OCR
RECOGNISING ACHIEVEMENT

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)

Thursday 20 January 2011
Morning

Duration: 1 hour 45 minutes

G642

G616830611

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. 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. 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.
- 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.

DC (SHW (CGW) 00579 2/10) 27844/3

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

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 **(a)** Fig. 1.1 shows the Earth tilted on its axis towards the Sun.

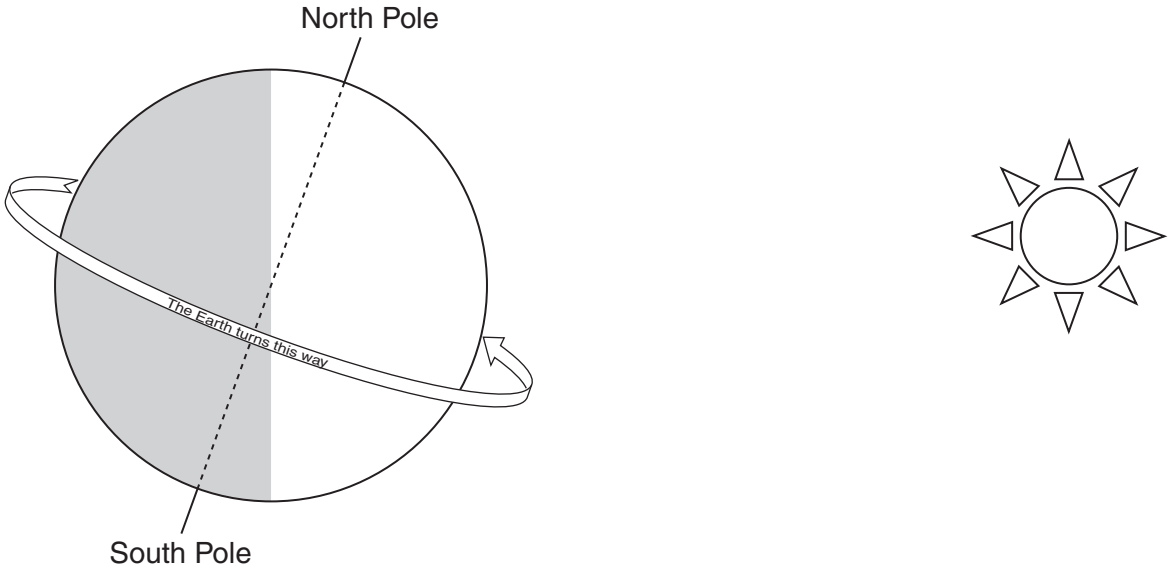


Fig. 1.1

Using the diagram, give two reasons why the air temperature in the northern hemisphere is, on average, warmer than in the southern hemisphere during the summer months.

1. .....

.....

2. .....

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

(b) An atmospheric pressure of $1.024 \times 10^5\,\text{N}\,\text{m}^{-2}$ is recorded on a warm summer's day.

Calculate the total force acting on an area of $250\,\text{m}^2$.

total force = ... unit ..... **[3]**

(c) (i) Describe and explain what would happen to the volume of a fixed mass of air when the temperature rises from 18 °C to 24 °C. Use ideas about the kinetic theory in your answer. (You do not need to do any calculations.)

.....

.....

.....

.....

.....

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

(ii) Fig. 1.2 shows the vertical movement of air above the Earth's surface.

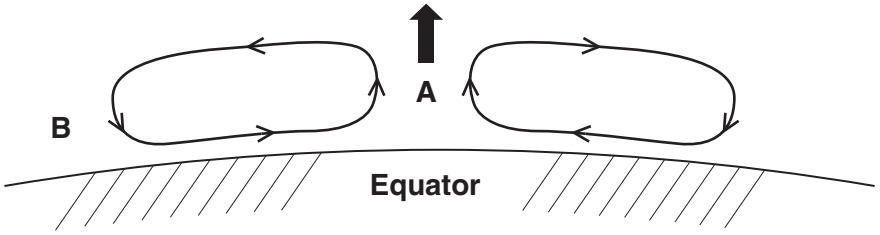


Fig. 1.2

Describe and explain the weather **and** atmospheric pressure conditions at points **A** and **B** using this information.

point **A** .....

