AQA

General Certificate of Education
Advanced Subsidiary Examination
January 2012

Applied Science   SC02

Unit 2   Energy Transfer Systems

Thursday 12 January 2012   1.30 pm to 3.00 pm

For this paper you must have:
- a pencil
- a ruler
- a calculator.

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.

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

1   Two men and two women are planning a short walking holiday.
They are all over 70 years old.
A doctor arranged for them to have some health assessment tests before they started training.

1 (a)   In the first test, the function of each person's heart was investigated using an electrocardiogram (ECG).
Part of a typical ECG trace is shown below.
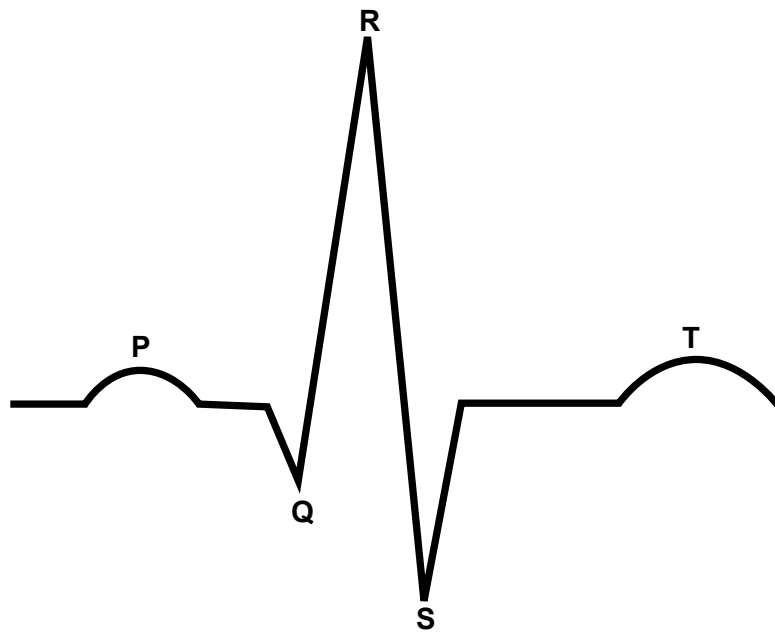
State what is happening to the heart at:

P ....

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QRS ....

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T ....

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(3 marks)

1 (b)   ECG traces were obtained for each person **A**, **B**, **C** and **D**, and are shown below.

For each person **A**, **B**, **C** and **D**, state what type of heartbeat each trace shows.

Choose from these four options:

<div align="center">

Normal heartbeat
Tachycardia
Ventricular fibrillation
Bradycardia

</div>

(4 marks)

Person A

time (seconds)

0   1   2   3   4   5

Type of heartbeat ....

Person B

time (seconds)

0   1   2   3   4   5

Type of heartbeat ....

Person C

time (seconds)

0   1   2   3   4   5

Type of heartbeat ....

Person D

time (seconds)

0   1   2   3   4   5
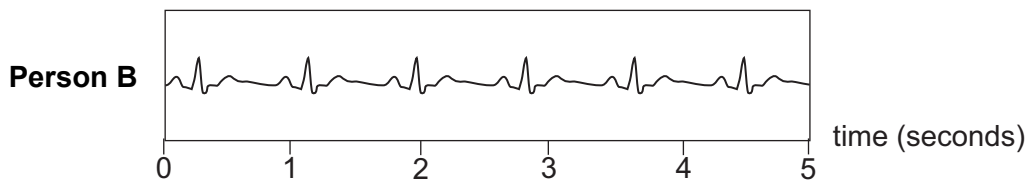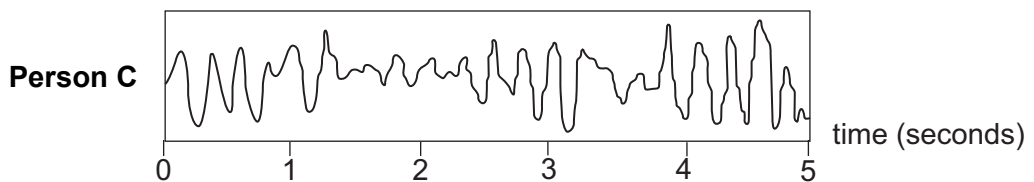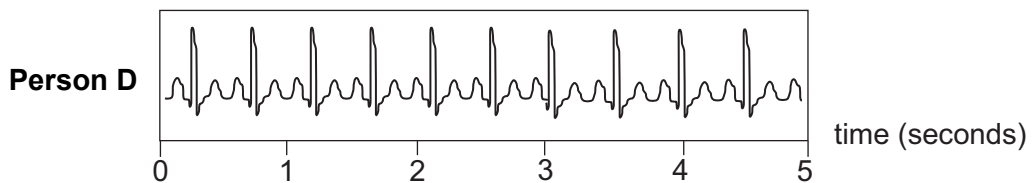
Type of heartbeat ....

