VITEEE Previous Year Paper 2014 with Solutions

Time Allowed :180 Minutes	**Maximum Marks :**120	**Total Questions :**120

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

1. The amplification factor of a triode is 50. If the grid potential is decreased by 0.20 V, what increase in plate potential will keep the plate current unchanged?

(1) 5V
(2) 10V
(3) 0.2V
(4) 50V

Correct Answer: (2) 10V

Solution:
For a triode, the plate current is related to the grid and plate potentials. To keep the plate current constant when the grid potential is decreased, the plate potential must be increased by a corresponding amount. The amplification factor of the triode is 50, which determines how much the plate potential must increase.

Quick Tip

The amplification factor of a triode is a measure of how much the plate potential changes in response to a change in the grid potential.

2. If the nuclear fission piece of uranium of mass 5.0 g is lost, the energy obtained in kWh is?

(1) 1.25×10^7
(2) 2.25×10^7
(3) 3.25×10^7
(4) 0.25×10^7

Correct Answer: (1) 1.25×10^7

Solution:
The energy released from nuclear fission can be calculated using the formula:

$$E = mc^2$$

Where m is the mass and c is the speed of light. Given the mass of uranium and the corresponding energy released, we can compute the energy in kWh.

Quick Tip

Nuclear fission releases a large amount of energy as a result of mass loss.

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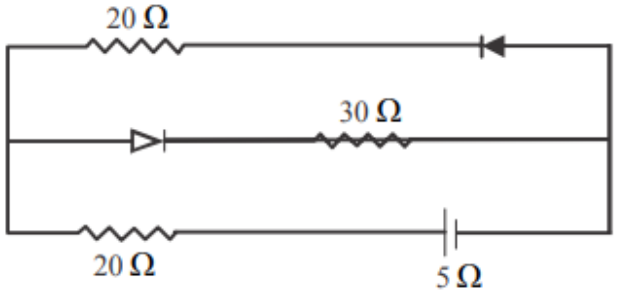
3. Current in the circuit will be?



(1) $\frac{5}{40}$ A
(2) $\frac{5}{50}$ A
(3) $\frac{5}{10}$ A
(4) 5 A

Correct Answer: (2) $\frac{5}{50}$ A

Solution:
Using Ohm's law, the current in the circuit can be calculated by dividing the voltage across the circuit by the total resistance.

Quick Tip

Use Ohm's law $I = \frac{V}{R}$ to calculate the current in the circuit.

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4. An installation consisting of an electric motor driving a water pump lets 75 L of water per second to a height of 4.7 m. If the motor consumes a power of 5 kW, then the efficiency of the installation is?

(1) 39%
(2) 69%
(3) 93%
(4) 96%

Correct Answer: (2) 69%

Solution:
The efficiency of the installation can be calculated by comparing the useful power output (energy used to lift water) with the total power input (motor power). The efficiency is given by:

$$\text{Efficiency} = \frac{\text{Useful Power Output}}{\text{Total Power Input}} \times 100$$

Quick Tip

Efficiency is the ratio of useful output power to the total input power.

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5. A potential difference across the terminals of a battery is 50 V when 11 A current is drawn and 60 V, when 1 A current is drawn. The emf and the internal resistance of the battery are?

(1) 62V, 2
(2) 63V, 1
(3) 61V, 1
(4) 64V, 2

Correct Answer: (3) 61V, 1

Solution:
The emf ($\mathcal{E}$) and internal resistance (r) of the battery can be determined using the following two equations derived from the law of electrical circuits:

$$V = \mathcal{E} - Ir$$

Where V is the terminal voltage, I is the current, and r is the internal resistance. By solving the system of equations, the values for $\mathcal{E}$ and r can be found.

Quick Tip

Use the terminal voltage equation to calculate the internal resistance and emf of a battery.

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6. Beyond which frequency, the ionosphere bands any incident electromagnetic radiation but do not reflect it back towards the earth?

(1) 50 MHz
(2) 40 MHz
(3) 30 MHz
(4) 20 MHz

Correct Answer: (2) 40 MHz

Solution:
The ionosphere bands electromagnetic radiation in a range of frequencies, with higher frequencies passing through and not being reflected back. The critical frequency for reflection is around 40 MHz.

Quick Tip

The ionosphere can reflect lower frequencies, but frequencies above a certain threshold (around 40 MHz) pass through without reflection.

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7. A metallic surface ejects electrons. When exposed to green light of intensity I but no photoelectrons are emitted, when exposed to yellow light of intensity 1 it is possible to eject electrons from the same surface by?

(1) Yellow light of same intensity which is more than I
(2) Green light of any intensity
(3) Red light of any intensity
(4) None of the above

Correct Answer: (1) Yellow light of same intensity which is more than I

Solution:
The photoelectric effect occurs when light of sufficient frequency strikes a metallic surface,

causing the emission of electrons. Yellow light has a higher frequency than green light, which is why it can cause the ejection of electrons even at the same intensity.

Quick Tip

The photoelectric effect depends on the frequency of light, not just the intensity.

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8. An electron moves at right angle to a magnetic field of $5 \times 10^{-2}\,T$ with a speed of 6×10^{7} m/s. If the specific charge of the electron is 1.7×10^{11} C/kg, the radius of the circular path will be?

(1) 2.9 cm
(2) 3.9 cm
(3) 2.35 cm
(4) 2 cm

Correct Answer: (3) 2.35 cm

Solution:
The radius of the circular path followed by an electron in a magnetic field can be calculated using the formula:

$$r = \frac{mv}{qB}$$

Where m is the mass, v is the speed, q is the charge, and B is the magnetic field strength.

Quick Tip

The radius of the electron's circular path depends on its speed, charge, and the strength of the magnetic field.

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9. A solenoid 30 cm long is made by winding 2000 loops of wire on an iron rod whose cross-section is $1.5\,\text{cm}^2$. If the relative permeability of the iron is 6000, what is the self-inductance of the solenoid?

(1) 1.5 H
(2) 2.5 H
(3) 3.5 H
(4) 0.5 H

Correct Answer: (1) 1.5 H

Solution:
The self-inductance L of a solenoid is given by the formula:

$$L = \frac{\mu_0 \mu_r N^2 A}{l}$$

Where μ_0 is the permeability of free space, μ_r is the relative permeability, N is the number of turns, A is the cross-sectional area, and l is the length of the solenoid.

Quick Tip

The self-inductance of a solenoid depends on its number of turns, length, and the properties of the material.

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10. A coil of resistance 10 and an inductance 5 H is connected to a 100 V battery. The energy stored in the coil is?

(1) 125 erg
(2) 250 erg
(3) 280 erg
(4) 250 J

Correct Answer: (4) 250 J

Solution:
The energy stored in an inductor is given by the formula:

$$E = \frac{1}{2} L I^2$$

Where L is the inductance and I is the current. First, calculate the current using Ohm's law, and then use it to find the energy stored in the inductor.

Quick Tip

The energy stored in an inductor depends on the current flowing through it and its inductance.

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11. A galvanometer has current range of 15 mA and voltage range 750 mV. To convert this galvanometer into an ammeter of range 25 A, the required shunt is?

(1) 0.8
(2) 0.93

(3) 0.03
(4) 2

Correct Answer: (3) 0.03

Solution:
To convert a galvanometer into an ammeter, a shunt resistor is added in parallel. The shunt resistor can be calculated using the formula:

$$I_{\text{max}} = \frac{V_{\text{max}}}{R_{\text{total}}}$$

where I_{max} is the maximum current (25 A), and R_{total} is the total resistance needed. The required shunt resistance can be derived from the voltage and current specifications.

Quick Tip

To convert a galvanometer to an ammeter, use a shunt resistor in parallel to bypass most of the current.

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12. The denial cell is balanced on 125 cm length of a potentiometer. Now, the cell is short-circuited by a resistance of 2 and the balance is obtained at 100 cm. The internal resistance of the denial cell is?

(1) $\frac{4}{3}$
(2) 1.5
(3) 1.25
(4) 0.5

Correct Answer: (4) 0.5

Solution:
The balance in a potentiometer is influenced by the internal resistance of the cell. By applying the relationship between the length and resistance, the internal resistance can be calculated.

Quick Tip

In potentiometer circuits, the internal resistance of the cell affects the balancing length.

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13. Four resistances of 10, 60, 100, and 200 respectively taken in order are used to form a Wheatstone's bridge. A 15V battery is connected to the ends of a 200 resistance, the current through it will be?

(1) 7.5×10^{-5} A
(2) 7.5×10^{-4} A
(3) 7.5×10^{-3} A
(4) 7.5×10^{-2} A

Correct Answer: (4) 7.5×10^{-2} A

Solution:
In a Wheatstone bridge, the current through the resistance is determined by the total resistance in the circuit. Using Ohm's law, the current through the given 200 resistance can be found.

Quick Tip

In a Wheatstone bridge, the current depends on the ratios of the resistances.

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14. A circuit has a self-inductance of 1 H and carries a current of 2A. To prevent sparking, when the circuit is switched off, a capacitor which can withstand 400 V is used. The least capacitance of the capacitor connected across the switch must be equal to?

