5. The heat capacity of 650 g lead is 84,5 $J \cdot K^{-1}$. Calculate the specific heat capacity of lead.

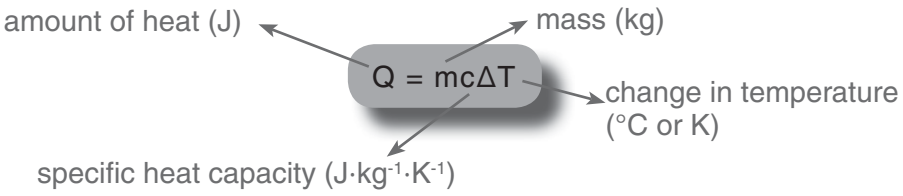
6. The heat capacity of a certain mass of ice is 15 500 $J \cdot K^{-1}$. Calculate the mass of ice in the sample if the specific heat capacity of ice is 2 053 $J \cdot kg^{-1} \cdot K^{-1}$.

1.4 Law of conservation of heat

This law is derived from the law of conservation of energy since heat is a form of energy.

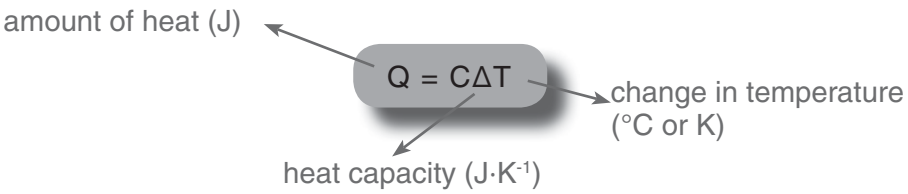
Law of conservation of heat: Law of conservation of heat states that the amount of heat lost equals the amount of heat gained, when no heat is lost to the surroundings.

The amount of heat lost or gained can be calculated using the following formula:



The SI unit for the amount of heat energy is the joule (J).

Substituting the formula C = mc into the formula Q = mcΔT, the amount of heat may also be calculated using:



Example

The mass of the copper point of a soldering iron is 130 g. How much heat is required to heat the point from 20°C to 330°C? The specific heat capacity of copper is 390 $J \cdot kg^{-1} \cdot K^{-1}$.

Solution:

$Q = mc\Delta T$
$Q = 0{,}13 \times 390 \times (330 - 20)$
$Q = 0{,}13 \times 390 \times 310$
$Q = 15\ 717$ J

60 g of warm water at a temperature of 35°C is poured into a metal container which has a temperature of 13°C. The final temperature at which the water and metal container stabilise is 33°C. The specific heat capacity of water is 4 200 $J \cdot kg^{-1} \cdot K^{-1}$.

1. Calculate the amount of heat lost by the water.
2. How much heat energy is gained by the metal container? Motivate your answer.
3. Calculate the heat capacity of the metal container.
4. The mass of the metal container is 125 g. Calculate the specific heat capacity of the metal from which the metal container is made.

Solution:

1. $Q = mc\Delta T$
$Q = 0{,}06 \times 4\ 200 \times (33 - 35)$
$Q = 0{,}06 \times 4\ 200 \times (-2)$
$Q = -504$ J
$\therefore$ 504 J of heat energy is lost by the water.

2. 504 J of heat energy is gained by the metal. According to the law of conservation of heat, the heat lost by the water is equal to the heat gained by the metal container.

3. Heat capacity is the amount of energy required to increase the temperature of the metal container 1°C or 1 K. However, the metal container's temperature increased by (33 - 13) = 20°C.

$Q = C\Delta T$
$\therefore C = Q/\Delta T$
$C = 504/20$
$C = 25{,}2\ J \cdot K^{-1}$

4. $C = mc$
$25{,}5 = 0{,}125c$
$c = 201{,}6\ J \cdot kg^{-1} \cdot K^{-1}$

Quick facts

$Q = mc\Delta T$ and $C = mc$
$\therefore Q = C\Delta T$