Atoms and Molecules Chemistry Questions with Solutions

Q1. Which of the following has the maximum number of atoms?

a) 18 g H_2O
b) 18 g of O
c) 18 g of CO_2
d) 18 g of CH_4

Correct Answer. (d) 18 g of CH_4.

Q2. Which of the following statements is not true about an atom?

a) Atoms are not able to exist independently.
b) Atoms are the basic units from which molecules and ions are formed.
c) Atoms are always neutral in nature.
d) Atoms aggregate in large numbers to form the matter that we can see, feel or touch.

Correct Answer. (a) Atoms are not able to exist independently.
Explanation. Noble gas atoms have the ability to exist independently. They have a completely filled outermost shell, allowing them to exist indefinitely.

Q3. All noble gas molecules are-

a) Monoatomic
b) Diatomic
c) Triatomic
d) Both (a) and (b)

Correct Answer. (a) Monoatomic

Q4. Which number is represented by 1 mole?

Answer. 6.022×10^{23}. It is denoted by N_A and is known as Avogadro's number.

Q5. State True or False.
There are no forces of attraction between the molecules of inert gases.

Answer. False.
Although the molecules of inert gases are stable and there are no electrostatic forces of attraction between them, they do have weak van der Waals forces and weak London dispersion forces.

Q6. The relative atomic mass of oxygen atom is 16. Explain its meaning.

Answer. An atom's relative atomic mass is its average mass as compared to one-twelfth the mass of one carbon-12 atom.

Q7. Which part of Dalton's atomic theory came from the law of constant proportions given by Proust?

Answer. The elements are made up of atoms with fixed masses, and the number and type of atoms in each element in a given compound are fixed.

Q8. Answer the following-
a) Name the element used as a standard for atomic mass scale.
b) Which particular atom of the above element is used for this purpose?
c) What value has been given to the mass of this reference atom?

Answer.
a) Carbon is used as a standard for atomic mass scale.
b) Atom with 6 neutrons and 6 protons in its nucleus so that its mass number is 12.
c) Mass = 12 u

Q9. An element form an oxide Al_2O_5.
(i) What is the valency of element A?
(ii) What will be the formula of the chloride of the element?

Answer. The formula of the oxide of the element = A_2O_5
(i) The valency of the element A in the oxide = 5.
The formula of its chloride will be $AlCl_5$.

Q10. Why do atoms form ions?

Answer. Atoms achieve stability by acquiring the stable electronic configuration of the nearest noble gas, for which they either lose or gain electrons, resulting in noble gas configuration. As a result, they produce ions.

Q11. Define the term gram atom. How is it related to mole and Avogadro number?

Answer. Gram atomic mass refers to an element's atomic mass expressed in grams. One gram of any element contains 6.022×10^{23} of the element's atoms. It is the same as one mole of atoms. One gram of atomic mass equals 6.022×10^{23} atoms = one mole.

Q12. a) State the various postulates of Dalton's atomic theory of matter.
b) Which postulate of Dalton's atomic theory can explain the law of conservation of mass?

c) Which postulate of Dalton's atomic theory can explain the law of constant proportions?

Answer.
a) Dalton's atomic theory postulates:

- All the matter is made up of very small particles called 'atoms'.
- Atoms cannot be divided.
- Atoms can neither be created nor be destroyed.
- Atoms are of various kinds. There are as many kinds of atoms as are elements.
- All the atoms of a given element are identical in every respect, having the same mass, size and chemical properties.
- Atoms of different elements differ in mass, size and chemical properties.
- The 'number' and 'kind' of atoms in a given compound is fixed.
- During chemical combination, atoms of different elements combine in small whole numbers to form compounds.
- Atoms of the same elements can combine in more than one ratio to form more than one compound.

b) The postulate "The elements are made up of atoms, and atoms cannot be created or destroyed" can be used to explain the law of conservation of mass.
c) The postulate "The elements consist of atoms of fixed mass, and the number and type of atoms of each element in a given compound are fixed" can be used to explain the law of constant proportions.

