

## 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

<u>System</u>	<u>Components</u>	<u>Phases</u>
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  $f = \chi - \phi + 2$ , where  $f$  is the number of thermodynamic degrees of freedom,  $\chi$  is the # of components, and  $\phi$  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)