(1) 50 F
(2) 25 F
(3) 100 F
(4) 12.5 F

Correct Answer: (2) 25 F

Solution:
To prevent sparking, the capacitor needs to absorb the energy stored in the inductor when the circuit is switched off. The capacitance needed can be calculated using the energy balance between the inductor and the capacitor.

Quick Tip

The least capacitance can be calculated by equating the energy stored in the inductor to that in the capacitor.

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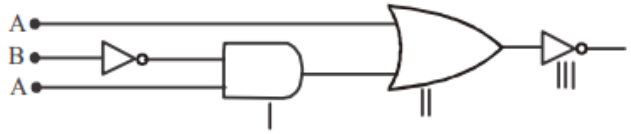
15. The output Y of the logic circuit shown in figure is best represented as?



(1) $A + BC$
(2) $A + \overline{BC}$
(3) $\overline{A + BC}$
(4) $A + \overline{B + C}$

Correct Answer: (4) $A + \overline{B + C}$

Solution:
The output of the logic circuit depends on the combination of logic gates. By analyzing the circuit diagram, we can derive the Boolean expression for the output.

Quick Tip

Use Boolean algebra to simplify and derive the output expression for logic circuits.

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16. A resistor of 6k with tolerance 10

(1) 5(2) 10(3) 12(4) 15

Correct Answer: (2) 10

Solution:
When resistors are connected in series, the tolerances add. The total tolerance is the sum of the individual tolerances, which can be calculated for the given resistors.

Quick Tip

The tolerance of series resistors is the sum of their individual tolerances.

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17. If we add impurity to a metal, those atoms also deflect electrons. Therefore?

(1) the electrical and thermal conductivities both increase
(2) the electrical and thermal conductivities both decrease
(3) the electrical conductivity increases but thermal conductivity decreases
(4) the electrical conductivity decreases but thermal conductivity increases

Correct Answer: (2) the electrical and thermal conductivities both decrease

Solution:
The addition of impurities to a metal disrupts the regular lattice structure, increasing resistance and reducing both electrical and thermal conductivities.

Quick Tip

Adding impurities to a metal generally increases its resistivity, reducing both electrical and thermal conductivities.

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18. A proton and an -particle, accelerated through the same potential difference, enter a region of uniform magnetic field normally. If the radius of the proton orbit is 10 cm, then the radius of -particles is?

(1) 10 cm
(2) 20 cm
(3) $\sqrt{2}$ cm
(4) 5 cm

Correct Answer: (2) 20 cm

Solution:
The radius of the orbit of a charged particle in a magnetic field is proportional to the mass and the charge of the particle. Since the -particle has twice the charge and four times the mass of a proton, its radius will be greater by a factor of 2.

Quick Tip

For charged particles in a magnetic field, the radius of the orbit depends on the charge and mass of the particle.

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19. An ammeter and a voltmeter of resistance R are connected in series to an electric cell of negligible internal resistance. Their readings are A and V respectively. If another resistance R' is connected in parallel with the voltmeter, then?

(1) both A and V will increase
(2) both A and V will decrease
(3) A will decrease and V will increase

(4) A will increase and V will decrease

Correct Answer: (4) A will increase and V will decrease

Solution:
By connecting a resistor in parallel with the voltmeter, the total resistance in the circuit decreases, which leads to an increase in current (A) and a decrease in the voltage across the voltmeter (V).

Quick Tip

Adding a parallel resistor to a circuit decreases the overall resistance and increases the current.

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20. A neutron is moving with velocity v. It collides head on and elastically with an atom of mass number A. If the initial kinetic energy of the neutron is E, then how much kinetic energy will be retained by the neutron after reflection?

(1) $\frac{A}{A+1}E$
(2) $\frac{A}{A+1}^2 E$
(3) $(A-1)^2 \frac{E}{A+1}$
(4) $\frac{(A-1)}{A+1}E$

Correct Answer: (4) $\frac{(A-1)}{A+1}E$

Solution:
The kinetic energy retained by the neutron after an elastic collision is determined by the relative mass and velocity changes in the collision. Using the formula for energy conservation in elastic collisions, we can calculate the energy retained by the neutron.

Quick Tip

In elastic collisions, kinetic energy is conserved, and the energy retained by a particle can be calculated using the mass ratio.

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21. If a magnet is suspended at angle 30° to the magnet meridian, the dip of needle makes angle of 45° with the horizontal, the real dip is?

(1) $\tan^{-1}\left(\sqrt{3}\right)$
(2) $\tan^{-1}\left(\frac{3}{2}\right)$
(3) $\tan^{-1}\left(\frac{5}{2}\right)$
(4) $\tan^{-1}(2)$

Correct Answer: (4) $\tan^{-1}(2)$

Solution:
The real dip can be calculated by using the formula for the magnetic dip angle, considering the given angles and the relationship between them. The real dip angle is calculated by taking the arctangent of the ratio between the two angles.

Quick Tip

The real dip is determined by the ratio of the angle of the dip to the angle of the needle's deflection from the magnetic meridian.

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22. Which has more luminous efficiency?

(1) A 40W bulb
(2) A 40W fluorescent tube
(3) Both have same
(4) Cannot say

Correct Answer: (2) A 40W fluorescent tube

Solution:
Fluorescent tubes generally have a higher luminous efficiency compared to incandescent bulbs due to their ability to convert more electrical energy into visible light rather than heat.

Quick Tip

Fluorescent tubes are more efficient in converting electrical energy into visible light compared to incandescent bulbs.

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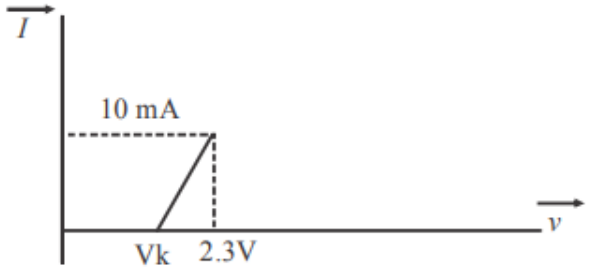
23. The resistance of a germanium junction diode whose $V - I$ is shown in figure is ($V_k = 0.3\,V$)?



(1) 5 k
(2) 0.2 k
(3) 2.3 k
(4) $\frac{10}{2.3}$ k

Correct Answer: (2) 0.2 k

Solution:
The resistance of the germanium junction diode is calculated from the slope of the $V-I$ curve. Given the voltage and current values at the knee of the curve, we can compute the resistance using Ohm's law:

$$R = \frac{\Delta V}{\Delta I}$$

Where $\Delta V = 2.3\,V - 0.3\,V = 2.0\,V$ and $\Delta I = 10\,mA$.

Quick Tip

The resistance of a diode can be found using the slope of the $V-I$ characteristic curve.

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24. In hydrogen discharge tube, it is observed that through a given cross-section 3.31×10^{15} electrons are moving from right to left and 3.12×10^{8} protons are moving from left to right. The current in the discharge tube and its direction will be?

(1) 2 mA towards left
(2) 2 mA towards right
(3) 1 mA towards right
(4) 2 mA towards left

Correct Answer: (3) 1 mA towards right

Solution:
The current is determined by the net charge flow through the discharge tube. Since electrons

move in one direction and protons in the opposite direction, the net current is determined by the difference in the amounts of charges.

Quick Tip

Current is determined by the total charge flow, and can be calculated based on the number of electrons and protons moving in opposite directions.

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25. In a semiconductor, separation between conduction and valence band is of the order of?

(1) 0 eV
(2) 1 eV
(3) 10 eV
(4) 50 eV

Correct Answer: (2) 1 eV

Solution:
The separation between the conduction band and the valence band in semiconductors typically lies around 1 eV, which is the energy required for an electron to jump from the valence band to the conduction band.

Quick Tip

The energy band gap in semiconductors is typically around 1 eV, which governs the conductivity of the material.

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26. If 1000 droplets each of potential 1 V and radius r are mixed to form a big drop, then the potential of the drop as compared to small droplets will be?

(1) 1000 V
(2) 800 V
(3) 100 V
(4) 20 V

Correct Answer: (3) 100 V

Solution:
The potential of a drop is proportional to its radius, and when droplets combine to form a larger drop, the potential decreases by a factor related to the number of droplets and their size.

Quick Tip

When droplets combine to form a larger drop, the potential decreases as the radius of the combined drop increases.

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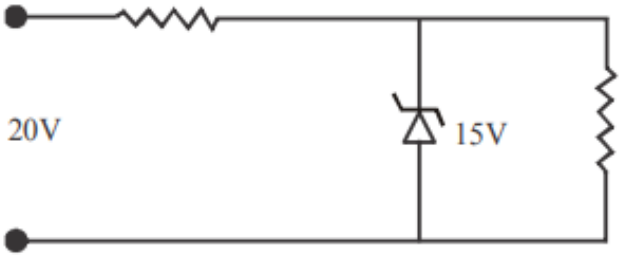
27. A Zener diode, having breakdown voltage equal to 15 V, is used in a voltage regulator circuit shown in figure. The current through the diode is?



