

ADVANCED SUBSIDIARY GCE
SCIENCE
Science and Human Activity

G642

Candidates answer on the question paper.

OCR supplied materials:

None

Other materials required:

- Electronic calculator
- Ruler (cm/mm)

Monday 6 June 2011
Afternoon

Duration: 1 hour 45 minutes




Candidate forename		Candidate surname	
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Centre number						Candidate number				
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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. Pencil may be used for graphs and diagrams only.
- 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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Answer **all** the questions.
- 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 **20** pages. Any blank pages are indicated.

AS SCIENCE RELATIONSHIPS SHEET

pressure = force \div area

energy transferred = mass \times specific heat capacity \times temperature rise

density = mass \div volume

wavenumber = 1 / wavelength

speed = frequency \times wavelength

energy = Planck constant \times frequency

current = charge \div time

power = voltage \times current

power loss = (current)² \times resistance

Answer **all** the questions.

- 1 The following question is about the Earth's atmosphere and the factors that give rise to weather conditions.

Use the words in the box below to complete the paragraph.

anti-clockwise	clockwise	condenses	contracts	descends		
downwards	dry	evaporates	expands	high	low	rises
stratosphere	tropopause	troposphere	warm	wet		

The lowest layer of the Earth's atmosphere is called the Horizontal and vertical movements of air in this layer are responsible for weather conditions at the Earth's surface. Energy from the Sun causes heating of the air and it As a result, the air and water vapour The low pressure created is usually associated with weather. Differences in atmospheric pressure lead to horizontal movements of air. This air moves from areas of to pressure but the Coriolis effect causes it to be deflected in the northern hemisphere. [7]

[Total: 7]

- 2 Water has several remarkable properties. It has an unusually high specific heat capacity and is an excellent solvent for a wide range of substances. The bonding in the molecule helps to explain these properties. Fig. 2.1 shows a diagram of a water molecule.

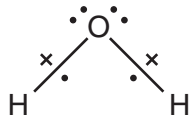


Fig. 2.1

- (a) (i) Label a bonding pair and a lone pair of electrons on the water molecule in Fig. 2.1. [2]
- (ii) Use the electronegativity values below to indicate the polarity of an OH bond on Fig. 2.2. Electronegativity values: O = 3.5 H = 2.1

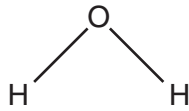


Fig. 2.2

[2]

- (iii) Explain why water molecules have a permanent dipole.

.....

.....

.....

..... [2]

- (b) One of the most important properties of water is its high specific heat capacity ($4.2 \text{ kJ kg}^{-1} \text{ } ^\circ\text{C}^{-1}$).

Explain why the high specific heat capacity of water is an important factor in determining features of the Earth's climate.

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..... [3]

(c) Fig. 2.3 shows an illustration of an ammonia molecule.

Use the diagram to explain why you would expect ammonia to be soluble in water.

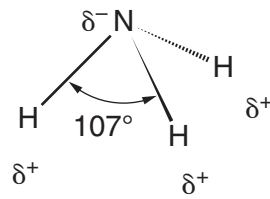


Fig. 2.3

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..... [3]

[Total: 12]

- 3** Ultra low sulfur diesel fuels used in the European Union must now contain less than 0.005% sulfur. The burning of sulfur in oxygen leads to the formation of acid rain.

(a) Complete the equations below for the formation of sulfuric acid in rain.



(b) (i) When acid rain soaks into the soil it can cause the release of metal ions from the soil.

Explain how this occurs.

You may use diagrams to help illustrate your answer.

.....

 [3]

(ii) The release of metal ions can damage the health of plants.

State and explain two ways in which this process affects plants.

1.

 [4]

(c) Acid rain can also cause corrosion of limestone.

A group of students carried out the following experiment to measure the corrosive effect of acid rain samples on limestone.

- 10cm³ samples of acid rain were collected from five different locations around the town of Newchester.
- 1.0g of limestone was added to each sample of acid rain.
- After 4 days, any remaining limestone was removed by filtration, dried and reweighed.

The results of the experiment are shown in Table 3.1.

Table 3.1

location number	mass of limestone at start of experiment/g	mass of limestone at end of experiment/g
1	1.0	0.8
2	1.0	1.3
3	1.0	0.9
4	1.0	0.8
5	1.0	1.0

(i) State two concerns that you have about the **reliability** of these results.

1.

2.
 [2]

(ii) Suggest four improvements that could be made to this experiment giving reasons for your choices.

improvements	reasons
1.	
2.	
3.	
4.	

