ENV-413: Thermodynamics of the Earth systems

Exercise session for Lecture 10

4. Consider a two-component system consistent of H_2O and NaCl. Write the Gibbs phase rule for this two-component system.

5. To conveniently represent the phase diagram on a graph, we can eliminate one degree of freedom if we examine the system only at constant pressure. For the two-component system at constant pressure, what is the maximum number of thermodynamic degrees of freedom for this system?

9. Matching:

_____ latent heat of fusion	a. 677 cal g^{-1}
_____ latent heat of vaporization	b. 597.3 cal g^{-1}
_____ latent heat of sublimation	c. 77.7 cal g^{-1}

10. During a phase change from liquid to vapor, state whether the following variables increase, decrease, or remain the same

Temperature _____

Pressure _____

Specific Volume _____

Entropy _____

Enthalpy _____

Gibbs energy _____

1. Nucleation of a pure phase of one component is referred to as
a) homogeneous
b) heterogeneous

2. Most of the nucleation processes in the atmosphere is:
a) homogeneous nucleation
b) heterogeneous nucleation

Surface tension work

3. Write an expression for surface tension work

4. What are the units for surface tension?

5a. The effect of surface tension on the internal energy of a droplet is (greater than, less than, the same) for a smaller drop.

6a. How much work is required to break a 1 cm cube of water into drops with radius 10 μm? (use surface tension 0.076 N m^{-1}.)

16. Refer to Fig. 5.3, which is a graph of Kelvin's equation

$$r^* = \frac{2\sigma_{lv}}{\rho_l R_v T \ln S} \qquad (5.14a)$$

a) Has a drop with radius 1 x 10^{-3} μm and S=1.5 been activated (i.e. will it grow spontaneously)?

b) Has a drop with radius 1 x 10^{-3} μm and S=4 been activated (i.e. will it grow spontaneously)?

17. The formation of pure water droplets requires a vapor pressure that is (less than, equal to, greater than) the saturation vapor pressure over a plane surface of pure water

18 .If the relative humidity of the air is 100%, droplets of pure water will
a) evaporate b) grow further by condensation c) remain the same size

19. Are values of S=1.5 and S=4 observed in the atmosphere? What is a realistic maximum value of S that is observed in the atmosphere?