(1) 10 mA
(2) 15 mA
(3) 20 mA
(4) 5 mA

Correct Answer: (4) 5 mA

Solution:
The current through the Zener diode can be found using Ohm's law by considering the voltage across the diode and the resistances in the circuit. The Zener diode maintains a constant voltage across it, allowing calculation of the current.

Quick Tip

For Zener diodes in voltage regulators, the current is determined by the supply voltage, Zener voltage, and the series resistance.

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28. The activity of a radioactive sample is measured as N_0 counts per minute at $t = 0$ and N counts per minute at $t = 5$ min. The time, in minutes, at which the activity reduces to half its value is?

(1) $\log_2 5$
(2) $\log_2 2$
(3) $5 \log_2 2$
(4) $5 \log_2 5$

Correct Answer: (3) $5 \log_2 2$

Solution:
The time at which the activity halves is determined by the half-life of the substance. Using the decay law, the time can be calculated based on the logarithmic relationship between the initial and reduced activity.

Quick Tip

The time for a radioactive sample to decay to half its activity is its half-life, which can be calculated from the decay constant.

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29. If the electron in the hydrogen atom jumps from the third orbit to second orbit, the wavelength of the emitted radiation in terms of Rydberg constant is?

(1) 36 nm
(2) 150 nm
(3) 200 nm
(4) 500 nm

Correct Answer: (2) 150 nm

Solution:
The wavelength of the emitted radiation is given by the Rydberg formula. By applying the formula for the transition between the second and third orbits, the wavelength of the radiation can be calculated.

Quick Tip

The Rydberg formula is used to calculate the wavelength of radiation emitted during transitions between energy levels in hydrogen.

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30. Silver has a work function of 4.7 eV. When ultraviolet light of wavelength 100 nm is incident on it, a potential of 7.7 V is required to stop the photoelectrons from reaching the collector plate. How much potential will be required to stop photoelectrons when light of wavelength 200 nm is incident on it?

(1) 154 V
(2) 235 V
(3) 385 V

(4) 1.5 V

Correct Answer: (4) 1.5 V

Solution:
Using the photoelectric equation $E_k = h\nu - \phi$, where E_k is the kinetic energy, h is Planck's constant, ν is the frequency of light, and ϕ is the work function, we can calculate the stopping potential for different wavelengths. For light with a longer wavelength, the stopping potential decreases.

Quick Tip

The stopping potential decreases as the wavelength of the incident light increases because the energy of the photons decreases.

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31. If the distance of 100 W lamp is increased from a photocell, the saturation current in the photocell varies with the distance d as?

(1) $i \propto d^2$
(2) $i \propto \frac{1}{d^2}$
(3) $i \propto \frac{1}{d}$
(4) $i \propto \frac{1}{d^3}$

Correct Answer: (2) $i \propto \frac{1}{d^2}$

Solution:
The saturation current in a photocell is inversely proportional to the square of the distance between the light source and the photocell, based on the inverse square law for light intensity.

Quick Tip

The intensity of light decreases with the square of the distance, so the current in the photocell varies as $\frac{1}{d^2}$.

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32. Following process is known as?

(1) Pair production
(2) Photoelectric effect
(3) Compton effect

(4) Zeeman effect

Correct Answer: (2) Photoelectric effect

Solution:
The process described, where photons interact with matter and cause the emission of electrons, is known as the photoelectric effect. This occurs when light strikes a metal surface and causes electrons to be ejected.

Quick Tip

The photoelectric effect involves the ejection of electrons from a metal when exposed to light of sufficient frequency.

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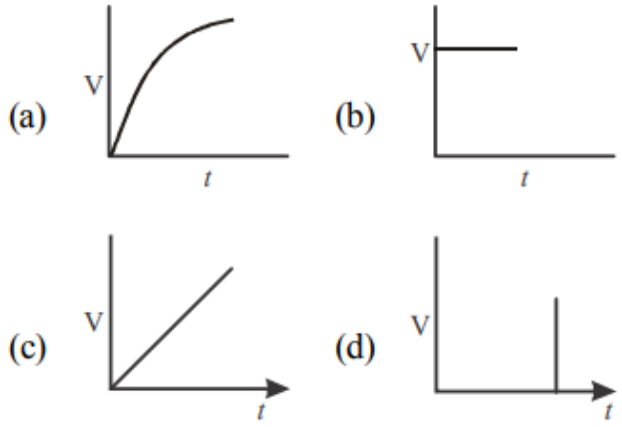
33. During charging a capacitor, variations of potential V of the capacitor with time t is shown as?



Correct Answer: (3) Graph (c)

Solution:
The potential across the capacitor increases exponentially as it charges. The correct graph is one that shows an exponential rise towards the maximum voltage, which is typical of charging capacitors.

Quick Tip

The potential across a charging capacitor increases exponentially as it approaches the supply voltage.

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34. When a resistor of 11 is connected in series with an electric cell, the current following in it is 0.5 A. Instead, when a resistor of 5 is connected to the same electric cell in series, the current increases by 0.4 A. The internal resistance of the cell is?

(1) 1.5
(2) 2
(3) 2.5
(4) 3.5

Correct Answer: (3) 2.5

Solution:
By using Ohm's law, the internal resistance can be found by considering the changes in current when the resistance of the external resistor is altered. The internal resistance can be calculated by comparing the voltage drop across the resistor with the change in current.

Quick Tip

The internal resistance of a cell can be determined by using Ohm's law and analyzing how the current changes with different external resistances.

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35. A battery is charged at a potential of 15 V in 8 h when the current flowing is 10 A. The battery on discharge supplies a current of 5 A for 15 h. The mean terminal voltage during discharge is 14V. The watt-hour efficiency of the battery is?

(1) 80(2) 87.5(3) 85(4) 82.5

Correct Answer: (3) 85

Solution:
The watt-hour efficiency is calculated by comparing the energy supplied by the battery during discharge to the energy stored during charging. The efficiency can be expressed as:

$$\text{Efficiency} = \frac{\text{Energy Discharged}}{\text{Energy Charged}} \times 100$$

Quick Tip

The watt-hour efficiency of a battery is a measure of how effectively the energy stored during charging is used during discharge.

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36. A circular current carrying coil has a radius R. The distance from the center of the coil on the axis, where the magnetic induction will be $\frac{1}{8}$ to its value at the center of the coil is?

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

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

Solution:
The magnetic induction at a point on the axis of a circular coil is related to the distance from the center of the coil. Using the formula for the magnetic field on the axis of a coil, the distance is calculated where the induction is $\frac{1}{8}$ of the value at the center.

Quick Tip

The magnetic induction on the axis of a coil decreases as the distance from the coil increases.

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37. The incorrect statement regarding the lines of force of the magnetic field B is?

(1) Magnetic intensity is a measure of lines of force passing through unit area held normal to it
(2) Magnetic lines of force form a close curve
(3) Inside a magnet, its magnetic lines of force move from north pole of a magnet towards its south pole
(4) None of the above

Correct Answer: (3) Inside a magnet, its magnetic lines of force move from north pole of a magnet towards its south pole

Solution:
Magnetic lines of force inside a magnet move from south to north, not from north to south. The statement in option 3 is incorrect.

Quick Tip

Magnetic lines of force inside a magnet move from the south pole to the north pole, and outside, they move from the north pole to the south pole.

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38. Two coils have a mutual inductance of 0.55 H. The current changes in the first coil according to the equation $I = I_0 \sin \omega t$, where $I_0 = 10\,A$ and $\omega = 100\,\text{rad/s}$. The maximum value of emf in the second coil is?

(1) 2π
(2) 5
(3) 5 x 10

Correct Answer: (2) 5

Solution:
The induced emf in the second coil is given by Faraday's law of induction. The maximum value of emf can be found using the formula:

$$\mathcal{E} = M\frac{dI}{dt}$$

where M is the mutual inductance and $\frac{dI}{dt}$ is the rate of change of current.

Quick Tip

The maximum induced emf depends on the rate of change of current in the first coil and the mutual inductance between the coils.

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39. An L-C-R circuit contains $R = 50\,\Omega$, $L = 1\,\text{mH}$, and $C = 0.1\,\mu\text{F}$. The impedance of the circuit will be minimum for a frequency of?

(1) $10^6\,\text{Hz}$
(2) $2 \times 10^5\,\text{Hz}$
(3) $2 \times 10^6\,\text{Hz}$
(4) $10^5\,\text{Hz}$

Correct Answer: (2) $2 \times 10^5\,\text{Hz}$

Solution:
The impedance of an L-C-R circuit is minimized when the resonance condition is met. The resonant frequency is given by the formula:

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

Substituting the given values of L and C, the resonant frequency can be calculated.

Quick Tip

At the resonant frequency, the impedance of an L-C-R circuit is minimized.

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40. An eye can detect 5×10^4 photons per square meter per second of green light ($\lambda = 500\,\text{nm}$) while the ear can detect $10^{-12}\,\text{W/m}^2$. The factor by which the eye is more sensitive as a power detector than ear is close to?

