

Surname											Other Names										
Centre Number											Candidate Number										
Candidate Signature																					

For Examiner's Use

General Certificate of Education
June 2008
Advanced Subsidiary Examination

APPLIED SCIENCE
Unit 2 Energy Transfer Systems

SC02



Friday 23 May 2008 9.00 am to 10.30 am

For this paper you must have:

- a pencil and a ruler
- a calculator.

Time allowed: 1 hour 30 minutes

Instructions

- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

Information

- The maximum mark for this paper is 80.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

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



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

- 1** Cystic fibrosis is an inherited disease which causes respiratory and digestive problems. A 14-year-old girl with the disease suffers from frequent severe chest infections. She would benefit from a heart and lung transplant. Suitable organs become available from a donor and tissue typing shows them to be a good match for the girl. The consultant discusses the procedure with the girl and her parents before surgery.

- 1** (a) State **two** pieces of information that the consultant should give the girl and her parents before they consent to surgery.

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(2 marks)

- 1** (b) What kind of improvements would the girl expect to see following the transplant?

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(2 marks)

- 1** (c) Before surgery, the girl had an average peak expiratory flow rate of $250 \text{ dm}^3 \text{ min}^{-1}$. How does this value compare with the normal value for the peak expiratory flow rate of an adult?

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(1 mark)



Chest infections occur regularly in people with cystic fibrosis. This is caused by the excessive production of mucus in their airways.

- 1 (d) (i) In a healthy person what is the function of the mucus produced in the trachea?

.....

 (2 marks)

- 1 (d) (ii) Name the cellular structure that beats with a wave-like action to move the mucus.

.....
 (1 mark)

Several months after surgery, the girl who had received a heart and lung transplant returned to the hospital for health assessment.

Her lung function was assessed and the tidal volume and vital capacity were found to have increased.

- 1 (e) (i) What equipment is used to measure lung volumes?

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 (1 mark)

- 1 (e) (ii) What is the value for tidal volume in a healthy adult?

..... cm³
 (1 mark)

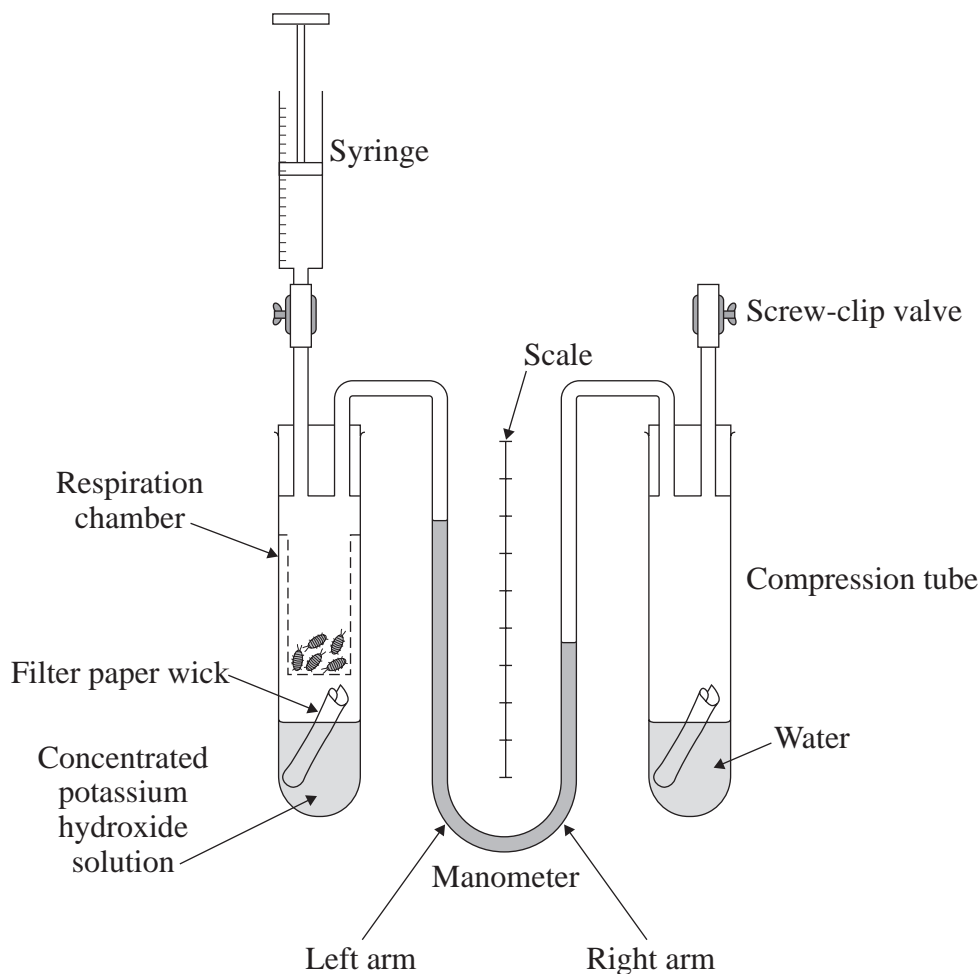
- 1 (e) (iii) What is the value for vital capacity in a healthy adult female?

