CHEM 130 Name ____

Quiz 10 – Due at the start of class Monday, December 3, 2018

Complete the following problems. Write your final answers in the blanks provided. You must show your work to receive full credit. Show your answers to the correct number of significant figures with the correct units.

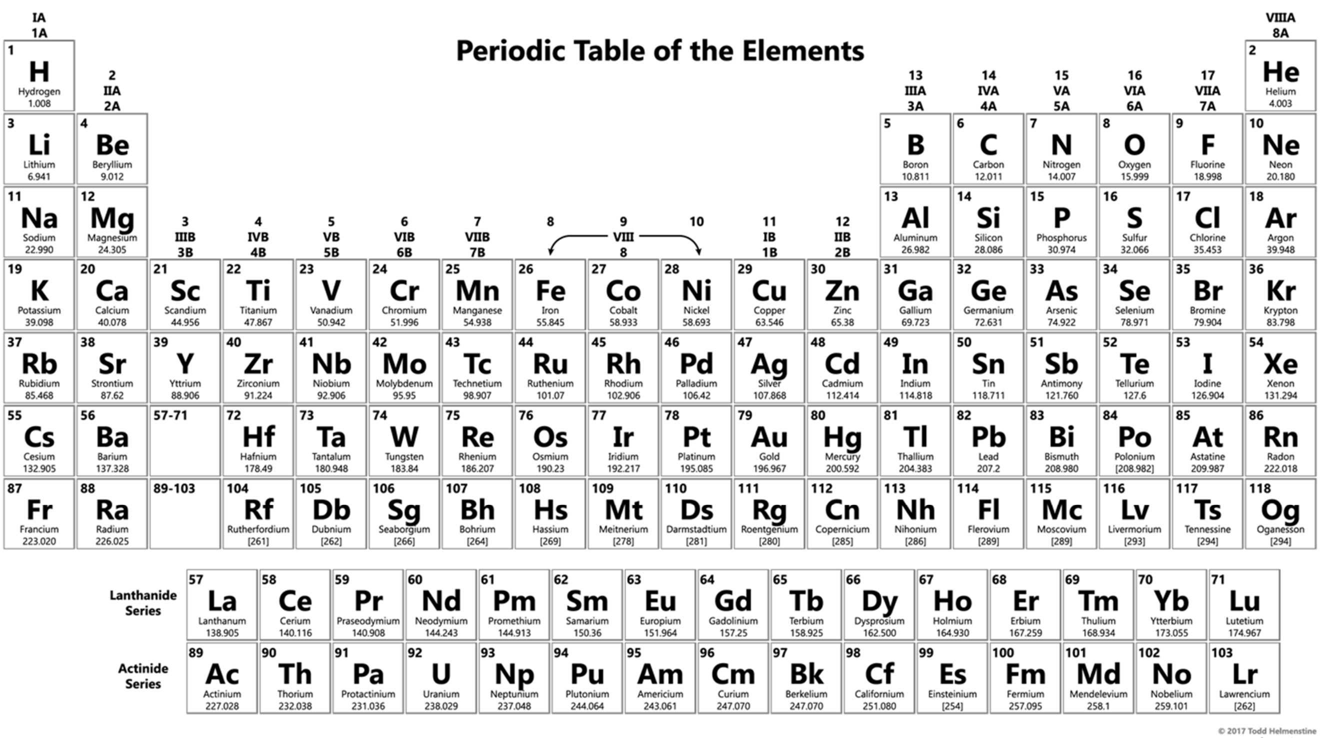
Rules for this take-home quiz.

DO NOT OPEN THE QUIZ UNTIL YOU ARE READY TO TAKE IT!

- You may allocate a maximum of **<u>50 continuous minutes</u>** for this quiz, split in to two 25-minute segments.
- For the first 25-minute segment, you will take the quiz using only the materials on these pages, a calculator and a **<u>pencil</u>**. Treat this time as though you were taking the quiz in the classroom. You may not use your book, notes, electronic sources or anyone else to help. Record the start and end of the first 25 minutes below.
- For the second 25 minutes, you may use your book, notes or electronic resources to make any corrections to your work. **Make these corrections in blue or red pen.** You **MAY NOT** ask anyone else for help. Record the end of the second 25 minute block below.
- Once you have completed the quiz, sign below to affirm that the quiz was taken following the rules above. This signature is your pledge that the quiz was completed in an ethical manner!