<div align="center">

Question 1 continues on the next page

</div>

Turn over ▶

1 (c) The second test assessed cardiovascular fitness and involved measuring the pulse rate at the following times:

- before exercise (resting pulse rate)
- immediately after exercise
- three minutes after exercise has finished.

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

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(1 mark)

1 (c) (ii) Explain how the results of this type of test can be used to assess the level of cardiovascular fitness.

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(2 marks)

1 (d) The results obtained for the cardiovascular fitness test for the four people are shown in **Table 1**.

Table 1

Person	Pulse rate before exercise (beats per minute)	Pulse rate after exercise (beats per minute)	Pulse rate 3 min after exercise has finished (beats per minute)
A	81	100	85
B	74	90	74
C	85	110	95
D	102	150	130

Two more tests were carried out to determine the peak expiratory flow rate and blood pressure for each person in the group. The results are shown in **Table 2**.

Table 2

Person	Peak expiratory flow rate (dm^3 min^{-1})	Blood pressure (mm Hg)
A	500	137/90
B	550	115/75
C	350	180/100
D	400	128/98

Using the information in **Table 1** and **Table 2**, and the earlier test results in part **(b)**, which person do you think is the fittest? Explain your answer.

Fittest person ………………

Explanation ....

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(4 marks)

Question 1 continues on the next page

Turn over ▶

1 (e) One of the people needed further tests. The tests showed that the person needed surgery to replace a faulty aortic valve.

Explain how a faulty aortic valve could affect blood flow in the body.

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(3 marks)

1 (f) Name an instrument that could be used to diagnose a faulty aortic valve.

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(1 mark)

1 (g) It was decided to replace the faulty aortic valve with either an artificial valve or a valve taken from a pig.

State **two** ethical issues that may be considered when deciding which is the most appropriate type of valve to be used in the person's heart.

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(2 marks)

20

2 (a) A nurse carries out a lung function test to find out if a person's respiratory system is working correctly.
The diagram shows the human respiratory system.

A

Rib

Intercostal muscle

B

Diaphragm
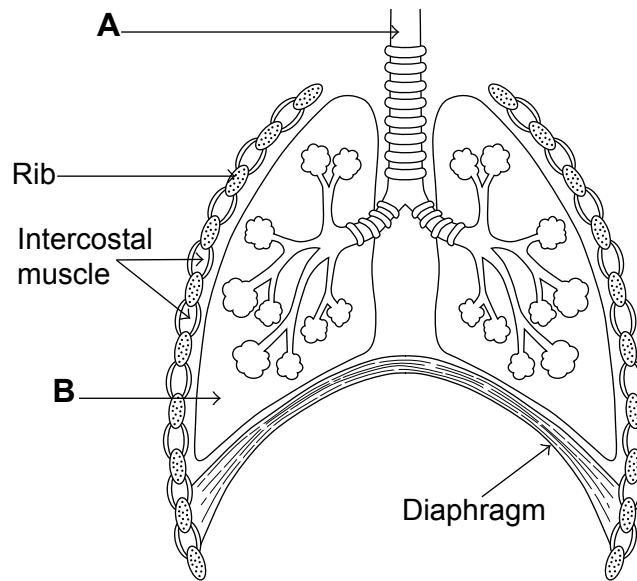
2 (a) (i) Complete the table to name the parts that the letters **A** and **B** represent.

	Name of part
A	
B	

(2 marks)

2 (a) (ii) Explain how air is expelled from the lungs during breathing.

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(4 marks)

Question 2 continues on the next page

Turn over ▶

2 (b)   Some students are demonstrating an experiment during a school open day.
The experiment shows how increasing the concentration of carbon dioxide in inspired (breathed in) air affects breathing rate.
The results of their experiment are shown in the table.

