“Recitation” CHMG 142 Group names:______________________

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Halogens, HON!

Piece #1 (1/2 pt). Carbon monoxide gas and chlorine gas will react to form $COCl_2$ gas. Write a balanced equation for this reaction.

$CO\ (g) + Cl_2\ (g) \leftrightarrow COCl_2\ (g)$

Piece #2 (1/2 pt) Carbon monoxide gas and chlorine gas will react to form $COCl_2$ gas. . This reaction is an equilibrium reaction. Write the equilibrium constant expression (K_c) for this reaction.

$$K_c = \frac{[COCl_2]}{[CO][Cl_2]}$$

Piece #3 (1/2 pt) Carbon monoxide gas and chlorine gas will react to form $COCl_2$ gas. 2 moles of carbon monoxide and 2 moles of chlorine are mixed in a 2 L flask at 350 K. Construct the ICE chart for this reaction. You don't need to solve it, just fill in ALL the boxes.

	CO(g)	+ Cl_2 (g)	↔	$COCl_2$ (g)
I	$\frac{2\,mol}{2\,L} = 1\,M$	$\frac{2\,mol}{2\,L} = 1\,M$		0 M
C	-x	-x		+x
E	1 M – x	1 M-x		x

Piece #4 (1/2 pt) Carbon monoxide gas and chlorine gas will react to form $COCl_2$ gas. 2 moles of carbon monoxide and 2 moles of chlorine are mixed in a 2 L flask at 350 K. Put your EQUILIBRIUM concentrations of all species into the equilibrium constant expression from piece #2.

$$K_c = \frac{[COCl_2]}{[CO][Cl_2]} = \frac{(x)}{(1-x)(1-x)}$$

Piece #5 (1/2 pt) Carbon monoxide gas and chlorine gas will react to form $COCl_2$ gas. 2 moles of carbon monoxide and 2 moles of chlorine are mixed in a 2 L flask at 350 K. The equilibrium constant for this reaction at 350 K is 0.123 Insert the equilibrium constant into the equilibrium constant expression from piece #4.

$$0.123 = \frac{(x)}{(1-x)(1-x)}$$

Piece #6 (1/2 pt) The equilibrium constant expression in piece #5 is a solvable polynomial expression. DON'T solve it. Make a simplifying assumption about the relative size of "x". Rewrite the equilibrium constant expression as the simplified polynomial.

$$0.123 = \frac{(x)}{(1-x)(1-x)}$$

Assume x<<1

Then $1 - x \approx 1$

$$0.123 = \frac{(x)}{(1-x)(1-x)} \approx \frac{x}{(1)(1)}$$

Piece #7 (1/2 pt) SOLVE the simplified polynomial from Piece #6.

$$0.123 \approx \frac{x}{(1)(1)}$$

$$x = 0.123\ M$$

Piece #8 (1/2 pt) Use the "5% rule" to assess the quality of your simplifying assumption. Does it pass the test?

X was compared to 1 M.

5% of 1 M is: $\frac{1\,M}{20} = 0.05\ M$ or $0.05 \times 1M = 0.05\ M$

I found x to be 0.123 M

0.123 M > 0.05 M, so it FAILS the 5% rule.

Piece #9 (1/2 pt) IF IF IF and only IF the 5% rule fails, return to the unsimplified polynomial from Piece #5 and SOLVE the polynomial. [Hint: Foil the denominator. Cross-multiply. Collect like powers of x. Use the quadratic equation to solve. OR you can use solver on your calculator or wolfram-alpha.]

$$0.123 = \frac{(x)}{(1-x)(1-x)}$$

$$0.123 = \frac{x}{1 - x - x + x^2} = \frac{x}{1 - 2x + x^2}$$

$$0.123 - 0.246x + 0.123\,x^2 = x$$

$$0.123 - 1.246x + 0.123\,x^2 = 0$$

In standard quadratic form: $ax^2 + bx + c = 0$:

$$0.123\,x^2 - 1.246x + 0.123 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-(-1.246) \pm \sqrt{(-1.246)^2 - 4(0.123)(0.123)}}{2(0.123)}$$

$$x = \frac{1.246 \pm \sqrt{1.492}}{0.246} = \frac{1.246 \pm 1.221}{0.246} = 0.102 \; and \; 10.03$$

Piece #10 (1/2 pt) 2nd order polynomial equations have TWO roots. Substitute each of the two roots back into the ICE chart from Piece #3. Put an X through the ICE chart that makes no sense and CIRCLE the ICE chart that is your final solution.

	$CO(g)$	$+ Cl_2$ (g)	$\leftrightarrow$	$COCl_2$ (g)
I	$\frac{2\,mol}{2\,L} = 1\,M$	$\frac{2\,mol}{2\,L} = 1\,M$		0 M
C	-10.3	-10.3		+10.3
E	-9.3 M	-9.3 M		10.3 M

	$CO(g)$	$+ Cl_2$ (g)	$\leftrightarrow$	$COCl_2$ (g)
I	$\frac{2\,mol}{2\,L} = 1\,M$	$\frac{2\,mol}{2\,L} = 1\,M$		0 M
C	-0.102	-0.102		+0.102
E	0.898 M	0.898 M		0.102 M

If you wanted to double-check, you could plug the E-values back into the K_C equation.

Negative Molarity makes no sense, so the top ICE chart is physically impossible. So the bottom ICE chart is my answer.