Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE

General Certificate of Secondary Education

WJEC CBAC

CYD-BWYLLGOR ADDYSG CYMRU

Tystysgrif Gyffredinol Addysg Uwchradd

125/02

SCIENCE: CHEMISTRY

HIGHER TIER (Grades D-A*)

A.M. WEDNESDAY, 13 June 2007

(2 hours 30 minutes)

For Examiner's use only	
Total Marks	

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all your working. Credit is given for correct working even when the final answer given is incorrect.

A mark is available for the quality of written communication in question 12 *(b)*.

The Periodic Table is printed on page 28 and the formulae for some common ions on page 27.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

Answer **all** *questions in the spaces provided.*

1. *(a)* Use the **data** and **key** on the Periodic Table of Elements, shown on the **back page** of the examination paper, to complete the following sentences.

(i) The chemical symbol for rubidium is ..... . [1]

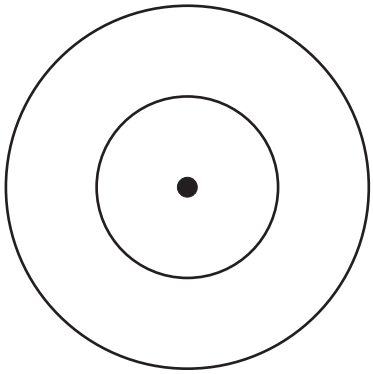
(ii) The atomic number of rubidium is ..... . [1]

(iii) The number of protons in an atom of boron is ..... . [1]

(iv) The element which has the electronic structure 2, 8, 3 is ..... . [1]

(v) The element which has the smallest atom in Group VI is ..... . [1]

(b) Using **X** to represent an electron, complete the following diagram to show the electronic structure for an atom of carbon. [1]



(c) Chlorine has two isotopes, $^{35}_{17}Cl$ and $^{37}_{17}Cl$.

Complete the table below which shows the number of protons, electrons and neutrons in each isotope. [4]

Isotope	*Number of protons*	*Number of electrons*	*Number of neutrons*
$^{35}_{17}Cl$	17		
$^{37}_{17}Cl$		17	

2. *(a)* The table below shows some physical properties of Group I elements.

Element	*Melting point* / °C	*Boiling point* / °C	*Density* / g cm^{-3}	*Electrical conductivity*
Lithium	180	1340	0.50	good
Sodium	98	880	0.97	good
Potassium	63	460	0.86	good

Use the information in the table above to answer part (a) (i) to (iii).

(i) Give **one** property of Group I elements which is typical of metals. [1]

.....

(ii) State **one** property of Group I elements which is **not** typical of metals. Explain your answer. [2]

.....

.....

(iii) Rubidium lies below potassium in Group I. Predict the approximate value for the melting point of rubidium. Give a reason for your answer. [2]

Melting point ..... °C

Reason .....

(b) When a freshly cut piece of potassium is left exposed to air, it immediately reacts with oxygen.

(i) Give the chemical name of the compound formed when potassium reacts with oxygen. [1]

.....

(ii) Complete and balance the **symbol** equation for this reaction. [2]

..... K + O_2 ⟶ .....

(iii) State how this change is normally prevented when storing potassium in the laboratory. [1]

.....

(iv) Give **one** safety precaution required when cutting a small piece of potassium. [1]

.....

3. *(a)* Sandstone is a sedimentary rock. Describe the formation of sedimentary rock. [2]

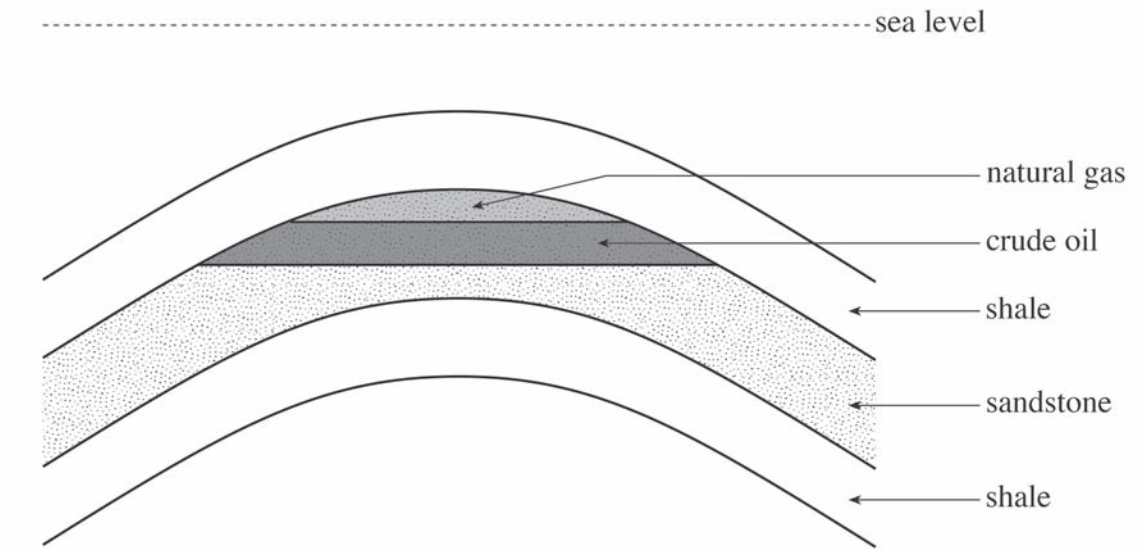
.....

