OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



EXAM QUESTION PACK

M1 ARITHMETIC AND NUMERICAL COMPUTATION

SCORE	PERCENTAGE
/89	%

STEMUP

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Gateway Chemistry A (9-1)

Maths 1: Arithmetic and numerical computation

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **89**.
- The total number of marks may take into account some 'either/or' question choices.

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1(a) Mark is heating different masses of magnesium in oxygen.

Magnesium oxide is made.

Look at Mark's results.

Experiment	Mass of magnesium heated in g	Mass of oxygen used in g	Mass of magnesium oxide made in g
1	0.20	0.13	0.33
2	0.40	0.27	0.67
3	0.60	0.40	1.00
4	1.00	_____	1.67

Complete the table.

(b) What do Mark's results tell you about the relationships between the mass of magnesium, mass of oxygen and the mass of magnesium oxide?

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[2]

(c) Look at the results.

Calculate the percentage by mass of magnesium in magnesium oxide.

percentage by mass of magnesium = _____ %

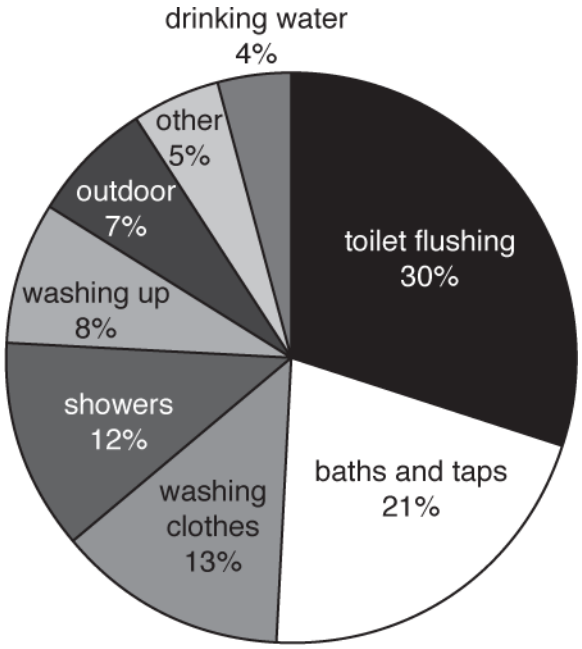
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2 Look at the pie chart. It shows how water is used in a typical home in the UK.



What percentage of water is used to wash clothes and wash dishes?

---------- % [1]

3(a) The acidity of sea water is increasing.

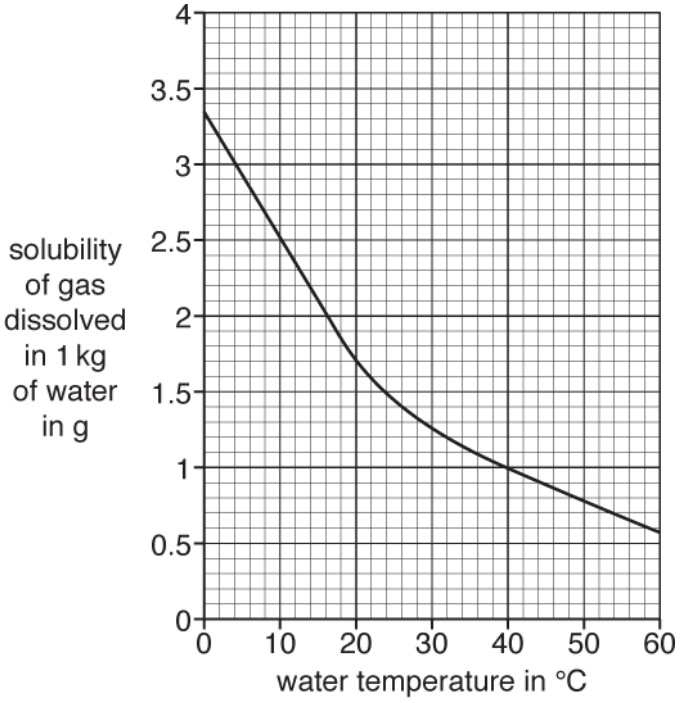
Scientists think that increased levels of carbon dioxide and sulfur dioxide in the air cause this increase.

