Monday 2 June 2014 – Morning

AS GCE SCIENCE

G642/01 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

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 page 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.

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 = $(\text{current})^2 \times$ resistance

Answer **all** the questions

1 This question is about water and the greenhouse effect.

(a) Fig. 1.1 shows two water molecules.

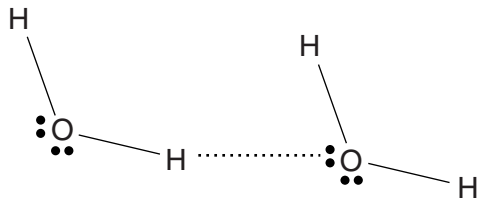

Fig. 1.1

(i) Label the following on Fig. 1.1:

- a covalent bond
- a hydrogen bond
- a lone pair.

[2]

(ii) Give a value for the H-O-H bond angle on Fig. 1.1.

.....° **[1]**

(b) Water has a higher boiling point than other molecules with a similar molecular mass.

Use Fig. 1.1 to explain why.

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

(c) Fig. 1.2 shows an infrared spectrum of water.

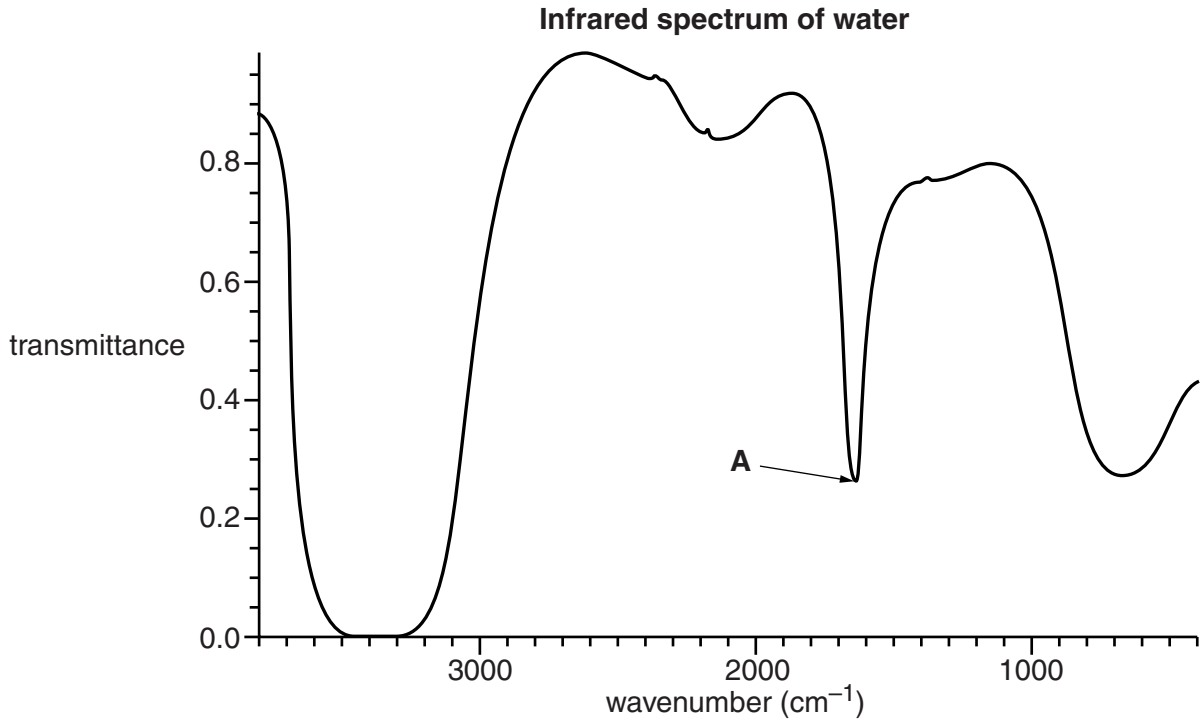

Fig. 1.2

(i) Give a value in wavenumbers for the peak labelled **A** in Fig. 1.2.

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

(ii) What happens to a molecule when it absorbs infrared radiation?

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

(d) Water vapour and carbon dioxide contribute to the greenhouse effect.

Describe the greenhouse effect **and** suggest **two** reasons why carbon dioxide and water vapour make different contributions to the greenhouse effect.

