

CLASS 9 SCIENCE

CHAPTER 9 • ATOMIC FOUNDATIONS OF MATTER

NUMERICAL PROBLEMS • Practice + Answers

Formula Sheet: Mass ratio → use proportionality | Molecular mass = sum of atomic masses of all atoms in a molecule
| Formula unit mass = sum of atomic masses in one formula unit | Neutrons = mass number – atomic number |
Neutral atom: electrons = protons | Ion charge = protons – electrons

1. Water contains hydrogen and oxygen in the mass ratio 1:8. If 9 g of water is decomposed, find the masses of hydrogen and oxygen obtained.

Answer: Total ratio = $1+8 = 9$. Hydrogen = **1 g**; oxygen = **8 g**.

2. Using the same 1:8 mass ratio for water, how much oxygen combines with 5 g of hydrogen?

Answer: Oxygen = $8 \times 5 = 40$ g.

3. A sample of water contains 16 g oxygen. Using the mass ratio H:O = 1:8, find the mass of hydrogen.

Answer: Hydrogen = $16/8 = 2$ g.

4. A compound contains sulfur and oxygen in the mass ratio 2:3. If 20 g of sulfur is present, calculate the mass of oxygen.

Answer: Oxygen = $(3/2) \times 20 = 30$ g.

5. A compound contains 40% sulfur and 60% oxygen by mass. If a sample contains 20 g sulfur, find the mass of oxygen.

Answer: $40\% : 60\% = 2:3$. Oxygen = $(60/40) \times 20 = 30$ g.

6. Carbon monoxide contains carbon and oxygen in the mass ratio 3:4. How much oxygen combines with 9 g carbon?

Answer: Oxygen = $(4/3) \times 9 = 12$ g.

7. Sodium chloride contains sodium and chlorine in the mass ratio 23:35.5. If 46 g sodium reacts completely, how much chlorine is needed?

Answer: Chlorine = $(35.5/23) \times 46 = 71$ g.

8. If 71 g chlorine reacts completely with 46 g sodium to form sodium chloride, calculate the total mass of sodium chloride formed.

Answer: By conservation of mass: $46 + 71 = 117$ g.

9. Hydrogen has atomic mass 1 u and oxygen has atomic mass 16 u. Calculate the molecular mass of H_2O .

Answer: Molecular mass = $(2 \times 1) + 16 = 18$ u.

10. Carbon has atomic mass 12 u and oxygen has atomic mass 16 u. Calculate the molecular mass of CO_2 .

Answer: Molecular mass = $12 + (2 \times 16) = 44$ u.

11. Calculate the molecular mass of nitric acid, HNO_3 , using $\text{H} = 1 \text{ u}$, $\text{N} = 14 \text{ u}$ and $\text{O} = 16 \text{ u}$.

Answer: Molecular mass = $1 + 14 + (3 \times 16) = 63 \text{ u}$.

12. Calculate the molecular mass of methane, CH_4 , using $\text{C} = 12 \text{ u}$ and $\text{H} = 1 \text{ u}$.

Answer: Molecular mass = $12 + (4 \times 1) = 16 \text{ u}$.

13. Calculate the molecular mass of ammonia, NH_3 , using $\text{N} = 14 \text{ u}$ and $\text{H} = 1 \text{ u}$.

Answer: Molecular mass = $14 + (3 \times 1) = 17 \text{ u}$.

14. Calculate the molecular mass of hydrogen sulfide, H_2S , using $\text{H} = 1 \text{ u}$ and $\text{S} = 32 \text{ u}$.

Answer: Molecular mass = $(2 \times 1) + 32 = 34 \text{ u}$.

15. Calculate the molecular mass of carbon tetrachloride, CCl_4 , using $\text{C} = 12 \text{ u}$ and $\text{Cl} = 35.5 \text{ u}$.

Answer: Molecular mass = $12 + (4 \times 35.5) = 154 \text{ u}$.

16. Calculate the formula unit mass of sodium oxide, Na₂O, using Na = 23 u and O = 16 u.

Answer: Formula unit mass = $(2 \times 23) + 16 = 62$ u.

17. Calculate the formula unit mass of sodium chloride, NaCl, using Na = 23 u and Cl = 35.5 u.

Answer: Formula unit mass = $23 + 35.5 = 58.5$ u.

