OCR
RECOGNISING ACHIEVEMENT

Tuesday 17 January 2012 – Afternoon

AS GCE SCIENCE

G642 Science and Human Activity

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Duration: 1 hour 45 minutes

G6422

G611550111

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.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- 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 **100**.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use an electronic calculator.
- This document consists of **24** pages. Any blank pages are indicated.

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AS SCIENCE RELATIONSHIPS SHEET

pressure = force ÷ area

energy transferred = mass × specific heat capacity × temperature rise

density = mass ÷ volume

wavenumber = 1 / wavelength

speed = frequency × wavelength

energy = Planck constant × frequency

current = charge ÷ time

power = voltage × current

power loss = $(\text{current})^2$ × resistance

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PLEASE DO NOT WRITE ON THIS PAGE

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Answer **all** the questions.

1 This question is about the Earth's atmosphere and the different weather conditions that occur.

At 12:00 midday the Sun is directly overhead at the equator as shown in Fig. 1.1.

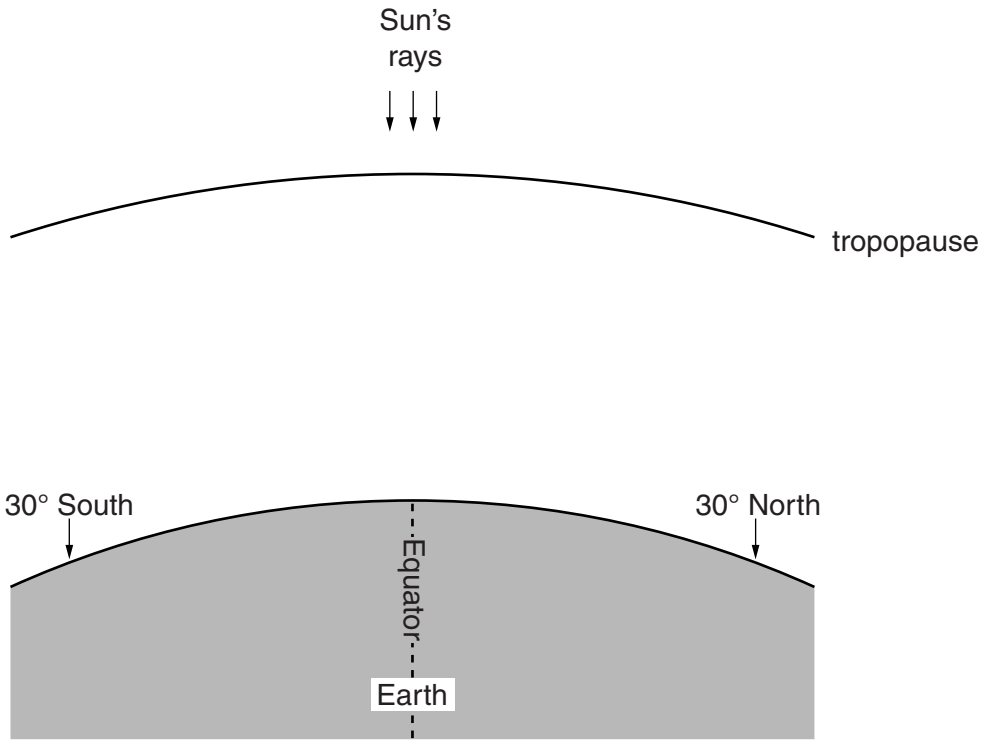

Fig. 1.1

(a) (i) Using Fig. 1.1, complete the diagram to show how air currents circulate between the equator and the points 30° north and south of the equator. **[3]**

(ii) State the likely weather conditions at 12:00 midday at the equator and 30° north of the equator.

equator .....

.....

30° north .....

..... **[2]**

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(b) Explain why a fixed mass of air descends when it cools. Use the kinetic theory of gases in your answer.

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..... **[3]**

(c) Air circulation patterns influence both weather and climate.

Explain the difference between the terms *weather* and *climate*.

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..... **[2]**

[Total: 10]

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2 The following question is about water and other small molecules.

Table 2.1 shows electronegativity values for 6 important non-metals.

atom	C	H	O	N	F	S
electronegativity	2.5	2.2	3.5	3.0	4.0	2.5

Table 2.1

(a) Explain what is meant by the term *electronegativity*.

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..... **[2]**

(b) Fig. 2.1 shows a 'dot and cross' diagram of a water molecule.

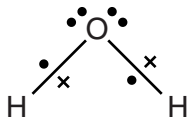

Fig. 2.1

(i) Label a lone pair of electrons on Fig. 2.1. **[1]**

(ii) With reference to Table 2.1, explain why you would expect a water molecule to possess a permanent dipole.

