Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE

General Certificate of Secondary Education

CYD-BWYLLGOR ADDYSG CYMRU

Tystysgrif Gyffredinol Addysg Uwchradd

125/02

SCIENCE: CHEMISTRY

HIGHER TIER (Grades D-A*)

A.M. WEDNESDAY, 14 June 2006

(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 *(c)*.

The Periodic Table is printed on page 32 and the formulae for some common ions on page 31.

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 the **key** on the Periodic Table of Elements, shown on the **back page** of the examination paper, to complete the following sentences.

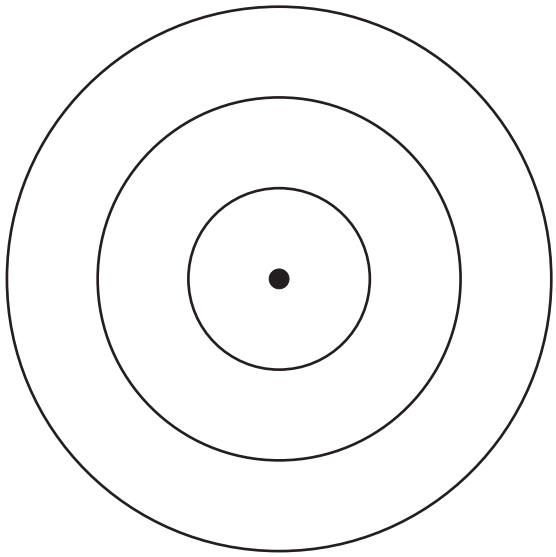
(i) The chemical symbol for krypton is ..... . [1]

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

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

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

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



2. *(a)* The table below shows some information relating to Group VII elements.

Element	*Atomic Number*	*Melting Point* / °C	*Boiling Point*/ °C	*Density* / g cm^{-3}
Chlorine	17	-101	-35	0·0029
Bromine	35	-7	59	3·1
Iodine	53	114	184	4·9

Use the information in the table above to help you answer part (a).

(i) State the information that determines the position of the elements in Group VII. [1]

.....

(ii) A sample of bromine is put in a test tube in a water bath at 60 °C. Describe what will happen to it. [1]

.....

(iii) Fluorine, not shown in the table, is above chlorine in Group VII.
Predict the state (solid, liquid or gas) of fluorine at room temperature, 20 °C. [1]

.....

(b) (i) Sodium reacts vigorously with chlorine, Cl_2, to form sodium chloride.

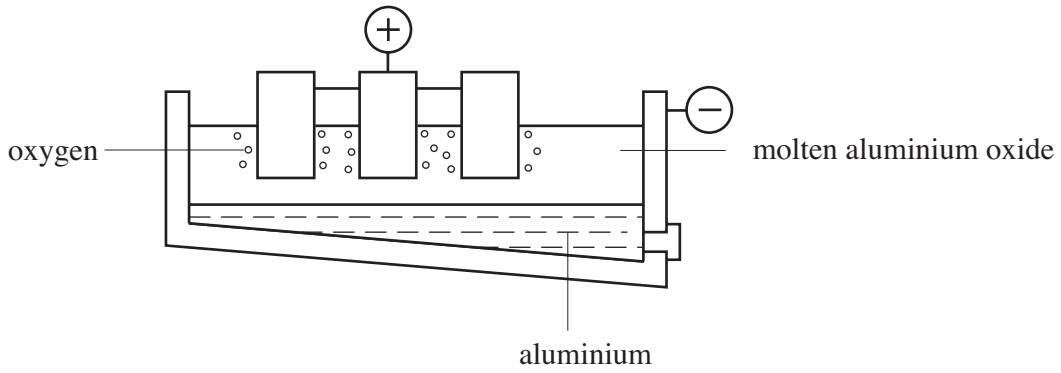
Write a balanced **symbol** equation for the reaction between sodium and chlorine. [3]

..... + ... ⟶ .....

(ii) All Group VII elements react with sodium.
Give the name of the Group VII element which would react **more** violently with sodium than chlorine does. [1]

.....

3. *(a)* The diagram below shows the extraction of aluminium by the electrolysis of molten aluminium oxide.



(i) Refer to the table of common ions on page 31 of this examination paper to answer this question.
Give the **formulae** of the **ions** present in molten aluminium oxide.

..... and ..... [2]

(ii) Explain why aluminium is formed at the negative electrode during electrolysis. [1]

.....

.....

(iii) State why the extraction of aluminium by the electrolysis of aluminium oxide is an expensive process. [1]

.....

(b) Several factors, such as available work force, transport systems and distance from built-up areas are considered when locating a new chemical plant.

Give **one** other factor that is important when locating a new ***aluminium*** extraction plant. [1]

.....

(c) Aluminium is used to make over-head power cables.

Give **two** properties of aluminium which make it suitable for this use.

