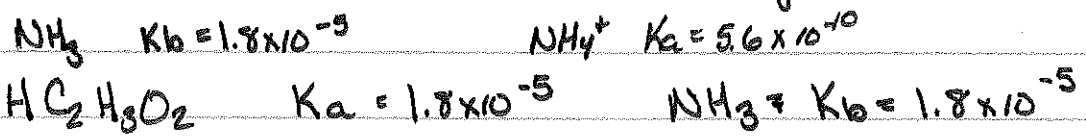


1/1

1st Determine the description of the contents of Each Beaker.
 2nd calculate the # of moles or millimoles of each species

Beaker	contents	Description	Amount
A	30 ml of 0.2M NaOH	Strong Base	(30)(.2) = 6mmol
B	50ml 0.3M H ₂ CO ₃	weak Acid	(50)(.3) = 15mmol
C	50ml 0.4M NH ₄ Cl	Acidic salt	(50)(.4) = 20mmol
D	60ml 0.1M HCl	Strong Acid	(60)(.1) = 6mmol
E	50ml 0.5M NaC ₂ H ₃ O ₂	BASIC salt	(50)(.5) = 25mmol
F	100ml 0.2M NH ₃	Weak Base	(100)(.2) = 20mmol
G	75ml 0.2M NaOH	Strong Base	(75)(.2) = 15mmol
H	37.5ml 0.2M NaOH	Strong Base	(37.5)(.2) = 7.5mmol
I	90 ml 0.2M NaOH	Strong Base	(90)(.2) = 18mmol



Beaker A

1) Strong Base $\text{pOH} = -\log [0.2]$ $\text{pH} = 14 - \text{pOH}$
 $= -\log [0.2]$ $\text{pH} = 13.30$
 $\text{pOH} = .70$

2) Beaker C = Acidic salt $K_a = 5.6 \times 10^{-10}$
 NH₄Cl

weak Base: NH₃ $\text{NH}_4\text{Cl} + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+$
 Strong Acid: HCl $\rightleftharpoons \text{NH}_4\text{Cl}$
 Strong wins $\rightleftharpoons \text{H}^+$

I	.4M	-	0	0
C	-x		x	x
E	.4-x		x	x

$K_a = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]}{[\text{NH}_4\text{Cl}]}$
 $K_a = \frac{(x)(x)}{.4-x}$ Assume 5%
 $(.4)(5.6 \times 10^{-10}) = x^2$

