SCIENCE -9 (CH-03- ATOMS & MOLECULES)

Question 1:

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

Answer 1:

In the given reaction, sodium carbonate reacts with acetic acid to produce sodium acetate, carbon dioxide, and water.

sodium carbonate + acetic acid →sodium acetate + carbon-dioxide + water

Mass of sodium carbonate = 5.3 g (Given)
Mass of acetic acid = 6 g (Given)
Mass of sodium acetate = 8.2 g (Given)
Mass of carbon dioxide = 2.2 g (Given)
Mass of water = 0.9 g (Given)
Now, total mass before the reaction = (5.3 + 6) g
= 11.3 g
And, total mass after the reaction = (8.2 + 2.2 + 0.9) g
= 11.3 g
∴Total mass before the reaction = Total mass after the reaction
Hence, the given observations are in agreement with the law of conservation of mass.

Question 2:

Hydrogen and oxygen combine in the ratio of 1:8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?

Answer 2:

It is given that the ratio of hydrogen and oxygen by mass to form water is 1:8.
Then, the mass of oxygen gas required to react completely with 1 g of hydrogen gas is 8 g.
Therefore, the mass of oxygen gas required to react completely with 3 g of hydrogen gas is 8 × 3 g = 24 g.

Question 3:

Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Answer 3:

The postulate of Dalton's atomic theory which is a result of the law of conservation of mass is: Atoms are indivisible particles, which can neither be created nor destroyed in a chemical reaction.

Question 4:

Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Answer 4:

The postulate of Dalton's atomic theory which can explain the law of definite proportion is: The relative number and kind of atoms in a given compound remains constant.

Question 1:

Define the atomic mass unit.

Answer 1:

Mass unit equal to exactly one-twelfth $\left(\frac{1}{12^{th}}\right)$ the mass of one atom of carbon-12 is called one atomic mass unit. It is written as 'u'.

Question 2:

Why is it not possible to see an atom with naked eyes?

Answer 2:

The size of an atom is so small that it is not possible to see it with naked eyes. Also, the atom of an element does not exist independently.

Question 1:

Write down the formulae of
(i) sodium oxide
(ii) aluminium chloride
(iii) sodium sulphide
(iv) magnesium hydroxide

Answer 1:

(i) Sodium oxide $\rightarrow Na_2O$
(ii) Aluminium chloride $\rightarrow AlCl_3$
(iii) Sodium sulphide $\rightarrow Na_2S$
(iv) Magnesium hydroxide $\rightarrow Mg(OH)_2$

Question 2:

Write down the names of compounds represented by the following formulae:
(i) $Al_2(SO_4)_3$
(ii) $CaCl_2$
(iii) K_2SO_4
(iv) KNO_3
(v) $CaCO_3$

Answer 2:

(i) $Al_2(SO_4)_3 \rightarrow$ Aluminium sulphate
(ii) $CaCl_2 \rightarrow$ Calcium chloride
(iii) $K_2SO_4 \rightarrow$ Potassium sulphate
(iv) $KNO_3 \rightarrow$ Potassium nitrate
(v) $CaCO_3 \rightarrow$ Calcium carbonate

Question 3:

What is meant by the term chemical formula?

Answer 3:

The chemical formula of a compound means the symbolic representation of the composition of a compound. From the chemical formula of a compound, we can know the number and kinds of atoms of different elements that constitute the compound.
For example, from the chemical formula CO_2 of carbon dioxide, we come to know that one carbon atom and two oxygen atoms are chemically bonded together to form one molecule of the compound, carbon dioxide.

Question 4:

How many atoms are present in a
(i) H_2S molecule and
(ii) PO_4^{3-} ion?

Answer 4:

(i) In an H_2S molecule, three atoms are present; two of hydrogen and one of sulphur.
(ii) In a PO_4^{3-} ion, five atoms are present; one of phosphorus and four of oxygen.

Question 1:

Calculate the molecular masses of H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH.

