AP Chemistry Test (Chapter 13)

Multiple Choice (20%)

1) Which one best describes the K_C for this reaction?

$$3\ A\ (aq) + 2\ D\ (aq) \leftrightarrow 4\ C\ (g) + B\ (s) + 2\ E\ (l)$$

A) $K_c = \dfrac{[A]^3[D]^2}{[C]^4[B][E]^2}$ B) $K_c = \dfrac{[C]^4[B][E]^2}{[A]^3[D]^2}$

C) $K_c = \dfrac{[A]^3[D]^2}{[C]^4}$ D) $K_c = \dfrac{[C]^4}{[A]^3[D]^2}$

2) Please consider the gas phase reaction: $2\ SO + Br_2 \leftrightarrow 2\ BrNO \quad \Delta H = -345\ kJ/mol$. Which one would increase the yield of BrNO?

A) High T & high P B) Low T & low P
C) High T & low P D) Low T & high P

3) Salt dissolves in water, according to this mechanism: $NaCl\ (s) \leftrightarrow Na^+\ (aq) + Cl^-\ (aq)$. What effect would the addition of concentrated HCl have on this equilibrium?

A) Q becomes larger & the reaction shifts right.
B) Q becomes larger & the reaction shifts left
C) Q becomes smaller & the reaction shifts right.
D) Q becomes smaller & the reaction shifts left.
E) There is no net effect on the equilibrium position.

4) Based upon the following information, which one is true about the reaction mixture?

$N_2O_4\ (g) \leftrightarrow 2\ NO_2\ (g)$ $K_P = 2.50$

$P\ (N_2O_4) = 7.20\ atm$ $P\ (NO_2) = 5.90\ atm$

A) The product concentrations are too high & the reaction will shift right to establish equilibrium.
B) The product concentrations are too high & the reaction will shift left to establish equilibrium
C) The reactant concentrations are too high & the reaction will shift right to establish equilibrium.
D) The reactant concentrations are too high & the reaction will shift left to establish equilibrium.

5) Which one will occur if the volume of the container is doubled?

$2\ A\ (g)\ +\ 3\ B\ (g)\ \leftrightarrow\ C\ (g)\ +\ 4\ D\ (s)\ +\ E\ (g)\ +\ 57\ kJ\ (Heat)\quad Kp = 6.25$

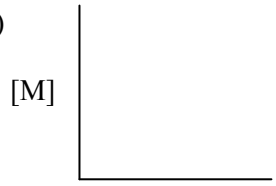
A) The mass of both A and B will decrease because the reaction will shift to less moles of gas.
B) The mass of both A and B will increase because the reaction will shift to more moles.
C) The mass of both A and B will increase because the reaction will shift to less moles.
D) The mass of both A and B will decrease because the reaction will shift to more moles.
E) None of these will occur.

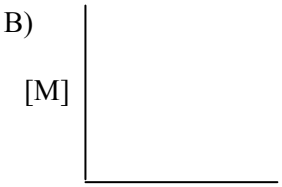
6) Consider the gaseous equilibrium: $2\ A \leftrightarrow 2\ B + C$.
Determine the value of the missing [C] at equilibrium.

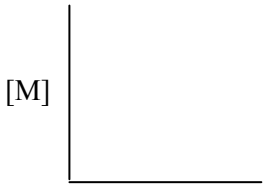
Experiment #	[A] at equilibrium	[B] at equilibrium	[C] at equilibrium
1	0.30 M	0.10 M	0.40 M
2	0.35 M	0.25 M	???

A) 0.087 M
B) 0.062 M
C) 0.023 M
D) 0.075 M
E) 0.044 M

7) Which one illustrates a reaction with K<1?

A)


B)


C)


8) If this system is at equilibrium in a closed vessel & a small amount of N_2H_4 is added, which one would not happen?

$HN_3\ (g) + 2\ H_2O\ (l)\ \leftrightarrow\ N_2H_4\ (g) + HNO_2\ (g)\qquad \Delta H = +545\ kJ/mol\ rxn$

A) The partial pressure of HNO_2 would decrease in re-establishing equilibrium.
B) The partial pressure of HN_3 would increase in re-establishing equilibrium.
C) Some N_2H_4 would form in re-establishing equilibrium.
D) The inside of the flask would have water droplets forming on it.
E) The temperature would increase.

9) $K_C = 2.4$ for this reaction: $C\ (s)\ +\ CO_2\ \leftrightarrow\ 2\ CO\ (g)$.
The concentration of CO in equilibrium with 0.30 M CO_2 is _____.

A) 0.22 M
B) 0.72 M
C) 0.85 M
D) 0.35 M
E) 0.46 M

10) If the reaction flask is placed into an ice bath, which one will occur?