Both these gases dissolve in water to make acidic solutions.

The solubility of these gases in water changes with temperature.

Look at graph 1.
It shows the solubility of carbon dioxide in water at different temperatures.

Graph 1 – solubility of carbon dioxide



(i) At what temperature is the solubility of carbon dioxide 1 g dissolved in 1 kg of water?

answer _____ [1]

(ii) Describe what happens to the solubility of carbon dioxide as the temperature increases.

_____

_____ [1]

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(iii) Julie has 3.0 kg of water at 10 °C.

She predicts she can dissolve 7.5 g of carbon dioxide in this water.

Is she correct?

Explain your answer using information from the graph.

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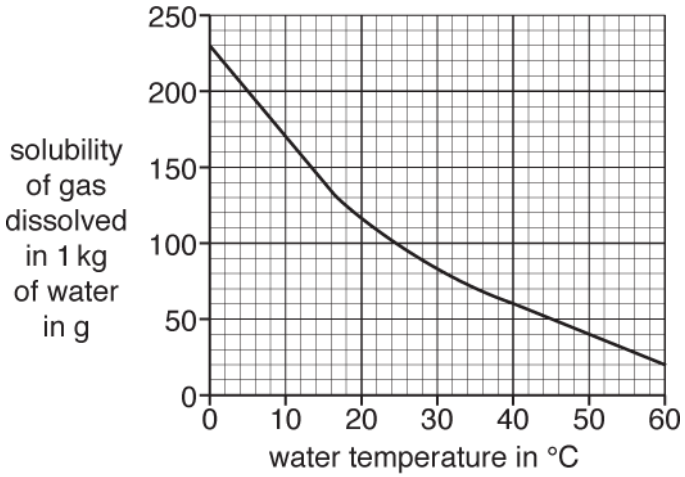
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(b) Look at graph **2**.

It shows the solubility of sulfur dioxide in water at different temperatures.

Graph 2 – solubility of sulfur dioxide



Sulfur dioxide is **more soluble** in water than carbon dioxide.

Explain how you can tell from graphs **1 and 2**.

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[2]

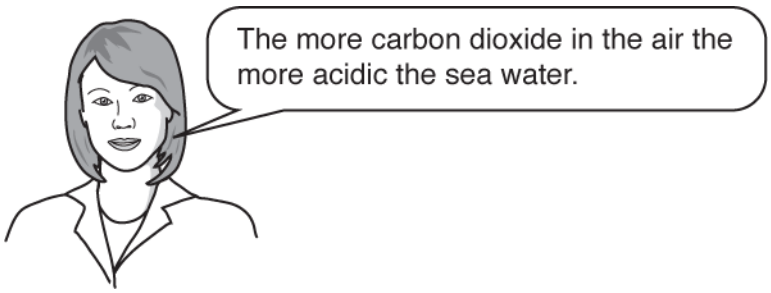
(c) Look at the table.

It shows information on sea water near a remote island in the Atlantic Ocean.

Year	pH of sea water	Percentage (%) by volume of carbon dioxide in the air	Mass of carbon dioxide in 1 kg of sea water in g
1990	8.00	0.035	1.50
1995	7.98	0.036	1.51
2000	7.95	0.037	1.52
2005	7.93	0.038	1.53
2010	7.90	0.039	1.55

The lower the pH of the ocean the more acidic it is.

Ann makes a conclusion.



(i) Which pattern in the information in the table supports this conclusion?

--- [1]

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(ii) Describe **two other** patterns in the information in the table.

---[2]

(iii) Nick thinks that the data in the table is not reliable or valid.

He thinks that the temperature of the ocean should have been recorded in the table.

Suggest why Nick is correct.

---[1]

4 A sample of 42 g of magnesium carbonate contains 12 g of magnesium.

Calculate the percentage by mass of magnesium in magnesium carbonate.

Quote your answer to **one** decimal place.

percentage by mass = ---------- % [2]

5(a) The acidity of sea water is increasing.

Scientists think that increased levels of carbon dioxide and sulfur dioxide in the air cause this increase.

