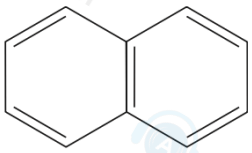
1 What is the molecular formula of naphthalene?



☒ **A** $C_{10}H_8$

☒ **B** $C_{10}H_{10}$

☒ **C** $C_{12}H_{10}$

☒ **D** $C_{12}H_{12}$

(Total for Question 1 = 1 mark)

5: Which mass of fertiliser contains 467 g of nitrogen?

☒ **A** 2 kg sodium nitrate ($NaNO_3$; $M_r = 85$)

☒ **B** 1 kg urea (NH_2CONH_2; $M_r = 60$)

☒ **C** 1 kg ammonium nitrate (NH_4NO_3; $M_r = 80$)

☒ **D** 1 kg ammonium sulfate ($(NH_4)_2SO_4$; $M_r = 132.1$)

(Total for Question 5 = 1 mark)

5 Diphosphane, P_2H_4, reacts spontaneously with oxygen.

$$xP_2H_4 + yO_2 \rightarrow P_4O_{10} + zH_2O$$

The equation for this reaction is balanced when

☒ **A** $x = 1$ $y = 6$ $z = 2$

☒ **B** $x = 2$ $y = 6$ $z = 2$

☒ **C** $x = 2$ $y = 7$ $z = 4$

☒ **D** $x = 4$ $y = 9$ $z = 8$

(Total for Question 5 = 1 mark)

7 This question is about the thermal decomposition of calcium nitrate.

$$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$$

What volume of gas is produced by the complete decomposition of 0.050 mol of calcium nitrate at room temperature and pressure (r.t.p.)?

[Molar volume of a gas at r.t.p. = 24 $dm^3 mol^{-1}$]

- ☒ **A** 600 cm^3
- ☒ **B** 1.20 dm^3
- ☒ **C** 3.00 dm^3
- ☒ **D** 6.00 dm^3

(Total for Question 7 = 1 mark)

4 What is the pressure when 5.00 mol of nitrogen in a container with a volume of 1.50 m^3 is heated to 500 K?

[$pV = nRT$ $R = 8.31\ J K^{-1} mol^{-1}$]

- ☒ **A** 13.9 Pa
- ☒ **B** 6 290 Pa
- ☒ **C** 13 900 Pa
- ☒ **D** 31 200 Pa

(Total for Question 4 = 1 mark)

1 What is the total number of **atoms** in 8.8 g of carbon dioxide?

[M_r value: $CO_2 = 44$ Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$]

- ☒ **A** 1.2×10^{23}
- ☒ **B** 3.6×10^{23}
- ☒ **C** 1.2×10^{24}
- ☒ **D** 3.6×10^{24}

(Total for Question 1 = 1 mark)

13 Which solution contains chloride ions with a concentration of 0.0500 mol dm^{-3}?

[A_r values: Ca = 40.1 Cl = 35.5 Na = 23.0]

	Solute	Mass of solute / g	Volume of solution / cm^3
☒ **A**	calcium chloride	1.39	250
☒ **B**	calcium chloride	1.39	500
☒ **C**	sodium chloride	1.46	250
☒ **D**	sodium chloride	1.46	1000

(Total for Question 13 = 1 mark)

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3 How many oxygen **atoms** are there in 0.0100 mol of H_2SO_4?

[Avogadro constant, $L = 6.020 \times 10^{23}$ mol^{-1}]

☒ **A** 6.020×10^{21}

☒ **B** 1.204×10^{22}

☒ **C** 2.408×10^{22}

☒ **D** 4.214×10^{22}

(Total for Question 3 = 1 mark)

6 Copper metal can displace silver from silver nitrate solution according to the equation shown.

$$Cu + 2AgNO_3 \rightarrow 2Ag + Cu(NO_3)_2$$

10 g of copper metal was added to an excess of silver nitrate solution.

The silver metal was collected, washed with deionised water and left to dry.

What is the mass of silver metal collected, assuming a 100 % yield?

☒ **A** between 10 g and 20 g

☒ **B** 20 g

☒ **C** between 20 g and 40 g

☒ **D** more than 40 g

(Total for Question 6 = 1 mark)

2 What is the concentration of hydroxide ions in a solution containing 5.00 g of $Ba(OH)_2$ in 250 cm^3?

[M_r $Ba(OH)_2$ = 171.3]

- ☒ **A** 0.0292 mol dm^{-3}
- ☒ **B** 0.0584 mol dm^{-3}
- ☒ **C** 0.1168 mol dm^{-3}
- ☒ **D** 0.2335 mol dm^{-3}

(Total for Question 2 = 1 mark)

4 N_xO_4 is an oxide of nitrogen.
The percentage by mass of oxygen in this oxide is 69.57%.

What is the relative molecular mass of this oxide?

