

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	



General Certificate of Education
Advanced Subsidiary Examination
January 2011

Applied Science

SC02

Unit 2 Energy Transfer Systems

Tuesday 11 January 2011 9.00 am to 10.30 am

<p>For this paper you must have:</p> <ul style="list-style-type: none"> • a pencil • a ruler • a calculator.
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Time allowed

- 1 hour 30 minutes

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- 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 marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You are expected to use a calculator where appropriate.

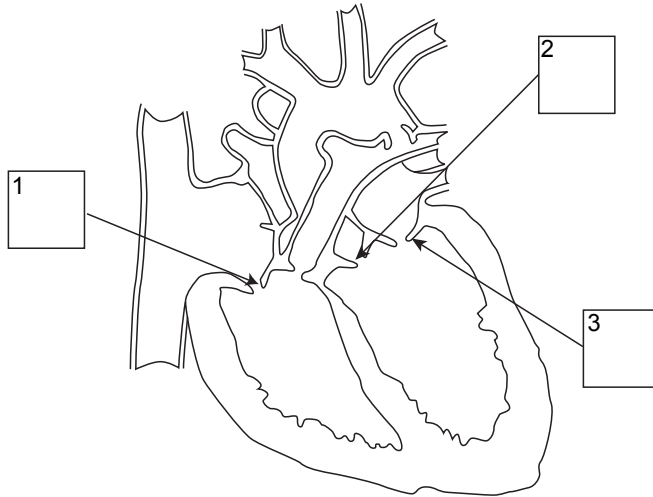


J A N 1 1 S C 0 2 0 1

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

1 Fitness trainers often give people an exercise programme to improve the function of their heart.

This is a diagram of the heart.



1 (a) The diagram shows three different valves:

- A** the tricuspid valve
- B** the bicuspid valve
- C** a semilunar valve.

Insert letters **A**, **B** or **C** in the appropriate box to show where each valve is.

(3 marks)

1 (b) Human beings have a double circulatory system.
Explain what is meant by a *double circulatory* system.

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(2 marks)



- 1 (c) (i) Two 20-year-old men, **X** and **Y**, working for the same company, decide to exercise regularly.
When they exercise, their heart rates increase.

Describe how the brain and nervous system cause the heart rate to increase during exercise.

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(3 marks)

- 1 (c) (ii) When the two men, **X** and **Y**, had been exercising regularly for three months, they decided to have a health assessment at a clinic.
Their blood pressure was measured and the results are shown in the table.

	Systolic pressure (mm Hg)	Diastolic pressure (mm Hg)
X	125	80
Y	135	88

Using the information in the table, which man, **X** or **Y**, do you think is fitter?

Man

Explain your answer

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(1 mark)

- 1 (c) (iii) Explain what is meant by *systolic* and *diastolic* blood pressure.

Systolic

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Diastolic

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(2 marks)

Question 1 continues on the next page

Turn over ▶



- 1 (d) (i) The company doctor decides to see if regular exercise could benefit the health of their employees.

100 employees were asked to take part in an experiment.

Suggest **two** reasons why 100 people, rather than 5, were tested.

Reason 1

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Reason 2

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(2 marks)

- 1 (d) (ii) After a period of three months, the employees in the experiment, who were all male, were asked to have health assessments.

The tidal volume of one of the employees was found to be 450 cm^3 .

How does this compare with the normal value for tidal volume?

.....

(1 mark)

- 1 (d) (iii) During the health assessment, another employee was found to have a peak expiratory flow rate of $340 \text{ dm}^3 \text{ min}^{-1}$.

How does this compare with the normal value for peak expiratory flow rate?

.....

(1 mark)

- 1 (e) Doctors often use resting heart rate as a measure of fitness. The table below shows typical resting heart rate measurements collected from a range of athletes and non-athletes.