..... dm³
 (1 mark)

Turn over for the next question



- 2 The diagram shows a simple respirometer which is often used in school laboratories to measure respiratory rate. In an experiment five woodlice are placed in the respiration chamber. The concentrated potassium hydroxide solution absorbs the carbon dioxide produced by the woodlice during aerobic respiration. The volume of air in the respiration chamber decreases as oxygen is used by the woodlice. Therefore, the fluid in the manometer moves towards the respiration chamber. The woodlice are not harmed during the experiment.



- 2 (a) (i) What does the term *aerobic respiration* mean?

.....
(1 mark)

- 2 (a) (ii) Write a balanced chemical equation for aerobic respiration.

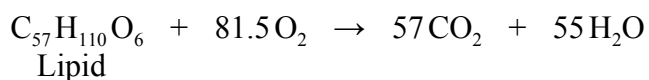
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(3 marks)



- 2 (a) (iii) The respiratory quotient (RQ) of a substance can be calculated as follows:

$$\text{RQ} = \frac{\text{Volume of carbon dioxide given off}}{\text{Volume of oxygen taken up}}$$

The chemical equation for aerobic respiration of a lipid is



In an experiment using the respirometer, the results shown in the table were obtained. Using data from the table calculate the RQ for this lipid.

Aerobic respiration of lipid	
Volume of carbon dioxide given off (cm ³)	Volume of oxygen used (cm ³)
5.7	8.15

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(2 marks)

The experiment was repeated, but with ten woodlice in the respiration chamber instead of five.

- 2 (b) (i) How would the level of fluid in the left arm of the manometer at the end of this experiment compare with that at the end of the first experiment?

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(1 mark)

- 2 (b) (ii) Explain your answer to part (b)(i).

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(1 mark)

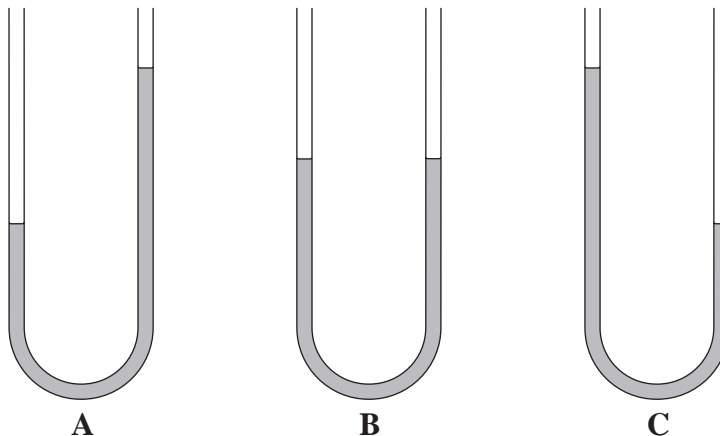
Question 2 continues on the next page

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- 2 (c) (i) A third experiment was set up, using 10 woodlice, but the concentrated potassium hydroxide solution was replaced by an equal volume of water. Which diagram, **A**, **B** or **C**, shows what you would expect to see in the manometer? Assume that the woodlice use carbohydrates in aerobic respiration.

