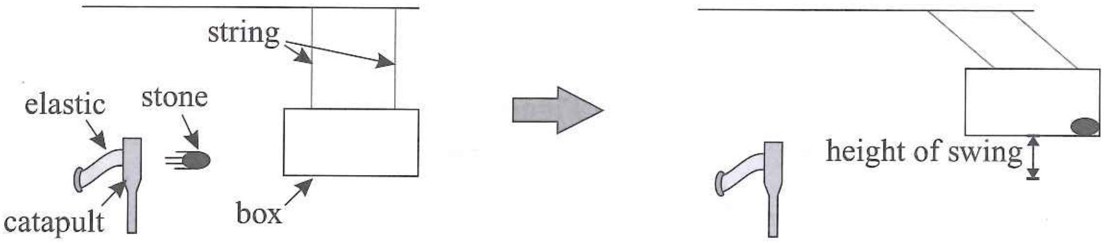
Energy Transfers

1 A catapult uses stretched elastic to fire objects at speed. A stone is fired horizontally into a box that is hanging from the ceiling. The stone is caught in the box and the box swings upwards, as shown in **Figure 1**.

Figure 1



After the stone lands in the box, the swing reaches a maximum height of 20 cm. The stone has a mass of 20 g and the box has a mass of 100 g. The gravitational field strength is 9.8 N/kg.

1.1 Calculate the speed of the stone just before it hit the box. You may assume that all the energy in the kinetic energy store of the stone was transferred to the gravitational potential energy stores of the stone and the box. Give your answer to two significant figures.

Speed = ... m/s
[6]

To fire the stone, the elastic was pulled so that its total length was twice its original length. The stone is fired again. This time the elastic is pulled so that it is four times its original length. It can be assumed that the elastic in the catapult is never stretched past its limit of proportionality.

1.2 What effect does this have on the energy transferred to the kinetic energy store of the stone? Tick **one** box.

The energy transferred is two times larger than the first time. ☐

The energy transferred is three times larger than the first time. ☐

The energy transferred is four times larger than the first time. ☐

The energy transferred is nine times larger than the first time. ☐

[1]

[Total 7 marks]

Score: ☐ /7

Exam Practice Tip

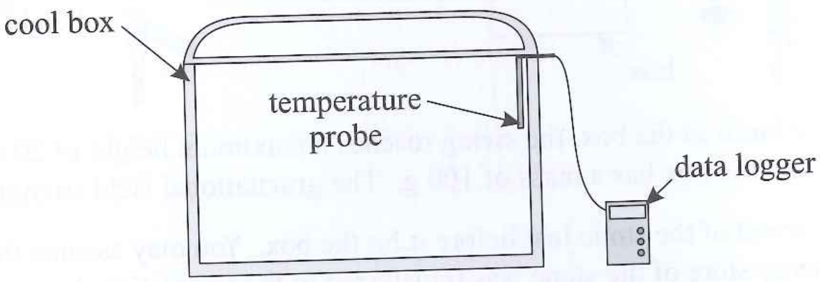
Some questions will involve a lot of variables and additional information that you need to pick and choose from in order to calculate the correct answer. As you work through the question, it may be helpful to add labels and notes to the diagrams you've been given so you can clearly see all the important information in one place and keep track of it easily.

