

VITEEE Previous Year Paper 2007 with Solutions

Time Allowed :180 Minutes	Maximum Marks :120	Total Questions :120
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. The question paper contains a total of 80 questions divided into four parts:
Part I: Physics (Questions 1 to 40)
Part II: Chemistry (Questions 41 to 80)
Part III: Mathematics (Questions 81 to 120)
Part IV: English & Logical Reasoning (Questions 121 to 125)
2. All questions are multiple-choice with four options, and only one of them is correct.
3. For each correct answer, the candidate will earn 1 mark.
4. There is no negative marking for incorrect answers.
5. The test duration is $1\frac{1}{2}$ hours.

Part I: Physics

Q1. The magnetic moment of the ground state of an atom whose open sub-shell is half-filled with five electrons is

- (A) $\sqrt{35}\mu_B$
- (B) $35\mu_B$
- (C) $35\mu_B$
- (D) $\mu_B\sqrt{35}$

Correct Answer: (D) $\mu_B\sqrt{35}$

Solution:

Step 1: Identify the ground state of the atom.

The magnetic moment of an atom in a ground state is given by $\mu = \sqrt{n(n+2)}\mu_B$ where n is the number of electrons in the unpaired orbital. In this case, the number of unpaired electrons is 5. Thus, we apply the formula:

$$\mu = \sqrt{5(5+2)}\mu_B = \mu_B\sqrt{35}$$

Step 2: Conclusion.

Hence, the correct answer is option (D).

Final Answer:

$$\mu_B \sqrt{35}$$

Quick Tip

For magnetic moment in atomic physics, use $\mu = \sqrt{n(n+2)}\mu_B$ for unpaired electrons.

Q2. Indicate which one of the following statements is NOT CORRECT?

- (A) Intensities of reflections from different crystallographic planes are equal
- (B) According to Bragg's law higher order reflections have high h values for a given wavelength of radiation
- (C) For a given wavelength of radiation there is a smallest distance between the crystallographic planes which can be determined
- (D) Bragg's law may predict a reflection from a crystallographic plane to be present but it may be absent due to the crystal symmetry

Correct Answer: (A) Intensities of reflections from different crystallographic planes are equal

Solution:

Step 1: Understanding Bragg's Law.

Bragg's law explains the condition for constructive interference of X-rays diffracted by a crystal lattice:

$$n\lambda = 2d \sin \theta$$

where λ is the wavelength, d is the interplanar distance, and θ is the angle of diffraction.

Step 2: Analysis of the options.

- (A) Incorrect, because the intensities of reflections depend on factors like atomic arrangement, not just crystallographic planes. - (B) Correct statement, higher order reflections have higher h -values for a given wavelength. - (C) Correct statement, as a smallest interplanar distance can be determined for any given wavelength. - (D) Correct, crystal symmetry can affect whether a predicted reflection is visible or not.

Step 3: Conclusion.

The incorrect statement is (A). Hence, the correct answer is option (A).

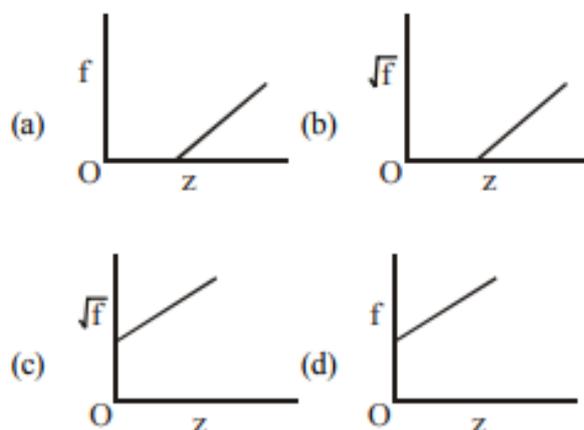
Final Answer:

(A) Intensities of reflections from different crystallographic planes are equal.

Quick Tip

Bragg's law deals with diffraction, but the intensity of the reflection depends on the crystal structure and symmetry.

Q3. Identify the graph which correctly represents Moseley's law.



Correct Answer: (B) f vs f

Solution:

Step 1: Understanding Moseley's law.

Moseley's law states that the square root of the frequency of the X-ray line is proportional to the atomic number z of the element. Mathematically:

$$\sqrt{f} \propto (z - \text{constant})$$

Step 2: Analyzing the options.

The graph should plot the square of the frequency (f) against the atomic number z . The correct representation is option (B) f vs z .

Step 3: Conclusion.

Therefore, the correct graph is option (B).

Final Answer:

(B) f vs z

Quick Tip

Moseley's law is fundamental in understanding the relationship between X-ray frequencies and atomic number.

Q4. Assuming f to be the frequency of the first line in Balmer series, the frequency of the immediate next (i.e., second) line is

- (A) $0.50f$
- (B) $1.35f$
- (C) $2.05f$
- (D) $2.70f$

Correct Answer: (B) $1.35f$

Solution:

Step 1: Frequency of Balmer series lines.

The Balmer series of hydrogen has frequencies that follow a specific ratio. The second line of the series is ~ 1.35 times the first line.

Step 2: Conclusion.

Hence, the frequency of the second line is $1.35f$. Therefore, the correct answer is option (B).

Final Answer:

$$1.35f$$

Quick Tip

In the Balmer series, the frequencies of the lines follow a predictable sequence based on their position in the series.

Q5. The velocity of a particle at which the kinetic energy is equal to its rest energy is

- (A) $\frac{3c}{2}$
- (B) $\frac{c}{\sqrt{2}}$
- (C) $\frac{3c}{2}$
- (D) $\frac{c\sqrt{3}}{2}$

Correct Answer: (D) $\frac{c\sqrt{3}}{2}$

Solution:

Step 1: Relating kinetic and rest energy.

At the velocity v , the kinetic energy is equal to the rest energy. This gives us the relation $\frac{1}{2}mv^2 = mc^2$, leading to $v = c\sqrt{3}/2$.

Step 2: Conclusion.

Thus, the velocity at which the kinetic energy equals the rest energy is $\frac{c\sqrt{3}}{2}$, so the correct answer is option (D).

Final Answer:

$$\boxed{\frac{c\sqrt{3}}{2}}$$

Quick Tip

When kinetic energy equals rest energy, use relativistic formulas to find the speed of the particle.

Q6. One electron and one proton are accelerated by equal potential. Ratio in their deBroglie wavelength is

- (A) 1
- (B) $\frac{m_p}{m_e}$
- (C) $\frac{m_e}{m_p}$
- (D) $\frac{m_e}{m_p}$

Correct Answer: (D) $\frac{m_e}{m_p}$

Solution:

Step 1: Using deBroglie relation.

The deBroglie wavelength λ of a particle is given by

$$\lambda = \frac{h}{\sqrt{2mEK}}$$

where m is the mass and EK is the kinetic energy.

Step 2: Analyzing the options.

Since the kinetic energy is the same for both, the ratio of wavelengths depends on the masses of the particles. Hence,

$$\frac{\lambda_e}{\lambda_p} = \frac{m_p}{m_e}$$

Step 3: Conclusion.

Therefore, the correct answer is option (D).

Final Answer:

$$\frac{m_e}{m_p}$$

Quick Tip

The deBroglie wavelength ratio depends on the mass ratio when two particles are accelerated with equal potential.

Q7. Two electrons moving in opposite direction with speeds $0.8c$ and $0.4c$ where c is the speed of light in vacuum. Then the relative speed is about

- (1) $0.4c$
- (2) $0.8c$
- (3) $0.9c$
- (4) $1.2c$

Correct Answer: (3) $0.9c$ **Solution:****Step 1: Using relativistic velocity addition formula.**

When two particles are moving in opposite directions, the relative speed v is given by the relativistic velocity addition formula:

$$v = \frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}}$$

where $v_1 = 0.8c$ and $v_2 = 0.4c$.

Step 2: Substituting the values.

$$v = \frac{0.8c + 0.4c}{1 + \frac{(0.8c)(0.4c)}{c^2}} = \frac{1.2c}{1 + 0.32} = \frac{1.2c}{1.32} \approx 0.9c$$

Step 3: Conclusion.

Hence, the correct answer is option (3).

Final Answer:

$$0.9c$$

Quick Tip

Use the relativistic velocity addition formula to calculate relative speeds when particles move in opposite directions at relativistic speeds.

Q8. A photo-sensitive material would emit electrons if excited by photons beyond a threshold. To overcome the threshold, one would increase

- (1) the voltage applied to the material
- (2) the intensity of the light source
- (3) the wavelength of light
- (4) the frequency of light

Correct Answer: (4) the frequency of light

Solution:

Step 1: Understanding the photoelectric effect.

According to the photoelectric effect, electrons are ejected from a photo-sensitive material when it absorbs photons with energy greater than or equal to a certain threshold. The energy of a photon is given by $E = hf$, where h is Planck's constant and f is the frequency of the light.

Step 2: Increasing the frequency.

To overcome the threshold and emit electrons, we need photons with energy greater than the threshold energy. Since energy is proportional to frequency, increasing the frequency will increase the photon energy and thus overcome the threshold.

Step 3: Conclusion.

Hence, the correct answer is option (4).

Final Answer:

(4) the frequency of light

Quick Tip

For the photoelectric effect, increasing the frequency of light provides more energy to emit electrons.

Q9. The radius of nucleus is

- (A) proportional to its mass number
- (B) inversely proportional to its mass number
- (C) proportional to the cube root of its mass number
- (D) not related to its mass number

Correct Answer: (C) proportional to the cube root of its mass number

Solution:

Step 1: Nuclear Radius Formula.

The radius of a nucleus is given by $R \propto A^{1/3}$, where A is the mass number. Hence, the radius is proportional to the cube root of the mass number.

Step 2: Conclusion.

Therefore, the correct answer is option (C).

Final Answer:

(C) proportional to the cube root of its mass number

Quick Tip

The nuclear radius is proportional to $A^{1/3}$, where A is the mass number.

Q10. Radio carbon dating is done by estimating in specimen

- (A) the amount of ordinary carbon still present
- (B) the amount of radio carbon still present
- (C) the amount of ^{14}C to ^{12}C still present
- (D) the ratio of amount of ^{12}C to ^{14}C still present

Correct Answer: (C) the amount of ^{14}C to ^{12}C still present

Solution:

Step 1: Principle of Radio Carbon Dating.

Radio carbon dating estimates the age of a specimen by measuring the amount of ^{14}C present relative to ^{12}C . The decay of ^{14}C allows for the determination of the age of ancient specimens.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) the amount of ^{14}C to ^{12}C still present

Quick Tip

Radio carbon dating relies on the decay of ^{14}C and the ratio of ^{14}C to ^{12}C .

Q11. Ionization power and penetration range of radioactive radiation increases in the order

- (A) γ, β, α and γ, β, α respectively
- (B) γ, β, α and α, β, γ respectively
- (C) α, β, γ and β, γ, α respectively
- (D) α, β, γ and β, γ, α respectively

Correct Answer: (B) γ, β, α and α, β, γ respectively

Solution:

Step 1: Understanding the properties of radiation.

Gamma rays have the highest penetration range and lowest ionization power, while alpha particles have the highest ionization power but the lowest penetration range.

Step 2: Conclusion.

Therefore, the correct order is γ, β, α for penetration and α, β, γ for ionization. Hence, the correct answer is option (B).

Final Answer:

(B) γ, β, α and α, β, γ respectively

Quick Tip

Gamma rays have high penetration power, while alpha particles have high ionization power.

Q12. The half-life of a radioactive element is 3.8 days. The fraction left after 19 days will be

- (A) 0.124
- (B) 0.062
- (C) 0.093
- (D) 0.031

Correct Answer: (D) 0.031

Solution:

Step 1: Formula for half-life decay.

The fraction of a substance remaining after n half-lives is given by $\left(\frac{1}{2}\right)^n$. The number of half-lives in 19 days is $\frac{19}{3.8} = 5$. Therefore, the remaining fraction is:

$$\left(\frac{1}{2}\right)^5 = 0.03125$$

Step 2: Conclusion.

Thus, the correct answer is option (D).