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(1 mark)



- 2 (c) (ii) Explain your answer to part (c)(i).

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.....
(1 mark)

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

Turn over ►



- 3** Three men and three women, all aged over 65, decided to walk 20 miles over moorland in the north of England.

They want to assess their level of fitness and train for two months before undertaking the walk.

The pulse rates of all members of the group were measured before and after exercising for 10 minutes by jogging on the spot.

The results are shown in the table.

Participant	Pulse rate before exercise (beats per minute)	Pulse rate straight after exercising (beats per minute)	Pulse rate 2 min after exercising (beats per minute)	Pulse rate 3 min after exercising (beats per minute)
A	85	120	113	90
B	100	140	135	120
C	97	156	144	133
D	75	125	110	85
E	105	138	125	115
F	82	133	82	82

- 3 (a) (i)** What is the range for resting pulse rate for a healthy adult?

.....
(1 mark)

- 3 (a) (ii)** Which participant, **A – F**, is most likely to be the fittest?

.....
(1 mark)

- 3 (a) (iii)** Explain your choice.

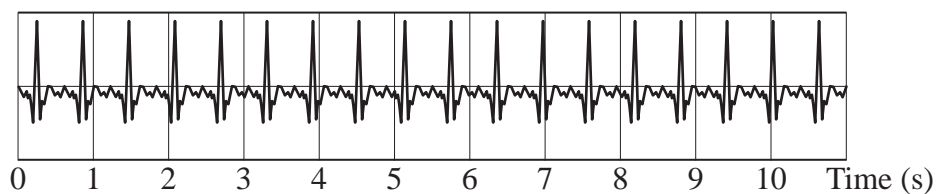
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 (3 marks)



- 3 (b) The health assessment includes using an electrocardiogram (ECG) to monitor heart activity.

The trace resulting from the ECG of one of the walkers is shown below.



This ECG trace shows an abnormal heart beat. What name is given to this type of heart beat irregularity?

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(1 mark)

- 3 (c) When the participants were jogging on the spot there was an increased demand for blood supply to the muscles.

Describe how the nervous system increases the heart rate to meet this demand.

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(3 marks)

Question 3 continues on the next page

- 3 (d) The blood pressure of the participants was also measured before exercise and the results are shown in the table.

Participant	Systolic pressure (mm Hg)	Distolic pressure (mm Hg)
A	125	79
B	152	118
C	169	130
D	145	95
E	132	80
F	109	72

What is the normal value of blood pressure for a healthy 40-year-old man?

.....
(1 mark)

- 3 (e) Suggest with reasons which participant, **A – F**, is most likely to be asked to consider doing only part of the walk.

Use data from the table on **page 8** and the table above when answering this question.

