

The Mole and Simple Calculations

Q1. (2018) – 4a (iii)

- 4 Ethanol can be used as a liquid fuel.

A student investigates how much heat energy is released when a known mass of ethanol is burned.

The apparatus is set up as shown in Figure 3.

A known volume of water is placed in a metal can.

The temperature of the water is measured.

The ethanol is ignited and placed under the beaker so that the flame is touching the beaker.

The water is heated by the flame.

The flame is extinguished.

The final temperature of the water is measured.

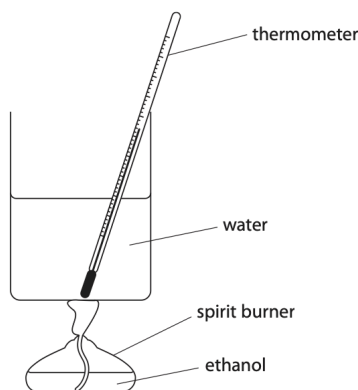


Figure 3

- (a) The theoretical temperature rise for burning a given mass of ethanol is 82.4°C.

In the experiment the actual temperature rise for burning this mass of ethanol was only 34.8°C.

One reason why the temperature rise is less than expected is that the ethanol does not burn completely.

- (iii) The amount of heat energy used to raise the temperature of the water by 34.8°C can be calculated using

$$\text{heat energy} = 210 \times \text{temperature rise}$$

Calculate the amount of heat energy used.

(2)

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heat energy = ... (energy units)

Q2. (2018) – 9b

- 9 (a) The rate of reaction between magnesium ribbon and dilute hydrochloric acid at room temperature is investigated.

The apparatus used is shown in Figure 11.

The volume of hydrogen gas given off was measured at regular intervals during the reaction.

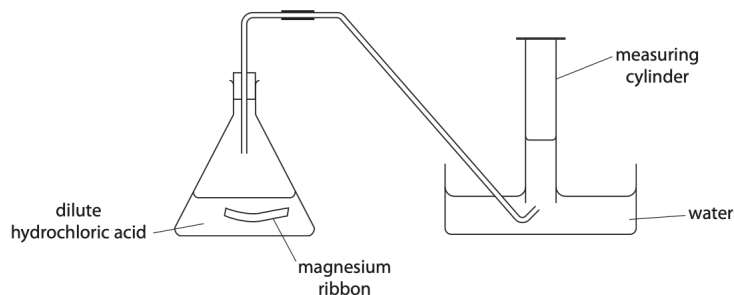


Figure 11

The graph in Figure 12 shows the results of this experiment.

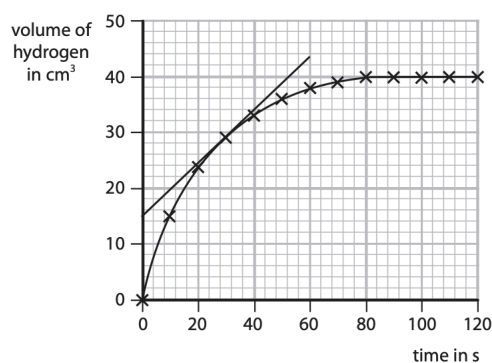
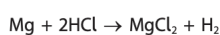


Figure 12

- (b) The balanced equation for this reaction is



Question:

- (i) In another experiment, 0.1 moles of hydrochloric acid, HCl, were reacted with 0.1 g of magnesium ribbon.

Calculate the number of moles of magnesium, Mg, in the 0.1 g sample of magnesium ribbon.

(relative atomic mass: Mg = 24)

(1)

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number of moles = ...

Q3. (2019) – 5c

(c) Calculate the number of molecules in 0.11 g of carbon dioxide.

Give your answer to two significant figures.

(relative formula mass : $\text{CO}_2 = 44$
Avogadro constant = 6.02×10^{23})

(3)

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number of molecules = ...

Q4. (2020) – 4d

4 Figure 2 shows the structure of a molecule of dichloroethene.

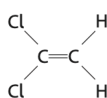


Figure 2

(d) An industrial process uses 500 tonnes of dichloroethene.
In the process only 96.5% of the dichloroethene molecules react.

Calculate the mass of dichloroethene that has **not** reacted.

Give your answer to two significant figures.

(3)

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mass = ... tonnes

Q5. (2020) – 7b

(b) The density of a gas can be found using the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

A student carried out an experiment to find the density of argon.

The mass of a stopper and flask, containing no gas, was known.
The flask was completely filled with argon and its mass measured.

Figure 4 shows the results the student wrote down.

mass of stopper and flask in g	78.639
mass of stopper and flask full of argon in g	79.120
volume of flask in cm^3	250.0

Figure 4

(i) Use the results to calculate the density of argon in g cm^{-3} .

(2)

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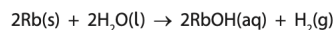
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density of argon = ... g cm^{-3}

Q6. (2020) – 8a (iii)

8 The first four elements in group 1 are lithium, sodium, potassium and rubidium.

(a) Rubidium reacts with water to form rubidium hydroxide and hydrogen.



