CLASS 9 SCIENCE

CHAPTER 9

ATOMIC FOUNDATIONS OF MATTER

FREE PRACTICE WORKSHEETS + COMPLETE ANSWER KEY

Chapter Focus: Laws of chemical combination • atoms, molecules and compounds • covalent bonding • ionic bonding • common ions and valencies • writing chemical formulae • properties of ionic and covalent compounds • molecular mass • formula unit mass

Name: _____ **Class:** _____ **Date:** _____

How to use: Complete the worksheets first. Show calculations clearly in numerical questions, then use the answer key for self-checking.

WORKSHEET 1

Law of Conservation of Mass

Core idea: In a chemical reaction, total mass of reactants equals total mass of products when the system is considered as a whole. In an open setup, escaping gas can make the measured mass appear lower.

A. Fill in the blanks.

1. The Law of Conservation of Mass was proposed by _____.

2. According to the law, total mass of reactants is _____ the total mass of products.

3. A reaction carried out in a closed system should show _____ mass before and after the reaction.

4. In an open setup, a gas may _____ and cause an apparent change in measured mass.

5. The law applies to _____ reactions.

B. Choose the correct answer.

6. Which statement best expresses conservation of mass?
■ Mass disappears during a reaction ■ Mass is created during a reaction
■ Total mass remains constant in a chemical reaction ■ Only solids have mass

7. Vinegar and baking soda produce carbon dioxide. In a closed setup, the final mass should be:
■ greater ■ smaller ■ equal to initial total mass ■ zero

8. If a gas escapes from an open reaction vessel, the balance may show:
■ a lower final mass ■ a higher final mass only ■ no mass at all ■ double the mass

C. Apply the law.

9. 18 g of hydrogen reacts completely with 142 g of oxygen in a closed system. What is the total mass of products?

_____

_____

10. Reactants have a total mass of 125 g. Products have a measured mass of 118 g in an open vessel. Give one likely reason for the difference.

_____

_____

11. Explain why dissolving salt in water does not destroy the mass of the salt.

_____

_____

WORKSHEET 2

Law of Constant Proportions

Core idea: A compound contains its constituent elements in a fixed ratio by mass, irrespective of its source.

A. Complete.

1. The Law of Constant Proportions is also called the Law of _____ Proportions.

2. Joseph _____ proposed the Law of Constant Proportions.

3. In water, hydrogen and oxygen occur in the mass ratio _____.

4. A fixed mass ratio is a property of a _____, not a mixture.

B. Numericals.

5. Water contains hydrogen and oxygen in the mass ratio 1:8. If 5 g of hydrogen combines completely, how much oxygen is needed?

_____

_____

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

_____

_____

7. A compound contains sulfur and oxygen in the mass ratio 40:60. If a sample contains 20 g sulfur, calculate the mass of oxygen.

_____

_____

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

_____

_____

C. Reasoning.

9. Why does the Law of Definite Proportions not apply to mixtures?

_____

_____

10. Two students obtain a copper oxide using mass ratios 4:1 and 8:2. Do these results support the law? Explain.

_____

_____

WORKSHEET 3

Dalton's Atomic Theory & Chemical Species

Core idea: Dalton's theory explains chemical combination using atoms; atoms combine in whole-number ratios and are rearranged in chemical reactions.

A. True or False.

1. Dalton proposed an atomic theory to explain laws of chemical combination. _____

2. Atoms of different elements are identical in every respect. _____

3. Atoms combine in whole-number ratios to form compounds. _____

4. Chemical reactions involve rearrangement of atoms. _____

5. Molecules can consist of more than one atom. _____

B. Distinguish.

6. Atom vs molecule

_____

_____

7. Element vs compound

_____

_____

8. Molecule of an element vs molecule of a compound

_____

_____

9. Ionic compound vs covalent compound

_____

_____

C. Correct the statements.

10. “A molecule of nitrogen gas contains three nitrogen atoms.” Correct the statement.

_____

_____

11. “Water is made of hydrogen and oxygen atoms in a fixed composition.” Explain why this is a compound rather than a mixture.

_____

_____

WORKSHEET 4

How Atoms Combine — Covalent Bonding

Covalent bond: A bond formed by sharing electrons between atoms. The shared electrons help the atoms attain a more stable arrangement.

