Dougherty Valley HS Chemistry
Equilibrium – Extra Practice

Worksheet #9*

Name: **Period:** **Seat#:**

Directions: Any worksheet that is labeled with an * means it is suggested extra practice. We do not always have time to assign every possible worksheet that would be good practice for you to do. You can do this worksheet when you have extra time, when you finish something early, or to help you study for a quiz or a test. If and when you choose to do this Extra Practice worksheet, please do the work on binder paper. If we end up with extra class time then portions of this may turn into required work. If that happens you will be told which problems are turned into required. Remember there is tons of other extra practice on the class website…and the entire internet! See me if you need help finding practice on a topic you are struggling with.

1) What is Dynamic Equilibrium Video – Fuse School
https://www.youtube.com/watch?v=wlD_ImYQAgQ

2) Le Chatelier's Principle Video Part 1 – Fuse School
https://www.youtube.com/watch?v=7zuUV455zFs

3) Le Chatelier's Principle Video Part 2 – Fuse School
https://www.youtube.com/watch?v=XhQ02egUs5Y

4) Reversible reactions – Bozeman Science
https://www.youtube.com/watch?v=b6WmwtVNDf4

5) Equilibrium video – Bozeman Science
https://www.youtube.com/watch?v=cHAjhM3y3ds

6) Le Chatelier's Principle – Bozeman Science
https://www.youtube.com/watch?v=PciV_Wuh9V8

7) Equilibrium Calculations – Crash Course
https://www.youtube.com/watch?v=DP-vWN1yXrY

8) Equilibrium Constant – Bozeman Science
https://www.youtube.com/watch?v=xfGlEXWDRZE&t=0s&list=PLllVwaZQkS2op2kDuFifhStNsS49LAxkZ&index=66

9) Reaction Quotient – Bozeman Science
https://www.youtube.com/watch?v=60Sylqei2DY&list=PLllVwaZQkS2op2kDuFifhStNsS49LAxkZ&index=64&t=0s

10) Equilibrium Disturbances – Bozeman Science
https://www.youtube.com/watch?v=dd5p0VZ-MZg&t=0s&list=PLllVwaZQkS2op2kDuFifhStNsS49LAxkZ&index=68

11) Calculating K, the Equilibrium Constant – The Organic Chemistry Tutor
https://www.youtube.com/watch?v=aJ0KNQ5-KaI

12) Calculating K, the Equilibrium Constant – Bozeman Science
https://www.youtube.com/watch?v=xfGlEXWDRZE

13) ICE Table Calculations - C. Sorensen-Unruh
https://www.youtube.com/watch?v=tT-2xk9ZG_A

14) ICE Table Calculations – chemisNATE
https://www.youtube.com/watch?v=WgB2kWtGnKA

15) 5% Rulehttps://www.youtube.com/watch?v=y6nSdGA11zc

16) ___$NH_{3\,(g)}$ + ___$O_{2\,(g)}$ ↔ ___$NO_{\,(g)}$ + ___$H_2O_{\,(g)}$ + energy
Determine the direction of shift resulting from each applied stress. Explain your reasoning:
a. addition of NO (*g*)
b. removal of O_2 (*g*)
c. increase the pressure by decreasing the volume
d. decreasing the temperature
e. adding a catalyst

17) Write equilibrium expressions for the following:
a. $2NO_{2\,(g)} \leftrightarrow N_2O_{4\,(g)}$
b. $N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3\,(g)}$
c. $2SO_{2\,(g)} + O_{2\,(g)} \leftrightarrow 2SO_{3\,(s)}$

18) Write the Ksp expression for the following reactions:
a. $AlPO_4$
b. AgCN
c. $Zn_3(AsO_4)_2$

19) State the effect of an increase in temperature:
a. $2SO_2 + O_2 \leftrightarrow 2SO_3$ + Heat
b. Heat + $PCl_5 \leftrightarrow PCl_3 + Cl_2$
c. Heat + $N_2 + O_2 \leftrightarrow 2NO$
d. $CO + H_2O \leftrightarrow CO_2 + H_2$ + Heat
e. $N_2 + 3H_2 \leftrightarrow 2NH_3$ + Heat

20) State the effect of an increase of pressure:
a. $2NO(g) + O_2\,(g) \leftrightarrow 2NO_2\,(g)$ + Heat
b. $CaCO_3\,(s) \leftrightarrow CaO\,(s) + CO_2\,(g)$
c. $H_2(g) + I_2\,(g) \leftrightarrow 2HI(g)$
d. $C_2H_4\,(g) + H_2\,(g) \leftrightarrow C_2H_6\,(g)$
e. $N_2\,(g) + 3H_2\,(g) \leftrightarrow 2NH_3\,(g)$

21) State the effect on the following equilibria if the stated stress is applied to the equilibrium indicated:
a. *(add O_2)* $2CO(g) + O_2\,(g) \leftrightarrow 2CO_2\,(g)$+ Heat
b. *(remove I_2)* $2HI(g) + O_2\,(g) \leftrightarrow 2H_2O\,(l) + I_2\,(s)$
c. *(add CO)* $H_2O\,(l) + CO(g) \leftrightarrow H_2\,(g) + CO_2\,(g)$
d. *(decrease pressure)* $CO(g) + 2H_2\,(g) \leftrightarrow CH_3OH$
e. *(remove HCl)* $H_2\,(g) + Cl_2\,(g) \leftrightarrow 2HCl\,(g)$

