Applications of Aqueous Equilibria

HH

Buffered Solutions

- A solution that resists a change in pH when either hydroxide ions **or** protons are added.
- Buffered solutions contain either:
  - A weak acid and its salt
  - A weak base and its salt

Acid/Salt Buffering Pairs

The salt will contain the anion of the acid, and the cation of a strong base (NaOH, KOH)

Weak Acid	Formula of the acid	Example of a salt of the weak acid
Hydrofluoric	HF	KF – Potassium fluoride
Formic	HCOOH	KHCOO – Potassium formate
Benzoic	C_6H_5COOH	NaC_6H_5COO – Sodium benzoate
Acetic	CH_3COOH	NaH_3COO – Sodium acetate
Carbonic	H_2CO_3	$NaHCO_3$ - Sodium bicarbonate
Propanoic	$HC_3H_5O_2$	$NaC_3H_5O_2$ - Sodium propanoate
Hydrocyanic	HCN	KCN - potassium cyanide

Base/Salt Buffering Pairs

The salt will contain the cation of the base, and the anion of a strong acid (HCl, HNO_3)

Base	Formula of the base	Example of a salt of the weak acid
Ammonia	NH_3	NH_4Cl - ammonium chloride
Methylamine	CH_3NH_2	CH_3NH_3Cl – methylammonium chloride
Ethylamine	$C_2H_5NH_2$	$C_2H_5NH_3NO_3$ - ethylammonium nitrate
Aniline	$C_6H_5NH_2$	$C_6H_5NH_3Cl$ – aniline hydrochloride
Pyridine	C_5H_5N	C_5H_5NHCl – pyridine hydrochloride

Calculate the $[H^+]$ in a solution that is 0.10 M in NaF and 0.20 M in HF. (K_a = 7.2 $\times 10^{-4}$)