In your answer, you should include information about both the greenhouse effect and how the two named gases contribute to it.

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

[Total: 14]

2 Fig. 2.1 shows the Earth tilted on its axis. (Not to scale)

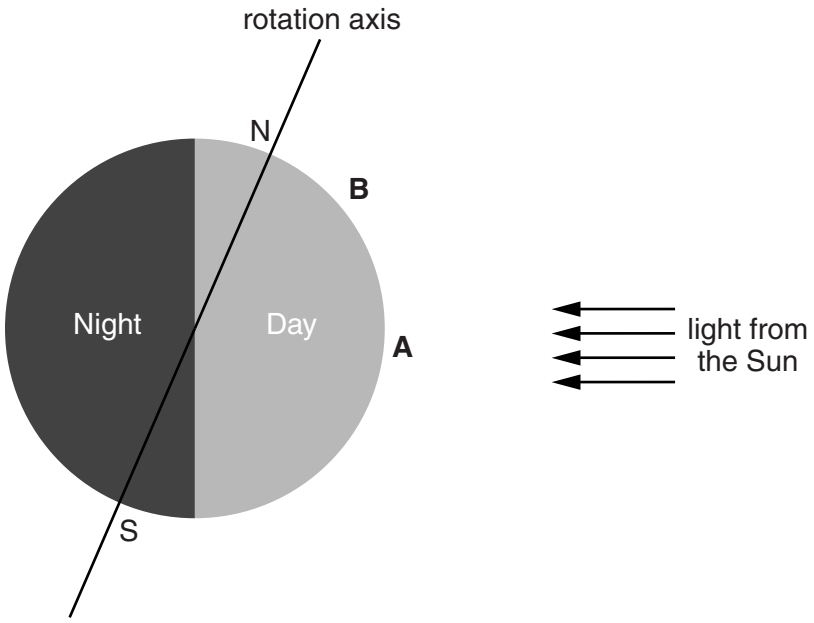

Fig. 2.1

(a) (i) With reference to Fig. 2.1, explain why the surface temperature at **A** is higher than at **B**.

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

(ii) The air immediately above the ground at point **A** becomes hot, which causes the air to rise.

Use the kinetic theory to explain this.

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(iii) Boyle's law states that:

"…at constant temperature the volume of a gas is inversely proportional to the pressure exerted on it".

Describe what happens to the volume of a gas if the pressure exerted on the gas is halved.

Use the kinetic theory of gases to explain why this happens.

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

Question 2(b) starts on page 8

(b) The Intertropical Convergence Zone (ITCZ) is a region of rising air which is formed close to the equator.

Fig. 2.2 shows the formation of the ITCZ at the equator.

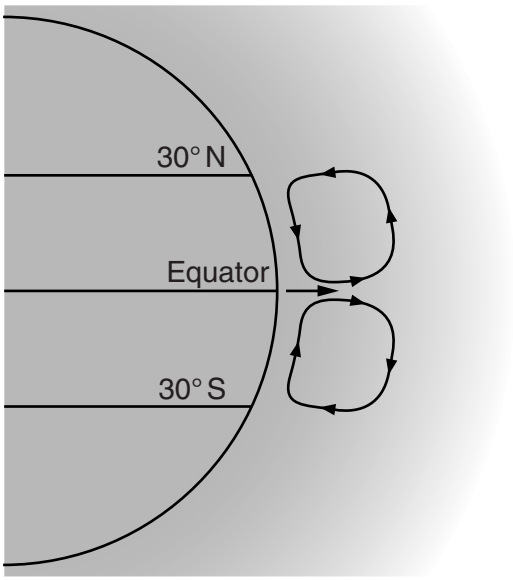

Fig. 2.2

(i) Use Fig. 2.2 to explain the formation of the Intertropical Convergence Zone (ITCZ) at the equator.

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

(ii) For large parts of the year, the ITCZ is not directly over the equator.

Suggest why the position of the ITCZ changes over the course of a year.

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

[Total: 15]

Question 3 starts on page 10

3 Heptane (C_7H_{16}) is a fossil fuel that comes from crude oil and is used in petrol.

(a) Balance the equation for the complete combustion of heptane.

$$C_7H_{16} + \ldots\ldots O_2 \rightarrow \ldots\ldots CO_2 + \ldots\ldots H_2O$$ **[2]**

(b) Some students want to measure the heat energy released from the combustion of heptane.

