



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 14 January 2010
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 clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

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

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Answer **all** the questions.

1 The following question concerns the Earth's atmosphere.

(a) Complete Table 1.1 below for the composition of dry air at sea level.

Give your answer to two significant figures.

Table 1.1

gas	percentage composition/%
nitrogen	78
oxygen	
argon	0.90
carbon dioxide	0.038

[2]

(b) Fig. 1.1 below represents the relationship between the volume of a fixed mass of gas and the pressure acting on the gas.

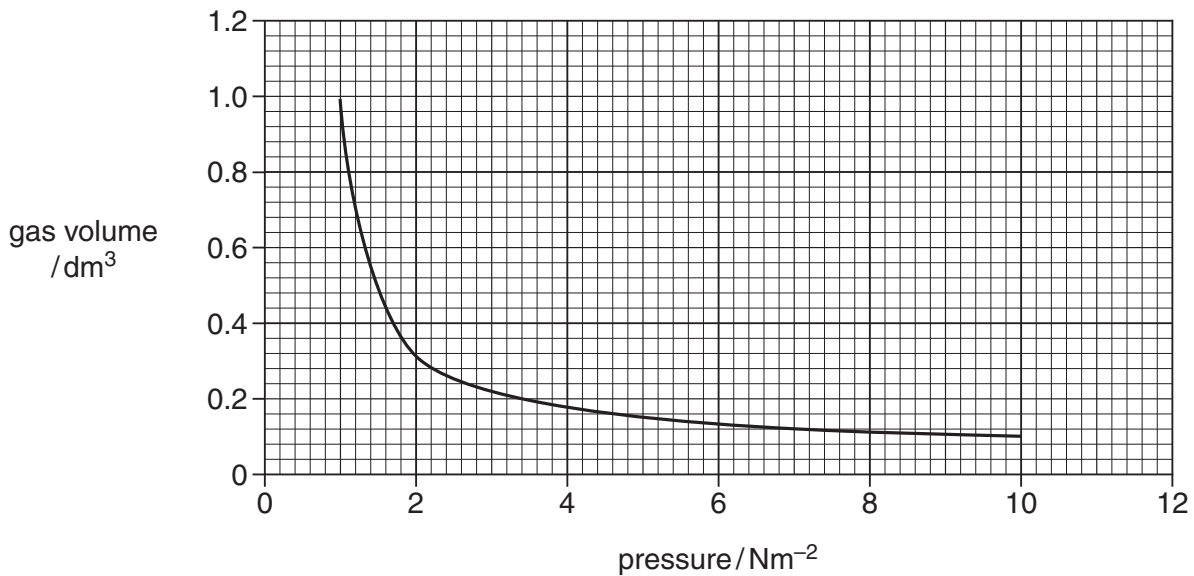


Fig. 1.1

Use the graph to calculate the change in the **volume** of this mass of air if the pressure acting on it falls from 6 Nm^{-2} to 2 Nm^{-2} .

.....

.....

.....

[3]

(c) Charles' Law states that '*the volume of a fixed mass of gas at constant pressure is directly proportional to its absolute temperature*'.

(i) In what unit should the temperature be measured for this law to be true?

..... [1]

(ii) Charles' Law can be used to explain the vertical movement of air.

Explain why a fixed mass of air at constant pressure rises when heated by the sun.

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

(d) Horizontal movements of the air also occur. Over the British Isles air moves in a clockwise direction around a region of high pressure.

(i) What is the name given to this effect?

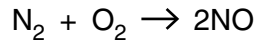
..... [1]

(ii) Explain the cause of the clockwise rotation.

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

[Total: 13]

- 2 Nitrogen monoxide is produced when nitrogen and oxygen react together at very high temperatures such as those produced in internal combustion engines.

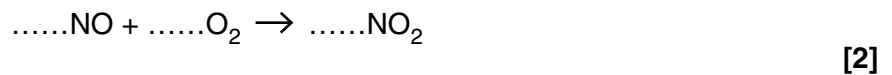


- (a) Why are high temperatures needed in this reaction?

..... [1]

- (b) Nitrogen monoxide can react further with oxygen to give nitrogen dioxide.

