Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

1091/01 **New AS**

CHEMISTRY CH1

A.M. WEDNESDAY, 3 June 2009

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-4	
B	5	
	6	
	7	
	8	
	9	
TOTAL MARK		

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- copy of the **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

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

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

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

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 20 may be used for rough work.

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SECTION A

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

1. The symbols $^{35}_{17}Cl$, $^{37}_{17}Cl$ and $^{39}_{19}K$, represent chlorine atoms and potassium atoms respectively.

(a) Use these symbols to explain the meaning of the terms

(i) atomic number, [1]

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(ii) isotope. [1]

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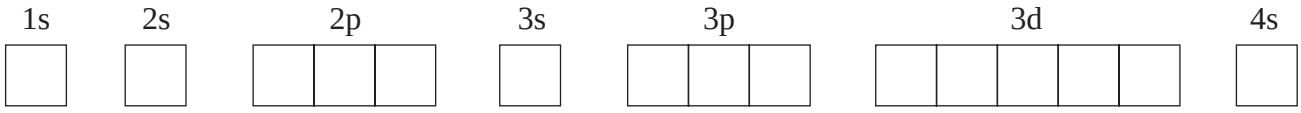
(b) By inserting arrows to represent electrons, complete the boxes below to show the electronic configuration of a potassium atom. [1]



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2. *(a)* Cobalt reacts with hydrochloric acid to give cobalt chloride and hydrogen.

$$Co(s) + 2HCl(aq) \longrightarrow CoCl_2(aq) + H_2(g)$$

(i) Suggest a method for measuring the rate of this reaction. [1]

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(ii) State what could be done to the cobalt to increase the rate of this reaction. [1]

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(b) A radioactive isotope of cobalt has a half-life of 71 days. Starting with 16 g, calculate the mass of this isotope remaining after 213 days. [1]

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3. State the mass of carbon that contains the same number of atoms as there are molecules in 16 g sulfur dioxide, SO_2. [1]

A 3 g

B 6 g

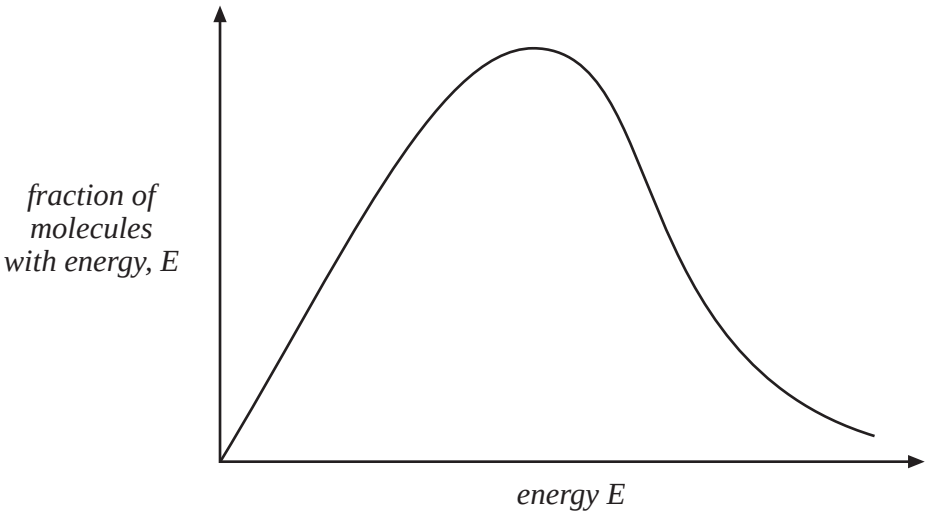
C 12 g

D 64 g .....

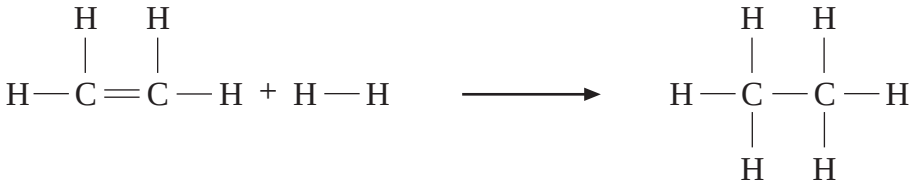
Examiner only

4. *(a)* The diagram below shows the distribution of molecular energies for a sample of ethene.

On the diagram, draw the distribution curve of molecular energies for the same sample of ethene at a higher temperature. [1]



(b) Ethene can be converted to ethane. The equation for the reaction is shown below.