Property 1 ..... [1]

Property 2 ..... [1]

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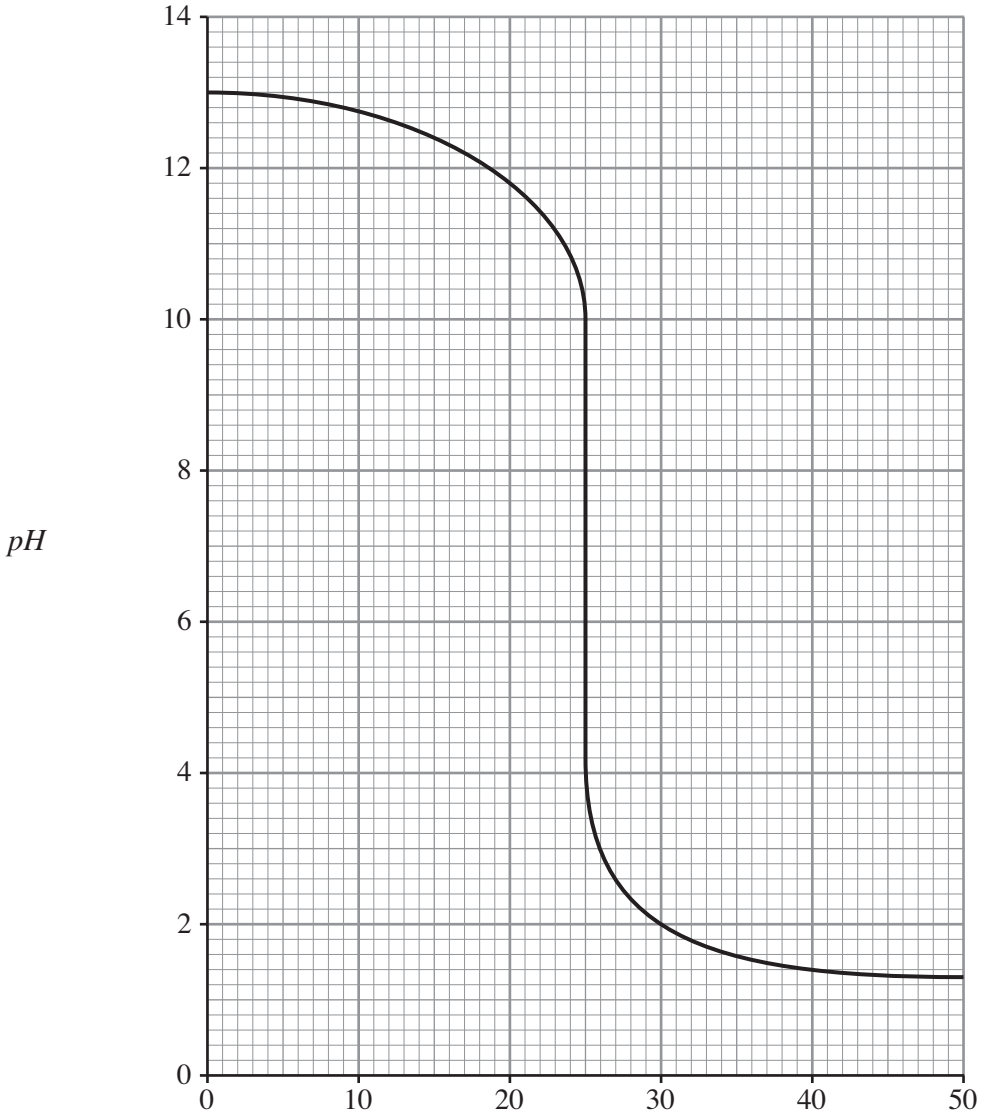
4. 50 cm^3 of dilute hydrochloric acid was added to 50 cm^3 of dilute sodium hydroxide solution.

The graph below shows how the pH of the reaction mixture changed ***as the acid was added***.



(i) Use the graph to find the

I. pH of the sodium hydroxide solution before any acid was added, [1]

.....

II. pH of the reaction mixture when 30 cm^3 of dilute hydrochloric acid is added, [1]

.....

III. volume of hydrochloric acid needed to neutralise the 50 cm^3 of sodium hydroxide solution. [1]

..... cm^3

(ii) 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

Give the **colour** of the reaction mixture when the volume of hydrochloric acid added is

