

Name: _____

period: _____ date: _____

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

test

70 points (5 ec)

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.

@ constant Temperature unless stated otherwise

1. In regards to the reaction: $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ at equilibrium is disturbed by ____; what is the effect on the number of moles of NH_3 & N_2 ? Basis / rationale? [20 points]

a. Addition of neon at constant volume

2 pt
2
no change in n_{N_2} & n_{NH_3}
b/c Q is not a function of n_{Ne}

b. Addition of neon at constant pressure

i) add $Ne \rightarrow \uparrow n_{total} \rightarrow \uparrow P_{total}$, but $\uparrow V$ b/c @ constant P

2
2
ii) $Q = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{n_{NH_3}^2 (\frac{1}{V})^2}{n_{N_2} n_{H_2}^3 (\frac{1}{V})^3} = \frac{n_{NH_3}^2 V}{n_{N_2} n_{H_2}^3}$

2
iii) $\uparrow V \rightarrow \uparrow Q \rightarrow \downarrow Q$ to reestablish equl $\rightarrow \downarrow n_{NH_3} \rightarrow \uparrow r_1 \rightarrow \uparrow n_{N_2}$

c. Addition of hydrogen gas

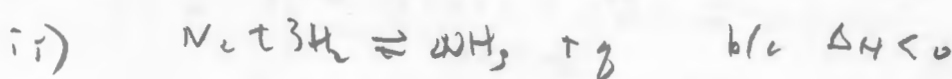
at constant V

5 pt
i) $\uparrow n_{H_2} \rightarrow \downarrow Q \rightarrow \uparrow Q$ to reestablish equl $\rightarrow \uparrow n_{NH_3} \rightarrow \uparrow r_2 \rightarrow \downarrow n_{N_2}$

free for 5° only

d. Increase in temperature

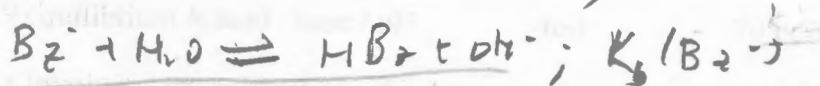
2 pt
i) $\Delta H = 2\Delta H_f(NH_3) - [\Delta H_f(N_2) + 3\Delta H_f(H_2)] < 0$ b/c $\Delta H_f(NH_3) < 0$



$\Delta r_{eq} = 2 - (1 + 3) = 0$

2
iii) $\uparrow T \rightarrow$ "want" $\downarrow T \rightarrow$ consume $\rightarrow \uparrow r_1 \rightarrow \downarrow n_{NH_3}$ & $\uparrow n_{N_2}$

5. What is the pH of a 125 mL aqueous solution of 1.0 mM sodium benzoate? [15 points]



ii)

| | | | | |
|---|----------|--|----|----|
| I | 1 mM | | 0 | 0 |
| C | -x | | +x | +x |
| E | 1 mM - x | | x | x |

iii) $K_b(\text{Bz}^-) = \frac{[\text{HBz}][\text{OH}^-]}{[\text{Bz}^-]}$

$\frac{K_w}{K_a(\text{HBz})} = \frac{x^2}{0.001 - x} \approx \frac{x^2}{0.001}$

$\frac{10^{-14}}{6.5 \cdot 10^{-5}} = \frac{x^2}{0.001} \rightarrow \sqrt{x^2} = \sqrt{1.538 \cdot 10^{-10}} (10^{-3})$

$x = 3.92 \cdot 10^{-7} \text{ M}$

iv) $[\text{H}^+][\text{OH}^-] = K_w$
 $[\text{H}^+](3.92 \cdot 10^{-7}) = 10^{-14}$
 $[\text{H}^+] = 2.55 \cdot 10^{-8}$

v) $\text{pH} = -\log[\text{H}^+]$
 $= -\log(2.55 \cdot 10^{-8})$
 $= 7.59$

3 ME

6. What is the pH of mixing 25 mL of 1.0 mM HCl (a strong acid) and 75 mL of 3.0 mM HNO₃ (a strong acid)? [10 points]

i) $[\text{H}^+] = \frac{n_{\text{H}^+}}{V} = \frac{n_{\text{H}^+ \text{ from HCl}} + n_{\text{H}^+ \text{ from HNO}_3}}{V}$

$= \frac{n_{\text{HCl}} + n_{\text{HNO}_3}}{V} = \frac{[\text{HCl}]V_{\text{HCl}} + [\text{HNO}_3]V_{\text{HNO}_3}}{V_{\text{HCl}} + V_{\text{HNO}_3}}$

$= \frac{1 \text{ mM} (25 \text{ mL}) + 3 \text{ mM} (75 \text{ mL})}{100 \text{ mL}} = 2.5 \text{ mM}$

ii) $\text{pH} = -\log[\text{H}^+]$
 $= -\log(2.5 \cdot 10^{-3})$

2 pt
2
2
2