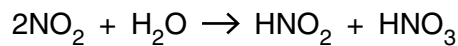
- (i) Balance the equation for this reaction below:



- (ii) Give the oxidation number for nitrogen in NO_2 .

..... [1]

- (c) Nitrogen dioxide can react with water according to the following equation to produce an acidic solution.



- (i) Explain what is meant by the term *acid*.

..... [1]

- (ii) HNO_2 is a weak acid and HNO_3 is strong acid.
Describe the difference between a **strong** and a **weak** acid.

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

- (d) HNO_2 and HNO_3 are both involved in the formation of acid rain.
State and explain one environmental problem associated with acid rain.

problem

explanation

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

- (e) The concentration of acid in rain water can be determined by titration. In an analysis of a sample of rain water the following results were obtained, Table 2.1.

Table 2.1

titration number	volume of rain water used/cm ³	volume of standardised alkali solution needed for neutralisation/cm ³
1	25.00	23.25
2	25.00	23.50
3	25.00	28.00
4	25.00	23.50

- (i) Give the name of the piece of apparatus that would be used to measure 25.00 cm³ of rain water.

..... [1]

- (ii) Identify the anomalous result in the experiment and calculate a suitable average result for the volume of alkali needed for neutralisation.

.....

 [3]

- (iii) Suggest and explain how the **reliability** of your average result might be improved.

.....
 [2]

[Total: 14]

- 3 Carbon dioxide molecules absorb specific wavelengths of infrared radiation. Fig. 3.1 shows the infrared spectrum of carbon dioxide.

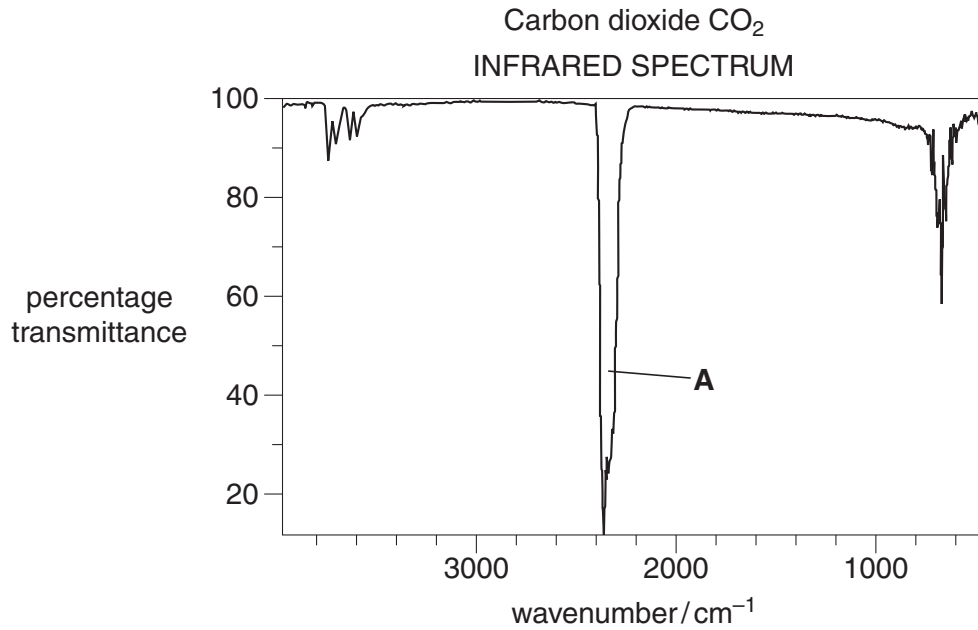


Fig. 3.1

- (a) (i) Use Fig. 3.1 to estimate the wavenumber at which maximum absorbance is shown by peak **A**.

wavenumber = cm⁻¹ [1]

- (ii) What happens to the carbon dioxide molecule when it absorbs infrared radiation as shown in Fig. 3.1?

.....

.....

.....

..... [3]

- (b) Methane also absorbs infrared radiation. Fig. 3.2 shows the *dot-and-cross* diagrams for carbon dioxide and methane.



Fig. 3.2

- (i) Describe **two** differences in the electron structures of these molecules.

.....

.....

..... [2]

- (ii) Fig. 3.3 shows the infrared spectrum of methane.

