PQ 2 Heat

Questions

Q and A

PQ1

- Specific heat capacity of a certain metal = 1200 J kg^{-1} K^{-1}.
- How much heat energy is needed to heat 4 kg of a metal by 8 ^{o}C?
- Energy = $mC\Delta\theta = 4 \times 1200 \times 8 = 38400$ J

PQ2

- If 48 000 J of heat energy are given off when a 2 kg block of metal cools by 12 ^{o}C, what is the specific heat capacity of the metal?
- Specific heat capacity = energy / ($m \Delta\theta$) = $48000 / (2 \times 12) = 200$ J kg^{-1} K^{-1}

PQ3

- A 50 W heater is used to heat, an aluminium block with a mass of 5 kg. After 10 minutes the temperature of the block has risen by 4 ^{o}C. Calculate:
- (a)the heat given out by the heater;
- Output energy = power x time = $50 \times 10 \times 60 = 30{,}000$ J
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- (b) the specific heat capacity of aluminium.
- Specific heat capacity = energy/ $(m \Delta\theta) = 30000 / (5 \times 4) = 1500$ J kg^{-1} K^{-1}
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- (c)Why is your answer different from the correct value given in the data above?
- Heat loss to the surroundings, so the energy retained by the metal is less than 30,000, so the value of C should be lower.

PQ4

- How much heat energy is given out when 3 kg of water at 40 °C cool to 25 °C?
- Heat energy given out = $mC\Delta\theta = 3 \times 4200 \times (40 - 25) = 189{,}000$ J= 189 kJ

PQ5

- How much heat energy is given out when 500 g of steam at 100 °C condenses and then cools to 50 °C?
- Energy in condensing =mL = $0.5 \times 2260000 = 1{,}130{,}000$ J
  - Energy during cooling = $mC\Delta\theta = 0.5 \times 4200 \times 50 = 105{,}000$ J
  - Total energy given out = 1,130,000 + 105 000 = 1,235,000 J =1,235 kJ

PQ6

- Why is a scald by steam at 100 ^{o}C much more painful than one by water at 100 ^{o}C?
- Because it has to condense first before cooling so giving out a large amount of latent heat.

PQ7

- How long will it take a 50 W heater to melt 2 kg of ice at 0 ^{o}C?
- Power x time = mL so time = mL/power = 2 $\times$ 335000 / 50 = 670000 / 50 = 13400 s = 223 min = 3.7 hours = 3 hrs 43 minutes
  - (Assumes no heat lost to the surroundings and the water remains at 0 ^{o}C.)

PQ8

- Calculate the amount of heat required to completely convert 50 g of ice at 0 ºC to steam at 100 ºC. The specific heat capacity of water is 4.18 kJ.kg-1.K-1. The specific latent heat of fusion of ice is 334 kJ.kg-1, and the specific heat of vaporization of water is 2260 kJ.kg-1.

PQ8 continued

- Heat is taken up in three stages: 1. The melting of the ice, 2. the heating of the water, and 3. the vapourization of the water. The heat taken up in the complete process is the sum of the heat taken up in each stage.
- 1. Heat taken up for converting ice at 0ºC to water at 0ºC
- mass of water x latent heat of fusion
  = 0.050 (kg) x 334 ($kJ.kg^{-1}$)
  = 16.7 kJ

PQ8 continued

- 2. Heat taken up heating the water from 0 ºC to the boiling point, 100 ºC
- mass of water x specific heat capacity x temperature change
  = 0.05 (kg) x 4.18 ($kJ.kg^{-1}. K^{-1}$)x 100 (º K)
  = 20.9 kJ
- 3. Heat taken up vaporizing the water
- mass of water x latent heat of vaporization
  0.05 (kg) x 2260 $kJ.kg^{-1}$
  = 113 kJ
- 16.7 + 20.9 + 113
  = 150.6 kJ (151 kJ)

PQ9

- *The heater in an electric kettle delivers 1.5 kW of power to 2 kg of water at its boiling point. The specific latent heat of vaporisation of water is 2.26 x 10^6 J/kg.*
- *(a) How much energy would be needed to boil off 1 kg of the water?*
- (a) 2.26 x 10^6 J

PQ9 continued

- *(b) The kettle is switched on for 100 s.*
- *(i) How much heat energy is delivered to the water in this time.*
- Heat supplied, E_h = power x time
- = $1.5 \times 10^3 \times 100$
- = 1.5×10^5 J

- *(ii) How much steam is produced in 100 s?*
- = $1.5 \times 10^5 / 2.26 \times 10^6$
- = 0.066
- mass of steam produced = 0.066 kg