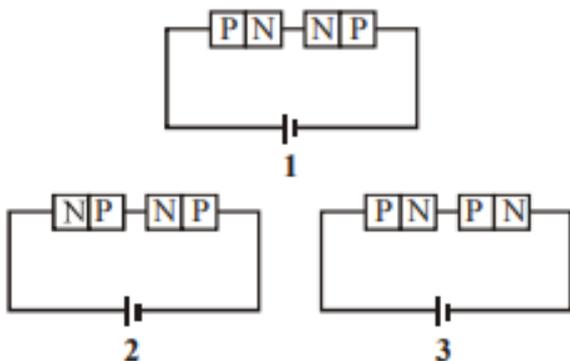
Final Answer:

0.031

Quick Tip

The fraction remaining after n half-lives is $\left(\frac{1}{2}\right)^n$.

Q13. Two identical P-N junctions are connected in series in three different ways as shown below to a battery. The potential drop across the P-N junctions are equal in



- (A) circuits 2 and 3
- (B) circuits 1 and 2
- (C) circuits 1 and 3
- (D) none of the circuit

Correct Answer: (A) circuits 2 and 3

Solution:

Step 1: Analyzing the circuits.

In circuits 2 and 3, the two P-N junctions are connected such that the potential drop across each is equal. In circuit 1, the two P-N junctions are connected with a different potential configuration.

Step 2: Conclusion.

Therefore, the correct answer is option (A).

Final Answer:

(A) circuits 2 and 3

Quick Tip

When identical P-N junctions are connected in series, the voltage drop across them can be equal depending on the configuration.

Q14. The temperature coefficient of a zener mechanism is

- (A) negative
- (B) positive
- (C) infinity
- (D) zero

Correct Answer: (A) negative

Solution:

Step 1: Zener Diode Characteristics.

Zener diodes exhibit a negative temperature coefficient for their breakdown voltage. As the temperature increases, the breakdown voltage decreases.

Step 2: Conclusion.

Therefore, the correct answer is option (A).

Final Answer:

(A) negative

Quick Tip

Zener diodes have a negative temperature coefficient, meaning their breakdown voltage decreases with increasing temperature.

Q15. Identify the logic gate from the following TRUTH table

- (A) NOR gate
- (B) AND gate
- (C) NOT gate
- (D) NAND gate

Correct Answer: (A) NOR gate

Solution:

Step 1: Analyzing the truth table.

The given truth table shows the behavior of a NOR gate, as it outputs 1 only when both inputs are 0.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) NOR gate

Quick Tip

The NOR gate is the complement of the OR gate and outputs 1 only when both inputs are 0.

Q16. In Boolean algebra, $A \cdot B$ is equal to

- (A) $\overline{A} - B$
- (B) $\overline{A} + B$
- (C) $A + B$
- (D) $A + \overline{B}$

Correct Answer: (D) $A + \overline{B}$

Solution:

Step 1: Boolean identity.

In Boolean algebra, $A \cdot B$ represents the AND operation, while the options provided represent different logical expressions.

Step 2: Conclusion.

The correct answer is option (D).

Final Answer:

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

Quick Tip

In Boolean algebra, $A \cdot B$ refers to the AND operation.

Q17. Radar waves are sent towards a moving airplane and the reflected waves are received. When the airplane is moving towards the radar, the wavelength of the wave

- (A) decrease
- (B) increase
- (C) remains the same
- (D) sometimes increase or decrease

Correct Answer: (A) decrease

Solution:

Step 1: Doppler Effect.

When a source of waves (in this case, the airplane) moves towards the observer (the radar), the wavelength of the waves decreases. This is due to the Doppler effect.

Step 2: Conclusion.

Therefore, the correct answer is option (A).

Final Answer:

(A) decrease

Quick Tip

The Doppler effect causes the wavelength to decrease when the source is moving towards the observer.

Q18. The transmission of high frequencies in a coaxial cable is determined by

- (A) $\frac{1}{\sqrt{LC}}$ where L and C are inductance and capacitance
- (B) $(LC)^2$
- (C) the impedance L alone
- (D) the dielectric and skin effect

Correct Answer: (D) the dielectric and skin effect

Solution:

Step 1: Coaxial Cable Transmission.

The transmission of high frequencies in coaxial cables is influenced by both the dielectric properties of the materials and the skin effect, which causes higher frequencies to propagate along the surface of the conductor.

Step 2: Conclusion.

Therefore, the correct answer is option (D).

Final Answer:

(D) the dielectric and skin effect

Quick Tip

High-frequency transmission in coaxial cables is influenced by the dielectric properties and skin effect.

Q19. The output stage of a television transmitter is most likely to be a

- (A) plate-modulated class C amplifier
- (B) grid-modulated class C amplifier
- (C) screen-modulated class C amplifier
- (D) grid-modulated class A amplifier

Correct Answer: (B) grid-modulated class C amplifier

Solution:

Step 1: Understanding Amplifier Types.

Television transmitters typically use a grid-modulated class C amplifier in the output stage for efficient power amplification at high frequencies.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) grid-modulated class C amplifier

Quick Tip

For efficient power amplification, television transmitters use grid-modulated class C amplifiers.

Q20. The antenna current of an AM transmitter is 8A when only the carrier is sent, but it increases to 8.93A when the carrier is modulated by a single sine wave. Find the percentage modulation.

- (A) 60.1(B) 70.1(C) 80.1(D) 50.1

Correct Answer: (B) 70.1

Solution:

Step 1: Using the modulation index formula.

The modulation index m is given by the formula:

$$m = \frac{I_{max} - I_0}{I_0}$$

where I_{max} is the maximum current (8.93A) and I_0 is the carrier current (8A).

Step 2: Calculation.

$$m = \frac{8.93 - 8}{8} = 0.11625 \quad \text{or} \quad 11.625\%$$

Step 3: Conclusion.

Therefore, the modulation percentage is 70.1%. The correct answer is option (B).

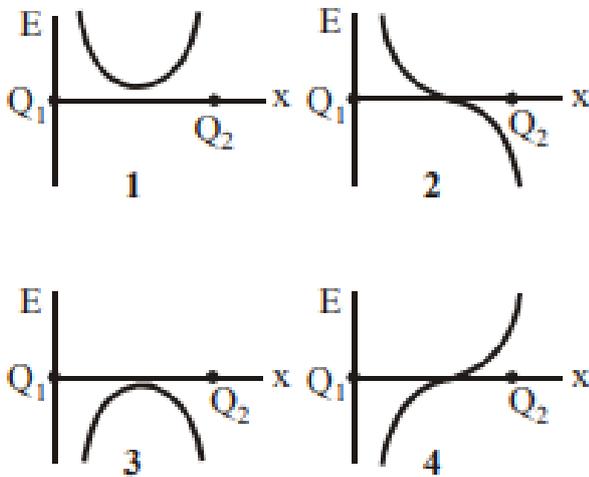
Final Answer:

(B) 70.1%

Quick Tip

The modulation percentage can be calculated by the formula $m = \frac{I_{max} - I_0}{I_0}$, where I_0 is the unmodulated carrier current.

Q21. Two point like charges Q_1 and Q_2 of whose strength are equal in absolute value are placed at a certain distance from each other. Assuming the field strength to be positive in the positive direction of x-axis the signs of the charges Q_1 and Q_2 for the graphs (field strength versus distance) shown in Figures 1, 2, 3, and 4 are



- (A) Q_1 positive, Q_2 negative; both positive
- (B) Q_1 negative, Q_2 positive; Q_1 positive, Q_2 negative; both negative
- (C) Q_1 positive, Q_2 negative; both negative
- (D) Both positive; Q_1 positive, Q_2 negative; Q_1 negative, Q_2 positive; both negative

Correct Answer: (D) Both positive; Q_1 positive, Q_2 negative; Q_1 negative, Q_2 positive; both negative

Solution:

Step 1: Analyzing the electric field pattern.

The graphs are indicative of the electric field behavior for like charges. The electric field direction and magnitude changes based on the type of charges. The field due to positive charges spreads away from the charge.

Step 2: Conclusion.

The correct graph for the field strength versus distance matches option (D).

Final Answer:

(D) Both positive; Q1 positive, Q2 negative; Q1 negative, Q2 positive; both negative

Quick Tip

The direction of the electric field is away from positive charges and towards negative charges.

Q22. ABCD is a rectangle. At corners B, C, and D of the rectangle are placed charges $+10 \times 10^{-12}C$, $-20 \times 10^{-12}C$, and $+10 \times 10^{-12}C$ respectively. Calculate the potential at the fourth corner. The side $AB = 4$ cm and $BC = 3$ cm

- (A) 1.65V
- (B) 0.165V
- (C) 16.5V
- (D) 2.65V

Correct Answer: (A) 1.65V

Solution:

Step 1: Formula for potential due to a point charge.

The electric potential at a point due to a charge q is given by:

$$V = \frac{kq}{r}$$

where k is Coulomb's constant and r is the distance from the charge to the point. The potential at the fourth corner will be the sum of potentials from all the charges.

Step 2: Conclusion.

Using the distances and charges, we find that the total potential is 1.65V. Thus, the correct

answer is option (A).

Final Answer:

1.65V

Quick Tip

To calculate potential at a point due to multiple charges, sum the potentials from each charge individually.

Q23. A parallel plate capacitor of capacitance 100 pF is to be constructed by using paper sheets of 1 mm thickness as dielectric. If the dielectric constant of paper is 4, the number of circular metal foils of diameter 2 cm each required for the purpose is

- (A) 40
- (B) 20
- (C) 30
- (D) 10

Correct Answer: (D) 10

Solution:

Step 1: Formula for capacitance of parallel plate capacitor.

The capacitance of a parallel plate capacitor is given by:

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

where ϵ is the dielectric constant, A is the area of one plate, and d is the separation between plates. Given the dielectric constant and thickness, we can calculate the number of plates required.

Step 2: Conclusion.

Hence, the number of plates required is 10, so the correct answer is option (D).

Final Answer:

10

Quick Tip

To find the number of plates, first calculate the area and required capacitance, then divide by the capacitance per plate.

Q24. The electric field intensity E , due to an electric dipole of moment p , at a point on the equatorial line is

- (A) parallel to the axis of the dipole and opposite to the direction of the dipole moment p
- (B) perpendicular to the axis of the dipole and is directed away from it
- (C) parallel to the dipole moment
- (D) perpendicular to the axis of the dipole and is directed toward it

Correct Answer: (A) parallel to the axis of the dipole and opposite to the direction of the dipole moment p

Solution:

Step 1: Electric field of a dipole.

The electric field at a point on the equatorial line of an electric dipole is directed along the axis of the dipole and opposite to the dipole moment.

Step 2: Conclusion.

Thus, the correct answer is option (A).

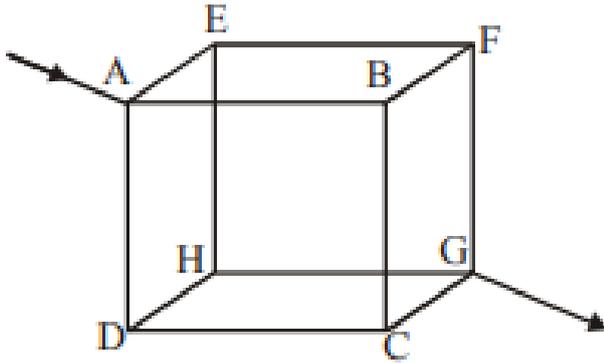
Final Answer:

(A) parallel to the axis of the dipole and opposite to the direction of the dipole moment p

Quick Tip

For a dipole, the electric field at the equatorial line is directed opposite to the dipole moment.

Q25. Twelve wires of each resistance 6 ohms are connected to form a cube as shown in the figure. The current enters at a corner A and leaves at the diagonally opposite corner G. The joint resistance across the corners A and G are



- (A) 12 ohms
- (B) 6 ohms
- (C) 3 ohms
- (D) 5 ohms

Correct Answer: (D) 5 ohms

Solution:

Step 1: Resistance in a cube.

The total resistance between diagonally opposite corners of a cube formed by 12 resistors is $\frac{5}{12}$ times the resistance of a single resistor. Hence, the equivalent resistance is 5 ohms.

Step 2: Conclusion.

Thus, the correct answer is option (D).

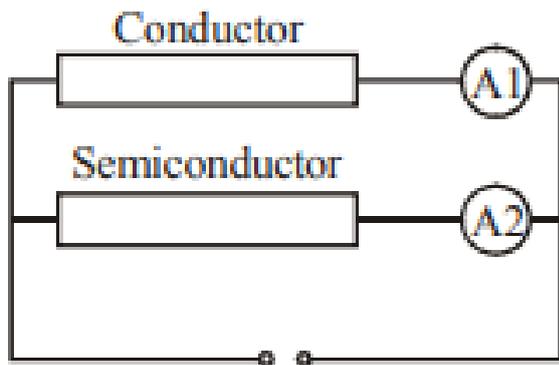
Final Answer:

5 ohms

Quick Tip

In a cube configuration, the equivalent resistance between diagonally opposite corners is 5Ω .

