

Specific heat capacity

The thermal energy needed to produce a temperature rise depends on three factors:

- **The mass of the material** – it takes more energy to warm up a kettful of water than a capful of water.
- **The type of material** – for any given temperature rise, a kg of water requires nearly five times as much thermal energy as a kilogram of aluminium. Water has a greater capacity for absorbing and storing heat energy.
- **The rise in temperature** – for any given object, a 10K rise in temperature requires ten times as much thermal energy as a 1K rise in temperature.

$$Q = m c \Delta t$$

Q – heat – J

m – mass – kg

Δt - °C or K

Specific heat capacity

The specific heat capacity of a substance is numerically the same as the thermal energy required to produce a 1K rise in temperature in a mass of 1kg without change of state.

For example:

Specific heat capacity of water is 4200J/(kgK) – 4200J of heat are required to produce a 1K temperature rise of 1kg of water.

$$c = Q / (\Delta t \cdot m)$$

c - specific heat capacity of a substance - J/(kgK) or J/(kg°C)

Q – heat – J

Δt – change in temperature - K or °C

m – mass - kg

Heat capacity – C

Heat capacity - The heat capacity of a substance is numerically the same as the thermal energy required to produce a 1K rise in temperature in a given mass without change of state.

$$C = c \cdot m$$

C – heat capacity – J/K or J/°C

c - specific heat capacity of a substance - J/(kgK) or J/(kg°C)

m – mass of a body - kg

•A 10 kg block of aluminium cools from 100°C to 50°C. How much thermal energy does it give out? (specific heat capacity of aluminium is 900 J/(kgK))

•4kg of copper at 25°C are heated and increase in temperature to 80°C. How much heat energy is required to do this? (specific heat capacity of copper is 380 J/(kgK))

•A 210 W heater is placed in 2kg of water. What temperature rise is produced if the heater is switched on for 200s? (specific heat capacity of water is 4200 J/(kgK))

•An electric kettle has a power rating of 2kW. The kettle is filled with 1kg of water at temperature of 20°C. How long after the kettle is switched on will the water start to boil? (specific heat capacity of water is 4200 J/(kgK))

Calorimetric equation:

• is used for calculation of final temperature of bodies of different temperatures in contact

$$c_1 m_1 (t_1 - t) = c_2 m_2 (t - t_2)$$

c_1 – specific heat capacity of a hotter body - J/(kgK) or J/(kg°C)

c_2 - specific heat capacity of a colder - J/(kgK) or J/(kg°C)

m_1 – mass of a hotter body - kg

m_2 – mass of a colder body - kg

t_1 – temperature of hotter body - °C or K

t_2 - temperature of colder body - °C or K

t – final temperature - °C or K

•A lump of metal of mass 0.2 kg and temperature 100°C is placed in water of mass 0.4kg and temperature 16°C . If the final temperature of the metal and water is 20°C , what is the specific heat capacity of the metal?