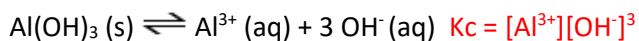
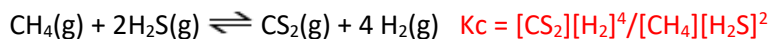
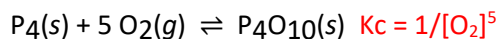
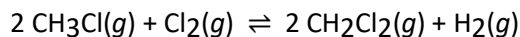
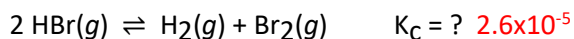
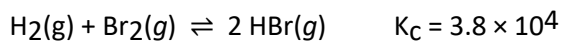


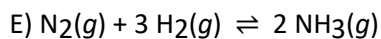
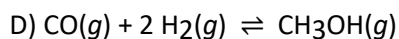
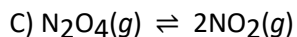
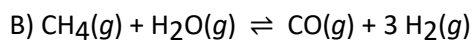
1. Write the equilibrium expression ( $K_c$ ) for following reactions. In each case indicate whether the equilibrium is Homogeneous or Heterogeneous



2. The equilibrium constant is given for one of the reactions below. Determine the value of the missing equilibrium constant.



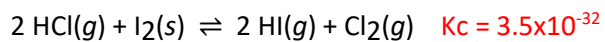
3. In which of the following reactions will  $K_c = K_p$ ?



4. For the reaction:  $\text{N}_2\text{O}(g) + \text{NO}_2(g) \rightleftharpoons 3 \text{NO}(g)$ ,  $K_c = 4.2 \times 10^{-4}$  at 500. K.  
What is  $K_p$  for the reaction at this temperature?  $K_p = 0.017$

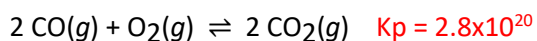
5. Determine the value of  $K_C$  for the following reaction if the equilibrium concentrations are as follows:

$[\text{HCl}]_{\text{eq}} = 0.13 \text{ M}$ ,  $[\text{HI}]_{\text{eq}} = 5.6 \times 10^{-16} \text{ M}$ ,  $[\text{Cl}_2]_{\text{eq}} = 0.0019 \text{ M}$ .

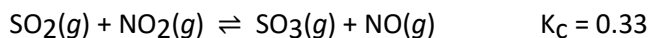


6. Determine the value of  $K_P$  for the following reaction if the equilibrium concentrations are as follows:

$P(\text{CO})_{\text{eq}} = 6.8 \times 10^{-11} \text{ atm}$ ,  $P(\text{O}_2)_{\text{eq}} = 1.3 \times 10^{-3} \text{ atm}$ ,  $P(\text{CO}_2)_{\text{eq}} = 0.041 \text{ atm}$ .



7. Consider the following reaction and its equilibrium constant:

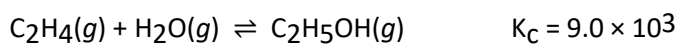


Is the reaction at equilibrium if it contains: 0.39 M  $\text{SO}_2$ , 0.14 M  $\text{NO}_2$ , 0.11 M  $\text{SO}_3$  and 0.14 M  $\text{NO}$ .

If it is not at equilibrium, in which direction will the equilibrium shift?

$Q < K$  right!

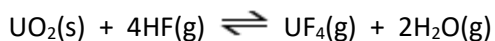
8. Consider the following reaction, equilibrium concentrations, and equilibrium constant at a particular temperature. Determine the equilibrium concentration of  $\text{H}_2\text{O}(g)$ .



$[\text{C}_2\text{H}_4]_{\text{eq}} = 0.015 \text{ M}$                        $[\text{C}_2\text{H}_5\text{OH}]_{\text{eq}} = 1.69 \text{ M}$

$[\text{H}_2\text{O}] = 0.013 \text{ M}$

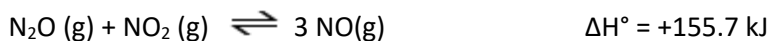
9. Consider the exothermic equilibrium reaction



In which direction will the equilibrium shift when the following changes are made? Explain your reasoning.

- (A) Additional  $\text{UO}_2(\text{s})$  is added? **No effect**
- (B) The water vapor is removed? **Right**
- (C) The reaction takes place in a glass container and the HF reacts with the glass? **Left**
- (D) The volume of the reaction vessel is reduced? **Right**
- (E) The temperature is increased? **left**

10. Consider the following reaction:



In which direction will the equilibrium be shifted by the following changes? Explain your reasoning.

