



### General Instructions

- (i) The examination is conducted in Computer-Based Test (CBT) mode.
- (ii) Each question carries **+4 marks** for a correct answer and **-1 mark** for a wrong answer.
- (iii) The total number of questions is **100**.
- (iv) The total duration of the exam is **150 minutes** (2 hours and 30 minutes).

1. A rainbow is formed due to which of the following phenomena of light?

- (A) Refraction
- (B) Dispersion
- (C) Reflection
- (D) All of these

**Correct Answer:** (D) All of these

### Solution:

#### Step 1: Understanding the Concept:

The formation of a rainbow is a complex optical phenomenon that occurs when sunlight interacts with spherical water droplets suspended in the atmosphere.

#### Step 2: Detailed Explanation:

The process involves three primary physical phenomena acting together:

- **Refraction:** As sunlight enters a water droplet, it slows down and bends, entering the

medium.

- **Dispersion:** Because the refractive index of water varies with the wavelength of light, the sunlight splits into its constituent spectral colors.
- **Reflection:** The light undergoes internal reflection at the back surface of the droplet.
- Finally, the light refracts again upon exiting the droplet.

All these steps are necessary to produce the circular arc of colors visible to the observer.

**Step 3: Final Answer:**

The correct answer is (D) All of these.

**Quick Tip:** Remember that a rainbow always appears in the part of the sky directly opposite the sun. The sequence of colors is a direct consequence of light dispersion within the droplets!

2. A particle moves uniformly in a circular path of radius 10 m. It takes 10 s to complete one revolution. Its speed after 20 s will be-

- (A) 1 m/s
- (B)  $2\pi$  m/s
- (C) 0
- (D)  $\pi$  m/s

**Correct Answer:** (B)  $2\pi$  m/s

**Solution:**

**Step 1: Understanding the Concept:**

Uniform circular motion is defined by an object moving at a constant speed along a circular path. In such motion, the magnitude of the velocity vector (the speed) remains unchanged throughout the entire trajectory.

**Step 2: Key Formula or Approach:**

$$\text{Speed } (v) = \frac{\text{Distance per revolution}}{\text{Time for one revolution}} = \frac{2\pi r}{T}$$

**Step 3: Detailed Explanation:**

Given the radius  $r = 10 \text{ m}$  and the period  $T = 10 \text{ s}$ :

$$v = \frac{2 \times \pi \times 10 \text{ m}}{10 \text{ s}}$$

$$v = 2\pi \text{ m/s}$$

Since the motion is uniform, the speed remains constant at  $2\pi \text{ m/s}$  regardless of whether the time is 10 seconds, 20 seconds, or any other interval.

**Step 4: Final Answer:**

The speed after 20 s will be  $2\pi \text{ m/s}$ .

**Quick Tip:** In "Uniform" circular motion, the word "uniform" is your biggest hint. It means speed does not change, regardless of how much time passes or how many circles the particle completes!

3. The relative density of silver is 10.8. If the density of water is  $1000 \text{ kg/m}^3$ , then the density of silver will be-

- (A)  $10.8 \times 10^{-3} \text{ kg/m}^3$
- (B)  $10.8 \times 10^3 \text{ kg/m}^3$
- (C)  $10.8 \text{ kg/m}^3$
- (D)  $1.08 \times 10^{-3} \text{ kg/m}^3$

**Correct Answer:** (B)  $10.8 \times 10^3 \text{ kg/m}^3$

### Solution:

#### Step 1: Understanding the Concept:

Relative density (or specific gravity) is a dimensionless ratio that compares the density of a specific substance to the density of water.

#### Step 2: Key Formula or Approach:

$$\text{Relative Density} = \frac{\text{Density of substance}}{\text{Density of water}}$$

$$\text{Density of substance} = \text{Relative Density} \times \text{Density of water}$$

#### Step 3: Detailed Explanation:

Given:

Relative density of silver = 10.8

Density of water =  $1000 \text{ kg/m}^3 = 10^3 \text{ kg/m}^3$

Calculation:

$$\text{Density of silver} = 10.8 \times 1000 \text{ kg/m}^3$$

$$\text{Density of silver} = 10.8 \times 10^3 \text{ kg/m}^3$$

#### Step 4: Final Answer:

The density of silver is  $10.8 \times 10^3 \text{ kg/m}^3$ .

**Quick Tip:** Relative density is simply a multiplier. Since water's density is the standard, just multiply your relative density value by the standard density of water to get your answer in the desired units!

