Equilibrium IV in-class practice Name: _____

1. Apply Le Chatelier's Principle to the following equilibrium system. $N_{2(g)} + 3\,H_{2(g)} \leftrightarrow 2\,NH_{3(g)} + 80\ kJ/mol$
What effect will each of the following changes have on the concentration of ammonia, $NH_{3(g)}$?
State **one reason** that justifies each answer.

↑ NH_3 a) increasing the total pressure shift right to dec. pressure (less molecules)
↓ NH_3 b) increasing the temperature left to lower temp. (absorbs energy)
↓ NH_3 c) increasing the volume of the container = ↓ Pressure shift left to inc. pressure
no change d) adding an appropriate catalyst no change
↑ NH_3 e) increasing the concentration of $N_{2(g)}$ shift right to use up N_2

2. What is the correct expression for the equilibrium constant for the reaction?

$$CN^-_{(aq)} + H_2O_{(l)} \leftrightarrow HCN_{(aq)} + OH^-_{(aq)}$$

A) $K_c = \dfrac{[HCN(aq)][OH^-(aq)]}{[CN^-(aq)][H_2O(l)]}$

B) $K_c = \dfrac{[OH^-(aq)]}{[CN^-(aq)][H_2O(l)]}$

C) $K_c = \dfrac{[HCN(aq)][OH^-(aq)]}{[CN^-(aq)]}$ (products / reactants)

D) $K_c = \dfrac{[CN^-(aq)]}{[HCN(aq)][OH^-(aq)]}$

3. Name the following compounds and give the equation that shows how it dissolves in water. (8)
(Show subscripts and balance)

a. $LiCl_{(s)}$: lithium chloride. $LiCl(s) \rightarrow Li^+_{(aq)} + Cl^-_{(aq)}$

b. $C_2H_6{}_{(g)}$: dicarbon hexahydride (ethane) $C_2H_6(g) \rightarrow C_2H_6(aq)$

c. $Li_2CO_3{}_{(s)}$: lithium carbonate $Li_2CO_3(s) \rightarrow 2\,Li^+_{(aq)} + CO_3^{2-}(aq)$

d. $NO_{2\,(g)}$: nitrogen dioxide $NO_2(g) \rightarrow NO_2(aq)$

4. The following orange-yellow solution is a system at equilibrium:

$$Cr_2O_7^{2-}{}_{(aq)} + 2\,OH^-{}_{(aq)} \leftrightarrow 2\,CrO_4^{2-}{}_{(aq)} + H_2O_{(l)}$$
orange *colorless* *yellow* *colorless*

An acidic solution containing $H^+_{(aq)}$ ions is added to this system. What will happen to this orange-yellow solution after equilibrium is re-established?

A) It will become more orange.
B) It will become more yellow.
C) It will become colorless.
D) It will show no change in color.

5. A student places 4.0 mol of A and 4.0 mol of B in a 1 litre flask. When equilibrium is reached, there are 2.0 mol of X. Calculate the Kc for this system.

$A(g) + 2\,B(g) \leftrightarrow 2\,X(g) + 4\,Y(g)$

I	4	4	0	0
C	-1	-2	+2	+4
E	3	2	2	4

$K_{eq} = \dfrac{[X]^2[Y]^4}{[A][B]^2}$

$= \dfrac{2^2 \cdot 4^4}{3 \cdot 2^2}$

$K_{eq} = 85$

6. If one had 500mL of a 0.46*M* solution, how much water would need to be added to produce a 0.10*M* solution?

$C_1V_1 = C_2V_2$

$(0.46\,M)(500\,mL) = (0.10\,M)\,V_2$

$V_2 = \dfrac{(0.46\,M)(500\,mL)}{(0.10\,M)} = 2300\,mL$

2300 − 500 = 1800 mL → 1.8L

7. In a closed system, the initial $[N_2O_{4(g)}]$ is 2.0 mol/L.
Find the equilibrium concentrations of both substances if the Keq is 0.4.

$N_2O_4(g) \leftrightarrow 2\,NO_2(g)$

I	2	0
C	−x	+2x
E	2−x	2x

$K_{eq} = \dfrac{[NO_2]^2}{[N_2O_4]}$

$0.4 = \dfrac{(2x)^2}{2-x}$

$0.4(2-x) = 4x^2$

$0.8 - 0.4x = 4x^2$

$4x^2 + 0.4x - 0.8 = 0$

$4(x^2 + 0.1x - 0.2) = 0$

$4(x-0.1)(x+0.2) = 0$

$x = 0.4$ or $x = -0.8$

$[N_2O_4] = 1.6\,M$

$[NO_2] = 0.8\,M$

Use this rxn for the remaining questions $2CO_{2(g)} + E \leftrightarrow 2\,CO_{(g)} + O_{2(g)}$

8. According to Le Chatelier how would this rxn react to the following changes? Which rxn would be favoured?

a.	If the temperature were increased?	Forward	Reverse	no change
b.	If the pressure were increased?	Forward	Reverse	no change
c.	If there was an increase in CO_2?	Forward	Reverse	no change
d.	If there was an increase in O_2?	Forward	Reverse	no change

9. Use the collision theory to explain the effect of decreasing the CO_2 concentration.

The forward rxn will slow down because CO_2 molecules are less likely to collide (due to the low concentration)

The reverse rxn is faster than the forward rxn.

→ shift to the left.

10. Use the rate theory to predict what would happen if the [CO] and $[CO_2]$ were doubled but the $[O_2]$ remained the same.

$rate_F = k[CO_2]^2$

$= k \times 2^2$

$= 4k$

$rate_R = k[CO]^2[O_2]$

$= k \times 2^2 \times 1$

$= 4k.$

no overall change.