A $7.2E^{-4}$ M

B 2.0 M

C $1.4E^{-3}$ M

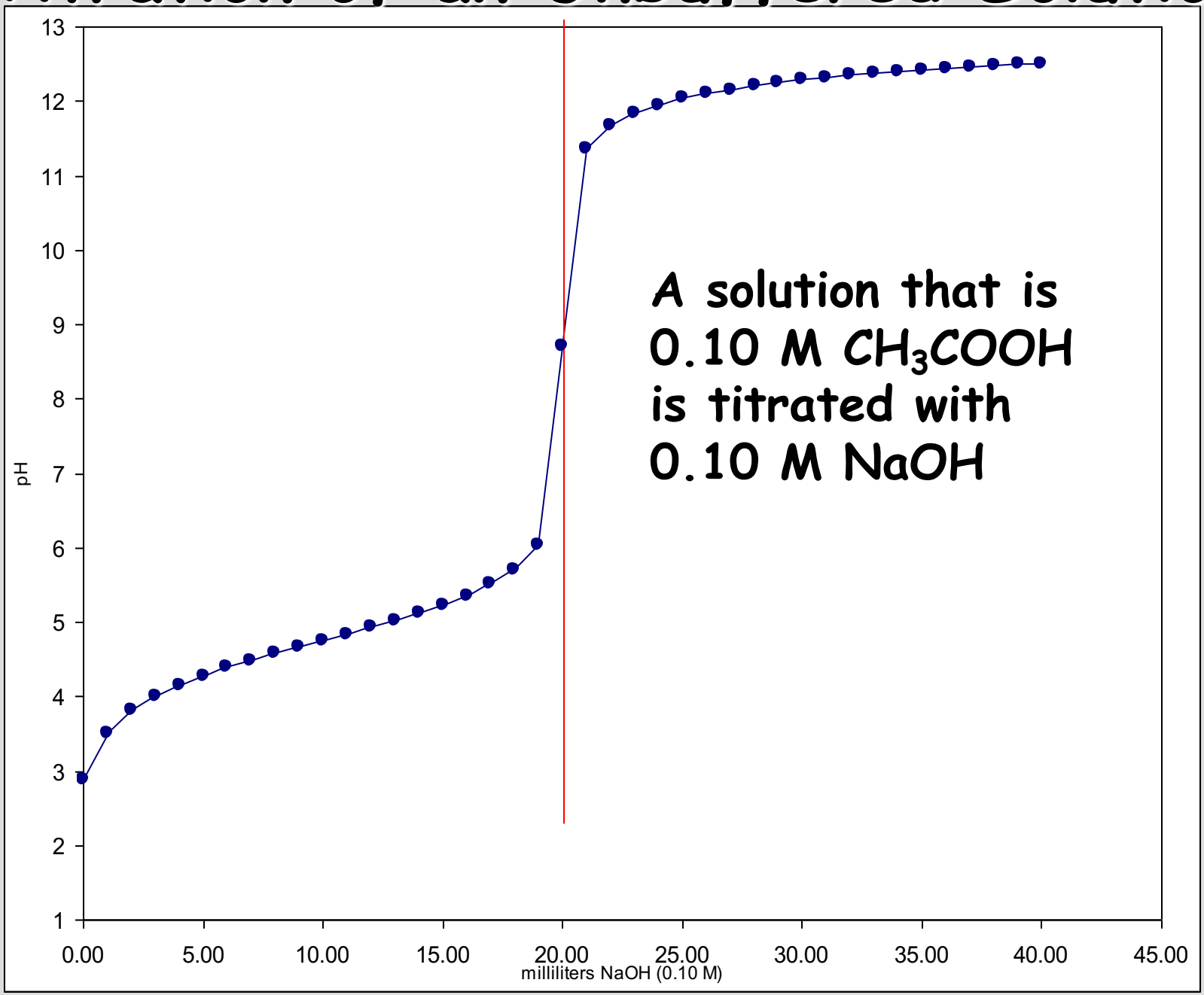
D 0.20 M

E none of these

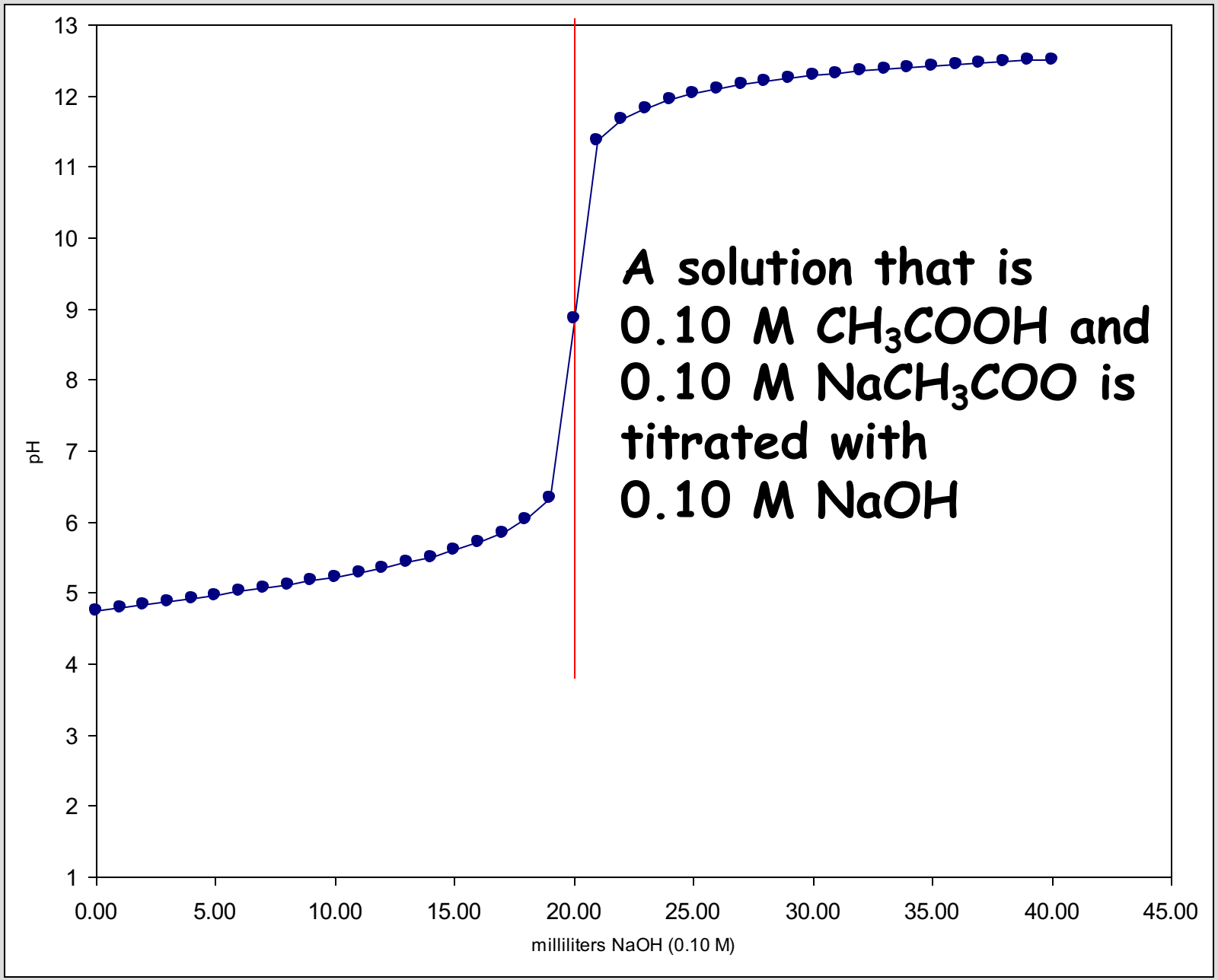
$$7.2E^{-4} = \frac{[H^+][0.10]}{[0.2]};$$