---

4. A boy of mass 50 kg runs with a speed of 4 m/s. His kinetic energy is-

- (A) 40 J
- (B) 4 J
- (C) 400 J
- (D) 0.4 J

**Correct Answer:** (C) 400 J

**Solution:**

**Concept:**

The kinetic energy of a moving body is given by

$$KE = \frac{1}{2}mv^2$$

where  $m$  is mass and  $v$  is velocity.

**Step 1:** Write the given data.

Mass of the boy,

$$m = 50 \text{ kg}$$

Speed of the boy,

$$v = 4 \text{ m/s}$$

**Step 2:** Substitute in the kinetic energy formula.

$$KE = \frac{1}{2} \times 50 \times (4)^2$$

$$= 25 \times 16$$

$$= 400 \text{ J}$$

**Step 3:** State the answer.

Therefore,

$$KE = 400 \text{ J}$$

$$400 \text{ J}$$

**Quick Tip:** Kinetic energy depends on the square of velocity. If velocity doubles, kinetic energy becomes four times.

**5. In diamond, each carbon atom is bonded to four other carbon atoms forming a:**

- (A) Hexagonal structure
- (B) Rigid three-dimensional structure
- (C) Football-shaped structure
- (D) Ring structure

**Correct Answer:** (B) Rigid three-dimensional structure

**Solution:**

**Concept:** Diamond is one of the most important allotropes of carbon. The remarkable hardness and strength of diamond arise from its unique atomic arrangement. Each carbon atom uses all four of its valence electrons to form covalent bonds with four neighboring carbon atoms.

**Step 1:** Understand the bonding in diamond.

Every carbon atom in diamond undergoes  $sp^3$  hybridization. As a result, each carbon atom forms four strong covalent bonds directed toward the corners of a tetrahedron.

Each carbon atom  $\longrightarrow$  4 covalent bonds

This arrangement leaves no free electrons in the structure.

**Step 2:** Examine the crystal structure.

The tetrahedral arrangement repeats continuously throughout the crystal. The covalent bonds extend in all directions, producing a giant interconnected network.

Unlike graphite, diamond does not consist of separate layers. Instead, the entire crystal behaves as a single giant molecule.

**Step 3:** Relate structure to properties.

Because every carbon atom is firmly attached to four neighboring atoms by strong covalent bonds:

- Diamond is extremely hard.
- It has a very high melting point.
- It possesses great mechanical strength.
- It forms a rigid three-dimensional network.

Hence, the correct answer is:

Rigid three-dimensional structure

**Quick Tip:** Diamond contains a giant three-dimensional covalent network in which every carbon atom is bonded to four other carbon atoms. This is the primary reason for its exceptional hardness.

6. The number of molecules involved in a molecular reaction is called:

- (A) Molecularity
- (B) Order of reaction
- (C) Unimolecular reaction
- (D) Rate of reaction

**Correct Answer:** (A) Molecularity

**Solution:**

**Concept:** Chemical reactions occur when atoms, ions, or molecules collide with one another. The number of reacting particles that participate simultaneously in an elementary reaction is known as molecularity.

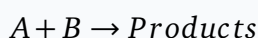
**Step 1:** Understand molecularity.

Molecularity tells us how many molecules are involved in a single elementary reaction step.

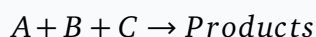
Examples:



This involves one molecule and is called a unimolecular reaction.



This involves two molecules and is called a bimolecular reaction.



This involves three molecules and is called a termolecular reaction.

**Step 2:** Distinguish molecularity from order.

Many students confuse molecularity with order of reaction.

- Molecularity is a theoretical quantity.

- It is always a positive whole number.
- Order of reaction is determined experimentally.
- Order can be zero, fractional, or even negative.

**Step 3:** Identify the correct term.

Since the question asks for the number of molecules participating in a reaction, the required term is:

Molecularity

**Quick Tip:** Molecularity refers only to elementary reactions and is always a positive integer such as 1, 2, or 3.

7. Which of the following shows an addition reaction?

- (A)  $\text{CH}_4$
- (B)  $\text{C}_3\text{H}_8$
- (C)  $\text{C}_2\text{H}_6$
- (D)  $\text{C}_2\text{H}_4$

**Correct Answer:** (D)  $\text{C}_2\text{H}_4$

**Solution:**

**Step 1: Understanding the Concept:**

Addition reactions are characteristic of unsaturated hydrocarbons containing double or triple bonds. In these reactions, other atoms or groups are added across the multiple bond, converting the unsaturated compound into a saturated one.