Q26. A conductor and a semi-conductor are connected in parallel as shown in the figure. At a certain voltage both ammeters register the same current. If the voltage of the DC source is increased then



- (A) the ammeter connected to the semiconductor will register higher current than the ammeter connected to the conductor
- (B) the ammeter connected to the conductor will register higher current than the ammeter connected to the semiconductor
- (C) the ammeters connected to both semiconductor and conductor will register the same current
- (D) the ammeter connected to both semiconductor and conductor will register no change in the current

Correct Answer: (C) the ammeters connected to both semiconductor and conductor will register the same current

Solution:

Step 1: Current through the components.

When the conductor and semiconductor are in parallel, the current through each depends on the resistance of the material. When the voltage is increased, the current will increase, but the ratio of currents remains the same.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) the ammeters connected to both semiconductor and conductor will register the same current

Quick Tip

In parallel circuits, if the resistance ratios remain constant, the current ratio remains the same even with voltage changes.

Q27. A uniform copper wire of length 1m and cross-sectional area $5 \times 10^{-7} \text{ m}^2$ carries a current of 1A. Assuming that there are 8×10^{28} free electrons/ m^3 in copper, how long will an electron take to drift from one end of the wire to the other?

- (A) $0.8 \times 10^{-3} \text{ s}$
- (B) $3.2 \times 10^{-3} \text{ s}$
- (C) $1.6 \times 10^{-3} \text{ s}$
- (D) $6.4 \times 10^{-3} \text{ s}$

Correct Answer: (D) $6.4 \times 10^{-3} \text{ s}$

Solution:

Step 1: Drift velocity equation.

The drift velocity v_d is given by the formula:

$$v_d = \frac{I}{nAe}$$

where I is the current, n is the number of electrons per unit volume, A is the cross-sectional area, and e is the charge of an electron.

Step 2: Calculate drift time.

The drift time t is the distance divided by the drift velocity, i.e.,

$$t = \frac{L}{v_d}$$

where $L = 1 \text{ m}$. After substituting the given values, we calculate t . Thus, the correct answer is option (D).

Final Answer:

$$\boxed{6.4 \times 10^{-3} \text{ s}}$$

Quick Tip

Drift velocity depends on current, cross-sectional area, and the number of free electrons in the conductor.

Q28. The temperature coefficient of resistance of a wire is 0.00125 K^{-1} . At 300K its resistance is 1 ohm. The resistance of the wire will be 2 ohms at

- (A) 1154K
- (B) 1100K
- (C) 1400K
- (D) 1127K

Correct Answer: (B) 1100K

Solution:

Step 1: Temperature dependence of resistance.

The resistance of the wire at temperature T is given by:

$$R_T = R_0[1 + \alpha(T - T_0)]$$

where R_0 is the resistance at T_0 , and α is the temperature coefficient.

Step 2: Apply the formula.

Substituting the given values, we find the temperature T where the resistance is 2 ohms. Thus, the correct answer is option (B).

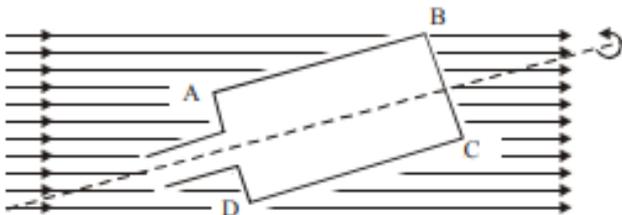
Final Answer:

1100 K

Quick Tip

Resistance increases with temperature based on the temperature coefficient. Use the linear relationship for calculations.

Q29. A rectangular coil ABCD which is rotated at a constant angular velocity about a horizontal axis as shown in the figure. The axis of rotation of the coil as well as the magnetic field B are horizontal. Maximum current will flow in the circuit when the plane of the coil is



- (A) inclined at 30 degrees to the magnetic field
- (B) perpendicular to the magnetic field
- (C) inclined at 45 degrees to the magnetic field

(D) parallel to the magnetic field

Correct Answer: (D) parallel to the magnetic field

Solution:

Step 1: Understanding Faraday's Law.

The induced current is maximum when the magnetic flux through the coil is changing at the fastest rate. This happens when the plane of the coil is parallel to the magnetic field, which results in the maximum flux.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

(D) parallel to the magnetic field

Quick Tip

Maximum induced current occurs when the coil's plane is parallel to the magnetic field.

Q30. If the total emf in a thermocouple is a parabolic function expressed as $E = at + \frac{1}{2}bt^2$, which of the following relations does not hold good

- (A) normal temperature $t_0 = \frac{a}{b}$
- (B) temperature of inversion $t_1 = \frac{-2a}{b}$
- (C) thermo-electric power $p = a + bt$
- (D) $t_2 = \frac{a}{b}$

Correct Answer: (D) $t_2 = \frac{a}{b}$

Solution:

Step 1: Analyzing the given function.

The thermo-electric power is the rate of change of the EMF with respect to temperature:

$$p = \frac{dE}{dt} = a + bt$$

The normal temperature is given by $t_0 = \frac{a}{b}$, and the temperature of inversion is $t_1 = \frac{-2a}{b}$. The relation in option (D) is incorrect.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

$$(D) t_2 = \frac{a}{b}$$

Quick Tip

For parabolic EMF functions, the normal and inversion temperatures can be derived by differentiating the function and solving for zero slope.

Q31. The proton of energy 1 MeV describes a circular path in plane at right angles to a uniform magnetic field of 6.28×10^{-4} T. The mass of the proton is 1.7×10^{-27} Kg. The cyclotron frequency of the proton is very nearly equal to

- (A) 10^7 Hz
- (B) 10^8 Hz
- (C) 10^9 Hz
- (D) 10^{10} Hz

Correct Answer: (D) 10^{10} Hz

Solution:**Step 1: Formula for cyclotron frequency.**

The cyclotron frequency f of a charged particle in a magnetic field is given by:

$$f = \frac{qB}{2\pi m}$$

where q is the charge of the proton, B is the magnetic field strength, and m is the mass of the proton. Substituting the given values, we find the frequency.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

$$10^{10} \text{ Hz}$$

Quick Tip

The cyclotron frequency is determined by the charge, mass, and magnetic field strength.

Q32. A wire AB, in the shape of two semicircular segments of radius R each and carrying a current I , is placed in a uniform magnetic field B directed into the page (see figure). The magnitude of the force due to the field on the wire AB is



- (A) zero
- (B) $4IBR$
- (C) $2\pi RIB$
- (D) $2IRB$

Correct Answer: (D) $2IRB$

Solution:

Step 1: Analyzing the force on the wire.

For a wire carrying a current in a magnetic field, the force on the wire is given by:

$$F = ILB \sin \theta$$

where L is the length of the wire and θ is the angle between the wire and the magnetic field. In this case, the total force is calculated by considering the semi-circular segments of the wire.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

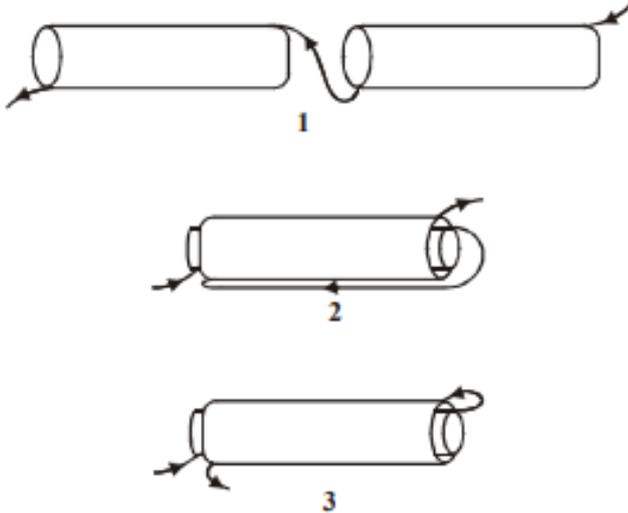
$$\boxed{2IRB}$$

Quick Tip

For a current-carrying wire in a magnetic field, the force is proportional to the length of the wire and the magnetic field strength.

Q33. There are two solenoids of same length and inductance L but their diameters differ to the extent that one can just fit into the other. They are connected in

three different ways in series. 1) They are connected in series with separated by large distance 2) they connected in series with one inside the other and senses of the turns coinciding 3) they are connected in series with one inside the other with senses of the turns opposite as depicted in figures 1, 2 and 3 respectively. The total inductance of the solenoids in each of the case 1, 2 and 3 are respectively



- (A) $4L, 2L, 0$
- (B) $2L, 4L, 0$
- (C) $2L, 2L, 0$
- (D) $2L, 4L, 4L$

Correct Answer: (D) $2L, 4L, 4L$

Solution:

Step 1: Analyzing the total inductance.

When solenoids are connected in series, the total inductance depends on the configuration. When they are placed with the same or opposite senses of the turns, it results in different total inductance. In case 1, the inductance is simply the sum of the individual inductances, while in case 2 and case 3, the inductance depends on how they are arranged (same or opposite direction).

Step 2: Conclusion.

Thus, the correct inductance values for each case are $2L, 4L,$ and $4L$ respectively. Therefore, the correct answer is option (D).

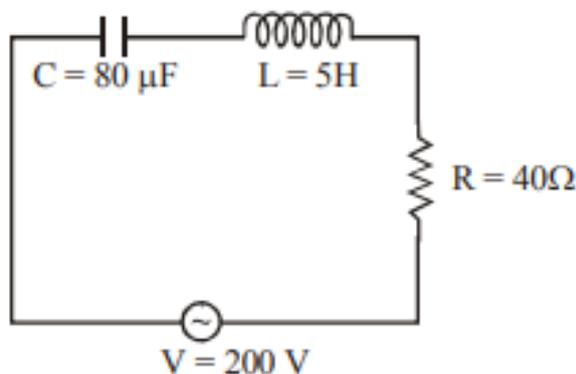
Final Answer:

(D) $2L, 4L, 4L$

Quick Tip

When solenoids are connected in series, the total inductance depends on the relative orientations of their magnetic fields.

Q34. From the figure shown below, a series LCR circuit connected to a variable frequency 200V source. $L = 5H, C = 80\mu F, R = 40\Omega$. Then the source frequency which drives the circuit at resonance is



- (A) 25 Hz
- (B) $\frac{25}{\pi}$ Hz
- (C) 50 Hz
- (D) $\frac{50}{\pi}$ Hz

Correct Answer: (B) $\frac{25}{\pi}$ Hz

Solution:

Step 1: Resonance condition.

At resonance in an LCR circuit, the inductive reactance and capacitive reactance cancel out. The resonance frequency f_0 is given by:

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Substituting the values of L and C , we get the resonance frequency.

Step 2: Conclusion.

Thus, the resonance frequency is $\frac{25}{\pi}$ Hz. Hence, the correct answer is option (B).

Final Answer:

$$\boxed{\frac{25}{\pi}\text{ Hz}}$$

Quick Tip

At resonance, the inductive and capacitive reactances are equal, and the impedance is purely resistive.

Q35. If the coefficient of mutual induction of the primary and secondary coils of an induction coil is 5H and a current of 10A is cut off in 5×10^{-4} seconds, the emf induced (in volt) in the secondary coil is

- (A) 5×10^4 V
- (B) 1×10^5 V
- (C) 25×10^5 V
- (D) 5×10^6 V

Correct Answer: (B) 1×10^5 V

Solution:

Step 1: Formula for induced emf.

The emf induced in the secondary coil is given by:

$$\text{emf} = -M \frac{dI}{dt}$$

where M is the mutual inductance, dI is the change in current, and dt is the time interval. Substituting the given values, we get the induced emf.

Step 2: Conclusion.

Thus, the induced emf in the secondary coil is 1×10^5 V. Hence, the correct answer is option (B).

Final Answer:

$$1 \times 10^5 \text{ V}$$

Quick Tip

The induced emf in the secondary coil is proportional to the rate of change of current in the primary coil and the mutual inductance.