.....

.....

.....

(b) The diagram below shows a crude oil (petroleum) deposit found in the North Sea.



(not to scale)

I. Crude oil deposits were formed in the geological past from decaying marine life.

Give **two** conditions needed to change decaying marine life into crude oil. [2]

Condition 1 .....

Condition 2 .....

II. Explain how crude oil becomes trapped in the sandstone layer. [2]

.....

.....

III. Crude oil is a mixture of many substances, most of which are hydrocarbon compounds.

Name the elements present in all hydrocarbons. [1]

..... and .....

(c) Natural gas, which is mainly methane, is the gas burned in domestic appliances.

The equation below shows the combustion of methane.

$$CH_4 + 2\,O_2 \longrightarrow CO_2 + 2\,H_2O$$

If combustion is incomplete, carbon monoxide is formed instead of carbon dioxide.

(i) Give the reason for incomplete combustion. [1]

.....

(ii) State why it is important to prevent the formation of carbon monoxide. [1]

.....

4. *(a)* The following table shows the colours of Universal indicator at different pH values.

Colour	*Red*	*Orange*	*Yellow*	*Green*	*Blue*	*Navy Blue*	*Purple*
pH	0 - 2	3 - 4	5 - 6	7	8 - 9	10 - 12	13 - 14

(i) Sodium carbonate solution turns Universal indicator navy blue. [1]

Give the pH range of this solution. .....

(ii) The pH of hydrochloric acid is 1. Give the colour of Universal indicator in a solution of hydrochloric acid. [1]

.....

(b) (i) Sodium carbonate, Na_2CO_3, reacts with hydrochloric acid forming sodium chloride solution and a colourless gas. The colourless gas turns limewater milky.

Write a balanced **symbol** equation for this reaction. [3]

..... + ... ⟶ ..... + ... + ...

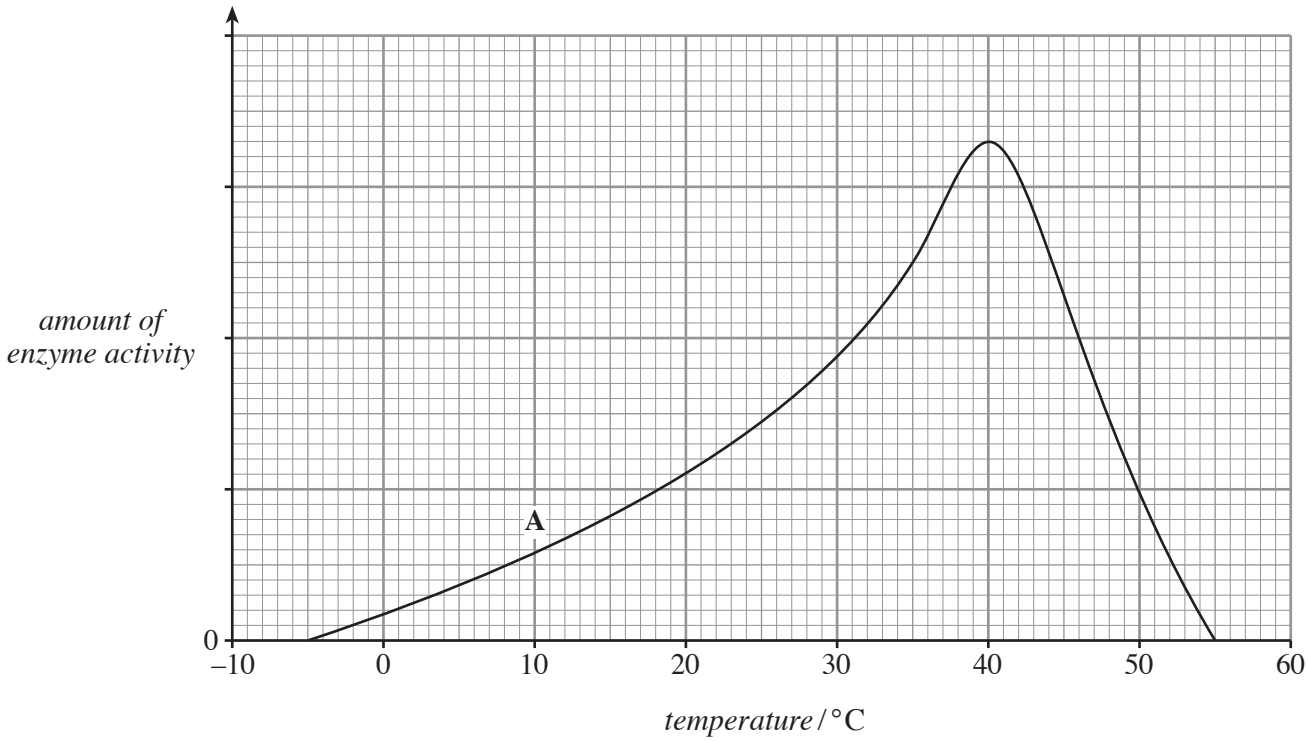
(ii) The reaction in part *(b)*(i) is an exothermic reaction.

State what is meant by the term ***exothermic***. [1]

.....

5. *(a)* The temperature range over which enzyme activity occurs can be different for different enzymes.

The graph below shows how the amount of activity of an enzyme, **A**, changes with temperature.