Specific Heat Capacity, Power and Efficiency

1 A cool box is a highly insulated container used for keeping food and drinks at a low temperature.

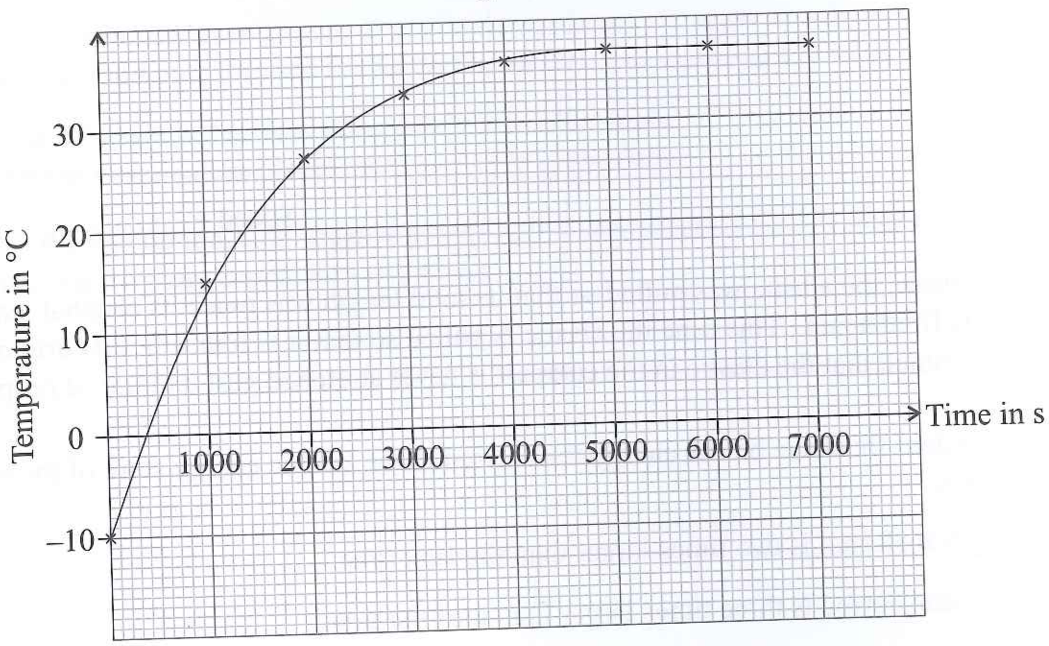
A student does an experiment to test the quality of insulation of a cool box, using the equipment shown in **Figure 1**. The student uses ice packs to bring the temperature inside the cool box down to –10 °C. He then leaves the cool box in a hot room.
The student measures the temperature inside the cool box every 1000 s, using a temperature probe and data logger.

Figure 1



The student plots the results of his experiment on the graph shown in **Figure 2**.

Figure 2



1.1 Using **Figure 2**, determine the instantaneous rate of temperature change inside the cool box 2000 s after the start of the experiment.

Rate of temperature change = ... °C/s
[3]

1.2 The walls of the cool box have a specific heat capacity of 1800 J/kg°C.
The cool box has a mass of 2.0 kg.
Calculate the instantaneous rate of energy transfer from the surroundings to the cool box 2000 s after the start of the experiment.

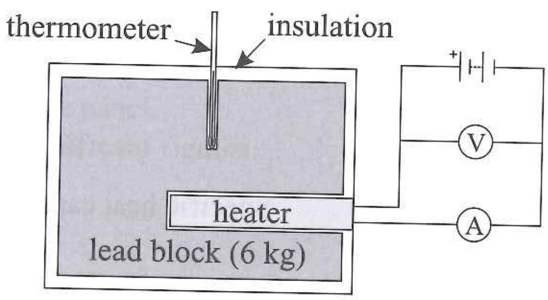
Rate of energy transfer = ... J/s
[2]

1.3 The freezer used to freeze the ice packs for the experiment has an efficiency of 95%.
The freezer has an input power of 250 W.
Calculate the useful energy transferred by the freezer in 20.0 minutes.

Energy transferred = ... J
[5]
[Total 10 marks]

2 A student is carrying out an experiment to determine the specific heat capacity of lead. She heats a 6 kg block of lead using the apparatus shown in **Figure 3**.