- (A) Adding  $\text{N}_2\text{O}$  **Right**
- (B) Removing  $\text{NO}_2$  **Left**
- (C) Removing  $\text{N}_2\text{O}$  **Left**
- (D) Adding a catalyst **No effect**
- (E) Adding  $\text{NO}$  **Left**
- (F) Increasing the temperature of the reaction mixture **Right**
- (G) Adding He gas to the reaction mixture at constant volume **no effect**
- (H) Decreasing the volume of the reaction vessel **Left**

11. Consider the following reaction at equilibrium:  $\text{CO (g)} + 2 \text{H}_2 \text{(g)} \rightleftharpoons \text{CH}_3\text{OH (g)}$   $\Delta H^\circ = -18 \text{ kJ}$

How will the amount of  $\text{CH}_3\text{OH}$  at equilibrium be affected by the following changes? Explain your reasoning.

(A) Adding  $\text{CO (g)}$  **go up**

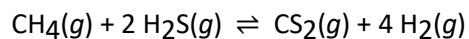
(B) Removing  $\text{H}_2 \text{(g)}$  **go down**

(C) Increasing the temperature **go down**

(D) Adding a catalyst **no effect**

(E) Decreasing the volume of the reaction container. **Go up**

12. Consider the following reaction:



A reaction mixture initially contains 0.50 M  $\text{CH}_4$  and 0.75 M  $\text{H}_2\text{S}$ . If the equilibrium concentration of  $\text{H}_2$  is 0.44 M, find the equilibrium constant ( $K_c$ ) for the reaction.

**$K_c = .038$**

13. Consider the following reaction:



A reaction mixture initially contains 0.56 atm  $\text{CO}_2$  and 0.32 atm  $\text{CO}$ . Determine the equilibrium pressure of  $\text{CO}$  if  $K_p$  for the reaction at this temperature is 2.25.

$$P(\text{CO}) = .85 \text{ atm}$$

14. For the reaction:  $2\text{NOCl}(g) \rightleftharpoons 2\text{NO}(g) + \text{Cl}_2(g)$ ,  $K_c = 1.6 \times 10^{-5}$ .

What are the equilibrium concentrations of each species if 1.0 mole of  $\text{NOCl}$  is initially placed in an empty 2.0 L flask?

$$[\text{NO}] = .020 \text{ M}, [\text{Cl}_2] = .010 \text{ M}, [\text{NOCl}_2] = .50 \text{ M}$$

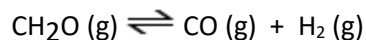
15. A reaction vessel is charged with hydrogen iodide, which partially decomposes to molecular hydrogen and iodine:

$2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ : When the system comes to equilibrium at 425 °C,  $P_{\text{HI}} = 0.708$  atm and  $P_{\text{H}_2} = P_{\text{I}_2} = 0.0960$  atm. Calculate  $K_p$  for this reaction.

$$K_p = K_c = .018$$

Calculate  $K_c$  for the same reaction.

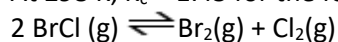
16. Consider the reaction



In an experiment, 0.050 mol of  $\text{CH}_2\text{O}(\text{g})$  was placed in empty 500. mL vessel. At equilibrium, the concentration of  $\text{CH}_2\text{O}(\text{g})$  was found to be 0.066 M. Calculate  $K_c$  for the reaction.

$$K_c = .018$$

17. At 298 K,  $K_c = 1.45$  for the following reaction



A reaction mixture was prepared with the following initial concentrations.

$[\text{BrCl}] = 0.0400$  M,  $[\text{Br}_2] = 0.0300$  M and  $[\text{Cl}_2] = 0.0300$  M

Calculate their equilibrium concentrations.

$$[\text{Br}_2] = [\text{Cl}_2] = 0.035 \text{ M}, [\text{BrCl}] = 0.029 \text{ M}$$

18. In air, at 25 °C and 1.00 atm, the concentrations of N<sub>2</sub> and O<sub>2</sub> are 0.033 M and 0.00180, respectively. The reaction N<sub>2</sub>(g) + O<sub>2</sub>(g)  $\rightleftharpoons$  2 NO (g) has K<sub>c</sub> = 4.8 x 10<sup>-11</sup> at 25 °C. Taking the given concentrations as the initial concentrations, calculate the equilibrium concentration of NO at 25 °C

$$[\text{NO}] = 5.3 \times 10^{-8} \text{ M}$$