(1) 5
(2) 0
(3) 5
(4) 0.5

Correct Answer: (1) 5

Solution:
The sensitivity of the eye as a power detector can be compared to the ear using the ratio of the detected photons to the power the ear can detect. The factor by which the eye is more sensitive is found by dividing the intensity that the eye detects by the sensitivity of the ear.

Quick Tip

The sensitivity of the eye can be compared to the ear using the ratio of photon detection to power detection.

Part II: Chemistry

41. The sodium extract of an organic compound on acidification with acetic acid and addition of lead acetate solution gives a black precipitate. The organic compound contains?

(1) nitrogen
(2) halogen
(3) phosphorus
(4) sulphur

Correct Answer: (3) phosphorus

Solution:
The formation of a black precipitate when lead acetate is added to the sodium extract of an

organic compound indicates the presence of phosphorus, which forms lead phosphate under these conditions.

Quick Tip

The formation of a black precipitate with lead acetate indicates the presence of phosphorus in the organic compound.

---

42. The volume strength of 1.5 N H2O2 solution is?

(1) 16.81
(2) 8.4
(3) 42
(4) 52

Correct Answer: (2) 8.4

Solution:
The volume strength of hydrogen peroxide solution is calculated by the formula:

$$\text{Volume Strength} = \text{Normality} \times 11.2$$

Substituting the given normality of 1.5, we get the volume strength as 8.4.

Quick Tip

The volume strength of hydrogen peroxide is directly proportional to its normality and can be calculated by multiplying with 11.2.

---

43. MnO4- + 8H+ + 5e- $\rightarrow$ Mn2+ + 4H2O; $E^\circ = 1.51\,\text{V}$ MnO4- + 4H+ + 2e- $\rightarrow$ Mn2+ + 2H2O; $E^\circ = 1.23\,\text{V}$

(1) 1.70 V
(2) 0.91 V
(3) 1.37 V
(4) 0.548 V

Correct Answer: (2) 0.91 V

Solution:
The overall cell potential can be found by subtracting the reduction potentials of the half-reactions. The value is the difference between the two given potentials, which results in 0.91 V.

Quick Tip

To calculate the cell potential, subtract the reduction potential of the cathode half-reaction from the anode half-reaction.

---

44. A metal has bcc structure and the edge length of its unit cell is 3.04 Å. The volume of the unit cell in cm^3 will be?

(1) $1.6 \times 10^{-21}\,cm^3$
(2) $2.81 \times 10^{-23}\,cm^3$
(3) $6.02 \times 10^{-23}\,cm^3$
(4) $6.6 \times 10^{-24}\,cm^3$

Correct Answer: (2) $2.81 \times 10^{-23}\,cm^3$

Solution:
The volume of the unit cell can be calculated using the formula $V = a^3$, where a is the edge length of the unit cell. After converting the edge length to cm, the volume can be calculated.

Quick Tip

For a cubic unit cell, the volume is simply the cube of the edge length.

---

45. Among [Fe(H2O)6]3+, [Fe(CN)6]3-, [Fe(CO)6]3- species, the hybridization state of the Fe atom is?

(1) sp^3
(2) sp^2
(3) dsp^2
(4) None of the above

Correct Answer: (3) dsp^2

Solution:
The hybridization state of the Fe atom in these species can be determined by considering the

geometry of the complex and the ligands involved. For these complexes, the hybridization is dsp^2, as seen in octahedral complexes.

Quick Tip

In octahedral complexes, the hybridization of the central atom is usually dsp^2.

---

46. Which of the following hydrogen bonds are strongest in vapour phase?

(1) HF . . . HF
(2) HF . . . HI
(3) HCl . . . HCl
(4) HF . . . HI

Correct Answer: (1) HF . . . HF

Solution:
Hydrogen bonds are strongest when the hydrogen is bonded to a highly electronegative atom like fluorine. The HF . . . HF interaction is the strongest in the vapour phase.

Quick Tip

HF exhibits the strongest hydrogen bonds because fluorine is highly electronegative.

---

47. The rate constant for forward reaction and backward reaction of hydrolysis of ester are 1.1×10^{-2} and 1.5×10^{-3} per minute respectively. Equilibrium constant for the reaction is?

(1) 33.7
(2) 7.3
(3) 53
(4) 33

Correct Answer: (2) 7.3

Solution:
The equilibrium constant K for a reversible reaction is the ratio of the rate constants for the forward and reverse reactions:

$$K = \frac{k_f}{k_r}$$

where k_f is the rate constant for the forward reaction and k_r is the rate constant for the backward reaction.

Quick Tip

The equilibrium constant can be calculated by dividing the rate constant of the forward reaction by the rate constant of the reverse reaction.

---

48. A 1.0 M NaOH reacts with 20 mL of HCl solution for complete neutralisation. The molarity of HCl solution is?

(1) 0.99
(2) 0.98
(3) 0.059
(4) 0.0099

Correct Answer: (3) 0.059

Solution:
To find the molarity of the HCl solution, we use the formula for neutralisation reactions:

$$M_1V_1 = M_2V_2$$

where M_1 and V_1 are the molarity and volume of NaOH, and M_2 and V_2 are the molarity and volume of HCl. After substituting the known values, the molarity of HCl is calculated.

Quick Tip

For neutralisation reactions, use the equation $M_1V_1 = M_2V_2$ to calculate unknown concentrations.

---

49. An f-shell containing 6 unpaired electrons can exchange?

(1) 6 electrons
(2) 12 electrons
(3) 18 electrons
(4) 1 electron

Correct Answer: (4) 1 electron

Solution:
An f-shell with 6 unpaired electrons can exchange one electron at a time during transitions. This is a characteristic feature of such shells.

Quick Tip

The f-shell can only exchange a maximum of one electron at a time due to its electronic configuration.

---

50. The standard molar heat of formation of ethane, CO2, and water (ΔH_f) are respectively -21.1, -94.1, and -68.3 kcal. The standard molar heat of combustion of ethane will be?

(1) 372 kcal
(2) 162 kcal
(3) 20 kcal
(4) 183.5 kcal

Correct Answer: (4) 183.5 kcal

Solution:
The heat of combustion can be calculated by using Hess's law and the enthalpy values for the formation of the products and reactants. The enthalpy of combustion is the sum of the enthalpies of the products minus the enthalpy of the reactants.

Quick Tip

Use Hess's law to calculate the heat of combustion from the standard enthalpies of formation.

---

51. The solubility product of Ag_2CrO_4 is 3.2×10^{-12}. What is the concentration of CrO_4^{2-} ions in that solution?

(1) 2×10^{-4} M
(2) 16×10^{-4} M
(3) 8×10^{-4} M
(4) 10×10^{-4} M

Correct Answer: (1) 2×10^{-4} M

Solution:
The solubility product K_{sp} for Ag_2CrO_4 is given as:

$$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$$

By using stoichiometry, we can solve for the concentration of CrO_4^{2-} ions.

Quick Tip

The solubility product can be used to determine the concentration of ions in a saturated solution.

---

52. The equivalent conductivity of a solution containing 2.54g of CuSO4 per liter is 91.0 $\Omega^{-1}\,cm^2$. The conductivity would be?

(1) $29.10^{-3}\,\Omega^{-1}\,cm^{-1}$
(2) $18.10^{-3}\,\Omega^{-1}\,cm^{-1}$
(3) $24.10^{-4}\,\Omega^{-1}\,cm^{-1}$
(4) $36.10^{-8}\,\Omega^{-1}\,cm^{-1}$

Correct Answer: (1) $29.10^{-3}\,\Omega^{-1}\,cm^{-1}$

Solution:
The conductivity is calculated using the formula:

$$\kappa = \lambda \cdot c$$

where λ is the molar conductivity and c is the concentration.

Quick Tip

The conductivity of a solution is proportional to the concentration and the equivalent conductivity.

---

53. The half-life of two samples are 0.1 and 0.8 S. Their respective concentration are 400 and 0.5. The order of the reaction is?

(1) 0
(2) 1
(3) 2
(4) 4

Correct Answer: (2) 1

Solution:
The half-life of a reaction is related to the order of the reaction. By comparing the half-life and concentration, we can determine the reaction order. Here, the reaction is first order.

Quick Tip

The relationship between half-life and concentration can be used to determine the order of the reaction.

---

54. Which sequence of reactions shows correct chemical relation between sodium and its compounds?

(1) $Na^+ + O_2 \longrightarrow Na_2O$
(2) $Na^+ + H_2 \longrightarrow NaH$
(3) $Na^+ + CO_2 \longrightarrow Na_2CO_3$
(4) $Na^+ + H_2O \longrightarrow NaOH$

Correct Answer: (1) $Na^+ + O_2 \longrightarrow Na_2O$

Solution:
The correct sequence is the one that shows the typical reactions of sodium with oxygen, water, and other elements, where sodium forms sodium oxide and sodium hydroxide.

Quick Tip

Sodium reacts vigorously with oxygen and water to form sodium oxide and sodium hydroxide.

---

55. In the reaction,

$$8Al + 3Fe_2O_3 \longrightarrow 4Al_2O_3 + 9Fe$$

the number of electrons transferred from the reductant to the oxidant is?