22) What is the effect on the [concentration] of chlorine if we---
a. (Add PCl_5) $PCl_{5(g)} \leftrightarrow PCl_{3(g)} + Cl_{2(g)}$
b. (Add CO) $CO_{(g)} + Cl_{2(g)} \leftrightarrow COCl_{2(s)}$
c. (Decr. pressure) $H_{2(g)} + Cl_{2(g)} \leftrightarrow 2HCl_{(g)}$
d. (Incr. pressure) $2HI_{(g)} + Cl_{2(g)} \leftrightarrow 2HCl_{(g)} + I_{2(s)}$
e. (Cool) $4HCl_{(aq)} + O_{2(g)} \leftrightarrow 2Cl_{2(g)} + 2H_2O_{(l)}$ + heat

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23) For the system, if we start with 0.100 mol/L of CO_2 and H_2, what are the concentrations of the reactants and products at equilibrium given that K_{eq} = 0.64 at 900K?

CO_2 (g) + H_2 (g) ↔ CO (g) + H_2O (g)

24) $COBr_2$, can be formed by reacting CO with Br_2. A mixture of 0.400 mol CO, 0.300 mol Br_2, and 0.0200 mol $COBr_2$ is sealed in a 5.00L flask. Calculate equilibrium concentrations for all gases K_{eq} = 0.680.

CO (g) + Br_2 (g) ↔ $COBr_2$ (g)

25) $2NH_3(g) \leftrightarrow N_2(g) + 3H_2(g)$ At 500 K, the following concentrations were measured: $[N_2] = 3.0 \times 10^{-2}$ M, $[H_2] = 3.7 \times 10^{-2}$ M, $[NH_3] = 1.6 \times 10^{-2}$ M. What is Kc?

26) At 1000 K, the equilibrium partial pressures for the reaction below are: CH_4 = 0.20 atm, H_2S = 0.25 atm, CS_2 = 0.52 atm, and H_2 = 0.10 atm. What is Kp?

27) A mixture of 1.0 mole carbon dioxide and 1.0 mole carbon monoxide are contained in a 1 liter vessel. Later 2.0 moles of water vapor is then introduced into the vessel. The following reversible reaction takes place

$$CO + H_2O \leftrightarrow CO_2 + H_2$$

This reaction has an equilibrium constant of 0.64. How many moles of the different molecules will be present after equilibrium is obtained?

28) 3.00 moles of N2 gas and 1.00 mole of H2 gas are combined in a 1 L reaction vessel. At equilibrium 0.663 moles of H2 remain. What are the resulting concentrations?

$$N_2 + 3H_2 \Leftrightarrow 2\ NH_3$$

29) Phosphorus pentachloride decomposes into Phosphorous tri chloride and Chlorine gas. 0.500 moles of pure Phosphorus pentachloride is placed in a 2.00 L bottle. What are the resulting concentrations?

$$PCl_{5(g)} \Leftrightarrow PCl_{3(g)} + Cl_{2(g)}$$

$$Kc = 0.0211$$

30) Consider the reaction for the decomposition of hydrogen iodine gas at 448C. The initial concentration of HI was 1.00 mol/L. Once an equilibrium was established, the concentration of HI was measured to be 0.078 mol/L. Calculate the equilibrium constant.

$$HI_{(g)} \Leftrightarrow H_{2(g)} + I_{2(g)}$$

31) Nitrogen dioxide can break down into nitrogen monoxide and oxygen gas. The equilibrium constant for this reaction is K= 0.40. If the equilibrium concentration of NO_2 gas is 0.2M and the equilibrium concentration of NO gas is 1M, what is the equilibrium concentration of the oxygen gas?

32) A mixture consisting initially of 3.00 moles NH3, 2.00 moles of N2, and 5.00 moles of H2, in a 5.00 L container was heated to 900 K, and allowed to reach equilibrium. Determine the equilibrium concentration for each species present in the equilibrium mixture.

$$2\ NH_{3(g)} \leftrightarrows N_{2(g)} + 3\ H_{2(g)} \quad Kc = 0.0076$$

33) 4.00 moles of HI are placed in an evacuated 5.00 L flask and then heated to 800 K. The system is allowed to reach equilibrium. What will be the equilibrium concentration of each species?

$$2\ HI(g) \leftrightarrows H_2(g) + I_2(g) \quad Kc = 0.016$$

34) 0.600 moles of NO and 0.750 moles of O2 are placed in an empty 2.00 L flask. The system is allowed to establish equilibrium. What will be the equilibrium concentration of each species in the flask?

$$2\ NO_2(g) \leftrightarrows 2\ NO(g) + {}_{O2}(g) \quad Kc = 0.50$$

35) The concentrations of an equilibrium mixture of O2 , CO, and CO2 were 0.18 M, 0.35 M, and 0.029 M respectively. Enough CO was added to the flask containing the equilibrium mixture to momentarily raise its concentration to 0.60 M. What will be the concentration of each species in the flask once equilibrium has been re-established after the additional carbon monoxide was added?

$$2\ CO_2(g) \leftrightarrows 2\ CO(g) + O_2(g)$$

36) Which of the following is a true statement about the role of catalysts in a reaction?

a. Catalysts more effectively lowers the activation energy in the forward direction.
b. Catalysts generally react with one or more reactants to form intermediates that subsequently give the final reaction product..
c. If a catalyst affects the equilibrium of the reaction, it must be consumed as the reaction proceeds.
d. Catalysts can may increase the reaction rate or selectivity or enable the reaction at a lower temperature.