Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Specific heat capacity

Time allowed: 1 hour 15 minutes

Subject code **0625**

Physics

Paper 4 (Extended)

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 75

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 9 questions worth 75 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 A student uses a 2400 W electric kettle to obtain a value for the specific heat capacity of sunflower oil.

Fig. 6.1 shows the apparatus.

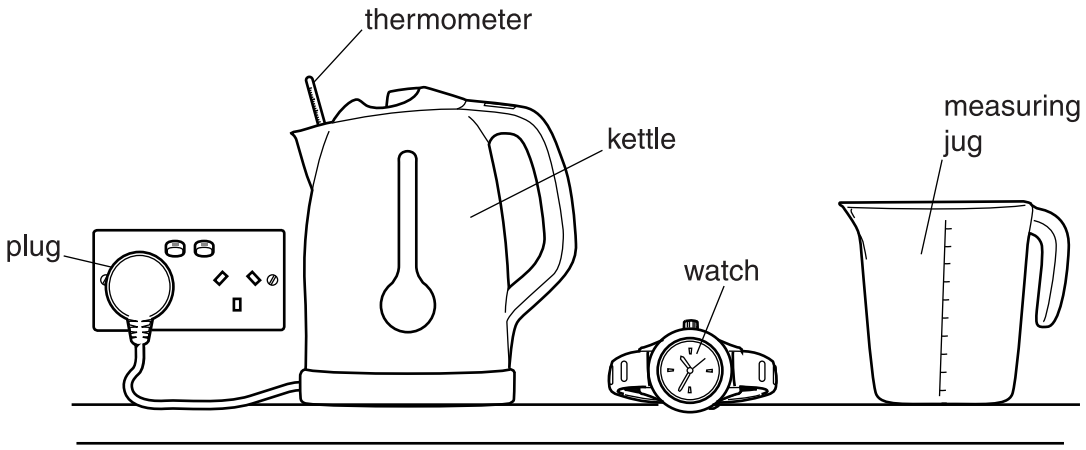


Fig. 6.1

The student uses a measuring jug and pours 1.5 kg of sunflower oil into the empty kettle. He uses a thermometer to measure the temperature of the oil.

The kettle is switched on and left on for 50 s. The temperature of the oil increases by 32 °C.

The student assumes that all the electrical energy is transferred as thermal energy to the oil.

(a) Calculate the value for the specific heat capacity of sunflower oil obtained by the student.

specific heat capacity = ... [4]

(b) State and explain whether the value for the specific heat capacity obtained by the student is too large or too small.

.....

..... [1]

[Total: 5]

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2 Fig. 4.1 shows some of the apparatus that a student uses to determine the specific heat capacity of aluminium.

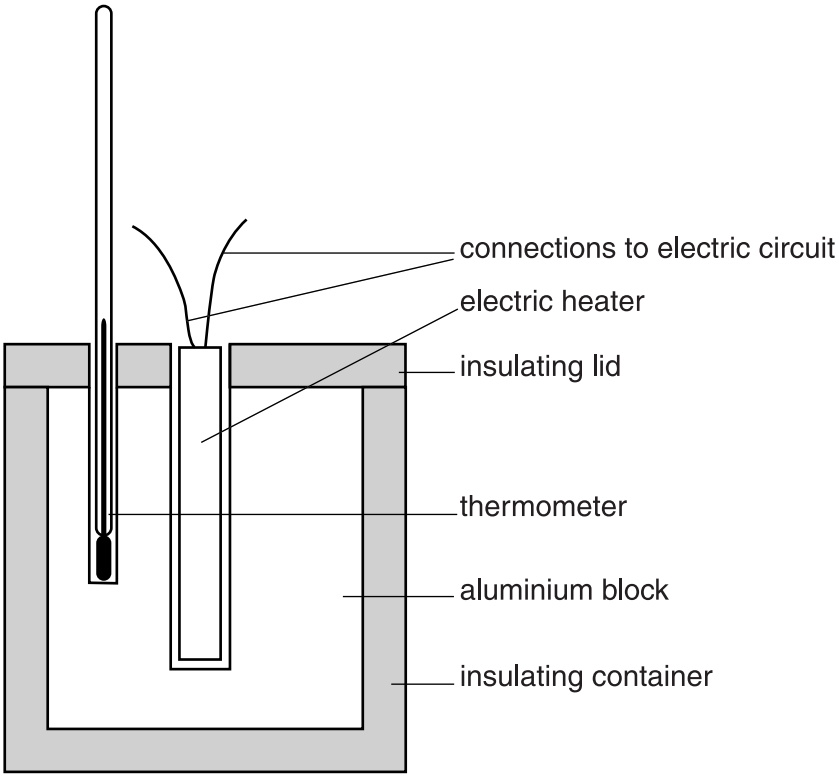


Fig. 4.1

(a) State the measurements the student needs to make, including those from the electric circuit. For each quantity measured, state a symbol.

.....

.....

.....

.....

.....

.....

