Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Secondary Education
January 2007

APPLIED SCIENCE (DOUBLE AWARD) **3860/2H**
Unit 2 Science for the Needs of Society
Higher Tier

H

Friday 19 January 2007 1.30 pm to 3.00 pm

For this paper you must have:
- a ruler.

You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

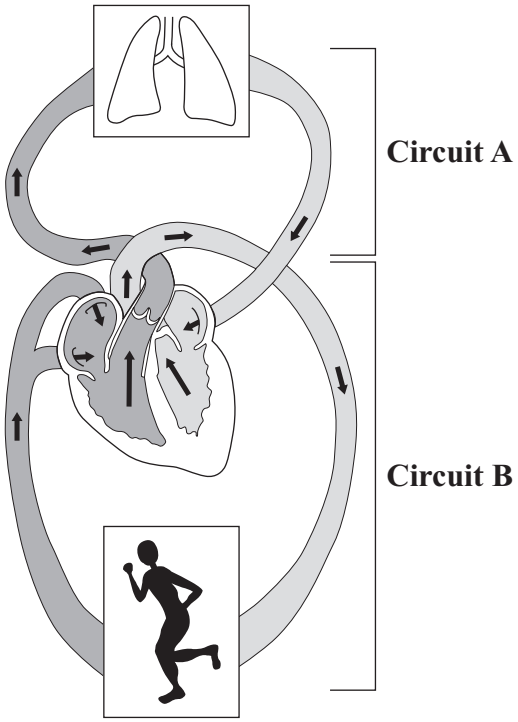
Information
- The maximum mark for this paper is 90.
- The marks for questions are shown in brackets.

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3		7	
4		8	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

1 A first aid course will include a lesson on the human circulatory system.

The human circulatory system has two parts. These are labelled **Circuit A** and **Circuit B** on the diagram.



(a) Write labels on the diagram to show:

(i) an artery

(ii) a vein.

(2 marks)

(b) Blood changes in different ways when it passes through each circuit.

(i) Give **two** ways in which blood changes as it passes through **Circuit A**.

1 .....

2 .....

(2 marks)

(ii) Give **two** ways in which blood changes as it passes through **Circuit B**.

1 .....

2 .....

(2 marks)

(c) Explain why it is more dangerous to cut an artery than a vein.

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(2 marks)

(d) Give **two** ways in which a first aider can protect a cut from infection.

1 .....

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2 .....

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(2 marks)

10

Turn over for the next question

2 A designer is choosing a material to use to make the frame of a bicycle.

Three suitable materials are described in the table below.

Use the information in the table to answer the questions that follow.

Material	Properties	Cost
Steel (iron with small amounts of carbon)	High tensile strength High density Corrodes easily and needs to be painted	Inexpensive
Aluminium alloy (aluminium with small amounts of copper)	High tensile strength Low density Resists corrosion	Expensive
Carbon fibre (a composite material)	High tensile strength Low density Does not corrode	Very expensive

(a) Why is carbon fibre described as a composite material?

.....

.....

(1 mark)

(b) Polymers and ceramics are **not** used to make bicycle frames.

(i) Give **one** reason why a polymer is **not** used to make a bicycle frame.

.....

.....

(1 mark)

(ii) Give **one** reason why a ceramic is **not** used to make a bicycle frame.

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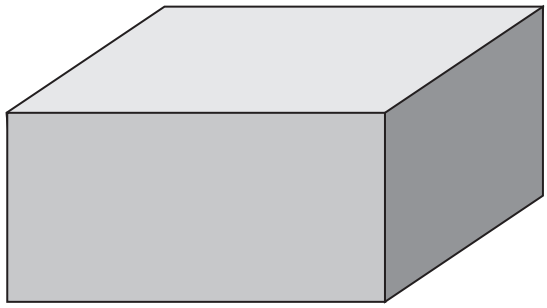
.....

(1 mark)

(c) The designer wants to measure the density of a block of aluminium alloy.



(i) Describe how the designer could measure the volume of the block.