I. $20\,cm^3$, ... [1]

II. $40\,cm^3$. ..... [1]

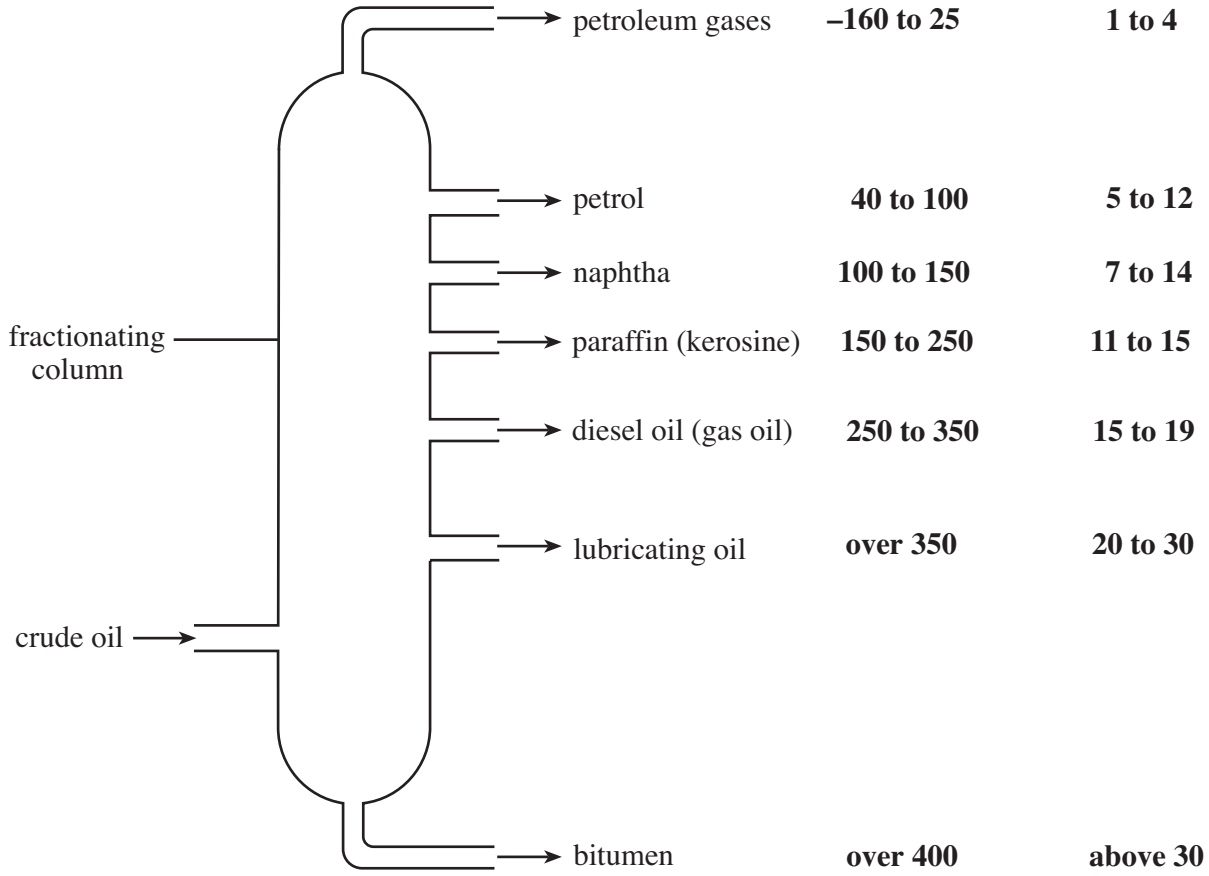
(iii) The neutral solution is evaporated to dryness to leave a white solid.

Name the

I. colourless liquid removed during evaporation, ... [1]

II. white solid that remains. ..... [1]

5. *(a)* Crude oil (petroleum) is a mixture of compounds called hydrocarbons which can be separated into fractions in a fractionating column.



Fraction	*Boiling Point Range / °C*	*Number of carbon atoms in chains*
petroleum gases	**–160 to 25**	**1 to 4**
petrol	**40 to 100**	**5 to 12**
naphtha	**100 to 150**	**7 to 14**
paraffin (kerosine)	**150 to 250**	**11 to 15**
diesel oil (gas oil)	**250 to 350**	**15 to 19**
lubricating oil	**over 350**	**20 to 30**
bitumen	**over 400**	**above 30**

Use only the information in the diagram above to answer parts (i) to (iii).

(i) Name the fraction which contains the compound with the

I. boiling point of –89 °C, ... [1]

II. formula C_5H_{12}. ..... [1]

(ii) Give the number of carbon atoms in the hydrocarbon compound found in both paraffin and diesel oil. [1]

.....

(iii) State the physical property of hydrocarbons that determines the height up the column at which a fraction is removed. [1]

.....

(iv) Apart from the petroleum gases, all the other fractions leave the column at different levels as liquids.

I. Give the term used to describe the process of a vapour changing into a liquid. [1]

.....

II. Give the reason why all fractions, apart from the petroleum gases, leave the column as liquids. [1]

.....

(b) The fractional distillation of crude oil takes place at oil refineries.

Give the reason why British oil refineries are located

(i) away from built up areas, [1]

.....

(ii) in coastal positions. [1]

.....

6. Chemists have designed a wide variety of steels to suit particular uses.

Some steels simply contain iron and carbon only, whereas others contain one or more other metals.

The table below shows the content and properties of some steels.

Type of steel	*Content of steel*	*Properties*
Mild steel	Iron plus 0·25% carbon only	easily shaped, not brittle
High carbon steel	Iron plus 1·5% carbon only	hard and brittle
Cast iron	Iron plus 4% carbon only	very hard and very brittle
Stainless steel	Iron plus 18% chromium and 8% nickel	tough and does not corrode

Use only the information in the table above to answer this question.

(i) Give **two** effects of increasing the percentage of carbon in steel. [2]

1. .....

2. .....

(ii) Choose, giving a reason, the type of steel you would use to make

I. car bodies,

Steel: ..... [1]

Reason: ..... [1]

II. hip replacement joints.

Steel: ..... [1]

Reason: ..... [1]

7. The table below shows the labels found on bottles of three different mineral waters **A**, **B** and **C**.

Ions present	*Typical analysis*/mg dm^{-3}		
	A	**B**	**C**
calcium	47·5	78	27
magnesium	16·5	24	6·9
sodium	5·7	5	6·6
potassium	0·4	1	0·8
hydrogencarbonate	206	357	103
chloride	9·0	4·5	6·4
sulphate	8·0	10·0	10·6
nitrate	3·5	3·8	2·0
pH	7·8	7·2	4·6

Answer parts (i) and (ii) using only the information in the table above.

(i) I. Give the **letter** (**A**, **B** or **C**) of the **hardest** mineral water. ..... [1]

II. Give **two** reasons for your choice in part (i) I. [2]

1. .....

2. .....

(ii) I. Give the **letter** of the **acidic** mineral water. ..... [1]

II. Give the reason for your choice in part (ii) I. [1]

.....