Percentage concentration of carbon dioxide in inspired air	0.04	0.79	1.52	2.28	3.11	5.48	6.02
Breathing rate (breaths per minute)	14	14	15	15	15	16	27

2 (b) (i)   What do the results in the table show?

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(2 marks)

2 (b) (ii)   Explain how an increase in the concentration of carbon dioxide in the blood causes a change in the rate of breathing.

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(3 marks)

11

3 (a) Geologists working for an oil company work in different parts of the world.
They often experience extreme temperatures.
The body temperature of humans is maintained within a certain range.

What is the name of the process that helps to keep body temperature at a more or less constant value?

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(1 mark)

3 (b) One of the geologists had to work in a very hot climate for a short time.
For health reasons, a nurse monitored his body temperature, measured by mouth, every hour.
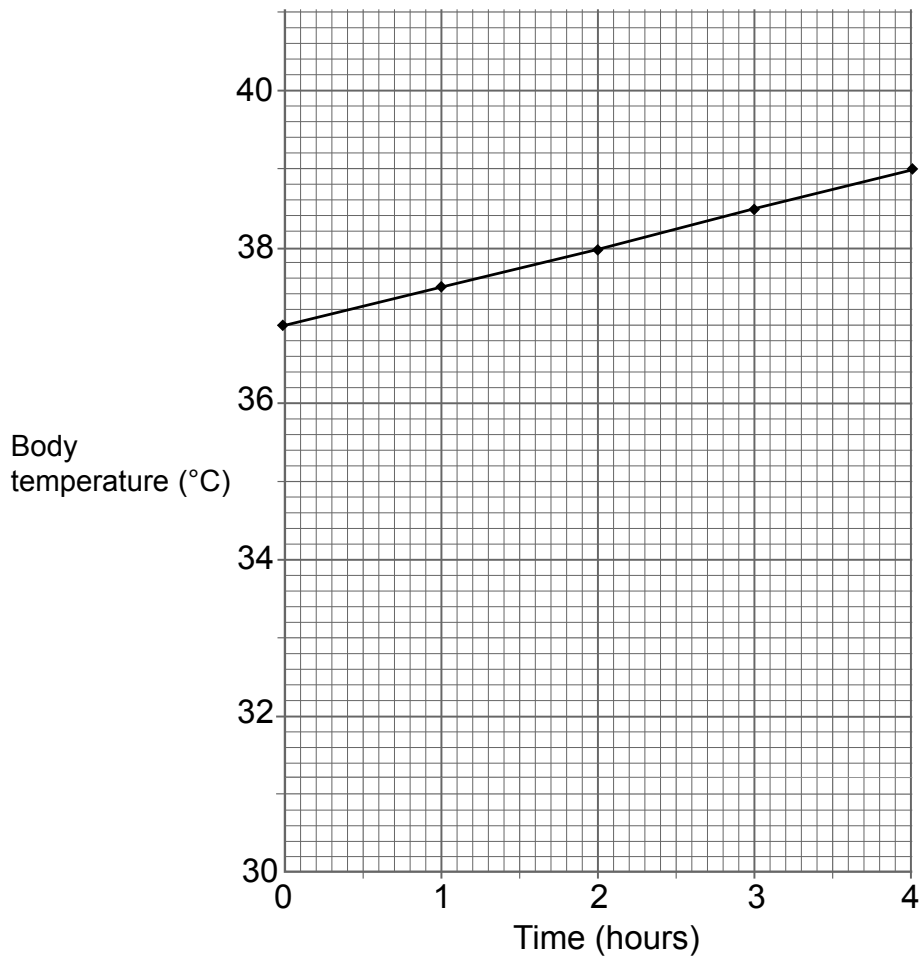
3 (b) (i) Use the information in the graph to suggest what is likely to happen to the man's condition after 2 hours.

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(1 mark)

Question 3 continues on the next page

Turn over ▶

3 (b) (ii) How could the nurse ensure that the temperature readings taken were reliable?

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(1 mark)

3 (b) (iii) The nurse wanted to measure the man's temperature. She only had available a digital thermometer and a liquid-in-glass thermometer.
Suggest which is more accurate and explain why.

