

PQ 7 Heat

Q

Data for Q1 to Q3

Specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ K}^{-1}$.

Specific heat capacity of iron at $100 \text{ }^\circ\text{C}$ = $220 \text{ J kg}^{-1} \text{ K}^{-1}$.

Latent heat of vaporisation of water = 2260 kJ kg^{-1} .

Latent heat of fusion of water = 334 kJ kg^{-1} .

Density of ice at 0°C is 917 kg m^{-3} .

Q1

- Compare the energy needed to raise the temperature of 1kg of water from 20°C to 100°C and the energy needed to boil 1 kg of water at 100°C.

Q2

A 5kg block of iron is heated to 800°C . It is placed in a tub containing 2 litre of water at 15°C . Assuming all the water is brought to the boil rapidly; calculate the mass of water which boils off.

Q3

Sunlight of intensity 0.6 kW m^{-2} falls on a patch of ice. Assuming the ice absorbs 20% of the light; calculate what thickness of ice would melt in 1 minute. (Assume any water produced runs off).

Q4

How much energy is required to change 2.6kg of **ice at 0 °C** into **water** at the same temperature?

E_h = heat energy (J)

m = mass = 2.6kg

L_f = 3.34×10^5 J/kg

Q5

How much energy is required to change 2.6kg of **water** at **100 °C** into **steam** at the same temperature?

E_h = heat energy (J)

m = mass = 2.6kg

L_v = 2.26×10^6 J/kg

Q6

How much energy is required in total to change 1.9kg of ice at -10°C to steam at 100°C ?

Q7

- The specific latent heat of fusion (melting) of ice is 334 000 J/kg. How much energy is needed to melt 5kg of ice at 0°C to 5 kg of water at 0°C?

Q8

- Calculate the amount of heat required to completely convert 50 g of ice at 0 °C to steam at 100 °C. The specific heat capacity of water is 4.18 kJ/kg/°C. The specific latent heat of fusion of ice is 334 kJ/kg, and the specific heat of vaporization of water is 2260 kJ/kg.

Q9

In a cappuccino machine, steam is passed into milk to heat it to a final temperature of 85°C . Calculate the rise in temperature, $\Delta\theta$ of 0.2kg of milk when 1.0g of steam at a temperature of 100°C is passed into it. Assume that the thermal energy losses to the surroundings are negligible.

Specific heat capacity of milk = $4.0\text{ kJ kg}^{-1}\text{ K}^{-1}$

Specific heat capacity of water = $4.2\text{ kJ kg}^{-1}\text{ K}^{-1}$

Specific latent heat of vaporization of water = 2.2 MJ kg^{-1}

Q10

A holiday park has an open-air swimming pool of circular design shown in the figure below. The mass of water in the pool is about $8.5 \times 10^5 \text{ kg}$

The water in the pool is heated to 30°C . In July, the temperature of the water taken from the supply is 9°C . Calculate the energy needed to raise the temperature of all the water in the pool from 9°C to 30°C assuming there are no energy losses.

Specific heat capacity of water = $4200 \text{ J kg}^{-1}\text{K}^{-1}$

Q11

- In order to extract the maximum flavour in the shortest amount of time, your local fast food purveyor has decided to brew its coffee at $90\text{ }^{\circ}\text{C}$ and serve it quickly so that it has only cooled down to $85\text{ }^{\circ}\text{C}$. While this may be economically sensible, it is negligent and dangerous from a health and safety standpoint. Water (which is what coffee mostly is) at $85\text{ }^{\circ}\text{C}$ is hot enough to cause third-degree burns (the worst kind) in two to seven seconds. You decide to add ice cubes to your coffee to cool it down to a more reasonable $55\text{ }^{\circ}\text{C}$ so you will be able to drink it sooner. How many 23.5 g ice cubes at $-18.5\text{ }^{\circ}\text{C}$ should you add to your 355 ml cup of coffee to accomplish your thermal goal?

Q12

A small object of mass $m = 0.26 \text{ kg}$ and unknown specific heat c , initially at 100°C , is placed into a body of liquid with a heat capacity of 1300 J K^{-1} , initially at 20°C . The final equilibrium temperature is 25°C . What is the value of c ? Ignore any heat that may be absorbed by the vessel containing the liquid.