$2\ A\ (g) + 3\ B\ (g) \leftrightarrow C\ (g) + 4\ D\ (s) + E\ (g) + 57\ kJ\ (Heat)$ $Kp = 6.25$

A) The mass of C, D and E will decrease because the reaction will favor product formation.
B) The mass of C, D and E will decrease because the reaction will favor reactant formation.
C) The mass of C, D and E will increase because the reaction will favor product formation.
D) The mass of C, D and E will increase because the reaction will favor reactant formation.
E) None of these will occur.

Problems (90%)

1) $NH_4CO_2NH_2\,(s) \ <===> \ 2\ NH_3\,(g) + CO_2\,(g)$

a) A sample of 200.0 grams of solid $NaHCO_3$ was placed in a previously evacuated rigid 8.00-liter container and heated to 160.0 °C. Some of the original solid remained and the total pressure in the container was 0.750 atm when equilibrium was reached. Calculate the number of moles of NH_3 (g) present at equilibrium.

b) How many grams of the original solid remained in the container under the conditions described in (a)?

c) Write the equilibrium expression for the equilibrium constant, Kp, and calculate its value for the reaction under the conditions in (a)

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2) $NH_4HS\ (s) \ <===> \ NH_3\,(g) + H_2S\ (g)$ $\Delta H° = -\ 193$ kilojoules/mol rxn

The equilibrium above is established by placing solid NH_4HS in an evacuated container at 298 K. At equilibrium, some solid NH_4HS remains in the container. Predict and explain each of the following.

a) The effect on the equilibrium partial pressure of H_2S gas when additional solid NH_4HS is removed from the container.

b) The effect on the equilibrium partial pressure of NH_3 gas when additional H_2S gas is removed from the container.

c) The effect on the mass of solid NH_4HS present when the volume of the container is increased.

d) The effect on the mass of solid NH_4HS present when the temperature is decreased.

e) If the temperature were lowered to 300 K, what effect would this have on the equilibrium constant?

3) $16\ A_3\ (g) \leftrightarrow 12\ A_4\ (g)$. $Kc = 0.0500$

What is Kc for each of these reactions.

a) $8\ A_3\ (g) \leftrightarrow 6\ A_4\ (g)$

b) $12\ A_4\ (g) \leftrightarrow 16\ A_3\ (g)$

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4) $3\ O_2\ (g) \leftrightarrow 2\ O_3\ (g)$

a) A 4.00-L flask at 305 K is injected with 29.8 g of oxygen gas. At equilibrium, the flask contains a total pressure of 4.52 atm. What mass of oxygen gas has been consumed to reach equilibrium?

b) For this reaction, write the expression for Kp and calculate its numerical value.

c) What is the concentration of O_2 at equilibrium?

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5) $2\ SO_3\ (g) \leftrightarrow 2\ SO_2\ (g) + O_2\ (g)$

When SO_3 decomposes at 2,000 K, equilibrium is achieved according to the equation above. In one experiment, the following equilibrium concentrations were measured.

$[SO_3] = 0.25$ mol/L
$[SO_2] = [O_2] = 0.40$ mol/L

a) What is the mole fraction of SO_2 (g) in the equilibrium mixture?

b) Using the equilibrium concentrations given above, calculate the value of K_c, the equilibrium constant for the reaction.

c) Determine Kp, in terms of Kc for this system.

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6) $N_2O_4\ (g) \ <===>\ 2\ NO_2\ (g)$

a) At a certain temperature, 1.25 mole of gaseous N_2O_4 is placed in a 4.00-liter flask, and equilibrium for the reaction is attained when 15.00 % of the N_2O_4 has decomposed. Write the equilibrium expression and calculate the value of the equilibrium constant K_c for the reaction.

b) At the same temperature, 0.52 mole NO_2 and 0.10 mole N_2O_4 are placed in a different 4.00-liter flask. When equilibrium is established, is there more of less than 0.10 mole N_2O_4 present? Justify your answer.

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7) At 35°C, Kp = 0.0200 for this reaction.

$$2\ NOCl\ (g) \leftrightarrow 2\ NO\ (g) + Cl_2\ (g)$$

a) Please determine Kc in terms of Kp.

b) 1.00 mol of each species is placed into a 3.00-L flask. What are the concentrations of each species after equilibrium is attained?