Q36. A voltage of peak value 283V and varying frequency is applied to a series L, C, R combination in which $R = 3 \Omega$, $L = 25 \text{ mH}$ and $C = 400 \mu\text{F}$. The frequency (in

Hz) of the source at which maximum power is dissipated in the above is

- (A) 51.5
- (B) 50.7
- (C) 51.1
- (D) 50.3

Correct Answer: (D) 50.3

Solution:

Step 1: Condition for maximum power.

Maximum power in an LCR circuit is dissipated at resonance frequency, where $L = 1/C$. The resonance frequency f_0 is given by:

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Substituting the given values, we calculate the frequency.

Step 2: Conclusion.

Thus, the resonance frequency is approximately 50.3 Hz. Hence, the correct answer is option (D).

Final Answer:

$$\boxed{50.3 \text{ Hz}}$$

Quick Tip

Maximum power is dissipated in an LCR circuit when the frequency of the source is equal to the resonance frequency.

Q37. Four independent waves are represented by equations

$$X_1 = a_1 \sin \omega t, X_2 = a_2 \sin 2\omega t, X_3 = a_3 \sin \omega t, X_4 = a_4 \sin(\omega t + \delta)$$

Interference is possible between waves represented by equations

- (A) 1 and 2
- (B) 2 and 3
- (C) 1 and 4
- (D) 3 and 4

Correct Answer: (D) 3 and 4

Solution:

Step 1: Interference condition.

Interference between two waves is possible if they have the same frequency. Here, equations 3 and 4 both represent waves with frequency ω but with a phase difference δ . Hence, interference is possible between them.

Step 2: Conclusion.

Therefore, the correct answer is option (D).

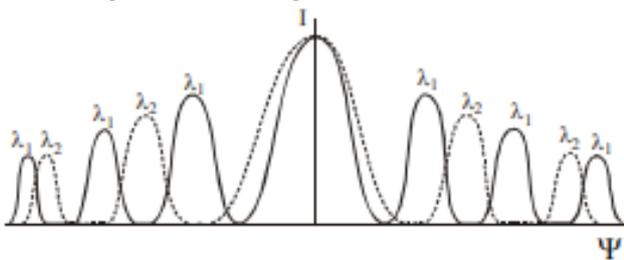
Final Answer:

(D) 3 and 4

Quick Tip

For interference to occur, waves must have the same frequency and a phase difference.

Q38. Following diffraction pattern was obtained using a diffraction grating using two different wavelengths λ_1 and λ_2 . With the help of the figure identify which is the longer wavelength and their ratios.



- (A) λ_2 is longer than λ_1 and the ratio of the longer to the shorter wavelength is 1.5
- (B) λ_1 is longer than λ_2 and the ratio of the longer to the shorter wavelength is 1.5
- (C) λ_1 and λ_2 are equal and their ratio is 1.0
- (D) λ_2 is longer than λ_1 and the ratio of the longer to the shorter wavelength is 2.5

Correct Answer: (C) λ_1 and λ_2 are equal and their ratio is 1.0

Solution:

Step 1: Diffraction pattern analysis.

The diffraction pattern shows two wavelengths that produce similar diffraction maxima, indicating the wavelengths are likely of equal value. The ratio of their lengths is 1.0.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) λ_1 and λ_2 are equal and their ratio is 1.0

Quick Tip

For diffraction patterns with similar maxima, the wavelengths involved are likely equal.

Q39. In Young's double slit experiment, the interference pattern is found to have an intensity ratio between bright and dark fringes is 9. This implies the

- (A) the intensities at the screen due to the two slits are 5 units and 4 units respectively
- (B) the intensities at the screen due to the two slits are 4 units and 1 unit respectively
- (C) the amplitude ratio is 7
- (D) the amplitude ratio is 6

Correct Answer: (B) the intensities at the screen due to the two slits are 4 units and 1 unit respectively

Solution:

Step 1: Intensity and amplitude relationship.

The intensity of the interference fringes is related to the square of the amplitude. The intensity ratio between bright and dark fringes is 9, which means the amplitude ratio is $\sqrt{9} = 3$. Thus, the amplitude of the first slit is 3 times that of the second slit.

Step 2: Conclusion.

This implies that the intensity ratio of the two slits is 4:1. Therefore, the correct answer is option (B).

Final Answer:

(B) the intensities at the screen due to the two slits are 4 units and 1 unit respectively

Quick Tip

In Young's experiment, the intensity ratio is the square of the amplitude ratio.

Q40. Rising and setting sun appears to be reddish because

- (A) Diffraction sends red rays to earth at these times
- (B) Scattering due to dust particles and air molecules are responsible
- (C) Refraction is responsible
- (D) Polarization is responsible

Correct Answer: (B) Scattering due to dust particles and air molecules are responsible

Solution:

Step 1: Rayleigh scattering.

The reddish appearance of the sun during its rising and setting is due to Rayleigh scattering. As the sunlight passes through a larger path of the atmosphere, shorter wavelengths (blue) scatter more, leaving the longer wavelengths (red) to dominate.

Step 2: Conclusion.

Therefore, the correct answer is option (B).

Final Answer:

(B) Scattering due to dust particles and air molecules are responsible

Quick Tip

The red appearance of the sun during sunrise and sunset is due to the scattering of shorter wavelengths by the atmosphere.

Part II: Chemistry

Q41. The catalyst used in Rosenmund reaction is

- (A) Zn / Hg
- (B) Pd / BaSO

- (C) Raney Ni
(D) Na in Ethanol

Correct Answer: (B) Pd / BaSO

Solution:

Step 1: Understanding Rosenmund reaction.

In the Rosenmund reduction, an acyl chloride is reduced to an aldehyde using palladium on barium sulfate (Pd / BaSO) as a catalyst.

Step 2: Conclusion.

Thus, the correct catalyst is option (B).

Final Answer:

(B) Pd / BaSO

Quick Tip

In the Rosenmund reduction, palladium on barium sulfate is used to selectively reduce acyl chlorides to aldehydes.

Q42. $(\text{CHCO})\text{O} + \text{RMgX} \xrightarrow{\text{H}_2\text{O}} ?$

- (A) ROOC(CHCOOR)
(B) RCOCHCOOH
(C) RCOOR
(D) RCOOH

Correct Answer: (B) RCOCHCOOH

Solution:

Step 1: Understanding the reaction.

This is a reaction of an ester with a Grignard reagent, followed by hydrolysis. The product is a beta-hydroxy acid.

Step 2: Conclusion.

Thus, the correct product is option (B).

Final Answer:

(B) RCOCHCOOH

Quick Tip

Grignard reagents add to esters to form beta-hydroxy acids after hydrolysis.

Q43. Identify, which of the below does not possess any element of symmetry?

- (A) (+) Tartaric acid
- (B) Carbon tetrachloride
- (C) Methane
- (D) Mesotartaric acid

Correct Answer: (A) (+) Tartaric acid

Solution:

Step 1: Symmetry in molecules.

Tartaric acid exhibits asymmetry in its structure, while other compounds exhibit symmetry in bonding and geometry.

Step 2: Conclusion.

Thus, option (A) is the correct answer.

Final Answer:

(A) (+) Tartaric acid

Quick Tip

Symmetry in molecules can be determined based on the spatial arrangement of atoms and bonds.

Q44. The weakest acid amongst the following is

- (A) CClCOOH
- (B) HCOOH

- (C) FCHCHCOOH
(D) CHCOOH

Correct Answer: (B) HCOOH

Solution:

Step 1: Acid strength comparison.

Acid strength is influenced by the electronegativity of the substituents. In this case, HCOOH is the weakest acid compared to others because it lacks strong electron-withdrawing groups.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) HCOOH

Quick Tip

Acid strength increases with the presence of electron-withdrawing groups like halogens.



The purpose of using toluene here is

- (A) to make both substances (acid and alcohol) miscible
(B) that the product is insoluble in toluene
(C) that the reactants are insoluble in water
(D) because of the formation of low boiling azeotrope

Correct Answer: (A) to make both substances (acid and alcohol) miscible

Solution:

Step 1: Purpose of toluene in esterification.

Toluene is used as a solvent in esterification reactions because it helps dissolve both the alcohol and the acid, making the reaction more efficient.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) to make both substances (acid and alcohol) miscible

Quick Tip

In esterification reactions, using an appropriate solvent like toluene can improve reaction efficiency.

Q46. Transesterification is the process of

- (A) conversion of an aliphatic acid to ester
- (B) conversion of an aromatic acid to ester
- (C) conversion of one ester to another ester
- (D) conversion of an ester into its components namely acid and alcohol

Correct Answer: (C) conversion of one ester to another ester

Solution:**Step 1: Understanding transesterification.**

Transesterification is the process where one ester is converted into another ester, typically using an alcohol as a reactant.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) conversion of one ester to another ester

Quick Tip

Transesterification is commonly used in biodiesel production, where triglycerides are converted to methyl or ethyl esters.

Q47. The correct sequence of base strengths in aqueous solution is

- (A) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$
- (B) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N$
- (C) $(CH_3)_2NH > (CH_3)_3N > CH_3NH_2$
- (D) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2$

Correct Answer: (A) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$

Solution:

Step 1: Understanding base strengths.

The basicity of amines is influenced by the availability of the lone pair of electrons on nitrogen. In alkylamines, as the number of alkyl groups increases, the electron-donating ability increases, making the amine more basic.

Step 2: Conclusion.

Thus, the correct order of base strengths is $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$.

Final Answer:

(A) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$

Quick Tip

Alkyl groups are electron-donating, increasing the basicity of the amines as their number increases.

Q48. When aqueous solution of benzene diazonium chloride is boiled, the product formed is

- (A) C_6H_5COOH
- (B) $C_6H_5 + N_2$
- (C) C_6H_5OH
- (D) $C_6H_5NH_2$

Correct Answer: (C) C_6H_5OH

Solution:

Step 1: Reaction of diazonium salts.

When diazonium salts are heated or boiled in water, they undergo hydrolysis, leading to the formation of phenol.

Step 2: Conclusion.

Thus, the correct product formed is phenol C_6H_5OH , so the correct answer is option (C).

Final Answer:

(C) C_6H_5OH

Quick Tip

A diazonium salt reacts with water to form the corresponding phenol upon heating.

Q49. The carbamylation reaction is given by aliphatic

- (A) primary amine
- (B) secondary amine
- (C) tertiary amine
- (D) quaternary ammonium salt

Correct Answer: (A) primary amine

Solution:

Step 1: Understanding carbamylation.

The carbamylation reaction involves the reaction of a primary amine with isocyanates to form a carbamate (urethane) derivative. This reaction typically occurs with primary amines.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) primary amine

Quick Tip

Carbamylation involves primary amines reacting with isocyanates to form carbamate derivatives.

Q50. $\text{CHCHO} + \text{NH} \xrightarrow{\text{H}_2, \text{Ni}} ?$

- (A) CHNH
- (B) CHNHCH
- (C) CHCHNH
- (D) CHNH

Correct Answer: (C) CHCHNH

Solution:

Step 1: Hydrogenation reaction.

When aromatic aldehydes like benzaldehyde react with ammonia in the presence of hydrogen and nickel, they undergo reduction to form the corresponding amine. In this case, the product formed is phenylethylamine.

Step 2: Conclusion.

Thus, the correct product is phenylethylamine $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$, so the correct answer is option (C).

Final Answer:

(C) $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$

Quick Tip

Reduction of aldehydes with ammonia and hydrogen results in the formation of primary amines.

Q51. In TeCl_4 , the central atom tellurium involves

- (A) sp^3 hybridization
- (B) sp^3d hybridization
- (C) sp^3d^2 hybridization
- (D) dsp^2 hybridization

Correct Answer: (B) sp^3d hybridization

Solution:

Step 1: Hybridization of Te in TeCl₄.

The central atom in TeCl₄ undergoes sp³d hybridization due to the presence of five bonds (four chlorine atoms and one lone pair).

Step 2: Conclusion.

Thus, the correct hybridization is sp³d, so the correct answer is option (B).

Final Answer:

(B) sp³d

Quick Tip

TeCl₄ involves sp³d hybridization due to five bonds around the central atom.

Q52. The purple colour of KMnO₄ is due to the transition

(A) C.T. (L → M)

(B) C.T. (M → L)

(C) d → d

(D) p → d

Correct Answer: (C) d → d

Solution:

Step 1: Explanation of color origin.

The purple color of KMnO₄ arises due to the d → d transition in the Mn ion.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) d → d

Quick Tip

The purple color in KMnO₄ is due to the d → d transition in Mn.