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(3 marks)

(ii) The designer's results are recorded below:

Volume of block = 12.0 cm^3

Mass of block = 31.2 g

Calculate the density of the block in g/cm^3.

.....

.....

(2 marks)

Question 2 continues on the next page

(d) Aluminium alloy is produced by adding small amounts of copper to pure aluminium.

Aluminium alloy has a higher tensile strength than pure aluminium.

Explain why adding a small amount of copper increases the tensile strength of the metal.

You may illustrate your answer with a labelled diagram that shows how aluminium atoms and copper atoms pack together in the alloy.

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(3 marks)

11

Turn over for the next question

3 Plant scientists study how water moves in and out of plant cells by osmosis.

(a) Complete the following definition of osmosis.

Osmosis is the movement of water:

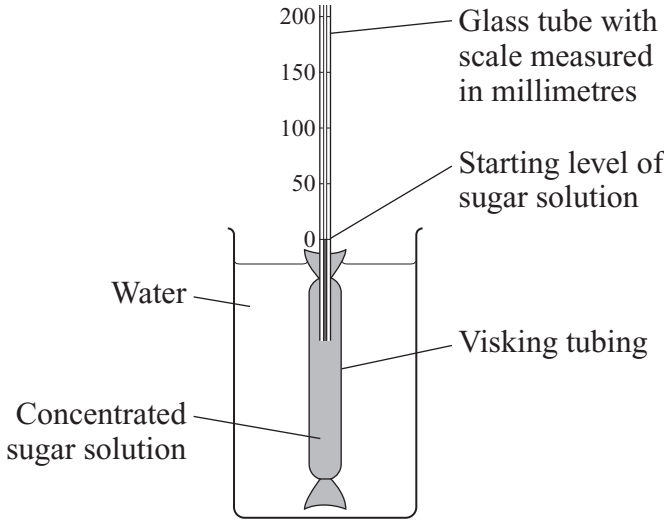
from .....

to .....

through .....

(3 marks)

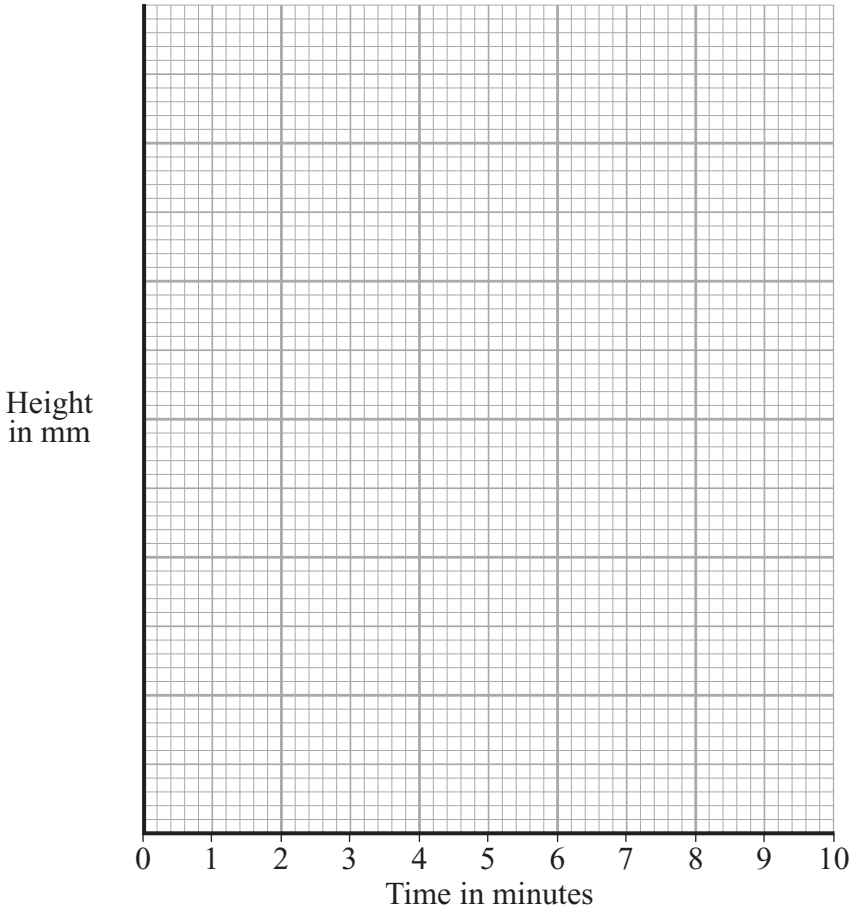
(b) A student set up an experiment to investigate osmosis.