Resting heart rate (beats per minute)				
Age (years)	Male athlete	Male non-athlete	Female athlete	Female non-athlete
18–25	52	72	57	76
26–35	52	73	57	75
36–45	53	73	57	76
46–55	54	74	57	76
56–65	54	74	57	76
65+	53	72	57	74



Describe **three** trends seen in the data in the table on **page 4**.

1.....

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(3 marks)

18

Turn over for the next question

Turn over ▶



2 Healthcare professionals often rely on imaging methods, such as X-rays, to diagnose illness and to monitor the health of patients.

2 (a) (i) State **two** reasons in favour of using X-rays to diagnose a medical problem.

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(2 marks)

2 (a) (ii) Give **two** disadvantages of using X-rays to diagnose a medical problem.

1.....
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2.....
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(2 marks)

2 (b) Scientists have developed a new method of using radioactive tracers to diagnose brain damage. They want to test the method on human patients. Before starting clinical trials they submit their research plan to an ethics committee. Briefly discuss the issues that the ethics committee needs to consider before it gives permission for the trials to take place.

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(3 marks)



2 (c) One imaging method involves using radioactive tracers to help identify problems inside the body.

2 (c) (i) State **two** reasons in favour of using radioactive tracers to diagnose a medical problem.

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2.....
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(2 marks)

2 (c) (ii) Give **two** disadvantages of using radioactive tracers to diagnose a medical problem.

1.....
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2.....
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(2 marks)

11

Turn over for the next question

Turn over ▶



3 In some parts of the world, people dive several metres below the surface of the sea to collect pearls. To do this they have to hold their breath for several minutes.

Aerobic respiration involves chemical reactions that use oxygen, a gas found in air.

3 (a) (i) Give **two** waste products of aerobic respiration.

1

2

(2 marks)

3 (a) (ii) Give **one** useful product of aerobic respiration.

.....

(1 mark)

3 (b) Metabolism is the term used to refer to the chemical reactions that take place in the body.

The respiratory quotient (RQ) is the ratio of the volume of carbon dioxide produced by an organism to the volume of oxygen consumed in a given period.

The value of the RQ also depends on the food being metabolised.

The respiratory quotient is defined as follows:

$$\text{RQ} = \frac{\text{volume of carbon dioxide produced}}{\text{volume of oxygen consumed}}$$

In an experiment to test different food types, the following RQ values and volumes of carbon dioxide produced were obtained.

Food type	Respiratory quotient (RQ)	Volume of carbon dioxide produced (cm ³)	Volume of oxygen consumed (cm ³)
Carbohydrate	1.0	20	20
Fat	0.7	25	
Protein	0.8	14	17.5

Calculate the value for the volume of oxygen consumed when fat is metabolised producing 25 cm³ of carbon dioxide.

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(2 marks)



3 (c) Chemical reactions taking place in the body generate heat. This heat is constantly lost from the body through the skin.

Name **three** other ways in which heat is lost from the body.

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3

(3 marks)

3 (d) Some health authorities are considering refusing heart bypass surgery to obese people until they have shown some commitment to losing weight.

Give **two** possible reasons why doctors might refuse to operate until the person has reached a target weight.

1

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(2 marks)

10

Turn over for the next question

Turn over ▶



4 The electricity supply industry is always looking for more efficient and more effective ways of producing electricity.
Using a coal-fired power station to generate electricity has several disadvantages.
One disadvantage is that it takes many hours to start up the power station before it produces electricity.

4 (a) Suggest **two** other disadvantages of using coal to generate electricity.