Participant

Explanation

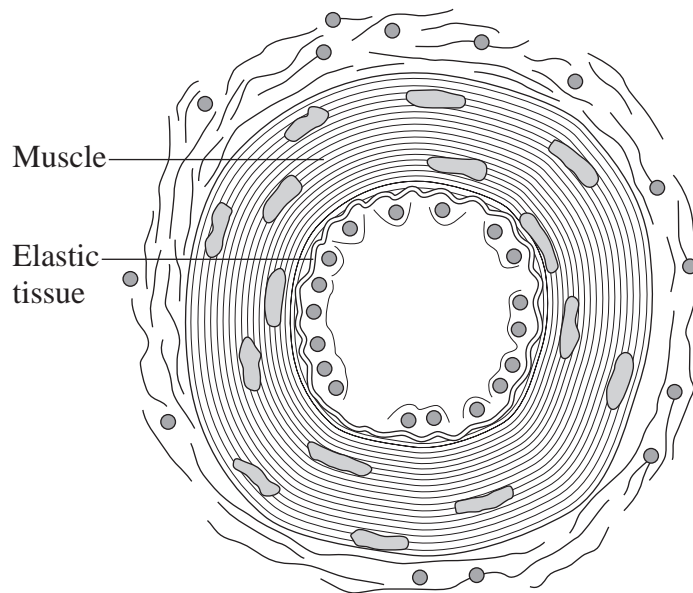
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(3 marks)



- 3 (f) The diagram shows a cross-section through the wall of an artery.



Explain how the structure of this artery helps to maintain blood pressure.

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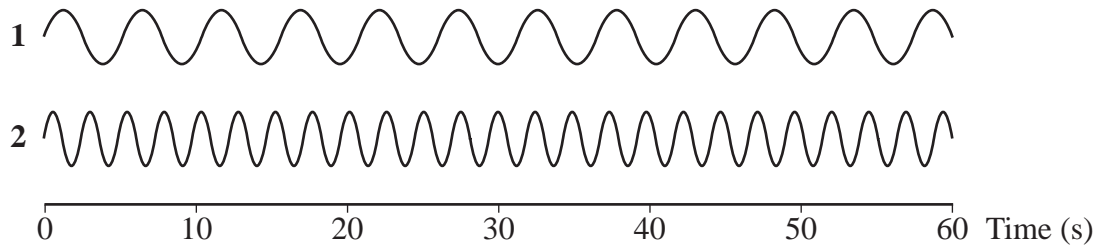
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(3 marks)

Question 3 continues on the next page



- 3 (g) The participants also had their breathing rate monitored at rest. The diagram below shows traces of the breathing rates for two of the participants.



One person is breathing normally and the other is suffering from a respiratory illness. Which trace (1 or 2) is taken from the person with a respiratory illness?

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Explain your choice.

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(1 mark)



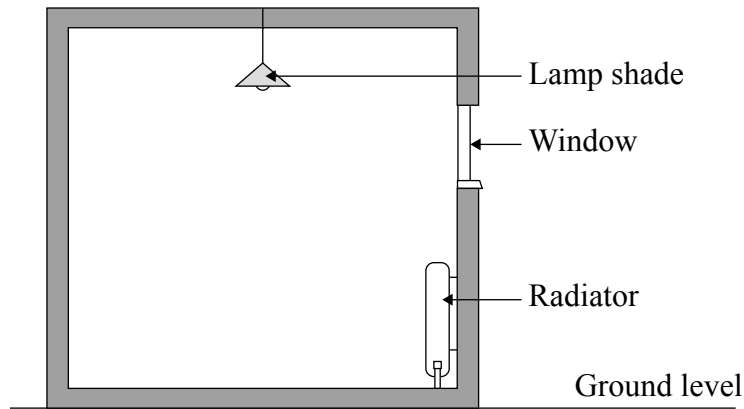
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- 4 An architect is designing a new block of classrooms for a school. She has been instructed to make sure that the heating costs are kept as low as possible. Heat will be supplied to the classrooms by hot water piped into radiators attached to the walls. These radiators heat the air near them, by conduction.



- 4 (a) The architect suggests that silver foil could be placed between the radiator and the wall. Explain how this would help to improve heat transfer into the room.

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(3 marks)

- 4 (b) The height of the ceiling can affect heating costs. Why has the architect designed rooms with low ceilings?