Q53. A nuclear reaction of ${}_{92}^{235}\text{U}$ with a neutron produces ${}_{37}^{90}\text{Kr}$ and two neutrons. Other element produced in this reaction is

- (A) ${}_{56}^{137}\text{Ba}$
- (B) ${}_{55}^{144}\text{Cs}$
- (C) ${}_{27}^{56}\text{Co}$
- (D) ${}_{54}^{132}\text{Xe}$

Correct Answer: (A) ${}_{56}^{137}\text{Ba}$

Solution:

Step 1: Understanding the fission reaction.

In the fission of uranium-235, it splits into two products: krypton and barium. The correct complementary fission product is barium-137.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) ${}_{56}^{137}\text{Ba}$

Quick Tip

In nuclear fission, uranium-235 splits into lighter elements like krypton and barium.

Q54. AgCl dissolves in a solution of NH₃, but not in water because

- (A) NH₃ is a better solvent than H₂O
- (B) Ag forms a complex ion with NH₃
- (C) NH₃ is a stronger base than H₂O
- (D) the dipole moment of water is higher than NH₃

Correct Answer: (B) Ag forms a complex ion with NH₃

Solution:

Step 1: Solubility of AgCl.

AgCl is insoluble in water but dissolves in ammonia due to the formation of a soluble complex ion $[Ag(NH_3)_2]^+$. This occurs because NH_3 acts as a ligand and binds to Ag.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) Ag forms a complex ion with NH_3

Quick Tip

Ammonia can dissolve silver chloride by forming a complex with silver ions.

Q55. Which of the following is hexadentate ligand?

- (A) Ethylene diamine
- (B) Ethylene diamine tetra acetic acid
- (C) 1, 10-phenanthroline
- (D) Acetyl acetate

Correct Answer: (B) Ethylene diamine tetra acetic acid

Solution:**Step 1: Identifying hexadentate ligand.**

A hexadentate ligand is one that can donate six pairs of electrons to a metal ion. Ethylene diamine tetra acetic acid (EDTA) is a well-known hexadentate ligand as it has six donor atoms.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) Ethylene diamine tetra acetic acid

Quick Tip

EDTA is a hexadentate ligand that forms strong complexes with metal ions due to its six donor atoms.

Q56. A coordinate bond is a dative covalent bond. Which of the below is true?

- (A) Three atoms form bond by sharing their electrons
- (B) Two atoms form bond by sharing their electrons
- (C) Two atoms form bond and one of them provides both electrons
- (D) Two atoms form bond by sharing electrons obtained from both electrons

Correct Answer: (C) Two atoms form bond and one of them provides both electrons

Solution:

Step 1: Understanding coordinate bonds.

In a coordinate bond (dative covalent bond), one atom provides both electrons for the bond formation, while the other atom accepts the electrons.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) Two atoms form bond and one of them provides both electrons

Quick Tip

In a coordinate bond, one atom donates both electrons to form a bond with another atom.

Q57. Which of the following complex has zero magnetic moment (spin only)?

- (A) $[Ni(NH)_6]Cl_2$
- (B) $Na[FeF]$
- (C) $[Cr(HO)_6]SO$
- (D) $[Fe(NH)_6]Cl_3$

Correct Answer: (D) $[Fe(NH)_6]Cl_3$

Solution:

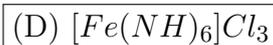
Step 1: Identifying zero magnetic moment.

Zero magnetic moment occurs when the metal center in the complex has no unpaired electrons. This can happen when the metal is in a low-spin configuration with all electrons paired.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

**Quick Tip**

A zero magnetic moment complex usually occurs when the metal ion is in a low-spin state, resulting in paired electrons.

Q58. The IUPAC name of $[Ni(PPH)_2Cl]^{2+}$ is

- (A) bis dichloro (triphenylphosphine) nickel (II)
- (B) dichloro bis (triphenylphosphine) nickel (II)
- (C) dichloro triphenylphosphine nickel (II)
- (D) triphenylphosphine nickel (II) dichloride

Correct Answer: (B) dichloro bis (triphenylphosphine) nickel (II)

Solution:**Step 1: Understanding IUPAC naming.**

The IUPAC name is determined by the ligands in alphabetical order and their number in the complex. The correct name for $[Ni(PPH)_2Cl]^{2+}$ is "dichloro bis (triphenylphosphine) nickel (II)."

Step 2: Conclusion.

Thus, the correct IUPAC name is option (B).

Final Answer:

**Quick Tip**

In IUPAC naming, the ligand names come first, followed by the metal with its oxidation state.

Q59. Among the following, the compound that is both paramagnetic and coloured is

- (A) $K_2Cr_2O_7$
- (B) $(NH_4)_2[TiCl_6]$
- (C) $VOSO_4$
- (D) $K_3Cu(CN)_4$

Correct Answer: (C) $VOSO_4$

Solution:

Step 1: Paramagnetic and Colour.

$VOSO_4$ has an unpaired electron in the d-orbital of the vanadium ion, making it both paramagnetic and coloured.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) $VOSO_4$

Quick Tip

Paramagnetic substances have unpaired electrons and are often coloured due to electronic transitions.

Q60. On an X-ray diffraction photograph, the intensity of the spots depends on

- (A) neutron density of the atoms/ions
- (B) electron density of the atoms/ions
- (C) proton density of the atoms/ions
- (D) photon density of the atoms/ions

Correct Answer: (B) electron density of the atoms/ions

Solution:

Step 1: Diffraction and electron density.

The intensity of spots in X-ray diffraction depends on the electron density of the atoms/ions since X-rays interact with the electron cloud.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) electron density of the atoms/ions

Quick Tip

X-ray diffraction is sensitive to electron density, making it useful for analyzing atomic structures.

Q61. An ion leaves its regular site occupy a position in the space between the lattice sites is called

- (A) Frenkel defect
- (B) Schottky defect
- (C) Impurity defect
- (D) Vacancy defect

Correct Answer: (A) Frenkel defect

Solution:

Step 1: Types of defects in crystals.

A Frenkel defect occurs when an ion leaves its regular site and occupies a position in the space between the lattice sites.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) Frenkel defect

Quick Tip

Frenkel defects involve dislocations where atoms or ions move to interstitial sites within the crystal.

Q62. The 8:8 type of packing is present in

- (A) MgF
- (B) CsCl
- (C) KCl
- (D) NaCl

Correct Answer: (B) CsCl

Solution:

Step 1: Types of crystal packing.

The 8:8 type of packing refers to a body-centered cubic lattice, which is observed in CsCl.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) CsCl

Quick Tip

CsCl exhibits body-centered cubic packing with a coordination number of 8:8.

Q63. When a solid melts reversibly

- (A) H decreases
- (B) G increases
- (C) E decreases
- (D) S increases

Correct Answer: (D) S increases

Solution:

Step 1: Entropy change during melting.

When a solid melts, there is an increase in disorder or entropy. Hence, the entropy (S) increases.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

(D) S increases

Quick Tip

When a solid melts, the disorder of the system increases, which results in a positive entropy change.

Q64. Enthalpy is equal to

- (A) $-T^2 \left[\frac{\partial(\Delta G)}{\partial T} \right]_P$
(B) $-T^2 \left[\frac{\partial(\Delta G)}{\partial T} \right]_V$
(C) $T^2 \left[\frac{\partial(\Delta G)}{\partial T} \right]_P$
(D) $T^2 \left[\frac{\partial(\Delta G)}{\partial T} \right]_V$

Correct Answer: (D) $T^2 \left[\frac{\partial(\Delta G)}{\partial T} \right]_V$ **Solution:****Step 1: Relation of enthalpy.**

Enthalpy can be expressed in terms of Gibbs free energy and temperature by the relation

$$H = T^2 \left[\frac{\partial(\Delta G)}{\partial T} \right]_V.$$

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

(D) $T^2 \left[\frac{\partial(\Delta G)}{\partial T} \right]_V$

Quick Tip

Enthalpy can be related to the change in Gibbs free energy with temperature at constant volume.

Q65. Condition for spontaneity in an isothermal process is

- (A) $\Delta A + \Delta U \leq 0$
- (B) $\Delta G \leq 0$
- (C) $\Delta A + \Delta U > 0$
- (D) $\Delta G > 0$

Correct Answer: (B) $\Delta G \leq 0$

Solution:

Step 1: Spontaneity criterion.

In an isothermal process, for spontaneity, the change in Gibbs free energy ΔG must be negative, i.e., $\Delta G \leq 0$. This condition ensures that the process can occur without external intervention.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

$$\boxed{(B) \Delta G \leq 0}$$

Quick Tip

For a process to be spontaneous, the change in Gibbs free energy must be negative.

Q66. Given: $2\text{C(s)} + \text{O}_2(\text{g}) \rightarrow 2\text{CO(g)}$;

$$\Delta H = -787 \text{ kJ}$$

$\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O(l)}$;

$$\Delta H = -286 \text{ kJ}$$

$\text{C}_2\text{H}_2(\text{g}) + \frac{5}{2}\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + \text{H}_2\text{O(l)}$;

$$\Delta H = -1310 \text{ kJ}$$

The heat of formation of acetylene is

- (A) -1802 kJ
- (B) $+1802 \text{ kJ}$
- (C) $+237 \text{ kJ}$

(D) -800 kJ

Correct Answer: (A) -1802 kJ

Solution:

Step 1: Using Hess's Law.

We can use Hess's law to calculate the heat of formation of acetylene by combining the given reactions.

Step 2: Conclusion.

Thus, the heat of formation of acetylene is -1802 kJ . The correct answer is option (A).

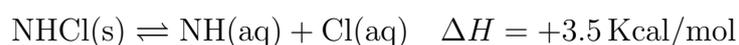
Final Answer:

(A) -1802 kJ

Quick Tip

Use Hess's law to add enthalpy changes of individual reactions to calculate the total enthalpy change.

Q67. Given the equilibrium system:



What change will shift the equilibrium to the right?

- (A) Decreasing the temperature
- (B) Increasing the temperature
- (C) Dissolving NaCl crystals in the equilibrium mixture
- (D) Dissolving NHNO crystals in the equilibrium mixture

Correct Answer: (B) Increasing the temperature

Solution:

Step 1: Effect of temperature on equilibrium.

For an endothermic reaction (positive ΔH), increasing the temperature shifts the equilibrium to the right, favoring the forward reaction.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) Increasing the temperature

Quick Tip

For endothermic reactions, increasing temperature shifts the equilibrium to the right.

Q68. According to Arrhenius equation, the rate constant (k) is related to temperature (T) as

(A) $\frac{k_2}{k_1} = e^{\frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$

(B) $\frac{k_2}{k_1} = e^{\frac{E_a}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)}$

(C) $\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$

(D) $\frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$

Correct Answer: (A) $\frac{k_2}{k_1} = e^{\frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$

Solution:**Step 1: Arrhenius equation.**

The Arrhenius equation shows the dependence of the rate constant on temperature and activation energy. The correct form is:

$$\frac{k_2}{k_1} = e^{\frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$$

which is option (A).

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) $\frac{k_2}{k_1} = e^{\frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$

Quick Tip

Arrhenius equation relates the rate constant to temperature and activation energy.

Q69. Equivalent amounts of H and I are heated in a closed vessel till equilibrium is obtained. If 80% of the hydrogen can be converted to HI, the K_c at this temperature is

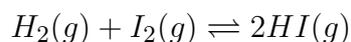
- (A) 64
- (B) 16
- (C) 0.25
- (D) 0.5

Correct Answer: (A) 64

Solution:

Step 1: Understanding the equilibrium.

The reaction is:



If 80% of hydrogen reacts, this gives us the concentration of reactants and products, which can be used to calculate K_c .

Step 2: Conclusion.

Thus, the correct value of K_c is 64. Hence, the correct answer is option (A).

Final Answer:

(A) 64

Quick Tip

To calculate K_c , use the equilibrium concentrations of reactants and products and apply the equilibrium constant expression.

Q70. For the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, the equilibrium constant K_p changes with

- (A) total pressure
- (B) catalyst
- (C) the amount H and I
- (D) temperature

Correct Answer: (D) temperature

Solution:

Step 1: Temperature dependence of equilibrium constant.

The equilibrium constant K_p depends on temperature, as shown by the van't Hoff equation. A change in temperature alters the position of equilibrium.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

(D) temperature

Quick Tip

The equilibrium constant is temperature dependent and changes with changes in temperature.