Both these gases dissolve in water to make acidic solutions.

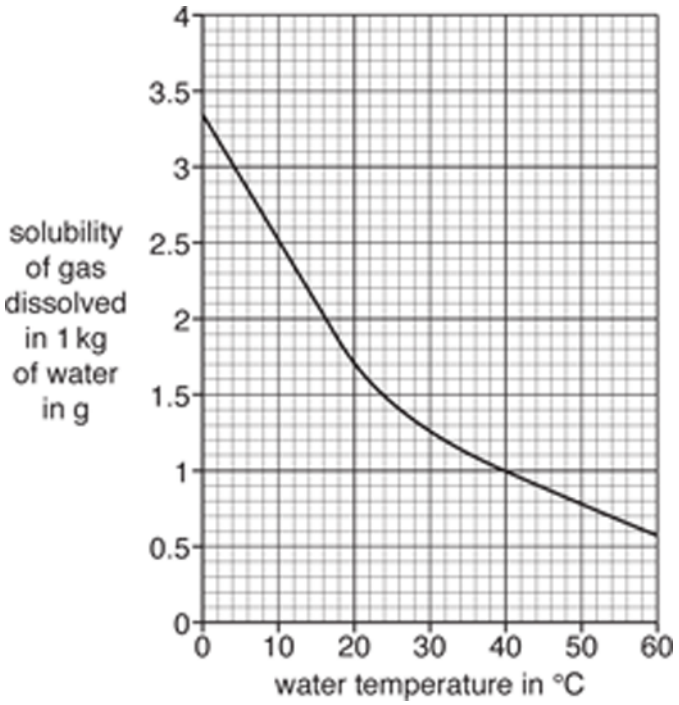
The solubility of these gases in water changes with temperature.

The more gas that dissolves in water the more acidic the solution.

Look at graph 1.

It shows the solubility of carbon dioxide in water at different temperatures.

Graph 1 – solubility of carbon dioxide



(i) At what temperature is the solubility of carbon dioxide 1.4 g dissolved in 1 kg of water?

----------°C **[1]**

(ii) Julie has 3.0 kg of water at 10 °C.

She predicts she can dissolve 7.5 g of carbon dioxide in this water.

Is she correct?

Explain your answer using information from the graph.

---

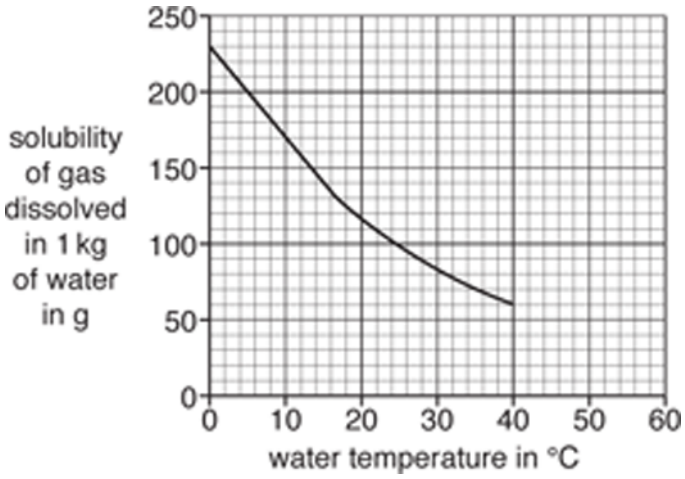
[2]

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(b) Look at graph **2**.

It shows the solubility of sulfur dioxide in water at different temperatures.

Graph 2 – solubility of sulfur dioxide



(i) Sulfur dioxide is at least fifty times more soluble in water than carbon dioxide.

Explain how you can tell from graphs **1** and **2**.

---

[2]

(ii) Use the graph to estimate the solubility of sulfur dioxide at 60 °C.

---g of gas dissolved per kg of water **[1]**

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(iii) The Arctic Ocean is very cold.

The Indian Ocean is quite warm.

Suggest why the Arctic Ocean is more acidic than the Indian Ocean.

Use information from graphs **1** and **2**.

