Friday worksheet 5 –Specific heat capacity

1. Use reference to hydrogen bonding to explain the high ***specific heat capacity*** of water.

   Temperature is a measure of the average kinetic energy of the particles in a substance. When temperature increases, the motion of these particles also increases. Now before these particles can increase in motion they must break away from the forces of attraction that holds them together in the liquid or solid states. Water has a particularly strong form of intermolecular force of attraction known as hydrogen bonding so heat is used to overcome these bonds before it is converted into kinetic energy.

2. Now let's use the formula shown on the right. Using information contained in table 1 complete the following exercises.

$$E = c \times m \times \Delta T$$

E = energy (joules)

m = mass in grams

ΔT =change in temperature

c = the specific heat capacity of the substance

Substance	c in J/g/c
Aluminum	0.900
Bismuth	0.123
Copper	0.386
Water	4.186
Gold	0.126

Table 1

i. Calculate the amount, in kJ, of energy needed to raise the temperature of 500.0g of water at 25.0 °C to 50.0 °C.

$E = Cm\Delta T$

=> 4.186 X 500 X 25.0

=> 52.3 kJ

ii. What is the final temperature of a 50.0g sample of pure water at 25.0 °C if 0.500 kJ of energy is supplied to it.

$E = Cm\Delta T$

=> $\Delta T = E/Cm$

=> ΔT = 500 / (4.186 X 50) = 2.4

=> 27.5 °C = final temperature

iii. 322 joules of energy is supplied to a sample of water of unknown mass at 34.2 °C. Calculate the mass, in grams, of the water if the final temperature is 51.2 °C.

$E = Cm\Delta T$

=> $m = E/(C\Delta T)$

=> m = 322 / (4.186 X 17.0) = 4.52 g

iv. Consider a 500g sample of pure water at 78°C in a cup that cools to 25°C.

   a. Will the person, holding the cup of water, feel their hand cooling or warming up. Explain your answer

      Heat must be removed from the water therefore the person's hand will warm up.

   b. Calculate the amount of energy, in kilojoules, involved .

      $E = Cm\Delta T$

      => 4.18 X 500 X 53 = 110.8 kJ.

3. 300g of hot tea at 85°C is poured into a glass containing 200g of water at 25°C. What is the temperature of the mixture of the two liquids? Assume no energy is lost and that the hot tea can be considered as being pure water.

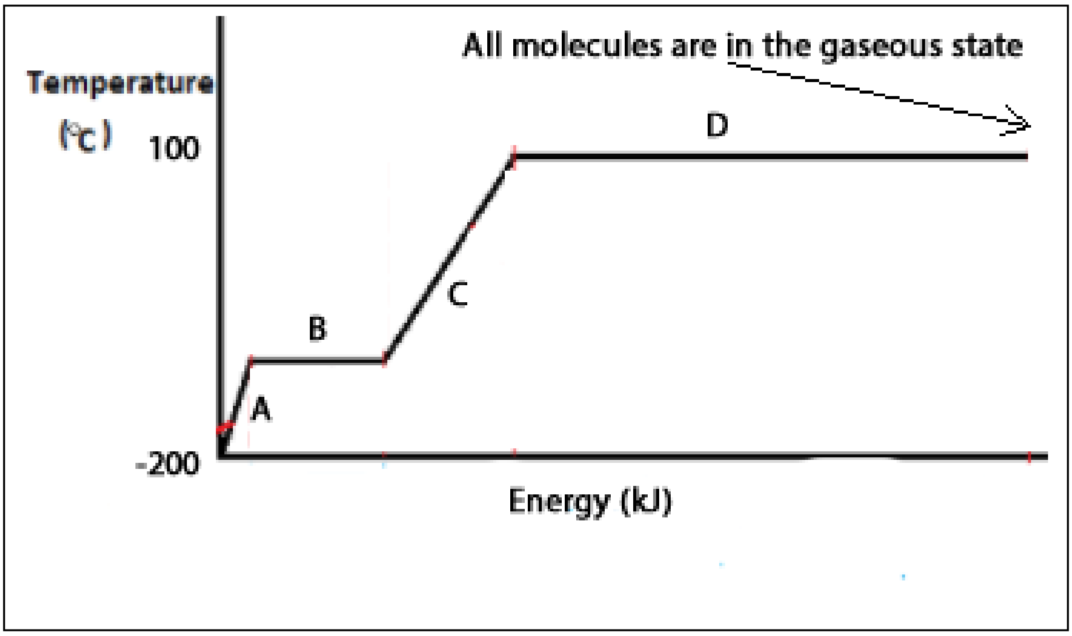
Since no energy is lost the energy lost from the hot drink will equal the energy gained by the cold water. The mixture of hot and cold water will reach a final temperature that we will call T_f.

=> Energy lost from hot drink = 4.18 X 300 X (85 − T_f)
=> Energy gained by cold water = 4.18 X 200 (T_f − 25)
=> 4.18 X 300 X (85 − T_f) = 4.18 X 200 (T_f − 25)

Solve for T_f

=> ~~4.18~~ X 300 X (85 − T_f) = ~~4.18~~ X 200 (T_f − 25)
=> 300 X (85 − T_f) = 200 (T_f − 25)
=>1.5 X (85 − T_f) = T_f -25
=> 127.5 -1.5T_f = T_f − 25
=> 152.5 = 2.5T_f
=> T_f = 61°C

4. Calculate the amount of energy, in kJ, that needs to be supplied to a 200.0g mass of ice at -200°C to vaporise all the water molecules at 100 °C. Latent heat of vaporisation of water is 2,260 kJ/kg while the latent heat of fusion of water is 334 kJ/kg. Specific heat of liquid water is 4.18 J/g/°C while the specific heat of ice is 2.108 J/°C.



5.

The route of ice at -200°C to steam at 100°C has four stages as pictured above.

A = energy required to get the mass of ice from -200 to 0 degrees
=> E_{joules} *= 2.108 X 200 X 200 = 84.32 kJ*
B = energy required to change state (latent heat of fusion)
=> E_{kJ} *= 334 kJ/kg X 0.200 Kg = 66.8*
C = Energy required to get the mass of water from 0 to 100
=> E_{joules} *= 4.18 X 200 X 100 = 83.66 kJ*
D = energy required to change state (latent heat of vaporisation)
=> E_{kJ} *= 2260 kJ/kg X 0.200 Kg = 452 kJ*
Total of 687 kJ of energy.