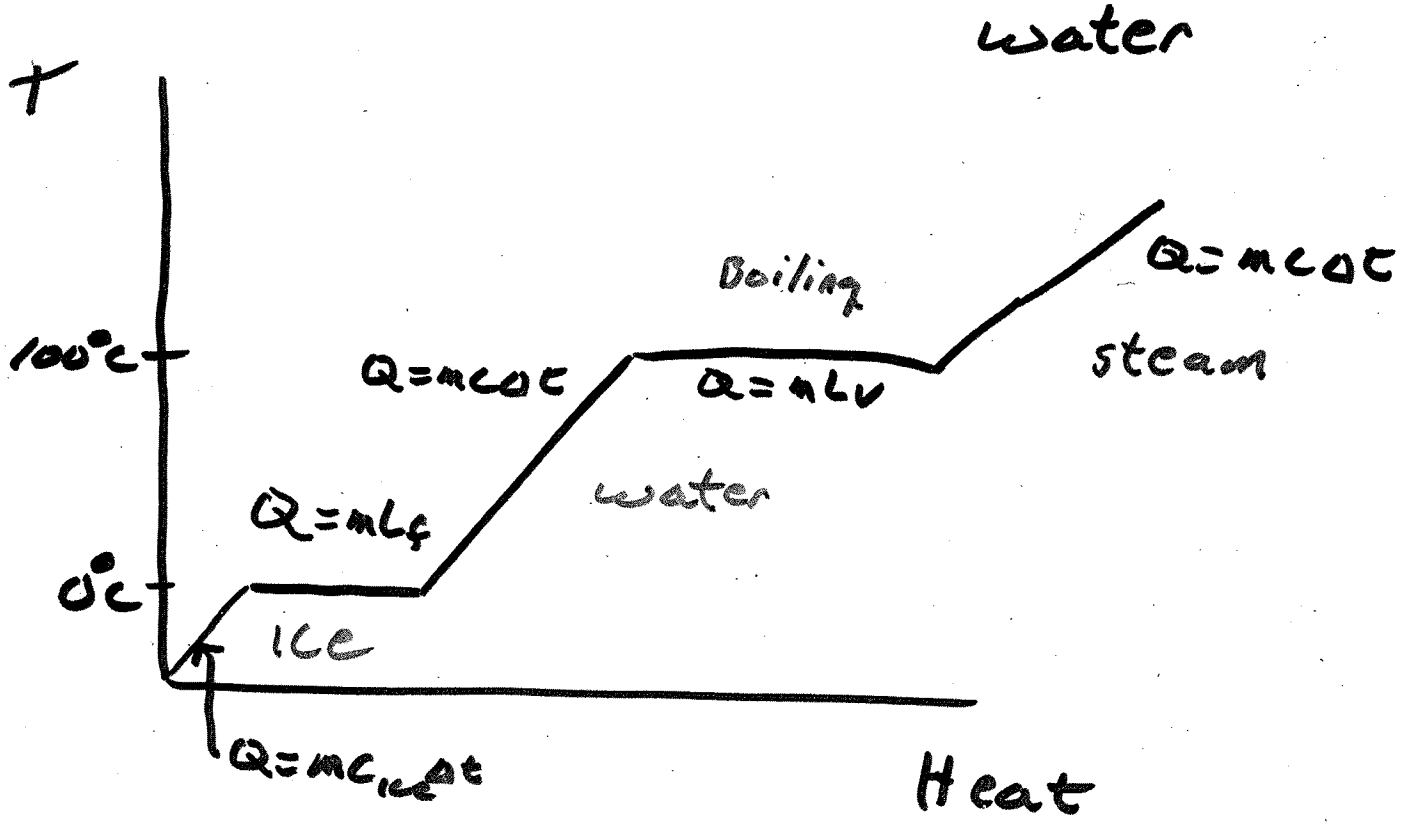
Read 10.5

Group tomorrow

$Q = mc\Delta t$

office hrs 1:30-2:30 today
2:45-3:45 tomorrow



Interactive Question

The first law of thermodynamics states that the increase in internal energy of a system is equal to