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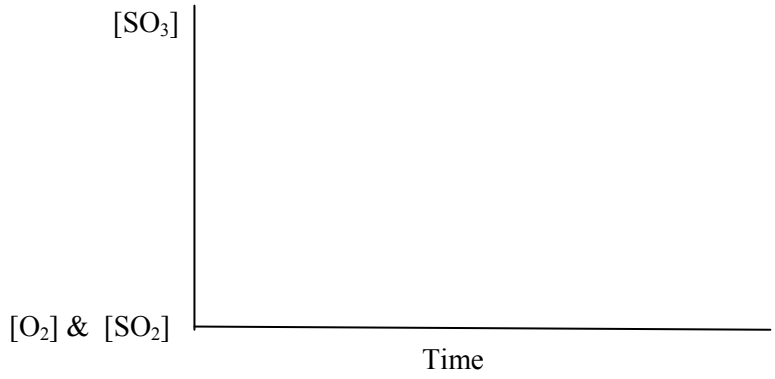
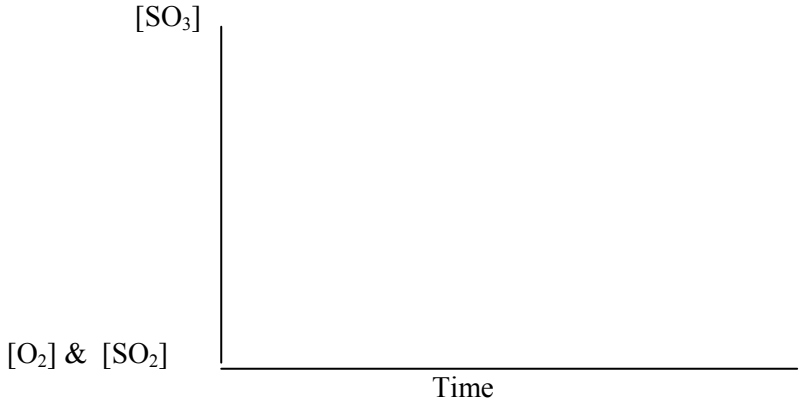
8) Please add to each graph what would occur if each stress is applied to this system at equilibrium.

$$2\ SO_3\ (g) \leftrightarrow 2\ SO_2\ (g) + O_2\ (g)$$

a) SO_3 is added.



b) O_2 is removed.



AP Chemistry Retest/Brownie Points (Chapter 13)

Multiple Choice (20%)

1) Please write the equilibrium expression for this reaction.

$$3\ A\ (aq) + 3\ D\ (s) \leftrightarrow 4\ C\ (l) + B\ (g) + 2\ E\ (s)$$

2) Please consider the gas phase reaction: $2\ NO + Br_2 \leftrightarrow 2\ BrNO \quad \Delta H = -345\ kJ/mol$.
Which one would increase the yield of NO?

A) High T & high P
B) Low T & low P
C) High T & low P
D) Low T & high P

3) What effect would the addition of concentrated H_2SO_4 have on this equilibrium?

$$Pb^{2+}\ (aq) + SO_4^{2-}\ (aq) \rightarrow PbSO_4\ (ppt)$$

4) Which way will this reaction shift if the initial pressures are the following:

$P\ (N_2O_4) = 2.20$ atm and $P\ (NO_2) = 3.90$

$N_2O_4\ (g) \leftrightarrow 2\ NO_2\ (g) \qquad K_P = 2.50$

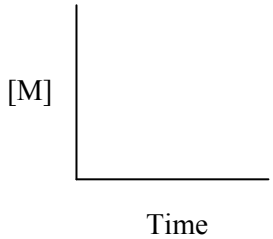
5) What will happen to the mass of D if the reaction flask is heated?

$2\ A\ (g) + 3\ B\ (g) \leftrightarrow C\ (g) + 4\ D\ (s) + E\ (g)$ $\qquad Kp = 6.25$
$\Delta H = +\ 251\ kJ/mol\ rxn$

6) Consider the gaseous equilibrium: $2\ A \leftrightarrow 2\ B + C$.
Determine the value of the missing [B] at equilibrium.

Experiment #	[A] at equilibrium	[B] at equilibrium	[C] at equilibrium
1	0.40 M	0.20 M	0.30 M
2	0.35 M	???	0.20 M

7) Please sketch the reactants R and the products P for a reaction where K>1?



8) If this system is at equilibrium in a closed vessel & a small amount of H_2O is added, what will happen to the temperature inside the vessel?

$$HN_3\,(g) + 2\,H_2O\,(l) \leftrightarrow N_2H_4\,(g) + HNO_2\,(g) \qquad \Delta H = -545 \text{ kJ/mol rxn}$$

9) $K_C = 3.2$ for this reaction: $C\,(s) + CO_2 \leftrightarrow 2\,CO\,(g)$.
The concentration of CO in equilibrium with 0.50 M CO_2 is _____.

10) If the reaction flask is placed into an ice bath, what will happen to the partial pressure of E?