Disadvantage 1

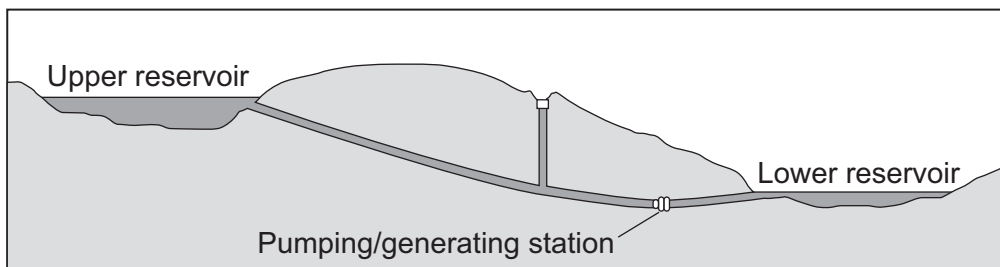
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Disadvantage 2

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(2 marks)

An alternative method of producing electricity is using hydroelectric power stations.
One type of hydroelectric power station uses a pumping station and a pair of reservoirs.



At night, when power stations across the country are producing more electricity than is needed, excess electricity is used to pump water uphill from the lower reservoir to the upper reservoir.
During the day, at times of peak electrical demand, water is allowed to flow down to the lower reservoir. This provides electricity almost immediately.

4 (b) Calculate the gravitational potential energy gained by 6×10^9 kg of water when it is lifted by 500 m to the upper reservoir. Give the correct unit in your answer.

Assume $g = 10 \text{ N kg}^{-1}$

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(3 marks)



4 (c) Why is the gravitational potential energy gained by the water **not** equal to the energy used by the pumps when they lifted the water?

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(2 marks)

4 (d) When the water flows back down to the lower reservoir it loses energy at the rate of 750 MW (7.5×10^8 W).
How long should it take for all the water to flow back down (using up all the gravitational potential energy stored in the water in the upper reservoir)?

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(2 marks)

4 (e) The water loses energy at a rate of 750 MW, but the electrical power generated is only 600 MW.
Calculate the efficiency of this process.

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(2 marks)

4 (f) Why might more energy be available in rainy weather?

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(2 marks)

Question 4 continues on the next page

Turn over ▶



4 (g) The upper reservoir is filled at night, when the cost of generating electricity is 5p per unit. It takes 7.5 million units of electricity to fill the upper reservoir with water.

The output energy is only 6.0 million units, but it is available at peak periods when the company can sell its electricity at 15p per unit.

A company accountant is concerned that this process may not be making enough profit.

Calculate the profit made in one cycle of filling and emptying the upper reservoir.

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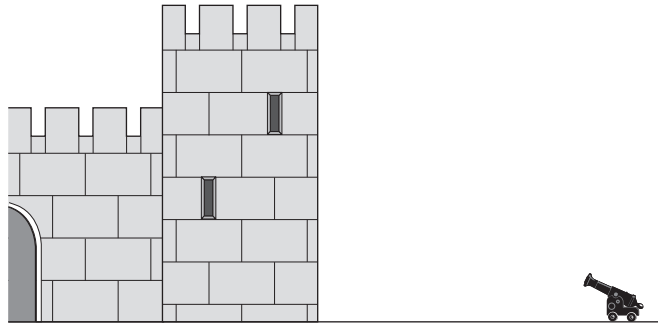
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(3 marks)

16



- 5** A film director wants to film a scene in which an army is firing cannonballs at a castle wall. Each cannonball has a mass of 5 kg, and is fired from a cannon of mass 2000 kg. The cannonball leaves the cannon at a speed of 300 m s^{-1} .



- 5 (a)** Calculate the maximum kinetic energy of **one** cannonball just after it has been fired from the cannon.

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 (3 marks)

- 5 (b)** Why is it not a good idea to stand directly behind the cannon when it is fired? Use ideas about momentum to explain your answer.