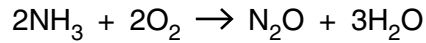
[8]

[Total: 20]

Turn over

- 4 This question is about the influence of the gas dinitrogen monoxide (nitrous oxide, N_2O) on the Earth's climate.

N_2O can be produced by the action of microbes on ammonia in the soil according to the following equation:



(a) Give the oxidation number of nitrogen in

(i) NH_3 [1]

(ii) N_2O [1]

(b) N_2O is a major contributor to the greenhouse effect. An infrared spectrum of N_2O is shown in Fig. 4.1.

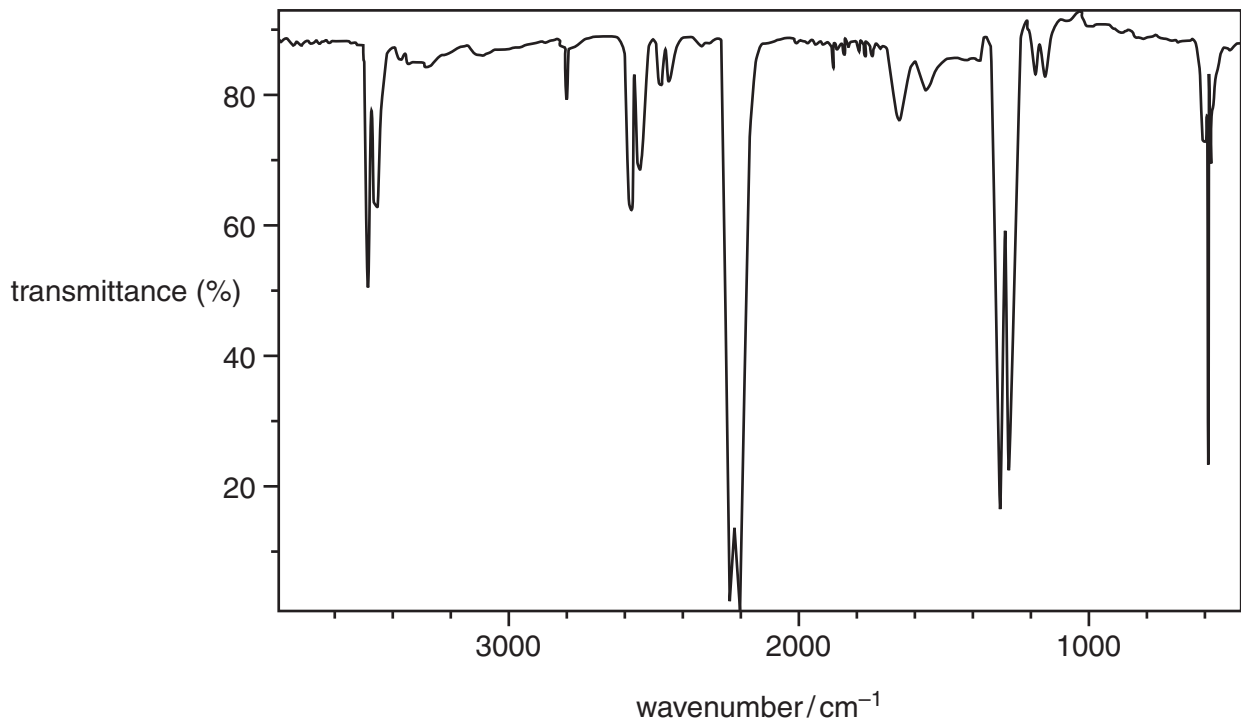


Fig. 4.1

(i) Use the graph to estimate the wavenumber at which N_2O has a maximum absorbance.

..... [1]

- (ii) The maximum absorbance is at a wavelength of 4.50×10^{-5} metres.
Using this value, calculate the frequency of this radiation given $c = 3.0 \times 10^8 \text{ m s}^{-1}$.

frequency of this radiation = Hz [2]

- (iii) The energy gained by a molecule when it absorbs radiation can be calculated using the frequency of the radiation.

Use your answer from **(b)(ii)** to calculate the energy of the radiation.
(Planck's constant, $h = 6.63 \times 10^{-34} \text{ J s}$)

energy of the radiation = unit [2]

- (c) (i) N_2O also causes ozone depletion in the stratosphere. One possible mechanism involves the reaction of N_2O with oxygen molecules, O_2 , to produce nitrogen monoxide.
Complete the following equation:



- (ii) NO is a radical that reacts rapidly with ozone.