- ☒ **A** 78
- ☒ **B** 92
- ☒ **C** 106
- ☒ **D** 109

(Total for Question 4 = 1 mark)

14 The formula of phosgene is $COCl_2$.
What is the total number of **atoms** in 9.9 g of phosgene?

[Avogadro constant (L) = 6.02×10^{23} mol^{-1} M_r value: $COCl_2$ = 99.0]

- ☒ **A** 1.51×10^{22}
- ☒ **B** 6.02×10^{22}
- ☒ **C** 1.81×10^{23}
- ☒ **D** 2.41×10^{23}

(Total for Question 14 = 1 mark)

7 1 kg of seawater contains 64 mg of bromide ions.

[A_r of Br = 80 Avogadro constant, $L = 6.0 \times 10^{23}$ mol^{-1}]

(a) What is the concentration of bromide ions in parts per million (ppm) by mass?

(1)

- ☒ **A** 0.80
- ☒ **B** 64
- ☒ **C** 800
- ☒ **D** 64 000

(b) How many bromide ions are in 500 g of the sample?

(1)

- ☒ **A** 2.4×10^{20}
- ☒ **B** 4.8×10^{20}
- ☒ **C** 1.9×10^{22}
- ☒ **D** 3.8×10^{22}

(Total for Question 7 = 2 marks)

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5 Four different solutions contain chloride ions.
Three of the solutions contain the same number of moles of chloride ions.

Which solution contains a different number?

- ☒ **A** 15.0 cm^3 of 0.80 mol dm^{-3} hydrochloric acid
- ☒ **B** 10.0 cm^3 of 0.40 mol dm^{-3} iron(III) chloride solution
- ☒ **C** 10.0 cm^3 of 0.90 mol dm^{-3} magnesium chloride solution
- ☒ **D** 20.0 cm^3 of 0.60 mol dm^{-3} sodium chloride solution

(Total for Question 5 = 1 mark)

21 Boric acid is a white solid often used as an antiseptic.

(a) Boric acid contains 17.48% by mass of boron, 77.67% of oxygen and the remainder is hydrogen. The molar mass of boric acid is 61.8 g mol^{-1}.
[A_r values: H = 1 B = 10.8 O = 16]

Show that the molecular formula of boric acid is H_3BO_3.

You must show all your working.

(4)

(b) The formula of boric acid can also be written as $B(OH)_3$.

(i) Draw a dot-and-cross diagram for this molecule.
Show outer electrons only.

(3)

(ii) Suggest a value for the O—B—O bond angle. Justify your answer.

(2)

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(Total for Question 21 = 9 marks)

17 Sodium hydroxide can be obtained as a hydrate, $NaOH \cdot xH_2O$.
When heated, the water of crystallisation is lost, leaving anhydrous sodium hydroxide, NaOH, as shown in the equation.

$$NaOH \cdot xH_2O \rightarrow NaOH + xH_2O$$

An experiment was carried out to determine the value of x in $NaOH \cdot xH_2O$.

Procedure

Step **1** Weigh and record the mass of a clean, dry crucible.

Step **2** Add approximately 1.0 g of $NaOH \cdot xH_2O$ to the crucible and record the mass.

Step **3** Heat the crucible and its contents until a constant mass has been reached.

Step **4** After allowing to cool, reweigh the crucible and the anhydrous solid.

Step **5** Calculate and record the mass of the anhydrous solid.

Repeat Steps **1** to **5** using a different mass of the hydrated sodium hydroxide.

