

Stoichiometry

30 questions: 15 multiple choice, 15 structured.

1 Core Formulae [1]

Limestone is mainly calcium carbonate. Which formula represents calcium carbonate?

- A Ca_2CO_3
- B CaCO_2
- C CaCO_3
- D $\text{Ca}(\text{CO}_3)_2$

2 Core Formulae [1]

What does the molecular formula of a compound show?

- A The number and type of each atom in one molecule of the compound
- B The simplest whole-number ratio of atoms in the compound
- C The charges on the ions in one formula unit of the compound
- D The percentage by mass of each element in the compound

3 Core Formulae [1]

Magnesium ribbon burns in air to form magnesium oxide. Which symbol equation, including state symbols, correctly represents this reaction?

- A $\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{MgO}_2(\text{s})$
- B $\text{Mg}(\text{s}) + \text{O}(\text{g}) \rightarrow \text{MgO}(\text{s})$
- C $2\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$
- D $2\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{MgO}(\text{s})$

4 Supplement Formulae [1]

A compound has the molecular formula C_4H_{10} . What is its empirical formula?

- A C_4H_{10}
- B C_2H_5
- C CH_2
- D C_2H_{10}

5**Supplement**

Formulae

[1]

Aluminium ions, Al^{3+} , and sulfate ions, SO_4^{2-} , combine to form an ionic compound. What is the formula of this compound?

- A $\text{Al}_2(\text{SO}_4)_3$
 - B AlSO_4
 - C Al_2SO_4
 - D $\text{Al}_3(\text{SO}_4)_2$
-

6**Supplement**

Formulae

[1]

Aqueous silver nitrate is added to aqueous sodium chloride, forming a white precipitate. Which ionic equation, with state symbols, correctly represents this reaction?

- A $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$
- B $\text{Ag}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{AgNO}_3(\text{s})$
- C $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
- D $2\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{Ag}_2\text{Cl}(\text{s})$

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Sodium reacts with water to produce sodium hydroxide and hydrogen gas.

(a) Give the formula of each of the following:

(i) sodium hydroxide

[1]

(ii) hydrogen gas

[1]

(b) Write a balanced symbol equation for this reaction, including state symbols.

[2]

The table shows the number of each type of atom present in one molecule of three compounds, P, Q and R.

Compound	Carbon atoms	Hydrogen atoms	Oxygen atoms
P	1	4	0
Q	2	6	1
R	1	2	1

- (a) Deduce the molecular formula of compound P. [1]

- (b) Deduce the molecular formula of compound Q. [1]

- (c) Deduce the molecular formula of compound R. [1]

- (d) State the meaning of the term *molecular formula*. [1]

Calcium carbonate is a solid. When it is heated strongly in an open container, it decomposes into calcium oxide, which is also a solid, and carbon dioxide gas.

- (a) Write a word equation for this reaction. [1]

- (b) Write a balanced symbol equation for this reaction, including state symbols. [2]

- (c) Explain, using the equation, why the total mass of solid remaining decreases when calcium carbonate is heated in an open container. [1]

10**Supplement**

Formulae

[4]

A hydrocarbon molecule contains 6 carbon atoms and 12 hydrogen atoms.

(a) State the meaning of the term *empirical formula*.

[1]

(b) Give the molecular formula of this hydrocarbon.

[1]

(c) Deduce the empirical formula of this hydrocarbon.

[1]

(d) A different hydrocarbon has the empirical formula CH_2 and its molecule contains 4 carbon atoms. Deduce its molecular formula.

[1]

The table gives the formula and charge of four ions.

Ion	Formula	Charge
Barium	Ba	2+
Sulfate	SO ₄	2-
Chloride	Cl	1-
Sodium	Na	1+

- (a) Deduce the formula of barium sulfate. [1]

- (b) Deduce the formula of sodium chloride. [1]

- (c) Aqueous barium chloride is mixed with aqueous sodium sulfate. A white precipitate of barium sulfate forms, leaving sodium chloride in solution. Write a balanced symbol equation for this reaction, including state symbols. [3]

12**Supplement**

Formulae

[5]

Dilute hydrochloric acid reacts with aqueous sodium hydroxide in a neutralisation reaction, producing water and aqueous sodium chloride.

