OCR
RECOGNISING ACHIEVEMENT

Monday 3 June 2013 – Afternoon

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

* G 6 4 2 0 1 *

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

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Question 1 begins on page 4

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Answer **all** the questions.

1 This question concerns carbon dioxide.

Carbon dioxide is produced from the complete combustion of hydrocarbon fuels. One such fuel is propane.

(a) Complete the equation below for the complete combustion of propane.

$$C_3H_8 + ...O_2 \rightarrow 3CO_2 + 4.....$$ **[2]**

(b) Some simple molecules have permanent dipoles.

Give **one** example of a molecule with a permanent dipole **and** explain why the dipole arises.

You may use diagrams to help illustrate your answer.

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

(c) Fig. 1.1 shows a dot and cross diagram for a molecule of carbon dioxide.

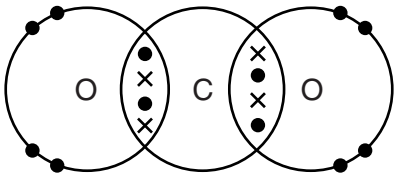

Fig. 1.1

(i) What is the total number of covalent bonds in this molecule?

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

(ii) Explain why a molecule of carbon dioxide would not have a permanent dipole.

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

(d) The graph in Fig. 1.2 shows how the mass of carbon dioxide dissolved in 100 g of water varies with temperature.

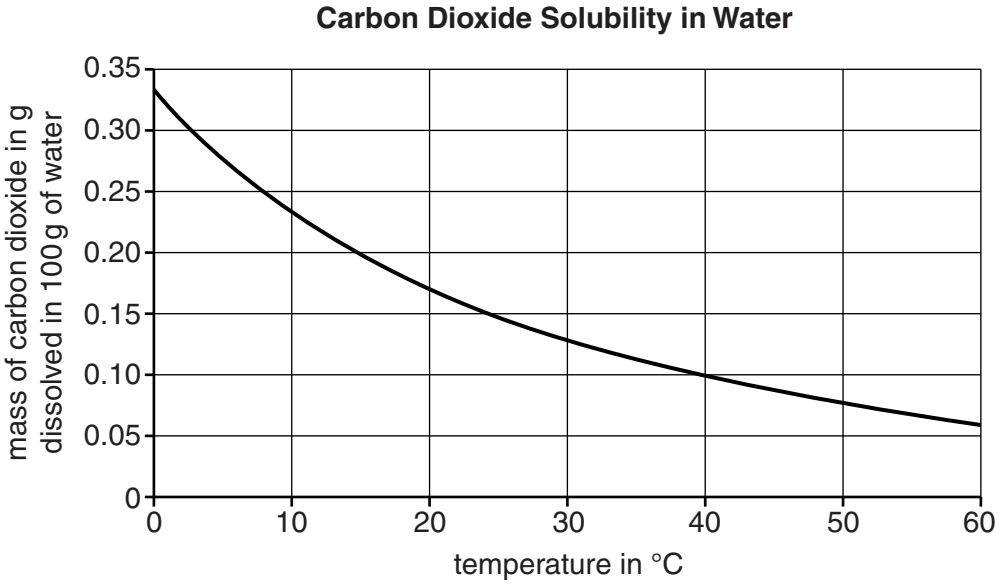

Fig. 1.2

(i) Use the graph to estimate the mass of carbon dioxide dissolved in 100 g of water at 30 °C.

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

(ii) The oceans contain carbon dioxide dissolved in water.

Use the graph in Fig. 1.2 to suggest what happens to the percentage of carbon dioxide in the **air above** the ocean as the water temperature rises. Explain your answer.

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.....

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

(e) Carbon dioxide dissolves in water to form a weak acid called carbonic acid (H_2CO_3).

(i) Give the formula for the particle responsible for acidity in solution.

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

(ii) Explain what is meant by a weak acid.

.....

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

(iii) Complete the equation below for the ionisation of carbonic acid.

$$H_2CO_3 \rightleftharpoons \text{.....} + \text{.....}$$ **[2]**

[Total: 15]

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Question 2 begins on page 8

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2 In 2011 damage to a nuclear plant at Fukushima in Japan led to the release of radioactive isotopes into the environment. One such isotope was iodine-131.

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

.....

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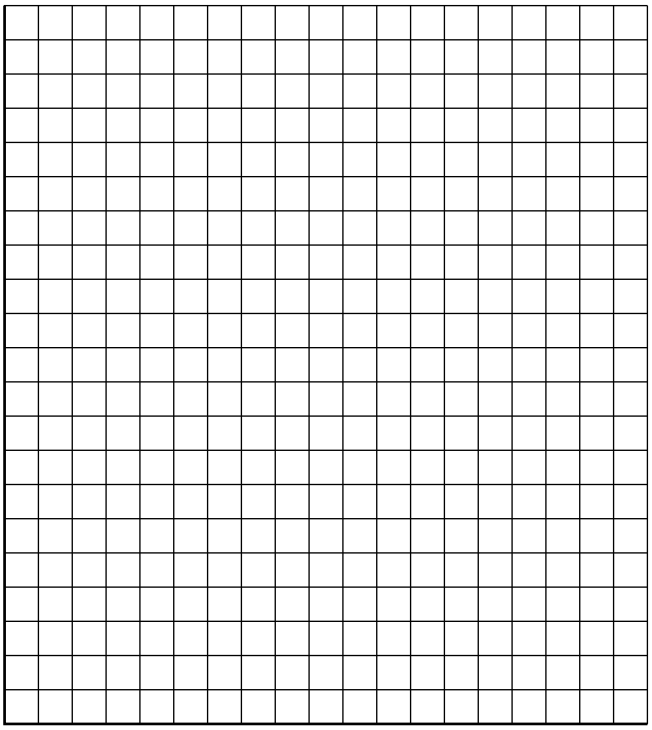
..... **[2]**

(b) A sample of milk contaminated with iodine-131 was shown to contain levels of radioactivity. The levels of radioactivity changed over time as shown in Table 2.1.

Time in days	Level of radioactivity (arbitrary units)
0	50
3	39
6	30
9	23
12	18

Table 2.1

(i) Using the data in Table 2.1 and the grid below, plot the level of radioactivity vs. time in days for iodine-131. Choose a suitable scale and label your axes clearly.



[4]

(ii) Use the graph you have plotted to estimate a value for the half-life of iodine-131 to the nearest day.

half-life = ... days **[1]**

(iii) Iodine-131 decays by β emission.

Complete the equation below showing the atomic number for xenon.

$$^{131}_{53}\text{I} \rightarrow {}^{131}_{\ldots\ldots}\text{Xe} + \beta \qquad \textbf{[1]}$$

(c) Iodine-131 is produced by nuclear fission in the nuclear reactor.

Explain what is meant by *nuclear fission*.

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

[Total: 10]

3 This question is about different types of proteins.

(a) Fig. 3.1 shows a ribbon diagram of the human prion protein 1HJM.

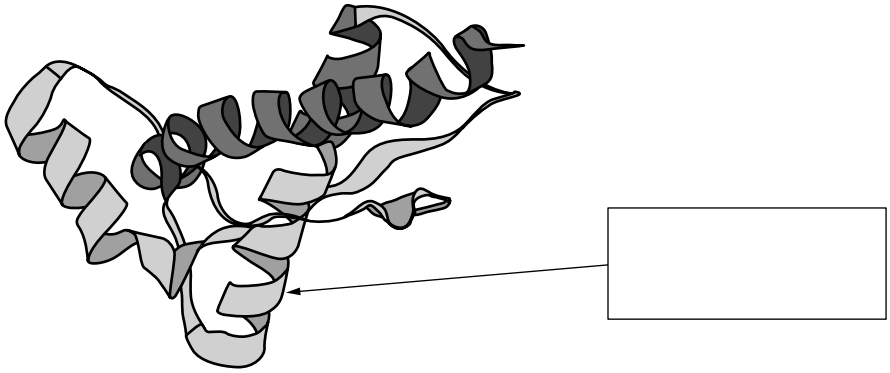

Fig. 3.1

(i) Label the type of secondary structure indicated with an arrow in the diagram. **[1]**

(ii) What is meant by the term *tertiary structure* as applied to proteins?

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

(iii) All proteins are made from sequences of amino acids. In the example above two cysteine amino acids occur at positions 179 and 214 in the sequence.

Explain why a mutation leading to a change in just one of the amino acids at positions 179 or 214 might have a particularly major effect on the tertiary structure of this protein.

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

(b) Enzymes are another type of protein. The activity of an enzyme can be affected by the pH of the solution in which the enzyme is acting as shown in Fig. 3.2.

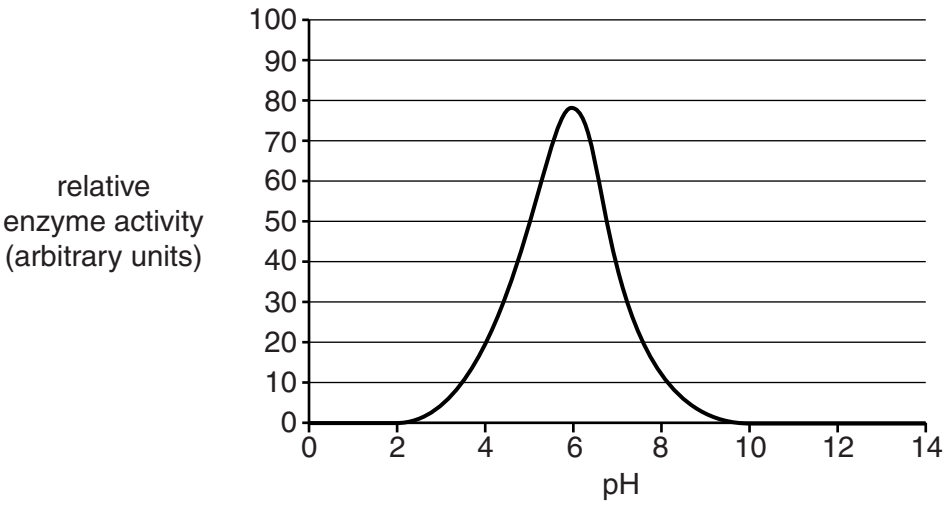

Fig. 3.2

Use the graph to describe **how** enzyme activity changes with pH. Explain **how** the change in pH affects the structure and activity of the enzyme.

In your answer your ideas should be logically sequenced.

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

[Total: 11]

4 This question is about methane (CH_4) and ozone (O_3), which are gases in the atmosphere in trace amounts that absorb electromagnetic radiation.

The infrared spectrum of ozone is shown below in Fig. 4.1.

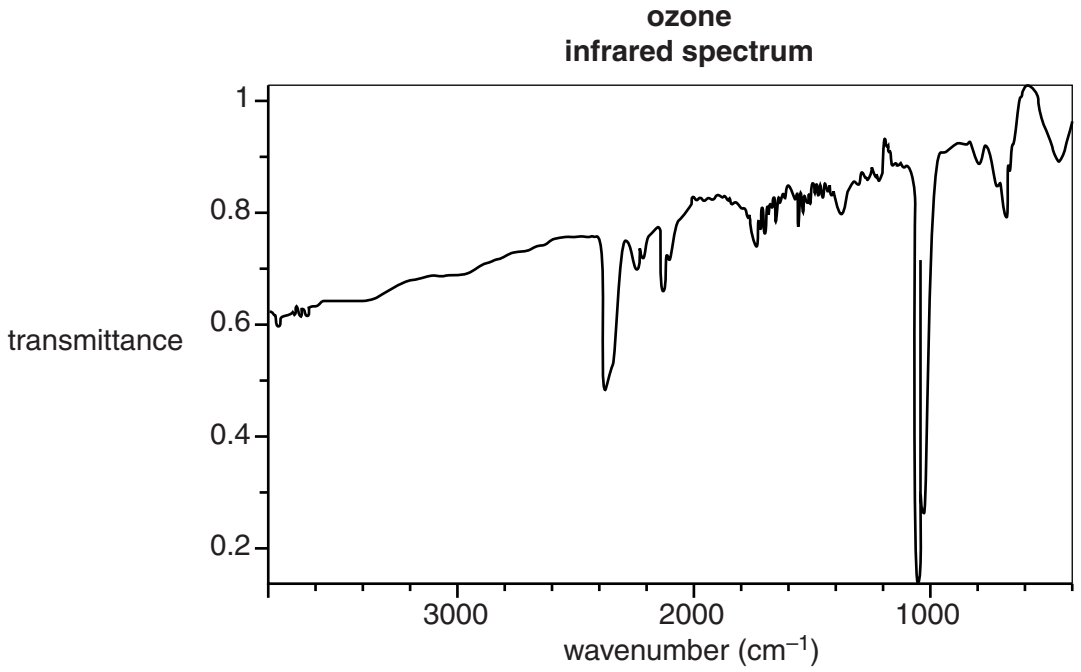

Fig. 4.1

(a) The structures of ozone (O_3) and methane (CH_4) are shown in Fig. 4.2.

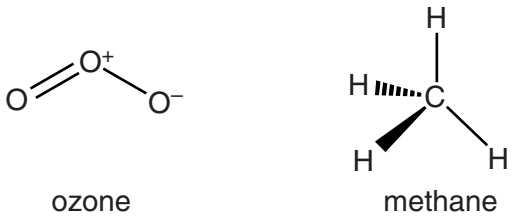

Fig. 4.2

With reference to the diagrams of molecules in Fig. 4.2, explain why methane could be expected to have a different infrared spectrum to ozone.

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

(b) Ozone can also absorb ultraviolet light of frequency 1.27×10^{15} Hz.

(i) Calculate the wavelength of this light.

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

wavelength = ... unit ..... **[3]**

(ii) Calculate the energy absorbed by 1 molecule of ozone when it absorbs a photon of frequency $1.27 \times 10^{15}\,\text{Hz}$

Planck constant $h = 6.63 \times 10^{-34}\,\text{Js}$

energy absorbed = ... unit ..... **[2]**

(iii) Free radicals can be formed by the absorption of ultraviolet light. What is meant by the term *free radical*?

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

(iv) Free radicals are thought to cause damage to DNA. Suggest how they are able to do this.

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

[Total: 10]

5 Fig. 5.1 shows how the volume of a fixed mass of gas changes with temperature.

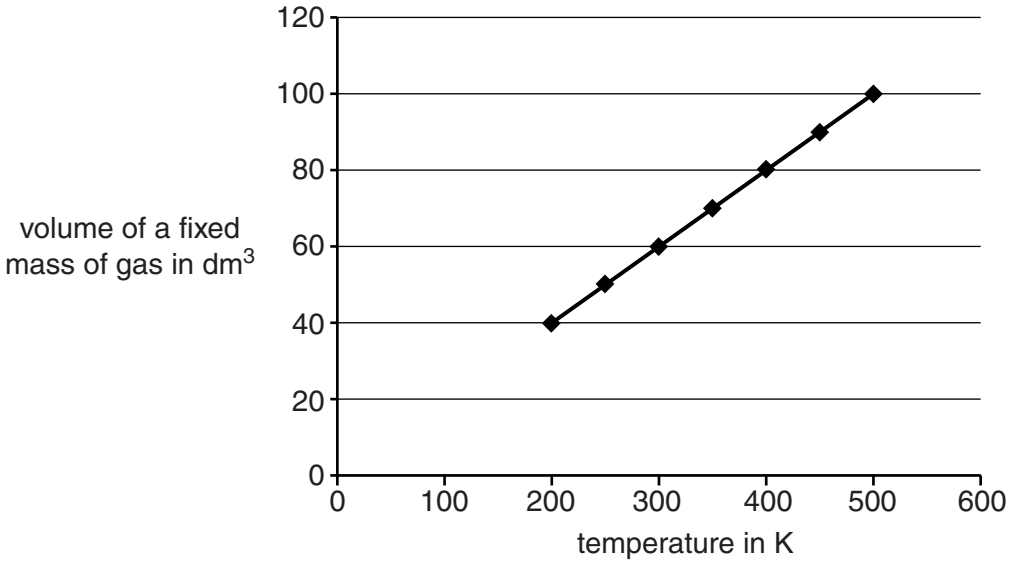

Fig. 5.1

(a) Use the graph to estimate the volume of this gas at 273 K.

volume = ... dm^3 **[1]**

(b) Use the molecular kinetic theory of gases to explain the following observations.

(i) At constant pressure, the volume of a gas increases as it gets warmer.

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

(ii) A fixed mass of gas gets hot when it is compressed.

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

(c) Water can exist as a solid, liquid or gas at the Earth's surface or in its atmosphere.

When water vapour condenses to form liquid water, heat is released.

Explain why heat is released in this process.

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

[Total: 7]

6 This question is about DNA and protein synthesis. Table 6.1 shows some DNA triplet codes and the amino acids they represent.

ATG	TCT	GGT	CAT	GCT	AGT	CGA	TAT
Methionine	Serine	Glycine	Histidine	Alanine	Serine	Arginine	Tyrosine

Table 6.1

(a) Look at the DNA sequence below.

ATGGCTGGTAGTTATGGT

(i) Which amino acid will appear twice when the sequence of bases is used to synthesise a protein?

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

(ii) Write down the sequence of **DNA bases** that would pair up with the following sequence.

ATGGCT

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

(b) What is the role of the following structures in protein synthesis?

(i) transfer RNA

.....

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

(ii) the ribosome

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

(c) Outline the role of hydrogen bonding in

(i) the process of DNA replication

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

(ii) the folding of a sequence of amino acids into an active protein.

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

[Total: 12]

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7 This question is about renewable and non-renewable fuels.

(a) Give two examples of non-renewable fossil fuels.

1. ..... 2. ..... **[1]**

(b) Bioethanol is an example of a renewable fuel. The complete combustion of this fuel is shown in the equation below:

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

This reaction is exothermic (releases heat). Use ideas about bonds in the reactants and the products to explain why.

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

(c) As an alternative to bioethanol, genetically modified (GM) bacteria can now produce biobutanol from plant cellulose.

Biobutanol burns to yield a higher amount of energy per kg of fuel and has been shown to produce less NO_x and CO when used as a car fuel.

The genetically modified bacteria can produce 4% biobutanol which is twice the yield achieved by naturally occurring bacteria.

Discuss the arguments for and against using biobutanol.

In your answer your ideas should be logically sequenced.

for .....

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.....

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against .....

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

[Total: 10]

8 This question is about the thermohaline currents in the Earth's oceans and their effect on climate.

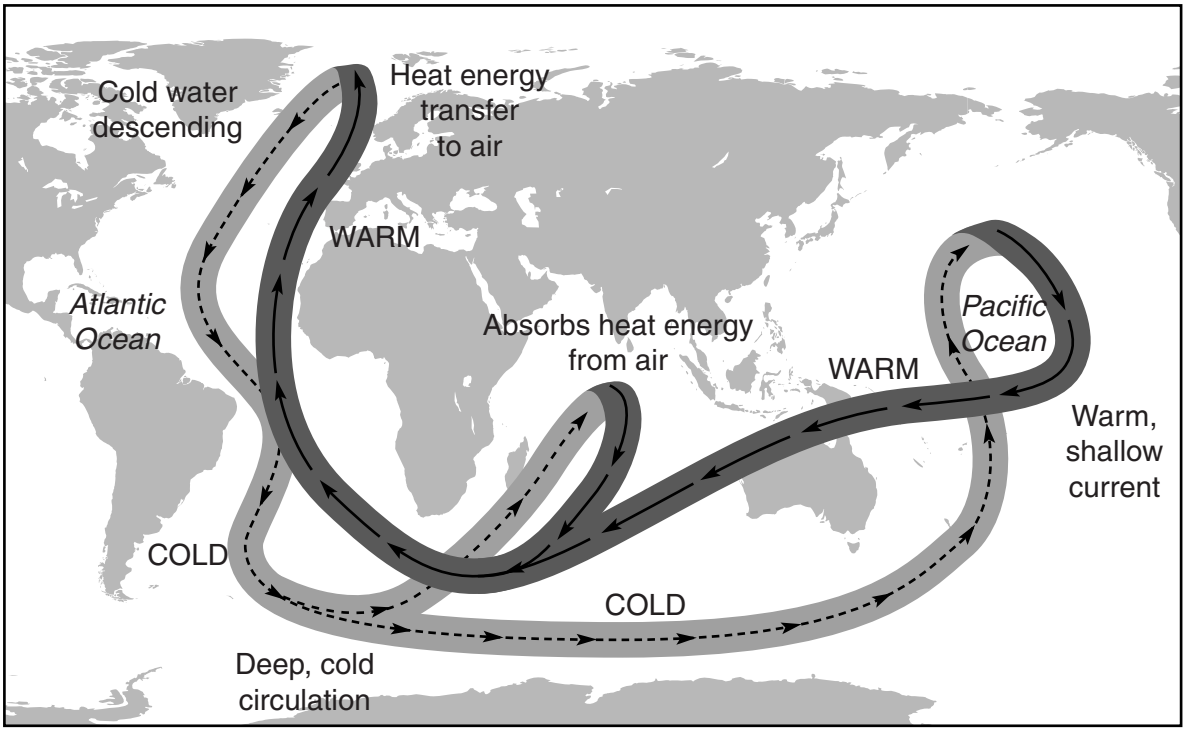

Fig. 8.1

(a) The thermohaline circulation is driven by the sinking and rising of water in different parts of the Earth's oceans. Give one property of the seawater which is important in determining whether it sinks or rises.

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

(b) In the Weddell Sea, off the coast of Antarctica, surface water currents sink. Describe the processes that lead to water currents sinking at this point.

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

(c) (i) Water has a specific heat capacity of 4.2 kJ kg^{-1} °C^{-1}.

Calculate the amount of energy released to the atmosphere when 80 kg of water cools by 5 °C.

energy released = ... unit ..... **[2]**

(ii) Explain why warm water creates areas of low atmospheric pressure and wet weather.

Use ideas from Fig. 8.1 and **(c)(i)** in your answer.

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

[Total: 12]

9 This question is about the generation of electricity in the UK, the National Grid and the use of electricity in the home.

amp	capacitor	coulomb	electrons
heat	high	ions	light
low	protons		sound
transformer			volt

(a) Use the words in the box to fill in the blanks in the following paragraph. Each word may be used once, more than once or not at all.

The unit for electrical charge is the ..... . When an electric current passes through a metal wire ..... are the particles which carry the charge.

Aluminium is used in overhead power cables because of its ..... electrical resistance. The electrical energy generated in the power station has to be modified before it is transferred to the National Grid.

This is achieved by a step-up ..... which produces electricity with a ..... voltage. This ensures that less energy is lost to the surroundings in the form of ..... .

[6]

(b) Modern energy saving light bulbs have a lower power rating than the old incandescent bulbs. A typical value for one of the new bulbs is 15 W.

(i) Define the term *power*.

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

(ii) Calculate how long it would take this 15 W bulb to use 10.5 kJ of energy. Show your working.

Use the appropriate number of significant figures.

time = ... unit ..... **[3]**

(iii) Household mains electricity has a voltage rating of 240V ac. Calculate the current drawn by a 15W light bulb. Show your working.

current drawn = ... unit ..... **[3]**

[Total: 13]

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.