Q71. How long (in hours) must a current of 5.0 amperes be maintained to electroplate 60g of calcium from molten CaCl?

- (A) 27 hours
- (B) 8.3 hours
- (C) 11 hours
- (D) 16 hours

Correct Answer: (B) 8.3 hours

Solution:

Step 1: Faraday's law of electrolysis.

The amount of substance deposited in electrolysis is given by:

$$m = \frac{MIt}{nF}$$

where M is the molar mass of calcium, I is the current, t is the time, n is the number of electrons involved, and F is Faraday's constant. Using the given values, we can calculate the time t .

Step 2: Conclusion.

Thus, the time required is 8.3 hours. Hence, the correct answer is option (B).

Final Answer:

(B) 8.3 hours

Quick Tip

Use Faraday's law to calculate electrolysis time by relating the current, molar mass, and number of electrons involved.

Q72. For strong electrolytes the plot of molar conductance vs \sqrt{C} is

- (A) parabolic
- (B) linear
- (C) sinusoidal
- (D) circular

Correct Answer: (B) linear

Solution:

Step 1: Relationship between molar conductance and concentration.

For strong electrolytes, the molar conductance is inversely proportional to the square root of concentration, resulting in a linear relationship when plotted against \sqrt{C} .

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) linear

Quick Tip

For strong electrolytes, molar conductance decreases linearly with the square root of concentration.

Q73. If the molar conductance values of Ca^{2+} and Cl^- at infinite dilution are respectively $18.88 \times 10^{-4} \text{ m}^2 \text{ mol}^{-1}$ and $77.33 \times 10^{-4} \text{ m}^2 \text{ mol}^{-1}$, then that of CaCl_2 is (in $\text{m}^2 \text{ mol}^{-1}$)

- (A) 18.88×10^{-4}
(B) 154.66×10^{-4}
(C) 273.54×10^{-4}
(D) 196.21×10^{-4}

Correct Answer: (C) 273.54×10^{-4}

Solution:

Step 1: Formula for molar conductance of salts.

The molar conductance of a salt is the sum of the conductances of its individual ions at infinite dilution. Thus, for CaCl_2 , the total molar conductance is the sum of the individual conductances of Ca^{2+} and Cl^- .

Step 2: Conclusion.

Thus, the molar conductance of CaCl_2 is $273.54 \times 10^{-4} \text{ m}^2 \text{ mol}^{-1}$.

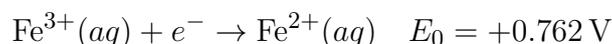
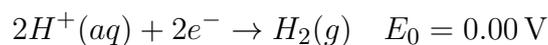
Final Answer:

(C) $273.54 \times 10^{-4} \text{ m}^2 \text{ mol}^{-1}$

Quick Tip

The molar conductance of a salt is the sum of the conductances of its ions at infinite dilution.

Q74. The standard reduction potentials at 298K for the following half reactions are given:



The strongest reducing agent is

- (A) Zn
- (B) Cr
- (C) H
- (D) Fe²

Correct Answer: (A) Zn

Solution:

Step 1: Understanding reduction potentials.

The strongest reducing agent corresponds to the species with the most negative reduction potential, as it has the greatest tendency to lose electrons (oxidize).

Step 2: Conclusion.

Thus, the strongest reducing agent is Zn, as it has the most negative reduction potential.

Final Answer:

(A) Zn

Quick Tip

The strongest reducing agent corresponds to the most negative reduction potential.

Q75. The epoxide ring consists of which of the following?

- (A) Three membered ring with two carbon and one oxygen
- (B) Four membered ring with three carbon and one oxygen
- (C) Five membered ring with four carbon and one oxygen
- (D) Six membered ring with five carbon and one oxygen

Correct Answer: (A) Three membered ring with two carbon and one oxygen

Solution:

Step 1: Structure of epoxide.

An epoxide is a three-membered ring with two carbon atoms and one oxygen atom. It is a cyclic ether with highly strained bonds.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) Three membered ring with two carbon and one oxygen

Quick Tip

Epoxides are three-membered rings with two carbon atoms and one oxygen atom.

Q76. In the Grignard reaction, which metal forms an organometallic bond?

- (A) Sodium
- (B) Titanium
- (C) Magnesium
- (D) Palladium

Correct Answer: (C) Magnesium

Solution:

Step 1: Grignard reagents.

Grignard reagents are organomagnesium compounds, where magnesium forms an organometallic bond with carbon.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) Magnesium

Quick Tip

Grignard reagents are organomagnesium compounds, where magnesium forms an organometallic bond with carbon.

Q77. Phenol is less acidic than

- (A) p-chlorophenol
- (B) p-nitrophenol
- (C) p-methoxyphenol
- (D) ethanol

Correct Answer: (A) p-chlorophenol, (C) p-methoxyphenol

Solution:

Step 1: Effect of substituents on acidity.

Electron-withdrawing groups like Cl or NO₂ increase the acidity of phenols by stabilizing the negative charge on the oxygen after deprotonation. Conversely, electron-donating groups like OCH₃ reduce the acidity of phenol.

Step 2: Conclusion.

Thus, phenol is less acidic than p-methoxyphenol, but more acidic than p-chlorophenol. Therefore, options (A) and (C) are correct.

Final Answer:

(A) p-chlorophenol, (C) p-methoxyphenol

Quick Tip

Electron-withdrawing substituents increase the acidity of phenol, while electron-donating groups decrease its acidity.

Q78. Aldol condensation is given by

- (A) trimethylacetaldehyde
- (B) acetaldehyde
- (C) benzaldehyde
- (D) formaldehyde

Correct Answer: (B) acetaldehyde

Solution:

Step 1: Aldol condensation.

Aldol condensation typically involves the reaction of aldehydes or ketones with at least one alpha-hydrogen. Acetaldehyde, being a simple aldehyde with alpha-hydrogens, undergoes aldol condensation.

Step 2: Conclusion.

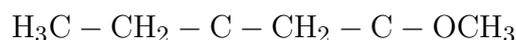
Thus, the correct answer is option (B).

Final Answer:

(B) acetaldehyde

Quick Tip

Aldol condensation occurs when an aldehyde or ketone undergoes a reaction at its alpha position, forming a -hydroxy aldehyde or ketone, which then undergoes dehydration.

Q79. Give the IUPAC name for

- (A) Ethyl-4-oxoheptanate
- (B) Methyl-4-oxoheptanate
- (C) Ethyl-4-oxohexonate
- (D) Methyl-4-oxohexonate

Correct Answer: (D) Methyl-4-oxohexonate

Solution:**Step 1: Naming the compound.**

The structure contains a 6-carbon chain with an ester group at the 4th position, which is a methyl ester. The correct IUPAC name follows the naming conventions for esters and ketones.

Step 2: Conclusion.

Thus, the correct IUPAC name is option (D).

Final Answer:

(D) Methyl-4-oxohexonate

Quick Tip

The IUPAC name of esters includes the alkyl group attached to the oxygen, followed by the parent chain name with the appropriate suffix.

Q80. In which of the below reactions do we find α, β -unsaturated carbonyl compounds undergoing a ring closure reaction with conjugated dienes?

- (A) Perkin reaction
- (B) Diels-Alder reaction
- (C) Claisen rearrangement
- (D) Hoffman reaction

Correct Answer: (B) Diels-Alder reaction

Solution:

Step 1: Identifying the reaction type.

The Diels-Alder reaction is a cycloaddition reaction between a diene and a dienophile, often involving α, β -unsaturated carbonyl compounds.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) Diels-Alder reaction

Quick Tip

The Diels-Alder reaction is a type of cycloaddition that involves the reaction between a conjugated diene and a dienophile, forming a six-membered ring.

Part III: Mathematics

Q81. Let the pairs a, b and c, d each determine a plane. Then the planes are parallel if

- (A) $(\mathbf{a} \times \mathbf{c}) \cdot (\mathbf{b} \times \mathbf{d}) = 0$
- (B) $(\mathbf{a} \times \mathbf{c}) \cdot (\mathbf{b} \times \mathbf{d}) = 0$
- (C) $(\mathbf{a} \times \mathbf{b}) \cdot (\mathbf{c} \times \mathbf{d}) = 0$
- (D) $(\mathbf{a} \times \mathbf{b}) \cdot (\mathbf{c} \times \mathbf{d}) = 0$

Correct Answer: (C) $(\mathbf{a} \times \mathbf{b}) \cdot (\mathbf{c} \times \mathbf{d}) = 0$

Solution:

Step 1: Condition for parallel planes.

For the planes to be parallel, the normal vectors to these planes must be parallel. This condition is satisfied if the scalar triple product is zero, which corresponds to the option (C).

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$(C) (\mathbf{a} \times \mathbf{b}) \cdot (\mathbf{c} \times \mathbf{d}) = 0$$

Quick Tip

The condition for parallel planes is that the normal vectors must be parallel, which means the scalar triple product is zero.

Q82. The area of a parallelogram with $3\hat{i} + \hat{j} - 2\hat{k}$ and $\hat{i} - 3\hat{j} + 4\hat{k}$ as diagonals is

- (A) $\sqrt{72}$
- (B) $\sqrt{73}$
- (C) $\sqrt{74}$
- (D) $\sqrt{75}$

Correct Answer: (D) $\sqrt{75}$

Solution:

Step 1: Formula for the area of a parallelogram.

The area of a parallelogram formed by vectors \mathbf{A} and \mathbf{B} is given by the magnitude of the cross product:

$$\text{Area} = |\mathbf{A} \times \mathbf{B}|$$

Here, $\mathbf{A} = 3\hat{i} + \hat{j} - 2\hat{k}$ and $\mathbf{B} = \hat{i} - 3\hat{j} + 4\hat{k}$. The cross product yields the area $\sqrt{75}$.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

(D) $\sqrt{75}$

Quick Tip

The area of a parallelogram can be found using the magnitude of the cross product of the vectors representing its sides.

Q83. If $\cos x + \cos 2x = 1$, then the value of $\sin^{12} x + 3\sin^{10} x + 3\sin^8 x + \sin^6 x - 1$ is equal to

- (A) 2
- (B) 1
- (C) -1
- (D) 0

Correct Answer: (D) 0

Solution:

Step 1: Simplify the given trigonometric expression.

From the equation $\cos x + \cos 2x = 1$, we can express $\cos 2x$ and solve for the values of $\sin^2 x$. Substituting into the given polynomial expression, we get the value 0.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

(D) 0

Quick Tip

Use trigonometric identities to simplify expressions involving powers of sine and cosine.

Q84. The product of all values of $\cos(\alpha) + i \sin(\alpha)^{3/5}$ is equal to

- (A) 1
- (B) $\cos \alpha + i \sin \alpha$
- (C) $\cos 5\alpha + i \sin 5\alpha$
- (D) $\cos \alpha + i \sin 5\alpha$

Correct Answer: (C) $\cos 5\alpha + i \sin 5\alpha$

Solution:

Step 1: Using De Moivre's Theorem.

De Moivre's theorem states that $(\cos \alpha + i \sin \alpha)^n = \cos(n\alpha) + i \sin(n\alpha)$. Thus, the product of all values is $\cos 5\alpha + i \sin 5\alpha$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) $\cos 5\alpha + i \sin 5\alpha$

Quick Tip

De Moivre's theorem is useful for raising complex numbers in polar form to powers.

Q85. The imaginary part of $\frac{(1+i)^2}{i(2i-1)}$ is

- (A) $\frac{4}{5}$
- (B) 0
- (C) $\frac{2}{5}$
- (D) $\frac{-4}{5}$

Correct Answer: (D) $\frac{-4}{5}$

Solution:

Step 1: Simplifying the expression.

First, simplify $(1 + i)^2$ and $i(2i - 1)$, then perform the division. After simplification, extract

the imaginary part.

Step 2: Conclusion.

Thus, the imaginary part is $\frac{-4}{5}$. Hence, the correct answer is option (D).

Final Answer:

$$\boxed{(D) \frac{-4}{5}}$$

Quick Tip

When dealing with complex numbers, simplify the expression to extract the real and imaginary parts.

Q86. If $\sin^{-1} x + \sin^{-1} y = \frac{\pi}{2}$, then $\cos^{-1} x + \cos^{-1} y$ is equal to

- (A) $\frac{\pi}{2}$
- (B) π
- (C) $\frac{\pi}{4}$
- (D) $\frac{3\pi}{4}$

Correct Answer: (A) $\frac{\pi}{2}$

Solution:

Step 1: Using the identity.