(i) Use the graph to give the temperature range over which the enzyme activity is increasing. [1]

..... to .....°C

(ii) Sketch the graph of the enzyme activity of a different enzyme, **B**, which is active between 5 and 50 °C and has the greatest amount of activity at 30 °C. Label the graph **B**. [2]

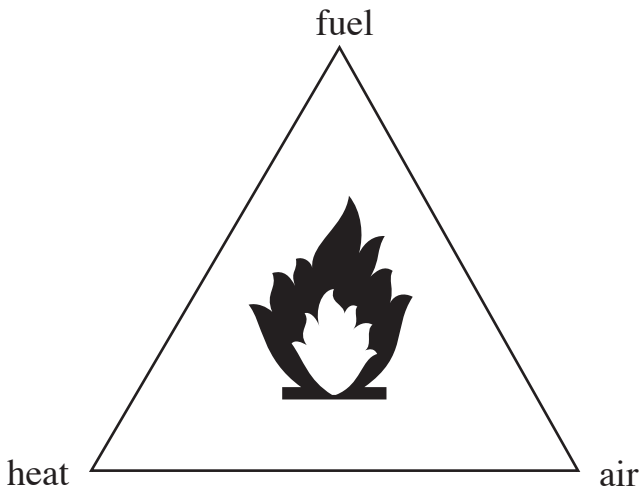
(iii) Give a temperature value at which **both** enzymes would not be active. [1]

..... °C

(b) Enzymes are used in biotechnology. Name **one** industry which uses enzymes in its production process. [1]

.....

6. The fire triangle shows the factors necessary to start and maintain a fire.



State and explain a different fire-fighting method for each of the following situations:

(i) a house on fire;

method ..... [1]

explanation .....

..... [1]

(ii) a forest fire;

method ..... [1]

explanation .....

..... [1]

(iii) a chip pan fire.

method ..... [1]

explanation .....

..... [1]

7. (i) Three samples of bottled water, **A**, **B** and **C**, were being tested for hardness using soap solution.

It was suspected that sample **A** was the most hard and sample **C** the least hard.

Describe an experiment you would do to show that the above statement is true. Include the expected observations. [4]

.....

.....

.....

.....

.....

(ii) Use the list of formulae for some common ions on page 27 and the Periodic Table of Elements on the **back page** of the examination paper to help you answer this question.

Hard water is caused by the presence of dissolved calcium and magnesium compounds.

I. Give the **formulae** of the ions of calcium and magnesium. [1]

Calcium ion ..... Magnesium ion .....

II. Give the number of the group in the Periodic Table in which both calcium and magnesium are found. [1]

Group .....

(iii) State **one** method of softening hard water. [1]

.....

(iv) State why hard water is considered to be

I. good for our health, [1]

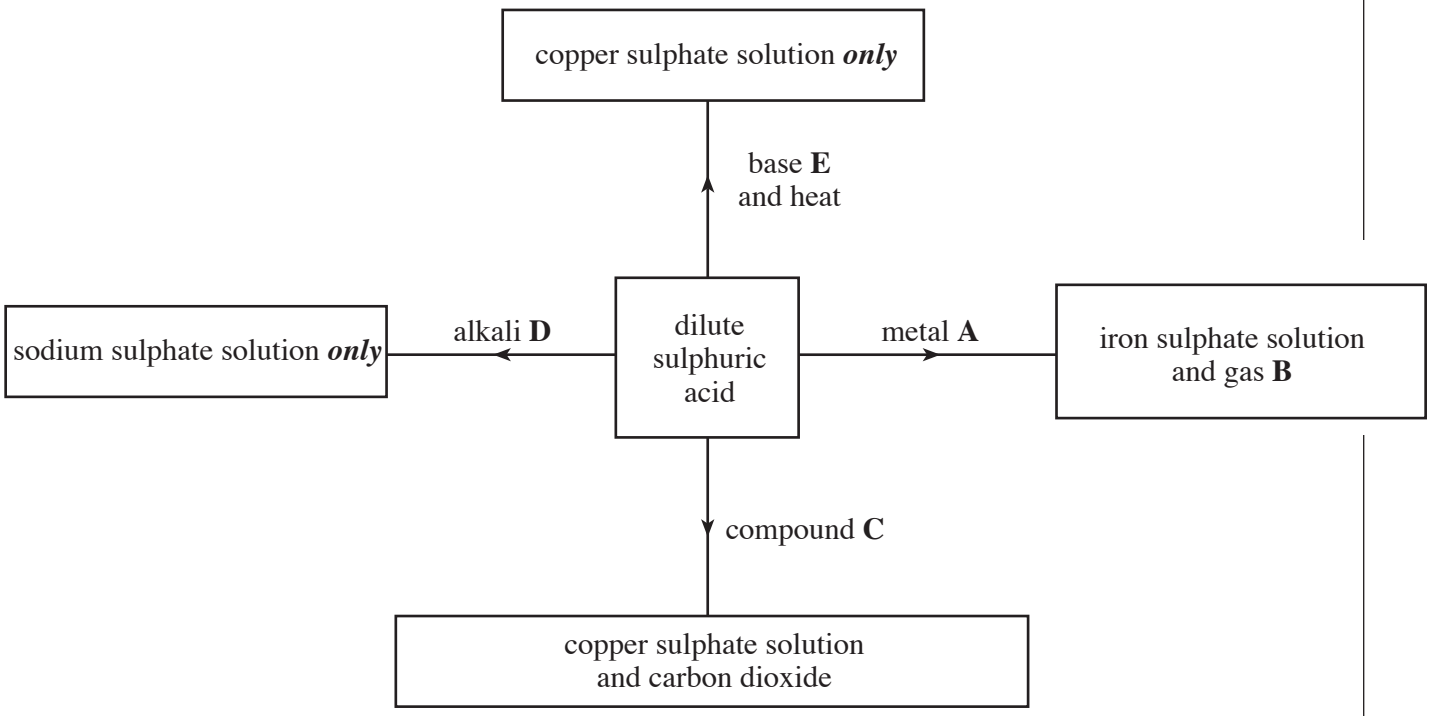
.....