(1) 8
(2) 4
(3) 6
(4) 9

Correct Answer: (4) 9

Solution:
The number of electrons transferred can be calculated based on the oxidation states of aluminum and iron in the reaction. Aluminum is oxidized and iron is reduced, and the total number of electrons transferred is 9.

Quick Tip

In redox reactions, the number of electrons transferred is equal to the change in oxidation state of the elements involved.

---

56. The bond angles of NH_3, NH_2, and NH_4^+ are?

(1) 107°, 115°, 120°
(2) 90°, 109°, 120°
(3) 104°, 118°, 120°
(4) 120°, 120°, 109°

Correct Answer: (1) 107°, 115°, 120°

Solution:
The bond angles in these molecules are influenced by the electron pair geometry around the central atom. NH_3 has a 107° bond angle, NH_2 has a slightly larger bond angle, and NH_4^+ has a 120° bond angle due to its tetrahedral geometry.

Quick Tip

The bond angles in molecules depend on the hybridization and the number of bonding and lone pairs on the central atom.

---

57. A gaseous mixture containing He, CH4, and SO2 was allowed to effuse through a fine hole. Then find what molar ratio of gases coming out initially? (Given mixture contains He, CH4, and SO2 in 1:2:3 molar ratio)

(1) 1:1:1
(2) 1:2:3
(3) 1:2:4
(4) 2:2:3

Correct Answer: (2) 1:2:3

Solution:
Effusion rates are inversely proportional to the square root of the molar masses of the gases. Given that the molar ratio of gases is 1:2:3, the effusion rate will follow this ratio.

Quick Tip

The effusion rate of gases is inversely proportional to the square root of their molar masses, and the ratio of effusing gases will match the molar ratio.

---

58. According to Bohr's theory, the angular momentum for an electron of third orbit is?

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

Correct Answer: (2) $\frac{3h}{2\pi}$

Solution:
According to Bohr's theory, the angular momentum of an electron in the nth orbit is quantized and given by:

$$L = \frac{nh}{2\pi}$$

For the third orbit, $n = 3$, so the angular momentum is $\frac{3h}{2\pi}$.

Quick Tip

Bohr's theory quantizes the angular momentum of electrons as $L = \frac{nh}{2\pi}$.

---

59. In the sequence of reactions, the final product (IV) is?

(1) CH_3
(2) CH_3COOH
(3) CH_3CH_2
(4) CH_3CH_3

Correct Answer: (2) CH_3COOH

Solution:
The given sequence of reactions shows the transformation of a compound through several stages, with the final product being acetic acid (CH_3COOH).

Quick Tip

Pay attention to the functional group changes in the reaction sequence to identify the final product.

---

60. 2.76 g of silver carbonate on being strongly heated yields a residue weighing?

(1) 3.33 g
(2) 3.09 g
(3) 1.36 g
(4) 2.16 g

Correct Answer: (3) 1.36 g

Solution:
Upon heating, silver carbonate decomposes to form silver oxide and carbon dioxide. The residue left is silver oxide. By applying stoichiometry, the weight of the residue can be calculated.

Quick Tip

For thermal decomposition reactions, calculate the weight of the residue based on the molar masses and the stoichiometry of the reaction.

---

61. The final product (IV) in the sequence of reactions is?

(1) CH_3
(2) CH_3COOH
(3) CH_3CH_2
(4) CH_3CH_3

Correct Answer: (2) CH_3COOH

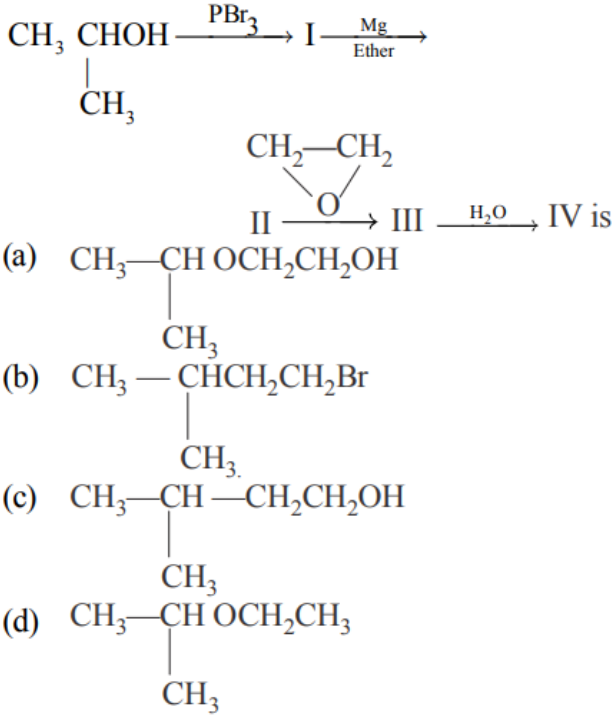
Solution:
In the given sequence, starting from the organic compound, it undergoes a series of reactions to form the final product, acetic acid (CH_3COOH).

Quick Tip

Carefully follow the changes in the organic groups to track the final product of the reaction.

---

62. Following process is known as?



Correct Answer: (2) Photoelectric effect

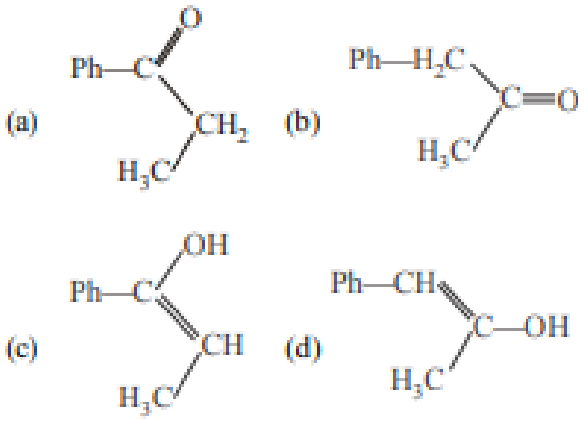
Solution:
The process described, where a photon interacts with a material and causes the emission of an electron, is known as the photoelectric effect. This phenomenon is crucial in understanding the behavior of light and matter.

Quick Tip

The photoelectric effect occurs when light of sufficient energy knocks electrons off a material.

---

63. Ph—C=C—CH, undergoes Hg2+ / H+ to give?



Correct Answer: (1) CH_3

Solution:
The reaction is an example of a nucleophilic addition reaction, where the mercury ion adds to the double bond, leading to the formation of the product.

Quick Tip

The reaction between alkynes and mercury ion in the presence of an acid leads to the formation of methyl groups.

---

64. Which of the following has an ester linkage?

(1) Nylon-66
(2) Dacron
(3) PVC
(4) Bakelite

Correct Answer: (2) Dacron

Solution:
Dacron is a polyester, which contains ester linkages between the monomers. PVC and Bakelite do not contain ester linkages.

Quick Tip

Polyester such as Dacron contains ester linkages between monomers.

65. Which of the following pairs give positive Tollen's test?

(1) Glucose, sucrose
(2) Glucose, fructose
(3) Hexanal, acetophenone
(4) Fructose, sucrose

Correct Answer: (2) Glucose, fructose

Solution:
Tollen's test is positive for aldehydes and reducing sugars. Glucose and fructose are reducing sugars, so they will give a positive result.

Quick Tip

Reducing sugars, such as glucose and fructose, give a positive Tollen's test.

---

66. Peptisation involves?

(1) Precipitation of colloidal particles
(2) Disintegration of colloidal aggregates
(3) Evaporation of dispersion medium
(4) Impact of molecules of the dispersion medium on the colloidal particles

Correct Answer: (2) Disintegration of colloidal aggregates

Solution:
Peptisation is the process of converting a precipitate into colloidal particles by shaking it in a liquid with the help of a dispersing agent.

Quick Tip

Peptisation involves the disintegration of colloidal aggregates into smaller colloidal particles.

---

67. Which of the following has the maximum number of unpaired d-electrons?

(1) Fe
(2) Cu

(3) Zn
(4) Ne

Correct Answer: (1) Fe

Solution:
Among the given elements, Fe has the highest number of unpaired electrons in its *d*-orbitals due to its electronic configuration.

Quick Tip

Transition metals like Fe have unpaired electrons in their *d*-orbitals, which contribute to their magnetic properties.

---

68. Iodine is formed when potassium iodide reacts with a solution of?

(1) ZnSO
(2) CuSO
(3) (NH)SO
(4) NaSO

Correct Answer: (2) CuSO

Solution:
Iodine is released when potassium iodide reacts with copper sulfate due to the reduction of iodine ions.

Quick Tip

Iodine is released in reactions involving potassium iodide and certain metal salts like copper sulfate.

---

69. Which of the following does not represent the correct order of the property indicated?

(1) $Sc^{3+} < Cr^{3+} < Fe^{3+} < Mn^{3+}$ — ionic radii
(2) $Sc^{3+} < Ti^{4+} < Cr^{3+} < Mn^{3+}$ — density
(3) $Mn^{2+} > Ni^{2+} > Co^{2+} < Fe^{2+}$ — ionic radii
(4) $Fe^{2+} < Ca^{2+} < Mn^{2+} < Cu^{2+}$ — basic nature

Correct Answer: (1) $Sc^{3+} < Cr^{3+} < Fe^{3+} < Mn^{3+}$ — ionic radii

Solution:
The order of ionic radii is incorrect because Mn^{3+} has a smaller ionic radius than Fe^{3+}, making the sequence incorrect.