Answer 1:

Molecular mass of H_2 = 2 × Atomic mass of H
= 2 × 1
= 2 u
Molecular mass of O_2 = 2 × Atomic mass of O
= 2 × 16
= 32 u
Molecular mass of Cl_2 = 2 × Atomic mass of Cl
= 2 × 35.5
= 71 u

Molecular mass of CO_2 = Atomic mass of C + 2 × Atomic mass of O
= 12 + 2 × 16
= 44 u
Molecular mass of CH_4 = Atomic mass of C + 4 × Atomic mass of H
= 12 + 4 × 1
= 16 u
Molecular mass of C_2H_6 = 2 × Atomic mass of C + 6 × Atomic mass of H
= 2 × 12 + 6 × 1
= 30 u
Molecular mass of C_2H_4 = 2 × Atomic mass of C + 4 × Atomic mass of H
= 2 × 12 + 4 × 1
= 28 u
Molecular mass of NH_3 = Atomic mass of N + 3 × Atomic mass of H
= 14 + 3 × 1
= 17 u
Molecular mass of CH_3OH = Atomic mass of C + 4 × Atomic mass of H + Atomic mass of O
= 12 + 4 × 1 + 16
= 32 u

Question 2:

Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Answer 2:

Formula unit mass of ZnO = Atomic mass of Zn + Atomic mass of O
= 65 + 16
= 81 u
Formula unit mass of Na_2O = 2 × Atomic mass of Na + Atomic mass of O
= 2 × 23 + 16
= 62 u
Formula unit mass of K_2CO_3 = 2 × Atomic mass of K + Atomic mass of C + 3 × Atomic mass of O
= 2 × 39 + 12 + 3 × 16
= 138 u

Question 1:

If one mole of carbon atoms weighs 12 grams, what is the mass (in grams) of 1 atom of carbon?

Answer 1:

One mole of carbon atoms weighs 12 g (Given)

i.e., mass of 1 mole of carbon atoms = 12 g

Then, mass of 6.022×10^{23} number of carbon atoms = 12 g

Therefore, mass of 1 atom of carbon $=\frac{12}{6.022\times10^{23}}$ g

$=1.9926\times10^{-23}$ g

Question 2:

Which has more number of atoms, 100 grams of sodium or 100 grams of iron (given, atomic mass of Na = 23 u, Fe = 56 u)?

Answer 2:

Atomic mass of Na = 23 u (Given)

Then, gram atomic mass of Na = 23 g

Now, 23 g of Na contains = 6.022×10^{23} number of atoms

Thus, 100 g of Na contains $=\frac{6.022\times10^{23}}{23}\times100$ number of atoms

= 2.6182×10^{24} number of atoms

Again, atomic mass of Fe = 56 u(Given)

Then, gram atomic mass of Fe = 56 g

Now, 56 g of Fe contains = 6.022×10^{23} number of atoms

Thus, 100 g of Fe contains $=\frac{6.022\times10^{23}}{56}\times100$ number of atoms

$=1.0753\times10^{24}$ number of atoms

Therefore, 100 grams of sodium contain more number of atoms than 100 grams of iron.

Question 1:

A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Answer 1:

Mass of boron = 0.096 g (Given)
Mass of oxygen = 0.144 g (Given)
Mass of sample = 0.24 g (Given)

Thus, percentage of boron by weight in the compound $= \frac{0.096}{0.24} \times 100\%$

$= 40\%$

And, percentage of oxygen by weight in the compound $= \frac{0.144}{0.24} \times 100\%$

$= 60\%$

Question 2:

When 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combinations will govern your answer?

Answer 2:

Carbon + Oxygen $\longrightarrow$ Carbon dioxide
3 g of carbon reacts with 8 g of oxygen to produce 11 g of carbon dioxide.
If 3 g of carbon is burnt in 50 g of oxygen, then 3 g of carbon will react with 8 g of oxygen. The remaining 42 g of oxygen will be left un-reactive.
In this case also, only 11 g of carbon dioxide will be formed.
The above answer is governed by the law of constant proportions.

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Question 3:

What are polyatomic ions? Give examples?

Answer 3:

A polyatomic ion is a group of atoms carrying a charge (positive or negative). For example, ammonium ion $\left(NH_4^+\right)$, hydroxide ion (OH^-), carbonate ion $\left(CO_3^{2-}\right)$, sulphate ion $\left(SO_4^{2-}\right)$.