weak BASE Strong Acid

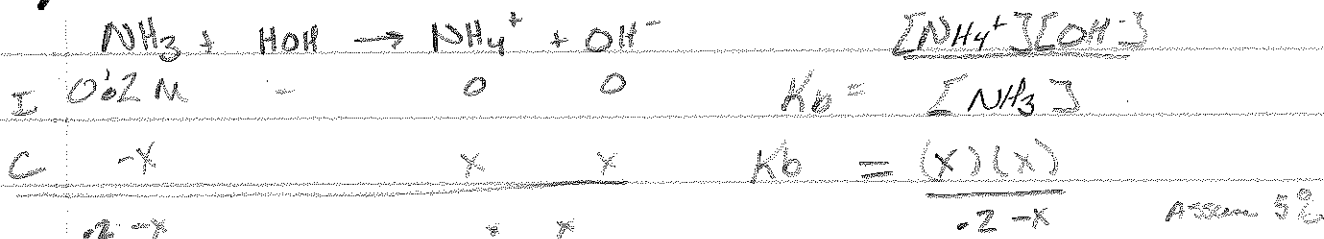
2) conti

$$X = 1.50 \times 10^{-5} \text{ M} = [\text{H}^+]$$

$$\text{pH} = -\log [\text{H}^+]$$

$$\boxed{\text{pH} = 4.82}$$

3) Beaker F NH_3 0.2M Weak Base $K_b = 1.8 \times 10^{-5}$



$$x^2 = (.2)(1.8 \times 10^{-5})$$

$$\text{pOH} = -\log [\text{OH}^-]$$

$$\text{pOH} = 2.72$$

$$[\text{OH}^-] = x = 1.90 \times 10^{-3}$$

$$\text{pH} = 14 - \text{pOH}$$

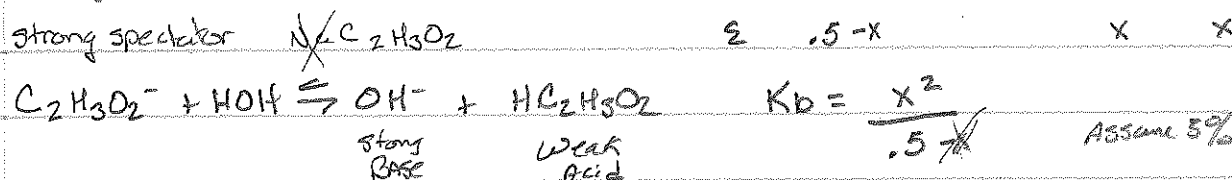
$$\boxed{\text{pH} = 11.28}$$

4) Beaker E $\text{NaC}_2\text{H}_3\text{O}_2$ Basic Salt

$$K_a = 1.8 \times 10^{-5} \quad 0.5\text{M}$$

$$K_b K_a = K_w$$

$$K_b = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$$



$$\text{pOH} = -\log [\text{OH}^-]$$

$$\text{pOH} = 4.78$$

$$\text{pH} = 14 - \text{pOH}$$

$$\boxed{\text{pH} = 9.22}$$

$$(.5)(5.6 \times 10^{-10}) = x^2$$

$$[\text{OH}^-] = x = 1.67 \times 10^{-5}$$

5) Beaker D 0.1M HCl
Strong Acid

$$pH = -\log \Sigma H^+$$

$$pH = -\log \Sigma .10$$

$$pH = 1.00$$

6) Beaker B 0.30M HC₂H₃O₂

Weak acid $K_a = 1.8 \times 10^{-5}$



$$K_a = \frac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$$

I	.30	-	0	0
C	-x		x	x
Σ	.30-x		x	x

$$1.8 \times 10^{-5} = \frac{(x)(x)}{.30 - x} \quad \text{Assume } x \ll .30$$

$$x = 2.32 \times 10^{-3} = [H^+]$$

$$pH = -\log \Sigma H^+$$

$$pH = 2.63$$

7) Beaker A + D

A → 30ml 0.20M NaOH 6mmol Strong Base

D → 60ml 0.10M HCl 6mmol Strong Acid



I	6mmol	6mmol	0	0
C	-x	-x	x	x
Σ	0	0	6	6

$$x = 6$$

Neutral Salt

$$pH = 7.0$$

8) Beaker A + B

A → 30ml 0.20M NaOH 6mmol Strong Base

B → 50ml 0.30M HC₂H₃O₂ 15mmol Weak Acid



I	6mmol	15mmol	-	0
C	-x	-x		+x
Σ	0	9mmol		6

$$x = 6$$

8) conti

In Beaker - water, weak acid, BASIC SALT

⇒ Buffer!



$[H^+] = K_a \frac{[Acid]}{[Base]}$

values from ICE Table!

$= (1.8 \times 10^{-5}) \left(\frac{9 \text{ mmol}}{6 \text{ mmol}} \right)$

$[H^+] = 2.7 \times 10^{-5}$

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

$pH = 4.57$

9) Beaker B+G

B ⇒ 50.0 ml 0.30 M HC₂H₃O₂

15 mmol

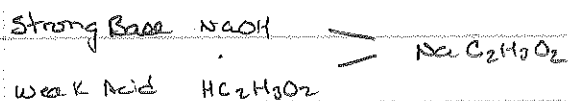
G ⇒ 75.0 ml 0.20 M NaOH

15 mmol



I	15 mmol	15 mmol	-	0
C	-x	-x		x
	0	0		15

In Beaker = BASIC SALT + H₂O



Strong wins ⇒ OH⁻

15 mmol	-	0	0
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Strong species NaC₂H₃O₂

x		x	x
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$K_a = 1.8 \times 10^{-5}$

15.0 x Assume 5%

$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}}$

$K_b = \frac{(x)(x)}{.12}$

$\frac{15.0 \text{ mmol}}{125 \text{ mL}} = .12 \text{ M}$

$K_b = 5.6 \times 10^{-10}$

$(.12)(5.6 \times 10^{-10}) = x^2$

$[OH^-] = x = 8.20 \times 10^{-6}$

* New Total Volume

$pOH = -\log [OH^-]$

$pH = 14 - pOH$

$50 + 75 = 125 \text{ mL}$

$pOH = 5.09$

$pH = 8.91$

10) Beaker B+H Beaker B 50ml 0.3M HC₂H₃O₂ 15mmol
 Beaker H 37.5ml 0.20M NaOH 7.5mmol