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(2 marks)
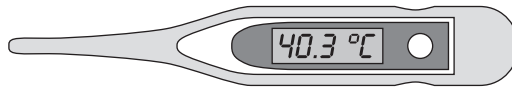
Digital thermometer
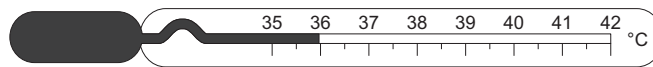
Liquid-in-glass thermometer

3 (c) About 75% of the energy produced by the human body is lost as heat.
Name **two** processes by which heat can be lost from the body.

Process 1 ....

Process 2 ....

(2 marks)

3 (d) The rate at which heat (energy) is lost from the body depends on several factors.

State **two** of these factors.

Factor 1 ....

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Factor 2 ....

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(2 marks)

9

Turn over for the next question

Turn over ▶

4 An engineer is improving the hot water system of an old house.
The gas boiler is situated on the ground floor, but the hot water tank is on the top floor.

Hot water to hot taps

Hot water tank

Hot water pipe

Gas boiler

Cold water supply to house

Cold water return pipe
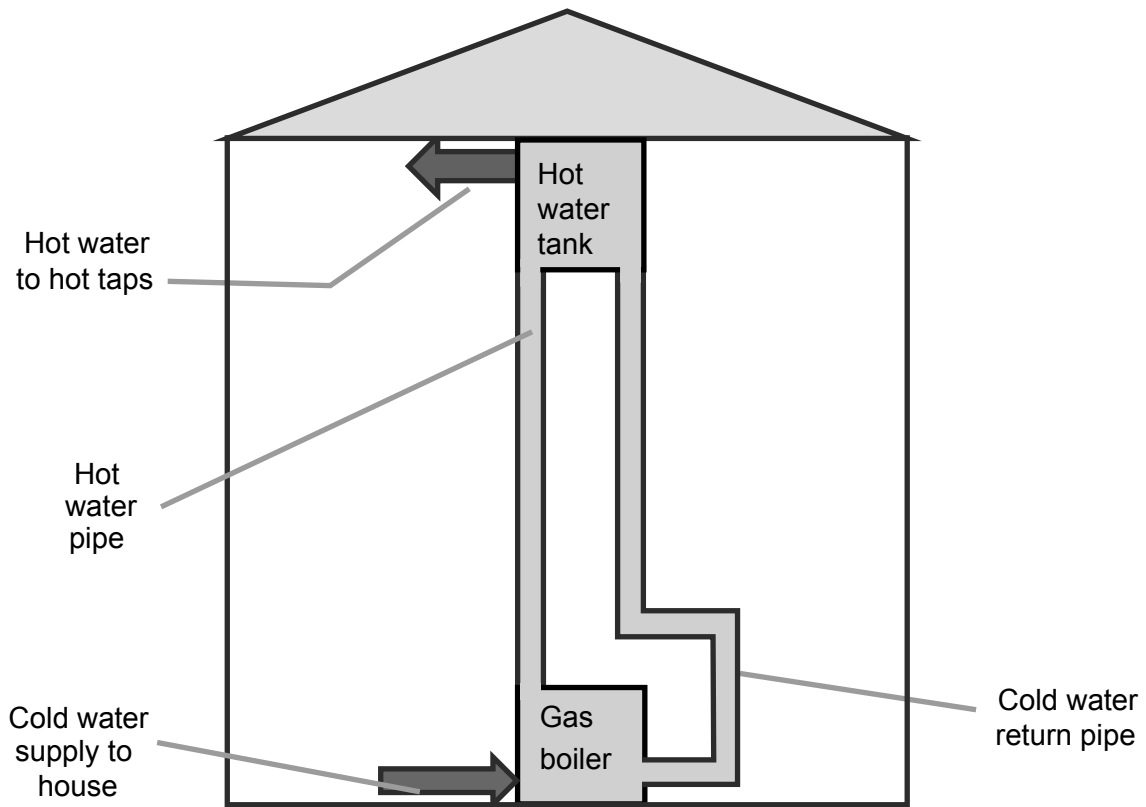
4 (a) Explain in detail how the hot water reaches the storage tank on the top floor.

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(3 marks)

4 (b) In one part of the house there are old copper water pipes. These pipes have become tarnished to a dark brown colour.

4 (b) (i) Explain how hot water passing through these old water pipes loses heat.

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(3 marks)

4 (b) (ii) The engineer has calculated that the hot water in the pipes is losing heat at a rate of 0.48 kW.
The surface area of the pipes is 1.2 m^2 and the water temperature averages 60 °C.
The temperature of the air next to the pipes averages 10 °C.