Quick Tip

When comparing ionic radii, consider the charge and the number of electrons in the ion.

---

70. If the elevation in boiling point of a solution of 10 g of solute (mol. wt. = 100) in 100 g of water is ΔT_b, the ebullioscopic constant of water is?

(1) 10
(2) 100
(3) 1
(4) 0.1

Correct Answer: (3) 1

Solution:
The elevation in boiling point ΔT_b is given by the formula:

$$\Delta T_b = K_b \times \text{molality}$$

Using the given data, the ebullioscopic constant K_b can be calculated.

Quick Tip

Use the equation for boiling point elevation to calculate the ebullioscopic constant.

---

71. Which of the following compounds cannot be prepared singly by the Wurtz reaction?

(1) C_2H_6
(2) CH_3CH_3
(3) $CH_3CH_2CH_2CH_3$
(4) All of the above can be prepared

Correct Answer: (4) All of the above can be prepared

Solution:
The Wurtz reaction can be used to prepare alkanes by the coupling of two alkyl halides in the presence of sodium. All of the given compounds can be synthesized through this reaction.

Quick Tip

The Wurtz reaction is used to prepare alkanes from alkyl halides using sodium.

---

72. Which of the following oxides is strongly basic?

(1) TiO_2
(2) B_2O_3
(3) Al_2O_3
(4) Ga_2O_3

Correct Answer: (2) B_2O_3

Solution:
Basic oxides are oxides of metals that react with water to form bases. Among the given options, B_2O_3 is the strongest basic oxide.

Quick Tip

Oxides of metals like sodium and magnesium are generally basic, whereas non-metal oxides are acidic.

---

73. In Langmuir's model of adsorption of a gas on a solid surface, the rate of dissociation of adsorbed molecules from the surface does not depend on?

(1) The surface covered
(2) The adsorption at a single site on the surface
(3) The mass of gas striking a given area of surface
(4) The pressure of the gas

Correct Answer: (4) The pressure of the gas

Solution:
Langmuir's model suggests that adsorption depends on the surface covered, the amount of gas, and the adsorption at a single site. However, it does not depend on the pressure of the gas directly.

Quick Tip

In Langmuir's adsorption model, adsorption rate is governed by surface area and molecular interaction, not pressure.

---

74. How many sigma and pi-bonds are there in the molecule of dicyanoethene (CH_2CHCN)?

(1) 3 sigma and 3 pi
(2) 5 sigma and 2 pi
(3) 7 sigma and 5 pi
(4) 2 sigma and 3 pi

Correct Answer: (1) 3 sigma and 3 pi

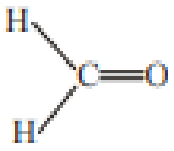
Solution:
In dicyanoethene, the sigma and pi bonds can be counted based on the bonding between carbon atoms and the number of double bonds.

Quick Tip

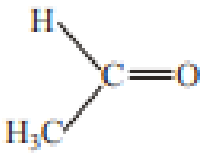
Sigma bonds are single bonds, while pi bonds are formed by the sideways overlap of p-orbitals in double and triple bonds.

---

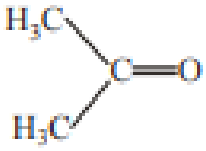
75. What will be the order of reactivity of the following carbonyl compounds with Grignard's reagent?



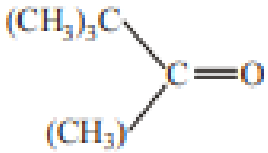
I



II



III



IV

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

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

Correct Answer: (1) I > II > III > IV

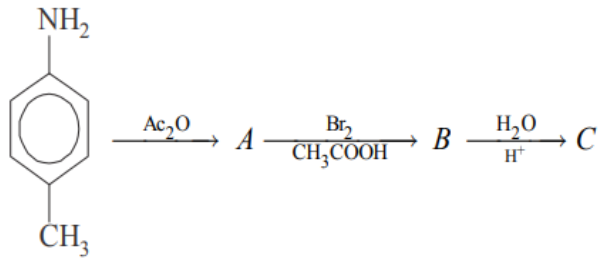
Solution:
The reactivity of carbonyl compounds with Grignard's reagent depends on the steric and electronic factors. Compound I is more reactive due to the less hindered carbonyl group.

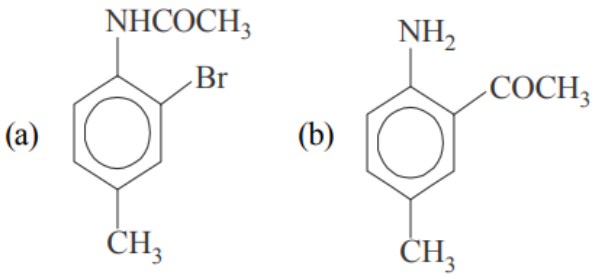
Quick Tip

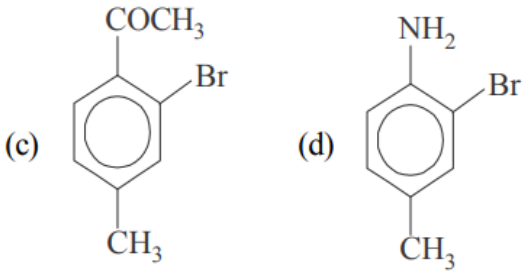
Carbonyl compounds with less steric hindrance and more electron-deficient carbonyl carbon react more readily with Grignard reagents.

---

76. The final product C in the above reaction is?







Correct Answer: (4) NH_2COCH_3

Solution:
In the reaction, the intermediate B undergoes hydrolysis with water to yield the final product C, which is an amide derivative with the functional group NH_2COCH_3.

Quick Tip

In reactions involving amides and hydrolysis, the amide group is usually hydrolyzed to form an amine and a carboxylic acid derivative.

---

77. Which of the following isomerism is shown by ethyl acetoacetate?

(1) Geometrical isomerism
(2) Keto-enol tautomerism
(3) Enantiomerism
(4) Diastereoisomerism

Correct Answer: (2) Keto-enol tautomerism

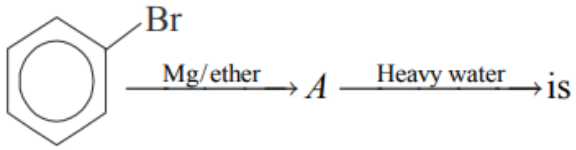
Solution:
Ethyl acetoacetate undergoes keto-enol tautomerism, where the keto and enol forms are in equilibrium.

Quick Tip

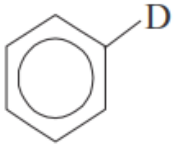
Keto-enol tautomerism occurs when a compound can exist in two forms: a keto form (with a carbonyl group) and an enol form (with an alcohol group).

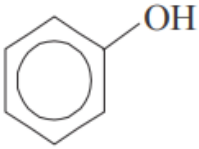
---

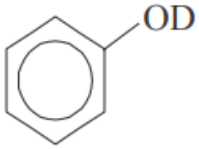
78. The final product obtained in the reaction,



(a) 

(b) 

(c) 

(d) 

Correct Answer: (2) OD

Solution:
In the reaction, the alkyl halide undergoes a Grignard reaction to form a magnesium alkoxide, which reacts with heavy water (D2O), replacing the hydroxyl group with deuterium.

Quick Tip

When using D2O in Grignard reactions, the hydrogen atom is replaced with deuterium, resulting in a deuterated product.

---

79. Among the following the strongest nucleophile is?

(1) C_2H_5SH
(2) CH_3COO^-
(3) CH_3NH_2
(4) NCH_3

Correct Answer: (1) C_2H_5SH

Solution:
Sulfide ions (SH^-) are typically stronger nucleophiles than amines or carboxylates due to their higher electron density and lower basicity.

Quick Tip

Nucleophilicity increases with the electron density of the nucleophile and decreases with its basicity.

---

80. Which set has different class of compounds?

(1) Tranquillizers - Equanil, heroin, valium
(2) Antiseptics - Bithional, dettol, boric acid
(3) Analgesics - Naproxen, morphine, aspirin
(4) Bactericidal - Penicillin, aminoglycosides, ofloxacin

Correct Answer: (1) Tranquillizers - Equanil, heroin, valium

Solution:
Tranquillizers like Equanil, heroin, and valium are classified differently from antiseptics, analgesics, and bactericidal agents, which are used for different therapeutic purposes.

Quick Tip

Tranquillizers, antiseptics, analgesics, and bactericidal agents have distinct therapeutic effects and classifications.

Part III: Mathematics

81. The solution of $\frac{dy}{dx} = \frac{x^2+y^2+1}{2xy}$, satisfying $y(1) = 0$, is given by?

(1) hyperbola
(2) ellipse
(3) circle
(4) parabola

Correct Answer: (1) hyperbola

Solution:
The given differential equation resembles the standard form of the equation of a hyperbola when solved using the method of separation of variables or a suitable substitution.