---

[1]

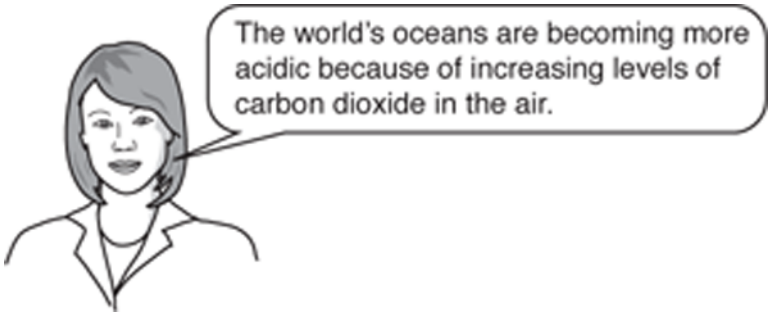
(c) Look at the table.

It shows information obtained on sea water near a remote island in the Atlantic Ocean.

Year	pH of sea water	Percentage (%) by volume of carbon dioxide in the air	Mass of carbon dioxide in 1 kg of sea water in g
1990	8.00	0.035	1.50
1995	7.98	0.036	1.51
2000	7.95	0.037	1.52
2005	7.96	0.038	1.53
2010	7.90	0.039	1.55

Ann knows that the lower the pH the more acidic a solution.

Ann makes a conclusion.



Nick thinks that the data in the table is not reliable or valid.

(i) He thinks that the temperature of the ocean should have been recorded in the table.

Suggest why Nick is correct.

---

[1]

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(ii) Suggest **two other** reasons why Ann's conclusion may not be reliable or valid.

---

[2]

6 Butane has the molecular formula C_4H_{10}.

What is the **empirical** formula of butane?

A CH_5

B C_2H_5

C C_4H_{10}

D CH_{14}

Your answer ☐ [1]

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7 Ethanol, C_2H_5OH, burns in oxygen. Carbon dioxide and water are made.

Which equation for this reaction is correctly balanced?

A $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$
B $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
C $C_2H_5OH + 2O_2 \rightarrow 3CO_2 + 2H_2O$
D $2C_2H_5OH + 7O_2 \rightarrow 4CO_2 + 6H_2O$

Your answer ☐ [1]

8 Oxygen reacts with 1.20 g of carbon. 4.40 g of carbon dioxide forms.

$C + O_2 \rightarrow CO_2$

What mass of oxygen is used in this reaction?

A 0.80 g
B 1.60 g
C 3.20 g
D 5.60 g

Your answer ☐ [1]

9 The symbol of an aluminium ion is Al^{3+}.

The symbol of an oxide ion is O^{2-}.

What is the formula of aluminium oxide?

A AlO
B Al_2O
C Al_3O_2
D Al_2O_3

Your answer ☐ [1]

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10 The burning of methane gas is an exothermic reaction.

When methane, CH_4, burns in oxygen, O_2, carbon dioxide, CO_2, and water, H_2O, are made.

Write the **balanced symbol equation** for this reaction.

[2]

11 Acids are substances that turn universal indicator paper red.

(i) What makes a substance acidic?

[1]

(ii) Sodium hydroxide, NaOH, is an alkali.

Sodium hydroxide neutralises sulfuric acid, H_2SO_4. The reaction makes a salt called sodium sulfate, Na_2SO_4. Water is also made.

Complete the **balanced symbol equation** for this reaction.

..... $NaOH + H_2SO_4 \rightarrow Na_2SO_4$ + ... H_2O

[2]

12 A student is making perfume using violet flowers.

The student does an experiment to extract the perfume from the flowers using the apparatus shown in **Fig. 21.1**.