.....

.....

.....

.....

.....

point **B** .....

.....

.....

.....

.....

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

[Total: 14]

2 **(a)** Name the **three** warm water currents labelled **P**, **Q** and **R** on Fig. 2.1.

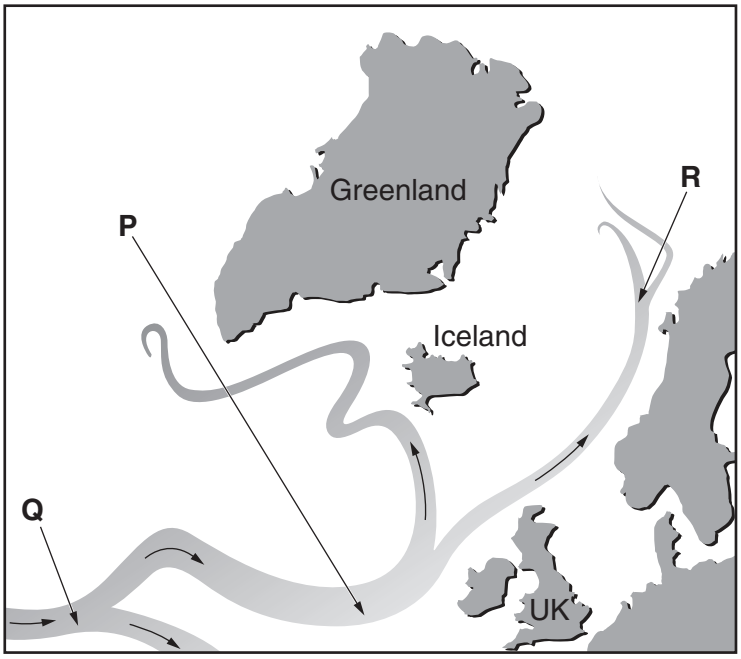


Fig. 2.1

P = ...

Q = ...

R = ... **[3]**

(b) As warm water currents cool, heat energy is transferred to the atmosphere above.

Assuming 100% energy transfer, calculate the amount of energy transferred to the atmosphere when 100 tonnes of water cools from 22 °C to 18 °C.

(1 tonne = 1000 kg) Specific heat capacity of water = 4.18 kJ kg^{-1} °C^{-1}

amount of energy transferred = ... unit ..... **[4]**

(c) (i) The currents shown in Fig. 2.1 are part of the thermohaline circulation. Thermohaline circulation is driven by difference in temperature and salinity of water.

Explain why the water in current **Q** eventually sinks.

.....

.....

.....

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

(ii) It has been suggested that the melting of the polar ice caps may disrupt the thermohaline circulation.

Table 2.1 shows the densities of pure water and sea water at 4 °C.

Table 2.1

substance	density / kg m^{-3}
sea water	1035
pure water	1000

Suggest why the melting of the polar ice caps may have a major impact on the thermohaline circulation.

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

.....

.....

.....

.....

.....

.....

.....

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

[Total: 13]

3 This question is about the chemistry behind the formation of nitrogen oxides and their effect on the environment.

(a) Nitrogen can react with oxygen at high temperatures to form oxides of nitrogen.

Balance the two equations below.

(i) ..... N_2 + ... O_2 $\rightarrow$ ..... NO

(ii) ..... NO + ... O_2 $\rightarrow$ ..... NO_2

[2]

(b) Nitrogen dioxide (NO_2) can react with water to form nitric acid (HNO_3).

Write a balanced equation to show the **dissociation** of nitric acid into ions.

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

(c) Nitrogen monoxide (NO) can catalyse the decomposition of ozone as shown in reactions **1** and **2** below. The overall reaction is **exothermic**.

1. $O_3 + NO \rightarrow NO_2 + O_2$

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

Overall $O_3 + O \rightarrow 2O_2$

(i) A mechanism for the catalysed decomposition of ozone is shown above.

How do these equations show that NO is acting as a catalyst?

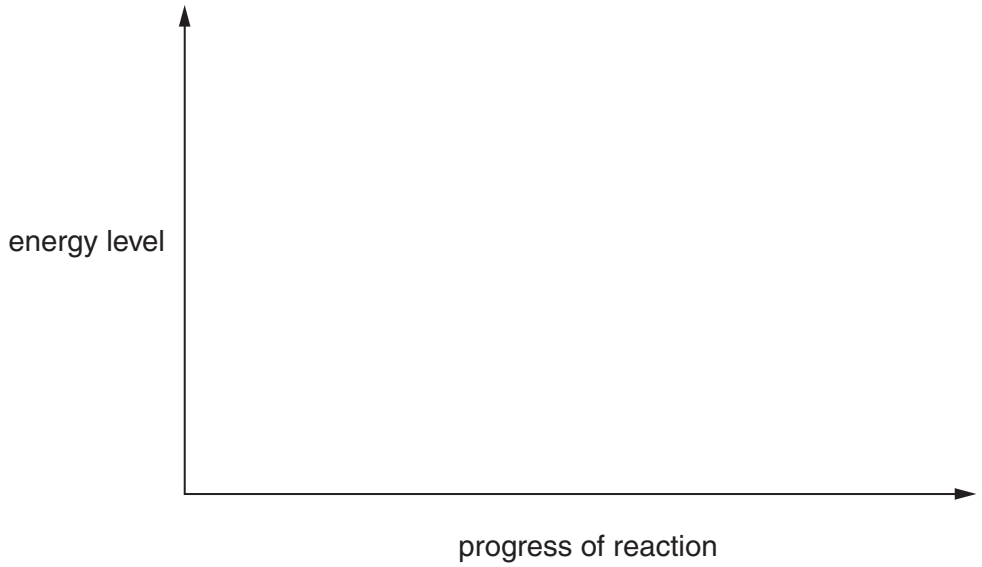
.....

.....

.....

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

(ii) Using the axes below **sketch and label** an energy level diagram for both the catalysed **and** uncatalysed decomposition of ozone.



[4]

(d) Another oxide of nitrogen has the formula N_2O.

(i) Give the oxidation number of nitrogen in this molecule.

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

(ii) N_2O is a greenhouse gas.

Describe and explain the greenhouse effect and outline some of the potential impacts that greenhouse gases may be having on the Earth's climate.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[7]**

[Total: 18]

4 DNA codes for protein synthesis. The first part of this process involves the transcription of a DNA sequence into a messenger RNA (mRNA) sequence.

(a) (i) Write down the sequence of bases in an mRNA molecule that will be formed from the following DNA fragment.

GAGTTTAGAAACATT

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

(ii) What is the maximum number of amino acids that could be coded for in this sequence?

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

(iii) The name of the process in which the mRNA code is converted into an amino acid sequence is called translation.

What is the site of translation in the cell?

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

(b) The formula in Fig. 4.1 represents the amino acid cysteine.

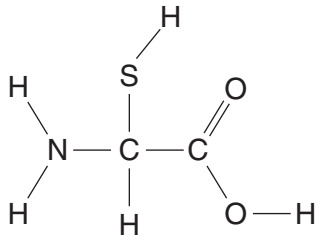


Fig. 4.1

(i) On Fig. 4.1, circle the **two** groups of atoms that are involved in the formation of a peptide link. **[2]**

(ii) Cysteine molecules have a unique role in the formation of a protein's tertiary structure.

1 Explain what is meant by *tertiary structure*.

.....

.....

.....

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

2 Describe the special role of cysteine molecules in maintaining the tertiary structure of a protein.

.....

.....

.....

.....

.....

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

[Total: 11]

5 This question involves the comparison of two fuels:

ethanol (C_2H_5OH) and hexane (C_6H_{14})

Both fuels are liquids at room temperature. The apparatus used for the experimental determination of energy of combustion (enthalpy of combustion) is shown in Fig. 5.1.