	I	15mmol	7.5mmol	-	0
x=7.5	C	-x	-x		x
		<u>-7.5</u>	<u>-7.5</u>		<u>7.5</u>
	E	7.5mmol	0		7.5mmol

In Beaker → Weak Acid, Basic Salt, H₂O

→ Buffer

$$K_a = 1.8 \times 10^{-5} \text{ HC}_2\text{H}_3\text{O}_2$$

$$[\text{H}^+] = K_a \frac{\text{Acid}}{\text{BASE}}$$

$$= (1.8 \times 10^{-5}) \frac{7.5 \text{ mmol}}{7.5 \text{ mmol}}$$

$$[\text{H}^+] = 1.8 \times 10^{-5}$$

$$\text{pH} = -\log[\text{H}^+]$$

$$\boxed{\text{pH} = 4.74}$$

11) Beaker B+I Beaker B 50ml 0.30M HC₂H₃O₂ 15mmol
 Beaker I 90ml 0.20M NaOH 18mmol



	I	15mmol	18mmol	0	0
x=15	C	-x	-x	*	x
		<u>-15</u>	<u>-15</u>		<u>15</u>
		0	3mmol		15mmol

In Beaker strong BASE, Basic Salt, water ⇒ Strong Base, Basic Salt

pH is dictated By the Strong Component
 New Volume = 50ml + 90ml = 140ml

11) cont.

3 mmol NaOH in Beaker w/ volume = 140 ml

$$\frac{3 \text{ mmol}}{140 \text{ ml}} = 0.021 \text{ M}$$

$$\text{pOH} = -\log [\text{OH}^-]$$

$$\text{pOH} = 1.68$$

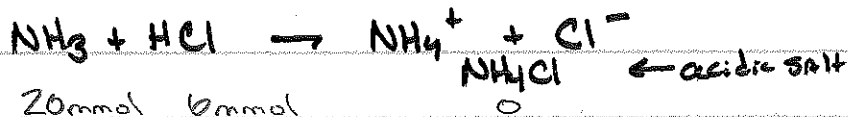
$$\text{pH} = 14 - \text{pOH}$$

$$\text{pH} = 12.32$$

12) Beaker F+D

Beaker F 100 ml 0.20 M NH_3 weak Base 20 mmol

Beaker D 60 ml 0.10 M HCl strong Acid 6 mmol



20 mmol 6 mmol

x=6

-x

-x

x

$$\text{NH}_4^+ K_a = 5.6 \times 10^{-10}$$

-6

-6

6

$$\text{NH}_3 K_b = 1.8 \times 10^{-5}$$

14 mmol

0

6 mmol

$$K_b > K_a$$

Weak Base

Acidic salt

\therefore Basic Buffer
in Beaker

$$[\text{H}^+] = K_a \frac{[\text{Acid}]}{[\text{Base}]}$$

$$= 5.6 \times 10^{-10}$$

$$= 2.4 \times 10^{-10}$$

$$\text{pH} = -\log [\text{H}^+]$$

$$\text{pH} = 9.62$$

$$\left(\frac{6 \text{ mmol}}{14 \text{ mmol}} \right)$$

$$\text{OR } [\text{OH}^-] = K_b \frac{[\text{Base}]}{[\text{Acid}]}$$

$$= (1.8 \times 10^{-5}) \left(\frac{14}{6} \right)$$

$$[\text{OH}^-] = 4.2 \times 10^{-5}$$

$$\text{pOH} = 4.38$$

$$\text{pH} = 14 - \text{pOH}$$

$$\text{pH} = 9.62$$

13) Beaker B+E

Weak
AcidBeaker B 50ml 0.30M $\text{HC}_2\text{H}_3\text{O}_2$ 15mmolBeaker E 50ml 0.30M $\text{NaC}_2\text{H}_3\text{O}_2$ 25mmol

Basic salt

IN Beaker Acidic Buffer

$$[\text{H}^+] = K_a \frac{\text{Acid}}{\text{Base}}$$

$$= 1.8 \times 10^{-5} \left(\frac{15 \text{mmol}}{25 \text{mmol}} \right)$$

$$= 1.08 \times 10^{-5}$$

$$\text{pH} = -\log [\text{H}^+]$$

$$\boxed{\text{pH} = 4.97}$$

$$K_a = 1.8 \times 10^{-5} \quad \text{HC}_2\text{H}_3\text{O}_2$$