

Formulae, Stoichiometry and the Mole Concept

Question Paper

Level	O Level
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Formulae, Stoichiometry and the Mole Concept
Booklet	Question Paper

Time Allowed: 60 minutes

Score: /50

Percentage: /100

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- 1 Compound **P** is the only substance formed when two volumes of ammonia gas react with one volume of carbon dioxide gas (both volumes being measured at r.t.p.).

What is the formula of **P**?

- A** $\text{NH}_2\text{CO}_2\text{NH}_4$
- B** $(\text{NH}_2)_2\text{CO}$
- C** $\text{NH}_4\text{CO}_2\text{NH}_4$
- D** $(\text{NH}_4)_2\text{CO}_3$

- 2 Two isotopes of chlorine are ^{35}Cl and ^{37}Cl .

Using these isotopes, how many different relative molecular masses are possible for the compound with molecular formula $\text{C}_2\text{H}_3\text{Cl}_3$?

- A** 2
- B** 3
- C** 4
- D** 5

- 3 How many moles of hydrogen chloride are formed when one mole of methane reacts with a large excess of chlorine in sunlight?

- A** 1
- B** 2
- C** 3
- D** 4

- 4 A particle contains 34 protons, 45 neutrons and 36 electrons.

Which symbol is correct for this particle?

- A** $^{79}_{34}\text{Se}$
- B** $^{79}_{34}\text{Se}^-$
- C** $^{79}_{34}\text{Se}^{2-}$
- D** $^{79}_{34}\text{Se}^{2+}$

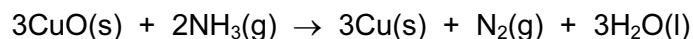
- 5 Powdered calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride, water and carbon dioxide.

Which is the correct ionic equation, including state symbols, for this reaction?

- A** $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
- B** $\text{Ca}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
- C** $\text{CO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
- D** $\text{CaCO}_3(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

- 6 What is the relative molecular mass, M_r , of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$?
- A** 127 **B** 160 **C** 178 **D** 250

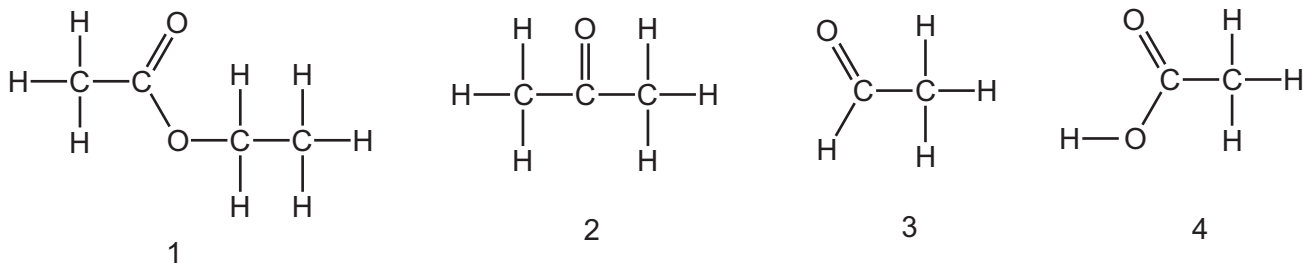
- 7 1.00 dm^3 of ammonia gas is passed over heated copper(II) oxide.



What is the volume of nitrogen formed when measured at the same temperature and pressure as the ammonia?

- A** 0.25 dm^3 **B** 0.50 dm^3 **C** 1.00 dm^3 **D** 2.00 dm^3
- 8 Using the Periodic Table for the relative atomic masses, which has the least mass?
- A** 0.1 moles of silicon dioxide, SiO_2
B 0.5 moles of oxygen, O_2
C 0.5 moles of lithium, Li
D 1.0 moles of ammonia, NH_3
- 9 Which positive ions are present in aqueous copper(II) sulfate?
- A** copper ions only
B copper ions and hydrogen ions
C sulfate ions only
D sulfate ions and hydroxide ions

15 Four compounds are shown.



Which pair of compounds have the same empirical formula?

- A** 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 and 4

16 A volume of ethane, C_2H_6 , at r.t.p. has a mass of 20 g.

What is the mass of an equal volume of propene, C_3H_6 , at r.t.p.?

- A** 20 g **B** 21 g **C** 28 g **D** 42 g

17 Analysis of a sample of an oxide of nitrogen gave the following data.

- percentage by mass of nitrogen 47%
- percentage by mass of oxygen 53%

What is the empirical formula of this oxide?

[A_r : N, 14; O, 16]

- A** NO **B** NO_2 **C** N_2O **D** N_2O_3

18 A compound **X** has the molecular formula $C_4H_8O_2$. It reacts with calcium carbonate to give carbon dioxide.

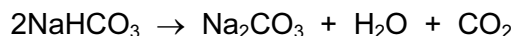
What is **X**?