The student measured the height of the sugar solution in the glass tube for 10 minutes.

Her results are recorded in the table.

Time in minutes	Height of sugar solution in mm
0	0
1	17
2	34
3	49
4	61
5	71
10	108



(i) Draw a graph of the student's results. *(3 marks)*

(ii) Join the points with a smooth curve. *(1 mark)*

(iii) Use your graph to estimate the height of the sugar solution after 8 minutes.

.....

(1 mark)

(iv) Why does the level of the sugar solution rise in the glass tube during the student's experiment?

.....

.....

(1 mark)

(v) The student repeated the experiment using less concentrated sugar solution in the visking tubing.

Predict the result of this experiment by drawing a second line on the graph and labelling it Experiment 2. *(2 marks)*

11

4 Many homes in the UK have gas central heating. Methane is burned in a boiler and the heat energy is used to heat water. Hot water circulates around the house through pipes and radiators.

In older boilers, heat energy is wasted when the methane burns. Hot gases are released as the products of combustion and pass out of the house through the chimney.

Modern condensing gas boilers are more efficient because they are fitted with a stainless steel heat exchanger. This extracts heat from the hot gases before they pass into the chimney.

Heat energy from the hot gases is used to pre-heat water before it enters the boiler.

One of the combustion products is condensed into a liquid.

(a) The chemical equation for the combustion of methane is given below.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

(i) Name the combustion product that is condensed into a liquid in a modern condensing gas boiler.

.....

(1 mark)

(ii) Suggest why the heat exchanger is made from stainless steel.

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(1 mark)

(b) Each room in the house is fitted with a hot water radiator.

Describe how a radiator filled with hot water transfers its heat to a room.

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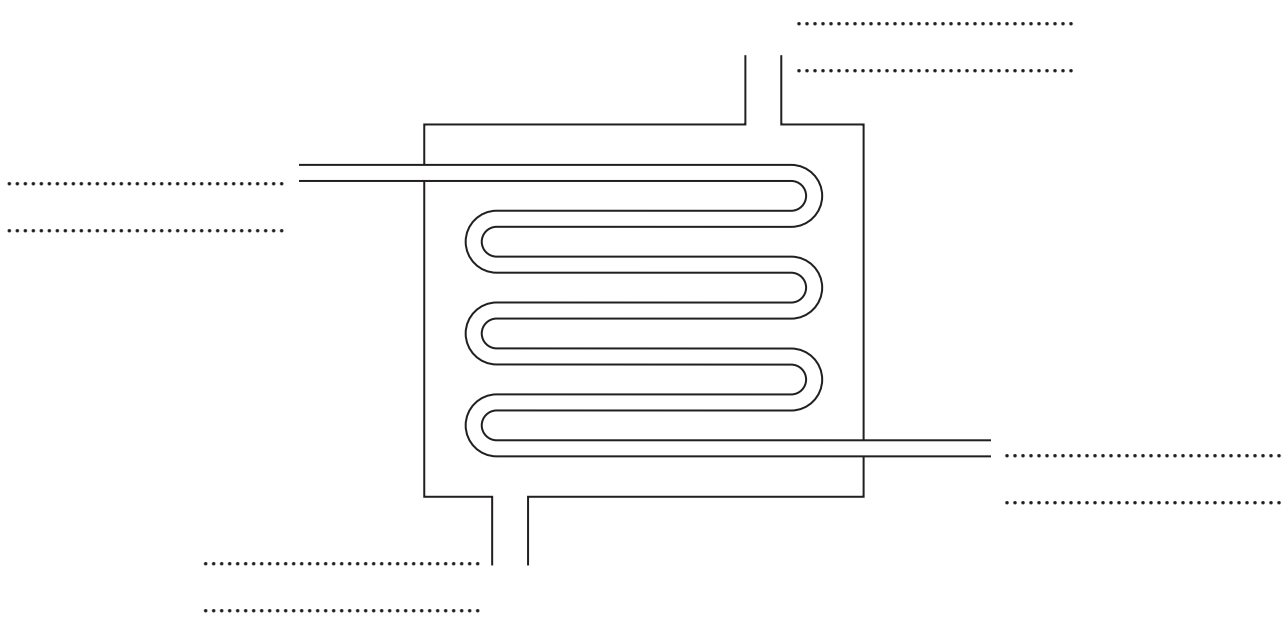
(2 marks)