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..... **[2]**

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(iii) The compound hydrogen sulfide has the formula H_2S and has the same shape as a water molecule, Fig. 2.2.

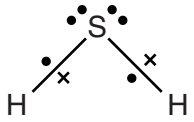

Fig. 2.2

Use information from Table 2.1 to suggest why hydrogen sulfide is a gas at room temperature whereas water is a liquid.

In your answer, you should make clear how your explanation links with the data given in Table 2.1.

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..... **[4]**

(c) Water has an unusually high specific heat capacity of 4.2 J K^{-1} g^{-1}.

If 2500 J of heat energy is completely transferred to 100 g of water with a starting temperature of 10 °C, what would be the final temperature of the water?
Show your working and give your answer to 2 significant figures.

final temperature = ... °C **[4]**

[Total: 13]

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3 This question concerns fossils fuels and the problems of pollution associated with their use.

Fill in the blanks using the words from the box below.

acidic	**alkaline**	**argon**	**carbon monoxide**	
chemical	**combustion**	**heat**	**infrared**	**inorganic**
kinetic	**methane**	**microwave**	**neutral**	
nitrogen monoxide	**organic**	**oxygen**	**photosynthesis**	
reduction	**respiration**	**ultraviolet**		
0.04	**0.4**	**4**		

Fossil fuels are formed from the decay of …… matter. The original energy source is the Sun. Light energy is captured by the process of …… and turned into …… energy. The process in which fossil fuels are burned is called …… . As a result, elements in the fossil fuels combine with …… from the air. Impurities, such as sulfur, in fossil fuels give rise to …… gases which lower the pH of rainwater. Another compound produced from the burning of fossil fuels is carbon dioxide (CO_2). Carbon dioxide makes up about …… % of the atmosphere and is responsible for preventing …… radiation escaping back into space. This is known as the greenhouse effect. Another gas that contributes significantly to the greenhouse effect is …… . **[9]**

[Total: 9]

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4 Nitrogen monoxide is produced when nitrogen and oxygen react together at very high temperatures in internal combustion engines.

$$N_2 + O_2 \rightarrow 2NO$$

(a) What is the name given to the **type** of chemical bond between oxygen and nitrogen in nitrogen monoxide?

..... **[1]**

(b) Nitrogen monoxide can react further with oxygen to give nitrogen dioxide, NO_2.

(i) Balance the equation for this reaction below.

..... NO + ... O_2 $\rightarrow$ ..... NO_2

[1]

(ii) Give the oxidation number for nitrogen in NO_2.

..... **[1]**

(c) NO_2 can react with water to form a strong acid called nitric acid, HNO_3.

(i) Define the term *acid*.

.....

..... **[1]**

(ii) Explain what is meant by a **strong** acid.

.....

..... **[1]**

(d) Limestone can be used to neutralise acidic substances in lakes and rivers. A student was trying to find out how much limestone was needed to neutralise a sample of nitric acid.

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

[key: (aq) aqueous solution, (g) gas, (l) liquid and (s) solid]

Using the equation above, suggest how the student could tell that all the acid had been neutralised, without the use of an indicator.

.....

..... **[1]**

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(e) Suggest why acidic exhaust fumes may have an environmental impact several hundred miles from where they are produced.

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.....

.....

..... **[2]**

(f) In order to reduce the environmental impact of nitrogen dioxide fumes, cars are now fitted with catalytic converters. The catalyst is usually a metal, such as platinum, coated onto a fine 'honeycomb' matrix that allows exhaust gases to pass over the catalyst. This type of catalyst is known as a heterogeneous catalyst.

(i) Explain the terms *heterogeneous* and *catalyst*.

heterogeneous .....

..... **[1]**

catalyst .....

.....

..... **[2]**

(ii) Suggest why the catalyst is coated onto a honeycomb matrix such as that shown in Fig. 4.1.

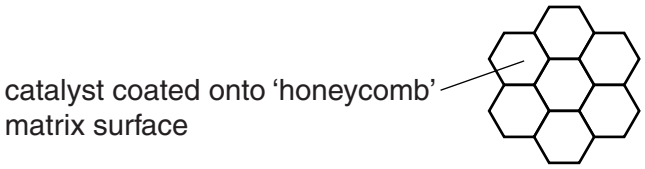

Fig. 4.1

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..... **[2]**

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(iii) Fig. 4.2 shows the energy profile diagram for an uncatalysed exothermic reaction.