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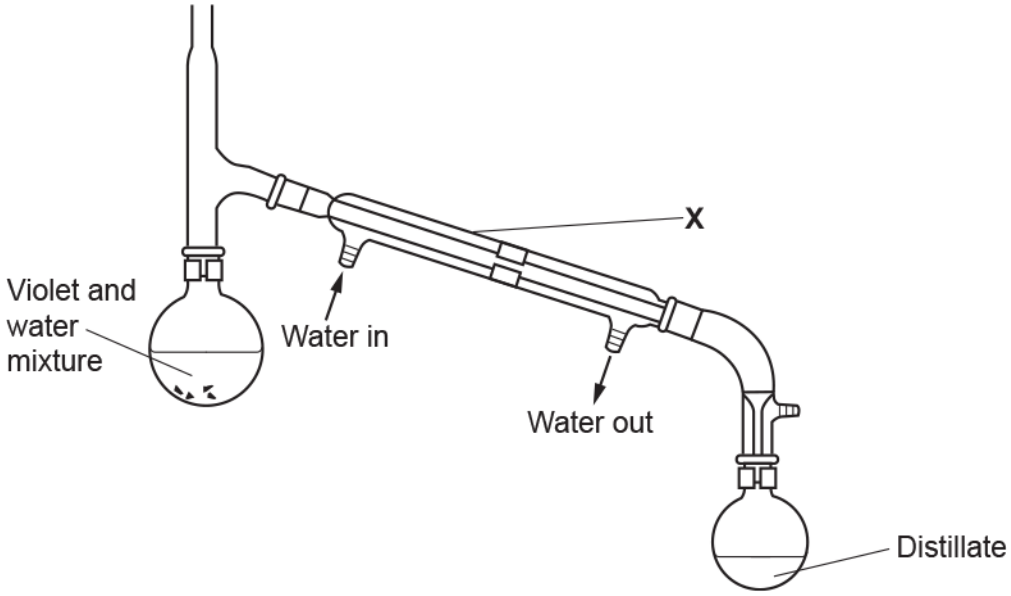


Fig. 21.1

The student finds out that phosphate fertilisers are used to help to grow flowers.

Compound **A** is a fertiliser of a metal **M** with the formula $\mathbf{M}_3PO_4$.

The relative formula mass of compound **A** is 164.0.

Do a calculation to identify metal **M**.

Use the relative atomic masses in the Periodic Table.

Metal **M** = ... **[3]**

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13 The formula of ammonium carbonate is $(NH_4)_2CO_3$.

What is the relative formula mass of ammonium carbonate?
(A_r: C = 12, H = 1, N = 14, O = 16)

A 78
B 90
C 96
D 120

Your answer ☐ **[1]**

14 Magnesium reacts with chlorine. Magnesium chloride is made.

What is the balanced symbol equation for this reaction?

A $Mg + Cl \rightarrow MgCl$
B $Mg + Cl_2 \rightarrow MgCl_2$
C $2Mg + Cl_2 \rightarrow 2MgCl$
D $2Mg + Cl_2 \rightarrow Mg_2Cl_2$

Your answer ☐ **[1]**

15 Avogadro's constant has a value of 6.02×10^{23}.

What is the number of atoms in 0.5 mol of water?

A 2.00×10^{23}
B 3.01×10^{23}
C 6.02×10^{23}
D 9.03×10^{23}

Your answer ☐ **[1]**

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16 Sodium hydroxide reacts with hydrochloric acid. Sodium chloride and water are made.

$NaOH + HCl \rightarrow NaCl + H_2O$

What mass of sodium hydroxide would be needed to make 46.8 g of sodium chloride?

A 16 g
B 32 g
C 50 g
D 64 g

Your answer [1]

17 Phosphoric acid contains phosphate ions, PO_4^{3-}.

Phosphoric acid is completely neutralised by sodium hydroxide.

What is the formula of the salt that is made?

A Na_2PO_4
B Na_3PO_4
C $Na(PO_4)_3$
D $Na_2(PO_4)_3$

Your answer [1]

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18 Calcium carbonate thermally decomposes to make calcium oxide and carbon dioxide.

$CaCO_3 \rightarrow CaO + CO_2$

Calculate the mass of calcium carbonate needed to make 209g of calcium oxide.

(A_r: Ca = 40.1, C = 12.0, O = 16.0)

Give your answer to **3** significant figures.

Mass of calcium carbonate = ... g **[4]**

19 Hydrogen gas, H_2, reacts with oxygen gas, O_2, to make water, H_2O.

$2H_2 + O_2 \rightarrow 2H_2O$

What is the **atom economy** for this reaction?