Question 4:

Write the chemical formulae of the following:
(a) Magnesium chloride
(b) Calcium oxide
(c) Copper nitrate
(d) Aluminium chloride
(e) Calcium carbonate

Answer 4:

(a) Magnesium chloride → $MgCl_2$
(b) Calcium oxide → CaO
(c) Copper nitrate → $Cu(NO_3)_2$
(d) Aluminium chloride → $AlCl_3$
(e) Calcium carbonate → $CaCO_3$

Question 5:

Give the names of the elements present in the following compounds:
(a) Quick lime
(b) Hydrogen bromide
(c) Baking powder
(d) Potassium sulphate

Answer 5:

Compound	Chemical formula	Elements present
Quick lime	CaO	Calcium, Oxygen
Hydrogen bromide	HBr	Hydrogen, Bromine
Baking powder	$NaHCO_3$	Sodium, Hydrogen, Carbon, Oxygen
Potassium sulphate	K_2SO_4	Potassium, Sulphur, Oxygen

Question 6:

Calculate the molar mass of the following substances:
(a) Ethyne, C_2H_2
(b) Sulphur molecule, S_8
(c) Phosphorus molecule, P_4 (atomic mass of phosphorus = 31)
(d) Hydrochloric acid, HCl
(e) Nitric acid, HNO_3

Answer 6:

(a) Molar mass of ethyne, $C_2H_2 = 2 \times 12 + 2 \times 1 = 26$ g
(b) Molar mass of sulphur molecule, $S_8 = 8 \times 32 = 256$ g
(c) Molar mass of phosphorus molecule, $P_4 = 4 \times 31 = 124$ g
(d) Molar mass of hydrochloric acid, $HCl = 1 + 35.5 = 36.5$ g
(e) Molar mass of nitric acid, $HNO_3 = 1 + 14 + 3 \times 16 = 63$ g

Question 7:

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 7:

(a) The mass of 1 mole of nitrogen atoms is 14 g.
(b) The mass of 4 moles of aluminium atoms is (4×27) g = 108 g
(c) The mass of 10 moles of sodium sulphite (Na_2SO_3) is
$10 \times [2 \times 23 + 32 + 3 \times 16]$ g = 10×126 g = 1260 g

Question 8:

Convert into mole.
(a) 12 g of oxygen gas
(b) 20 g of water
(c) 22 g of carbon dioxide

Answer 8:

(a) 32 g of oxygen gas = 1 mole
Then, 12 g of oxygen gas = $\frac{12}{32}$ mole = 0.375 mole
(b) 18 g of water = 1 mole
Then, 20 g of water = $\frac{20}{18}$ mole = 1.11 moles (approx)
(c) 44 g of carbon dioxide = 1 mole
Then, 22 g of carbon dioxide = $\frac{22}{44}$ mole = 0.5 mole

Question 9:

What is the mass of:
(a) 0.2 mole of oxygen atoms?
(b) 0.5 mole of water molecules?

Answer 9:

(a) Mass of one mole of oxygen atoms = 16 g
Then, mass of 0.2 mole of oxygen atoms = 0.2 × 16g = 3.2 g
(b) Mass of one mole of water molecule = 18 g
Then, mass of 0.5 mole of water molecules = 0.5 × 18 g = 9 g

Question 10:

Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.

Answer 10:

1 mole of solid sulphur (S_8) = 8 × 32 g = 256 g
i.e., 256 g of solid sulphur contains = 6.022×10^{23} molecules
Then, 16 g of solid sulphur contains = $\frac{6.022 \times 10^{23}}{256} \times 16$ molecules
= 3.76×10^{22} molecules (approx)

Question 11:

Calculate the number of aluminium ions present in 0.051 g of aluminium oxide.
(*Hint*: The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al = 27 u)

Answer 11:

1 mole of aluminium oxide (Al_2O_3) = 2 × 27 + 3 × 16
= 102 g
i.e., 102 g of Al_2O_3 = 6.022×10^{23} molecules of Al_2O_3
Then, 0.051 g of Al_2O_3 contains = $\frac{6.022 \times 10^{23}}{102} \times 0.051$ molecules
= 3.011×10^{20} molecules of Al_2O_3
The number of aluminium ions (Al^{3+}) present in one molecule of aluminium oxide is 2.
Therefore, the number of aluminium ions (Al^{3+}) present in 3.011×10^{20} molecules (0.051 g) of aluminium oxide (Al_2O_3) = $2 \times 3.011 \times 10^{20}$
= 6.022×10^{20}