- A** $HCO_2C_3H_7$
B $CH_3CO_2C_2H_5$
C $C_2H_5CO_2CH_3$
D $C_3H_7CO_2H$

- 19 What can be deduced about two gases that have the same relative molecular mass?
- A They have the same boiling point.
 - B They have the same number of atoms in one molecule.
 - C They have the same rate of diffusion at room temperature and pressure.
 - D They have the same solubility in water at room temperature.
- 20 In an experiment, 1 cm^3 of a gaseous hydrocarbon **X** required 4 cm^3 of oxygen for complete combustion to give 3 cm^3 of carbon dioxide. All gas volumes are measured at r.t.p.

Which formula represents **X**?

- A C_2H_2
 - B C_2H_4
 - C C_3H_4
 - D C_3H_8
- 21 What is the concentration of a solution containing 1.0g of sodium hydroxide in 250 cm^3 of solution?
- A 0.025 mol/dm^3
 - B 0.10 mol/dm^3
 - C 0.25 mol/dm^3
 - D 1.0 mol/dm^3
- 22 Sodium hydrogencarbonate decomposes on heating.



In an experiment, a 5.0 mol sample of sodium hydrogencarbonate is heated.

Which volume of carbon dioxide, measured at room temperature and pressure, is evolved?

- A 24 dm^3
- B 36 dm^3
- C 48 dm^3
- D 60 dm^3

23 Sulfur and selenium, Se, are in the same group of the Periodic Table.

From this, we would expect selenium to form compounds having the formulae

- A** Se_2O , Na_2Se and NaSeO_4 .
- B** SeO_2 , Na_2Se and NaSeO_4 .
- C** SeO_2 , Na_2Se and Na_2SeO_4 .
- D** SeO_3 , NaSe and NaSeO_4 .

24 The proton number of element X is 6. The proton number of element Y is 9.

What is the formula of a compound of these elements?

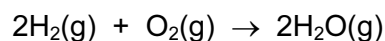
- A** X_2Y_3
- B** X_3Y_2
- C** XY_3
- D** XY_4

25 15.0 cm^3 of 1.0 mol/dm^3 potassium hydroxide just neutralise 20.0 cm^3 of a solution of nitric acid.

What is the concentration of the acid?

- A** 0.75 mol/dm^3
- B** 1.0 mol/dm^3
- C** 1.5 mol/dm^3
- D** 7.5 mol/dm^3

26 The equation for the burning of hydrogen in oxygen is shown.



What does this equation indicate?

- A** 2 atoms of hydrogen combine with 2 atoms of oxygen.
- B** 2g of hydrogen combine with 1g of oxygen.
- C** 2 moles of steam can be obtained from 0.5 mole of oxygen.
- D** 2 moles of steam can be obtained from 1 mole of oxygen.

- 27 A 10 cm³ sample of a gaseous hydrocarbon is completely burnt in oxygen. The total volume of the products is 70 cm³. All gas volumes are measured at room temperature and pressure.

Which equation represents the combustion of the hydrocarbon?

- A** $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
B $\text{C}_2\text{H}_4(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
C $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$
D $2\text{C}_2\text{H}_6(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$

- 28 The M_r of oxygen, O₂, is 32 and the M_r of sulfur is 256.

What is the formula of a molecule of sulfur?

- A** S₂ **B** S₄ **C** S₈ **D** S₁₆

- 29 Which contains the greatest mass of nitrogen?

- A** 0.5 moles (NH₄)₂SO₄
B 1 mole NH₄NO₃
C 1.5 moles (NH₄)₃PO₄
D 2 moles CO(NH₂)₂

- 30 What is the mass of oxygen contained in 72 g of pure water?
[Relative atomic masses: H = 1; O = 16]

- A** 16 g **B** 32 g **C** 64 g **D** 70 g

- 31 Element X has the electronic structure 2,8,5. Element Y has the electronic structure 2,8,7.

What is the likely formula of a compound containing only X and Y?

- A** XY₃ **B** X₂Y₃ **C** X₃Y **D** X₃Y₂

- 32 The equation for the reaction between calcium carbonate and hydrochloric acid is shown.



How many moles of calcium carbonate will give 24 cm^3 of carbon dioxide when reacted with an excess of the acid?

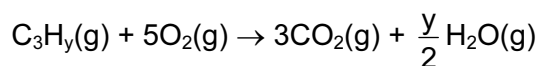
(Assume one mole of carbon dioxide occupies 24 dm^3 .)

- A** 1 mol **B** 0.1 mol **C** 0.01 mol **D** 0.001 mol
- 33 The empirical formula of a liquid compound is $\text{C}_2\text{H}_4\text{O}$.
To find the empirical formula, it is necessary to know the
- A** density of the compound.
B percentage composition of the compound.
C relative molecular mass of the compound.
D volume occupied by 1 mole of the compound.
- 34 When a compound X is reacted with sodium carbonate, carbon dioxide gas is evolved.
What could be the formula of compound X?
- A** $\text{C}_2\text{H}_5\text{CO}_2\text{CH}_3$ **B** $\text{C}_3\text{H}_7\text{CO}_2\text{H}$ **C** $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$ **D** $\text{C}_4\text{H}_9\text{OH}$
- 35 Which compound contains three elements?
- A** aluminium chloride
B iron(III) oxide
C potassium oxide
D sodium carbonate
- 36 What is the ratio of the number of molecules in 71 g of gaseous chlorine to the number of molecules in 2 g of gaseous hydrogen? [Relative atomic masses A_r (atomic weights): H, 1; Cl, 35.5]
- A** 1:1 **B** 1:2 **C** 2:1 **D** 71:2