Q13. What weight of calcium contains the same number of atoms as are present in 3.2 g of sulphur?

Answer. Number of atoms in 3.2 g of sulphur
Gram atomic mass of S = 32 g
32 g of sulphur contains = 6.022×10^{23}
3.2 g of sulphur contains = $(6.022 \times 10^{23} / 32\ g) \times 3.2\ g = 6.022 \times 10^{22}$ atoms
Weight of 6.022×10^{22} atoms of calcium
Gram atomic mass of Ca = 40g
6.022×10^{23} atoms of Ca weigh = 40g
6.022×10^{22} atoms of Ca weigh = $(40\ g / 6.022 \times 10^{23}) 6.022 \times 10^{22} = 4g$

Q14. What is the law of constant proportions?

Answer. The law of constant proportions states that chemical compounds are made up of elements that are present in a fixed ratio by mass. This implies that any pure sample of a compound, no matter the source, will always consist of the same elements that are present in the same ratio by mass. For example, pure water will always contain hydrogen and oxygen in a fixed mass ratio (a gram of water consists of approximately 0.11 grams of hydrogen and 0.88 grams of oxygen, the ratio is 1:8).

Q15. What is the mass of:
(a) 1 mole of nitrogen atoms?

(b) 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?
(c) 10 moles of sodium sulphite (Na_2SO_3)?

Answer.
(a) 1 mole of nitrogen atoms
= 1 x gram atomic mass of nitrogen atom
= 1 x 14 g = 14 g
(b) 4 moles of aluminium atoms
= 4 x gram atomic mass of aluminium atoms
= 4 x 27 g = 108 g
(c) 10 moles of sodium sulphite (Na_2SO_3)
= 10 (2 x gram atomic mass of Na + 1 x gram atomic mass of sulphur + 3 x- gram atomic mass of oxygen)
= 10(2x23g+1 x 32g + 3 x16g)
= 10 (46 g + 32 g + 48 g)
= 10 x 126 g = 1260 g

Practise Questions on Atoms and Molecules

Q1. A mole is quite often known as a chemist's dozen. Why is it so named?

Answer. A dozen represents a fixed number of articles i.e. 12. Similarly, a mole represents a fixed number of particles i.e. Avogadro's number (N_A) or 6.022×10^{23}.

Q2. Atoms of most elements are not able to exist independently. Name two atoms that exist as independent atoms.

Answer. Noble gases, such as argon (Ar) and helium (He), exist as independent atoms.

Q3. What exactly is a molecule? Give some examples.

Answer. A molecule is the smallest particle of an element or compound that can exist independently under normal conditions. It displays all of the substance's properties. For example, the molecule of oxygen is O_2, the molecule of ozone is O_3, the molecule of phosphorus is P_4, the molecule of sulphur is S_8, and so on.

Q4. Write the chemical symbols of two elements:
(i) Which are formed from the first letter of the elements' name?
(ii) Whose names have been taken from the names of the elements in Latin?
(iii) Which are formed from the first two letters of the elements' names?

Answer.

(i) The chemical symbols of elements formed from the first letter of the elements' names are N (Nitrogen) and F (Fluorine)
(ii) The chemical symbols of elements whose names have been taken from the names of the elements in Latin are Fe (Ferrum) and Cu (Cuprum).
(iii) The chemical symbols of elements that are formed from the first two letters of the elements' names Ca (Calcium) and He (Helium).

Q5. In a reaction, 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide, 0.9 g of water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass, sodium carbonate + ethanoic acid → sodium ethanoate + carbon dioxide + water.

Answer. Mass of reactants before experiment
= Mass of sodium carbonate + Mass of ethanoic acid
= 5.3 g + 6g = 11.3 g
Mass of products after experiment
= Mass of sodium ethanoate + Mass of carbon dioxide + Mass of water
=8.2 g + 2.2 g + 0.9 g = 11.3 g
The mass of reactants is equal to the mass of products, therefore, it proves the law of conservation of mass.