- (a) Write a full balanced symbol equation for this reaction, including state symbols. [2]

- (b) Identify the two spectator ions in this reaction. [1]

- (c) Write the ionic equation for this neutralisation reaction, including state symbols. [2]

13**Core**

Relative masses of atoms and molecules

[1]

Which statement correctly defines relative atomic mass, A_r ?

- A The mass of one atom of an element measured in grams
- B The average mass of the isotopes of an element compared with 1/12 of the mass of an atom of carbon-12
- C The number of protons and neutrons in the nucleus of an atom
- D The mass of one mole of atoms of an element

14**Core**

Relative masses of atoms and molecules

[1]

Using Ar: C = 12, O = 16, Ca = 40, what is the relative formula mass, M_r , of calcium carbonate, CaCO_3 ?

- A 68
B 84
C 116
D 100
-

15**Core**

Relative masses of atoms and molecules

[5]

Ar: H = 1, C = 12, N = 14, O = 16.

- (a) Calculate the relative molecular mass, M_r , of carbon dioxide, CO_2 . [1]

- (b) Calculate the relative molecular mass, M_r , of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$. [2]

- (c) Calculate the relative formula mass, M_r , of ammonium nitrate, NH_4NO_3 . [2]

In the reaction $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$, 24 g of magnesium reacts completely with oxygen to form 40 g of magnesium oxide (relative formula mass of $\text{MgO} = 40$).

- (a) Calculate the mass of oxygen that reacts with 24 g of magnesium. [1]

- (b) Calculate the mass of magnesium oxide formed when 9.6 g of magnesium is completely oxidised, using simple proportion. [2]

- (c) Calculate the mass of oxygen needed to react completely with 9.6 g of magnesium. [1]

17**Core**

Relative masses of atoms and molecules

[4]

Copper carbonate decomposes on heating: $\text{CuCO}_3 \rightarrow \text{CuO} + \text{CO}_2$

The relative formula masses are: $\text{CuCO}_3 = 124$, $\text{CuO} = 80$, $\text{CO}_2 = 44$.

- (a) Show that these three relative formula masses are consistent with conservation of mass in this equation. [1]

- (b) 3.1 g of copper carbonate is heated until it decomposes completely. Calculate the mass of copper oxide formed. [2]

- (c) Calculate the mass of carbon dioxide gas released in part (b). [1]

18**Core**

The mole and the Avogadro constant

[1]

Which pair of units can both be used to express the concentration of a solution?

- A g/dm^3 and mol/dm^3
B g/cm^3 and mol/g
C mol/dm^3 and dm^3/mol
D g/mol and mol/dm^3

19 **Supplement** The mole and the Avogadro constant [1]

What is the value of the Avogadro constant, and what does it represent?

- A 6.02×10^{23} ; the number of moles in one gram of a substance
 - B 6.02×10^{-23} ; the number of particles in one mole of a substance
 - C 6.02×10^{23} ; the number of particles in one mole of a substance
 - D 6.02×10^{23} ; the mass, in grams, of one mole of a substance
-

20 **Supplement** The mole and the Avogadro constant [1]

Ar: Na = 23. What amount, in moles, is present in 11.5 g of sodium?

- A 0.5 mol
 - B 0.05 mol
 - C 2.0 mol
 - D 5.0 mol
-

21 **Supplement** The mole and the Avogadro constant [1]

The molar gas volume is 24 dm^3 at room temperature and pressure (r.t.p.). What is the volume occupied by 0.25 mol of a gas at r.t.p.?