II. a problem in kettles and boilers. [1]

.....

Turn over.

8. The diagram below shows some reactions of dilute sulphuric acid.



Give the name of

I. metal **A**, ... [1]

II. gas **B**, ... [1]

III. compound **C**, ... [1]

IV. alkali **D**, ... [1]

V. base **E**. ..... [1]

9. *(a)* Magnesium, atomic number 12, reacts with chlorine, atomic number 17, to form magnesium chloride.

(i) Give the electronic structures of the two elements.

Magnesium ..... Chlorine ..... [2]

(ii) Explain, by means of diagrams or otherwise, the electronic changes that take place during the formation of magnesium chloride from magnesium and chlorine atoms. Include the charges on the ions. [4]

.....

.....

.....

.....

(iii) Give the chemical formula of magnesium chloride. ..... [1]

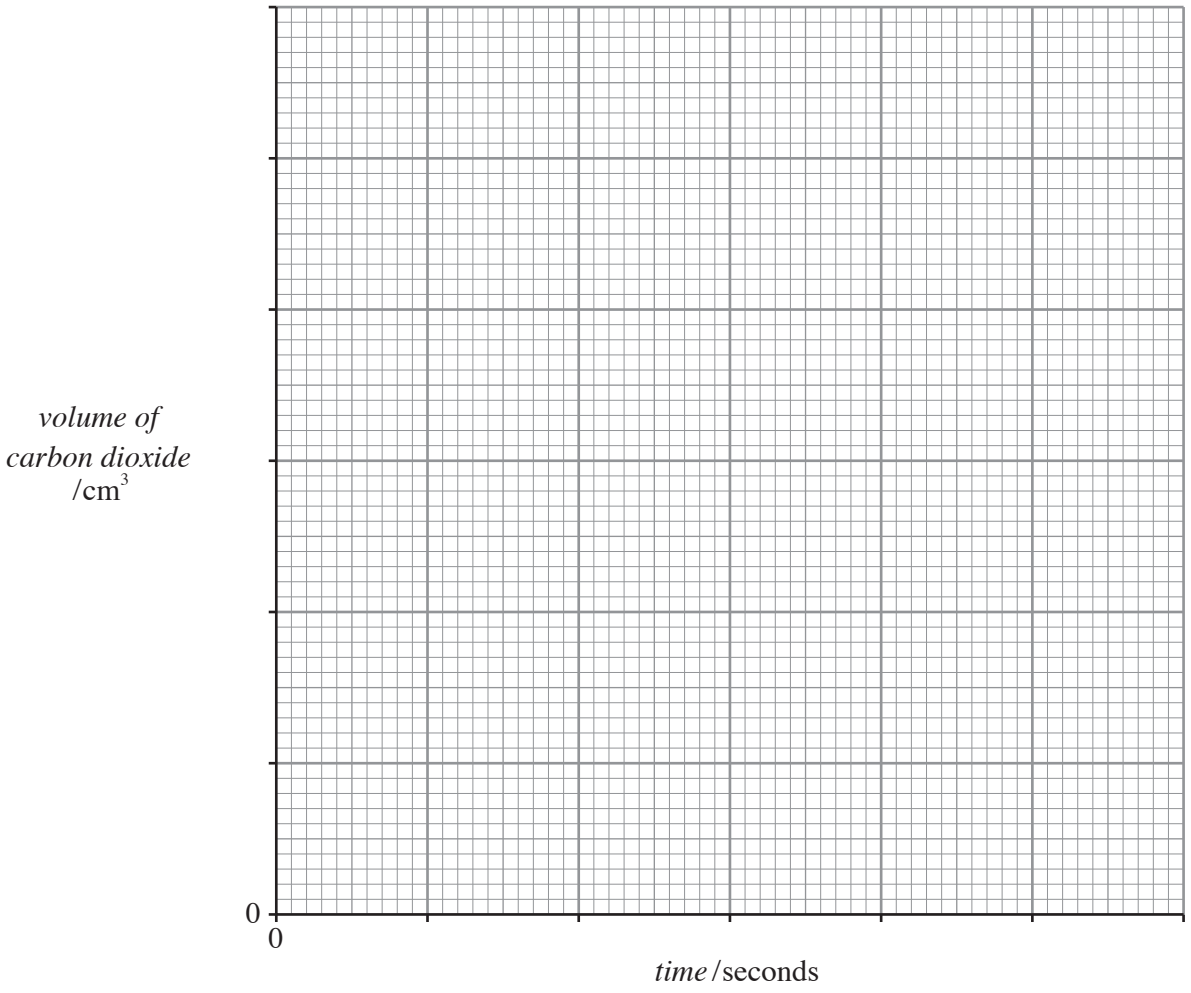
(b) Chlorine also forms a compound with hydrogen, atomic number 1, called hydrogen chloride, HCl. By means of a diagram, show the bonding in a hydrogen chloride molecule and name this type of bonding. [3]

Type of bonding .....