State what is meant by a *radical*.

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

11
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5 This question is about protein structure.

Table 5.1 shows the messenger RNA (mRNA) base codons and the amino acids for which they code.

Table 5.1

triplet code	amino acid
GCA	alanine (ala)
AUG	methionine (met)
UGC	cysteine (cys)
GGA	glycine (gly)
AAA	lysine (lys)
GUA	valine (val)
UAC	tyrosine (tyr)

(a) (i) Use Table 5.1 to translate the following mRNA base sequence into an amino acid sequence. You may use the three letter abbreviations for each amino acid.

→

AUGAAAUGCGGAGCAUAC

Translated sequence



[2]

(ii) The amino acid cysteine has a sulfur-containing thiol (-SH) group. As a result of a mutation UGC is changed to UAC.

1 Which amino acid will now replace cysteine in the protein section above?

..... [1]

2 Suggest why this mutation may be particularly damaging to the **tertiary structure** of the final protein.

.....

 [3]

6 In 1911 whilst investigating the atom, Ernest Rutherford's research team carried out the famous 'scattering' experiment. The team used the results to develop a new model of the atom to replace Thompson's 'plum pudding' model.

Explain why the results led to a new model of the atom.

In your answer you should include:

- a description of the experiment (you may wish to include a diagram)
- the results of the experiment
- the conclusions made from these results
- how these results disprove the 'plum pudding' model.



In your answer, you should link evidence with the model proposed.

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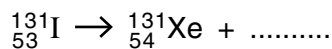
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7 This question is about two radioactive isotopes.

(a) A radioactive isotope of iodine (I-131) can be used to treat an overactive thyroid gland.

(i) Complete the equation for the decay of $^{131}_{53}\text{I}$



[2]

(ii) Radiation produced by this isotope is ionising.

Explain what is meant by *ionising radiation*.

.....

 [2]

(iii) Radioactive isotopes of iodine have the same chemical properties as non-radioactive isotopes.

Explain why all isotopes of iodine will have the same chemical properties.

.....

 [2]

(iv) Iodine-131 has a half-life of 8.02 days.
 Starting with 60 mg, what mass of this isotope would remain after 40.1 days?

mass of isotope remaining = [2]

- (b) Thorium-230 can be found in trace amounts in granite rocks such as those in Devon and Cornwall. It decays by alpha emission.

Explain why the decay of thorium-230 in these rocks is not considered to be a major health risk.

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[3]

[Total: 11]

8 This question is about the generation of electricity in the UK.
Mains electricity in the UK was delivered at 240 volts 50Hz a.c.

(a) Fig. 8.1 shows how the current changes over time.
Show on Fig. 8.1 one full cycle.

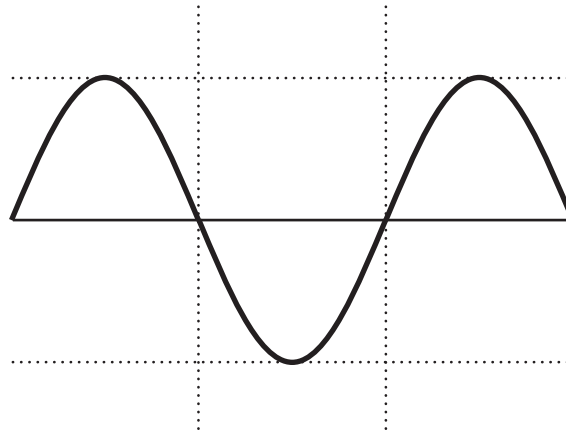


Fig. 8.1

[1]

(b) (i) A hairdryer has a power rating of 1400W. Assuming a voltage supply of 240V, calculate the current supply drawn from the mains by the hairdryer.

current = A [2]

(ii) Use your answer to (b)(i) to calculate the total resistance of the hairdryer.

total resistance = unit [3]

(c) Some of the electricity in the UK is generated by **nuclear fission**.

(i) State what is meant by the term *nuclear fission*.

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

(ii) Recent concerns about the impact of using fossil fuel on the global environment have lead many scientists to reconsider nuclear fission reactors as a possible solution to our future energy needs in the UK.

Discuss the advantages **and** disadvantages of using more nuclear fission reactors to generate electricity.

advantages:
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.....

disadvantages:
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..... [6]

(iii) Some people suggest that **nuclear fusion** would be an alternative method to supply electricity in the UK.

Suggest why it has proved difficult to develop a cost effective nuclear fusion reactor.

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..... [2]

[Total: 16]

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