NCERT Solutions for Atoms and Molecules

Question 1.

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 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

In the given reaction, sodium carbonate reacts with ethanoic acid to produce sodium ethanoate, carbon dioxide, and water.
Sodium Carbonate + Ethanoic acid → sodium ethanoate + carbon dioxide + water

Mass of sodium carbonate = 5.3 g (Given)
Mass of ethanoic acid = 6 g (Given)
Mass of sodium ethanoate = 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

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

The postulate of Dalton: "Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction" is the result of the law of conservation of mass.

Question 4.

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

Answer

The postulate of Dalton, "The relative number and kinds of atoms are constant in a given compound", can explain the law of definite proportions.

Question 5.

Define atomic mass unit.

Answer

Mass unit equal to exactly one-twelfth the mass of one atom of carbon-12 is called one atomic mass unit. It is written as 'u'.

Question 6.
Why is it not possible to see an atom with naked eyes?

Answer

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 7.

Write down the formulae of

(i) sodium oxide

(ii) aluminium chloride

(iii) sodium sulphide

(iv) magnesium hydroxide

Answer

i)	sodium oxide	Na_2O
ii)	aluminium chloride	$AlCl_3$
iii)	sodium sulphide	Na_2S
iv)	magnesium hydroxide	$Mg(OH)_2$

Question 8.
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

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

Question 9.

What is meant by the term chemical formula?

Answer

The chemical formula of a compound is a symbolic representation of its composition.

For example

Chemical Formula for water is H_2O

Question 10

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

Answer

(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 11.

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

Useful information for solving these questions

Atomic mass of H=1

Atomic mass of N=14

Atomic mass of O=16

Atomic mass of Cl=35.5

S.no	Compound	Molecular Mass
i)	H_2	2 × Atomic mass of H = 2 × 1 = 2 u
ii)	O_2	2 × Atomic mass of O = 2 × 16 = 32 u
iii)	Cl_2	2 × Atomic mass of Cl

		= 2 × 35.5 = 71 u
iv)	CO_2,	Atomic mass of C + 2 × Atomic mass of O = 12 + 2 × 16 = 44 u
v)	CH_4	Atomic mass of C + 4 × Atomic mass of H = 12 + 4 × 1 = 16 u
vi)	C_2H_6	= 2× Atomic mass of C + 6× Atomic mass of H = 2 × 12 + 6 × 1 = 30 u
vii)	C_2H_4	2 x Atomic mass of C + 4 × Atomic mass of H = 2 × 12 + 4 × 1 = 28 u
viii)	NH_3	Atomic mass of N + 3 × Atomic mass of H = 14 + 3×1 = 17 u
ix)	CH_3OH	Atomic mass of C + 3 × Atomic mass of H + Atomic mass of O + Atomic mass of H = 12 + 3×1 + 8 + 1 = 24 u

Question 12.

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

S.no	Compound	Molecular Mass
i)	ZnO	Atomic mass of Zn + Atomic mass of O = 65 + 16 = 81 u
ii)	Na_2O	2 × Atomic mass of Na + Atomic mass of O = 2 × 23 + 16 = 62 u
iii)	Cl_2	2 × Atomic mass of Cl = 2 × 35.5 = 71 u
iv)	K_2CO_3	2 × Atomic mass of K + Atomic mass of C + 3 × Atomic mass of O = 2 × 39 + 12 + 2 × 16

		= 78 + 12 + 32= 122 u

Question 13.

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

Answer

Given as per the question One mole of carbon atoms weighs 12 g
Now 1 mole=6.022×10^{23} number of carbon atoms
So, mass of 6.022×10^{23} number of carbon atoms = 12 g
Therefore, mass of 1 atom of carbon = 12 / (6.022×10^{23})
= 1.9926×10^{-23} g

Question 14.

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

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} g number of atoms
Thus, 100 g of Na contains = 6.022×10^{23} / 23×100 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} g number of atoms
Thus, 100 g of Fe contains = 6.022×10^{23} / 56 × 100 number of atoms
= 1.0753×10^{24} number of atoms

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

Question 15.
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

Given as per the question

Total mass of Compound = 0.24 g
Mass of boron = 0.096 g
Mass of oxygen = 0.144 g

So, percentage of boron by weight in the compound = 0.096 / 0.24 × 100%
= 40%

And, percentage of oxygen by weight in the compound = 0.144 / 0.24 × 100% = 60%

Question 16.

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

3.0 g of carbon combines with 8.0 g of oxygen to give 11.0 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.

Question 17.
What are polyatomic ions? Give examples?

Answer

A polyatomic ion is a group of atoms carrying a charge (positive or negative). For example, Nitrate (NO_3^-) , hydroxide ion (OH -).

Question 18.

Write the chemical formulae of the following:

(a) Magnesium chloride

(b) Calcium oxide

(c) Copper nitrate

(d) Aluminium chloride

(e) Calcium carbonate

Answer

S.no	Compound	Chemical Formula
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 19.

Give the names of the elements present in the following compounds:

(a) Quick lime
(b) Hydrogen bromide
(c) Baking powder
(d) Potassium sulphate

Answer

a)	Quick lime	Calcium and oxygen
b)	Hydrogen bromide	Hydrogen and bromine
c)	Baking powder	Sodium, hydrogen, carbon, and oxygen
d)	Potassium sulphate	Potassium, sulphur, and oxygen

Question 20. 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

Given

atomic mass of phosphorus = 31

atomic mass of Sulphur = 32

atomic mass of Chlorine = 35.5

S.no	Compound	Molecular Mass
i)	Ethyne, C_2H_2	$2 \times 12 + 2 \times 1 = 26$ g
ii)	Sulphur molecule, S_8	$8 \times 32 = 256$ g
iii)	Phosphorus molecule, P_4	$4 \times 31 = 124$ g
iv)	Hydrochloric acid, HCl	$1 + 35.5 = 36.5$ g
v)	Nitric acid, HNO_3	$1 + 14 + 3 \times 16 = 63$ g

Question 21.

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) As Atomic mass of Nitrogen = 14

So, the mass of 1 mole of nitrogen atoms is 14 g.

(b) As Atomic mass of aluminium = 27
So, 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 22.

Convert into mole.

(a) 12 g of oxygen gas
(b) 20 g of water
(c) 22 g of carbon dioxide

Answer

(a) 32 g of oxygen gas = 1 mole
Then, 12 g of oxygen gas = 12 / 32 mole = 0.375 mole

(b) 18 g of water = 1 mole
Then, 20 g of water = 20 / 18 mole = 1.111 mole

(c) 44 g of carbon dioxide = 1 mole
Then, 22 g of carbon dioxide = 22 / 44 mole = 0.5 mole

Question 23.

What is the mass of:

(a) 0.2 mole of oxygen atoms?
(b) 0.5 mole of water molecules?

Answer

(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) Atomic mass of water= 2×atomic mass of Hydrogen+ atomic mass of oxygen

=2+16=18

So, 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 24.
Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.

Answer

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 = 6.022 × 10^{23} / 256 = 16 molecules
= 3.76375 × 10^{22} molecules

Question 25

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

1 mole of aluminium oxide (Al_2O_3) = 2 × 27 + 3 × 16
= 102 g

Now, 102 g of Al_2O_3 = 6.022 × 10^{23} molecules of Al_2O_3
Then, 0.051 g of Al_2O_3 contains = 6.022 × 10^{23} / 102 × 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 × 3.011 × 10^{20}
= 6.022 × 10^{20}