.....[4]

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(b) Use your symbols from **(a)** to complete the formula used to determine the specific heat capacity *c*.

specific heat capacity c =

.....[2]

(c) Another student performs the experiment without using insulation. He obtains a higher value for *c*.

Explain why this student's measurements lead to this higher value.

.....

..... [1]

[Total: 7]

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3 **(a)** An object of mass m and specific heat capacity c is supplied with a quantity of thermal energy Q. The temperature of the object increases by $\Delta\theta$.

Write down an expression for c in terms of Q, m and $\Delta\theta$.

c = ...[1]

(b) Fig. 4.1 shows the heating system of a hot water shower.

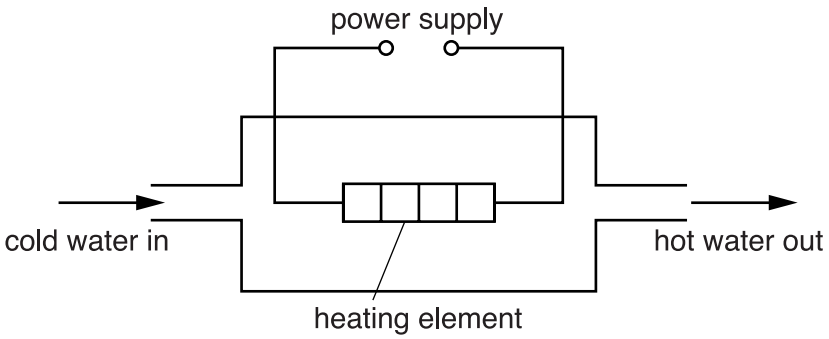


Fig. 4.1

Cold water at 15 °C flows in at the rate of 0.0036 m^3/minute. Hot water flows out at the same rate.

(i) Calculate the mass of water that passes the heating element in one minute. The density of water is 1000 kg/m^3.

mass = ...[2]

(ii) The power of the heating element is 8.5 kW.

Calculate the temperature of the hot water that flows out. The specific heat capacity of water is 4200 J/(kg °C).

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temperature = ...[4]

[Total: 7]

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4 **(a)** State what is meant by the *specific heat capacity* of a substance.

.....

.....

..... [2]

(b) A student carries out an experiment to find the specific heat capacity of aluminium. He uses an electric heater and a thermometer, inserted into separate holes in an aluminium block.

The following data are obtained.

mass of aluminium block = 2.0 kg
power of heating element = 420 W
time of heating = 95 s
initial temperature of block = 19.5 °C
final temperature of block = 40.5 °C

Calculate the value of the specific heat capacity of aluminium given by this experiment.

specific heat capacity = ... [4]

(c) In the experiment in **(b)**, no attempt is made to prevent loss of thermal energy from the surfaces of the block.

Suggest two actions the student could take to reduce the loss of thermal energy from the surfaces of the block.

1. .....

2. .....

[2]

[Total: 8]

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5 **(a)** Define specific heat capacity.

.....

.....

..... [2]

(b) A volume of 0.0024 m^3 of oil is heated in a pan for 7.0 min. The temperature of the oil increases from 20 °C to 180 °C.

The density of the oil is 910 kg/m^3. The specific heat capacity of the oil is 2000 J/(kg °C).

(i) Calculate the mass of oil in the pan.

mass = ... [2]

(ii) Calculate the energy required to increase the temperature of the oil.

energy = ... [2]

(iii) Calculate the power required to supply the energy calculated in **(b)(ii)**.

power = ... [2]

[Total: 8]

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6 **(a)** Define *specific heat capacity*.

.....

..... [2]

(b) Solar energy is striking the steel deck of a ship.

(i) Describe how the colour of the deck affects the absorption of the solar energy.

.....

..... [1]

(ii) The solar energy strikes the deck at the rate of 1400 W on every square metre.

The steel plate of the deck is 0.010 m thick.

Steel has a density of 7800 kg / m^3 and a specific heat capacity of 450 J / (kg °C).

13% of the solar energy striking the deck is absorbed and the rest is reflected.

Using these figures, calculate

1. how many joules of solar energy are absorbed by 1.0 m^2 of the deck in 1.0 s,

number of joules = ... [1]

2. the mass of 1.0 m^2 of deck,

mass = ... [2]

3. the rate of rise in temperature of the deck, stating the equation you use.

rate of rise = ... °C / s [3]

[Total: 9]

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7 Fig. 4.1 shows a stainless-steel saucepan being heated on an electric cooker. The saucepan contains water.

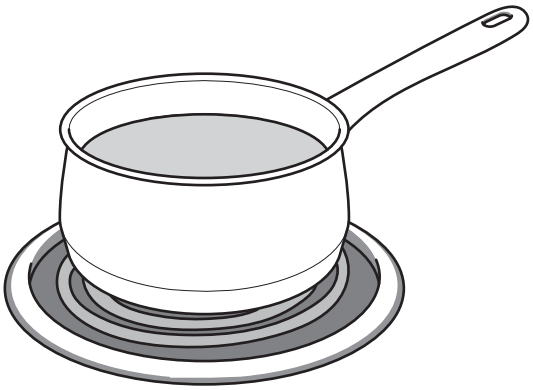


Fig. 4.1

(a) State what happens to the water particles as the water temperature increases.