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(1 mark)



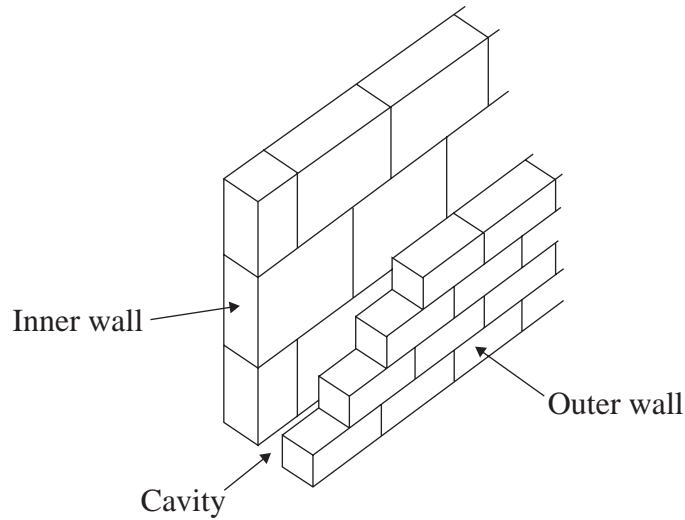
- 4 (c) What is the advantage of having the radiator near to the floor rather than higher up the wall?

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(1 mark)

- 4 (d) The building is to be constructed with cavity walls.



The cavity can be filled with air, foam or solid concrete. Which of these three materials should be used to fill the cavity? Explain your answer in terms of heat transfer.

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(3 marks)

Question 4 continues on the next page



- 4 (e) Suggest **two** ways, apart from through the walls, in which heat might be lost from the classrooms. For each, explain how this heat loss could be reduced.

1

Explanation

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2

Explanation

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(2 marks)

- 4 (f) Each classroom is to be fitted with a thermostat. This responds to changes in temperature by opening or closing the valve which controls the flow of hot water to the radiators. Explain how this works as an automatic feedback system to control the temperature in the classroom.

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(3 marks)



- 4 (g) (i) The school governors want to further reduce the cost of heating the classrooms. They decide to set the thermostats to a slightly lower temperature. Explain how keeping the classrooms at a lower temperature would reduce the rate of heat loss.

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(2 marks)

- 4 (g) (ii) Explain how this would reduce costs.

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(1 mark)

- 4 (h) State **two** advantages (apart from reduced financial cost) of reducing the amount of energy used in heating these classrooms.

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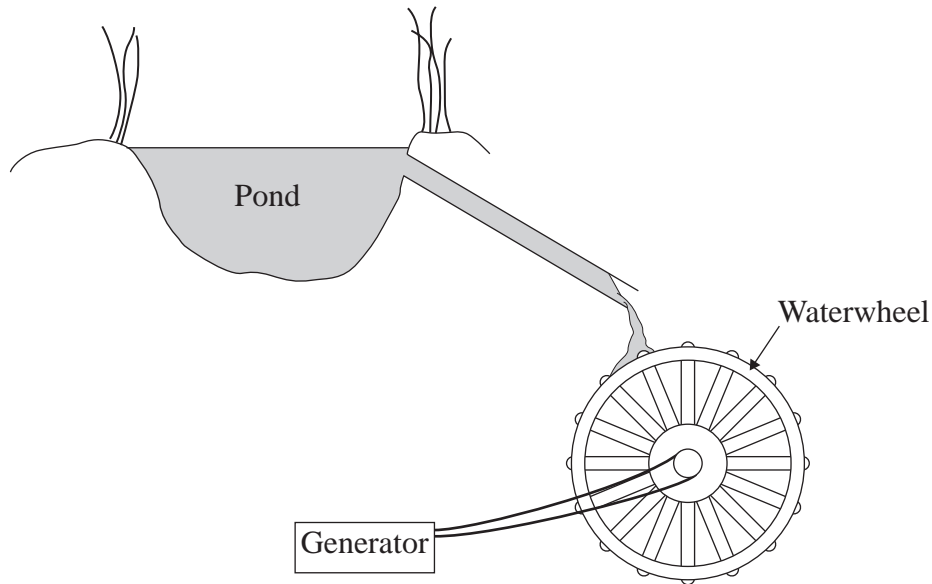
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(2 marks)

Turn over for the next question



- 5 A farmer is building his own power station to generate electricity. He has installed a waterwheel to turn a generator. Water is piped from a pond 5 metres above the waterwheel. On average, 720 kg of water reaches the waterwheel in 1 minute.