10. The table below shows the volume of carbon dioxide formed during a reaction between ***excess*** marble chips and dilute hydrochloric acid.

Time / seconds	0	10	20	30	40	50	60
Volume of carbon dioxide / cm^3	0	38	66	84	88	100	100

(i) Draw a graph using the data in the table. Label this graph **A**. [4]



(ii) On the same grid, sketch carefully the graph that would be obtained if the acid had been replaced by

I. an equal volume of hydrochloric acid of **half** the concentration, with the marble chips still in ***excess***. Label this graph **B**. [2]

II. an equal volume and concentration of hydrochloric acid at a **lower** temperature with the marble chips still in ***excess***. Label this graph **C**. [2]

(iii) On the same grid, sketch carefully the graph that would be obtained if the marble chips had been ground to a powder, with the volume and concentration of the acid the same as for graph **A**. Label this graph **D**. [2]

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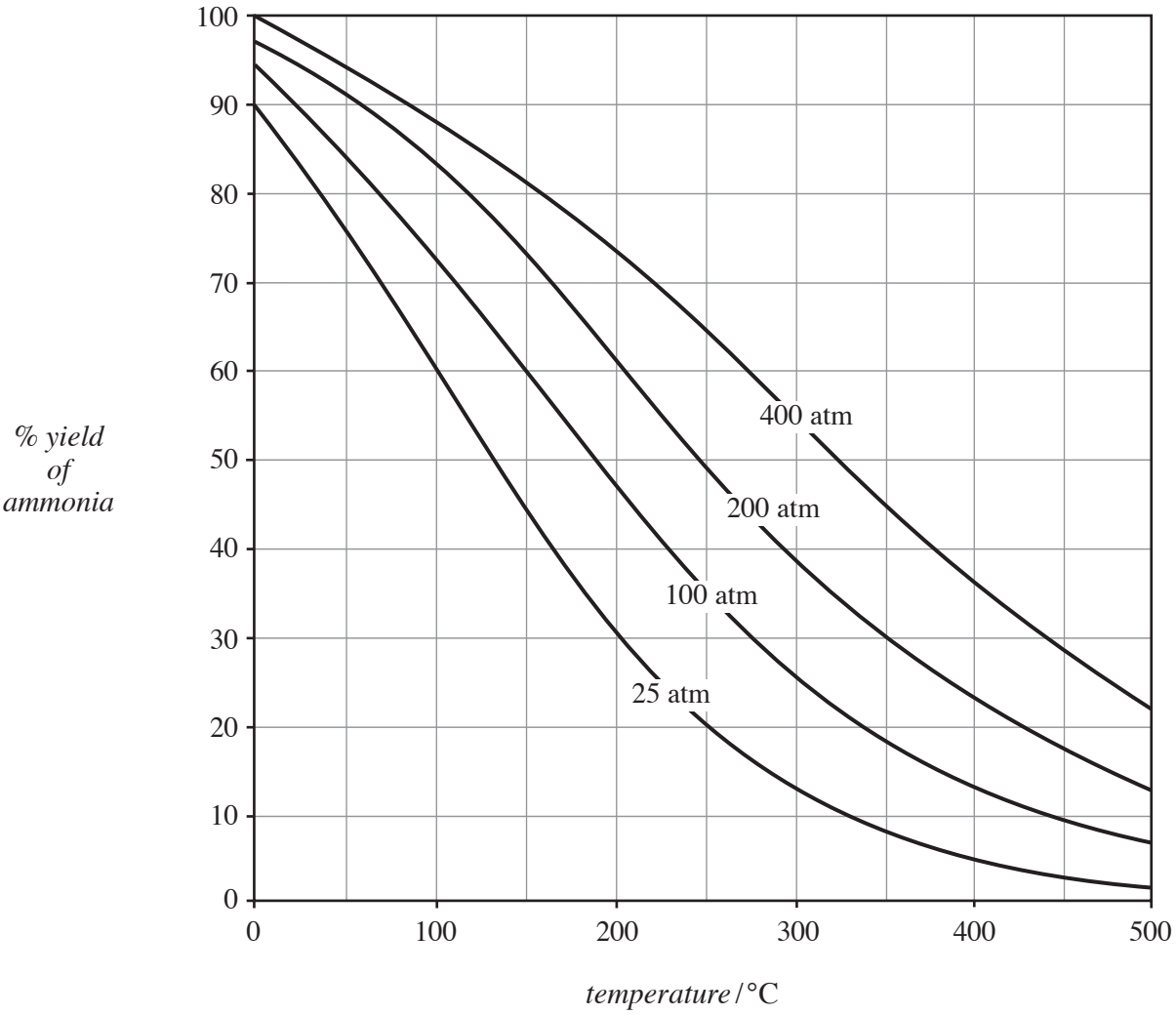
11. Ammonia, NH_3, is manufactured by the reaction between nitrogen and hydrogen.

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

(i) The graph below shows the yield of ammonia at different pressures and temperatures.



Use the graph to find the

I. temperature needed to obtain 30% yield of ammonia at a pressure of 200 atmospheres,

..... °C [1]

II. percentage yield obtained at a temperature of 100 °C and a pressure of 25 atmospheres.

..... % [1]

(ii) State how the rate of ammonia production is **increased**, apart from changing the temperature and pressure.