..... [1]

(b) The saucepan contains 250 cm^3 of water. The specific heat capacity of water is 4200 J / (kg °C). The density of water is 1000 kg / m^3.

(i) Show that the mass of the water in the saucepan is 0.25 kg.

[2]

(ii) Calculate the energy required to increase the water temperature from 20 °C to 65 °C.

energy = ... [3]

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(iii) The heater supplies enough power to heat the water in 39 s.
A student measures the time taken to heat the water as 115 s.

Suggest why the actual time taken to heat the water is longer. Assume that the student takes accurate measurements.

.....

..... [1]

(c) The stainless-steel saucepan is replaced with an aluminium saucepan of the same mass. It contains the same volume of water.

The specific heat capacity of stainless steel is 500 J / (kg °C).
The specific heat capacity of aluminium is 890 J / (kg °C).

Explain how using an aluminium saucepan will affect the time taken to heat the water.

.....

.....

..... [2]

[Total: 9]

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8 A student in a laboratory uses the apparatus shown in Fig. 4.1 to determine the specific heat capacity of aluminium.

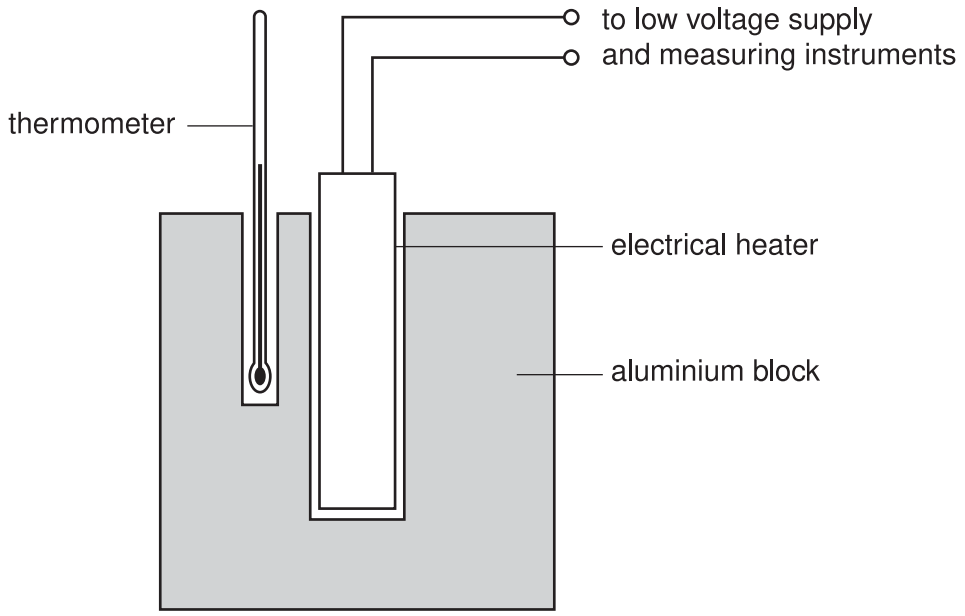


Fig. 4.1

The readings obtained in the experiment are given below.

mass of aluminium block = 0.930 kg
initial temperature of block = 13.1 °C
final temperature of block = 41.3 °C
electrical energy supplied = 23 800 J

(a) Define *specific heat capacity*.

.....

..... [2]

(b) Use the readings above to calculate the specific heat capacity of aluminium.

State the equation you use.

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specific heat capacity = ... [3]

(c) Because the student knows it is good scientific practice to repeat readings, after a short time he carries out the experiment again, supplying the same quantity of electrical energy.

This time the temperature readings are:

initial temperature of block = 41.0 °C

final temperature of block = 62.1 °C

(i) Use these figures to calculate a second value for the specific heat capacity of aluminium.

specific heat capacity = ... [1]

(ii) The student did not make any mistakes when taking the readings.

Suggest why the second value for the specific heat capacity of the aluminium is greater than the first.

.....

..... [2]

(d) Suggest two ways of improving the experiment in order to give as accurate a result as possible.

1. .....

.....

2. .....

..... [2]

[Total: 10]

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9 **(a)** **(i)** In the space below, draw a labelled diagram of the apparatus you would use to measure the specific heat capacity of a liquid. If you choose an electrical method, you must include the circuit.

[3]

(ii) List the quantities you would need to measure, or previously know, in order to calculate the specific heat capacity of the liquid.

.....

.....

.....

.....

.....[3]

(b) Some sea water has a specific heat capacity of 3900 J/(kg °C) and a boiling point of 100.6 °C.

(i) Calculate the energy required to raise the temperature of 0.800 kg of this sea water from 12.0 °C up to its boiling point. State the equation that you use.

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energy = ...[4]

(ii) The energy to raise the temperature in **(b)(i)** is supplied at the rate of 620 W.

Calculate the time taken to raise the sea water to its boiling point.

time = ...[2]

[Total: 12]

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