A. Complete the statements.

1. Covalent bonding involves _____ of electrons.

2. In H■, each hydrogen atom shares _____ electron.

3. The shared electron pair attracts _____ nuclei.

4. H—H represents a _____ covalent bond.

5. In HCl, hydrogen and chlorine share _____ pair of electrons.

B. Write the formula.

6. Hydrogen molecule: _____

7. Water: _____

8. Hydrogen chloride: _____

9. Ammonia: _____

10. Carbon dioxide: _____

11. Hydrogen sulfide: _____

C. Explain.

12. Why do atoms share electrons?

_____

_____

13. Why does H■ contain two hydrogen atoms?

_____

_____

14. Draw an electron-dot or simple sharing representation for H—H.

_____

_____

WORKSHEET 5

Ionic Bonding, Cations & Anions

Ionic bond: Oppositely charged ions are held together by electrostatic attraction after electrons are transferred. Loss of electrons forms a cation; gain forms an anion.

A. Complete.

1. An ion formed by loss of electrons is a _____.

2. An ion formed by gain of electrons is an _____.

3. A positively charged ion is a _____.

4. A negatively charged ion is an _____.

5. The force between oppositely charged ions is an _____ force.

6. Ionic compounds form repeating three-dimensional _____ structures.

B. Identify the ion.

7. Sodium loses one electron. Write the ion: _____

8. Chlorine gains one electron. Write the ion: _____

9. Magnesium loses two electrons. Write the ion: _____

10. Oxygen gains two electrons. Write the ion: _____

11. Aluminium loses three electrons. Write the ion: _____

C. Reasoning.

12. Why does sodium become Na■ after losing one electron?

_____

_____

13. Why does chloride have a negative charge?

_____

_____

14. Why do Na■ and Cl■ attract each other?

_____

_____

WORKSHEET 6

Writing Chemical Formulae

Formula rule: Write the cation first in an ionic formula, then the anion. Use valencies/charges to obtain the simplest whole-number ratio. Use brackets when more than one polyatomic ion is needed.

A. Write the formula.

1. Hydrogen chloride — H(1), Cl(1) → _____

2. Hydrogen sulfide — H(1), S(2) → _____

3. Carbon tetrachloride — C(4), Cl(1) → _____

4. Calcium oxide — Ca^{2}■ and O^{2}■ → _____

5. Calcium bromide — Ca^{2}■ and Br■ → _____

6. Aluminium oxide — Al^{3}■ and O^{2}■ → _____

7. Aluminium hydroxide — Al^{3}■ and OH■ → _____

8. Aluminium sulfate — Al^{3}■ and SO_{4}^{2}■ → _____

9. Potassium sulfate — K■ and SO_{4}^{2}■ → _____

10. Ammonium chloride — NH_{4}■ and Cl■ → _____

B. Formula detective.

11. Why is Al(OH)■ written with brackets but NaOH does not need brackets?

_____

_____

12. Why is the formula of an ionic compound written as a simplest whole-number ratio?

_____

_____

WORKSHEET 7

Common Ions & Naming Compounds

Useful ions: OH■ hydroxide, NO■■ nitrate, HCO■■ hydrogencarbonate, CO■²■ carbonate, SO■²■ sulfate, NH■■ ammonium.

A. Name the formula.

1. CO■ — _____

2. NO■ — _____

3. SF■ — _____

4. PCl■ — _____

5. NaHCO■ — _____

6. SO■ — _____

7. FeCl■ — _____

8. Cu■O — _____

B. Write the formula.

9. Sodium hydrogencarbonate — _____

10. Sulfur dioxide — _____

11. Ferric chloride — _____

12. Cuprous oxide — _____

13. Ferric hydroxide — _____

14. Potassium carbonate — _____

C. Challenge.

15. Explain why the formula of aluminium sulfate is Al■(SO■)■.

_____

_____

16. What is the charge balance in CaCl■?

_____

_____

WORKSHEET 8

Properties of Ionic & Covalent Compounds

Compare: Ionic compounds consist of ions in a crystal lattice. Covalent compounds consist of molecules. Their properties differ because the particles and bonding are different.

