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| Surname | | Other Names | |
| Centre Number | | Candidate Number | |
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| For Examiner's Use |
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General Certificate of Education
January 2007
Advanced Subsidiary Examination



APPLIED SCIENCE
Unit 2 Energy Transfer Systems

SC02

Tuesday 16 January 2007 1.30 pm to 3.00 pm

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|---|
| <p>For this paper you must have:</p> <ul style="list-style-type: none"> • a pencil and ruler • 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.
- 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 (a) A ski-lift operator working in a very cold part of the world needs to wear special clothing which retains body heat. A fall in body temperature, below a certain point, is life threatening.

(i) What is this temperature?°C
(1 mark)

(ii) Name the physiological condition when the body temperature is too low.
.....
(1 mark)

(iii) State **two** symptoms shown by a person suffering from this condition.
Symptom 1
.....
Symptom 2
.....
(2 marks)

(b) Homeostasis helps to maintain a constant body temperature when the surrounding temperature is very low. Describe how this happens.

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(4 marks)

- (c) (i) When people exercise they become hot and begin to sweat.
Explain how sweating helps the body to cool down.

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(3 marks)

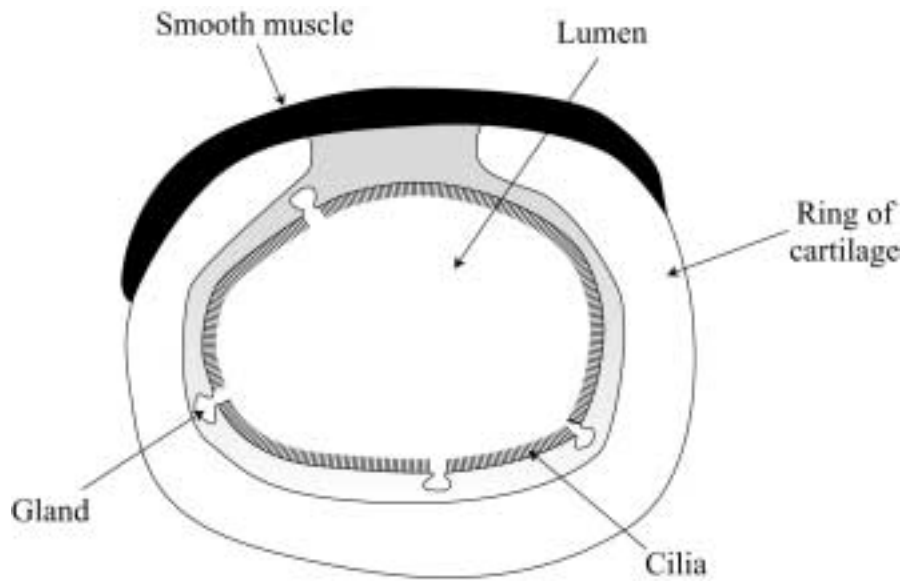
- (ii) State **three** ways, other than sweating, by which heat is lost from the body.

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

Turn over for the next question

- 2 Air travels to and from the lungs through the trachea (windpipe).
The diagram shows a cross-section through the trachea.



(a) For each of the structures listed below, state its function and why it is important.

- (i) Ring of cartilage

Function.....
.....
Importance

(2 marks)

- (ii) Gland

Function

Importance

(2 marks)

- (iii) Cilia

Function

Importance

(2 marks)

- (b) (i) What does the term *aerobic* mean?