They use the following apparatus:

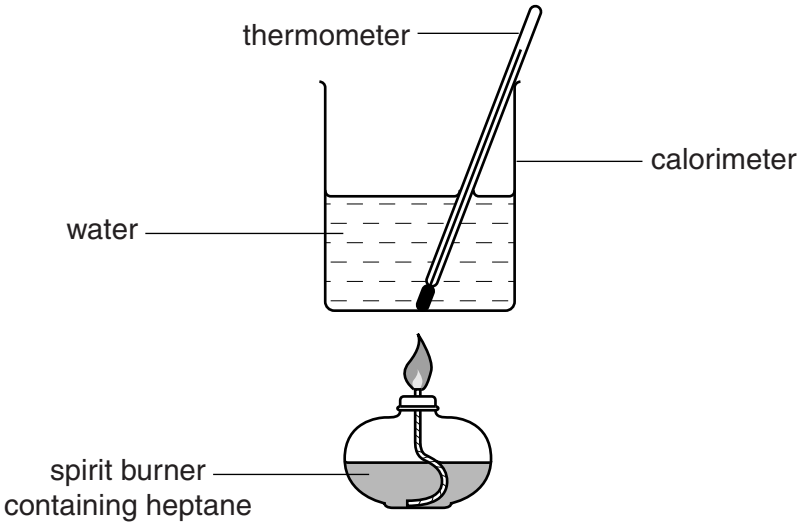

Fig. 3.1

(i) Outline an experimental method, using the apparatus shown in Fig. 3.1, which the students could use to measure the amount of heat energy released from a known mass of heptane.

You should include:

- the measurements taken
- what the students could do to ensure precision
- what the students could do to ensure reliability.

(no calculation is required)

In your answer, you should use appropriate sequencing of ideas.

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(ii) Suggest a suitable material from which the calorimeter should be made **and** explain your choice.

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

[Total: 11]

4 Proteins are formed from small molecules called amino acids.

Fig. 4.1 shows the structure of three molecules.

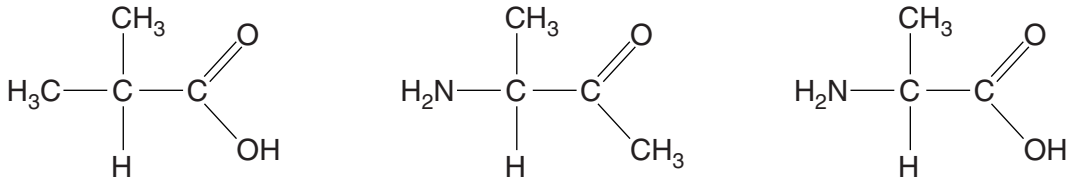

Fig. 4.1

(a) Which structure, **A, B** or **C** represents an amino acid? ..... **[1]**

(b) Fig. 4.2 shows a ribbon diagram of an **alpha helix**, which is a secondary structure seen in many proteins.

Fig. 4.2

Describe the type of bond that maintains the structure of the alpha helix.

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

(c) Some proteins are enzymes.

Fig. 4.3 shows the formation of the enzyme-substrate complex from an enzyme and its substrate.

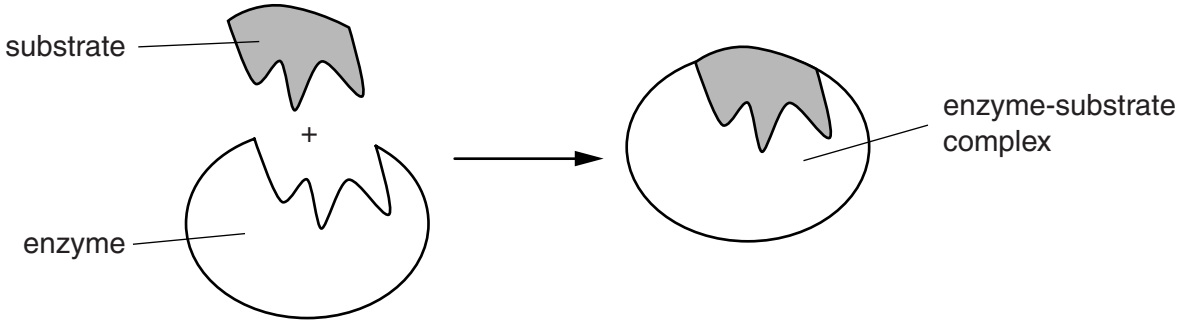

Fig. 4.3

(i) Use Fig. 4.3 to explain why an enzyme is specific to its substrate.