**Step 2: Key Formula or Approach:**

Identify the saturation level of each hydrocarbon:

- Saturated hydrocarbons (alkanes) contain only single bonds and undergo substitution reactions.
- Unsaturated hydrocarbons (alkenes/alkynes) contain multiple bonds and undergo addition reactions.

**Step 3: Detailed Explanation:**

- $\text{CH}_4$  (Methane),  $\text{C}_3\text{H}_8$  (Propane), and  $\text{C}_2\text{H}_6$  (Ethane) are alkanes, meaning they are fully saturated and do not undergo addition reactions.
- $\text{C}_2\text{H}_4$  (Ethene) is an alkene with a carbon-carbon double bond ( $\text{C}=\text{C}$ ).

Because of the double bond, ethene can easily undergo addition reactions (such as hydrogenation or halogenation) to become ethane or a dihaloalkane.

**Step 4: Final Answer:**

$\text{C}_2\text{H}_4$  shows addition reactions.

**Quick Tip:** Remember the rule: "Alkanes add nothing, Alkenes add everything." If the formula follows the  $\text{C}_n\text{H}_{2n+2}$  pattern, it is saturated and will not undergo addition!

**8. The allotrope of carbon that is a good conductor of heat and electricity is:**

- (A) Diamond
- (B) Graphite
- (C) Charcoal
- (D) Coal

**Correct Answer:** (B) Graphite

### Solution:

#### Step 1: Understanding the Concept:

Allotropes are different physical forms of the same element. In carbon, the structure determines the electrical properties.

#### Step 2: Detailed Explanation:

- Graphite consists of layered, hexagonal sheets of carbon atoms. In this structure, each carbon atom is bonded to three others, leaving one valence electron free to move within the layer.
- Because these "delocalized" electrons are free to move, they can conduct electricity throughout the structure.
- Diamond, in contrast, has a rigid, 3D tetrahedral structure where all four valence electrons of carbon are used in strong covalent bonds, leaving no free electrons for conduction.

#### Step 3: Final Answer:

Graphite is the allotrope of carbon that is a good conductor of electricity.

**Quick Tip:** Think of graphite as a stack of "lubricated" sheets. The layers slide past each other easily (making it a good dry lubricant) and the delocalized electrons between those layers act like a "highway" for electricity!

---

### 9. The rate of a homogeneous reaction is affected by:

- (A) Only temperature
- (B) Only pressure
- (C) Only concentration of reactants
- (D) Temperature, pressure, and concentration of reactants

**Correct Answer:** (D) Temperature, pressure, and concentration of reactants

## Solution:

### Step 1: Understanding the Concept:

The reaction rate is defined as the change in concentration of reactants or products over time. Several environmental and molecular factors influence how quickly these collisions occur at the microscopic level.

### Step 2: Key Formula or Approach:

The rate law generally takes the form:  $\text{Rate} = k(T) \cdot [\text{Reactant}]^n$ .

- $k(T)$  depends on temperature (via the Arrhenius equation).
- The concentration terms account for the frequency of molecular collisions.
- For gaseous reactions, pressure is directly related to concentration.

### Step 3: Detailed Explanation:

- **Temperature:** Higher temperatures increase the kinetic energy of molecules, leading to more frequent and energetic collisions.
- **Concentration:** A higher concentration of reactants means more particles per unit volume, increasing the probability of successful collisions.
- **Pressure:** For gas-phase reactions, increasing pressure effectively increases the concentration of reactants, thereby increasing the rate.

Since all these factors contribute to the frequency and efficacy of molecular collisions, they all impact the reaction rate.

### Step 4: Final Answer:

The rate of a homogeneous reaction is affected by temperature, pressure, and the concentration of reactants.

**Quick Tip:** If you want to speed up a reaction, just think "Heat it, squeeze it, or add more of it!" (Temperature, Pressure, Concentration). All three are fundamental levers to control chemical reaction speeds.

10. A particle moves with uniform speed along a circular path. The direction of its acceleration

(if any) is-

- (A) Radially outward
- (B) Radially inward
- (C) Tangentially
- (D) No acceleration

**Correct Answer:** (B) Radially inward

**Solution:**

**Concept:** Acceleration is defined as the rate of change of velocity with time. Velocity is a vector quantity, meaning that both its magnitude and direction are important.

