AQA Examination-style questions

specific heat capacity of water = $4200\,J\,kg^{-1}\,K^{-1}$
specific heat capacity of ice = $2100\,J\,kg^{-1}\,K^{-1}$
specific latent heat of fusion of ice = $3.3 \times 10^{5}\,J\,kg^{-1}$
specific latent heat of vaporisation of water = $2.3 \times 10^{6}\,J\,kg^{-1}$

1 A tray containing 0.20 kg of water at 20 °C is placed in a freezer.

(a) The temperature of the water drops to 0 °C in 10 min.
Calculate:
(i) the energy lost by the water as it cools to 0 °C,
(ii) the average rate at which the water is losing energy, in $J\,s^{-1}$. *(3 marks)*

(b) (i) Estimate the time taken for the water at 0 °C to turn completely into ice.
(ii) State any assumptions you make. *(3 marks)*

AQA, 2003

2 (a) Calculate the energy released when 1.5 kg of water at 18 °C cools to 0 °C and then freezes to form ice, also at 0 °C. *(4 marks)*

(b) Explain why it is more effective to cool cans of drinks by placing them in a bucket full of melting ice rather than in a bucket of water at an initial temperature of 0 °C. *(2 marks)*

AQA, 2006

3 An electrical heater is used to heat a 1.0 kg block of metal, which is well lagged. The table shows how the temperature of the block increased with time.

temp/°C	20.1	23.0	26.9	30.0	33.1	36.9
time/s	0	60	120	180	240	300

(a) Plot a graph of temperature against time. *(3 marks)*

(b) Determine the gradient of the graph. *(2 marks)*

(c) The heater provides thermal energy at the rate of 48 W. Use your value for the gradient of the graph to determine a value for the specific heat capacity of the metal in the block. *(2 marks)*

(d) The heater in part (c) is placed in some crushed ice that has been placed in a funnel as shown in **Figure 1**.

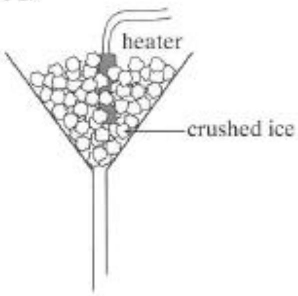

Figure 1

The heater is switched on for 200 s and 32 g of ice are found to have melted during this time.
Use this information to calculate a value for the specific latent heat of fusion for water, stating **one** assumption made. *(3 marks)*

AQA, 2002

4 In an experiment to measure the temperature of the flame of a Bunsen burner, a lump of copper of mass 0.12 kg is heated in the flame for several minutes. The copper is then transferred quickly to a beaker, of negligible heat capacity, containing 0.45 kg of water, and the temperature rise of the water measured.

specific heat capacity of copper = $390\,J\,kg^{-1}\,K^{-1}$

(a) If the temperature of the water rises from 15 °C to 35 °C, calculate the thermal energy gained by the water. *(2 marks)*

(b) (i) State the thermal energy lost by the copper, assuming no heat is lost during its transfer.

(ii) Calculate the fall in temperature of the copper.

(iii) Hence calculate the temperature reached by the copper while in the flame. *(4 marks)*

AQA, 2006

5 A bicycle and its rider have a total mass of 95 kg. The bicycle is travelling along a horizontal road at a constant speed of $8.0\,m\,s^{-1}$.

(a) Calculate the kinetic energy of the bicycle and rider. *(2 marks)*

(b) The brakes are applied until the bicycle and rider come to rest. During braking, 60% of the kinetic energy of the bicycle and rider is converted to thermal energy in the brake blocks. The brake blocks have a total mass of 0.12 kg and the material from which they are made has a specific heat capacity of $1200\,J\,kg^{-1}\,K^{-1}$.

(i) Calculate the maximum rise in temperature of the brake blocks.

(ii) State an assumption you have made in part (b)(i). *(4 marks)*

AQA, 2004

6 A female runner of mass 60 kg generates thermal energy at a rate of 800 W.

(a) Assuming that she loses no energy to the surroundings and that the average specific heat capacity of her body is $3900\,J\,kg^{-1}\,K^{-1}$, calculate:

(i) the thermal energy generated in one minute,

(ii) the temperature rise of her body in one minute. *(3 marks)*

(b) In practice it is desirable for a runner to maintain a constant temperature. This may be achieved partly by the evaporation of sweat. The runner in part (a) loses energy at a rate of 500 W by this process.

Calculate the mass of sweat evaporated in one minute. *(3 marks)*

(c) Explain why, when she stops running, her temperature is likely to fall. *(2 marks)*

AQA, 2005

7 In a geothermal power station, water is pumped through pipes into an underground region of hot rocks. The thermal energy of the rocks heats the water and turns it to steam at high pressure. The steam then drives a turbine at the surface to produce electricity.

(a) Water at 21 °C is pumped into the hot rocks and steam at 100 °C is produced at a rate of $190\,kg\,s^{-1}$.

(i) Show that the energy per second transferred from the hot rocks to the power station in this process is at least 500 MW.

(ii) The hot rocks are estimated to have a volume of $4.0 \times 10^6\,m^3$. Estimate the fall of temperature of these rocks in one day if thermal energy is removed from them at the rate calculated in part (i) without any thermal energy gain from deeper underground.

specific heat capacity of the rocks = $850\,J\,kg^{-1}\,K^{-1}$

density of the rocks = $3200\,kg\,m^{-3}$ *(7 marks)*

(b) Geothermal energy originates as energy released in the radioactive decay of the uranium isotope deep inside the Earth. Each nucleus that decays releases 4.2 MeV.

Calculate the mass of $^{238}_{92}U$ that would release energy at a rate of 500 MW.

half-life of $^{238}_{92}U = 4.5 \times 10^9$ years

molar mass of $^{238}_{92}U = 0.238\,kg\,mol^{-1}$ *(5 marks)*

AQA, 2006