(iii) Different samples of water can be tested for hardness using soap solution.
Describe an experiment you would do to show which is the hardest mineral water.
Include in your answer

- any measurements which need to be taken,
- the observations you would expect to see. [4]

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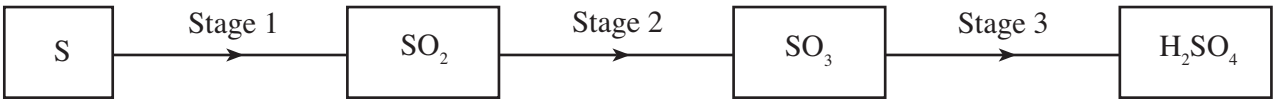
8. The flow diagram below shows the manufacture of sulphuric acid, H_2SO_4.



(i) Write the word equation for Stage 1. [2]

..... + ... ⟶ .....

(ii) Stage 2 requires vanadium(V) oxide, a temperature of 450 °C and a pressure of 2-3 atmospheres.

I. State the purpose of the vanadium(V) oxide. [1]

.....

II. State what happens to the mass of the vanadium(V) oxide. [1]

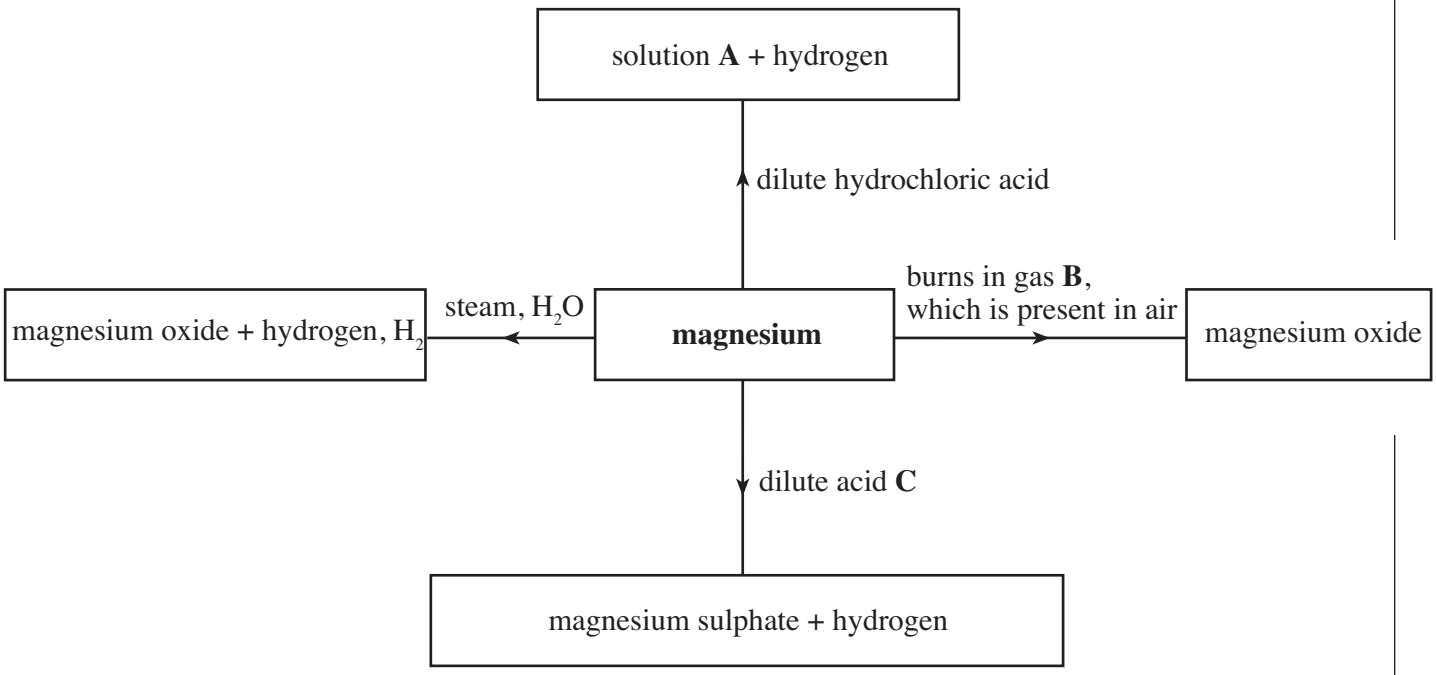
.....

(iii) Give the **main** reason for **not** allowing any of the sulphur dioxide to escape into the atmosphere. [1]

.....

.....

9. The diagram below shows some reactions of magnesium.



(a) Give the chemical name for

(i) solution **A**, ... [1]

(ii) gas **B**, ... [1]

(iii) dilute acid **C**. ..... [1]

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

..... + ... ⟶ ..... + ...

10. *(a)* Magnesium, atomic number 12, reacts with oxygen, atomic number 8, to form magnesium oxide.

(i) Give the electronic structures of the two elements. [2]

Magnesium ..... Oxygen .....

(ii) Explain, by means of **diagrams** or otherwise, the electronic changes that take place during the formation of magnesium oxide from magnesium and oxygen atoms. Include the charge on each of the ions. [4]

.....

.....