$2\,A\,(g) + 3\,B\,(g) \leftrightarrow C\,(g) + 4\,D\,(s) + E\,(g)$ Kp = 6.25
$\Delta H = +55$ kJ/mol rxn

Problems (90%)

1) $NH_4CO_2NH_2\,(s) \text{ <===> } 2\,NH_3\,(g) + CO_2\,(g)$

a) A sample of 300.0 grams of solid $NH_4CO_2NH_2\,(s)$ was placed in a previously evacuated rigid 6.00-liter container and heated to 200.0 °C. Some of the original solid remained and the total pressure in the container was 0.606 atm when equilibrium was reached. Calculate the number of moles of CO_2 (g) present at equilibrium.

b) How many grams of the original solid remained in the container under the conditions described in (a)?

c) Write the equilibrium expression for the equilibrium constant, Kp, and calculate its value for the reaction under the conditions in (a)

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2) $NH_4HS\,(s) \text{ <===> } NH_3\,(g) + H_2S\,(g) \qquad \Delta H° = +193$ kilojoules/mol rxn

The equilibrium above is established by placing solid NH_4HS in an evacuated container at 598 K. At equilibrium, some solid NH_4HS remains in the container. Predict and explain each of the following.

a) The effect on the equilibrium partial pressure of H_2S gas when the volume of the container is reduced.

b) The effect on the equilibrium partial pressure of NH_3 gas when solid NH_4HS is added to the container.

c) The effect on the mass of solid NH_4HS when the partial pressure of H_2S increases.

d) The effect on the mass of solid H_2S when the temperature is increased.

f) If the temperature were lowered to 300 K, what effect would this have on the equilibrium constant?

3) $16\ A_3\ (g) \leftrightarrow 12\ A_4\ (g)$. $Kc = 0.470$

What is Kc for each of these reactions.

a) $4\ A_3\ (g) \leftrightarrow 3\ A_4\ (g)$

b) $12\ A_4\ (g) \leftrightarrow 16\ A_3\ (g)$

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4) $3\ O_2\ (g) \leftrightarrow 2\ O_3\ (g)$

a) A 5.00-L flask at 305 K is injected with 20.8 g of oxygen gas. At equilibrium, the flask contains a total pressure of 5.20 atm. What mass of oxygen gas has been consumed to reach equilibrium?

b) For this reaction, write the expression for Kp and calculate its numerical value.

c) What is the partial pressure of O_2 at equilibrium?

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5) $2\ SO_3\ (g) \leftrightarrow 2\ SO_2\ (g) + O_2\ (g)$

When SO_3 decomposes at 2,000 K, equilibrium is achieved according to the equation above. In one experiment, the following equilibrium concentrations were measured.

$[SO_3] = 0.33$ mol/L
$[SO_2] = [O_2] = 0.25$ mol/L

a) What is the mole fraction of SO_2 (g) in the equilibrium mixture?

b) Using the equilibrium concentrations given above, calculate the value of K_c, the equilibrium constant for the reaction.

c) Determine Kp, in terms of Kc for this system.

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6) $N_2O_4\ (g) \ <===>\ 2\ NO_2\ (g)$

a) At a certain temperature, 2.40 moles of gaseous N_2O_4 is placed in a 4.00-liter flask, and equilibrium for the reaction is attained when 20.00 % of the N_2O_4 has decomposed. Write the equilibrium expression and calculate the value of the equilibrium constant K_c for the reaction.

b) At the same temperature, 0.52 mole NO_2 and 0.68 mole N_2O_4 are placed in a different 4.00-liter flask. When equilibrium is established, is there more of less than 0.68 mole N_2O_4 present? Justify your answer.

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7) At 35°C, Kp = 0.0340 for this reaction.

$$2\ NOCl\ (g) \leftrightarrow 2\ NO\ (g) + Cl_2\ (g)$$

a) Please determine Kc in terms of Kp.

b) 2.00 mol of each species is placed into a 5.00-L flask. What are the concentrations of each species after equilibrium is attained?

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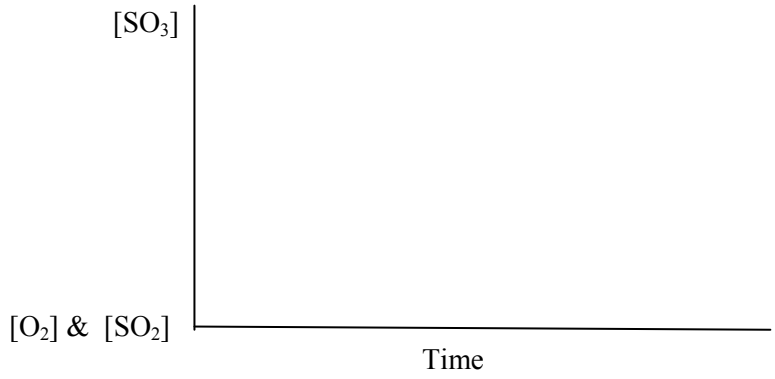
8) Please add to each graph what would occur if each stress is applied to this system at equilibrium.

$$2\ SO_3\ (g) \leftrightarrow 2\ SO_2\ (g) + O_2\ (g)$$

a) SO_3 is removed.



b) SO_2 is added.