~~77%~~ 92%

Eq Asmt

[44 marks]

$\frac{40.5}{44}$ Yowza!

Communication [3 marks] 3

1. The reaction of N_2 with O_2 to form NO might be considered a means of 'fixing' nitrogen:

$$N_2(g) + O_2(g) \leftrightarrow 2NO(g)$$

The value for the equilibrium constant for this reaction at 25°C is $K_c = 1 \times 10^{-30}$. Discuss the feasibility of this reaction for nitrogen fixation. [3 marks]

1×10^{-30} is very small, so a very small product to reactant ratio. Very little nitrogen is fixed, so most of it stays as $N_2(g) + O_2(g)$

3

Making Connections [8 marks] 8

2. Will lithium acetate form an acidic or basic solution? Explain your reasoning. [3 marks]

$LiCH_3COO(s) \rightarrow Li^+(aq) + CH_3COO^-(aq)$

$Li^+ + H_2O(l) \leftrightarrow LiOH(aq) + H^+(aq)$ → strong base (group 1)

$CH_3COO^- + H_2O(l) \rightleftharpoons HCH_3COO(aq) + OH^-(aq)$ → weak acid

3

∴, $LiCH_3COO$ is basic, because LiOH is a strong base, and will overpower HCH_3COO, which is a weak acid

3. For the reaction, $PBr_5(g) \leftrightarrow PBr_3(g) + Br_2(g)$ (heat +), in what direction will the equilibrium shift when the following actions are taken on the system at equilibrium? [5 marks]

(a) $Br_2(g)$ is removed right ✓

(b) the temperature is decreased left ✓

(c) the volume of the reaction system is decreased left ✓

(d) a catalyst is added none ✓

(e) $PBr_5(g)$ is removed left ✓

5

Inquiry [19 marks] 17

4. Calculate the pH of a 0.155 M solution of benzoic acid. [8 marks]

	$HAc(aq)$	$\rightleftharpoons$	$H^+(aq)$	$+$	$Ac^-(aq)$
I	0.155 M		0		0
C	$-x$		x		x
E	$0.155-x$		x		x

Ka benzoic acid $= 6.6\times10^{-5}$

$$K_a = \frac{[H^+][Ac^-]}{[HAc]}$$

1

$$6.6\times10^{-5} = \frac{x^2}{0.155-\cancel{x}}$$

$x = \sqrt{(0.155)(6.6\times10^{-5})}$

$x = 0.00001023M$

$x = 1.02\times10^{-5}$

$[H^+] = 1.02\times10^{-5}$

$pH = -\log(1.02\times10^{-5}M)$

$pH = 4.99$

$\boxed{pH = 5.0}$

$= 3.2\times10^{-3}$

$pH = -\log(3.2\times10^{-3})$

$= 2.49$

5. A 0.325 M solution of an unknown acid has a pH of 5.34. What is the K_a of the acid? [8 marks]

$C = 0.325M$

$pH = 5.34$

$K_a = ?$

	$HX(aq)$	$\rightleftharpoons$	$H^+(aq)$	$+$	$X^-(aq)$
I	0.325		0		0
C	$-x$		x		x
E	$0.325-x$		x		x

1 $$K_a = \frac{[H^+][X^-]}{[HX]} = \frac{x^2}{0.325-\cancel{x}}$$

2

$pH = -\log[H^+]$

$[H^+] = 10^{-pH} = 10^{-5.34}$

$[H^+] = 4.57\times10^{-6}$

3 $x = 4.57\times10^{-\cancel{5}\,6}$

$$\frac{(4.57\times10^{-\cancel{5}\,6})^2}{0.325} = K_a$$

$\boxed{K_a = 6.42\times10^{-9}}$

alculate the pH of a buffer that is 0.25 M in lactic acid, $HC_3H_5O_3$ (K_a=1.4 × 10^{-4}) and 0.20 M in sodium lactate, $NaC_3H_5O_3$. [3 marks]

$pKa = -\log Ka$
$= -\log(1.4\times10^{-4})$
3.85

← $HC_3H_5O_3$ $NaC_3H_5O_3$ → base

0.25M 0.2M

3

① $pH = pKa + \log\left(\frac{[NaC_3H_5O_3]}{[HC_3H_5O_3]}\right)$ → ② $pH = 3.85 + \log\left(\frac{0.2}{0.25}\right)$

③ $pH = 3.85 + (-0.0969) = \boxed{3.75}$

Knowledge & Understanding [14 marks] (2.5)

7. Show the neutralization reaction between sulfuric acid and potassium hydroxide. [4 marks]

4

$$H_2SO_4(aq) + 2KOH^{(aq)} \longrightarrow K_2SO_4 + 2H_2O(l)$$

8. Show the dissociation of ammonium phosphate in water. [2 marks]

1.5

$$(NH_4)_3PO_4 \longrightarrow 3(NH_4^+)(aq) + PO_4^{3-}(aq)$$

9. Calculate the molar solubility of zinc cyanide, at 25°C, in the presence of 0.20 M potassium cyanide. The K_{sp} for zinc cyanide at 25°C is 8.0 × 10^{-12}. [8 marks]

$K_{sp} = 8.0\times10^{-12}$

	$Zn(CN)_2(s)$ ⇌	$Zn^{2+}(aq)$	$+ 2CN^-(aq)$	
I	/	0	0.020	0.20
C	/	x	$2x$	
E	/	x	$0.020+2x$	

7

$K_{sp} = [CN^-]^2[Zn^{2+}]$

$8.0\times10^{-12} = (0.020+2x)^2(x)$

$8.0\times10^{-12} = 0.0004x$

$x = 0.00000002 = 2.0\times10^{-8}$ M $\frac{mol}{L}$

∴ molar solubility of $Zn(CN)_2$ is $\boxed{2.0\times10^{-8}\ M}$