On the diagram, sketch the energy profile for the same reaction when a catalyst is used. Mark on the diagram reactants, products and activation energy.

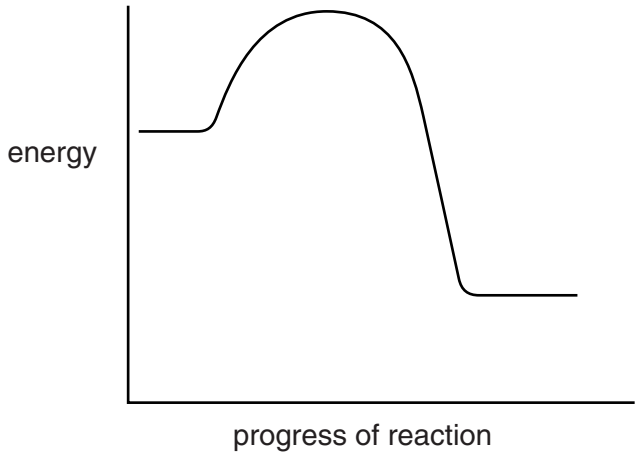

Fig. 4.2

[3]

[Total: 16]

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5 Fig. 5.1 shows a ribbon diagram of an enzyme called RNA polymerase.

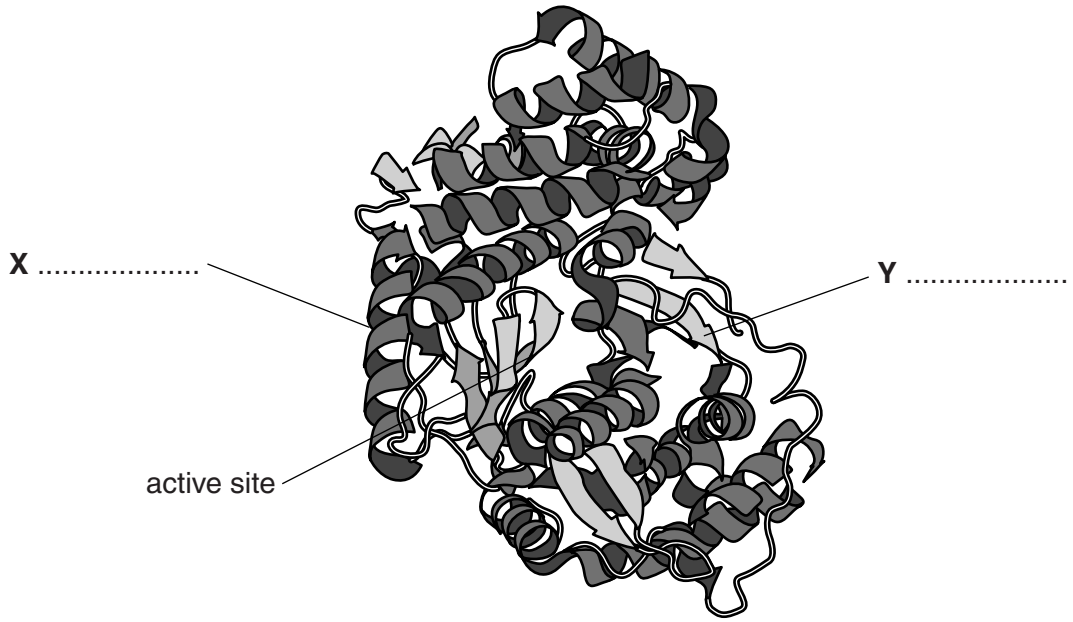

Fig. 5.1

(a) (i) Label the types of secondary structure **X** and **Y** shown in Fig. 5.1. **[2]**

(ii) Explain what is meant by an *enzyme*.

.....

.....

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..... **[2]**

(b) RNA polymerase is one of the enzymes responsible for transcription. The process of transcription has produced an mRNA sequence.

Part of an mRNA sequence that is translated is shown below.

Sequence: AUGGCAGAGGGAGCG

mRNA codon	amino acid
GCG	Alanine (Ala)
CUU	Leucine (Leu)
GCA	Alanine (Ala)
AGC	Serine (Ser)
AUG	Methionine (Met)
UGG	Tryptophan (Trp)
GAG	Glutamic acid (Glu)
GGA	Glycine (Gly)
AAA	Lysine (Lys)

Table 5.1

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(i) Use Table 5.1 to translate this mRNA sequence into an amino acid sequence. Use the three letter code for each amino acid given.