M_r : H_2 = 2, O_2 = 32, H_2O = 18.

A 50%
B 53%
C 89%
D 100%

Your answer ☐ **[1]**

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20(a) This question is about elements in the Periodic Table.

Look at the table. It shows some properties of Group 7 elements.

Element	Molecular formula	State at room temperature	Radius of an atom (nm)	Order of reactivity
Fluorine	F_2	.....	0.072	most reactive  least reactive
Chlorine	Cl_2	gas	0.099	
Bromine	Br_2	liquid	0.114	
Iodine	I_2	solid	0.133	
Astatine	At_2	solid	.....	

Complete the table. Use ideas about trends down a Group to help you. **[2]**

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(b) In the table, the Group 7 elements are listed in order of reactivity.

The equations show a displacement reaction of Group 7 elements.

chlorine + sodium bromide → sodium chloride + bromine

Cl_2 + 2NaBr → 2NaCl + Br_2

(i) Complete the word equation.

bromine + sodium iodide → _____ + _____ [1]

(ii) There is no reaction between iodine and sodium bromide.

Explain why.

_____

_____ [1]

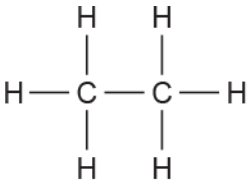
(iii) Chlorine reacts with sodium iodide. Sodium chloride and iodine are made.

Write the **balanced symbol** equation for this reaction.

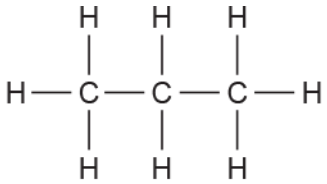
_____ [2]

21 This question is about compounds of carbon.

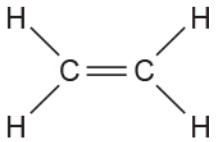
Look at the displayed formulae of ethane, propane and ethene.



Ethane

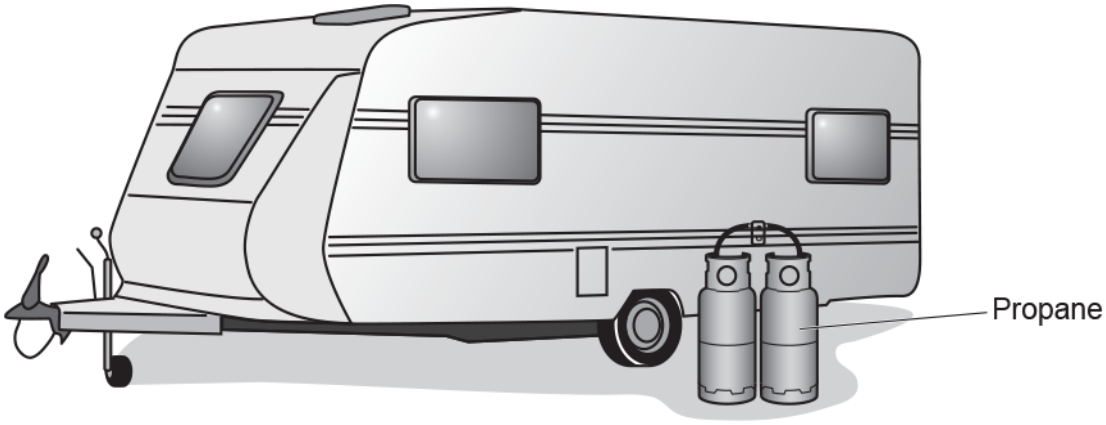


Propane



Ethene

* Propane gas is used as a fuel for cooking and heating in caravans.



Incomplete combustion of propane can occur if the campers do not take sensible precautions.

Describe how incomplete combustion of hydrocarbons such as propane happens and the problems it can cause for campers.

Include a **balanced symbol** equation in your answer.

[6]

22 Ammonium nitrate, NH_4NO_3, is fertiliser made from ammonia.

Ammonium nitrate is made by reacting ammonia with nitric acid.

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

(i) Calculate the mass of **ammonium nitrate** that could be made from 25.5 tonnes of ammonia.