(c) The diagram shows the heat exchanger that transfers heat energy from the hot combustion products to cold water.



Add the following labels to the diagram, and use arrows to show the direction of flow of water and gases.

cold water **cool gases** **warm water** **hot gases**

(3 marks)

(d) Explain why a modern condensing gas boiler is cheaper to run than an older boiler.

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(2 marks)

(e) Describe **two** other ways in which a modern home can be made more energy efficient.

1 .....

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2 .....

.....

(2 marks)

11

5 Vaccination can protect us from infection by microorganisms.

The chart below shows information taken from the United Kingdom Childhood Vaccination Schedule.

Disease(s)	Name of vaccine	Age at which vaccine is given	Comments
Diphtheria, tetanus, pertussis (whooping cough), polio, haemophilus influenzae type b	DTaP/IPV/Hib	2, 3 and 4 months	Primary course (three doses, a month between each dose)
Meningococcal type C	men C	2, 3 and 4 months	Primary course (three doses, a month between each dose)
	MMR	12–15 months	First dose (can be given at any age over 12 months)
Diphtheria, tetanus, pertussis (whooping cough), polio	dTaP/IPV	3–5 years	Booster dose (to be given 3 years after completion of primary course)
	MMR	3–5 years	Second dose
Diphtheria, tetanus, polio	Td/IPV	13–18 years	Booster dose

(a) Explain why many of the diseases listed in the chart cannot be treated by antibiotics.

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(2 marks)

(b) What is a vaccine?

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(2 marks)

(c) Explain how vaccination protects a child from infection by microorganisms.

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(3 marks)

(d) A child receives two doses of the MMR vaccine.

(i) Name the diseases prevented by the MMR vaccine.

.....

.....

(2 marks)

(ii) Suggest why a vaccination may be given more than once.

.....

.....

(1 mark)

Question 5 continues on the next page

(e) The table shows the number of confirmed cases of mumps between 2000 and 2004.

Year	Confirmed cases of mumps
2000	703
2001	777
2002	502
2003	1549
2004	8104

(i) Suggest a reason for the rapid increase in the number of confirmed cases of mumps between 2002 and 2004.

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(1 mark)

(ii) What could be done to reduce the number of mumps infections in the future?

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(1 mark)

12

6 Hydrogen chloride is a gas that dissolves in water to form hydrochloric acid. Large quantities of hydrochloric acid are used in the chemical industry, the pharmaceutical industry and the metal industry.

Hydrogen chloride can be manufactured by reacting hydrogen gas with chlorine gas. The chemical equation for the reaction is given below.

$$H_2 + Cl_2 \longrightarrow 2HCl$$

This is an exothermic reaction.

(a) What is an exothermic reaction?

.....

.....

(1 mark)

(b) Describe the chemical bonding in hydrogen chloride.

You may use a labelled diagram.

[Number of electrons: H = 1, Cl = 17]

.....

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.....

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(2 marks)

Question 6 continues on the next page

(c) During the reaction between hydrogen and chlorine, bonds in hydrogen molecules and chlorine molecules are broken, and bonds in hydrogen chloride molecules are formed.

$$H–H + Cl–Cl \longrightarrow 2H–Cl$$

The table gives the energy required to break these bonds and the amount of energy given out when these bonds are formed.