18. Calculate the formula unit mass of magnesium oxide, MgO, using Mg = 24 u and O = 16 u.

Answer: Formula unit mass = $24 + 16 = 40$ u.

19. Calculate the formula unit mass of calcium chloride, CaCl₂, using Ca = 40 u and Cl = 35.5 u.

Answer: Formula unit mass = $40 + (2 \times 35.5) = 111$ u.

20. Calculate the formula unit mass of aluminium oxide, Al₂O₃, using Al = 27 u and O = 16 u.

Answer: Formula unit mass = $(2 \times 27) + (3 \times 16) = 102$ u.

21. For the species $^{27}_{13}\text{Al}$, the atomic number is 13. Calculate its number of protons, electrons and neutrons.

Answer: Protons = 13; neutral Al has 13 electrons; neutrons = $27 - 13 = 14$.

22. For $^{80}_{35}\text{Br}^-$, the atomic number of bromine is 35. Calculate its protons, electrons and neutrons.

Answer: Protons = 35; Br^- has one extra electron, so electrons = **36**; neutrons = $80 - 35 = 45$.

23. For $^{201}_{80}\text{Hg}^{2+}$, the atomic number of mercury is 80. Calculate its protons, electrons and neutrons.

Answer: Protons = 80; Hg^{2+} has lost 2 electrons, so electrons = **78**; neutrons = $201 - 80 = 121$.

24. An atom has mass number 35 and contains 17 protons. Find its neutrons and, if it is neutral, its electrons.

Answer: Neutrons = $35 - 17 = 18$. Neutral atom has **17 electrons**.

25. An ion has 20 protons and 18 electrons. Determine its charge and identify whether it is a cation or an anion.

Answer: Charge = $20 - 18 = +2$. It is a **cation (2+)**.

ANSWER CHECKLIST

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Problem	Final Answer	Problem	Final Answer
1	Total ratio = $1+8 = 9$. Hydrogen = 1 g; oxygen = 8 g.	13	Molecular mass = $14 + (3 \times 1) = 17$ u.
2	Oxygen = $8 \times 5 = 40$ g.	14	Molecular mass = $(2 \times 1) + 32 = 34$ u.
3	Hydrogen = $16/8 = 2$ g.	15	Molecular mass = $12 + (4 \times 35.5) = 154$ u.
4	Oxygen = $(3/2) \times 20 = 30$ g.	16	Formula unit mass = $(2 \times 23) + 16 = 62$ u.
5	40% : 60% = 2:3. Oxygen = $(60/40) \times 20 = 30$ g.	17	Formula unit mass = $23 + 35.5 = 58.5$ u.
6	Oxygen = $(4/3) \times 9 = 12$ g.	18	Formula unit mass = $24 + 16 = 40$ u.
7	Chlorine = $(35.5/23) \times 46 = 71$ g.	19	Formula unit mass = $40 + (2 \times 35.5) = 111$ u.
8	By conservation of mass: $46 + 71 = 117$ g.	20	Formula unit mass = $(2 \times 27) + (3 \times 16) = 102$ u.
9	Molecular mass = $(2 \times 1) + 16 = 18$ u.	21	Protons = 13; neutral Al has 13 electrons; neutrons = 2
10	Molecular mass = $12 + (2 \times 16) = 44$ u.	22	Protons = 35; Br has one extra electron, so electrons =
11	Molecular mass = $1 + 14 + (3 \times 16) = 63$ u.	23	Protons = 80; Hg ²⁺ has lost 2 electrons, so electrons =
12	Molecular mass = $12 + (4 \times 1) = 16$ u.	24	Neutrons = $35 - 17 = 18$. Neutral atom has 17 electrons.
25	Charge = $20 - 18 = +2$. It is a cation (2+).		

Source alignment: Chapter 9 covers the Law of Constant Proportions, writing chemical formulae, molecular mass of covalent compounds, formula unit mass of ionic compounds, and calculations involving protons, electrons and neutrons. The textbook explicitly gives the water 1:8 ratio, the sodium chloride 23:35.5 example, molecular-mass examples for H₂O and CO₂, formula-unit mass of Na₂O, and the ²⁷Al, ⁸⁰Br and ²⁰¹Hg²⁺ particle-count problem.