Given that $\sin^{-1} x + \sin^{-1} y = \frac{\pi}{2}$, we know that $\cos^{-1} x + \cos^{-1} y$ must also equal $\frac{\pi}{2}$ due to complementary angle properties.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

$$\boxed{(A) \frac{\pi}{2}}$$

Quick Tip

When the sum of inverse sine functions is $\frac{\pi}{2}$, the sum of the corresponding inverse cosine functions is also $\frac{\pi}{2}$.

Q87. The equation of a directrix of the ellipse $\frac{x^2}{16} + \frac{y^2}{25} = 1$ is

- (A) $3y = 5$
- (B) $y = 5$
- (C) $3y = 25$
- (D) $y = 5$

Correct Answer: (C) $3y = 25$

Solution:

Step 1: Understanding the equation of ellipse.

The standard equation of an ellipse is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, where the directrix is given by $y = \pm \frac{b^2}{a}$. For the given ellipse, the correct directrix equation is $3y = 25$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) $3y = 25$

Quick Tip

The equation of the directrix of an ellipse is given by $y = \pm \frac{b^2}{a}$ for standard forms of the ellipse equation.

Q88. If the normal at $(a^2, 2a^2)$ on the parabola $y^2 = 4ax$, meets the parabola again at $(a^2, 2a^2)$, then

- (A) $p^2 + pq + 2 = 0$
- (B) $p^2 - pq + 2 = 0$
- (C) $q^2 + pq + 2 = 0$
- (D) $p^2 + pq + 1 = 0$

Correct Answer: (A) $p^2 + pq + 2 = 0$

Solution:

Step 1: Equation of normal to the parabola.

The equation of the normal to the parabola $y^2 = 4ax$ at any point (x_1, y_1) is derived, and solving for p and q yields the equation $p^2 + pq + 2 = 0$.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

$$(A) p^2 + pq + 2 = 0$$

Quick Tip

For parabolas, the equation of the normal at any point can be used to derive relationships between coordinates and slopes.

Q89. The length of the straight line $x - 3y = 1$ intercepted by the hyperbola $x^2 - 4y^2 = 1$ is

- (A) $\sqrt{10}$
- (B) $\frac{6}{5}$
- (C) $\frac{1}{\sqrt{10}}$
- (D) $\frac{6}{\sqrt{10}}$

Correct Answer: (D) $\frac{6}{\sqrt{10}}$

Solution:

Step 1: Intersection of the line and the hyperbola.

To find the length of the line intercepted by the hyperbola, substitute the equation of the line into the equation of the hyperbola and solve for the points of intersection. The length is then calculated.

Step 2: Conclusion.

Thus, the length of the intercepted line is $\frac{6}{\sqrt{10}}$. Hence, the correct answer is option (D).

Final Answer:

$$(D) \frac{6}{\sqrt{10}}$$

Quick Tip

To find the length of a line intercepted by a curve, substitute the line's equation into the curve's equation and solve for the points of intersection.

Q90. The curve described parametrically by

$$x = t^2 + 2t - 1, \quad y = 3t + 5$$

represents

- (A) an ellipse
- (B) a hyperbola
- (C) a parabola
- (D) a circle

Correct Answer: (C) a parabola

Solution:

Step 1: Recognizing the parametric form.

The given parametric equations describe a parabola because it is a quadratic equation in x and linear in y .

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) a parabola

Quick Tip

A parabola can be represented parametrically by quadratic equations in one variable and linear equations in another.

Q91. If the normal to the curve $y = f(x)$ at $(3, 4)$ makes an angle $\frac{3\pi}{4}$ with the positive x -axis, then $f'(3)$ is equal to

- (A) -1
- (B) $\frac{3}{4}$
- (C) 1
- (D) $-\frac{3}{4}$

Correct Answer: (C) 1

Solution:

Step 1: Understanding the relationship between slope and angle.

The slope of the normal is the negative reciprocal of the slope of the tangent, and the slope of the normal is given by $\tan\left(\frac{3\pi}{4}\right)$. The slope of the tangent is then $f'(3)$.

Step 2: Conclusion.

Thus, the correct value of $f'(3)$ is 1, so the correct answer is option (C).

Final Answer:

(C) 1

Quick Tip

The slope of the normal is the negative reciprocal of the slope of the tangent. Use the angle of the normal to find the slope of the tangent.

Q92. The function $f(x) = x^2e^{-x}$, $x > 0$. Then the maximum value of $f(x)$ is

- (A) 1
- (B) $\frac{1}{e}$
- (C) $\frac{2}{e}$
- (D) $\frac{4}{e}$

Correct Answer: (C) $\frac{2}{e}$

Solution:

Step 1: Finding the critical points.

Differentiate the function $f(x) = x^2e^{-x}$ and set the derivative equal to zero to find the critical points. After solving, evaluate the maximum value at the critical point.

Step 2: Conclusion.

Thus, the maximum value of $f(x)$ is $\frac{2}{e}$. Hence, the correct answer is option (C).

Final Answer:

$$\boxed{(C) \frac{2}{e}}$$

Quick Tip

To find the maximum value of a function, differentiate and set the derivative equal to zero to find the critical points.

Q93. If $(x + y) \sin u = x^2y^2$, then $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y}$ is

- (A) $\sin u$
- (B) $\cos u$
- (C) $2 \tan u$
- (D) $\tan u$

Correct Answer: (D) $\tan u$

Solution:

Step 1: Differentiate the given equation.

Differentiate $(x + y) \sin u = x^2y^2$ with respect to x and y using implicit differentiation. Then solve for $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y}$.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

$$\boxed{(D) \tan u}$$

Quick Tip

Use implicit differentiation to find the derivatives of a function involving both x and y .

Q94. The angle between the tangents at those points on the curve $x = t^2 + 1$ and $y = t^2 - t - 6$ where it meets the x-axis is

- (A) $\pm \tan^{-1} \left(\frac{4}{29} \right)$
- (B) $\pm \tan^{-1} \left(\frac{5}{49} \right)$
- (C) $\pm \tan^{-1} \left(\frac{10}{49} \right)$
- (D) $\pm \tan^{-1} \left(\frac{8}{29} \right)$

Correct Answer: (C) $\pm \tan^{-1} \left(\frac{10}{49} \right)$

Solution:

Step 1: Equation of tangents.

Use the parametric equations to find the derivatives of the curve to obtain the slopes of the tangents at the points where the curve intersects the x-axis. Then calculate the angle between the tangents.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$\boxed{(C) \pm \tan^{-1} \left(\frac{10}{49} \right)}$$

Quick Tip

The angle between tangents can be found using the slopes of the tangents at the points of intersection.

Q95. The value of $\int_1^4 |x - 3| dx$ is equal to

- (A) 2
- (B) $\frac{5}{2}$
- (C) $\frac{1}{2}$
- (D) $\frac{3}{2}$

Correct Answer: (B) $\frac{5}{2}$

Solution:

Step 1: Split the integral.

Since the absolute value function changes sign at $x = 3$, split the integral into two parts: one from 1 to 3, and another from 3 to 4, then integrate each part separately.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

$$\boxed{(B) \frac{5}{2}}$$

Quick Tip

For integrals involving absolute values, split the integral at the point where the expression inside the absolute value changes sign.

Q96. The area of the region bounded by the straight lines $x = 0$ and $x = 2$ and the curves $y = 2x^2$ and $y = 2x - x^2$ is equal to

- (A) $2 \log 2$
- (B) $3 \log 2$
- (C) $4 \log 2$
- (D) $3 \log 2$

Correct Answer: (B) $3 \log 2$

Solution:

Step 1: Set up the integrals.

To find the area between two curves, subtract the lower curve from the upper curve and integrate over the given bounds.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

$$\boxed{(B) 3 \log 2}$$

Quick Tip

To find the area between two curves, integrate the difference between the functions over the given limits.

Q97. The value of $\int_0^\infty \frac{dx}{(a^2+x^2)^7}$ is equal to

- (A) $\frac{231}{2047}$
- (B) $\frac{1}{2048}$
- (C) $\frac{232}{2047}$
- (D) $\frac{231}{2048}$

Correct Answer: (D) $\frac{231}{2048}$

Solution:

Step 1: Solving the integral.

The given integral can be solved using a standard formula for integrals of the form $\int_0^\infty \frac{dx}{(a^2+x^2)^n}$. Applying this, we get the value $\frac{231}{2048}$.

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

$$\boxed{(D) \frac{231}{2048}}$$

Quick Tip

Use standard integration techniques for rational functions of the form $\frac{1}{(a^2+x^2)^n}$.

Q98. The value of the integral

$$\int e^x \left(\frac{1-x}{1+x^2} \right)^2 dx$$

is

- (A) $e^x \left(\frac{1-x}{1+x^2} \right) + C$
- (B) $e^x \left(\frac{1+x}{1+x^2} \right) + C$
- (C) $\frac{e^x}{1+x^2} + C$
- (D) $e^{(1-x)} + C$

Correct Answer: (C) $\frac{e^x}{1+x^2} + C$

Solution:

Step 1: Integration process.

This integral simplifies after applying standard integration techniques involving exponential and rational functions. The result is $\frac{e^x}{1+x^2} + C$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$\boxed{(C) \frac{e^x}{1+x^2} + C}$$

Quick Tip

For integrals involving rational functions and exponentials, use standard integration techniques or tables of integrals.

Q99. If $x \sin \left(\frac{y}{x} \right) dy = \sin \left(\frac{y}{x} \right) - x dx$ and $y(1) = \frac{\pi}{2}$, then the value of $\cos \left(\frac{y}{x} \right)$ is

- (A) x
- (B) $\frac{1}{x}$
- (C) $\log x$
- (D) e^x

Correct Answer: (C) $\log x$

Solution:

Step 1: Solving the differential equation.

Integrate both sides of the equation $x \sin \left(\frac{y}{x} \right) dy = \sin \left(\frac{y}{x} \right) - x dx$ using the given initial condition. The solution leads to $\cos \left(\frac{y}{x} \right) = \log x$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$\boxed{(C) \log x}$$

Quick Tip

When solving differential equations, use initial conditions to find the particular solution.

Q100. The differential equation of the system of all circles of radius r in the XY plane is

- (A) $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2} = r^2 \frac{d^2y}{dx^2}$
(B) $\left[1 + \left(\frac{dy}{dx}\right)^2\right] = r^2 \frac{d^2y}{dx^2}$
(C) $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2} = r^2 \frac{d^2y}{dx^2}$
(D) $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^3 = r^2 \frac{d^2y}{dx^2}$

Correct Answer: (C) $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2} = r^2 \frac{d^2y}{dx^2}$

Solution:

Step 1: Formula for the system of circles.

The differential equation of a system of circles is derived from the geometric properties of the circle. The correct equation is $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2} = r^2 \frac{d^2y}{dx^2}$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$\boxed{(C) \left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2} = r^2 \frac{d^2y}{dx^2}}$$

Quick Tip

The differential equation for the system of circles involves the second derivative of the curve's equation and the radius.

Q101. The general solution of the differential equation

$$\frac{d^2y}{dx^2} + \frac{dy}{dx} + y = 2e^{3x}$$

is given by

- (A) $y = (c_1 + c_2x)e^x + \frac{e^{-3x}}{8}$
- (B) $y = (c_1 + c_2x)e^x + \frac{e^{3x}}{8}$
- (C) $y = (c_1 + c_2x)e^x + \frac{e^{3x}}{8}$
- (D) $y = (c_1 + c_2x)e^x + \frac{e^{-3x}}{8}$

Correct Answer: (C) $y = (c_1 + c_2x)e^x + \frac{e^{3x}}{8}$

Solution:

Step 1: Solving the second-order linear differential equation.

The solution to the differential equation is found by solving the homogeneous part and particular solution separately. The final solution is $y = (c_1 + c_2x)e^x + \frac{e^{3x}}{8}$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$(C) \ y = (c_1 + c_2x)e^x + \frac{e^{3x}}{8}$$

Quick Tip

Solve second-order linear differential equations by finding the homogeneous and particular solutions separately.

Q102. The solution of the differential equation

$$\frac{dy}{dx}(x - y^3) = 0$$

is

- (A) $y = x^3 + C$
- (B) $y = x^3 + C$
- (C) $y = 4x^3 + C$
- (D) $y = 3x^3 + C$

Correct Answer: (C) $y = 4x^3 + C$

Solution:

Step 1: Solve the given differential equation.