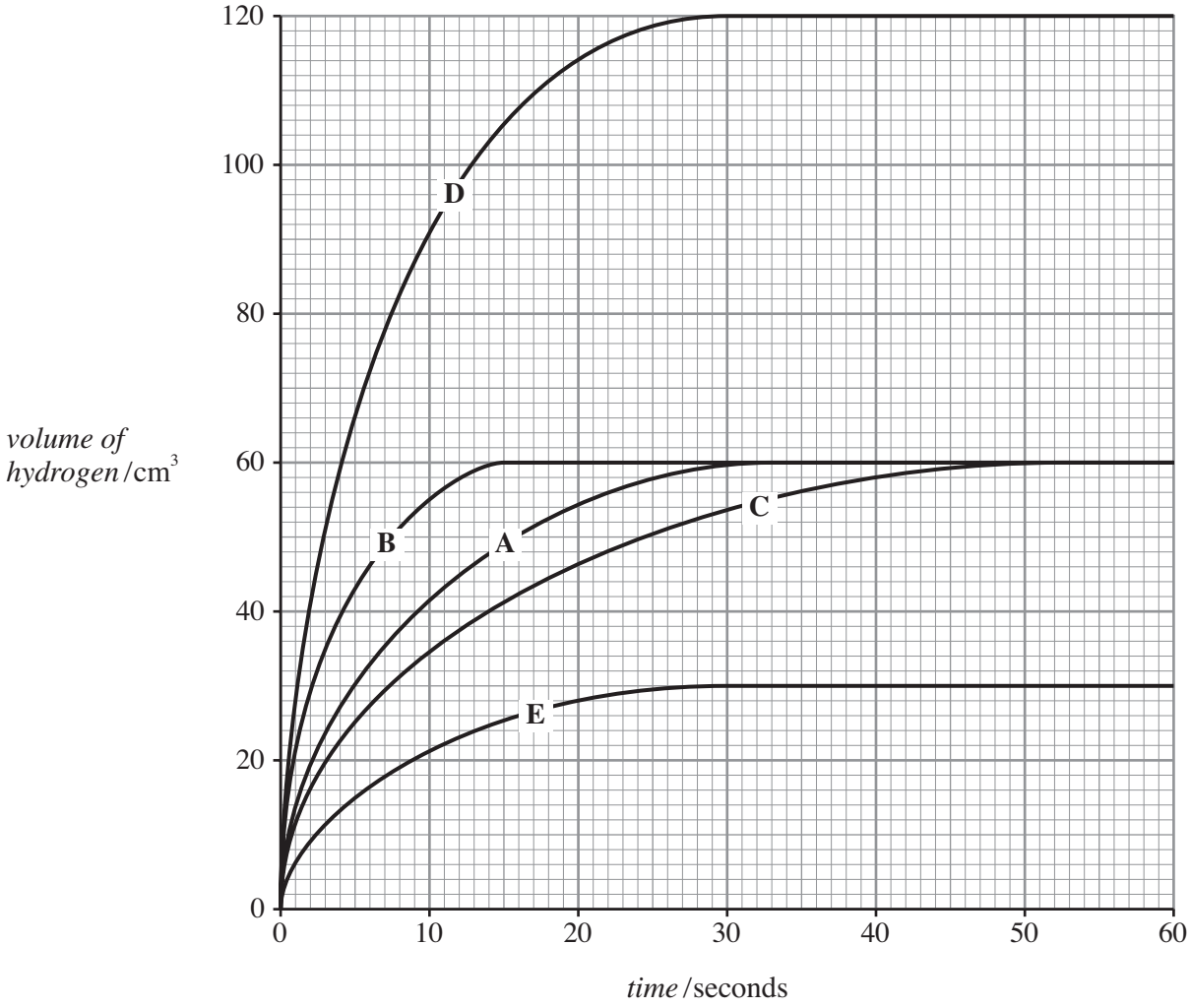
.....

.....

(b) Hydrogen , atomic number 1, forms hydrogen molecules, H_2.
By means of a diagram, show the bonding in a hydrogen molecule. [2]

(c) An oxygen molecule, O_2, contains a double bond and can be represented by the structural formula $O=O$. By means of a diagram, show the bonding in an oxygen molecule. [2]

11. Graph **A** below, shows the volume of hydrogen formed during the reaction between some magnesium ribbon and excess dilute hydrochloric acid.



State and explain, using ***particle theory***, which graph, **B**, **C**, **D** or **E**, could represent the results obtained if

(i) the magnesium ribbon is replaced by an equal mass of magnesium ***powder***,

Graph ..... [1]

Explanation .....

.....

.....

[2]

(ii) the same mass of magnesium ribbon as for graph **A** had been added to excess hydrochloric acid of the same concentration at a ***lower temperature***,

Graph ..... [1]

Explanation .....

.....

.....

[2]

(iii) ***half the mass*** of magnesium ribbon as for graph **A** had been added to excess hydrochloric acid of the same concentration.

Graph ..... [1]

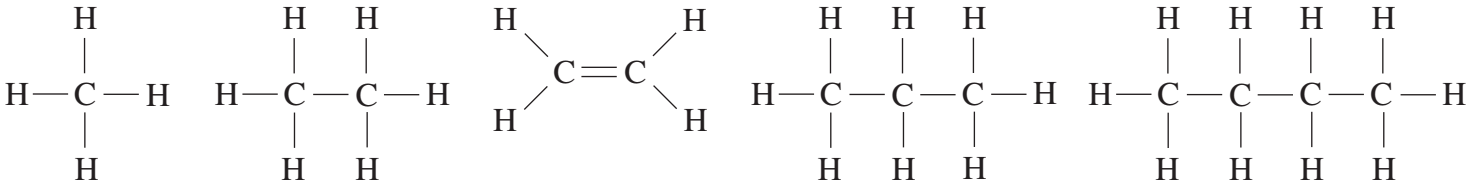
Explanation .....