Figure 3

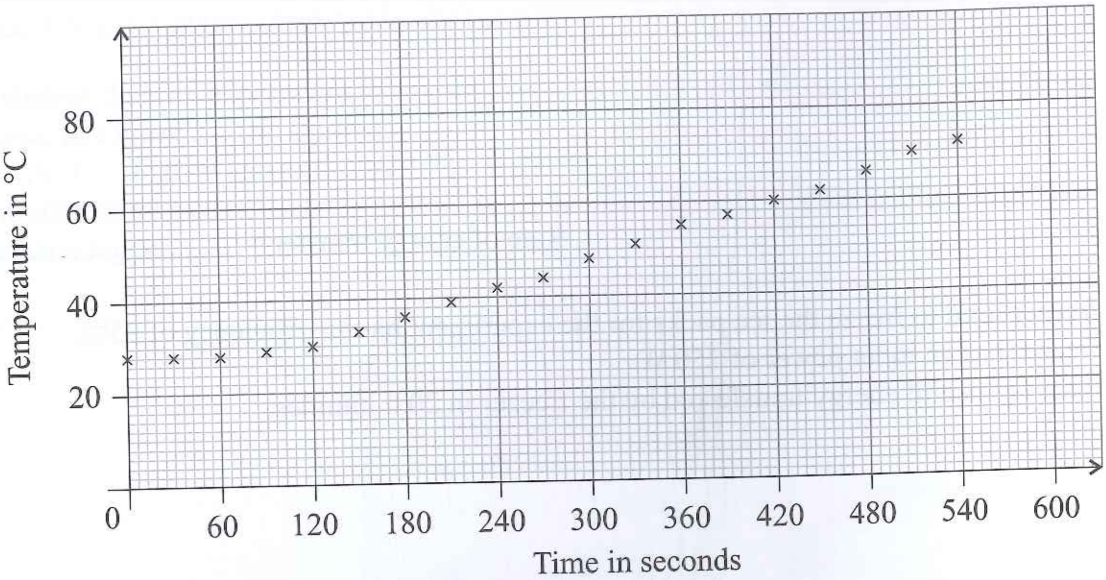


2.1 The circuit supplies 0.1 kW of useful power to the lead.
The student calculates that, during 9 minutes of use, the circuit wastes 300 J of energy to the thermal energy stores of the surroundings.
Calculate the efficiency of the circuit. Give your answer to two significant figures.

Efficiency = ...
[6]

The student plots the results of her experiment on a graph to show how the temperature of the lead changes with time, as shown in **Figure 4**.

Figure 4



2.2 Using **Figure 4**, estimate what the temperature of the lead would be 10 minutes after the start of the experiment if she continued heating the lead block.

Temperature = ... °C
[2]

2.3 Calculate the specific heat capacity of lead, using **Figure 4**.
Give your answer to three significant figures.

Specific heat capacity = ... J/kg°C
[6]

2.4 Explain how the value obtained for the specific heat capacity would change if the insulation around the lead block had a higher thermal conductivity.

....

....

....

....

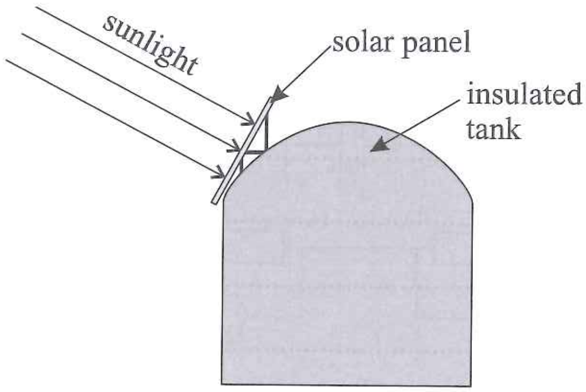
....

....
[3]

[Total 17 marks]

3 A solar panel is attached to an insulated tank that contains 3000 kg of liquid X, as shown in **Figure 5**. The solar panel absorbs energy from the Sun during the day and transfers some of that energy to liquid X.

Figure 5



The useful energy that is transferred to liquid X in one day is 47.5 MJ.
This causes the temperature of liquid X to increase by 4.0 °C.

3.1 Calculate the specific heat capacity of liquid X.
Give your answer to three significant figures.

Specific heat capacity = ... J/kg°C
[4]

The solar panel is in sunlight for approximately 12 hours per day.
The average solar power that would be incident on the solar panel is 5 kW.

3.2 Estimate the efficiency of the panel.
Give your answer to two significant figures.

Efficiency = ...
[5]

[Total 9 marks]

Score: ☐ **/36**

Exam Practice Tip

In some high demand questions, you'll need to do multiple calculations before you get your final answer. It can be easy to make a mistake if you try to juggle all that information in your head. Write down all your working — not only can it help you keep track of what information you have, it may also get you marks even if you get the final answer wrong.