- 5 (a) How much gravitational potential energy is lost when 720 kg of water falls a distance of 5 m?
You may assume that 1 kg of water weighs 10 N.

.....

 J
 (2 marks)

- 5 (b) Calculate the power available if this energy is delivered to the generator in 1 minute.

.....

 W
 (2 marks)



- 5 (c) The generator is 75% efficient.
Calculate the maximum electrical power output from the generator.

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..... W
(2 marks)

- 5 (d) What other forms of energy are likely to be produced by the generator?

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(2 marks)

- 5 (e) Suggest **two** environmental advantages of using this method of generating electricity, compared with using a diesel-powered generator.

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(2 marks)

- 5 (f) Give **one** disadvantage of using the pond water as a source of energy.

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(1 mark)

Question 5 continues on the next page



- 5 (g) Another farmer has a larger waterwheel and a generator that produces 1500 watts of electrical power.
He uses the power from this generator for 60 hours each week.
Calculate the cost each week if he had bought this energy from an electricity company that charged 12p per unit of electrical energy.

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(2 marks)

13

Turn over for the next question



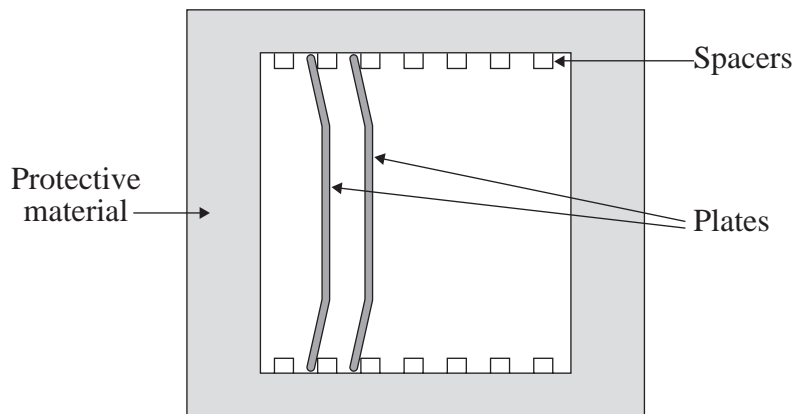
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- 6** A pottery makes china plates for export. They have to pack them carefully to avoid breakage. You have been asked to help design the packaging for the plates.
- The plates will be packed in a wooden crate.
- The greatest danger is that the crate might be dropped.
- The maximum distance that the crate might fall is likely to be 0.5 m.
- The crate will be packed with plates in the middle, surrounded by a layer of protective material to minimise the risk of damage.



- 6 (a) Suggest a type of material to be used in the protective layer.

(1 mark)

- 6 (b)** Use your understanding of momentum to explain why a thick layer of protective material is better at preventing damage to the plates than a thin layer would be.

[illegible]

(4 marks)



- 6 (c) The pottery manager has requested tests of the proposed protective material to make sure that it protects the plates effectively.
Give **two** factors you would keep the same in all your tests if you are testing **one** packaging material only.

1.....

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2.....

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(2 marks)

- 6 (d) What **one** factor would you change in each test?

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(1 mark)

- 6 (e) Suggest **one** way to make your result as accurate as possible.

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(1 mark)

- 6 (f) Suggest **two** disadvantages of using too much protective material in the crate.

1.....

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2.....

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(2 marks)

END OF QUESTIONS

There are no questions printed on this page

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