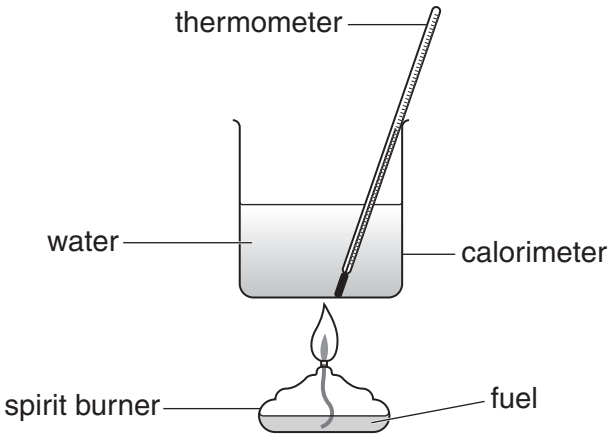


Fig. 5.1

The measurements recorded for each fuel are given in Table 5.1. Each fuel was tested twice.

Table 5.1

experiment number	fuel used	mass of fuel used/g	mass of water in calorimeter/g	initial temperature of water/°C	final temperature of water/°C	temperature rise/°C
1	ethanol	0.50	50	18	73	55
2	ethanol	0.50	50	19	75	.....
3	hexane	0.50	50	19	74	.....
4	hexane	0.50	50	18	89	71

(a) (i) Complete the temperature rise column in the table. **[1]**

(ii) Calculate the **mean** temperature rise for both fuels.

mean temperature rise for ethanol .....

mean temperature rise for hexane ..... **[2]**

(iii) Using your values from **(a)(ii)**, calculate the energy released per gram of fuel used, for both fuels.

Specific heat capacity of water = $4.18\,J\,g^{-1}\,°C^{-1}$

ethanol = ... $kJ\,g^{-1}$

hexane = ... $kJ\,g^{-1}$ **[5]**

(iv) The values obtained in this experiment are much lower than the values in a data book.

The data book values are:

ethanol = $-29.7\,kJ\,g^{-1}$ hexane = $-48.4\,kJ\,g^{-1}$

Suggest one major source of error using the apparatus in Fig. 5.1.

.....

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

(b) Suggest why the result in **(a)(iii)** for ethanol might be considered more **reliable** than that for hexane?

.....

.....

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

(c) Suggest which fuel might be the better choice for cars in the future.

You should discuss:

- data book energy values given in **(a)(iv)**
- availability of the fuels
- sustainability of fuels
- environmental impact

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[8]**

[Total: 18]

6 This question is concerned with the processes of radiation, fission and fusion.

Use the words from the box to fill in the gaps in the passage below.

burn	**decay**	**electrons**	**heavier**	**increase**	**ions**	**isotopes**
	lighter	**mass**	**neutrons**	**nucleus**	**number**	
	orbitals	**pressures**	**protons**	**reduce**	**temperatures**	

$^{137}_{55}Cs$ and $^{133}_{55}Cs$ represent …… of the element caesium. $^{137}_{55}Cs$ is unstable and will …… by beta emission to the element barium. Beta radiation consists of high energy …… that are emitted from the …… of an unstable atom. In this example the atomic …… is unchanged but the atomic …… increases by one.

Nuclear fusion is a process that requires very high …… and releases very large amounts of energy. As a result of nuclear fusion, …… nuclei are produced which is why stars like the Sun can be thought of as 'element factories'. **[8]**

[Total: 8]

7 This question is about electricity, electrical appliances and electricity generation.

(a) Mains voltage in the UK was rated at 240 V and 50 Hz a.c.

(i) Explain what is meant by 50 Hz a.c.

.....

.....

.....

.....

.....

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

(ii) An electric fire has a power rating of 3 kW.

Calculate the electrical current used by the fire when it is switched on.

electrical current = ... unit ..... **[4]**

(iii) Using your answer from **(a)(ii)**, calculate the resistance of the fire.

resistance of the fire = ... unit ..... **[3]**

(b) When electricity is distributed to the National Grid, what can be done to minimise power loss as it is transferred to customers? You may use equations to support your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

(c) Some people are suggesting that coal-fired power stations should be replaced by wind turbines.

Other than cost, give **two** advantages and **two** disadvantages of using only wind turbines to generate energy.

advantages .....

.....

.....

.....

.....

disadvantages .....

.....

.....

.....

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

[Total: 18]

END OF QUESTION PAPER

ADDITIONAL PAGE

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