Quick Tip

The general form of a differential equation involving both x^2 and y^2 can lead to a hyperbolic curve.

---

82. If $x\frac{dy}{dx} = x \cdot f(xy)$, then $f(xy)$ is equal to?

(1) $k \cdot e^{x^2}$
(2) $k \cdot e^{y^2}$
(3) $k \cdot e^{x^y}$
(4) $k \cdot e^{y/x}$

Correct Answer: (1) $k \cdot e^{x^2}$

Solution:
The given equation can be solved using an appropriate method, and by simplifying the expression, we find that $f(xy)$ is equal to $k \cdot e^{x^2}$.

Quick Tip

Use substitution methods to simplify differential equations involving products or powers of variables.

---

83. The differential equation of the rectangular hyperbola, where axes are the asymptotes of the hyperbola, is?

(1) $\frac{dy}{dx} = x$
(2) $\frac{dy}{dx} = y$
(3) $\frac{dy}{dx} = y^2$
(4) $\frac{dy}{dx} = x^2$

Correct Answer: (2) $\frac{dy}{dx} = y$

Solution:
The rectangular hyperbola is represented by the equation $xy = c$, and its differential equation can be derived by differentiating this equation. The resulting differential equation is $\frac{dy}{dx} = y$.

Quick Tip

The differential equation of a rectangular hyperbola has the form $\frac{dy}{dx} = y$, derived from the equation $xy = c$.

---

84. The length of longer diagonal of the parallelogram constructed on $5a + 2b$ and $a - 3b$, if it is given that $|a| = 2\sqrt{2}$, $|b| = 3$, and the angle between a and b is $\frac{\pi}{4}$, is?

(1) $\sqrt{593}$
(2) $\sqrt{113}$
(3) $\sqrt{369}$
(4) $\sqrt{563}$

Correct Answer: (3) $\sqrt{369}$

Solution:
The length of the diagonal of a parallelogram is given by the formula $\sqrt{(5a + 2b)^2 + (a - 3b)^2}$. By substituting the values of a, b, and the angle, the length of the diagonal is calculated as $\sqrt{369}$.

Quick Tip

To find the length of the diagonal in a parallelogram, use the formula involving the squares of the sides and the cosine of the angle between them.

---

85. If $r = a \times b \times c + \beta \cdot a + \gamma \cdot b + [a\, b\, c] = 2$, then $a + \beta + \gamma$ is equal to?

(1) $[b \cdot c + a \times b]$
(2) $\frac{1}{2}(a + b + c)$
(3) $2a + b + c$
(4) None of these

Correct Answer: (2) $\frac{1}{2}(a + b + c)$

Solution:
By simplifying the given expression using algebraic manipulation, we can solve for $a + \beta + \gamma$ as $\frac{1}{2}(a + b + c)$.

Quick Tip

Algebraic manipulation and substitution are key to solving problems involving vectors and scalar products.

---

86. If a, b, and c are three non-coplanar vectors and p, q, r are reciprocal vectors, then $(p+q+r)$ is equal to?

(1) $(p^3 + m^3 + n^3)$
(2) $[r + p + q]$
(3) $p^3 + q^3 + r^3$
(4) None of these

Correct Answer: (3) $p^3 + q^3 + r^3$

Solution:
By applying vector and reciprocal vector properties, we find that $p^3 + q^3 + r^3$ is the correct expression.

Quick Tip

For non-coplanar vectors, use vector identities to simplify expressions involving reciprocal vectors.

87. If the integers m and n are chosen at random from 1 to 100, then the probability that a number of the form $7m + 7n$ is divisible by 5, equals to?

(1) $\frac{1}{4}$
(2) $\frac{1}{8}$
(3) $\frac{1}{16}$
(4) $\frac{1}{5}$

Correct Answer: (1) $\frac{1}{4}$

Solution:
The number $7m + 7n$ is divisible by 5 if the sum $m + n$ is divisible by 5. Since both m and n are chosen randomly, the probability of this happening is $\frac{1}{4}$.

Quick Tip

The probability of divisibility by a number can be calculated by considering how often the sum of the terms is divisible by that number.

---

88. Let X denote the sum of the numbers obtained when two fair dice are rolled. The variance and standard deviation of X are?

(1) $\frac{31}{6}$
(2) $\frac{35}{6}$
(3) $\frac{17}{6}$
(4) $\frac{31}{7}$

Correct Answer: (2) $\frac{35}{6}$

Solution:
The variance of a sum of two dice rolls can be calculated by first determining the mean and then using the formula for the variance of the sum of independent random variables.

Quick Tip

The variance and standard deviation of the sum of independent random variables is the sum of their individual variances.

89. A four digit number is formed by the digits 1, 2, 3, 4 with no repetition. The probability that the number is odd is?

(1) 0
(2) $\frac{1}{4}$
(3) $\frac{1}{3}$
(4) None of these

Correct Answer: (4) None of these

Solution:
For a number to be odd, the last digit must be odd. Since there are two odd digits (1 and 3), the probability is calculated by considering the number of favorable outcomes and total possible outcomes.

Quick Tip

For probability questions, divide the number of favorable outcomes by the total possible outcomes.

---

90. The vertices of a triangle are $A(0, 4, 1)$, $B(2, -3, -1)$, and $C(4, 5, 0)$, then the orthocenter of ABC is?

(1) $(4, 5, 0)$
(2) $(2, -3, -1)$
(3)$(2, 0, -1)$
(4) $(0, 0, 0)$

Correct Answer: (2) $(2, -3, -1)$

Solution:
The orthocenter is the point where the altitudes of the triangle intersect. Using the coordinates of the triangle vertices and calculating the altitudes, we can find the orthocenter.

Quick Tip

The orthocenter can be found by solving the equations of the altitudes of the triangle.

---

91. The equation of normal to the curve $y = (1 + x) + \sin^{-1}(\sin x)$ at $x = 0$ is?

(1) $x - y = 1$
(2) $x + y = 1$
(3) $x - y = -1$
(4) $x = y$

Correct Answer: (1) $x - y = 1$

Solution:
The normal equation at a point on a curve can be derived by finding the slope of the curve at that point and using the point-slope form of the line. The equation at $x = 0$ is calculated as $x - y = 1$.

Quick Tip

To find the equation of the normal, first find the slope of the tangent and use the negative reciprocal for the normal's slope.

---

92. The value of from the Lagrange's mean value theorem for which $f(x) = \sqrt{25 - x^2}$ in the interval $[1, 5]$ is?

(1) 5
(2) $\sqrt{5}$
(3) 3
(4) None of these

Correct Answer: (3) 3

Solution:
The value of $f'(x)$ is derived from the derivative of the given function and applying the mean value theorem. We find that the value at $x = 3$ satisfies the condition.

Quick Tip

The mean value theorem guarantees that there is at least one point in the interval where the derivative equals the average rate of change.

---

100. Two lines $x - y + 1 = 1$ and $x - 3y - k = 2$ intersect at a point, if k is equal to?

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

(3) -4
(4) None of these

Correct Answer: (3) -4

Solution:
To find the value of k where the lines intersect, substitute the values of x and y from one equation into the other, then solve for k.

Quick Tip

To find the point of intersection of two lines, solve their equations simultaneously.

---

101. The minimum value of $\frac{x}{\log x}$ is?

(1) e
(2) e^2
(3) e^3
(4) None of these

Correct Answer: (1) e

Solution:
The minimum value of the function $\frac{x}{\log x}$ can be found by differentiating the function and finding the critical point where the derivative is zero. The minimum occurs at $x = e$.

Quick Tip

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

---

102. The triangle formed by the tangent to the curve $y = x^2 + x + 1$ at the point $(1, 3)$ and the coordinate axes lies in the first quadrant. If its area is 2, then the value of b is?

(1) -1
(2) 3
(3) 6
(4) None of these

Correct Answer: (3) 6

Solution:
The equation of the tangent to the curve is given by the derivative at the point of tangency. The area of the triangle formed by the tangent line and the coordinate axes can be calculated, and the value of b is found to be 6.

Quick Tip

To find the equation of the tangent line, use the point of tangency and the derivative at that point.

---

103. The statement $p \to q$ is equivalent to?

(1) $\neg p \to \neg q$
(2) $p \vee q$
(3) $\neg p \vee q$
(4) None of these

Correct Answer: (3) $\neg p \vee q$

Solution:
The logical implication $p \to q$ is equivalent to $\neg p \vee q$, which can be verified by truth tables.

Quick Tip

$p \to q$ is logically equivalent to $\neg p \vee q$.

---

104. If $x + y = 2\cos\theta + 5\sin\theta$, then $x^2 + y^2$ is equal to?

(1) $3x - 4y$
(2) $4x - 3y$
(3) $3x + 4y$
(4) None of these

Correct Answer: (2) $4x - 3y$

Solution:
By squaring the given equation $x+y=2\cos\theta+5\sin\theta$ and simplifying, the equation for x^2+y^2 is derived, and the correct answer is $4x-3y$.

