

## ENV-413: Thermodynamics of the Earth systems

### Worksheet for Lecture 6

1. Determine the number of phases and components for each of the thermodynamic systems listed below

System	Components	Phases
liquid water with ice		
mixture of two gases		
oil and vinegar		
water and alcohol		
sugar in water		
sand in water		
2 blocks of copper		

2. The Gibbs phase rule is given by  $f = \chi - \varphi + 2$ , where  $f$  is the number of thermodynamic degrees of freedom,  $\chi$  is the # of components, and  $\varphi$  is the # of phases. Consider the  $\chi=1$  system, water. Write the Gibbs phase rule for this 1 component system.

For 1 phase, how many free state variables ( $T, p, \rho$ ) can be independently varied?

For 2 phases in equilibrium, how many free state variables can be independently varied?

For 3 phases in equilibrium, how many free state variables can be independently varied?

3. A mixture containing salt dissolved in water consists of \_\_\_\_\_ phase(s) and \_\_\_\_\_ component(s)

4. A system consisting of liquid water in contact with moist air consists of \_\_\_\_\_ phase(s) and \_\_\_\_\_ component(s)