

Key

Name:

[Redacted Name]

period:

5^o

date:

5/18/22

ch. 18 & 19 equilibrium and acid / base / pH

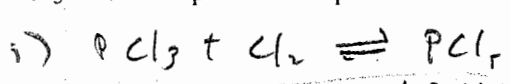
test

70 points

honors chemistry

In problems involving any calculation, show your work in an organized manner, include (i) any relevant equation (or formula), (ii) conversion factor(s), (iii) put the proper units in your calculations and answer, and (iv) have the proper number of significant figures in your answer.

1. In the reaction: $\text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{PCl}_5(\text{g})$, mixing 5.0 mM PCl_3 , 6.0 mM Cl_2 , and 100.0 mM PCl_5 , how much PCl_5 would be present at equilibrium if the equilibrium constant's value is 2.0? [20 points]



I	5 mM	6 mM	100 mM
C	-x	-x	+x
E	(5 mM - x)	(6 mM - x)	(100 mM + x)

$$Q = \frac{[\text{PCl}_5]}{[\text{PCl}_3][\text{Cl}_2]} = \frac{100 \cdot 10^{-3}}{(5 \cdot 10^{-3})(6 \cdot 10^{-3})} = \frac{1}{30} \cdot 10^5$$

$\therefore Q > K \rightarrow$ [C] $\text{PCl}_5 \rightarrow$ " - "
or
constant guess

ii) $K_c = \frac{[\text{PCl}_5]}{[\text{PCl}_3][\text{Cl}_2]}$

$$2 = \frac{0.1 - x}{(0.005 + x)(0.006 + x)}$$

\downarrow
 $x = \cancel{0.079}, 0.084$

iii) $[\text{PCl}_5] = 0.1 - 0.084 = 0.016 \text{ M}$

7pts

2. What is the pH of 75 mL of 25.0 mM nitric acid, a strong acid? [10 points]

4
3
3

$$\text{pH} = -\log[\text{H}^+] = -\log(25 \cdot 10^{-3}) = 1.60$$

3. What would be the effect of ^{decrease} ~~decreasing~~ the volume on the number of moles of the product in the below chemical reactions at equilibrium? basis / rationale? [10 points]

a. $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$ [i.e. ^{decrease} ~~increase~~ container's volume]

Free

2pt

$$i) Q = \frac{n_{\text{PCl}_3} n_{\text{Cl}_2} (\frac{1}{V})^2}{n_{\text{PCl}_5} (\frac{1}{V})} \quad \cdot \quad \frac{n_{\text{PCl}_3} n_{\text{Cl}_2}}{n_{\text{PCl}_5} V}$$

3

ii) $\downarrow V \rightarrow \uparrow Q \rightarrow \downarrow Q \text{ to reestablish equilibrium} \rightarrow \downarrow n_{\text{PCl}_5} \text{ \& } n_{\text{Cl}_2}$

b. $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightleftharpoons \text{NaNO}_3(\text{aq}) + \text{AgCl}(\text{s})$ [i.e. add water]

Free

2pt

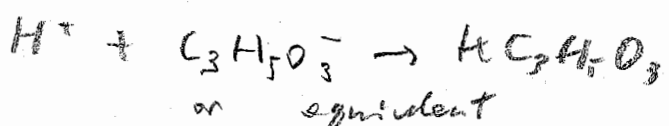
$$i) Q = \frac{n_{\text{NaNO}_3} (\frac{1}{V})}{n_{\text{AgNO}_3} n_{\text{NaCl}} (\frac{1}{V})^2} \quad \cdot \quad \frac{n_{\text{NaNO}_3} V}{n_{\text{AgNO}_3} n_{\text{NaCl}}}$$

3

ii) $\downarrow V \rightarrow \downarrow Q \rightarrow \uparrow Q \text{ to reestablish equilibrium} \rightarrow \uparrow \text{ products AgCl \& } \text{NaNO}_3$

4. Write the net ionic equation that describes the reaction due to adding _____. [10 points]

a. HCl (aq) to an aqueous solution of lactic acid / sodium lactate

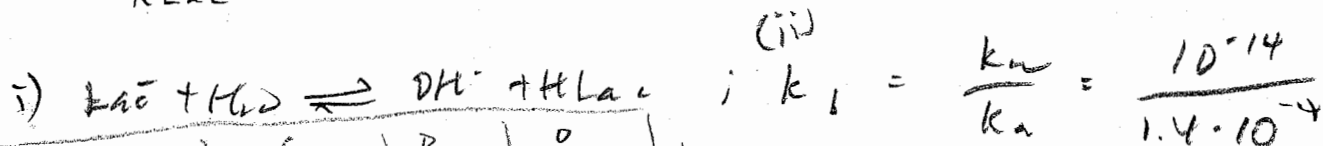


b. KOH (aq) to an aqueous solution of $\text{CH}_3\text{NH}_2 / \text{CH}_3\text{NH}_3\text{Cl}$



5. What is the pH of 75 mL of 25.0 mM potassium lactate? [20 points]

base salt



I	25mM	0	0
C	-x	+x	+x
E	25mM-x	x	x

ii) $k_b = \frac{[OH^-][HLa]}{[La^-]}$

$7.14 \cdot 10^{-11} = \frac{x^2}{0.025 - x} \approx \frac{x^2}{0.025}$

$x = \sqrt{0.025(7.14 \cdot 10^{-11})}$

$= 1.34 \cdot 10^{-6} M$

4pt

iii) $[H^+][OH^-] = 10^{-14}$
 $[H^+](1.34 \cdot 10^{-6}) = 10^{-14}$
 $[H^+] = 7.46 \cdot 10^{-9}$

iv) $pH = -\log[H^+]$
 $= -\log(7.46 \cdot 10^{-9})$
 $= 8.13$