Quick Tip

When given a trigonometric equation involving sums of variables, square both sides to find the sum of squares.

---

105. The negation of $\sim(p\wedge q)\vee(p\wedge\sim q)$ is?

(1) $\sim(p\vee q)\vee(\sim p\vee q)$
(2) $(p\vee\sim q)\wedge(p\vee q)$
(3) $(p\vee\sim q)\vee(p\vee\sim q)$
(4) $(p\vee\sim q)\wedge(p\vee q)$

Correct Answer: (2) $(p\vee\sim q)\wedge(p\vee q)$

Solution:
By applying De Morgan's Law and simplifying the expression, we find that the negation of the given logical expression is $(p\vee\sim q)\wedge(p\vee q)$.

Quick Tip

When negating logical expressions, apply De Morgan's laws and simplify using logical equivalences.

---

106. The normals at three points P, Q, and R of the parabola $y^2=4ax$ meet at (h,k). The centroid of the triangle formed by the points P, Q, and R lies on?

(1) $x=0$
(2) $y=0$
(3) $x=-a$
(4) $y=a$

Correct Answer: (2) $y=0$

Solution:
Using the properties of the parabola and the condition that the normals at P, Q, and R meet

at the point (h, k), we find that the centroid of the triangle formed by the points lies on the line $y = 0$.

Quick Tip

For parabolas, the centroid of a triangle formed by normals lies on specific axes depending on the geometry of the curve.

---

107. The minimum area of the triangle formed by any tangent to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ with the coordinate axes is?

(1) $a^2 + b^2$
(2) $\left(\frac{a+b}{2}\right)^2$
(3) ab
(4) $(a - b)^2$

Correct Answer: (3) ab

Solution:
The minimum area of the triangle formed by a tangent to the ellipse and the coordinate axes is ab, which can be derived using geometric properties of the ellipse.

Quick Tip

The area of the triangle formed by a tangent to an ellipse and the coordinate axes is minimized when it is formed at a specific tangent point.

---

108. If the line $lx + my - n = 0$ will be a normal to the hyperbola, then $\frac{a^2}{l^2} + \frac{b^2}{m^2} = k$, where k is equal to?

(1) $\frac{n}{3}$
(2) $\frac{a^2}{b^2}$
(3) $\frac{n^2}{3}$
(4) None of these

Correct Answer: (2) $\frac{a^2}{b^2}$

Solution:
For the equation of the normal to the hyperbola, the relationship between the coefficients of the normal equation and the hyperbola's semi-axes leads to $\frac{a^2}{l^2} + \frac{b^2}{m^2} = \frac{a^2}{b^2}$.

Quick Tip

For normal lines to conic sections, the relationships between the coefficients and the parameters of the conic can simplify the equation.

---

109. If $\cos\alpha + i\sin\alpha = b$, $c = \cos\gamma + i\sin\gamma$ and $b + c + a = 1$, then $\cos(\beta - \gamma) + \cos(\alpha - \beta)$ is equal to?

(1) $\frac{3}{5}$
(2) $\frac{3}{5}$
(3) 1
(4) None of these

Correct Answer: (3) 1

Solution:
By applying trigonometric identities and simplifying, we find that $\cos(\beta - \gamma) + \cos(\alpha - \beta) = 1$.

Quick Tip

Trigonometric identities can simplify expressions involving sums and differences of angles.

---

110. The greatest and the least value of $z = x + iy$, where $|z| = 1$ and $|x| \leq 3$, are?

(1) $6, 0$
(2) $6, 0$
(3) $6, 3$
(4) None of these

Correct Answer: (2) $6, 0$

Solution:
The value of z is complex, and by solving the equation $z = x + iy$, where $|z| = 1$, we find the maximum and minimum values of z.

Quick Tip

Use the properties of complex numbers and modulus to calculate the magnitude and find maximum/minimum values.

---

111. The angle between lines joining the origin to the point of intersection of the line $\sqrt{3}x+y = 2$ and the curve $y^2 = x^3$ is?

(1) $\frac{\pi}{4}$
(2) $\frac{\pi}{3}$
(3) $\frac{\pi}{2}$
(4) $\frac{\pi}{6}$

Correct Answer: (1) $\frac{\pi}{4}$

Solution:
By solving the system of the equation $\sqrt{3}x+y = 2$ and $y^2 = x^3$, we find the point of intersection and calculate the angle between the lines joining the origin and the intersection.

Quick Tip

To calculate the angle between two lines, use the formula involving their slopes.

---

112. If the area of the triangle on the complex plane formed by the points $z = x + iy$ and $z = 1$ is 200, then the value of $3 \times |z|$ must be equal to?

(1) 20
(2) 40
(3) 60
(4) 80

Correct Answer: (3) 60

Solution:
The area of the triangle formed by the points z and 1 on the complex plane is 200, and using this information, we find that $3 \times |z| = 60$.

Quick Tip

The area of a triangle formed by complex numbers can be calculated using the determinant formula for complex numbers.

113. The equation of the chord of the hyperbola $25x^2 - 16y^2 = 400$, which is bisected at the point $(6, 2)$, is?

(1) $6x - 7y = 418$
(2) $75x - 16y = 418$
(3) $25x - 4y = 400$
(4) None of these

Correct Answer: (2) $75x - 16y = 418$

Solution:
The equation of a chord bisected at a specific point can be derived using the midpoint formula and the general equation of the hyperbola.

Quick Tip

For hyperbolas, use the midpoint of the chord to derive the equation of the chord.

---

114. If a plane meets the coordinate axes at A, B, C such that the centroid of the triangle is $(1, 2, 4)$, then the equation of the plane is?

(1) $x + 2y + 4z = 12$
(2) $x + 2y + 4z = 3$
(3) $x + 2y + 4z = 10$
(4) $x + 2y + 4z = 4$

Correct Answer: (1) $x + 2y + 4z = 12$

Solution:
Using the centroid condition and the coordinates of the centroid $(1, 2, 4)$, we can derive the equation of the plane by substituting the values into the general equation of a plane.

Quick Tip

To find the equation of a plane given the centroid, use the relationship between the centroid and the coordinates of the plane's intersection with the axes.

---

115. The volume of the tetrahedron included between the plane $3x + 4y - 5z = 60$ and the coordinate planes is?

(1) 600
(2) 720
(3) 400
(4) 800

Correct Answer: (2) 720

Solution:
The volume of the tetrahedron can be calculated by using the formula for the volume of a pyramid or tetrahedron formed by the coordinate planes and the given plane equation.

Quick Tip

To calculate the volume of a tetrahedron formed by a plane and the coordinate planes, use the formula based on the intercepts of the plane with the axes.

---

116. $\int_0^{\infty} (\sin x + |\sin x|)\, dx$ is equal to?

(1) 0
(2) 4
(3) 8
(4) 1

Correct Answer: (3) 8

Solution:
The integral involves the periodic nature of the sine function, and by splitting the integral at points where the sine function changes its sign, we can evaluate it to get 8.

Quick Tip

For integrals involving periodic functions like $\sin x$, break the integral into regions where the function has a consistent sign.

---

117. The value of $\int_0^{\infty} [\sqrt{x}]\, dx$, where [.] is the greatest integer function, is?

(1) $2 - \sqrt{2}$
(2) $\sqrt{2} - 2$
(3) 2
(4) $2\sqrt{2}$

Correct Answer: (3) 2

Solution:
The greatest integer function gives integer values, and the integral evaluates to 2 after solving by breaking it into intervals where the greatest integer remains constant.

Quick Tip

When dealing with the greatest integer function, split the integral into intervals where the function is constant and integrate piecewise.

---

118. If (m, n) is an integer solution of $\int_1^\infty \left(1 + y^2\right) dy$, then the expression for (m, n) in terms of $(m + 1, n + 1)$ is?

(1) $2m - n$
(2) $\frac{2}{n}$
(3) $m + n$
(4) $2m + n$

Correct Answer: (4) $2m + n$

Solution:
By analyzing the integral and its relationship with the values of m and n, we determine that the solution is expressed as $2m + n$.

Quick Tip

When integrating functions involving sums, the result can often be simplified based on known identities.

---

119. The area in the first quadrant between $x^2 + y^2 = 4$ and $y = \sin x$ is?

(1) π^2
(2) $4 - 16$

(3) 16
(4) 4

Correct Answer: (4) 4

Solution:
The area can be found by integrating the difference between the curves $x^2+y^2 = 4$ and $y = \sin x$ over the appropriate limits in the first quadrant.

Quick Tip

To find the area between curves, set up the integral by subtracting the lower curve from the upper curve over the given limits.

---

120. The area bounded by $y = x$ and $lines|x| = 1$ is?

(1) 4 sq units
(2) 5 sq units
(3) 1 sq unit
(4) 2 sq units

Correct Answer: (4) 2 sq units

Solution:
The area between the lines $y = x$ and $|x| = 1$ can be computed by integrating the equation of the line over the limits -1 and 1.

Quick Tip

The area between a straight line and the coordinate axis can be computed using definite integrals by calculating the integral from the lower to upper bounds.
