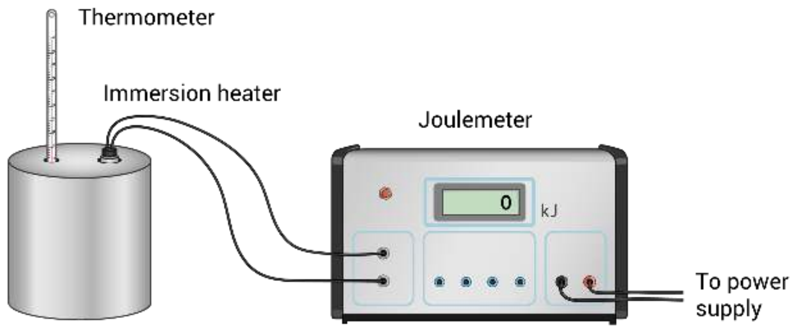
0 1

Jafar is using the below setup to heat a steel cylinder of mass 1.6 kg. The initial temperature of the steel used was 20 °C.



0 1 . 1

The reading on the joulemeter was observed to be 48 kJ after four minutes. Calculate the power which was delivered to the immersion heater.

P = E ÷ t = 48,000 ÷ (4 × 60) = **200 W**

0 1 . 2

Define what is meant by the specific heat capacity of a material.

The amount of energy required to increase the temperature of 1 kg [1] of a substance by 1 °C [1].

0 1 . 3

The specific heat capacity of the steel used was 500 J/kg °C. Estimate what the temperature of the steel would have been after it had been heated for four minutes.

TOP TIP: remember that Δθ means 'the change in temperature'.

E = m c Δθ
48,000 = 1.6 × 500 × Δθ
48,000 = 800 × Δθ
Δθ = 60 °C
Final temperature = initial temperature + Δθ
Final temperature = 20 + 60 = **80 °C**

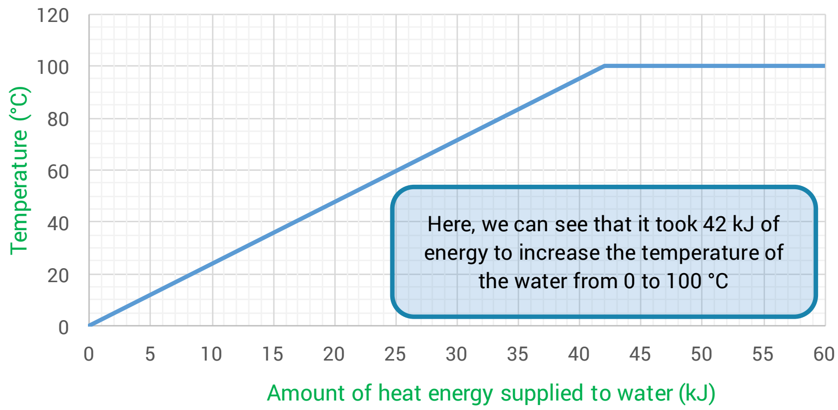
0 1 . 4

When Jafar actually performed the experiment he measured a temperature lower than that which is estimated from the calculation of the previous question. Explain why.

In the previous calculation, we assumed that all (48 kJ) of the energy supplied to the steel cylinder was transferred to its thermal energy store ('used to increase its temperature') [1]. In practice, some of the energy supplied would have been transferred to the surrounding air (and thermometer and immersion heater) as thermal (heat) energy [1].

0 2

A small amount of freezing water is placed into a saucepan before being heated on a gas stove. The below graph shows how the temperature of the water changes with time.



0 2 . 1

Show that 100 g of water is being heated in the saucepan. The specific heat capacity of water is 4200 J/kg °C. You may assume that the amount of energy lost by the water while it is being heated is negligible.

$E = m\,c\,\Delta\theta$
$42{,}000 = m \times 4200 \times 100$
$42{,}000 = 420{,}000\,m$
$m = 0.1$ kg = 100 g

0 2 . 2

Describe and explain the variation in the temperature of the water when the amount of heat energy supplied to it goes above 42 kJ.

When the amount of heat energy supplied goes above 42 kJ (in the right-hand section of the graph), the temperature of the water remains constant at 100 °C [1]. (Although heat energy is being supplied, the temperature of the water does not increase.)

The extra heat energy supplied breaks bonds between the water particles [1] to allow them to (escape the surface of the liquid and) evaporate [1]. OR this extra heat energy provides the specific latent heat of vaporization [2].

0 2 . 3

Determine the total amount of energy required to evaporate this entire mass of water from an initial temperature of 100 °C.

The specific latent heat of vaporisation of water is 2.5×10^6 J/kg.

$E = m\,L_v$
$E = 0.1 \times 2.5 \times 10^6 =$ **2.5×10^5 J**

Remember: if this question had been about the melting or freezing of a substance, it would have talked about the specific latent heat of *fusion* instead (L_f).