..... [1]

(iii) Ammonia is used to make the fertiliser ammonium nitrate, NH_4NO_3.

I. Calculate the relative molecular mass (M_r) of ammonium nitrate. [2]

$A_r(H) = 1$; $A_r(N) = 14$; $A_r(O) = 16$.

.....

.....

II. If 10 g of ammonium nitrate are present in 250 cm^3 of solution, calculate the concentration of this solution in mol dm^{-3}. [2]

.....

.....

.....

.....

III. Describe **one** disadvantage of using the fertiliser, ammonium nitrate. [1]

.....

.....

12. *(a)* The molecular formulae of four hydrocarbons are shown below.

CH_4	C_2H_4	C_2H_6	C_3H_8
A	**B**	**C**	**D**

(i) Draw the structural formulae for hydrocarbons **B** and **C** in the boxes below. [2]

B

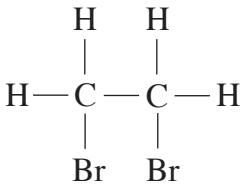
C

(ii) Name the group of hydrocarbons to which each of **B** and **C** belongs. [2]

B belongs to the group of hydrocarbons called .....

C belongs to the group of hydrocarbons called .....

(iii) I. Give the letter of the hydrocarbon which reacts with bromine, Br_2, to form the compound below and give a reason for your answer. [1]



.....

Reason ..... [1]

II. Give the term used for this type of reaction. [1]

.....

(iv) On the complete combustion of hydrocarbon **C**, carbon dioxide and water vapour are formed.

Complete and balance the **symbol** equation for this reaction. [3]

$2\ C_2H_6$ + ... ⟶ ..... + ...

(b) Explain how the combustion of hydrocarbon fuels is believed by some scientists to be responsible for global warming. Include one effect of global warming in your answer. [2+1]

One mark is available for the quality of written communication in your answer.

.....

.....

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.....

13. Aluminium is extracted from aluminium oxide by electrolysis.

(i) For electrolysis to occur, aluminium ions and oxide ions must be free to move in the electrolyte.
State what must be done to aluminium oxide to enable the ions to become mobile. [1]

.....

(ii) I. Complete the following electrode equation. [1]

$$\text{.....} + 3e \longrightarrow Al$$

II. State on which electrode aluminium is deposited and give a reason for your answer. [2]

Electrode .....

Reason .....

(iii) The overall equation for the extraction of aluminium is

$$2\ Al_2O_3 \longrightarrow 4\ Al + 3\ O_2$$

Use this equation to calculate how many tonnes of aluminium oxide are needed to produce 108 tonnes of aluminium. [3]

$A_r(O) = 16$; $A_r(Al) = 27$.

.....

.....

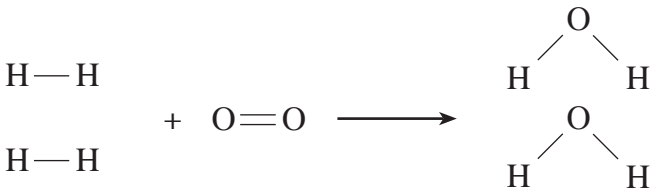
.....

.....

(iv) State **one** way of reducing the need for aluminium ore to be mined. [1]

.....

14. When hydrogen, H_2, burns in air, water is formed.



The relative amounts of energy needed to break the bonds in the above reaction are shown in the table.

Bond	*Amount of energy needed to break the bond* / kJ
H—H	436
O=O	498
O—H	464

*NOTE: The amount of energy **released** in making a bond is equal and opposite to that **needed** to break the bond.*

(i) Use the bond energy values in the table to calculate the relative energy

I. needed to break **all** the bonds in the **reactants**, [2]

.....

.....

II. released when **all** the bonds in the **product** are formed. [2]

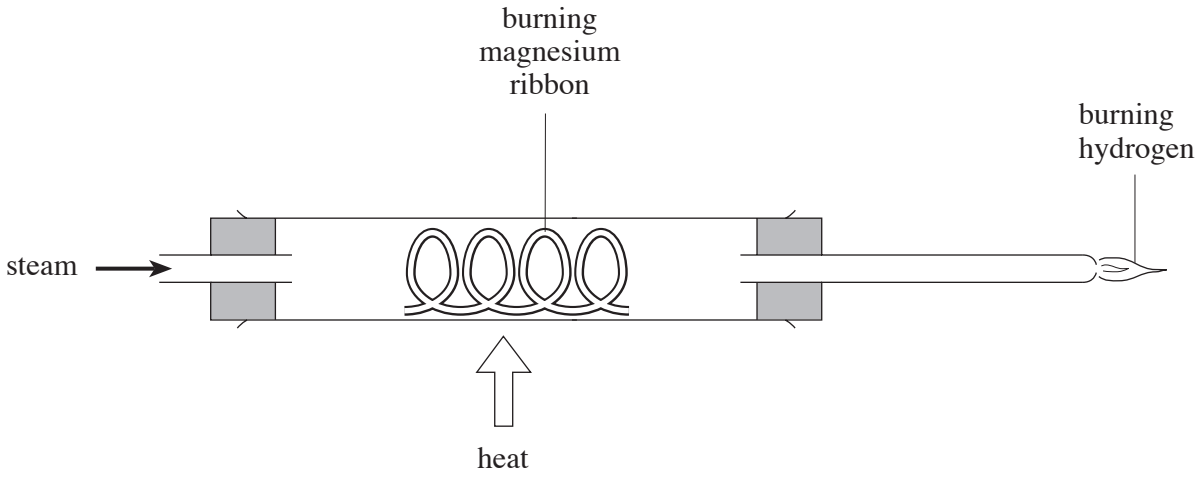
.....