A) the amount of heat added to the system minus the amount of work done on the system

B) the amount of heat added to the system plus the amount of work done on the system

C) the amount of heat added to the system minus the amount of work done by the system

D) the amount of heat added to the system minus the amount of work done on the system

Problem: A 50 g lead bullet is moving at 250 m/s when it strikes a wall and stops. If all the energy of the bullet is converted to heat which is absorbed by the bullet, by how much does its temperature change?

$Q = mc\Delta T$

$m = 50\,g$

$v_i = 250\,m/s \quad v_f = 0\,m/s$

$c = 0.0305\ cal/g^\circ C$

$Q = \cancel{U}^{0} + \Delta\cancel{PE}^{0} + \Delta KE + \Delta\cancel{U}^{0}$

$Q = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$Q = \frac{1}{2}(0.050\,kg \times 250\,m/s)^2 = 1560\,J$

$\frac{1560\,J}{4.186\,J/1\,cal} = 372.7\,cal$

$\Delta T = \frac{Q}{mc} = \frac{372.7\,cal}{(.0305\,cal/g^\circ C)(50\,g)} = 244^\circ C$

Problem: In order to melt ice, you put a pan on the stove and heat it while stirring the ice. If the ice is initially at 0 °C, you do 400 J of work by stirring, and the stove adds 500 cal of heat, how much ice is melted?

$Q = 500\ cal$

$W = -400\ J$

$L_f = 80\ cal/g$

1st law of thermodynamics

$$\Delta U = Q - W$$

$$\Delta U = 500\ cal - (-400\ J)\frac{1\ cal}{4.186\ J}$$

$$500\ cal + 96\ cal$$

$$\Delta U = 596\ cal$$

$$\Delta U = m L_f \qquad m = \frac{\Delta U}{L_f} = \frac{596\ cal}{80\ cal/g} = 7.5\ g$$

Interactive Question

When the temperature of a quantity of gas is increased

A) the pressure must increase.
B) the volume must increase.
C) the pressure and/or the volume must increase.
D) none of the above.

Interactive Question

Two identical rooms in a house are connected by an open doorway. The temperatures in the two rooms are maintained at different values. Which room contains more air?

A) The room with the higher temperature
B) The room with the lower temperature
C) Neither because they both have the same volume
D) Neither because they both have the same pressure

Problem: A 2 liter bottle is filled with nitrogen (N_2) at STP and closed tight. (STP is "Standard Temperature and Pressure" of 273 K and 1 atm.)

(a) How many molecules of N_2 are there?

$T = 273\,K \quad p = 1\,atm$

$V = 2L \quad$ want N

$1\,L = 1 \times 10^{-3}\,m^3$

$pV = NkT$

$$N = \frac{pV}{kT} = \frac{(1.013 \times 10^5\,N/m^2)(2 \times 10^{-3}\,m^3)}{(1.381 \times 10^{-23}\,J/K)(273\,K)}$$

$$= 5.4 \times 10^{22}\ \text{molecules}$$

Problem: A 2 liter bottle is filled with nitrogen (N_2) at STP (Standard Temperature and Pressure of 1 atm and 273 K) and closed tight.

(b) If the temperature is raised to 100° C, what will be the new pressure.

$T_2 = 373\,K$

Ideal gas law $\frac{PV}{T} = Nk$

$\frac{PV}{T} \equiv$ constant

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ $\quad P_2 = \frac{P_1 V_1}{T_1} \cdot \frac{T_2}{V_2}$ $\quad V_1 = V_2$

$P_2 = P_1 \cdot \frac{T_2}{T_1} = (1\,atm)\left(\frac{373\,K}{273\,K}\right) = 1.37\,atm$