37 Which equation shows a reaction that would actually take place?

- A $2\text{MgO} + \text{C} \rightarrow \text{CO}_2 + \text{Mg}$
- B $\text{MgO} + \text{Cu} \rightarrow \text{CuO} + \text{Mg}$
- C $\text{PbO} + \text{Zn} \rightarrow \text{ZnO} + \text{Pb}$
- D $\text{ZnO} + \text{H}_2 \rightarrow \text{H}_2\text{O} + \text{Zn}$

38 A hydrocarbon, C_3H_y , burns in air to form carbon dioxide and water.



What is the value of y?

- A 4 B 6 C 7 D 8

39 Under certain conditions 1 mole of ethane reacts with 2 moles of chlorine in a substitution reaction.

What is the formula of the organic product in this reaction?

- A $\text{C}_2\text{H}_5\text{Cl}$ B $\text{C}_2\text{H}_4\text{Cl}_2$ C $\text{C}_2\text{H}_2\text{Cl}_4$ D CH_2Cl_2

40 What is the mass of one mole of carbon-12?

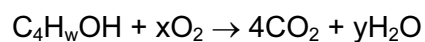
- A 0.012g B 0.024g C 1g D 12g

41 Two different hydrocarbons each contain the same percentage by mass of hydrogen.

It follows that they have the same

- A empirical formula.
- B number of isomers.
- C relative molecular mass.
- D structural formula.

- 42 When butanol, represented by C_4H_wOH , burns in air, carbon dioxide and water are formed.



Which values of w , x and y balance the equation?

	w	x	y
A	8	6	4
B	9	6	4
C	9	6	5
D	10	7	5

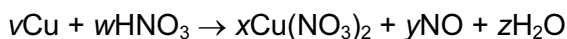
- 43 What is the concentration of iodine molecules, I_2 , in a solution containing 2.54 g of iodine in 250 cm^3 of solution?

- A** 0.01 mol/dm^3
- B** 0.02 mol/dm^3
- C** 0.04 mol/dm^3
- D** 0.08 mol/dm^3

- 44 Which gas contains the same number of molecules as 9 g of water?

- A** 2 g of hydrogen
- B** 14 g of nitrogen
- C** 32 g of oxygen
- D** 44 g of carbon dioxide

45 The equation for the reaction between copper and nitric acid is shown.



v , w , x , y and z are whole numbers.

Which values of v , w , x , y and z balance the equation?

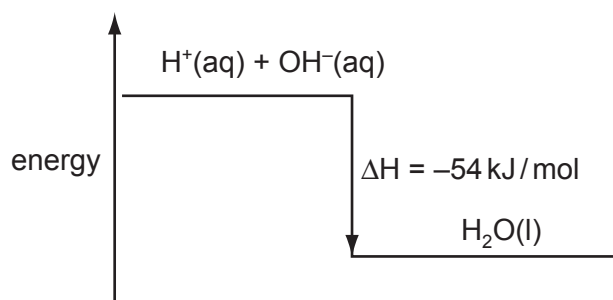
	v	w	x	y	z
A	1	2	1	1	1
B	1	4	1	2	2
C	3	4	3	2	2
D	3	8	3	2	4

46 The mass of one mole of a chloride formed by a metal Y is 74.5g.

What is the formula of the chloride?

- A** Y_3Cl **B** Y_2Cl **C** YCl **D** YCl_2

47 The energy diagram for the reaction between sodium hydroxide and hydrochloric acid is shown.



Which quantity of heat is liberated when 100 cm^3 of 1 mol/dm^3 hydrochloric acid reacts with 100 cm^3 of 1 mol/dm^3 sodium hydroxide?

- A** 0.54 kJ **B** 2.70 kJ **C** 5.40 kJ **D** 10.8 kJ

48 What is the **ionic** equation for the reaction between zinc and aqueous copper(II) sulfate?

- A $\text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq})$
- B $\text{Zn}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{ZnSO}_4(\text{s})$
- C $\text{Zn}(\text{s}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu}(\text{s})$
- D $\text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s})$

49 Calcium reacts with phosphorus to form the ionic compound calcium phosphide.

Which ions will this compound contain?

- A Ca^{2+} and P^{3-}
- B Ca^{2+} and P^{5-}
- C Ca^{2-} and P^{3+}
- D Ca^{2-} and P^{5+}

50 A sample of hydrogen is a mixture of the two isotopes ${}^1_1\text{H}$ and ${}^2_1\text{H}$.

The relative atomic mass of oxygen is 16.

What are possible values of the relative molecular mass of different molecules of water formed by the combination of oxygen and hydrogen?

- 1 18
 - 2 19
 - 3 20
- A 1 only
 - B 1 and 2 only
 - C 1 and 3 only
 - D 1, 2 and 3