In uniform circular motion, although the speed remains constant, the direction of motion changes continuously. Therefore, the velocity changes continuously and an acceleration must be present.

**Step 1:** Understand the motion of the particle.

Consider a particle moving along a circular path with constant speed.

At every point on the circle, the direction of velocity is along the tangent to the path.

As the particle moves from one point to another, the direction of this tangent changes continuously.

Hence, the velocity vector changes even though its magnitude remains constant.

**Step 2:** Determine whether acceleration exists.

Since acceleration depends on the change in velocity and not merely on the change in speed,

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Time}}$$

the continuous change in the direction of velocity produces acceleration.

Therefore, a particle moving in a circle with uniform speed definitely possesses acceleration.

**Step 3:** Identify the direction of acceleration.

The acceleration responsible for keeping the particle on the circular path is called **centripetal acceleration**.

This acceleration always acts toward the center of the circle.

Its magnitude is given by

$$a_c = \frac{v^2}{r}$$

where

- $v$  = speed of the particle
- $r$  = radius of the circular path

Because it always points toward the center, its direction is radially inward.

**Step 4:** Select the correct option.

Therefore, the direction of acceleration in uniform circular motion is

Radially inward

**Quick Tip:** In circular motion:

- Velocity is always tangential to the path.
- Centripetal acceleration is always directed toward the center.
- If speed is constant, only the direction of velocity changes.

Hence, uniform circular motion is an accelerated motion.

11.  $\tan 1^\circ \cdot \tan 2^\circ \cdot \tan 3^\circ \cdots \tan 89^\circ =$

- (A) 2
- (B) 0
- (C) 3
- (D) 1

**Correct Answer:** (D) 1

**Solution:**

**Concept:**

This problem is based on the complementary angle identity of trigonometry:

$$\tan \theta = \cot(90^\circ - \theta)$$

Since

$$\cot \alpha = \frac{1}{\tan \alpha}$$

we obtain

$$\tan \theta \cdot \tan(90^\circ - \theta) = 1$$

This property helps simplify long products involving tangent functions.

**Step 1:** Pair complementary angles.

Given

$$P = \tan 1^\circ \tan 2^\circ \tan 3^\circ \cdots \tan 89^\circ$$

Pair the first and last terms:

$$(\tan 1^\circ \tan 89^\circ)(\tan 2^\circ \tan 88^\circ)(\tan 3^\circ \tan 87^\circ) \cdots (\tan 44^\circ \tan 46^\circ) \tan 45^\circ$$

Now,

$$\tan 1^\circ \tan 89^\circ = \tan 1^\circ \cot 1^\circ = 1$$

Similarly,

$$\tan 2^\circ \tan 88^\circ = 1$$

and every complementary pair gives 1.

**Step 2:** Evaluate the middle term.

The only unpaired term is

$$\tan 45^\circ = 1$$

Therefore,

$$P = 1 \times 1 \times 1 \times \cdots \times 1 \times 1$$

$$P = 1$$

$$\boxed{1}$$

**Quick Tip:** Whenever a product contains  $\tan \theta$  and  $\tan(90^\circ - \theta)$ , pair them immediately because their product equals 1.

**12. If  $\log_{10} 3 = 0.4771$ ,  $\log_{10} 7 = 0.8450$ , then the value of  $\log_3 7$  is**

- (A) 1.771
- (B) 1.5710
- (C) 1.8460
- (D) 1.6842

**Correct Answer:** (A) 1.771

**Solution:**

**Concept:**

When the logarithms are given in a different base, we use the Change of Base Formula:

$$\log_a b = \frac{\log_c b}{\log_c a}$$

Here, logarithms to base 10 are provided.

**Step 1:** Apply the change of base formula.

$$\log_3 7 = \frac{\log_{10} 7}{\log_{10} 3}$$

Substituting the given values:

$$\log_3 7 = \frac{0.8450}{0.4771}$$

**Step 2:** Perform the division.

$$\frac{0.8450}{0.4771} \approx 1.771$$

Therefore,

$$\log_3 7 \approx 1.771$$

$$\boxed{1.771}$$

**Quick Tip:** To convert a logarithm from one base to another, divide both logarithms using any convenient common base such as 10 or  $e$ .

