

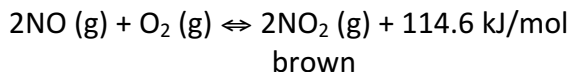
Name: \_\_\_\_\_ Per \_\_\_\_\_

Equilibrium  
PS 53

1. Define enthalpy
2. Define entropy
3. Define collision theory
4. Equilibrium systems result from the natural tendency towards \_\_\_\_\_ enthalpy and \_\_\_\_\_ entropy.
5. For each of the following reactions, give the direction of the enthalpy drive and the entropy drive. Predict if the reaction will favor the products, the reactants, or result in equilibrium.
  - a.  $\text{N}_2 (\text{g}) + 2\text{O}_2 (\text{g}) + 33.8 \text{ kJ/mol} \rightleftharpoons 2\text{NO}_2 (\text{g})$
  - b.  $\text{Cl}_2 (\text{g}) \rightleftharpoons \text{Cl}_2 (\text{aq}) + 25 \text{ kJ/mol}$
  - c.  $2\text{Na} (\text{s}) + 2\text{H}_2\text{O} (\text{l}) \rightleftharpoons 2\text{NaOH} (\text{aq}) + \text{H}_2 (\text{g}) + 184 \text{ kJ/mol}$
  - d.  $\text{Na}_2\text{CO}_3 (\text{s}) + 2\text{HCl} (\text{aq}) \rightleftharpoons \text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l}) \quad \Delta H = -27.7 \text{ kJ/mol}$
  - e.  $\text{N}_2 (\text{g}) + 3\text{H}_2 (\text{g}) \rightleftharpoons 2\text{NH}_3 (\text{g}) \quad \Delta H = -92 \text{ kJ/mol}$
  - f.  $\text{P}_4 (\text{s}) + 6\text{H}_2 (\text{g}) \rightleftharpoons 4\text{PH}_3 (\text{g}) \quad \Delta H = 37 \text{ kJ/mol}$
6. State Le Châtelier's Principle

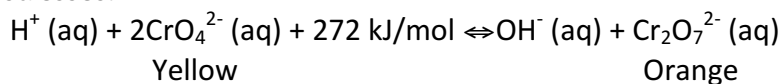
Name: \_\_\_\_\_ Per \_\_\_\_\_

7. Explain what would happen to  $[\text{NO}_2]$  and to the color (darker brown, or lighter brown) for each of the following stresses.



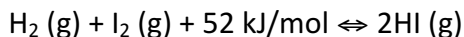
- |                           |                              |
|---------------------------|------------------------------|
| a. Increase $[\text{NO}]$ | c. Decreases the temperature |
| b. Increase the pressure  | d. Decrease $[\text{O}_2]$   |

8. Explain what would happen to  $[\text{CrO}_4^{2-}]$ ,  $[\text{Cr}_2\text{O}_7^{2-}]$ , and to the color (more orange or more yellow) for each of the following stresses.



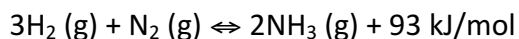
- |                             |                             |
|-----------------------------|-----------------------------|
| a. Increase $[\text{H}^+]$  | c. Decrease $[\text{OH}^-]$ |
| b. Increase the temperature | d. Decrease the temperature |

9. Explain what would happen to  $[\text{I}_2]$  and to the color (darker purple, or lighter purple) for each of the following stresses.



- |                           |                             |
|---------------------------|-----------------------------|
| a. Increase $[\text{HI}]$ | c. Decrease the temperature |
| b. Increase the volume    | d. Increase $[\text{H}_2]$  |

10. Explain what would happen to  $[\text{NH}_4]$  for each of the following stresses



- increase the temperature
- increase the pressure
- increase the volume
- increase  $[\text{H}_2]$