Calculate the *U*-value of the copper pipes.

Use the equation:
    rate of heat loss = *U*-value x surface area x temperature difference

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.... W m^{-2} C^{-1}

(3 marks)

4 (c) The owner of the house suggests heating the water to a higher temperature to allow for this heat loss.

Suggest **one** disadvantage, other than cost, of doing this.

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(1 mark)

Question 4 continues on the next page

Turn over ▶

4 (d) Suggest **two** changes that could be made to the system that would reduce the amount of energy lost from the pipes.
Explain how your suggested changes would help.

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(4 marks)

4 (e) The engineer thinks too much heat may be being lost from the hot water tank. To check this, he wants to create an experiment in the laboratory to compare three different designs of hot water tank insulation – sprayed-on foam, a fibreglass jacket and no insulation.
He intends to heat the water and then measure the change in temperature of the water overnight (while the heating is turned off).

Describe how he would carry out this experiment.

In your description you should state the following:

- The readings he should take
- The precautions he should take to ensure that his results were valid.

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(5 marks)

4 (f)   When on holiday, the family live in a country cottage that has no gas supply. They have to heat their cottage with energy from the electrical mains supply.
The cost of operating an electrical heater is 15 p per unit.

Calculate the cost of supplying 0.48 kW of electrical power for 24 hours.

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(2 marks)

21

Turn over for the next question

Do not write
outside the
box

5 An Army technician is installing a bank of sand to put behind the targets on a rifle range, to stop the bullets.

Target

sand bank

Direction of bullets
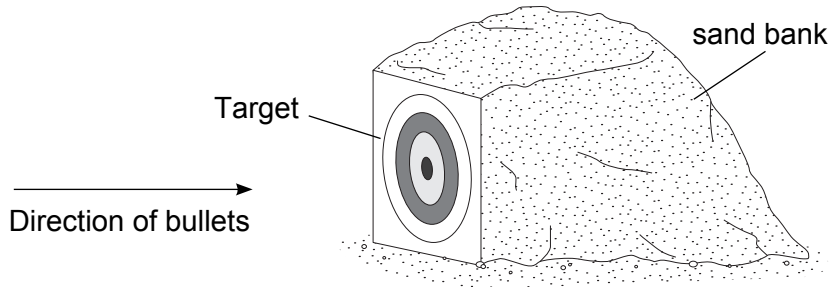
5 (a) Why does the technician intend to use sand to stop the bullets, rather than a strong steel plate?
Use ideas about momentum in your answer.

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(3 marks)

5 (b) Each bullet used has a mass of 60 g.
Calculate the kinetic energy of a bullet when it is moving at a speed of $500 \, \text{m s}^{-1}$.

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.... J
(3 marks)

5 (c) A different bullet, also of mass 60 g, is fired directly upwards with a kinetic energy of 4800 J.
Assume $g = 10 \, \text{m s}^{-2}$.

5 (c) (i) What is the maximum height this bullet could reach?

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(3 marks)

5 (c) (ii) Why does the bullet fail to reach this height?

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(3 marks)

Turn over for the next question

12

6   A holiday-maker thinks his motorhome is wasting energy when moving.
He has read on the internet that his diesel engine has an efficiency of 25%.

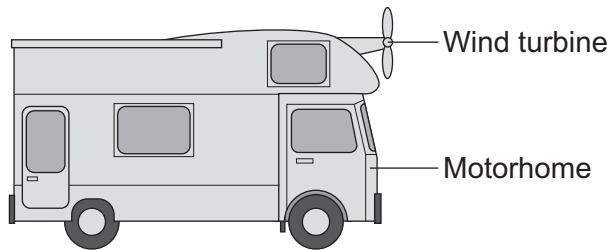**6 (a)**   What is meant by an *efficiency of 25%*?

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(2 marks)

6 (b)   The holiday-maker has seen small wind turbines fitted to yachts.
He buys one and fits it to his motorhome to generate electricity as he drives.

Suggest **two** disadvantages of this idea.

1 ....

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2 ....

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(2 marks)

6 (c)   Suggest a more efficient way for the holiday-maker to generate electricity for his motorhome.

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(1 mark)

6 (d)   How is the increased use of motor vehicles contributing to global warming?

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(2 marks)

7

END OF QUESTIONS

There are no questions printed on this page

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