.....

.....

[2]

12. *(a)* The structural formulae of five hydrocarbons are shown below.



A **B** **C** **D** **E**

Use only the information above to answer parts (i) to (iv) I and (v).

(i) Give the **molecular** formula for hydrocarbon **D**. ..... [1]

(ii) Give the letter of a **saturated** hydrocarbon. ..... [1]

(iii) Give the letters of **two** hydrocarbons which belong to the family of compounds called the ***alkanes***.

..... and ..... [1]

(iv) I. Give the **letter** of the hydrocarbon used to make the polymer, poly(ethene), commonly called polythene. [1]

.....

II. Explain your choice of letter in part (iv) I. [1]

.....

.....

III. Give the name of the type of polymerisation that occurs during the formation of polythene. [1]

.....

(v) Give the **letter** of the compound which reacts with hydrogen to form compound **B**. [1]

.....

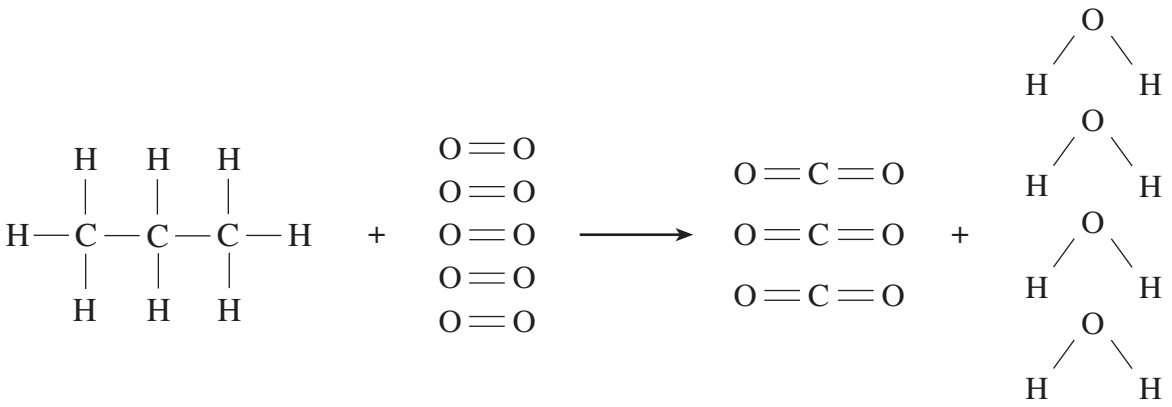
(vi) Some compounds can have more than one different structural formula.

I. Draw a different structural formula for compound **E**. [1]

II. Give the term used to describe different compounds with the same molecular formula but different structural formulae. [1]

.....

(b) When the hydrocarbon, **D**, burns in air, carbon dioxide and water are formed.



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

Bond	*Amount of energy needed to break the bond* (kJ)
C═O	805
H—C	413
C—C	347

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

Use the bond energy values in the table above to help you answer parts (i) and (ii).

(i) The total energy needed to break all the bonds in the **reactants** is 6488 kJ. Calculate the amount of energy needed to break an O═O bond. [3]

.....

.....

.....

.....

(ii) The total energy released when all the bonds in the **products** are formed is 8542 kJ. Calculate the amount of energy released in forming an O—H bond. [2]

.....

.....

(iii) The overall energy change during the reaction is – 2054 kJ. Explain how this value is calculated. [1]

.....

(c) Plastics, such as polythene, have replaced many traditional materials, such as iron, glass and paper, to make everyday objects.
Briefly outline the reasons why plastics have replaced each of the three materials stated above.
Give a **different** reason for each material.
One mark is available for the quality of written communication in your answer. [3+1]

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13. Ammonia is made industrially from nitrogen and hydrogen by the Haber Process.