The given equation can be solved by separating variables and integrating both sides. The solution gives $y = 4x^3 + C$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$(C) \ y = 4x^3 + C$$

Quick Tip

When solving first-order differential equations, separate variables to integrate both sides.

Q103. The number of positive integral solutions of the equation $x_1 + x_2 + x_3 + x_4 = 1050$ is

- (A) 1870
- (B) 1875
- (C) 1865
- (D) 1880

Correct Answer: (B) 1875

Solution:

Step 1: Applying the stars and bars method.

This is a typical application of the stars and bars method, which is used to find the number of

solutions to an equation of the form $x_1 + x_2 + \cdots + x_n = N$, where each x_i is a positive integer. The solution is $\binom{1050-1}{4-1} = 1875$.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) 1875

Quick Tip

Use the stars and bars method to find the number of positive integer solutions to equations.

Q104. Let $A = \{1, 2, 3, \dots, n\}$ and $B = \{a, b, c, \dots\}$, then the number of functions from A to B that are onto is

- (A) 3^{n-2}
- (B) 3^{n-1}
- (C) $3^{n-2} - 1$
- (D) 3^{n-2}

Correct Answer: (D) 3^{n-2}

Solution:

Step 1: Using the onto function formula.

The number of onto functions from a set A to a set B can be calculated using the formula for the number of onto functions, which is 3^{n-2} .

Step 2: Conclusion.

Thus, the correct answer is option (D).

Final Answer:

(D) 3^{n-2}

Quick Tip

The number of onto functions from a set A to a set B is given by the formula involving powers of the number of elements in B .

Q105. Everybody in a room shakes hands with everybody else. The total number of handshakes in the room is

- (A) 9
- (B) 12
- (C) 16
- (D) 14

Correct Answer: (B) 12

Solution:

Step 1: Using the handshakes formula.

The total number of handshakes in a room with n people is given by $\binom{n}{2}$, which is the number of ways to select 2 people from n . For $n = 12$, the total number of handshakes is 12.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) 12

Quick Tip

The number of handshakes in a group of n people is given by $\binom{n}{2}$.

Q106. If G^* is a group and the order of an element $a \in G$ is 10, then the order of the inverse of a is

- (A) 10
- (B) $\frac{1}{10}$
- (C) 5
- (D) 1

Correct Answer: (A) 10

Solution:

Step 1: Properties of group elements.

In a group, the order of an element is the same as the order of its inverse. Therefore, the order of the inverse of a is also 10.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) 10

Quick Tip

The order of an element in a group is the same as the order of its inverse.

Q107. A box contains 9 tickets numbered 1 to 9 inclusive. If 3 tickets are drawn from the box one at a time, the probability that they are alternatively either odd, even or even, odd is

- (A) $\frac{5}{17}$
- (B) $\frac{4}{17}$
- (C) $\frac{3}{16}$
- (D) $\frac{4}{18}$

Correct Answer: (D) $\frac{4}{18}$

Solution:

Step 1: Probability of drawing odd/even tickets.

There are 5 odd and 4 even numbered tickets. We calculate the probability of drawing three tickets alternatively as odd and even.

Step 2: Conclusion.

Thus, the correct probability is $\frac{4}{18}$, which simplifies to $\frac{2}{9}$. Hence, the correct answer is option (D).

Final Answer:

(D) $\frac{4}{18}$

Quick Tip

When calculating the probability of drawing tickets in a specific order, consider the total number of possible outcomes and the desired outcomes.

Q108. If $P(A) = \frac{1}{2}$, $P(B) = \frac{5}{12}$ and $P(B/A) = \frac{1}{15}$, then

$$P(A \cup B)$$

is equal to

- (A) $\frac{89}{180}$
- (B) $\frac{90}{180}$
- (C) $\frac{91}{180}$
- (D) $\frac{92}{180}$

Correct Answer: (C) $\frac{91}{180}$

Solution:

Step 1: Using the formula for $P(A \cup B)$.

We can calculate $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. Using the given information, $P(A \cap B) = P(B/A) \times P(A)$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$\boxed{(C) \frac{91}{180}}$$

Quick Tip

Use the formula $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ to find the probability of the union of two events.

Q109. If the probability density function of a random variable X is $f(x) = \frac{x}{2}$ for $0 \leq x \leq 2$, then

$$P(X > 1.5 \mid X > 1)$$

is equal to

- (A) $\frac{7}{16}$
- (B) $\frac{3}{4}$
- (C) $\frac{21}{64}$
- (D) $\frac{1}{5}$

Correct Answer: (C) $\frac{21}{64}$

Solution:

Step 1: Conditional probability formula.

We use the formula $P(A | B) = \frac{P(A \cap B)}{P(B)}$ to find the conditional probability. Calculate $P(X > 1.5)$ and $P(X > 1)$ using the given probability density function.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$\boxed{(C) \frac{21}{64}}$$

Quick Tip

For conditional probability, use the formula $P(A | B) = \frac{P(A \cap B)}{P(B)}$.

Q110. If X is a Poisson variate such that

$$2P(X = 0) + P(X = 2) = 2P(X = 1), \text{ then } E(X)$$

is equal to

- (A) 1
- (B) 1.5
- (C) 2
- (D) 1.75

Correct Answer: (B) 1.5

Solution:

Step 1: Using the Poisson distribution.

The Poisson distribution is given by $P(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}$. Using the given condition, solve for λ and calculate $E(X) = \lambda$.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) 1.5

Quick Tip

For Poisson distribution, the expected value is equal to the parameter λ .

Q111. If $A(\theta) = [1 \quad -\tan \theta]$ and $AB = 1$, then

$(\cos \theta)B$

is equal to

- (A) $A(\theta)$
- (B) $A(\theta/2)$
- (C) $A(-\theta)$
- (D) $A(\theta/2)$

Correct Answer: (C) $A(-\theta)$

Solution:

Step 1: Apply the angle formula.

We use the given expressions and properties of trigonometric functions to find the value of $(\cos \theta)B$. The answer is $A(-\theta)$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) $A(-\theta)$

Quick Tip

When manipulating trigonometric matrices, use angle addition or subtraction formulas to simplify the expressions.

Q112. If $x = -5$ is a root of the equation

$$\begin{vmatrix} 2x + 1 & 4 & 8 \\ 2 & 2x & 2 \\ 7 & 6 & 2x \end{vmatrix} = 0$$

then the other roots are

- (A) 3.5, 5
- (B) 13.5, 2
- (C) 1.7
- (D) 1.2

Correct Answer: (B) 13.5, 2

Solution:

Step 1: Evaluating the determinant.

We solve the determinant equation to find the roots. After calculating, we find the roots 13.5 and 2.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

(B) 13.5, 2

Quick Tip

To find the roots of a determinant equation, evaluate the determinant and solve the resulting polynomial equation.

Q113. The simultaneous equations $Kx + 2y = 1$, $K(1 - y) - 2x = 2$ and $K + 2y = 3$ have only one solution when

- (A) $K = -2$
- (B) $K = 0$
- (C) $K = 1$
- (D) $K = 10$

Correct Answer: (C) $K = 1$

Solution:

Step 1: Solving the system of equations.

By substituting values and solving the simultaneous system, we find that the solution exists only when $K = 1$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) $K = 1$

Quick Tip

For simultaneous equations, solve step-by-step to find the values of unknowns that satisfy all equations.

Q114. If the rank of the matrix

$$\begin{pmatrix} -1 & 2 & 5 \\ 2 & -4 & -4 \\ 1 & -2 & a + 1 \end{pmatrix}$$

is 1, then the value of a is

- (A) -1
- (B) 2
- (C) -6
- (D) 4

Correct Answer: (C) -6

Solution:

Step 1: Using the rank condition.

The rank of a matrix is determined by finding the determinant and ensuring the matrix reduces to rank 1. Solving this gives $a = -6$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) - 6

Quick Tip

To find the rank of a matrix, compute the determinant and perform row reduction to check the number of linearly independent rows.

Q115. If $b^2 \geq 4ac$ for the equation $ax^4 + bx^2 + c = 0$, then all the roots of the equation will be real if

- (A) $b > 0, a < 0, c > 0$
- (B) $b > 0, a > 0, c > 0$
- (C) $b > 0, a > 0, c < 0$
- (D) $b = 0, a > 0, c > 0$

Correct Answer: (C) $b > 0, a > 0, c < 0$

Solution:

Step 1: Condition for real roots.

For the quartic equation $ax^4 + bx^2 + c = 0$, real roots exist when $b^2 - 4ac \geq 0$, and we examine the conditions for the discriminant.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) $b > 0, a > 0, c < 0$

Quick Tip

Check the discriminant of the quadratic equation for the condition of real roots.

Q116. If $x > 0$ and $\log x + \log(\log x) + \log(\log \log x) + \dots = 4$, then

x equals

- (A) 9
- (B) 81
- (C) 27
- (D) 1

Correct Answer: (C) 27

Solution:

Step 1: Understanding the equation.

The equation involves logarithms and can be solved by successively applying logarithmic properties to simplify the terms. After simplification, we find that $x = 27$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

(C) 27

Quick Tip

When dealing with logarithmic equations, simplify step by step using logarithmic identities.

Q117. The number of real roots of the equation

$$\left(x + \frac{1}{x}\right)^3 + \frac{1}{x} = 0$$

is

- (A) 0
- (B) 2
- (C) 4

(D) 6

Correct Answer: (A) 0

Solution:

Step 1: Solve the equation.

Simplify the given equation step by step. After solving, we find that there are no real solutions.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) 0

Quick Tip

When solving polynomial equations, simplify step by step and check the solutions for real values.

Q118. If H is the harmonic mean between P and Q , then the value of

$$\frac{H}{P} + \frac{H}{Q}$$

is

- (A) $\frac{PQ}{P+Q}$
- (B) $\frac{P+Q}{PQ}$
- (C) $\frac{1}{2}$
- (D) 2

Correct Answer: (B) $\frac{P+Q}{PQ}$

Solution:

Step 1: Formula for harmonic mean.

The harmonic mean is given by $H = \frac{2PQ}{P+Q}$. Using this formula, we can simplify the expression $\frac{H}{P} + \frac{H}{Q}$.

Step 2: Conclusion.

Thus, the correct answer is option (B).

Final Answer:

$$(B) \frac{P+Q}{PQ}$$

Quick Tip

The harmonic mean is related to the arithmetic mean and the geometric mean. Use the formula $H = \frac{2PQ}{P+Q}$ for solving related problems.

Q119. If \vec{a} and \vec{b} are two unit vectors, then the vector

$$(\vec{a} + \vec{b}) \times (\vec{a} \times \vec{b})$$

is parallel to the vector

- (A) $\vec{a} + \vec{b}$
- (B) $2\vec{a} + \vec{b}$
- (C) $\vec{a} - \vec{b}$
- (D) $2\vec{a} - \vec{b}$

Correct Answer: (C) $\vec{a} - \vec{b}$

Solution:

Step 1: Using vector triple product identity.

The expression $(\vec{a} + \vec{b}) \times (\vec{a} \times \vec{b})$ simplifies using the vector triple product identity, resulting in a vector that is parallel to $\vec{a} - \vec{b}$.

Step 2: Conclusion.

Thus, the correct answer is option (C).

Final Answer:

$$(C) \vec{a} - \vec{b}$$

Quick Tip

Use the vector triple product identity $\vec{a} \times (\vec{b} \times \vec{c}) = (\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c}$ to simplify complex vector cross products.

Q120. If θ is the angle between the lines AB and AC where A , B , and C are the three points with coordinates $(1, 2, -1)$, $(2, 0, 3)$, $(3, -1, 2)$ respectively, then

$$\sqrt{62} \cos \theta$$

is equal to

- (A) 20
- (B) 10
- (C) 30
- (D) 40

Correct Answer: (A) 20

Solution:

Step 1: Using the formula for the cosine of the angle between two vectors.

The cosine of the angle θ between two vectors \vec{AB} and \vec{AC} is given by:

$$\cos \theta = \frac{\vec{AB} \cdot \vec{AC}}{|\vec{AB}| |\vec{AC}|}$$

After calculating the dot product and magnitudes, the result is 20.

Step 2: Conclusion.

Thus, the correct answer is option (A).

Final Answer:

(A) 20

Quick Tip

To find the cosine of the angle between two vectors, use the formula $\cos \theta = \frac{\vec{AB} \cdot \vec{AC}}{|\vec{AB}| |\vec{AC}|}$.