- A 24 dm^3
 - B 96 dm^3
 - C 0.25 dm^3
 - D 6 dm^3
-

22 **Supplement** The mole and the Avogadro constant [1]

0.25 mol of solute is dissolved in 250 cm^3 of solution. What is the concentration of this solution, in mol/dm^3 ?

- A 0.1 mol/dm^3
- B 1.0 mol/dm^3
- C 4.0 mol/dm^3
- D 1000 mol/dm^3

23**Supplement**

The mole and the Avogadro constant

[1]

A compound contains 82.4% nitrogen and 17.6% hydrogen by mass. Ar: N = 14, H = 1. What is the empirical formula of this compound?

- A NH
 - B NH₂
 - C NH₃
 - D N₃H
-

24**Supplement**

The mole and the Avogadro constant

[1]

A student expected to obtain 12.0 g of a salt from a reaction but actually obtained 9.6 g. What is the percentage yield?

- A 20%
- B 80%
- C 96%
- D 125%

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25**Supplement**

The mole and the Avogadro constant

[5]

Ar: Na = 23, O = 16, H = 1.

A solution of sodium hydroxide has a concentration of 8.0 g/dm^3 .

- (a) Calculate the relative formula mass, M_r , of sodium hydroxide, NaOH. [1]

- (b) Calculate the concentration of this solution in mol/dm^3 . [2]

- (c) Calculate the amount, in moles, of sodium hydroxide present in 250 cm^3 of this solution. [2]

26**Supplement**

The mole and the Avogadro constant

[5]

Ar: Mg = 24.

- (a) Calculate the amount, in moles, of magnesium atoms in 3.0 g of magnesium. [2]

- (b) Calculate the number of magnesium atoms in this 3.0 g sample. [2]

- (c) Calculate the mass of 0.60 mol of magnesium atoms. [1]

Ar: Mg = 24, H = 1, Cl = 35.5.

Magnesium reacts with hydrochloric acid: $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$

2.4 g of magnesium is added to 120 cm³ of hydrochloric acid of concentration 2.0 mol/dm³.

- (a) Calculate the amount, in moles, of magnesium used. [1]

- (b) Calculate the amount, in moles, of hydrochloric acid used. [2]

- (c) Determine which reactant is in excess. Show your working. [2]

- (d) Calculate the maximum mass of magnesium chloride, MgCl₂, that could form. [2]

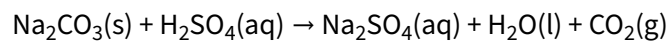
28**Supplement**

The mole and the Avogadro constant

[4]

Ar: Na = 23, C = 12, O = 16.

Excess dilute sulfuric acid reacts with 5.3 g of sodium carbonate:

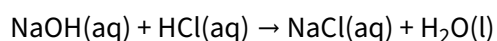


- (a) Calculate the amount, in moles, of sodium carbonate reacted. [1]

- (b) Calculate the amount, in moles, of carbon dioxide gas produced. [1]

- (c) Calculate the volume of carbon dioxide gas produced, measured at r.t.p. [2]

In a titration, 25.0 cm³ of a sodium hydroxide solution of unknown concentration was exactly neutralised by 22.5 cm³ of hydrochloric acid of concentration 0.100 mol/dm³.



- (a) Calculate the amount, in moles, of hydrochloric acid used. [1]

- (b) Calculate the amount, in moles, of sodium hydroxide that reacted. [1]

- (c) Calculate the concentration of the sodium hydroxide solution, in mol/dm³. [2]

- (d) Ar: Na = 23, O = 16, H = 1. Calculate the concentration of the sodium hydroxide solution in g/dm³. [2]

A hydrocarbon contains 85.7% carbon and 14.3% hydrogen by mass. Its relative molecular mass, M_r , is 42.

Ar: C = 12, H = 1.

- (a) Calculate the empirical formula of this hydrocarbon. Show your working. [3]

- (b) Calculate the molecular formula of this hydrocarbon. [2]
