Name_____________
Class_____________
Date_____________

SOLVING EQUILIBRIUM PROBLEMS WITH THE TI-NSPIRE

Discussion:

The equilibrium constant (K) for any given reaction does not vary so long as the temperature of the reaction remains constant. The usual temperature for equilibrium calculations is room temperature (25°). The Law of Mass Action will be used to solve for the unknown species (x):

$$K=\frac{[C]^l[D]^m}{[A]^j[B]^k}$$

When the concentration of a species (x) in an equilibrium expression is to be determined, it is often necessary to use the quadratic formula or to approximate using the 5% rule. When the value of K is relatively large, the 5 % rule fails and other, more complicated means of solution are necessary. With the TI-Nspire Numerical Solve function, solving for the value of x is extremely quick and easy.

Objective:

In this activity the student will use the Calculator application to determine the unknown species (x) using known initial concentrations, the change in concentration, and a given value for the equilibrium constant (K). The student will use the following functions:

1. the Calculator Application
2. the Numerical Solve Function

Procedure:

A. The equilibrium reaction that we will be working with is:

$$2NOCl_{(g)} \leftrightarrow 2NO_{(g)} + Cl_{2(g)}$$

B. The equilibrium expression for this reaction is:

$$K=\frac{[NO]^2[Cl_2]}{[NOCl]^2}$$

Where K = 1.6 x 10^{-5}

C. The concentrations can be summarized as follows:

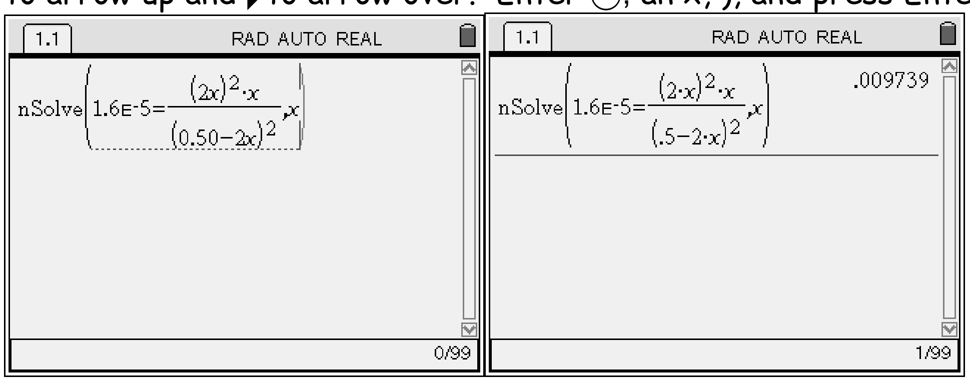
	$2NOCl_{(g)}$	↔	$2NO_{(g)}$	$Cl_{2(g)}$
Initial	0.50		0	0
Change	-2x		+2x	+x
Equilibrium	0.50-2x		2x	x

D. Substituting into the Law of Mass Action gives the following result:

$$1.6 \text{ x } 10^{-5} = \frac{[2x]^2[x]}{[0.50\text{-}2x]^2}$$

E. Turn on the TI-Nspire and choose the (home) on the upper right. Choose New Document and choose Calculator.

E. To calculate x, choose Menu, Calculations, Numerical Solve. Inside the parentheses, enter 1.6x10^{-5}, choose (=), choose (ctrl) (fraction), then enter $(2x)^2$ * x in the top of the fraction. Use the ▼ on the NavPad to move to the denominator of the fraction and enter $(0.50\text{-}2x)^2$. Use the ▲ to arrow up and ▶ to arrow over. Enter (,), an x,), and press Enter.



The value of **x** will be given as 9.8 x 10^{-3}M to two significant figures.

G. The equilibrium concentrations for the reaction will be as follows:

[NOCl] = 0.50 – 2x = 0.48 M

[NO] = 2x = 2(9.8 x 10^{-3}) = 1.9 x 10^{-2} M

[Cl_2] = x = 9.8 x 10^{-3}M

H. **Selfcheck**: **Always** check calculations by substituting the values that were determined into the Equilibrium Expression. If the K value calculated from these values equal the given value of K, then the calculations are correct.

PartII:

A. While the previous problem could not have been solved using the quadratic formula, it could have been approximated by using the 5%

rule. The next problem has a large value of K; therefore, the 5 % rule would not work for this example.

B. The equilibrium reaction that we will be working with is called the Haber Process and is as follows:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

C. The equilibrium expression for this reaction is:

$$K = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K = 5.27 \times 10^5$$

D. The concentrations can be summarized as follows:

	$N_{2(g)}$	$3H_{2(g)}$	↔	$2NH_{3(g)}$
Initial	0	0		2.12×10^{-3}
Change	+x	+3x		-2x
Equilibrium	+x	+3x		$2.12 \times 10^{-3} - 2x$

E. Substituting into the Law of Mass Action gives the following result:

$$5.27 \times 10^5 = \frac{\left[2.12 \times 10^{-3} - 2x\right]^2}{[x][3x]^3}$$

F. Turn on the TI-Nspire and choose the con the upper right. Choose New Document and choose Calculator.

G. Solve for x as in the previous example and then calculate the concentrate the equilibrium concentrations of the reactants and products.

$[N_2]$ = ______M

$[H_2]$ = ______M

$[NH_3$ = _____M

H. **Selfcheck:** Check the validity of the equilibrium concentrations by substituting back into the Equilibrium Expression and solving for K.

Evaluation:

Students will be expected to master the skills taught in this exercise in order to solve equilibrium problems. Final evaluation will be use of those skills to solve similar problems on the Equilibrium Unit Test. See the following rubric.

Skill	**Complete activity without referring to instructions (3 points)**	**Complete activity with reference to instructions (2 points)**	**Complete activity with teacher assistance (1 point)**
Enter data into lists			
Name lists			
Use formulas to populate data			
Determine regression equations			
Graph data			
Plot regression equations			
Use the calculator application			