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

Question 4(c) continues on page 14

(ii) The activity of an enzyme depends on temperature. Fig. 4.4 shows the relationship between activity and temperature for a particular enzyme.

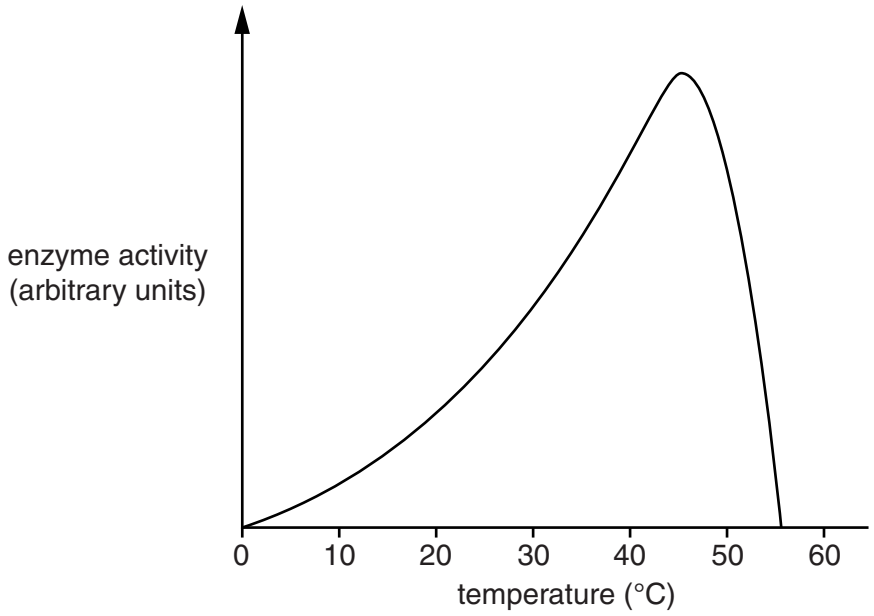

Fig. 4.4

Describe **and** explain the shape of the graph.

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..... **[5]**

[Total: 11]

5 This question is about genetics and protein synthesis.

(a) Match the term with the correct description. One has been done for you.

Term	Description
Ribosome	The set of characteristics displayed by an organism
transfer RNA	A specific sequence of nucleotides that codes for a protein
Virus	An example of a codon
Phenotype	Forms polypeptides from amino acids
Gene	Can be used to insert foreign genetic material into a target organism
DNA	Brings a specific amino acid to the ribosome
TCA	The genetic material that chromosomes are made from

[4]

(b) During protein synthesis, a DNA base sequence is transcribed into a messenger RNA base sequence.

Complete Table 5.1 to show the messenger RNA base sequence.

DNA	A	G	T	T	A	C	G	C
Messenger RNA								

[2]

Table 5.1

[Total: 6]

6 This question is about radioactive isotopes.

(a) Isotopes of plutonium (Pu) are produced by the β decay of neptunium-239 isotopes.

(i) Complete the equation below for the β decay of neptunium-239.

$$^{239}_{93}\text{Np} \rightarrow {}^{.....}_{.....}\text{Pu} + {}^{0}_{-1}\beta$$

[2]

(ii) Write down the number of protons in an atom of neptunium.

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

(iii) Neptunium-239 has a half life of 2.4 days.

A sample of neptunium-239 has a mass of 0.8 mg.

Calculate the mass of neptunium-239 that would remain after 9.6 days.

mass of neptunium-239 remaining = ... mg **[2]**

(b) Isotopes of plutonium are found in large amounts in the waste from nuclear reactors. The most common plutonium isotope in the waste has a half life of 24,000 years. It decays by alpha emission.

Describe the hazards associated with disposal of waste containing this isotope **and** explain one way in which this isotope may be contained.

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[Total: 10]

7 Electrical energy is increasingly being generated by renewable energy sources such as wind, wave, tidal and solar power.

(a) Explain why these energy sources are described as *renewable energy sources*?

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

(b) A school is considering using either wind, wave, tidal or solar power to generate some of its electricity.

Discuss the factors that the school needs to take into account before deciding which renewable energy source to use.

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[Total: 9]

8 This question is about electricity generation and the National Grid.

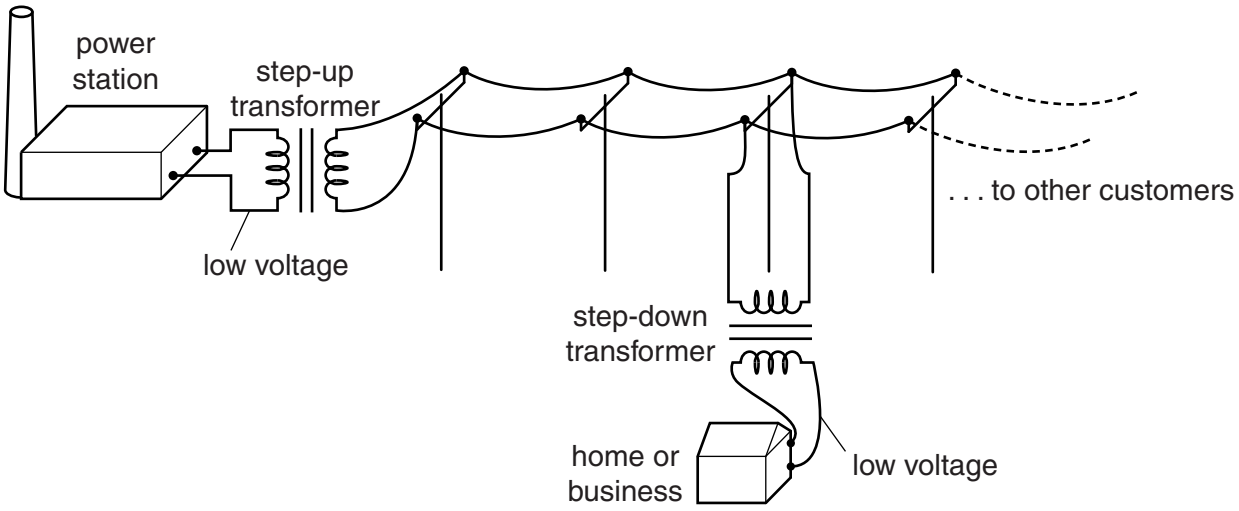

Fig. 8.1

(a) A power station, such as the one shown in Fig. 8.1, has a power output of 850 MW.

1 MW = 1×10^6 Watts

(i) Calculate the energy in joules produced by the power station **in 30 seconds**.

1 Watt = 1 Joule/second

Show your working.

Energy = ... J **[3]**

(ii) Explain the function of the **step-up transformer** as shown in Fig. 8.1.

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

(iii) Mains electricity supply in the UK is described as 50 Hz a.c.

Explain what is meant by 50 Hz **and** what is meant by a.c.

50 Hz .....

.....

a.c. .....

[2]

(b) The mains voltage in the UK is 230 V.

An electric kettle has a power rating of 2500 W.

Calculate the current supplied to the kettle.

Show your working and give your answer to three **significant figures**.

Current = ... unit ..... **[4]**

[Total: 12]

9 This question is about how nitrogen oxides are involved in the breakdown of the ozone layer and in the formation of acid rain.

(a) Explain why the breakdown of the ozone layer may be harmful to life on the Earth's surface.

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

(b) One oxide of nitrogen, NO, is involved in the breakdown of ozone, as shown in the two equations:

$$NO + O_3 \longrightarrow NO_2 + O_2$$

$$NO_2 + O \longrightarrow NO + O_2$$

Describe what happens to the oxidation number of nitrogen in these reactions.

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

(c) **(i)** The molecule NO_2 can dissolve in water to form nitric acid, HNO_3, which is a strong acid.

Explain what is meant by the term *acid*.

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

(ii) Complete the equation below for the ionisation of HNO_3 in solution.

$$HNO_3 \longrightarrow \text{.....} + \text{.....}$$

[2]

(iii) Nitric acid in acid rain can damage plants through a process of ion exchange in the soil.

Describe the process of ion exchange in soil **and** explain why this can damage plants.

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..... **[5]**

[Total: 12]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

PLEASE DO NOT WRITE ON THIS PAGE