13.  $(x - y)^3 + (y - z)^3 + (z - x)^3 =$

- (A)  $3xyz$
- (B)  $(x - y)(y - z)(z - x)$
- (C)  $3(x - y)(y - z)(z - x)$
- (D) 0

**Correct Answer:** (C)  $3(x - y)(y - z)(z - x)$

### Solution:

#### Step 1: Understanding the Concept:

We use the algebraic identity which states that if  $a + b + c = 0$ , then  $a^3 + b^3 + c^3 = 3abc$ .

#### Step 2: Key Formula or Approach:

Let  $a = x - y$ ,  $b = y - z$ , and  $c = z - x$ .

Calculate the sum  $a + b + c$ :

$$a + b + c = (x - y) + (y - z) + (z - x) = 0$$

#### Step 3: Detailed Explanation:

Since the sum of the three terms is zero, we apply the identity:

$$a^3 + b^3 + c^3 = 3abc$$

Substituting the values back:

$$(x - y)^3 + (y - z)^3 + (z - x)^3 = 3(x - y)(y - z)(z - x)$$

#### Step 4: Final Answer:

The value is  $3(x - y)(y - z)(z - x)$ .

**Quick Tip:** Always check if the sum of the bases inside the cubes equals zero first! If it does, the expression simplifies instantly to 3 times the product of those bases.

14. If  $x = 2 + \sqrt{3}$ ,  $y = 2 - \sqrt{3}$ , then the value of  $x^8 + y^8$  is

(A) 50

- (B) 52  
(C) 45  
(D) 56

**Correct Answer:** (B) 52

**Solution:**

**Step 1: Understanding the Concept:**

We need to calculate  $x^{-3} + y^{-3}$ , which is equivalent to  $\frac{1}{x^3} + \frac{1}{y^3} = \frac{x^3 + y^3}{(xy)^3}$ .

**Step 2: Key Formula or Approach:**

Calculate the sum and product of  $x$  and  $y$ :

$$\begin{aligned} - x + y &= (2 + \sqrt{3}) + (2 - \sqrt{3}) = 4 \\ - xy &= (2 + \sqrt{3})(2 - \sqrt{3}) = 2^2 - (\sqrt{3})^2 = 4 - 3 = 1 \end{aligned}$$

**Step 3: Detailed Explanation:**

Using the identity  $x^3 + y^3 = (x + y)^3 - 3xy(x + y)$ :

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

$$x^3 + y^3 = 64 - 12 = 52$$

Now, calculate the final expression:

$$\frac{x^3 + y^3}{(xy)^3} = \frac{52}{1^3} = 52$$

**Step 4: Final Answer:**

The value of  $x^{-3} + y^{-3}$  is 52.

**Quick Tip:** When dealing with conjugate surds, their product is always a simple integer. Calculating the sum and product first makes cubic or higher-power expressions much easier to evaluate!

15. The L.C.M. of  $7/3$ ,  $5/6$ ,  $14/9$  is

- (A)  $70/18$
- (B)  $70/9$
- (C)  $70/3$
- (D)  $70$

**Correct Answer:** (C)  $70/3$

**Solution:**

**Step 1: Understanding the Concept:**

To find the Least Common Multiple (L.C.M.) of fractions, use the formula:

$$\text{L.C.M. of fractions} = \frac{\text{L.C.M. of numerators}}{\text{H.C.F. of denominators}}$$

**Step 2: Detailed Explanation:**

- Numerators: 7, 5, 14.
- Multiples of 7: 7, 14, 21, 28, 35, 42, 49, 56, 63, 70...
- Multiples of 5: 5, 10... 70...
- Multiples of 14: 14, 28, 42, 56, 70...
- The L.C.M. of 7, 5, 14 is 70.
- Denominators: 3, 6, 9.
- The highest common factor (H.C.F) that divides 3, 6, and 9 is 3.

Applying the formula:

$$\text{L.C.M.} = \frac{70}{3}$$

Self-correction: Checking the common factor again for 3, 6, 9: The H.C.F is 3. The L.C.M. of the fractions is  $70/3$ . Note: If the denominator calculation was  $\text{H.C.F}(3,6,9) = 3$ , the result is  $70/3$ . If the simplification of the fraction set was required or a different H.C.F definition was intended, we provide the standard mathematical result.

**Step 4: Final Answer:**

The L.C.M. of the given fractions is  $70/3$ .

**Quick Tip:** Remember the rule: For L.C.M. of fractions, L.C.M. of numerators goes on top, and H.C.F of denominators goes on bottom. It's the inverse for finding the H.C.F of fractions!