.....

(ii) Using your answers to parts I. and II., explain why the reaction is exothermic. [1]

.....

15. The diagram below shows an apparatus used to pass steam over heated magnesium.



Steam reacts violently with burning magnesium forming magnesium oxide and hydrogen, H_2.

(i) State and explain the change in appearance of magnesium on reaction with steam. [2]

.....

.....

(ii) Write a balanced **symbol** equation for the reaction between steam and burning magnesium. [3]

..... + ... ⟶ ..... + ...

(iii) Use the Periodic Table of Elements on the **back page** of this examination paper to answer this question.

State which Group II element you would expect to react **less** violently with steam than magnesium does. Explain your answer in terms of **electronic structure**. [3]

Group II element .....

Explanation .....

.....

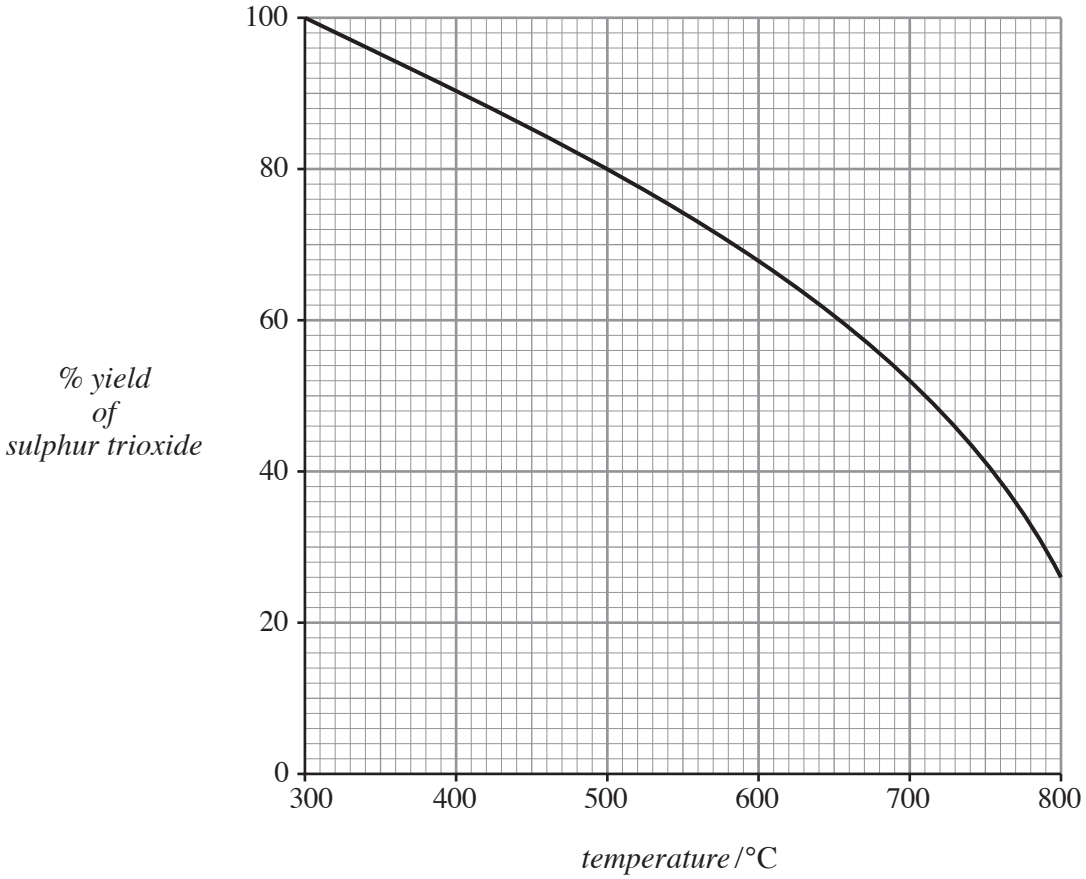
.....

16. One of the main stages in the manufacture of sulphuric acid is the reaction between sulphur dioxide and oxygen to form sulphur trioxide.

(i) Complete and balance the **symbol** equation for this reaction. [2]

$$\text{.....}SO_2 + O_2 \rightleftharpoons \text{.....}$$

(ii) The graph below shows how the percentage yield of sulphur trioxide changes with temperature between 300 °C and 800 °C.



I. State what happens to the percentage yield of sulphur trioxide when the temperature is raised. [1]

.....

II. Use the graph to find the percentage yield at 500 °C. [1]

..... %

(iii) A yield of 100% could be achieved at 300 °C. Give the reason for most manufacturers choosing a temperature of 500 °C. [1]

.....

(iv) State the purpose of using vanadium(V) oxide in this process. [1]

.....

17. The table below shows some tests which can be used to identify ions.

Tests used to identify ions
Flame test. Add dilute hydrochloric acid. Add dilute nitric acid followed by silver nitrate solution. Add dilute hydrochloric acid followed by barium chloride solution. Add sodium hydroxide solution and warm. Add litmus. Add Universal indicator solution.