The number of bonds broken is the same in each case.

Bond	**Energy in kJ**
H–H	436
Cl–Cl	243
H–Cl	432

(i) Calculate the total amount of energy required to break the bonds in hydrogen and chlorine.

.....

.....

..... kJ
(2 marks)

(ii) Calculate the total amount of energy given out when the bonds in hydrogen chloride are formed.

.....

.....

..... kJ
(2 marks)

(iii) Calculate the overall energy change for the reaction.

.....

.....

..... kJ
(2 marks)

(iv) Explain why this is an exothermic reaction.

.....

.....

(2 marks)

(d) Hydrochloric acid will dissolve metals.

The chemical equation for the reaction of zinc with hydrochloric acid is given below.

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

The rate at which the metal dissolves depends on the temperature, the size and the shape of the pieces of metal, and on the concentration of the acid.

Describe an experiment that could be carried out in a school laboratory to measure how the rate at which zinc dissolves in hydrochloric acid is affected by the concentration of the acid.

You may use a labelled diagram as part of your description.

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(4 marks)

15

7 The power of an electrical appliance can be used to calculate the amount of electricity used in a given time.

The power of an electrical appliance is given by the formula:

$$\textbf{power}\ (\text{kW}) = \frac{\textbf{energy}\ (\text{kWh})}{\textbf{time}\ (\text{h})}$$

The information below is printed on a plate attached to an electrical vacuum cleaner.

1800 W 240 V

(a) The vacuum cleaner is switched on for 30 minutes. Use the information to show that the electrical energy used by the vacuum cleaner in that time is 0.9 kWh.

.....

.....

..... kWh

(3 marks)

(b) One Unit of electricity costs 7 p.

Calculate the cost of using the vacuum cleaner for 30 minutes.

.....

..... p

(2 marks)

(c) Electrical current is measured in amps.

Calculate the electrical current used by the vacuum cleaner.

.....

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..... amps
(3 marks)

(d) The vacuum cleaner lost 0.2 kWh of energy as heat when it was switched on for 30 minutes.

Use the information given in part (a) to calculate the percentage efficiency of the vacuum cleaner.

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(3 marks)

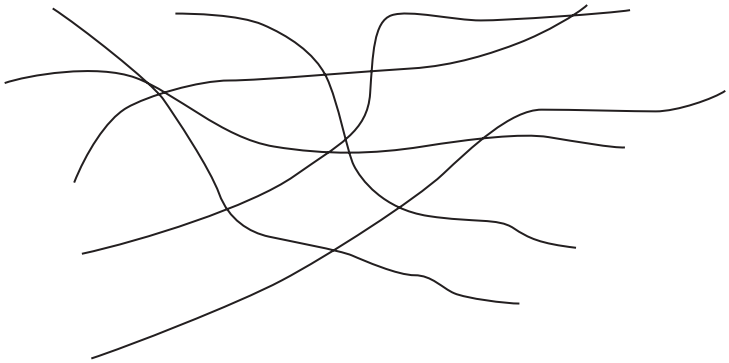
11

Turn over for the next question

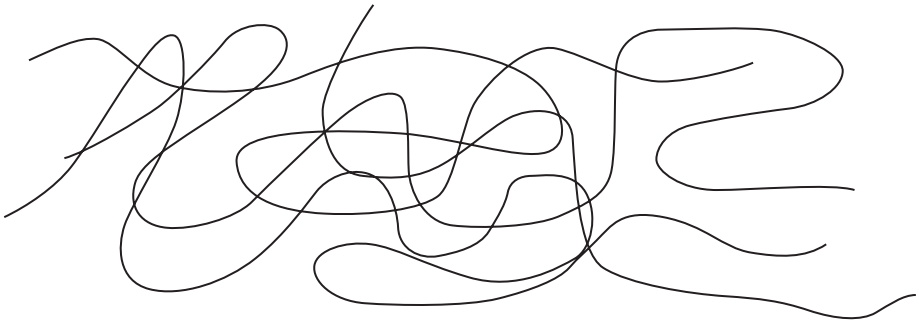
8 Polymer chemists can produce new polymers with a range of properties to suit a range of applications.