A. Complete the comparison table.

Property	Ionic compounds	Covalent compounds
Basic particles	_____	_____
Structure	_____	_____
Melting/boiling point	_____	_____
Electrical conduction	_____	_____

B. Choose the best answer.

5. Ionic compounds generally have:
■ high melting/boiling points ■ very low melting points only ■ no crystal structure ■ no ions

6. A solid ionic compound generally does not conduct because its ions are:
■ free to move ■ fixed in the lattice ■ gases ■ covalent molecules

7. An ionic compound can conduct when molten because:
■ ions can move ■ atoms disappear ■ electrons are destroyed ■ molecules become neutral

8. Covalent compounds generally have:
■ molecular units ■ ionic lattices only ■ free ions in solids ■ only metals

C. Explain.

9. Why does molten sodium chloride conduct electricity?

_____

_____

10. Why does solid sodium chloride not conduct electricity as easily as its molten form?

_____

_____

WORKSHEET 9

Molecular Mass & Formula Unit Mass

Method: Molecular mass = sum of atomic masses of all atoms in a molecule. Formula unit mass = sum of atomic masses in the simplest ionic formula unit.

Use these atomic masses: H=1 u, C=12 u, N=14 u, O=16 u, Na=23 u, Mg=24 u, Al=27 u, S=32 u, Cl=35.5 u, K=39 u, Ca=40 u.

A. Molecular mass.

1. H■O: _____ u

2. CO■: _____ u

3. HNO■: _____ u

4. CH■: _____ u

5. NH■: _____ u

6. SO■: _____ u

B. Formula unit mass.

7. Na■O: _____ u

8. KCl: _____ u

9. Ca(NO■)■: _____ u

10. Mg(OH)■: _____ u

11. Al■(SO■)■: _____ u

C. Concept check.

12. Why is the term “formula unit mass” used for ionic compounds instead of molecular mass?

_____

_____

13. What is the difference between molecular mass and formula unit mass?

_____

_____

WORKSHEET 10

Complete Chapter Revision Test

Suggested time: 45 minutes. Complete independently before checking the answer key.

Section A — MCQs

1. The Law of Conservation of Mass says:
■ mass is created ■ mass is destroyed ■ total mass remains constant in a chemical reaction ■ only gases have mass

2. A compound has elements in:
■ any ratio ■ a fixed ratio by mass ■ a random ratio ■ no ratio

3. A covalent bond involves:
■ electron sharing ■ electron transfer only ■ neutron transfer ■ proton transfer

4. A cation is:
■ negative ■ positive ■ neutral ■ always gaseous

5. An anion is:
■ positive ■ negative ■ neutral ■ always metallic

6. The formula unit of an ionic compound represents:
■ simplest whole-number ratio of ions ■ a single molecule only ■ only electrons ■ only atoms of one element

Section B — True/False

7. Matter can be created in a chemical reaction. _____

8. Water has a fixed hydrogen:oxygen mass ratio. _____

9. A covalent bond is formed by sharing electrons. _____

10. Ionic compounds consist of a 3-D arrangement of ions. _____

11. Molecular mass is found by adding atomic masses in a molecule. _____

12. Formula unit mass is used for ionic compounds. _____

Section C — Numericals & application

13. 25 g of reactants form products in a closed system. What is the total product mass?

_____

14. Water has H:O mass ratio 1:8. How much oxygen combines with 12 g hydrogen?

_____

15. Write the formula of aluminium oxide using Al^{3}■ and O^{2}■.

_____

16. Write the formula of calcium hydroxide using Ca^{2}■ and OH■.

_____

17. Calculate the molecular mass of CO■.

_____

18. Calculate the formula unit mass of KCl.

_____

19. An element A has one electron in its third shell and element B has six electrons in its second shell. Predict the type of bond formed when they combine and the likely formula.

_____

20. Explain two differences between ionic and covalent compounds.

_____

ANSWER KEY

Use for self-checking, classroom correction and revision. Answers follow the supplied Chapter 9 worksheet and study-note content.

Worksheet 1

1. Antoine Lavoisier; 2. equal to; 3. the same; 4. escape; 5. chemical. 6. Total mass remains constant in a chemical reaction. 7. equal to initial total mass. 8. a lower final mass. 9. 18+142=160 g. 10. Gas produced may have escaped from the open vessel. 11. Dissolving changes the physical arrangement, but the salt's mass remains part of the solution.

Worksheet 2

1. Definite; 2. Proust; 3. 1:8; 4. compound. 5. 5×8=40 g O. 6. (35.5/23)×46=71 g Cl. 7. Oxygen=(60/40)×20=30 g. 8. Oxygen=(4/3)×9=12 g. 9. A mixture can have variable composition; a compound has a fixed composition. 10. 4:1 and 8:2 are equivalent ratios, so yes, they support the law.