.....
(1 mark)

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

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.....
.....
(3 marks)

Turn over for the next question

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| 10 |

Turn over ▶

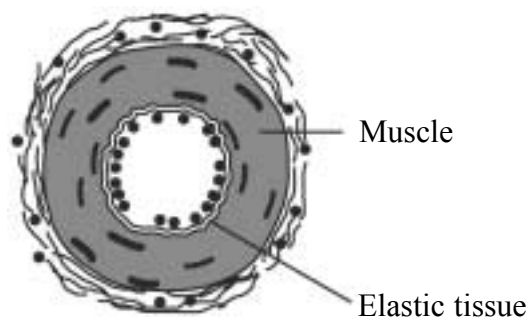
- 3 A company decided to send seven employees, **A–G**, for a health assessment for insurance purposes. During the assessment they had their blood pressure measured. Some of the results are shown in the table below.

| Employee | Systolic pressure (mm Hg) | Diastolic pressure (mm Hg) |
|----------|---------------------------|----------------------------|
| A | 126 | 78 |
| B | | |
| C | 133 | 80 |
| D | 160 | 95 |
| E | 89 | 58 |
| F | 113 | 72 |
| G | 135 | 85 |

- (a) (i) Employee **B** is a healthy 20-year-old female. Put the results you might expect for her blood pressure in the spaces in the table. *(1 mark)*
- (ii) Suggest which employee, **A–G**, is most likely to be asked back for further tests.
Employee
- (1 mark)*
- (iii) Explain your choice.

.....
.....
(1 mark)

- (b) The diagram shows a cross-section through the aorta.



How does the structure of the aorta help to maintain blood flow?

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(2 marks)

(c) What aids the return of blood back to the heart through the veins?

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(3 marks)

(d) Blood pressure changes depending on the needs of the body.
Explain how arterioles are able to alter blood pressure.

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(4 marks)

(e) The fitness professional at a company gym decides to assess the cardiovascular fitness of the employees.
Design an experiment to assess cardiovascular fitness, using pulse rate as an indicator.

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(4 marks)

Turn over ▶

4 An engineer is installing a new lift in a tall building. The lift rises 50 m between the basement and the top floor. The total mass of the lift, when fully loaded with passengers, is 400 kg.

- (a) Calculate the gravitational potential energy gained by the fully loaded lift (including passengers) as it rises from the basement to the top floor.
Assume $g = 10 \text{ m s}^{-2}$

.....

.....

.....

Gravitational potential energy = J
(2 marks)

- (b) How much work is done on the lift, including the passengers, as it rises from the basement to the top floor?

..... J
(1 mark)

- (c) The lift takes 40 seconds to rise from the basement to the top floor.
Using your answer from part (a) calculate the minimum power of the electric motor needed to operate the lift.
State the correct unit in your answer.

.....

.....

..... (3 marks)

- (d) The engineer installed a motor with more power than the minimum you have calculated in part (c). Explain why.

.....

.....

..... (2 marks)

- (e) The engineer conducts a safety test on the new lift.
In this safety test, the lift is filled with bags of sand until its mass reaches 400 kg, and the lifting cable is detached from the lift.
The lift falls a short distance until it is stopped by the safety brake.
The safety brake changes the kinetic energy of the lift into other forms of energy.
What are the **two** main forms of energy produced?

1

2

(2 marks)

- (f) Two models of safety brake are available.
Model **A** stops the lift in 0.1 seconds, and model **B** stops the lift in 0.5 seconds.
Both are activated as soon as the lift's speed of fall reaches 3 m s^{-1} .
Model **B** was chosen as the more suitable safety brake to use.
Using ideas about momentum, explain why.

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(4 marks)

Turn over for the next question

- 5 Two families, the Greens and the Browns, live next door to each other. Both families enjoy eating outdoors, but as autumn starts they find the weather too cold for comfort.

The Brown family use a patio heater (a powerful gas burner) to keep them warm as they sit outside for their evening meal. The heater produces 10 kW of power, and runs off a cylinder of compressed (liquefied) gas. They use it for two hours each day.



- (a) (i) Calculate the number of kilowatt hours (units) of energy produced by the heater when used over a 30 day period.

.....

(1 mark)

- (ii) Mains electricity costs 12 p per unit. How much would it cost to supply the same amount of energy from a mains electricity supply?

.....