Polymers are materials made up of large molecules. The molecules are long chains. The atoms in the chains are held together by strong bonds but there are weak forces of attraction between the chains.

Long-chain polymer molecules



(a) Chain length affects the flexibility and melting point of a polymer. The diagram below shows polymer molecules with longer chains.



(i) Describe the effect of an increase in chain length on the flexibility and melting point of a polymer.

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(2 marks)

(ii) Explain the changes caused by an increase in the chain length.

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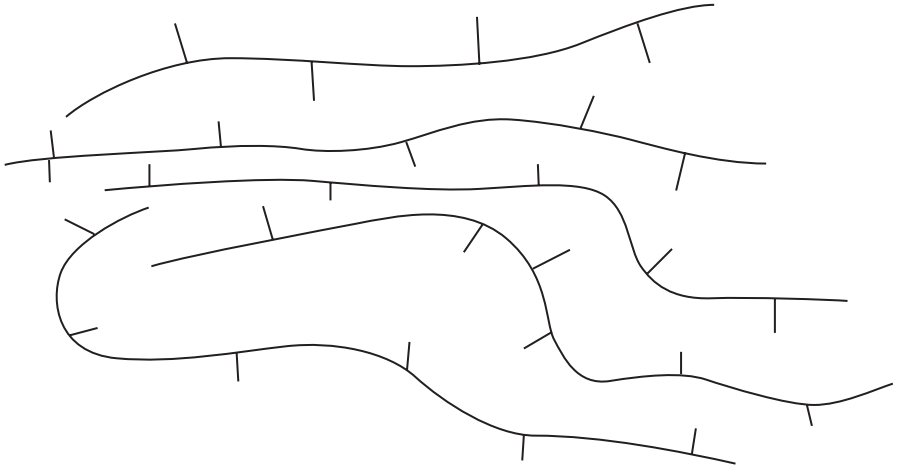
(1 mark)

(b) Branching of chains affects the flexibility and melting point of a polymer.

The diagram below shows polymer molecules with branched chains.



(i) Describe the effect of chain branching on the flexibility and melting point of a polymer.

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(2 marks)

(ii) Explain the changes caused by an increase in chain branching.

.....

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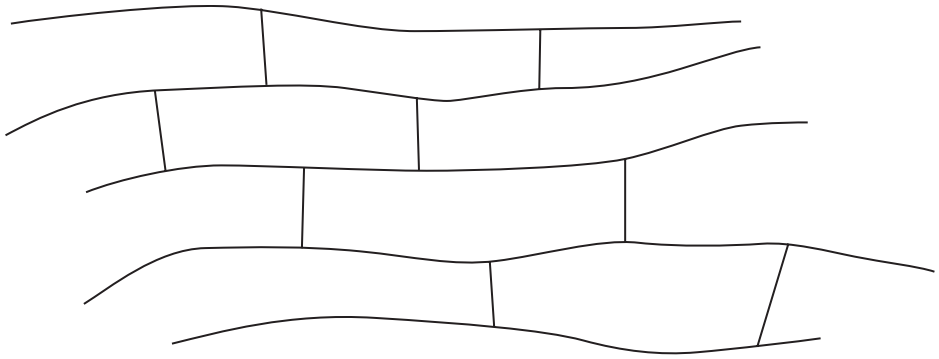
(1 mark)

Question 8 continues on the next page

(c) Cross-linking between chains affects the flexibility and melting point of a polymer.

The diagram below shows polymer molecules with cross-linking between the chains.



(i) Describe the effect of cross-linking between the chains on the flexibility and melting point of a polymer.

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(2 marks)

(ii) Explain the changes caused by cross-linking between the polymer chains.

.....

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(1 mark)

9

END OF QUESTIONS

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Question 5 Health Protection Agency Centre for Infections