[2]

(ii) As a result of a mutation, one of the amino acids in the full protein sequence is replaced by a different one. Two students argue about how this will affect the phenotype of the organism. Patrick predicts that the phenotype will be different but Eleanor says it might be the same.

1 What is meant by the *phenotype* of an organism?

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..... **[2]**

2 Explain why both students might be correct in their predictions. In your answer you may want to refer to Fig. 5.1.

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..... **[6]**

[Total: 14]

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6 This question is about the ozone layer and its importance in protecting the Earth's surface from overexposure to ultraviolet radiation.

(a) Fig. 6.1 shows how the ozone concentration varies with altitude (height).

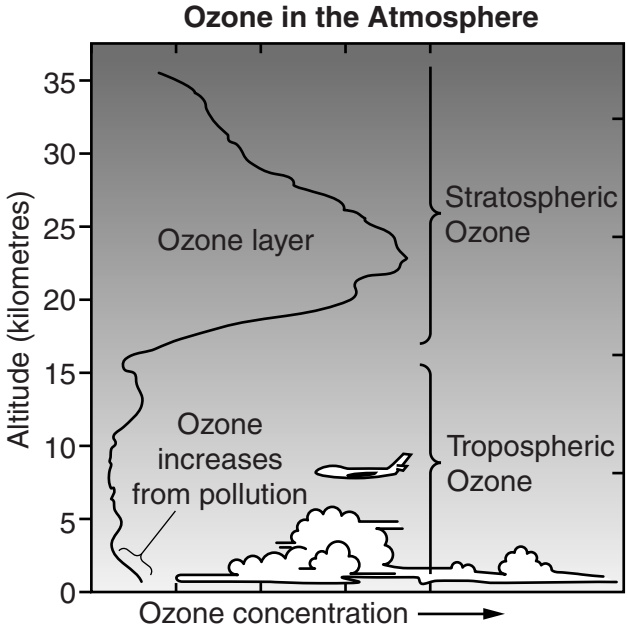

Fig. 6.1

(i) Use Fig. 6.1 to estimate the altitude at which the ozone concentration is at a maximum.

..... **[1]**

(ii) Ozone, O_3, absorbs ultraviolet light in the wavelength range 240 nm to 310 nm.

Calculate the frequency of 240 nm ultraviolet light.

Show your working.
$1\,\text{nm} = 1 \times 10^{-9}\,\text{m}$
$c = 3.0 \times 10^{8}\,\text{m s}^{-1}$

frequency = ... unit ..... **[4]**

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(iii) Ultraviolet light that reaches the Earth's surface can result in the increased incidence of random mutations in living organisms.

Explain how ultraviolet light can cause mutation.

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..... **[2]**

(b) CFCs (chlorofluorocarbons) have been implicated in the depletion of the ozone layer causing more ultraviolet light to reach the Earth's surface.

Explain the role of CFCs in ozone depletion.

In your answer, you should use ideas about
- what happens to CFCs in the atmosphere
- the role of radicals.

In your answer, you should present your explanation in a logical sequence.

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..... **[4]**

[Total: 11]

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7 This question is about electrical energy supply in the UK.

Fig. 7.1 shows a coal fired power station and its connection to the national grid.

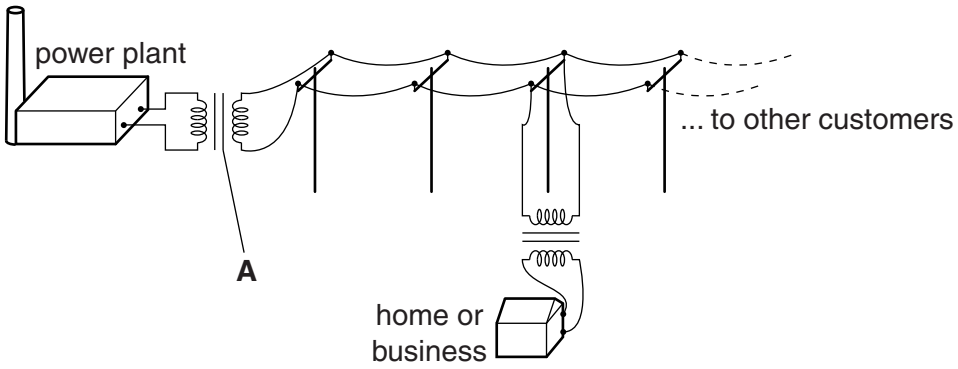

Fig. 7.1

(a) Suggest **one** benefit of having a **national grid** for electrical energy.

.....

..... **[1]**

(b) Fig. 7.1 shows the use of a transformer labelled **A**.

What is the function of the transformer and why is it necessary?