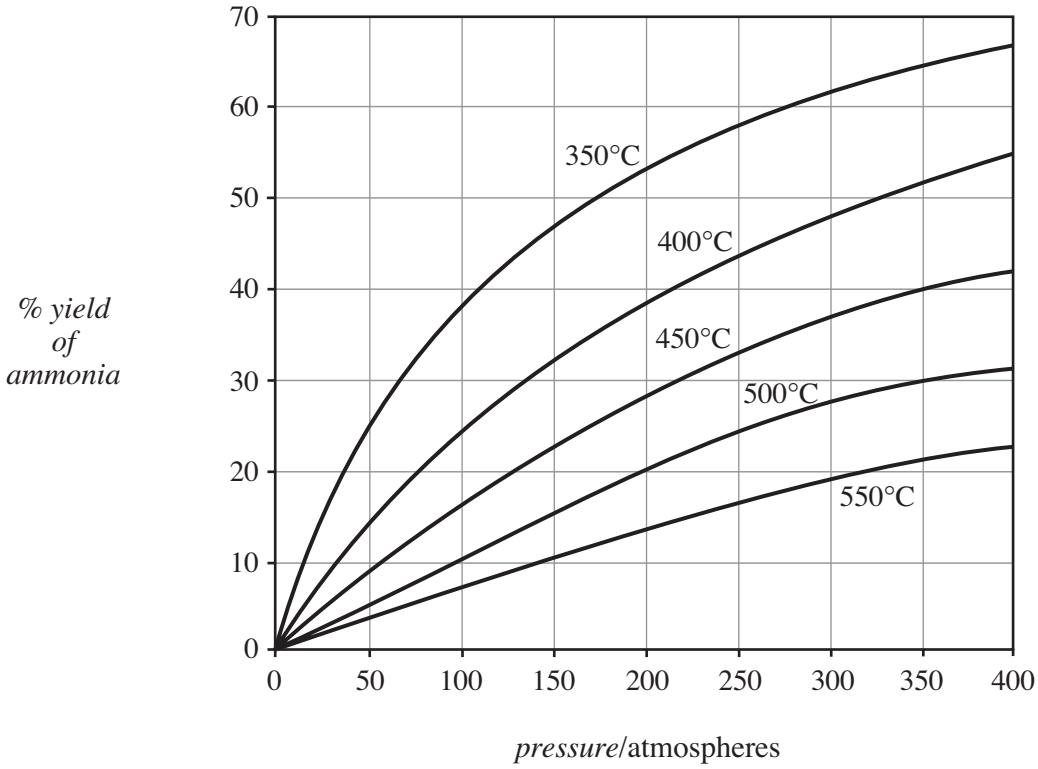
(i) I. Complete and balance the equation below, which represents the formation of ammonia. [2]

$$N_2 + \ldots\ldots H_2 \rightleftharpoons \ldots\ldots$$

II. State what is meant by the symbol $\rightleftharpoons$. [1]

.....

(ii) The graph below shows the yield of ammonia at different temperature and pressure conditions.



Use the graph to answer parts I to III.

State what happens to the yield of ammonia as the

I. temperature increases, ... [1]

II. pressure increases. ..... [1]

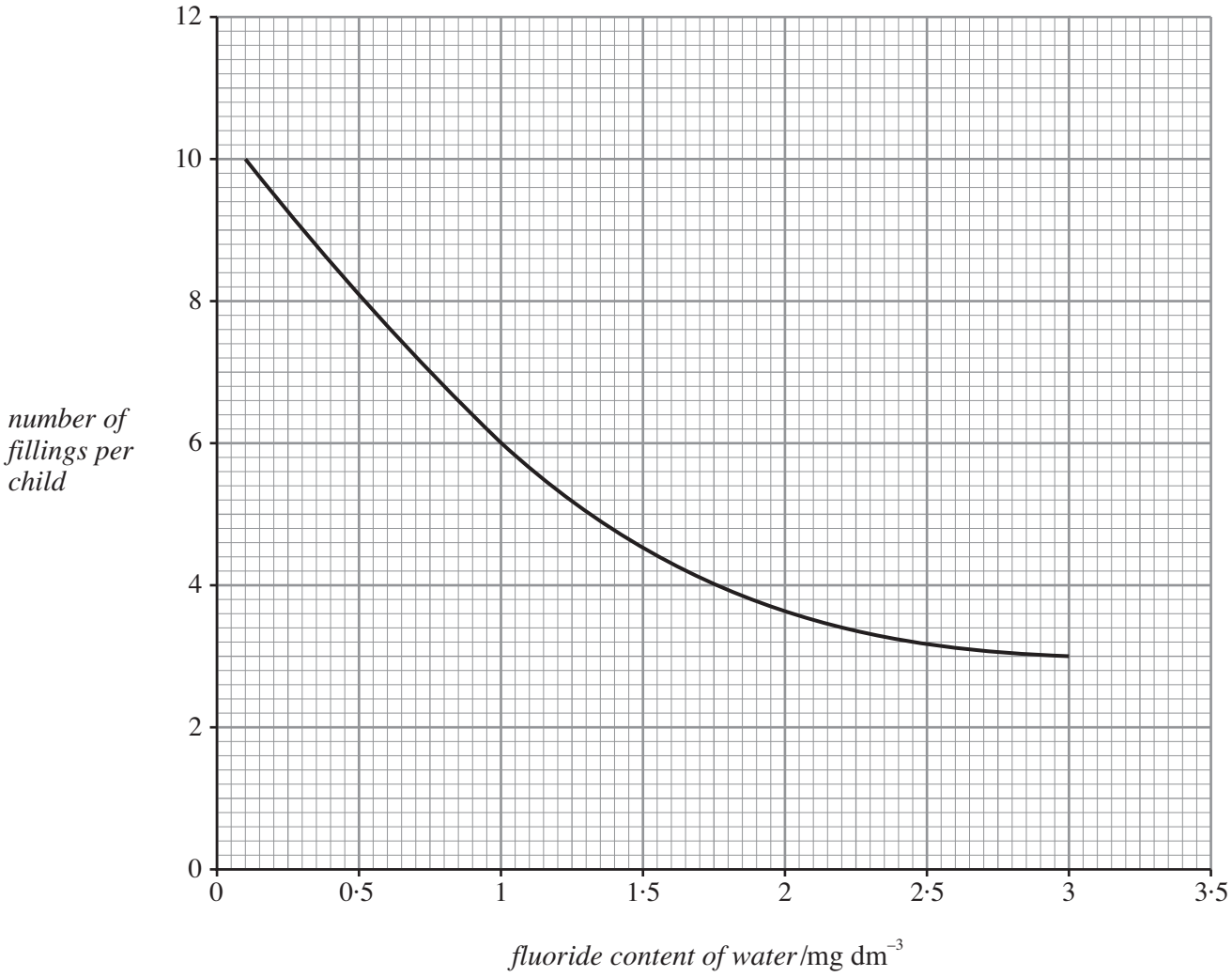
III. Calculate the ***change*** in yield if the temperature is decreased from 500 °C to 450 °C at a pressure of 350 atmospheres. [1]

.....

