$\frac{\quad}{37} =$ %

Name: _____

SCH 4U - Qualatitive Equilibrium

1. The following equilibrium is the equilibrium that occurs within a can of pop (when sealed):

$CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$ ΔH = negative value

The carbon dioxide gas will dissolve in water and react with water molecules to form carbonic acid. Suggest two ways in which the concentration of $H_2CO_3(aq)$ can be maximized. Explain your choices clearly using Le Chatelier's Principle.

consider temperature

D shift right

H exothermic reaction

R ↑Q

S ↓Q

∴ lower temperature

consider pressure

D shift right

H make less moles of gas

R ↓P

S ↑P

∴ increase pressure

(or reduce volume

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2. List six criteria that must be met before one can be certain that a given reaction is an equilibrium reaction. Order is not important

1.	reversable physical or chemical change
2.	consistency of observable properties
3.	forward and reverse reaction rates are equal
4.	closed system
5.	equilibrium can be established from react/prod.
6.	continuous activity at the molecular level

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3. $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ $\Delta H = -$

Explain the effect on the concentration of carbon monoxide gas and the K_{eq} value for this equilibrium when:

a) the volume is increased

S: ↓P
R: ↑P
H: make more moles of gas
D: shift left
E: ↑n_{CO} but ↑in volume results in an overall slight ↓[CO]

no effect on K_{eq} (not affected pressure or concentrations)

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b) the temperature is increased

S: ↑Q
R: ↓Q
H: endothermic
D: shift left
E: ↑[CO]

∴ ↓K_{eq} i.e. $\downarrow K_{eq} = \frac{[CO][Cl_2]\downarrow}{\uparrow[CO]\uparrow[Cl_2]}$

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4. Write the equilibrium expression for each of the following:

a) $AlCl_3(s) \rightleftharpoons Al^{3+}(aq) + 3Cl^{1-}(aq)$

$$K_{sp} = [Al^{3+}][Cl^{1-}]^3$$

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b) $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

$$K_{eq} = \frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5}$$

/2

c) $2Fe_2O_3(s) + 6Cl_2(g) \rightleftharpoons 4FeCl_3(s) + 3O_2(g)$

$$K_{eq} = \frac{[O_2]^3}{[Cl_2]^6}$$

/2

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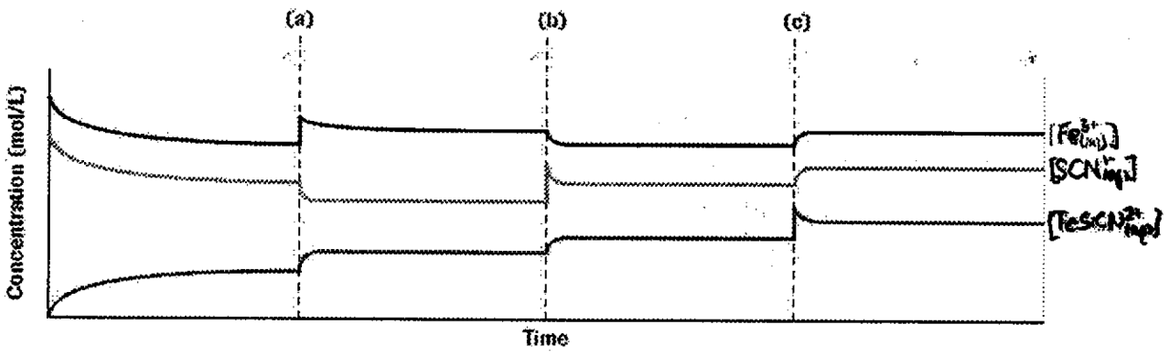
5. The concentration vs time curve shown below is for the equilibrium studied in class with the help of the overhead projector:

$$FeSCN^{2+}(aq) \rightleftharpoons Fe^{3+}(aq) + SCN^{1-}(aq)$$

If you recall, this equilibrium was produced by mixing a solution made from $Fe(NO_3)_3(s)$ to a solution made from KSCN(s)



Answer the following questions:

a) In general, how can you tell if the system is at equilibrium (as apposed to on the way to equilibrium)?

- lines are flat

b) What may have happened at a)

- injection of Fe^{3+} (add $Fe(NO_3)_3$)

c) What may have happened at b)

- injection of SCN^{1-} (add KSCN)

d) What was the initial $[FeSCN^{2+}(aq)]$ at time = 0 and how is this possible given the above equilibrium reaction equation

- $[FeSCN^{2+}] = 0$ at $t = 0$
- equilibrium established from products

e) What is the equilibrium expression for this equilibrium

$$K_{eq} = \frac{[Fe^{3+}][SCN^-]}{[FeSCN^{2+}]}$$

f) How could one prove that this entire concentration curve was performed at a constant temperature

- determine K_{eq} at different parts of the experiment (would need to know concentrations for this)
- if K_{eq} are the same temp is constant