(iii) 8.5 g of rubidium are reacted completely with water.

The reaction makes a solution of rubidium hydroxide.

The volume of this solution is 2.5 dm³.

Calculate the concentration of the rubidium hydroxide solution in g dm⁻³.

(relative atomic mass: Rb = 85; relative formula mass: RbOH = 102)

(4)

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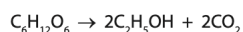
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concentration = ... g dm⁻³

Q7. (2020) – 10b

(b) The equation for the fermentation of a carbohydrate is



Calculate the maximum mass of carbon dioxide that could be produced if 135 g of this carbohydrate is fully fermented.

(relative formula masses: CO₂ = 44; C₆H₁₂O₆ = 180)

(3)

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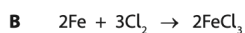
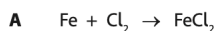
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mass of carbon dioxide = ... g

Q8. (2021) – 8c

(c) When iron reacts with chlorine, iron chloride is formed.

Two possible equations for this reaction are



In an experiment, 8.40 g iron reacts with chlorine to form 19.05 g iron chloride.

Show, using a calculation, which reaction, **A** or **B**, is taking place.

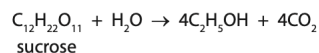
You must show your working.

(relative atomic masses: Cl = 35.5, Fe = 56.0)

(3)

Q9. (2021) – 10b

- (b) The balanced equation for the production of ethanol from the carbohydrate sucrose is



Calculate the minimum mass of sucrose needed to produce 26.9 g of ethanol.

(relative formula masses: $\text{C}_2\text{H}_5\text{OH} = 46$, $\text{C}_{12}\text{H}_{22}\text{O}_{11} = 342$)

(2)

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minimum mass of sucrose = ... g

Q10. (2021) – 10c

- (c) Calculate the total number of atoms in 10.0 g of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$.

(relative formula mass: $\text{C}_{12}\text{H}_{22}\text{O}_{11} = 342$; Avogadro constant = 6.02×10^{23})

(2)

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number of atoms = ...

Q11. (2022) – 3c

- (c) When calcium carbonate is heated it decomposes.



When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.

(2)

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mass of carbon dioxide = ... g

Q12. (2022) – 3e

- (e) Oxygen gas has the formula O_2 .

Calculate the number of oxygen **atoms** in 3.50 mol of oxygen gas.

(Avogadro constant = 6.02×10^{23})

(2)

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.....

number of oxygen atoms = ...

Q13. (2022) – 7b, 7c

A)

- (b) Magnesium reacts with oxygen from the air to form magnesium oxide.

A student carries out an investigation to determine the mass of magnesium oxide formed when a known mass of magnesium reacts completely with oxygen.

This is the method the student used.

- step 1** find the mass of a crucible and lid
- step 2** put a known mass of magnesium into the crucible and put the lid on
- step 3** heat for five minutes using a roaring Bunsen burner flame
- step 4** let the crucible, lid and contents cool down
- step 5** find the final mass of the crucible, lid and contents

Explain how the student could check that the magnesium had reacted completely with oxygen.

(2)

B)

- (c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

(4)

Q14. (2024) – 3b

- (b) Copper reacts with oxygen to form copper oxide.

2.100 g of copper will react completely with 0.529 g of oxygen.

In an experiment, 4.200 g of copper is heated with 50.000 g of oxygen until the reaction is complete.

Calculate the mass of oxygen remaining at the end of the experiment.

(2)

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mass of oxygen = ... g

Q15. (2024) – 6b (ii)

- (ii) A hydrocarbon,
- C_xH_y
- , is burned in excess oxygen, forming 26.4 g of carbon dioxide and 5.4 g of water.

The relative formula mass of C_xH_y is 78.

Calculate the molecular formula of the hydrocarbon C_xH_y .

(relative atomic masses: H = 1.0, C = 12;

relative formula masses: H_2O = 18, CO_2 = 44)

(4)

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molecular formula = ...

Q16. (2024) – 10a (ii)

10 (a) Figure 13 shows the apparatus used to burn different alcohols.

The mass of each alcohol required to raise the temperature of the water by 40°C is found.

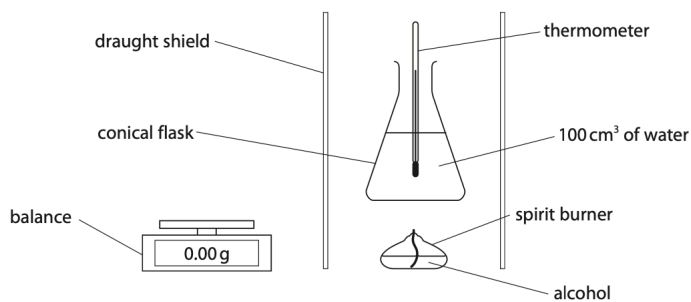


Figure 13

(ii) It is found that 1.6 g of ethanol is used to raise the temperature of water by 40°C .

Calculate the number of moles of ethanol used.
Give your answer to two significant figures.
(relative formula mass: ethanol = 46)

(2)

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number of moles = ...