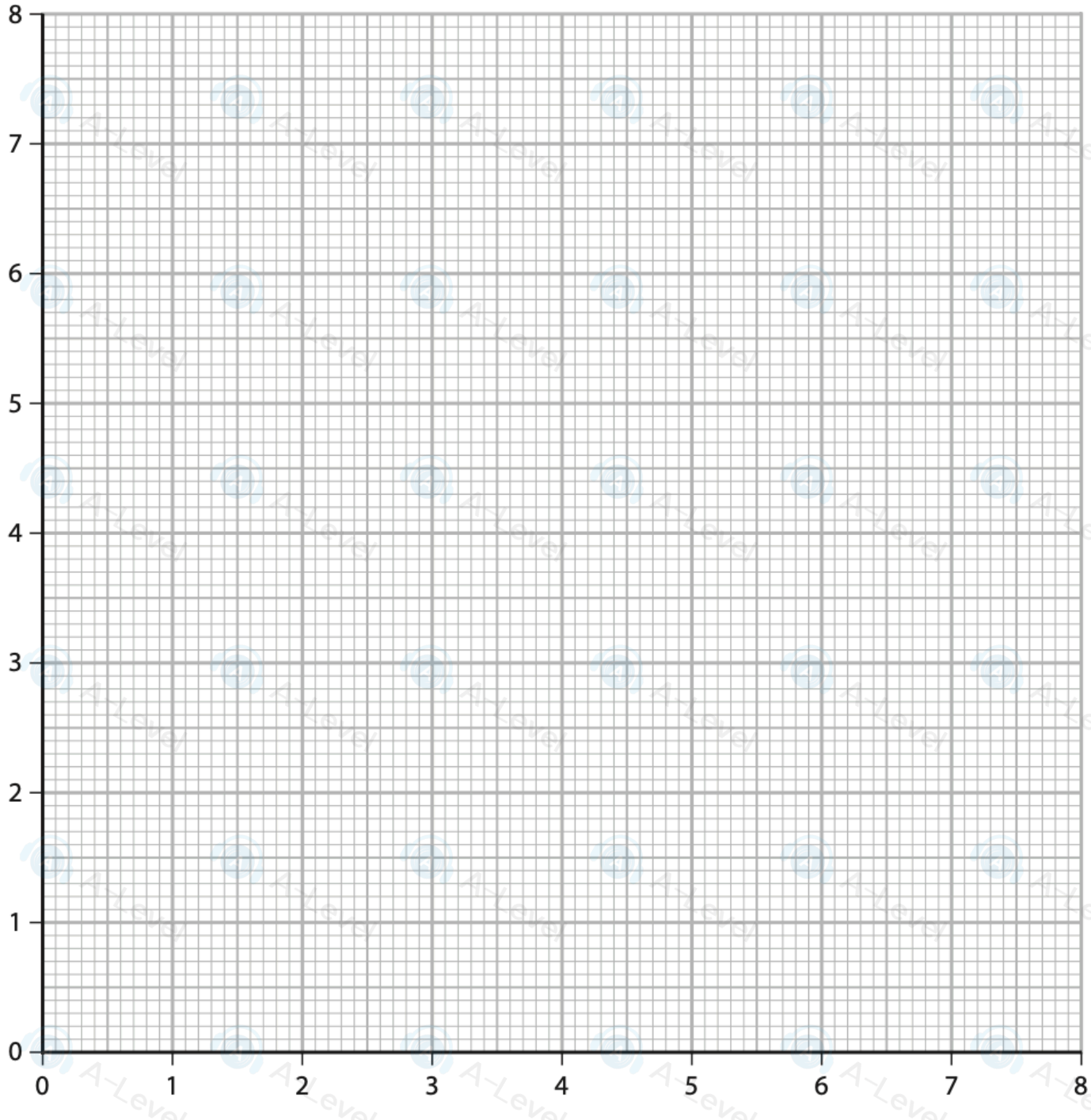
Results

Mass of $NaOH \cdot xH_2O$ / g	Mass of NaOH / g
1.00	0.69
2.10	1.45
3.50	2.41
4.90	3.38
6.60	4.55
8.00	5.52

(a) (i) Complete a graph of the results by

- plotting the points
- labelling the axes
- including a straight line of best fit.

(3)



(ii) Use your graph to determine the mass of $NaOH \cdot xH_2O$ needed to form 4.0 g of NaOH. You must show your working on the graph.

(1)

(iii) Calculate the value of x in $NaOH \cdot xH_2O$ using your answer to (a)(ii) and the equation for the reaction.

$$NaOH \cdot xH_2O \rightarrow NaOH + xH_2O$$

(3)

(b) Sodium hydroxide also forms a heptahydrate, $NaOH \cdot 7H_2O$.

Calculate the mass of this heptahydrate needed to make 250 cm^3 of a solution of sodium hydroxide of concentration 0.150 mol dm^{-3}.

(2)

24 A sample of a volatile liquid **X** was vaporised.
At 473 K and 110 000 Pa, 3.50 g of **X** occupies 1.79 dm^3.

(a) (i) Calculate the number of moles of **X** in the sample.

[$R = 8.31\ J\ mol^{-1}\ K^{-1}$]

Use $pV = nRT$

(4)

(ii) Deduce the relative molecular mass of **X**.

(1)

(iii) Compound **X** contains 85.7 % carbon and 14.3 % hydrogen by mass.

Calculate the empirical formula of **X**.

(2)

(iv) Deduce the molecular formula of **X**.

(1)

(b) A few drops of a purple solution of acidified potassium manganate(VII) were added to a sample of liquid **X** and shaken.
The solution remained purple.

State what can be deduced about the structure of **X** from this experiment.

(1)

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(c) Identify, by name or formula, **two** possible structural isomers of **X** using your answers to (a)(iv) and (b).

(2)

(Total for Question 24 = 11 marks)