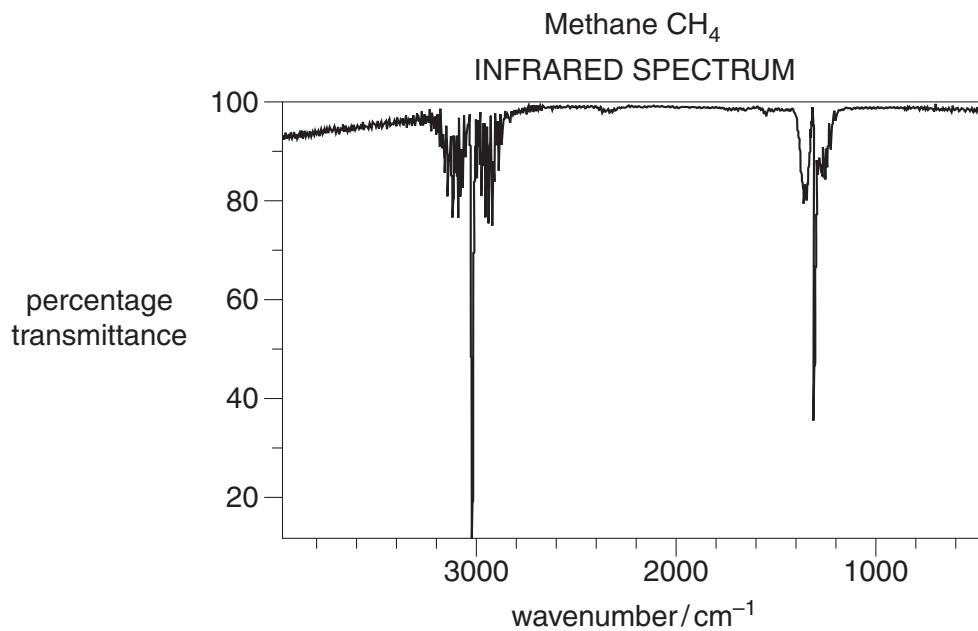


Fig. 3.3

Explain why methane has an infrared spectrum different from that of carbon dioxide.

.....

.....

.....

..... [3]

(c) In the last 200 years there has been an increase in the amounts of methane and carbon dioxide in the air which has resulted in an increase in the greenhouse effect.

(i) Explain what is meant by the *greenhouse effect*.



In your answer, you should present your explanation in a logical sequence.

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Suggest the main sources of the increase in amounts of carbon dioxide and methane.

.....

..... [2]

[Total: 15]

11
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- 4 This question is about proteins and enzyme function. Proteases are enzymes which break down proteins into simpler molecules including dipeptides and amino acids. Fig. 4.1. shows a dipeptide.

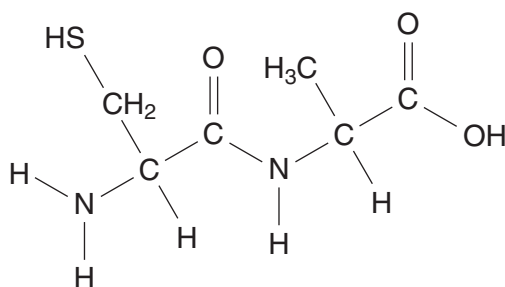


Fig. 4.1

- (a) (i) Suggest why this molecule can be described as a **dipeptide**.

.....
 [2]

- (ii) Draw a circle around the peptide link. [1]

- (b) A student investigated how enzyme activity was affected by different pH values. The graph, Fig. 4.2, shows the activity at different pH values.

