Please note that all calculations below can be worked without the aid of a calculator.

1. Write a mass action quotient for the following chemical equation:
   $CaCO_3(s)$ □ $CaO(s) + CO_2(g)$

2. Write a mass action quotient for the following chemical equation:
   $H_2O(l)$ □ $H^+(aq) + OH^-(aq)$

3. Based on your answers to numbers 1 & 2, what types of reactants and products always appear in mass action quotients? What types never appear in mass action quotients? Why?

4. What are the units of **all** equilibrium constants?

5. Complete the RICE diagram below. Express unknown quantities in terms of X.

Reaction	$CO(g)$	+	$NO_2(g)$	□	$CO_2(g)$	+	$NO(g)$
Initial	5 M		5 M		0 M		
Change							
Equilibrium							8 M

6. Assuming K = 0.5, what was the initial concentration of NO(g)?

7. How would the chemical system in numbers 5 & 6 respond to a decrease in volume? What about addition of CO(g)? What about removal of NO(g)?

8. The Clausius-Clapeyron equation and the van't Hoff equation are very similar in appearance. What is the main difference between the two equations and why are they so similar?

9. Based on the van't Hoff equation, how will an exothermic reactions equilibrium constant respond to changes in temperature? What about an endothermic reaction?

10. In a 1 liter container you initially have one mole of each species below.
   $4Fe(s) + 3O_2(g)$ □ $2Fe_2O_3(s)$ $K = 10^{12}$
What happens as this system approaches equilibrium?

11. List the 7 strong acids from memory.

12. List the 8 strong bases from memory.

13. What would be the pH of 1 liter of a 10 M solution of nitric acid?

14. Ho many grams of barium hydroxide would be needed to neutralize the solution in number 13

15. Rank the following solutions from lowest pH to highest pH: 0.5 M HI, 0.1 M $Sr(OH)_2$, 2 M $HClO_4$, 0.5 M H_2SO_4, 0.1 M NaOH, 2 M KOH.

16. What is meant by the term "autoprotolysis of water?" What chemical equation describes this?

17. What is K_w? What is its value to at room temperature? How does temperature influence K_w?

18. What would be the pOH of a 0.5 M solution of a weak acid with a $K_a = 2 \times 10^{-4}$?

19. Complete the RICE diagram for the reaction of a general weak base (:B) with water. Use general terms (e.g. C_b for initial concentration of base).

Reaction	:B(aq) +	$H_20(l)$	---->	$BH^+(aq)$	+	$OH^-(aq)$
Initial						
Change						
Equilibrium						

20. Write K for the reaction in number 19 and then substitute the values from the RICE diagram.