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..... **[2]**

(c) **(i)** An electric kettle has a power rating of 2 kW.

How much energy does it transfer per second?

energy = ... unit ..... **[1]**

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(ii) This kettle is switched on for 4 minutes.

Calculate the mass of coal that has to be burned in the power plant to supply the energy.

Coal has an energy density of $3.3 \times 10^4\,\text{kJ}\,\text{kg}^{-1}$.
Assume that **one third** of the coal energy is converted to electrical energy.

mass of coal = ... kg **[4]**

(iii) Although coal still generates about 25% of our electrical energy it is now rarely used in private homes.

Suggest why this is the case.

.....

..... **[1]**

(d) Some people have expressed a concern about the possible health risks associated with living close to high voltage power cables.

(i) Identify **two** features of electricity transmission that have been developed to minimise any possible risk.

.....

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..... **[2]**

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(ii) Possible health risks can be evaluated using epidemiological studies.
For example, two methods of carrying out a study into the causes of leukaemia are

- the Case-control study and
- the Cohort study.

Outline the main features of each method and identify one limitation of each method.

Case-control study .....

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Cohort study .....

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..... **[6]**

[Total: 17]

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8 This question concerns atomic structure and the existence of isotopes.
Three isotopes of copper are shown in Table 8.1.

isotope	mass number	atomic number
^{65}Cu	65	29
^{64}Cu	64	29
^{63}Cu	63	29

Table 8.1

(a) Give the number of protons and neutrons for isotopes ^{63}Cu and ^{65}Cu.

^{63}Cu protons ..... neutrons .....

^{65}Cu protons ..... neutrons ..... **[1]**

(b) ^{64}Cu is a radioactive isotope.

Explain what happens during radioactive decay.

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.....

.....

..... **[2]**

(c) Exposure to radiation can cause cell damage and mutation. State why.

..... **[1]**

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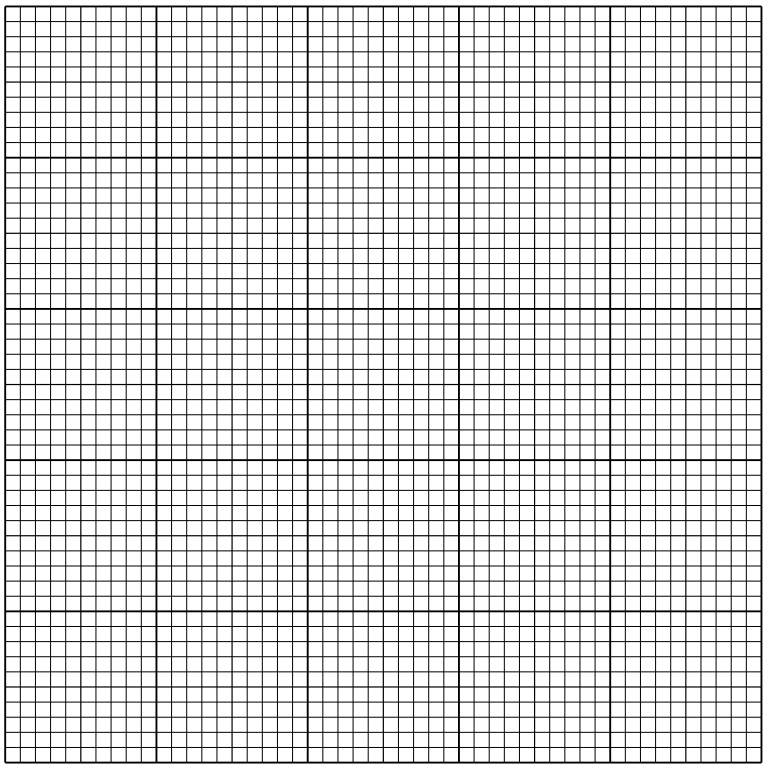
(d) The data in Table 8.2 shows how the mass of ^{64}Cu changes over time.

mass of isotope ^{64}Cu remaining in the sample /g	time/hours
1.0	0
0.8	4
0.6	9
0.4	18
0.2	31
0.1	44
0.05	55

Table 8.2

(i) Plot the data from Table 8.2. Label the axes and connect the points with a line of best fit.



[3]

(ii) Estimate the half life of ^{64}Cu showing clearly how you arrived at your answer on the graph.

half life of ^{64}Cu = ... hours **[2]**

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(e) Despite being radioactive, ^{64}Cu is chemically identical to the other stable isotopes of copper.

Explain why this is the case.

.....

..... **[1]**

[Total: 10]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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