Using the average bond enthalpy values listed below, calculate the enthalpy change, in kJ mol^{-1}, for the reaction. [2]

Bond	*Average bond enthalpy* / kJ mol^{-1}
C — C	348
C ═ C	612
C — H	412
H — H	436

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Section A Total [10]

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SECTION B

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

5. *(a)* The table below shows the molar first ionisation energy values, IE, for the first ten elements of the Periodic Table.

Element	H	He	Li	Be	B	C	N	O	F	Ne
IE / kJ mol^{-1}	1310	2370	520	900	800	1090	1400	1310	1680	2080

(i) Complete the graph shown on the next page, to show how first ionisation energy varies for the first ten elements.

Four of the points have been plotted for you. [3]

(ii) Explain why

I. helium has a higher first ionisation energy than neon, [2]

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II. neon has a higher first ionisation energy than nitrogen, [1]

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III. nitrogen has a higher first ionisation energy than oxygen. [2]

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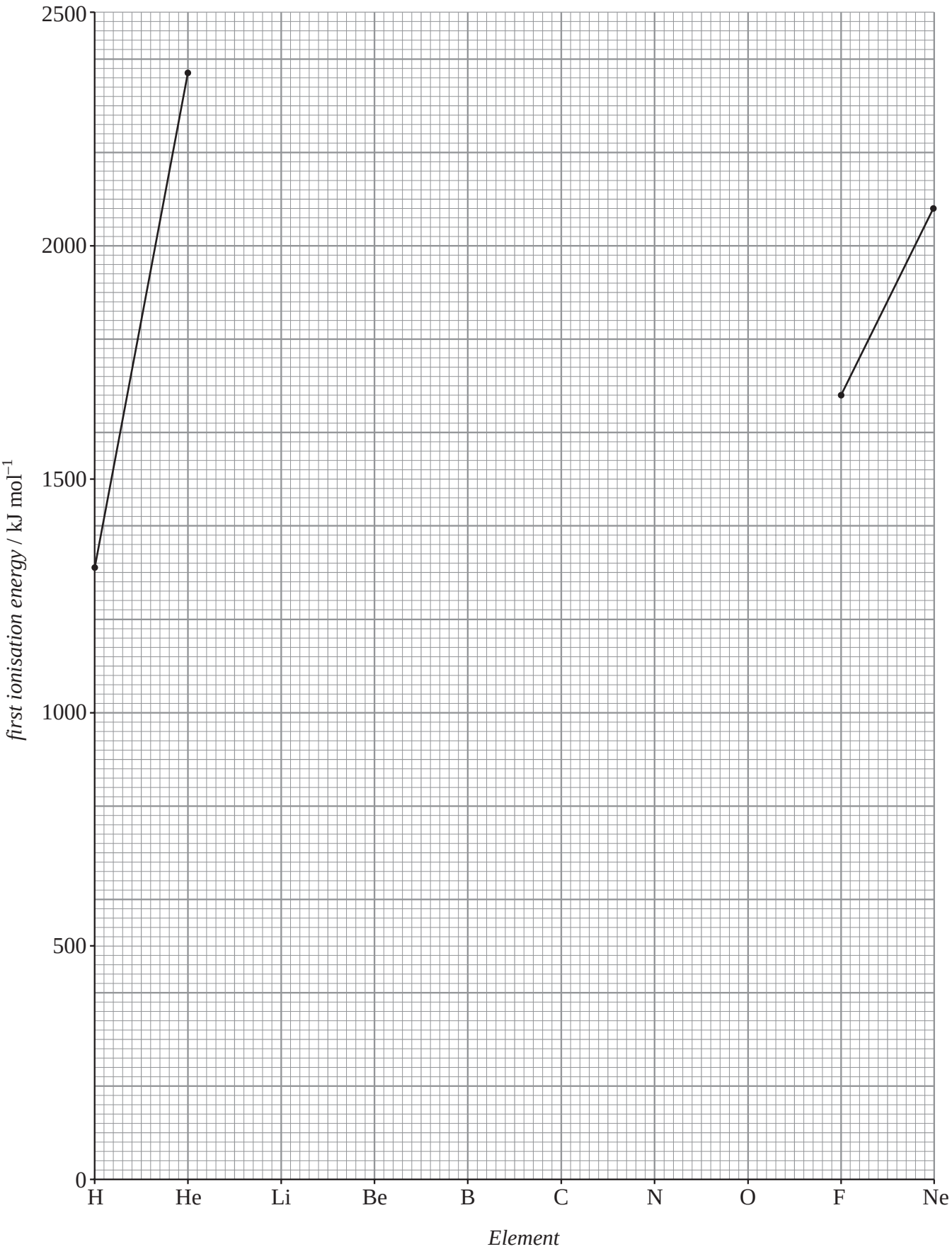

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(b) The use of lead compounds in paints and pigments has been common for many centuries, although, due to its toxicity, this is now rare.

(i) 'White lead', which is based on lead carbonate, was used as a skin whitening cosmetic by Queen Elizabeth I in the 16th century.

Analysis of lead carbonate shows that it has the following percentage composition by mass: Pb 77.5%; C 4.50%; O 18.0%.

Calculate the empirical formula of lead carbonate.
Show your working. [2]

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(ii) 'Red lead', which is based on lead oxide, Pb_3O_4, is used in anti-corrosive paint. It is formed by oxidising lead(II) oxide with oxygen.

$$6PbO + O_2 \longrightarrow 2Pb_3O_4$$

I. Calculate the molar mass of Pb_3O_4. [1]

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II. Calculate the mass of Pb_3O_4 that could be formed from 134 g of PbO. [3]

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Total [14]

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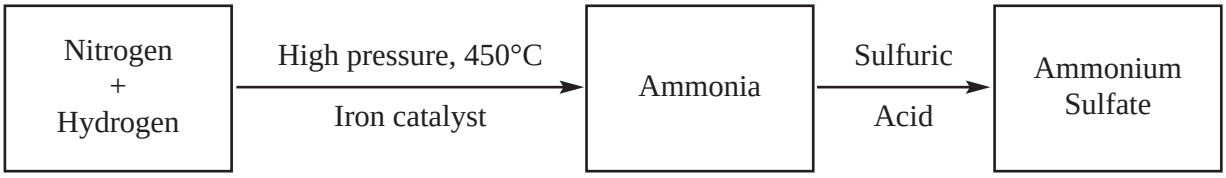
Examiner only

6. *(a)* Ammonia, a very important industrial product, is produced by the Haber process. Ammonia can be converted to ammonium sulfate, $(NH_4)_2SO_4$, a common fertiliser, by reacting it with sulfuric acid, H_2SO_4.



The Haber process can be represented by the following equation.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H^{\ominus} = -92 \text{ kJ mol}^{-1}$$

(i) Explain how a catalyst speeds up a reaction. [2]

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(ii) What **type** of catalyst is iron in the above process? [1]

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(iii) For the equilibrium reaction, explain why

I. there has been much research to find a better catalyst, [2]

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II. a high pressure is used, [2]

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III. ammonia is removed from the equilibrium mixture as it forms. [2]

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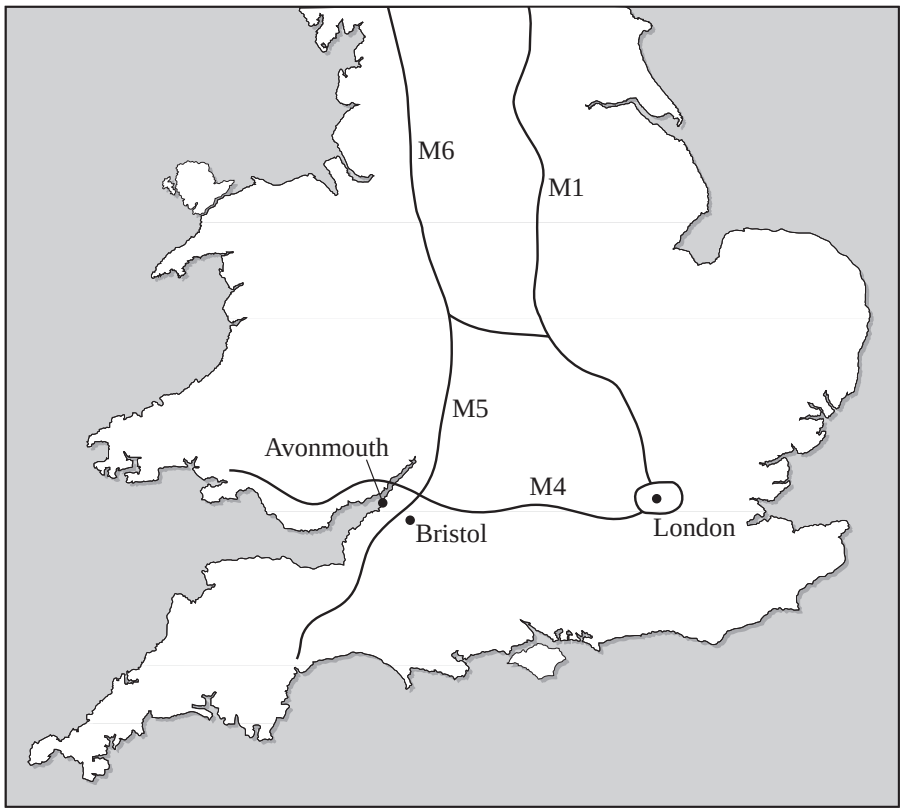
(iv) In Britain, an ammonia factory is sited at Avonmouth on the banks of the River Severn near Bristol.



Give **two** reasons why this site was chosen. [2]

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(b) (i) Write an equation for the acid-base reaction of ammonia with sulfuric acid. [1]

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(ii) Explain why ammonia behaves as a base in this reaction. [1]

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(iii) Farmers use ammonium sulfate as a fertiliser.

Calculate the percentage by mass of nitrogen in ammonium sulfate, $(NH_4)_2SO_4$. [2]

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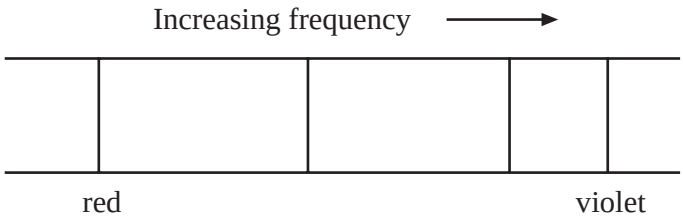
Total [15]

Examiner only

7. *(a)* The diagram below shows the emission spectrum of the hydrogen atom in the visible region.



(i) Explain why hydrogen emits only certain definite frequencies of visible light. [2]

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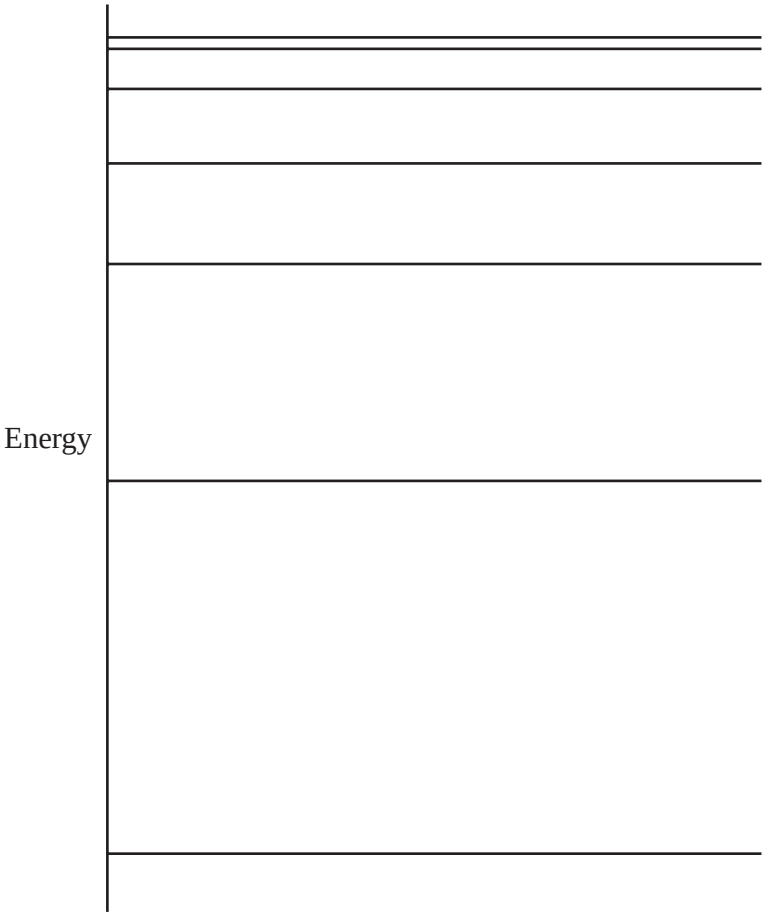
(ii) The horizontal lines below show the electron energy levels of a hydrogen atom.

Label these horizontal lines and draw the transitions corresponding to the four spectral lines in *(a)* above, clearly indicating which transition represents the red spectral line. [3]



Examiner only

(iii) On the diagram, draw and label the transition corresponding to the ionisation of the atom. [1]

(b) Hydrogen exists as two naturally occurring isotopes, ^{1}H and ^{2}H.

(i) A mass spectrum of a sample of hydrogen showed that it contained ^{1}H 99.20% and ^{2}H 0.8000%.

Calculate the relative atomic mass of the hydrogen sample, giving your answer to **four significant figures**. [2]

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(ii) In the mass spectrum, explain why peaks due to hydrogen atoms are present, although hydrogen gas contains only H_2 molecules. [1]

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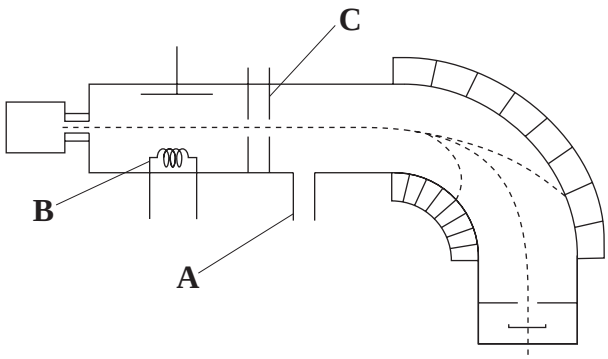
(c) Below is a diagram of a mass spectrometer.



(i) Name part **B**. [1]

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(ii) Name part **C**. [1]

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(iii) State the function of part **A**. [1]

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Examiner only

(d) Hydrogen also has an artificial isotope which is radioactive by β decay.

Complete the table below which shows the nature and effect of radioactive emission. [4]

Type	*Nature*	*Effect on atomic number*
α particle		
β particle		
γ radiation	Electromagnetic radiation of high energy	No effect

Total [16]

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Examiner only

8. *(a)* In 1987, the United Nations published a report on sustainable development, which included the following statement:

"Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs."

(i) In the UK, most electricity is generated in gas-fired power stations.
Give **two** reasons why the use of gas to generate electricity does not match the definition of sustainability. [2]

QWC [1]

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(ii) Suggest **one** method of generating electricity which would be sustainable and outline how it works. [2]

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Examiner only

(b) In some countries, ethanol is replacing petrol (octane) as a car fuel.

(i) When ethanol, C_2H_5OH, is burnt in air, the only products are carbon dioxide and water.

Balance the following equation for this reaction. [1]

C_2H_5OH + ... O_2 ⟶ ..... CO_2 + ... H_2O

(ii) Use the standard enthalpy change of formation values given in the table to calculate the standard enthalpy change, $\Delta H^{\ominus}$, for the combustion of ethanol. [2]

Compound	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
$C_2H_5OH(l)$	–278
$CO_2(g)$	–394
$H_2O(l)$	–286
$O_2(g)$	0

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(iii) The standard enthalpy change of combustion for octane $\Delta H_c^{\ominus}(C_8H_{18})$ is –5512 kJ mol^{-1}.

Using this value and your answer to *(b)*(ii), show that octane gives more energy per gram of fuel burned than ethanol. [2]

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(iv) Suggest a reason why ethanol is being used rather than petrol. [1]

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Total [11]

Examiner only

9. Elinor is given a mixture containing sodium carbonate and she carries out a two-part experiment to determine the percentage of sodium carbonate in the mixture.

In part 1, she accurately weighs 2.05 g of the mixture, transfers all of it to an appropriate container, adds 100 cm^3 of distilled water to ensure that it all dissolves and accurately makes up the solution to 250 cm^3 with distilled water.

In part 2, she pipettes 25.0 cm^3 of the solution into a container, adds 3 drops of an appropriate indicator and titrates this solution with hydrochloric acid of concentration 0.100 mol dm^{-3}. She repeats this procedure three times and obtains the following results.

Titration	1	2	3	4
Final reading (cm^3)	23.50	24.10	24.10	23.40
Initial reading (cm^3)	0.40	0.15	0.90	0.25
Titre (cm^3)				

(a) Name a suitable container to make up the solution that could be used in part 1. [1]

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(b) Complete the table to show the values of the titres. [1]

(c) Identify clearly any anomalous results and calculate a mean value. [1]

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(d) The equation for the reaction between sodium carbonate and hydrochloric acid is given below.

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

(i) Use your answer to part *(c)* to calculate the number of moles of HCl used in the titration. [1]

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(ii) Deduce the number of moles of Na_2CO_3 in 25.0 cm^3 of the solution. [1]

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Examiner only

(iii) Calculate the total number of moles of Na_2CO_3 in the original 250 cm^3 solution. [1]

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(iv) Calculate the mass of Na_2CO_3 in the original solution. [1]

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(v) Calculate the percentage of Na_2CO_3 in the mixture. [1]

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(e) Elinor's percentage for sodium carbonate was slightly lower than the actual value. When asked why, she stated 'I did not add the acid drop by drop at the end and so overshot the end-point'.

State **two** other common sources of error in such experiments and explain why Elinor's statement cannot be correct.
(Assume that all the equipment is clean and all chemicals are pure.) [4]

QWC [2]

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Total [14]

Section B Total [70]

Examiner only

Rough Work