Start time: _______________ End of 1st 25 minutes: _______________ End of 2nd 25 minutes: _____________

Signature____Date___________________________



Possibly Useful Information

$(a + b)(c + d) = ac + ad + bc + bd$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	$R = 0.08206$ L atm mol^{-1} K^{-1} $R = 8.314$ J mol^{-1} K^{-1}
$pV = nRT$	$\Delta G = -RT\ln K$	$K_p = K_c(RT)^{\Delta n}$

1. Determine K_p for the reaction: $N_2(g) + O_2(g) + Cl_2(g) \rightleftharpoons 2NOCl(g)$ from the following data at 298K: (8 pts)

$$\tfrac{1}{2} N_2(g) + O_2(g) \rightleftharpoons NO_2(g) \qquad K_p = 1.0 \times 10^{-9}$$
$$NOCl(g) + \tfrac{1}{2} O_2(g) \rightleftharpoons NO_2Cl(g) \qquad K_p = 1.1 \times 10^{2}$$
$$NO_2(g) + \tfrac{1}{2} Cl_2(g) \rightleftharpoons NO_2Cl(g) \qquad K_p = 0.3$$

We need to rearrange reactions to make our target reaction:

$$2(\tfrac{1}{2} N_2(g) + O_2(g) \rightleftharpoons NO_2(g)) \qquad K_p = (1.0 \times 10^{-9})^2$$
$$2(NO_2Cl(g) \rightleftharpoons NOCl(g) + \tfrac{1}{2} O_2(g)) \qquad K_p = 1/(1.1 \times 10^{2})^2$$
$$2(NO_2(g) + \tfrac{1}{2} Cl_2(g) \rightleftharpoons NO_2Cl(g)) \qquad K_p = (0.3)^2$$

So, the sum of the reactions is:

$$N_2 + \cancel{2}O_2 + 2\cancel{NO_2Cl} + \cancel{2NO_2} + Cl_2 \rightleftharpoons \cancel{2NO_2} + \cancel{2NOCl} + \cancel{O_2} + 2NO_2Cl$$
$$N_2 + O_2 + Cl_2 \rightleftharpoons 2NO_2Cl$$

$$K_p = \frac{(1.0 \times 10^{-9})^2(0.3)^2}{(1.1 \times 10^{2})^2} = 7.4\text{x}10^{-24}$$

Answer_____7×10^{-24}______

2. Consider the equilibrium below. At a certain temperature, 0.740 mol of SO_3 is placed in a 2.00-L container. At equilibrium, 0.180 mol of O_2 is present. Calculate K_c. (8 pts)

$$2SO_3\,(g) \rightleftharpoons 2SO_2\,(g) + O_2\,(g)$$

The initial concentration of SO_3 = (0.740 mol)/2.00 L = 0.370 M SO_3

We need to determine equilibrium concentrations for all species. Since we have no SO_2 or O_2initially, we know the reaction must produce more products and consume reactants. Mapping out the chemistry:

	$2SO_3$	$\rightleftharpoons$	$2SO_2$	+	O_2
i	0.370M		0		0
c	-2x		+2x		+x
e	0.370-2x		2x		x

We are told that there is 0.180 mol of O_2 present at equilibrium. Therefore, x must be

0.180 mol/2.00 L = 0.0900M

And:

$[SO_3]$ = 0.370M-2(0.0900M) = 0.190M

$[SO_2]$ = 2(0.0900M) = 0.180M

Plugging in to K_c:

$$K_c = \frac{[SO_2]^2[O_2]}{[SO_3]^2} = \frac{(0.180)^2(0.0900)}{(0.190)^2} = \mathbf{0.0808}$$

Answer_____0.0808______

3. Consider the reaction below. If the initial concentrations of H_2, F_2, and HF are 0.100M, 0.250 M, and 2.20 M, respectively, is the system at equilibrium? If not, which way will the reaction go to achieve the equilibrium condition? Set up, but do not complete the calculation you would use to determine the equilibrium concentrations of each of the species in the reaction. You DO NOT need to arrive at a numerical answer, just get to the point where you have one algebraic expression you could solve, given additional time. **Be sure to tell me what you would do with the result of your calculation.** (9 pts)

$$H_2(g) + F_2(g) \rightleftharpoons 2HF(g) \qquad K = 115$$

Since we have intimal concentrations of all species, we need to calculate Q first to determine the direction the reaction must go to get to equilibrium.

$$Q = \frac{[HF]^2}{[H_2][F_2]} = \frac{(2.20\text{ M})^2}{(0.100\text{ M})(0.25\text{ M})} = 194$$

Since Q>K, the reaction is product heavy and more reactants will be formed on the way to equilibrium.

	H_2	+	F_2	$\rightleftharpoons$	2 HF
i	0.100 M		0.25 M		2.20 M
c	+x		+x		-2x
e	0.100 + x		0.25 +x		2.20 – 2x

Insert these values into the equilibrium constant expression:

$$K = \frac{[HF]^2}{[H_2][F_2]} = \mathbf{\frac{(2.20 - 2x)^2}{(0.100 + x)(0.25 + x)} = 115}$$

The boldface expression can now be solved for x, giving two possible solutions (quadratic). This is as far as you needed to go. If you did continue and solve he expression, after choosing the chemically sensible solution, equilibrium concentrations can be calculated:

$[HF] = (2.20 – 2x)M$, $[H_2] = (0.100 + x)M$, $[F_2] = (0.25 + x)M$