Use the tests in the table above to help you answer the appropriate parts of the following.

(i) It is suspected that an unlabelled laboratory reagent bottle contains dilute sulphuric acid. Give the test you would use to identify I. the presence of an acid and II. sulphate ions. Include the results expected for a positive test in each case.

I. Test for the presence of an acid .....

Result ..... [1]

II. Test for sulphate ions .....

Result ..... [1]

(ii) Table salt contains mainly sodium chloride. Give the test you would use to identify the presence of I. sodium ions and II. chloride ions.

I. Test for sodium ions .....

Result ..... [1]

II. Test for chloride ions .....

Result ..... [1]

18. Alcoholic drinks contain ethanol, C_2H_5OH.

(i) Draw the structural formula for a molecule of ethanol. [1]

(ii) When ethanol is exposed to the air, it turns into a weak acid.

I. Give the name of the process occurring in the change above.

..... [1]

II. Name the weak acid formed when ethanol is exposed to the air.

..... [1]

19. Write a **brief** account on **each** of the following.
(*Relevant chemical equations and/or diagrams may be included in your answer where appropriate*.)

(a) Describe the advantages and disadvantages of plastics in everyday life. [5]

(b) Outline the industrial extraction of iron in the blast furnace. [5]

Turn over for part *(c)*

(c) Explain how the properties of diamond and graphite relate to their molecular structures. [5]

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
Aluminium	Al^{3+}	Bromide	Br^{-}
Ammonium	NH_4^{+}	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^{-}
Calcium	Ca^{2+}	Fluoride	F^{-}
Copper(II)	Cu^{2+}	Hydroxide	OH^{-}
Hydrogen	H^{+}	Iodide	I^{-}
Iron(II)	Fe^{2+}	Nitrate	NO_3^{-}
Iron(III)	Fe^{3+}	Oxide	O^{2-}
Lithium	Li^{+}	Sulphate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^{+}		
Silver	Ag^{+}		
Sodium	Na^{+}		

Turn over.

(125-02)

PERIODIC TABLE OF ELEMENTS

I	II	Group									III	IV	V	VI	VII	0
								$^{1}_{1}$H Hydrogen								$^{4}_{2}$He Helium
$^{7}_{3}$Li Lithium	$^{9}_{4}$Be Beryllium										$^{11}_{5}$B Boron	$^{12}_{6}$C Carbon	$^{14}_{7}$N Nitrogen	$^{16}_{8}$O Oxygen	$^{19}_{9}$F Fluorine	$^{20}_{10}$Ne Neon
$^{23}_{11}$Na Sodium	$^{24}_{12}$Mg Magnesium										$^{27}_{13}$Al Aluminium	$^{28}_{14}$Si Silicon	$^{31}_{15}$P Phosphorus	$^{32}_{16}$S Sulphur	$^{35}_{17}$Cl Chlorine	$^{40}_{18}$Ar Argon
$^{39}_{19}$K Potassium	$^{40}_{20}$Ca Calcium	$^{45}_{21}$Sc Scandium	$^{48}_{22}$Ti Titanium	$^{51}_{23}$V Vanadium	$^{52}_{24}$Cr Chromium	$^{55}_{25}$Mn Manganese	$^{56}_{26}$Fe Iron	$^{59}_{27}$Co Cobalt	$^{59}_{28}$Ni Nickel	$^{64}_{29}$Cu Copper	$^{65}_{30}$Zn Zinc	$^{70}_{31}$Ga Gallium	$^{73}_{32}$Ge Germanium	$^{75}_{33}$As Arsenic	$^{79}_{34}$Se Selenium	$^{80}_{35}$Br Bromine	$^{84}_{36}$Kr Krypton
$^{86}_{37}$Rb Rubidium	$^{88}_{38}$Sr Strontium	$^{89}_{39}$Y Yttrium	$^{91}_{40}$Zr Zirconium	$^{93}_{41}$Nb Niobium	$^{96}_{42}$Mo Molybdenum	$^{99}_{43}$Tc Technetium	$^{101}_{44}$Ru Ruthenium	$^{103}_{45}$Rh Rhodium	$^{106}_{46}$Pd Palladium	$^{108}_{47}$Ag Silver	$^{112}_{48}$Cd Cadmium	$^{115}_{49}$In Indium	$^{119}_{50}$Sn Tin	$^{122}_{51}$Sb Antimony	$^{128}_{52}$Te Tellurium	$^{127}_{53}$I Iodine	$^{131}_{54}$Xe Xenon
$^{133}_{55}$Cs Caesium	$^{137}_{56}$Ba Barium	$^{139}_{57}$La Lanthanum	$^{179}_{72}$Hf Hafnium	$^{181}_{73}$Ta Tantalum	$^{184}_{74}$W Tungsten	$^{186}_{75}$Re Rhenium	$^{190}_{76}$Os Osmium	$^{192}_{77}$Ir Iridium	$^{195}_{78}$Pt Platinum	$^{197}_{79}$Au Gold	$^{201}_{80}$Hg Mercury	$^{204}_{81}$Tl Thallium	$^{207}_{82}$Pb Lead	$^{209}_{83}$Bi Bismuth	$^{210}_{84}$Po Polonium	$^{210}_{85}$At Astatine	$^{222}_{86}$Rn Radon
$^{223}_{87}$Fr Francium	$^{226}_{88}$Ra Radium	$^{227}_{89}$Ac Actinium														

Key: