

Monday 23 May 2016 – Morning

AS GCE SCIENCE

G642/01 Science and Human Activity

Candidates answer on the Question Paper.

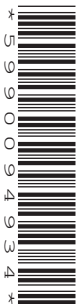
OCR supplied materials:

None

Other materials required:

- Electronic calculator
- Ruler

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. 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(s) 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 \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

voltage = current \times resistance

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Answer **all** the questions.

- 1 Chlorofluorocarbons, CFCs, can be used as refrigerants. Refrigerants are molecules that evaporate at room temperature (approximately 20°C) so they cool the air in refrigerators, freezers and air-conditioning units.

Since 1985, most CFCs have been replaced by less damaging substances.

(a) CFCs destroy ozone (O₃) molecules in the upper atmosphere.

- (i) The destruction of ozone in the upper atmosphere can result in problems for human health. Explain why.

.....

 [3]

- (ii) CFC molecules contain chlorine. A chlorine atom can act as a catalyst for the reaction that destroys ozone.

Describe the action of a catalyst.

.....

 [2]

(b) One type of CFC molecule is CFC-11. Its structure is shown in Fig. 1.1.

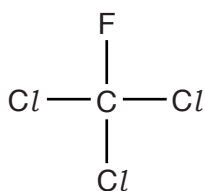


Fig. 1.1

The CFC-11 molecule has polar C–Cl bonds and a polar C–F bond.

- (i) The electronegativity values of C, Cl and F are:

- C = 2.5
- F = 4.0
- Cl = 3.5

On Fig. 1.1, show the polarity of **one** of the C–Cl bonds.

[2]

(ii) The most polar bond in the CFC-11 molecule is the C–F bond. State the reason for this.

..... [1]

(iii) There are four pairs of electrons around the central C atom in a molecule of CFC-11. What is the shape of the CFC-11 molecule?

..... [1]

(c) CFC-11 has been replaced by less damaging substances with a lower ozone depletion potential (ODP).

Table 1.1 shows some of the properties of CFC-11 and its possible replacements.

Compound	ODP	Boiling point/°C	Flammable?
CFC-11	1.00	24	No
HCFC 134a	0.00	–26	No
HCFC 123	0.02	29	No
Propane	0.00	–42	Yes

Table 1.1

Use the information in Table 1.1 to discuss the most appropriate replacement for CFC-11.

.....

 [4]

[Total: 13]

2 Deoxyribonucleic acid, DNA, is a molecule found in living cells. The structure of DNA helps scientists to understand how genetic information is copied and how protein synthesis occurs.

(a) Complete the following passage about the structure of DNA.

Use the words in the box to complete the passage below. You may use each word once, more than once, or not at all.

acid	alpha	amino acids
codon	covalent	double
hydrogen	nitrate	nucleotides
peptides	phosphate	trio

DNA is a polymer made up of monomers called These monomers are formed when three units bond together: a sugar, a base and a

The DNA found in cells has the structure of a helix. The two strands of DNA are held together by bonds between base pairs.

A sequence of three bases makes up a structure known as a

The sequence of these structures provides information that determines the order of in a protein. [4]

(b) Transfer RNA (tRNA) is also found in cells. Describe the role of tRNA in protein synthesis.

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

[Total: 7]

3 The weather at the surface of the Earth is affected by patterns of high and low pressure in the Earth's atmosphere.

(a) (i) Use the molecular-kinetic theory of gases to explain how a gas exerts pressure.

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

(ii) The average pressure at sea level is $1.01 \times 10^5 \text{ Nm}^{-2}$.
This pressure is exerted on a surface area 500 m^2 .

Calculate the total force on this surface. Give your answer in standard form.

Answer: $\times 10$ N [2]

- (b) The North Atlantic Oscillation (NAO) describes the changes in pressure patterns at sea level in the North Atlantic Ocean.

Fig. 3.1 shows the pressure pattern when the NAO is **positive**.

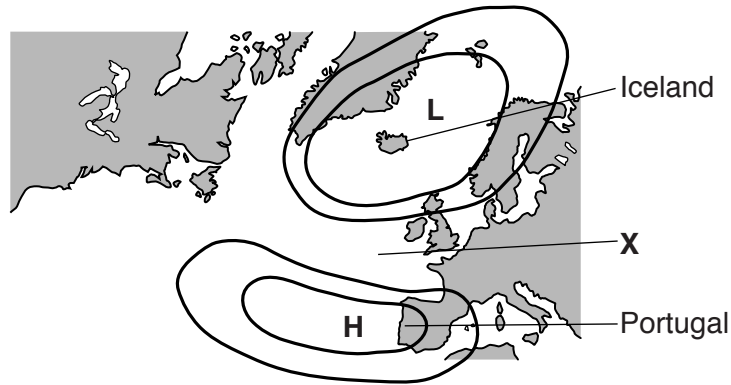


Fig. 3.1

- (i) On Fig. 3.1, draw an arrow to show the likely surface wind direction at point X. [1]
- (ii) Explain your answer, using ideas about the factors that affect horizontal movement of air.

.....

.....

..... [2]

- (c) Sometimes the NAO becomes **negative**. When this happens, the wind direction at point X reverses.

Suggest why this happens.

.....

.....

..... [2]

(d) Fig. 3.2 shows a diagram of the surface sea water currents in the North Atlantic.

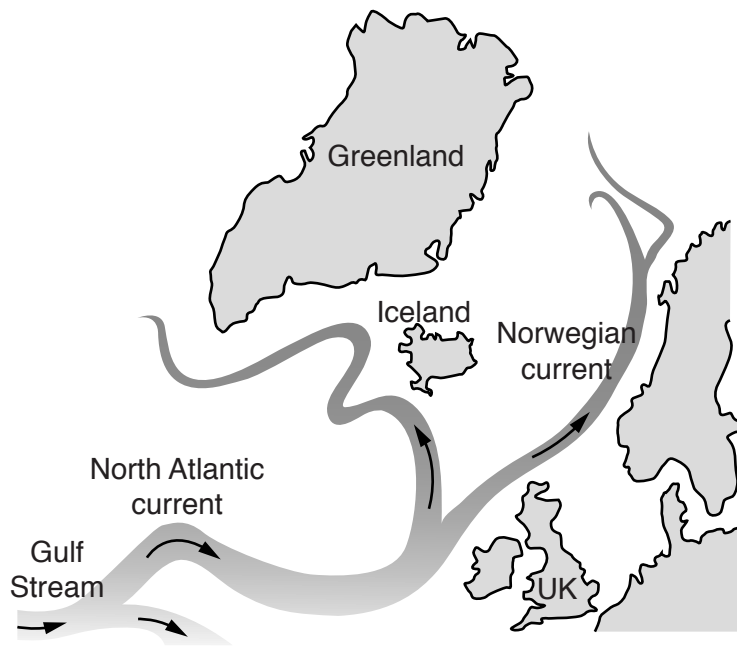


Fig. 3.2

(i) Sinking of sea water occurs at various points in the North Atlantic.

On Fig. 3.2, use a cross (X) to mark **one** point where the sea water starts to sink. [1]

(ii) Explain the processes that cause sea water to sink in the North Atlantic.

.....

.....

.....

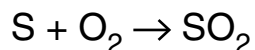
..... [3]

[Total: 14]

- 4 Some old buildings in the UK are made from limestone (calcium carbonate).

The limestone in these buildings has been damaged over the last century. Scientists think that acid deposition has caused this damage.

- (a) One of the causes of acid deposition is the sulfur dioxide formed when sulfur, S, is burnt in air:



- (i) Sulfur is oxidised in this reaction.

Use the idea of oxidation states to explain what happens to the **oxygen** in this reaction.

.....

 [2]

- (ii) SO_2 can take part in further reactions to form sulfuric acid, H_2SO_4 .

Balance these equations.



[2]

- (iii) Sulfuric acid is a **strong acid**.

Explain the meaning of this statement.

Include a chemical equation to illustrate your answer.

.....

 [3]

12
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- 5 In 2015, the Mars Curiosity Rover discovered evidence of the molecule methane, CH_4 , in the atmosphere of Mars. Some scientists believe that this could be evidence that there may have been living organisms on Mars millions of years ago.

- (a) Methane contains C–H bonds. One way of detecting methane is to use infrared spectroscopy. The infrared spectrum of methane is shown in Fig. 5.1.

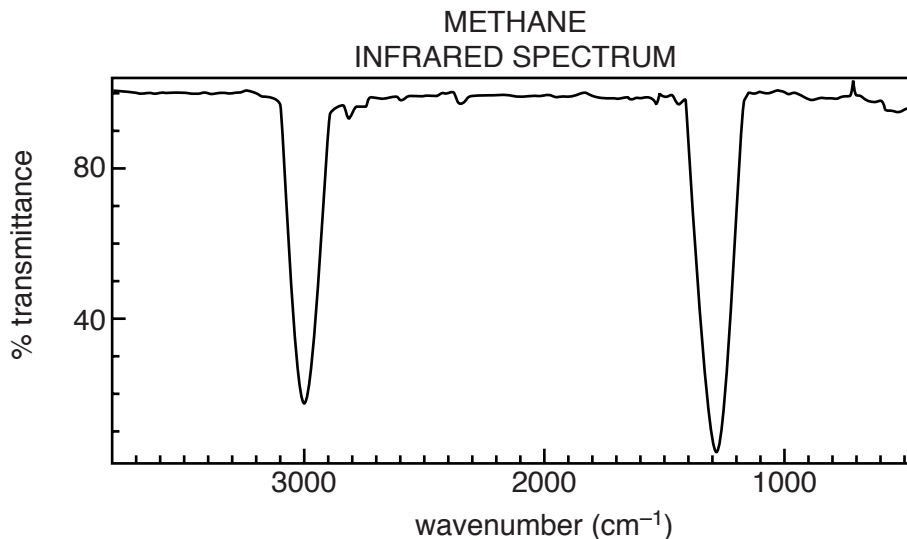


Fig. 5.1

- (i) Describe what happens to a C–H bond in methane, CH_4 , when it absorbs infrared radiation.

.....
 [1]

- (ii) One of the peaks in this spectrum has a wave number of 3000cm^{-1} .

Calculate the wavelength **in m** of the radiation that produces this peak.

Wavelength = m [2]

- (iii) The other peak has a wavelength of 7.69×10^{-6} m. Calculate the frequency, in Hz, of this radiation.

Velocity of light, $c = 3.00 \times 10^8 \text{ m s}^{-1}$.

Frequency = Hz [2]

- (b) Scientists want to find out if the methane came from living organisms. They can do this by comparing the ratio of $^{13}_6\text{C}$ and $^{12}_6\text{C}$ isotopes in the methane molecules.

- (i) Explain why $^{13}_6\text{C}$ and $^{12}_6\text{C}$ are described as *isotopes*.

.....
 [2]

- (ii) The infrared spectrum of methane containing $^{13}_6\text{C}$ atoms is different from that of methane containing only $^{12}_6\text{C}$.

Describe and explain this difference.

.....

 [2]

- (c) There is another form of carbon, $^{14}_6\text{C}$, that is present in living organisms on Earth. This is radioactive with a half-life of 5740 years.

- (i) $^{14}_6\text{C}$ undergoes nuclear decay.

Complete the nuclear equation:



- (ii) Natural gas is a fossil fuel. It contains methane that was formed from the remains of living organisms. However, natural gas does not contain any $^{14}_6\text{C}$.

Explain why there is no $^{14}_6\text{C}$ in natural gas.

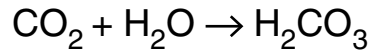


You should link your explanation clearly to the relevant scientific information.

.....

 [2]

- 6 The enzyme carbonic anhydrase catalyses the reaction between carbon dioxide and water to form carbonic acid, H_2CO_3 :



- (a) Place a tick next to the name of any molecule that is a **substrate** of this reaction.

carbon dioxide	
carbonic acid	
water	
carbonic anhydrase	

[1]

- (b) A ribbon diagram of carbonic anhydrase is shown in Fig. 6.1:

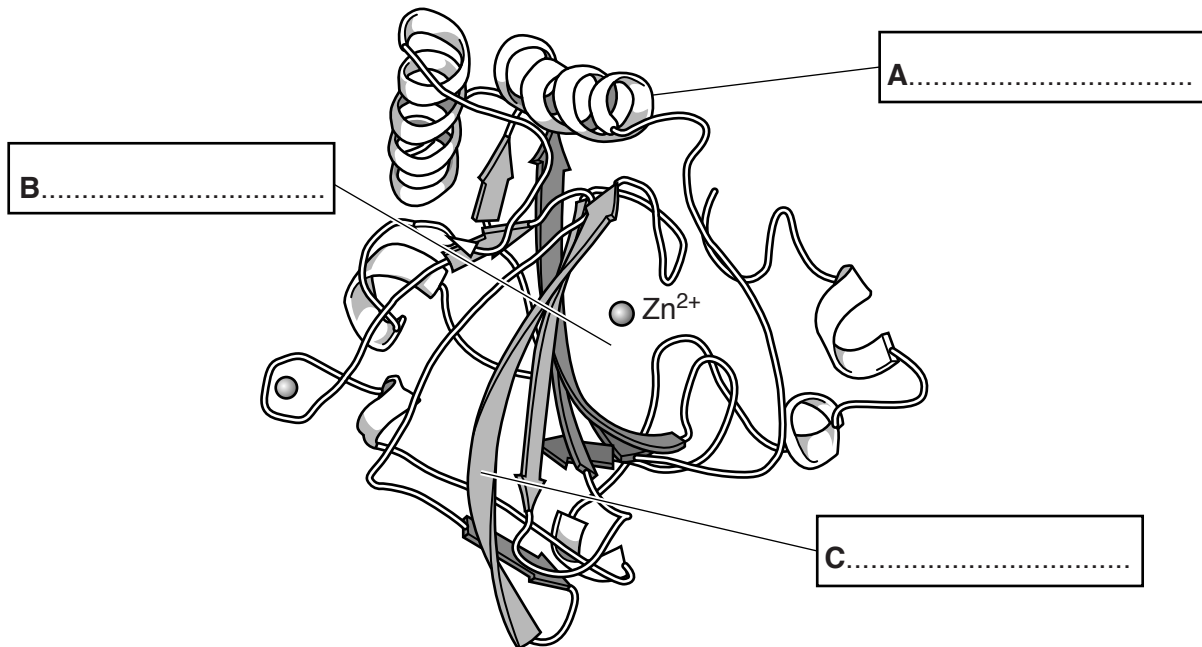


Fig. 6.1

Complete the labels **A**, **B** and **C** in Fig. 6.1.

Choose from:

alpha helix

beta pleated sheet

active site

[1]

- (c) The activity of the carbonic anhydrase enzyme is investigated over a range of different pH values. The results of this investigation are shown in Fig. 6.2.

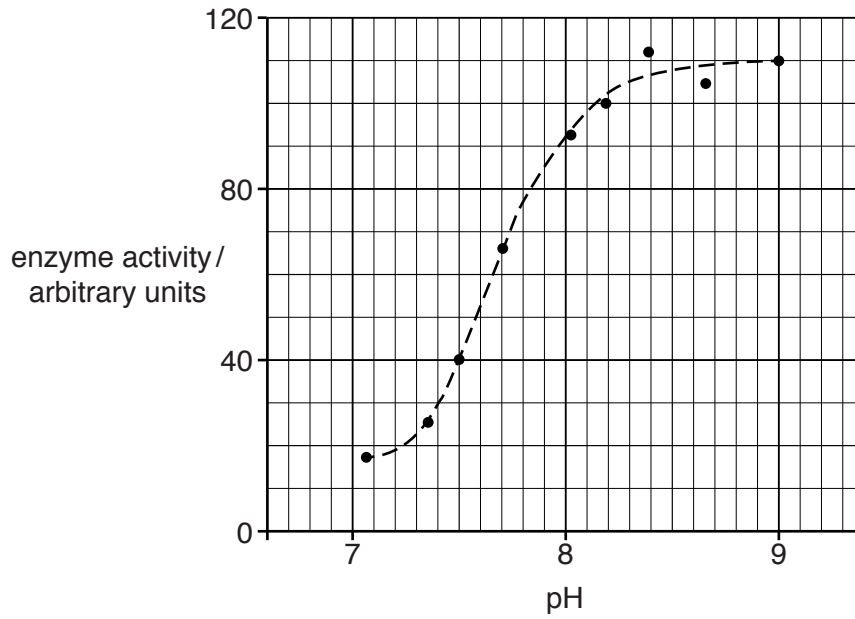


Fig. 6.2

- (i) Use Fig. 6.2 to describe the relationship between pH and the activity of carbonic anhydrase.

.....

.....

.....

..... [3]

- (ii) Explain why enzyme activity is affected by changes in pH.

Use ideas about the mechanism of enzyme action in your answer.

.....

.....

.....

..... [3]

(d) Scientists want to use carbonic anhydrase to help with a technique called carbon capture.

Carbon capture prevents the carbon dioxide, CO₂, produced by some power stations reaching the atmosphere.

(i) Why is it desirable to prevent CO₂ reaching the atmosphere?

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

(ii) The CO₂ produced by some power stations is released at a temperature of 120°C.

Explain why carbonic anhydrase may not work so effectively at this high temperature.

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

(iii) Power stations may also produce other waste gases, such as carbon monoxide, CO.

Suggest whether carbonic anhydrase could also be used to prevent CO reaching the atmosphere.

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

7 When an electric current flows through a wire, a magnetic field is produced.

Fig. 7.1 shows the magnetic field around a wire carrying an electric current.

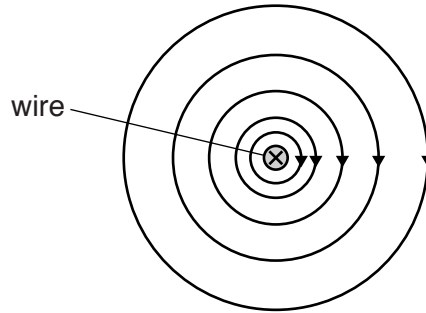


Fig. 7.1

(a) (i) What is meant by the term *magnetic field*?

.....
 [2]

(ii) The magnetic field becomes stronger as the distance from the wire decreases.

Explain how you can tell this from the diagram.

..... [1]

(b) There are also magnetic fields around electrical power lines.

Electrical power lines are cables that usually carry an a.c. electrical supply.

(i) The magnetic fields around these electrical power lines are alternating fields.

Explain why electrical power lines usually produce alternating magnetic fields.

.....
 [2]

(ii) Electrical power lines operate at a high voltage.

State why a high voltage, rather than a low voltage, is used.

..... [1]

(c) Some modern power lines use direct current (d.c.).

(i) One such power line in Brazil has a voltage of 650 kV and supplies 3150 MW of electrical power.

Calculate the current in the power line. Give your answer to 3 significant figures.

1 kV = 1000V
1 MW = 10⁶W

Current unit [4]

(ii) People are concerned about the health risks of living close to power lines.

They are not as concerned about living close to this power line in Brazil.

Suggest a reason for this.

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

[Total: 11]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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

A large area of lined paper for writing. It consists of a vertical solid line on the left side, creating a margin. To the right of this line are horizontal dotted lines spaced evenly down the page, providing a guide for writing.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines extending across the page, providing a space for writing answers.



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