(1 mark)

- (iii) The patio heater heats a large metal cylinder above the Brown family's table until the cylinder is red-hot. Name and describe the thermal transfer mechanism by which most of the thermal energy is transferred from the red-hot cylinder to the Brown family as they sit round the table.

.....

(2 marks)

(iv) How does the widescale use of patio heaters like this affect the environment?

.....
.....

(2 marks)

(v) The Green family wear an extra layer of clothing to keep them warm when they eat outside. Use ideas about conduction and convection in your answer to explain how this helps to keep them warm.

Conduction

Convection

(4 marks)

(b) Both families have infrared (heat) sensors which turn on the lights outside the house when anyone walks up the path.

(i) Explain why a human body can be detected by an infrared sensor.

.....
.....

(1 mark)

(ii) One of the children wishes to surprise the family by walking up the path without activating the infrared sensors. He has a choice of clothing, including black, white and camouflage coloured overalls. He also has access to large amounts of cling-film, bubble-wrap and thin aluminium cooking foil.

Which covering would give him the best chance of passing the sensors without being noticed?

Explain your choice.

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.....

(2 marks)

6 Telephones on remote islands send signals to the mainland using radiowaves, rather than by cable. Engineers need to design a power supply for the radiowave system. This system is run from a battery. The battery is charged by a small wind-operated generator.

- (a) (i) The system needs a power of 0.6 watts. The battery has to supply energy for up to one week (604 800 seconds). Calculate the minimum amount of energy that the battery must be able to store.

.....

 (2 marks)

- (ii) The wind can supply a maximum of 45 W of power to the generator. The generator has an efficiency of 30%. What is the maximum possible rate that the generator can supply electrical energy to the battery?

.....
 (2 marks)

- (iii) Explain why the efficiency of the generator is always less than 100%.

.....

 (1 mark)

- (b) You have been asked to design an experiment to compare the electrical output of two wind turbines, one made by Whirligig and the other by Jolly Miller. You have been supplied with the companies' catalogues, listing all their different types of wind turbine; your first task is to choose one machine from each company to test.

| Company | Type | Cost (£) | Noise level (dBA) | Blade area (cm ²) | Maximum operational wind speed (m s ⁻¹) |
|--------------|------|----------|-------------------|-------------------------------|---|
| Whirligig | A | 580 | 35 | 900 | 20 |
| Whirligig | B | 600 | 42 | 2500 | 30 |
| Whirligig | C | 620 | 50 | 5000 | 40 |
| Jolly Miller | X | 550 | 40 | 600 | 35 |
| Jolly Miller | Y | 600 | 45 | 1600 | 40 |
| Jolly Miller | Z | 650 | 50 | 2500 | 45 |

- (i) Give **one** type of machine from each company that you would choose for your initial test.

Give a reason for your choice.

Whirligig machine

Jolly Miller machine

Reason

.....

(1 mark)

- (ii) Your employer supplies you with two machines that she has chosen for you to test.

Name **two** further things that you would ensure are the same for each wind turbine to make this a fair test.

1

.....

2

.....

(2 marks)

- (c) It has been suggested that the power for sending the telephone signals could be supplied by normal torch batteries, which would be replaced once a month.

If each battery is able to provide a steady power of 3 watts for one month (which you may assume is 720 hours), and if the cost of one unit of electrical power is 12p, calculate the cost of the electrical energy delivered by the battery.

.....

.....

.....

.....

(1 mark)

Question 6 continues on the next page

Turn over ▶

(d) Suggest a form of pollution that might be expected from each of the two energy sources.

(i) Pollution from wind turbines is

.....

(ii) Pollution from torch batteries is

.....

(2 marks)

(e) Suggest **one** advantage of using each system.

(i) An advantage of using a wind turbine is

.....

.....

.....

(ii) An advantage of using torch batteries is

.....

.....

.....

(2 marks)

END OF QUESTIONS

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There are no questions printed on this page