PQ 10 Heat

Q and A

Q1

- How much heat energy is needed to raise the temperature of 3 kg of copper by 6 K?
- (Specific heat capacity of copper = 385 J/(kg K)

- Heat energy = mass x specific heat capacity x temperature change = 3 x 385x 6 = 6930J

Q2

- What is the rise in temperature of 5 kg of water if it is given 84 000 J of heat energy?
- Specific heat capacity of water = 4200 J/(kg K).

- Heat energy input = 84000 = 5x4200x temperature rise
- Temperature rise = 84000/[5x4200] = 4 K

Q3

- How much heat is lost by 3 kg of lead when it cools from 1000 oC to 200 oC?
- Specifc heat capacity of lead = 126 J/(kg K)

- Heat energy given out = 3x126x80 = 30240J

Q4

- A heater of 800W is use to heat a 600 g cast iron cooker plate.
- How long will it take to raise the temperature of the plate by 200 oC?
- Specific heat capacity of iron = 500 J/(kg K)

- Heat energy needed = 0.6x500x200 = 60 000J
- Time needed = 60 000/800 = 75 s = 1 minute 15 s

Q5

- Find the energy needed to change 4 kg of water at 100oC into steam at 100oC.
- Specific latent heat of vaporisation of water = 2 260 000 J/kg.

- Energy required = 4 x 2 260 000 = 9 040 000 J.

Q6

- Find the energy needed to change 500 g of ice at 0oC to water at 0oC. Specific latent heat of fusion of water = 334 000 J/kg.

- Energy required = 0.5 x 334 000 = 167 000 J.
- Much more heat is needed to turn 1 kg of water into steam than to melt 1 kg of ice.

Q7

- Calculate the mass of water that will be turned to steam if a kettle is left boiling (at 100oC) for 5 minutes. Will the kettle boil dry?
- 1 litre of water
- Power of kettle = 2 kW
- Time of boiling = 5 mins = 600s
- Heat energy produced in that time = 2000 x 600 = 1 200 000J
- Heat energy needed to turn 1 kg of water into steam = 2 260 000 J
- Mass of water turned to steam = 1 200 000/2 260 000 = 0.53 kg = 530 g.

- The kettle will usually have more water in it than this at the start and so it should not boil dry. We have assumed that there is no heat lost by the kettle.
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Q8

- A 2 kg lump of cast iron at 90oC in put into a plastic bucket containing 10 kg of water at 20oC. What is the final temperature of the water and iron (you can ignore the heat energy absorbed by the bucket and assume that no heat energy is lost to the surroundings.)

- Specific heat capacity of water = 4200 J/(kg K).
- Specific heat capacity of cast iron = 500 J/(kg K)

- Let the final temperature of the mixture be θ.
- Heat energy lost by the iron = 2x500x(90 - θ) = heat energy gained by the water = 10x4200x(θ-20)

- Therefore 1000(90 - θ) = 42000(θ -20) 90000 – 1000θ = 42000q – 840000
- 930000 = 41000<θ and so θ = 930000/41000 = 22.7oC

Q9

- A 2kg block of iron is given 10kJ of energy and its temperature rises by 10˚C. What is the specific heat capacity of iron?

- Energy = mass x specific heat capacity x change in temperature
- ……So, specific heat capacity = Energy / (mass x change in temperature)
- …… specific heat capacity = 10000 / (2 x 10)
- …… specific heat capacity = 500 J / kg˚C

Q10

- An electrical immersion heater supplies heat at a steady rate to 2.5 kg of water at 20°C in a container of thermal capacity 1500 J/K and it is noticed that in 8.0 minutes the temperature of the water rose to 100°C.

- After another hour, the water was just boiled away.

- (a) Calculate the rate at which energy is supplied by the heater.

- (Specific heat capacity of water = 4200 J/kg K)

Q10 continued

- Heat given to the water while bringing it to the boil:
- Q = mass x specific heat capacity x T
- = 2.5 x 4200 x (100-20)
- = 840,000 J

Q10 continued

- Heat given to the container as the water got hotter:
- Q = heat capacity x T
- = 1500 x 80
- = 120,000 J

Q10 continued

- Total heat energy supplied in 8.0 minutes:
- Q = 840,000 + 120,000 = 960,000J

- Rate of heat supplied per second = heat supplied/time taken
- power = P = 960,000/(8.0 x 60)
- = 2000 J/s
- = 2.0 kW

Q10 continued