CREST Olympiads

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CREST Science Olympiad (CSO) Worksheet for Class 9

Topic

Atoms and Molecules

@crestolympiads info@crestolympiads.com +91-98182-94134

Worksheet on Atoms and Molecules

1. **When 5 g of calcium carbonate ($CaCO_3$) is heated, it decomposes to form calcium oxide (CaO) and carbon dioxide (CO_2). If the residue left after heating weighs 3.4 g, what is the mass of carbon dioxide released?**

   a. 1.8 g
   b. 2.4 g
   c. 1.6 g
   d. 3.2 g

2. **The molar mass of element X is 64 g/mol and the molar mass of element Y is 32 g/mol. If the molar mass of the compound they form is 128 g/mol, what is the molecular formula of the compound?**

   a. XY
   b. X_2Y
   c. XY_2
   d. X_3Y_2

3. **In a chemical reaction, if 4 moles of hydrogen react with 8 moles of oxygen, how many moles of water will be produced?**

   a. 2 moles
   b. 4 moles
   c. 6 moles
   d. 8 moles

4. **The molar mass of nitrogen gas (N_2) is 28 g/mol. How many grams of nitrogen gas are there in 2 moles of N_2?**

   a. 56 g
   b. 14 g
   c. 28 g
   d. 112 g

5. **In the following question, you will find an assertion and a reason. Select the appropriate option that applies.**

   Assertion: The Avogadro number ($6.022 \times 10^{23)}$ is used to convert between the number of molecules and the number of moles of a substance.
   Reason: Avogadro's number represents the number of particles (atoms, molecules, ions) in one mole of a substance, allowing for easy conversions between these quantities.

   a. Both the assertion and reason are correct, and the reason explains the assertion.
   b. Both the assertion and reason are correct, but the reason does not explain the assertion.
   c. The assertion is correct, but the reason is incorrect.
   d. The assertion is incorrect, but the reason is correct.

Answer Key

1. c - To solve this question, we can use the concept of conservation of mass. The total mass of the reactants should be equal to the total mass of the products. In this case, the reactant is calcium carbonate ($CaCO_3$), and the products are calcium oxide (CaO) and carbon dioxide (CO_2).

Given information:
Initial mass of calcium carbonate ($CaCO_3$) = 5 g
Mass of the residue left after heating = 3.4 g

Let's denote the mass of carbon dioxide released as "m."

According to the conservation of mass, the mass of the reactant ($CaCO_3$) = mass of the products (CaO + CO_2):
5 g = (mass of CaO) + m (mass of CO_2)

We are given that the mass of the residue (CaO) is 3.4 g. Therefore, the mass of carbon dioxide released (m) can be calculated as:
m = 5 g - 3.4 g
m = 1.6 g

2. c - Molar mass of element X = 64 g/mol
Molar mass of element Y = 32 g/mol
The molar mass of the compound = 128 g/mol

To find the molecular formula, we need to compare the molar masses of the elements and the compound to see how many atoms of each element are present in the compound.

Let's analyse the options:

a. XY: The molar mass would be 64 g/mol + 32 g/mol = 96 g/mol
b. X_2Y: The molar mass would be (2 × 64 g/mol) + 32 g/mol = 160 g/mol
c. XY_2: The molar mass would be 64 g/mol + (2 × 32 g/mol) = 128 g/mol (matches the compound's molar mass)
d. X_3Y_2: The molar mass would be (3 × 64 g/mol) + (2 × 32 g/mol) = 256 g/mol

Among the options, option c) XY_2 is the molecular formula that matches the given compound's molar mass (128 g/mol).
Therefore, the correct molecular formula of the compound is XY_2.

3. b - Given the balanced chemical equation:
$2H_2 + O_2 \rightarrow 2H_2O$

We see that for every 2 moles of hydrogen (H_2), we need 1 mole of oxygen (O_2) to form 2 moles of water (H_2O). This means that the balanced equation requires an equal number of moles of hydrogen and oxygen to react fully.

If we have 4 moles of hydrogen (H_2) and 4 moles of oxygen (O_2), we can see that we have twice the required amount of oxygen. This makes oxygen the excess reagent in the reaction, as not all of it will be used up.

In this case, the balanced reaction will only be able to utilise the 2 moles of oxygen with 4 moles of hydrogen to produce 4 moles of H_2O.

4. a - Molar mass of nitrogen gas (N_2) = 28 g/mol
Number of moles of N_2 = 2 moles

To find the mass of nitrogen gas (N_2) in 2 moles, we can use the formula:
Number of Moles = Mass / Molar Mass
Mass = Molar mass × Number of moles

Plugging in the values:
Mass = 28 g/mol × 2 moles
Mass = 56 g

5. a - Both the assertion and reason provided in the question are correct. The assertion states that the Avogadro number is used to convert between the number of molecules and the number of moles of a substance, which is true. The reason provided further explains that Avogadro's number represents the number of particles (atoms, molecules, ions) in one mole of a substance. This accurate representation of Avogadro's number enables easy conversions between these quantities. Since both the assertion and reason are correct, and the reason logically explains the assertion, option "a" is the correct choice.

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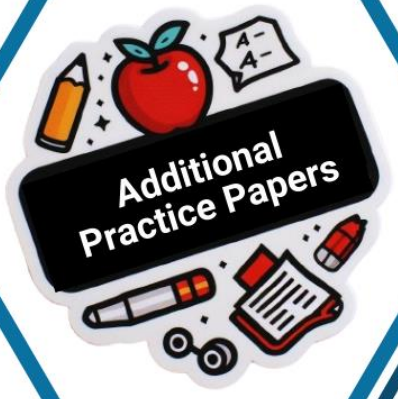

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