A_r: H = 1.0, N = 14.0, O = 16.0

Mass of ammonium nitrate = ... tonnes **[3]**

(i) A student makes some ammonium nitrate in the laboratory.

He predicts that he should make 12.5 g of ammonium nitrate.

His percentage yield is 80%.

Calculate the **actual mass** of ammonium nitrate that the student makes.

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Actual mass of ammonium nitrate = ... g **[2]**

23 In 2008 the USA produced 4 900 000 barrels of crude oil per day. In 2019 this had increased to 11 000 000 barrels of crude oil per day.

Calculate the percentage increase in the number of barrels of crude oil produced per day from 2008 to 2019.

Use the formula: percentage increase $= \frac{\text{increase}}{\text{original}} \times 100$

Give your answer to **2** decimal places.

Percentage increase = ... % **[3]**

24 Hydrogen gas, H_2, reacts with oxygen gas, O_2, to make water, H_2O.

$2H_2 + O_2 \rightarrow 2H_2O$

What is the **atom economy** for this reaction?

M_r: $H_2 = 2$, $O_2 = 32$, $H_2O = 18$

A 50%
B 53%
C 89%
D 100%

Your answer ☐ **[1]**

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25 In the Haber process, nitrogen reacts with hydrogen to make ammonia.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

What is the maximum volume of ammonia, NH_3, that can be made from $150cm^3$ of hydrogen, H_2?

A $50cm^3$
B $100cm^3$
C $225cm^3$
D $450cm^3$

Your answer [ ] **[1]**

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26 Ammonium nitrate, NH_4NO_3, is a fertiliser made from ammonia.

Ammonium nitrate is made by reacting ammonia with nitric acid.

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

(i) Calculate the mass of **ammonium nitrate** that could be made from 25.5 tonnes of ammonia.

A_r: H = 1.0, N = 14.0, O = 16.0

Mass of ammonium nitrate = ... tonnes **[3]**

(ii) A student makes some ammonium nitrate in the laboratory.

He predicts that he should make 12.5 g of ammonium nitrate.

His percentage yield is 80%.

Calculate the **actual mass** of ammonium nitrate that the student makes.

Actual mass of ammonium nitrate ..... g **[2]**

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27 * A student has unlabelled samples of three liquids.

The student knows that the three liquids are:

- pentane, C_5H_{12}
- pentene, C_5H_{10}
- ethanoic acid, CH_3COOH.

Describe tests that the student should do to identify each of the three liquids.

Include **balanced symbol** equations for the reactions described.

[6]

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28(a) A student investigates the reactivity of four metals, **A**, **B**, **C** and **D**.

He adds a small piece of each metal to cold water.

He then adds a small piece of each metal to dilute hydrochloric acid.

Look at his results.

"

Metal	Observations in water	Observations in dilute hydrochloric acid
A	slow bubbling	very fast bubbling
B	no reaction	no reaction
C	fast bubbling	very fast bubbling
D	no change	slow bubbling

The piece of metal **C** used by the student produces 30 cm^3 of hydrogen gas when it reacts with the dilute hydrochloric acid at room temperature and pressure.

(i) Calculate the number of **moles** of hydrogen gas produced.

One mole of any gas occupies 24 dm^3 at room temperature and pressure.

Moles of hydrogen gas = ... **[2]**

(ii) Use your answer from **(i)** to calculate the **mass** of hydrogen gas produced.

Mass of hydrogen gas = ... g **[1]**

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(b) Chromium metal, Cr, reacts with nickel sulfate solution, $NiSO_4$. Solid nickel is made.

Two possible equations for this reaction are:

Equation 1 $Cr + NiSO_4 \rightarrow CrSO_4 + Ni$

Equation 2 $2Cr + 3NiSO_4 \rightarrow Cr_2(SO_4)_3 + 3Ni$

10.40 g of chromium metal reacts with excess nickel sulfate solution to make 17.61 g of nickel.

Deduce which equation, **1** or **2**, represents the reaction which takes place.

A_r: Cr = 52.0, Ni = 58.7

---

[3]

END OF QUESTION PAPER