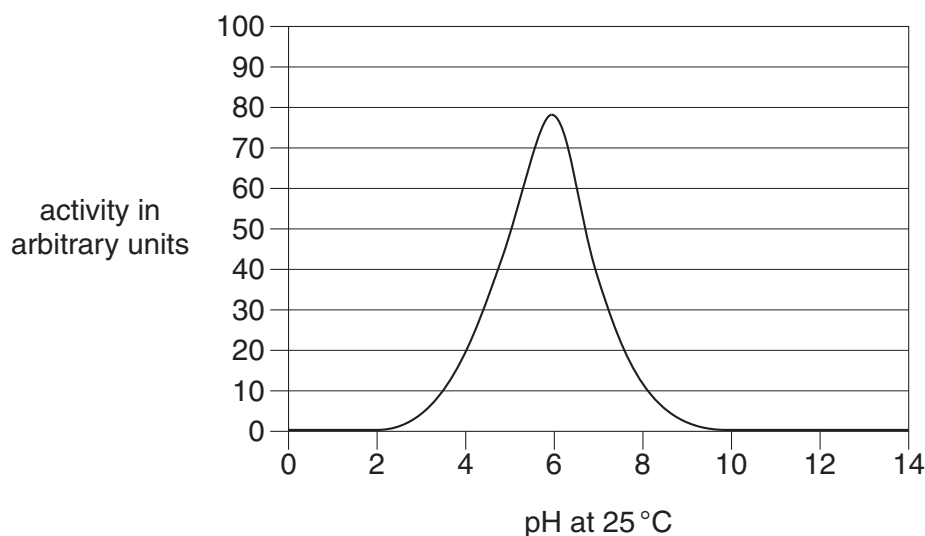


Fig. 4.2

- (i) Use the graph to estimate the pH at which the enzyme has optimum activity.

pH = [1]

- (ii) Give an example of another **variable** that it is important to control if this experiment is to generate valid results.

..... [1]

(iii) Stomach pH is acidic. The enzyme does not break down proteins in the stomach. Use Fig. 4.2 to suggest an explanation for this fact.

.....

.....

.....

..... [3]

(c) The experiment with the enzyme is repeated under the same conditions as in (b). However, this time, a competitive inhibitor is also present, Fig. 4.3.

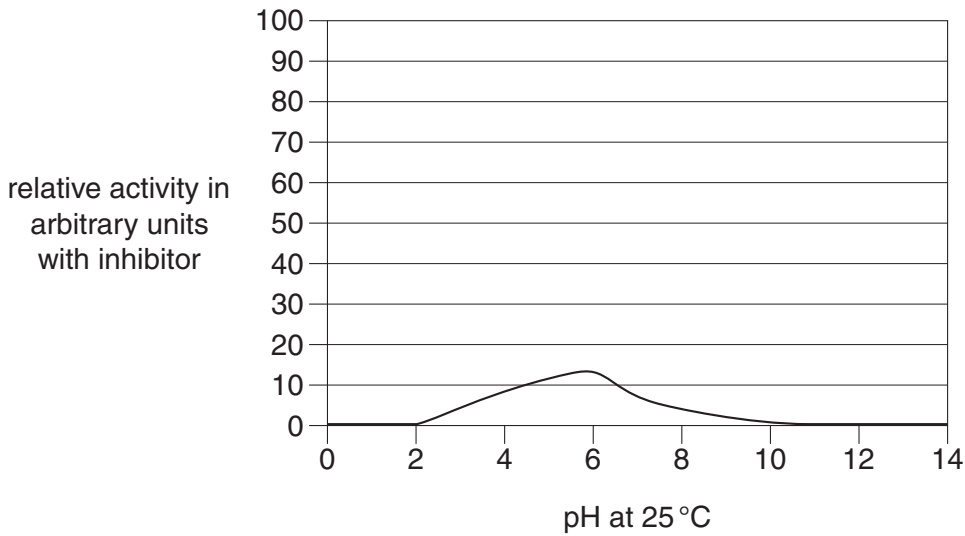


Fig. 4.3

Figs. 4.2 and 4.3 show that the competitive inhibitor has an effect on the activity of the enzyme.

(i) Describe the effect of the competitive inhibitor on the activity of the enzyme.

.....

..... [2]

(ii) Explain this effect.

.....

.....

.....

.....

.....

..... [4]

[Total: 14]
Turn over

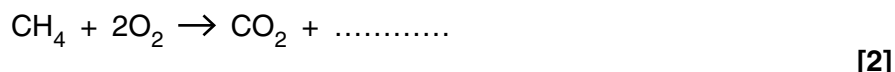
- 5 About 75% of electrical energy in the UK is generated in power stations that use **fossil fuels** as their energy source.

(a) Explain what is meant by a *fossil fuel*.

.....