Worksheet 3

1. True; 2. False; 3. True; 4. True; 5. True. 6. Atom: smallest unit of an element retaining its identity; molecule: neutral entity of more than one atom capable of independent existence. 7. Element contains one kind of atom; compound contains different elements chemically combined. 8. Element molecule contains same kind of atoms; compound molecule contains different kinds. 9. Ionic: electron transfer/ions; covalent: electron sharing/molecules. 10. Nitrogen gas molecule contains two nitrogen atoms (N■). 11. Water has a chemically fixed composition and new properties, so it is a compound, not a mixture.

Worksheet 4

1. sharing; 2. one; 3. both; 4. single; 5. one. 6. H■; 7. H■O; 8. HCl; 9. NH■; 10. CO■; 11. H■S. 12. Sharing helps atoms attain a more stable electron arrangement. 13. Each H atom needs one more electron to complete its K-shell, so two H atoms share a pair. 14. H—H with one shared pair.

Worksheet 5

1. cation; 2. anion; 3. cation; 4. anion; 5. electrostatic; 6. crystal. 7. Na■; 8. Cl■; 9. Mg^{2}■; 10. O^{2}■; 11. Al^{3}■. 12. It has one fewer electron than neutral sodium, giving a net +1 charge. 13. It has gained one electron, giving one extra negative charge. 14. Opposite charges attract.

Worksheet 6

1. HCl; 2. H■S; 3. CCl■; 4. CaO; 5. CaBr■; 6. Al■O■; 7. Al(OH)■; 8. Al■(SO■)■; 9. K■SO■; 10. NH■Cl. 11. Al(OH)■ has three hydroxide ions, so brackets show the whole polyatomic ion is repeated. 12. Ionic compounds form extended lattices, so the formula represents the simplest whole-number ratio of ions.

Worksheet 7

1. carbon dioxide; 2. nitrogen dioxide; 3. sulfur hexafluoride; 4. phosphorus trichloride; 5. sodium hydrogencarbonate; 6. sulfur dioxide; 7. ferric chloride; 8. cuprous oxide. 9. NaHCO■; 10. SO■; 11. FeCl■; 12. Cu■O; 13. Fe(OH)■; 14. K■CO■. 15. Al³■ and SO■²■ require 2 Al³■ (+6) and 3 sulfate ions (−6), giving Al■(SO■)■. 16. Ca²■ is balanced by two Cl■, so CaCl■ has total charge 0.

Worksheet 8

Table: Ionic—ions; 3-D crystal lattice; generally high melting/boiling points; conducts when ions are mobile (molten/aqueous). Covalent—molecules; molecular structure; generally lower melting/boiling points; usually poor conductors. 5. high melting/boiling points; 6. fixed in the lattice; 7. ions can move; 8. molecular units. 9. In molten NaCl the ions are free to move and carry charge. 10. In solid NaCl the ions are held in fixed lattice positions and cannot move freely.

Worksheet 9

1. H■O=18 u; 2. CO■=44 u; 3. HNO■=63 u; 4. CH■=16 u; 5. NH■=17 u; 6. SO■=64 u. 7. Na■O=62 u; 8. KCl=74.5 u; 9. Ca(NO■)■=164 u; 10. Mg(OH)■=58 u; 11. Al■(SO■)■=342 u. 12. Ionic compounds form crystal lattices rather than independent molecules, so formula unit mass is used. 13. Molecular mass sums atoms in one molecule; formula unit mass sums atoms represented by the simplest ionic formula unit.

Worksheet 10

1. total mass remains constant in a chemical reaction; 2. a fixed ratio by mass; 3. electron sharing; 4. positive; 5. negative; 6. simplest whole-number ratio of ions. 7. False; 8. True; 9. True; 10. True; 11. True; 12. True. 13. 25 g. 14. 12×8=96 g O. 15. Al■O■. 16. Ca(OH)■. 17. 44 u. 18. 74.5 u. 19. A has 2,8,1 and tends to lose one electron; B has 2,6 and tends to gain two. An ionic bond is expected; the likely formula is A■B (corresponding to MgO if A is magnesium and B is oxygen). 20. Ionic compounds contain ions in lattices and conduct when ions are mobile; covalent compounds contain molecules and generally do not conduct electricity.

Correction made: The original Chapter 9 file's first page began directly with “A. Fill in the blanks” and did not display a proper **WORKSHEET 1** heading. This fixed version restores the Worksheet 1 heading and keeps Worksheets 1–10 clearly labelled, followed by the complete answer key. The chapter content and answers are based on the supplied Chapter 9 worksheet and study notes.