Name: ________________________________

Physics 117

Quiz 6 (4/9/2003)

Use as far as possible formula and try to explain your reasoning.

A) If the temperature of 1000 gr of ethanol drops by 25 °C, how much heat is released?

(Specific heat of ethanol=c_{eth}=0.75 cal/(gr °C))

$$c = \frac{Q}{m\Delta T} \Rightarrow Q = cm\Delta T$$

$$Q = 0.75\ \frac{cal}{gr \cdot {}^{\circ}C} \cdot 1000\ gr \cdot \left(-25\ {}^{\circ}C\right) = -18750\ calories$$

B) 100 grams of hot water at 90° Celsius are mixed with 200 grams of cold water at 0° Celsius.

- Calculate the final temperature of the water at thermal equilibrium assuming no net heat loss from the system.

The amount of exchanged heat is the same for both the hot and cold water but of opposite sign

$$c_{hot} m_{hot} \Delta T_{hot} = -Q \quad c_{cold} m_{cold} \Delta T_{cold} = Q$$

So

$$c_{hot} m_{hot} \left(T_{hot,initial} - T_{final}\right) = c_{cold} m_{cold} \left(T_{final} - T_{cold,initial}\right)$$

$$\Downarrow$$

$$\left(c_{hot} m_{hot} + c_{cold} m_{cold}\right) T_{final} = c_{hot} m_{hot} T_{hot,initial} + c_{cold} m_{cold} T_{cold,initial}$$

$$\Downarrow$$

$$T_{final} = \frac{\left(c_{hot} m_{hot} T_{hot,initial} + c_{cold} m_{cold} T_{cold,initial}\right)}{\left(c_{hot} m_{hot} + c_{cold} m_{cold}\right)} = \frac{(9000 + 0)}{100 + 200}\ {}^{\circ}C = 30\ {}^{\circ}C$$

- After the above described system has reached thermal equilibrium a quantity of heat is subtracted to the system. What would be the final temperature if 3000 calories of heat were lost from the system?

We have now 300 gr of water at 30 $^{\circ}C$

We know that $c_{water} m_{water} \Delta T_{water} = -Q_{loss} \Rightarrow \Delta T_{water} = \frac{-Q_{loss}}{c_{water} m_{water}}$

$$\Downarrow$$

$$T_{final} = T_{initial} - \frac{Q_{loss}}{c_{water} m_{water}} = 30\ {}^{\circ}C - \frac{3000\ cal}{1\ \frac{cal}{gr \cdot {}^{\circ}C}\ 300\ gr} = 30\ {}^{\circ}C - 10\ {}^{\circ}C = 20\ {}^{\circ}C$$

Name: ______________________________

C) How much energy is required to convert 5 Kg of ice at 268 K in water at 278 K?
(Specific heat of water c_{watyer}=4186 J/(Kg·K), Specific heat of ice c_{ice}=2090 J/(Kg·K),
latent heat ice-water transition=$L_{ice\text{-}water}$=334 kJ/kg=334000 J/kg.)

The heat necessary to change the temperature of the ice from 268 K (-5 ˚C) to 273 K (0 ˚C) is

$$Q_{ice} = c_{ice} m_{ice} \Delta T_{ice} = 2090 \ \frac{J}{Kg \cdot K} \cdot 5 \ \ Kg \cdot (273 - 268) \ \ K = 52250 \ \ J = 52.250 \ \ kJ$$

The heat necessary to complete the melting of 5 Kg of ice is

$$Q_{latent,water \to ice} = L_{water \to ice} \cdot m_{ice} = 334 \ \frac{kJ}{Kg} \cdot 5 \ \ Kg = 1670 \ \ kJ$$

The heat necessary to change the temperature of the water from 273 K (0 ˚C) to 278 K (5 ˚C) is

$$Q_{water} = c_{water} m_{water} \Delta T_{water} = 4186 \ \frac{J}{Kg \cdot K} \cdot 5 \ \ Kg \cdot (278 - 273) \ \ K = 104650 \ \ J = 104.650 \ \ kJ$$

Hence the total heat necessary is

$$Q_{total} = Q_{ice} + Q_{latent,water \to ice} + Q_{water} = 158.570 \ kJ$$