 [2]

(b) About 38% of UK electrical energy is generated by natural gas. Natural gas is mostly methane (CH₄). Complete the equation below for the combustion of methane.



(c) The element carbon has an atomic number of 6. Three isotopes of carbon occur naturally with atomic masses 12, 13 and 14.

Draw a labelled diagram of the isotope carbon-12 clearly showing

- the number **and** type of particles in the nucleus of a carbon-12 atom
- the number **and** arrangement of electrons in the shells of a carbon-12 atom.

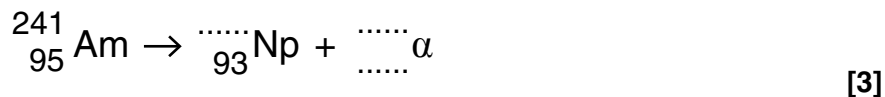
[4]

(d) Carbon-14 is a radioactive isotope of carbon and decays by β emission.

Complete the equation below for the decay of carbon-14.



(e) Alpha (α) radiation is emitted by the radioactive decay of Americium-241 according to the following equation. Complete the equation.



(f) Our understanding of radioactive decay and the existence of isotopes makes use of the Rutherford model of the nuclear atom.

(i) Describe the Rutherford model of the atom.

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

(ii) Describe how the ‘ α scattering experiment’ provides evidence to support Rutherford’s model of the atom. You may use a diagram to support your answer.



In your answer, you should make clear how your explanation links with the evidence.

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..... [4]

[Total: 18]

6 Fig. 6.1 shows a simple electrical circuit with a *d.c.* power supply.

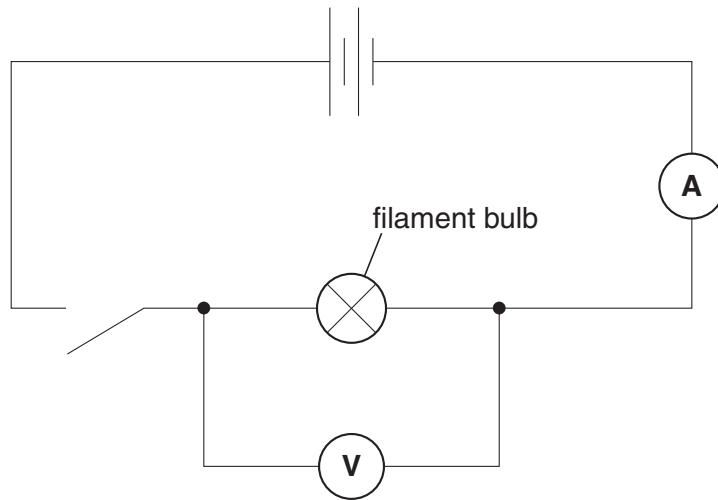


Fig. 6.1

(a) (i) Explain what is meant by the term *d.c.*

.....
 [2]

(ii) When the switch in the circuit is closed, the following measurements at **A** and **V** are made:

$$A = 0.25A \quad V = 3.0V$$

Use this information to calculate the **resistance** of the filament bulb. Show your working.

The relationship between voltage and current is

$$\text{voltage} = \text{resistance} \times \text{current.}$$

resistance = unit [3]

(b) Electricity in the UK is supplied by the national grid. A typical power station produces 1.5 GW (1 GW = 1×10^9 watts).

(i) How many joules of energy does the power plant produce in **1 minute**?

(1 watt = 1 joule per second) Show your working.

energy produced = J [4]

(ii) The frequency of mains electricity supply in the UK is 50 Hz **a.c.**

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

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

(iii) The voltage of the electricity supply is **stepped-up** as it leaves the power station. Explain why this is done.

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

[Total: 13]

7 Rice is a cereal foodstuff and is important in the diet of many people in the world. The phenotype of the cereal can be altered by genetic engineering.

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

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

(b) Describe the role of the following in the **genetic modification** of an organism such as rice.

(i) restriction enzymes
.....
..... [3]

(ii) vectors
.....
..... [3]

(c) Give **two** potential benefits of the genetic engineering of crops such as rice.

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

(d) Describe one **negative** environmental implication of the use of the technique.

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

[Total: 13]

END OF QUESTION PAPER

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