.....

14. Drinking water often contains fluoride ions. They may be naturally present or have been added at the water treatment works. Sodium fluoride is used as a rat poison.

(i) The graph below shows the effect of fluoride in water supplies on tooth decay.



Use the graph to

I. state how the number of fillings per child depends on the fluoride content in drinking water, [1]

.....

.....

II. give the reason why a maximum of 1 mg dm^{-3} of fluoride is usually added to water supplies. [1]

.....

.....

(ii) Some people support the addition of fluoride to drinking water. Others oppose it. Give **one** reason to

I. support it, ... [1]

II. oppose it. ..... [1]

(iii) Suggest **one** other way, apart from the fluoridation of water, in which people take in small amounts of fluoride ions. [1]

.....

15. *(a)* The table below shows the electronic structures of some Group I elements.

Element	*Electronic structure*
Lithium	2,1
Sodium	2,8,1
Potassium	2,8,8,1

State and explain, **in terms of electronic structure**, which element from the table above is the **most** reactive.

Element: ..... [1]

Explanation: .....

.....

.....

[2]

(b) 6·2 g of an oxide of sodium was found to contain 4·6 g of sodium.

$A_r(O) = 16$ $A_r(Na) = 23$

(i) Calculate the mass of oxygen contained in the oxide. [1]

.....

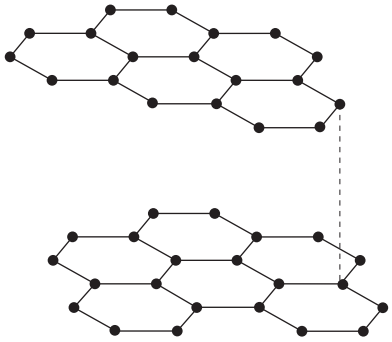
(ii) Calculate the ***simplest*** formula for this oxide of sodium.

Show your workings. [2]

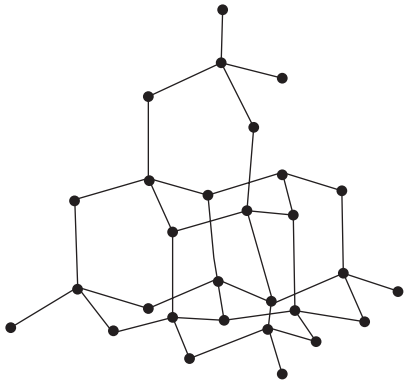
.....

.....

16. The diagrams below show two different forms of carbon.



graphite



diamond

(i) Give the term used for different forms of the same element in the same physical state. [1]

.....

(ii) Give the name of the type of bonding found in **both** graphite and diamond. [1]

.....

(iii) I. State **two** physical properties of diamond which result from its structure. [2]

Property 1 .....

Property 2 .....

II. Give **one** use of diamond which relies on its strong, uniform bonding. [1]

.....

(iv) Graphite, unlike diamond, is soft and conducts electricity. Give the reason why graphite is

I. soft, ...

.....

[1]

II. conducts electricity. .....

.....

[1]

(v) Give **one** use of graphite which relies on it being

I. soft, ... [1]

II. an electrical conductor. ..... [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 only the information in the table above to help you answer the following.

(i) It was suspected that egg shells contained calcium carbonate.

Give the test you would use to identify I. calcium ions and II. carbonate ions in the egg shells.
Include the result expected for each test.

I. Test for calcium ions: .....

Result: ..... [1]

II. Test for carbonate ions: .....

Result: ..... [1]

(ii) Nitrogenous fertilisers usually contain ammonium nitrate or ammonium sulphate.

Give the test you would use to establish that a fertiliser contained ammonium sulphate. Include the observations expected for each test.

I. Test for ammonium ions: .....

Result: ..... [1]

II. Test for sulphate ions: .....

Result: ..... [1]

18. Hydrochloric acid reacts with sodium hydroxide solution according to the equation

$$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(aq)$$

(i) It was found that 20·0 cm^3 of dilute hydrochloric acid was needed to neutralise 25·0 cm^3 of sodium hydroxide solution of concentration 0·01 mol dm^{-3}.
Calculate the concentration of the acid in mol dm^{-3}. [3]

.....

.....

.....

.....

.....

(ii) The experiment described in part (i) involved accurately measuring 25·0 cm^3 sodium hydroxide solution followed by adding dilute hydrochloric acid 0·1 cm^3 at a time.

Name the piece of apparatus used to

I. **accurately** measure 25·0 cm^3 sodium hydroxide solution,

..... [1]

II. add dilute hydrochloric acid 0·1 cm^3 at a time.

..... [1]

(iii) State and explain what is needed to show that neutralisation has occurred. [2]

.....

.....

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 how the ***appearance*** of rocks is used to classify rocks as igneous, metamorphic and sedimentary. [5]

(b) Describe how crude oil is ***formed*** and explain why it becomes ***trapped*** in a rock layer. [5]

Turn over for part (*c*)

(c) Outline how you would prepare a crystalline sample of copper(II) sulphate in the laboratory. [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: