BITSAT 2025 June 23 Shift 1 Question Paper With Solutions

Time Allowed :3 Hours	**Maximum Marks :**390	**Total questions :**130

General Instructions

Read the following instructions very carefully and strictly follow them:

1. Duration of Exam: 3 Hours
2. Total Number of Questions: 130 Questions
3. Section-wise Distribution of Questions:
    - Physics - 40 Questions
    - Chemistry - 40 Questions
    - Mathematics - 50 Questions
4. Type of Questions: Multiple Choice Questions (Objective)
5. Marking Scheme: Three marks are awarded for each correct response
6. Negative Marking: One mark is deducted for every incorrect answer.
7. Each question has four options; only one is correct.
8. Questions are designed to test analytical thinking and problem-solving skills.

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1. Calculate the electric field at a point due to a uniformly charged spherical shell.

(1) $\frac{Q}{4\pi\epsilon_0 r^2}$

(2) 0

(3) $\frac{Q}{4\pi\epsilon_0 r}$

(4) $\frac{Q}{8\pi\epsilon_0 r^2}$

Correct Answer: (2) 0

Solution:

We are asked to find the electric field at a point due to a uniformly charged spherical shell. The solution involves understanding the application of Gauss's Law, which is a fundamental concept in electrostatics.

1. Gauss's Law states that the electric flux through a closed surface is proportional to the charge enclosed by that surface:

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

Where: - $\vec{E}$ is the electric field, - $d\vec{A}$ is an infinitesimal area element, - Q_{enc} is the enclosed charge, - ϵ_0 is the permittivity of free space.

2. For a spherical shell, the symmetry of the charge distribution means that the electric field inside the shell must be uniform and radially symmetric. - At any point inside the spherical shell, the contribution to the electric field from all parts of the shell cancels out due to symmetry. - This is because the field due to a charge element at one part of the shell is canceled by the field due to a charge element at the opposite side of the shell. Thus, the electric field inside the shell is zero.

3. Therefore, the electric field at a point inside the shell is zero. This result is independent of the radius of the shell or the charge enclosed by the shell.

4. Outside the shell (for $r > R$), the electric field behaves as though the entire charge is concentrated at the center, but the question asks for the field at a point inside the shell. Thus, option (1), (3), and (4) are incorrect.

Option (2) is correct because the electric field inside the shell is zero.

Quick Tip

For spherical symmetry, remember that the electric field inside a uniformly charged spherical shell is always zero, regardless of the shell's charge or radius.

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2. Determine the final temperature when two bodies at different temperatures are brought into thermal contact.

(1) The temperature will always be the average of the two temperatures.

(2) The temperature will depend on the masses and specific heats of the bodies.

(3) The temperature will always be the temperature of the body with the higher initial temperature.

(4) The temperature will be the higher of the two initial temperatures.

Correct Answer: (2) The temperature will depend on the masses and specific heats of the bodies.

Solution:

This problem involves the concept of thermal equilibrium and the principle of heat exchange.

1. Heat Transfer and Energy Conservation: - When two bodies at different temperatures come into thermal contact, heat flows from the hotter body to the cooler body until both bodies reach the same final temperature. This process is governed by the first law of thermodynamics, which is essentially the law of conservation of energy.

2. The amount of heat Q transferred is given by:

$$Q = mc\Delta T$$

Where: - m is the mass of the body, - c is the specific heat capacity of the material, - ΔT is the change in temperature ($T_f - T_i$).

3. Equation Setup: - Let the masses of the two bodies be m_1 and m_2, their specific heats be c_1 and c_2, and their initial temperatures be T_1 and T_2, respectively. - The heat lost by the hotter body equals the heat gained by the cooler body. This can be written as:

$$m_1c_1(T_f - T_1) = -m_2c_2(T_f - T_2)$$

Where T_f is the final temperature that we need to solve for.

4. Solving for Final Temperature: - Rearranging the equation:

$$m_1c_1(T_f - T_1) = -m_2c_2(T_f - T_2)$$

$$m_1c_1T_f - m_1c_1T_1 = -m_2c_2T_f + m_2c_2T_2$$

$$(m_1c_1 + m_2c_2)T_f = m_1c_1T_1 + m_2c_2T_2$$

$$T_f = \frac{m_1c_1T_1 + m_2c_2T_2}{m_1c_1 + m_2c_2}$$

5. This equation shows that the final temperature depends on the masses and specific heat capacities of the bodies involved. Option (1) is incorrect because it assumes the final temperature is just the average of the initial temperatures. Option (3) and (4) are incorrect because they ignore the relationship between mass, specific heat, and energy transfer. Option (2) is correct.

Quick Tip

To find the final temperature of two bodies in thermal contact, use the equation $T_f = \frac{m_1c_1T_1+m_2c_2T_2}{m_1c_1+m_2c_2}$, which accounts for the masses and specific heats.

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3. Find the focal length of a lens in a compound lens system.

(1) $\frac{1}{f_{total}} = \frac{1}{f_1} + \frac{1}{f_2}$

(2) $\frac{1}{f_{total}} = \frac{1}{f_1} - \frac{1}{f_2}$

(3) $f_{total} = f_1 + f_2$

(4) $f_{total} = f_1 - f_2$

Correct Answer: (1) $\frac{1}{f_{total}} = \frac{1}{f_1} + \frac{1}{f_2}$

Solution:

This question requires us to apply the formula for the total focal length of a compound lens system (i.e., two lenses placed in contact).

1. The formula for compound lenses: - When two thin lenses are placed in contact, the total focal length f_{total} is given by the reciprocal of the sum of the reciprocals of the individual focal lengths f_1 and f_2:

$$\frac{1}{f_{total}} = \frac{1}{f_1} + \frac{1}{f_2}$$

- This relationship is derived from the fact that each lens produces its own image, and the total effect on the image is the combination of the individual lens effects.

2. Explanation: - If f_1 and f_2 are the focal lengths of the two lenses, the total focal length is determined by the above equation. This is based on the optical principle that the net effect of two lenses in contact is the sum of the individual effects.

3. Incorrect Options: - Option (2) $\frac{1}{f_{total}} = \frac{1}{f_1} - \frac{1}{f_2}$ is incorrect because it does not follow the correct reciprocal formula. - Option (3) $f_{total} = f_1 + f_2$ is incorrect because focal lengths do not simply add. - Option (4) $f_{total} = f_1 - f_2$ is also incorrect because the subtraction does not apply in this case.

4. Conclusion: - The correct formula for lenses in contact is $\frac{1}{f_{total}} = \frac{1}{f_1} + \frac{1}{f_2}$, making Option (1) correct.

Quick Tip

When two lenses are in contact, use the reciprocal rule: $\frac{1}{f_{total}} = \frac{1}{f_1} + \frac{1}{f_2}$. This is essential for calculating the total focal length.

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4. Calculate the de Broglie wavelength of an electron moving with a given velocity.

(1) $\lambda = \frac{h}{mv}$

(2) $\lambda = \frac{h}{2mv}$

(3) $\lambda = \frac{mv}{h}$

(4) $\lambda = \frac{2mv}{h}$

Correct Answer: (1) $\lambda = \frac{h}{mv}$

Solution:

This question involves de Broglie's hypothesis, which describes the wave-particle duality of matter.

1. de Broglie Wavelength Formula: - According to de Broglie, any moving particle, including electrons, has an associated wave. The de Broglie wavelength λ is given by the formula:

$$\lambda = \frac{h}{mv}$$

Where: - h is Planck's constant, - m is the mass of the particle (electron in this case), - v is the velocity of the particle.

2. Understanding the Formula: - This equation tells us that the wavelength associated with a particle is inversely proportional to its momentum (mass $\times$ velocity). - The higher the velocity, the shorter the wavelength.

3. Analysis of Options: - Option (1) is the correct de Broglie wavelength formula. - Option (2) $\lambda = \frac{h}{2mv}$ is incorrect because it introduces an unnecessary factor of 2. - Option (3) $\lambda = \frac{mv}{h}$ is incorrect because it reverses the relationship. - Option (4) $\lambda = \frac{2mv}{h}$ is incorrect for the same reason as Option (3).

Quick Tip

To find the wavelength of any particle, use de Broglie's formula $\lambda = \frac{h}{mv}$. The higher the velocity, the shorter the wavelength!

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5. What is the major product of the reaction of an alkene with bromine water?

(1) Alkane

(2) Dibromoalkane

(3) Alcohol

(4) Bromoalkene

Correct Answer: (2) Dibromoalkane

Solution:

The reaction of an alkene with bromine water is a classic example of an electrophilic addition reaction. Here's how the reaction proceeds:

1. Alkene Structure: - Alkenes contain a carbon-carbon double bond, which is rich in electrons and acts as a nucleophile. The pi-electrons of the double bond are highly reactive and can undergo a reaction with electrophiles.

2. Reaction with Bromine: - Bromine (Br_2) is an electrophile. When it reacts with an alkene, the double bond breaks and forms a three-membered bromonium ion intermediate. This intermediate is unstable and quickly reacts with a bromide ion (Br^-) from the bromine water.

- The bromide ion attacks the more stable carbon of the bromonium ion, leading to the formation of a dibromoalkane where two bromine atoms add to the carbon atoms that were previously involved in the double bond.

3. Major Product: - The major product of this reaction is a dibromoalkane, where the two bromine atoms add across the double bond.

4. Incorrect Options: - Option (1) ”Alkane” is incorrect because the reaction does not involve hydrogenation (which would convert the alkene to an alkane). - Option (3) ”Alcohol” is incorrect because alcohol formation requires a different reaction mechanism (such as hydration). - Option (4) ”Bromoalkene” is incorrect because the reaction results in the addition of two bromine atoms, not just one.

Quick Tip

In electrophilic addition reactions, alkenes undergo the addition of two atoms across the double bond. For alkenes with bromine, the result is a dibromoalkane.

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6. Identify the geometry and hybridization of the central atom in SF.

(1) Trigonal bipyramidal, sp^2 hybridization

(2) Tetrahedral, sp^3 hybridization

(3) Seesaw, sp^3d hybridization

(4) Square planar, sp^3d^2 hybridization

Correct Answer: (3) Seesaw, sp^3d hybridization

Solution:

In SF (sulfur tetrafluoride), sulfur is the central atom. To determine the geometry and hybridization of the central atom, we need to consider the Lewis structure and the electron-pair repulsion model (VSEPR theory).

1. Lewis Structure of SF: - Sulfur has 6 valence electrons, and each fluorine has 7 valence electrons. The total number of valence electrons in SF is:

$$6\,(\text{from S}) + 4 \times 7\,(\text{from F}) = 34\,\text{electrons}$$

- In the Lewis structure, sulfur forms four single bonds with fluorine atoms. Two lone pairs

of electrons remain on sulfur, giving a total of 6 electron pairs around the sulfur atom.

2. Electron Geometry: - According to VSEPR theory, with 6 electron pairs (4 bonding and 2 lone pairs), the electron geometry is octahedral. However, lone pairs occupy equatorial positions to minimize repulsion, so the resulting molecular geometry is seesaw.

3. Hybridization: - The central sulfur atom needs to form 4 sigma bonds with fluorine and accommodate 2 lone pairs. This requires the use of sp^3d hybrid orbitals, which are derived from the mixing of one s orbital, three p orbitals, and one d orbital.

4. Conclusion: - The molecular geometry of SF is seesaw, and the hybridization of the sulfur atom is sp^3d.

Quick Tip

In molecules with lone pairs, remember that the lone pairs affect the geometry. In SF, the electron geometry is octahedral, but the molecular geometry is seesaw due to the lone pairs.

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7. What is the oxidation state of chromium in KCrO?

(1) +6

(2) +3

(3) +2

(4) 0

Correct Answer: (1) +6

Solution:

The compound given is KCrO (potassium dichromate). To determine the oxidation state of chromium (Cr), we need to follow the steps below:

1. Assign Oxidation States: - Potassium (K) has a charge of $+1$ because it is an alkali metal. - Oxygen (O) generally has an oxidation state of -2 in most compounds, including this one.

2. Set up the equation: - Let the oxidation state of chromium be x. - In KCrO, we have 2 potassium ions ($+2$), 2 chromium ions ($2x$), and 7 oxygen atoms ($7 \times -2 = -14$). - The total

charge on the compound is zero, so the sum of all oxidation states must equal zero:

$$2 \times (+1) + 2x + 7 \times (-2) = 0$$

$$2 + 2x - 14 = 0$$

$$2x = 12$$

$$x = +6$$

3. Conclusion: - The oxidation state of chromium in $K_2Cr_2O_7$ is $+6$.

Quick Tip

In ionic compounds, the sum of the oxidation states of all elements equals the net charge of the molecule. Use this principle to find unknown oxidation states.

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8. What is the molecular geometry of the water molecule (HO)?

(1) Linear

(2) Trigonal planar

(3) Bent

(4) Tetrahedral

Correct Answer: (3) Bent

Solution:

Water (HO) is a simple molecule, but its geometry can be determined using VSEPR theory (Valence Shell Electron Pair Repulsion theory). Here's how we analyze it:

1. Lewis Structure: - Oxygen has 6 valence electrons, and each hydrogen has 1 valence electron. In HO, oxygen forms two single bonds with hydrogen atoms, and it has two lone pairs of electrons remaining.

2. Electron Geometry: - The oxygen atom has 4 electron pairs around it: 2 bonding pairs (with H) and 2 lone pairs. According to VSEPR theory, these 4 electron pairs are arranged in a tetrahedral geometry to minimize repulsion.

3. Molecular Geometry: - However, the lone pairs are not visible in the molecule's structure. The lone pairs cause the bonding pairs to repel each other, resulting in a bent molecular

shape. - The bond angle between the hydrogen-oxygen-hydrogen atoms is approximately 104.5°, which is less than the ideal tetrahedral angle (109.5°) due to the lone pair repulsion.

4. Conclusion: - The molecular geometry of water is bent.

Quick Tip

When determining molecular geometry, remember that lone pairs affect the shape. Water has a bent shape due to the presence of lone pairs on oxygen.

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9. Calculate the rate constant of a reaction with a given half-life.

(1) $k = \frac{0.693}{t_{1/2}}$

(2) $k = \frac{1}{t_{1/2}}$

(3) $k = \frac{2.303}{t_{1/2}}$

(4) $k = \frac{0.5}{t_{1/2}}$

Correct Answer: (1) $k = \frac{0.693}{t_{1/2}}$

Solution:

The relationship between the rate constant k and the half-life $t_{1/2}$ depends on the order of the reaction. For a first-order reaction, the formula for the half-life is:

1. First-Order Reaction Half-Life: - For a first-order reaction, the half-life is given by the equation:

$$t_{1/2} = \frac{0.693}{k}$$

- Rearranging the equation to solve for the rate constant k, we get:

$$k = \frac{0.693}{t_{1/2}}$$

2. Conclusion: - Therefore, the correct formula for the rate constant in terms of the half-life is $k = \frac{0.693}{t_{1/2}}$.

Quick Tip

For first-order reactions, remember that the half-life depends only on the rate constant and is given by $t_{1/2} = \frac{0.693}{k}$.

10. What is a primary key in a relational database?

(1) A unique identifier for each record in a table

(2) A key used for sorting records

(3) A key linking two tables

(4) A key for encrypting data

Correct Answer: (1) A unique identifier for each record in a table

Solution:

A primary key is a fundamental concept in relational database design. Let's break down the details:

1. Definition of Primary Key: - A primary key is a field (or a combination of fields) in a database table that uniquely identifies each record in that table. It ensures that no two records can have the same value in the primary key field(s), thus guaranteeing uniqueness.

2. Importance: - The primary key is used to ensure that each row in a table is distinct and can be uniquely referenced by other tables through foreign keys. This is essential for maintaining data integrity and supporting efficient queries.

3. Incorrect Options: - Option (2) refers to sorting, but the primary key is not used for sorting records. - Option (3) refers to a foreign key, which is used for linking tables, not for identifying records uniquely in a single table. - Option (4) refers to encryption, which is unrelated to primary keys.

4. Conclusion: - The correct definition of a primary key is a unique identifier for each record in a table, making option (1) correct.

Quick Tip

When designing a database, choose primary keys that are simple, unique, and stable (like IDs), as they ensure data integrity.