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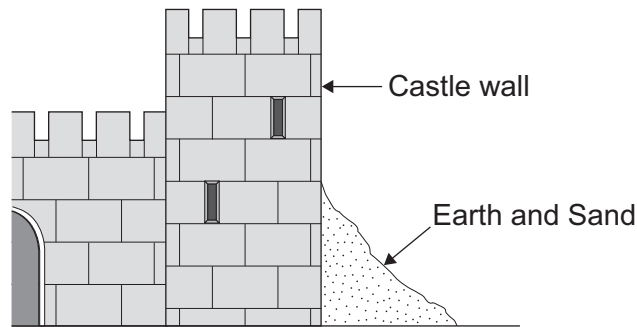
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Question 5 continues on the next page

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- 5 (c) In the film, the attacking army tries to make each cannonball hit the same part of the castle wall, to concentrate the damage in one place. The defenders tip a large quantity of earth and sand over the wall where the cannonballs are hitting it to reduce the chance of the wall being destroyed.



Explain how this layer of earth and sand would reduce the damage to the wall from each cannonball.

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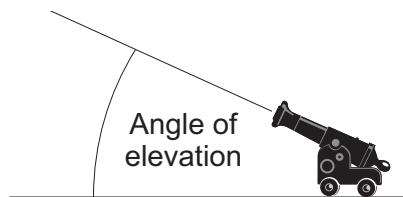
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(3 marks)

- 5 (d) The gunner needs to know the angle of elevation to use to fire the cannonball as far as possible. A technician is told to design an experiment to investigate this.



List **four** key features of a well-designed experiment to find the angle of elevation that fires the cannonball the longest distance.

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(4 marks)

