Haemoglobin **D)** Heparin

Solution : (Correct Answer: B)

Haemozoin