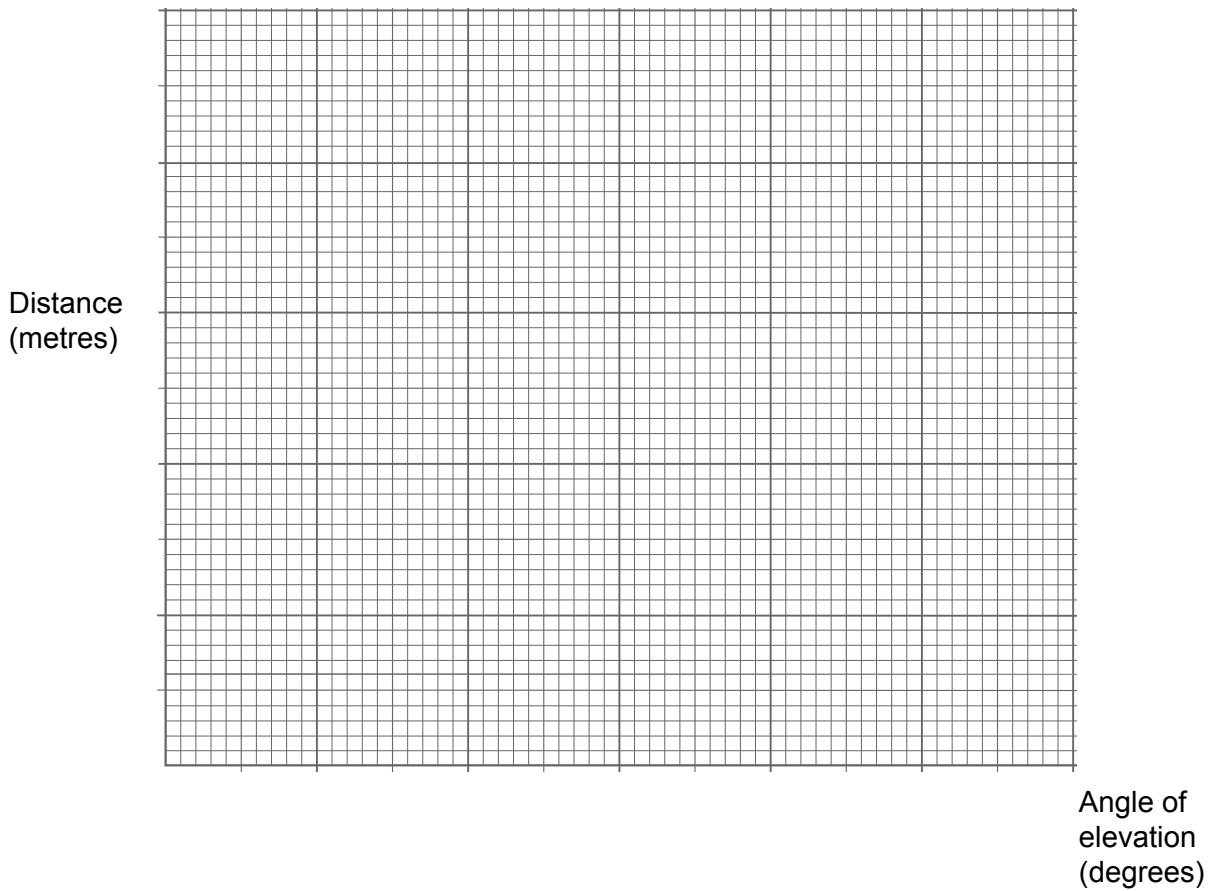


- 5 (e) In a first trial, the technician fires the cannon 5 times, once at each of five different angles, getting the results shown in the table.

Angle of elevation (degrees)	30	35	40	45	50
Distance cannonball travels (metres)	790	860	905	920	900

Plot these points on the grid provided.
Draw a line of best fit.

(3 marks)



- 5 (f) The technician claims that these results prove that the longest distance travelled by the cannonball is achieved using an angle of elevation of 45 degrees.
Give **one** reason for disagreeing with the technician.

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(1 mark)

Turn over ▶



6 An architect has been asked to draw up plans to convert a garage into an extra room for a house.
She has to design the room using a material with a U -value of $2 \text{ W m}^{-2} \text{ K}^{-1}$ or less for the walls, and a material with a U -value of $1.5 \text{ W m}^{-2} \text{ K}^{-1}$ or less for the ceiling.

6 (a) Why should the U -value of the ceiling material be less than the U -value of the wall material?

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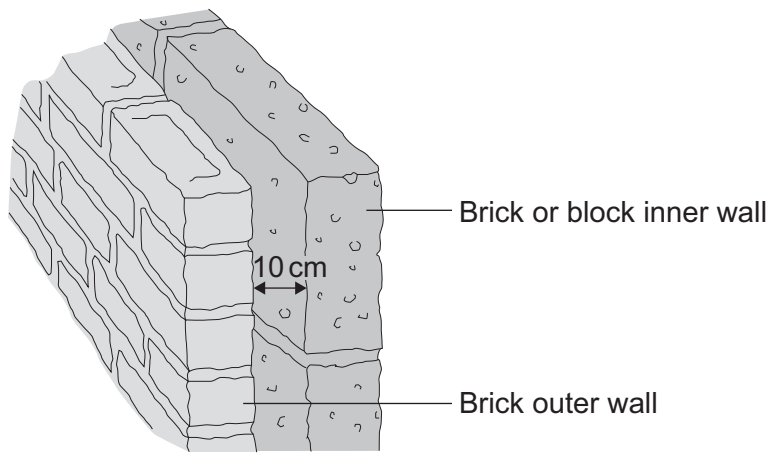
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(3 marks)

6 (b) (i) The garage currently has brick walls, 30 cm thick, including a 10 cm air gap.



Suggest **one** change that the architect can make to the design of the walls, to reduce the overall U -value.

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(1 mark)



6 (b) (ii) Explain how this change reduces heat loss.

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(3 marks)

6 (c) In a similar room, the wall has an overall U -value of $1.5 \text{ W m}^{-2} \text{ K}^{-1}$.
The wall area is 40 m^2 .
The room temperature is 20°C and the outside temperature is 5°C .

At what rate is heat leaving the room through the walls?

Use the equation

$$\text{rate of heat loss} = \text{temperature difference} \times U\text{-value} \times \text{wall area}$$

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(2 marks)

9

END OF QUESTIONS



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