$$[H^+] = 1.44E^{-3}M$$

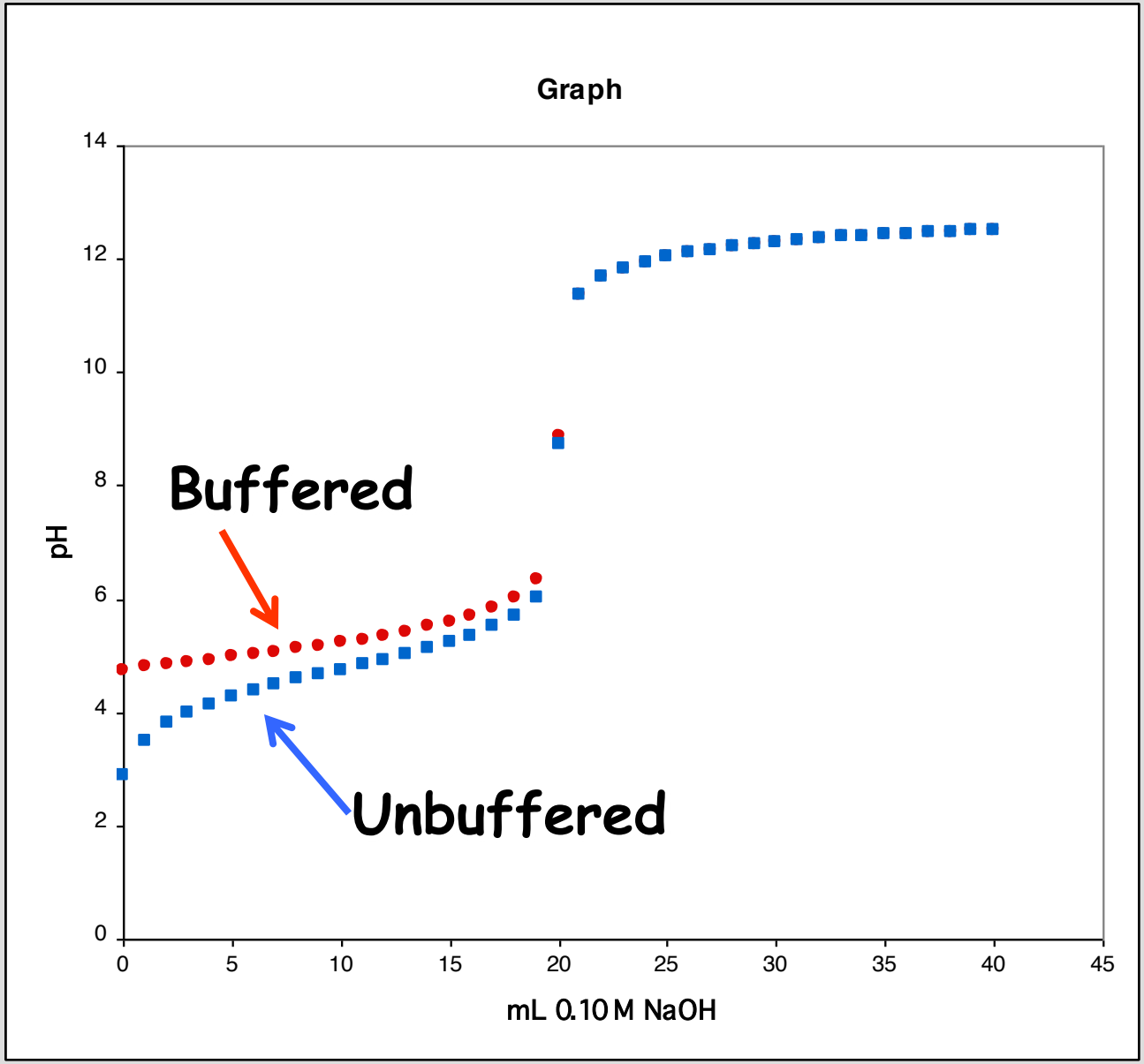
Titration of an Unbuffered Solution



Titration of a Buffered Solution

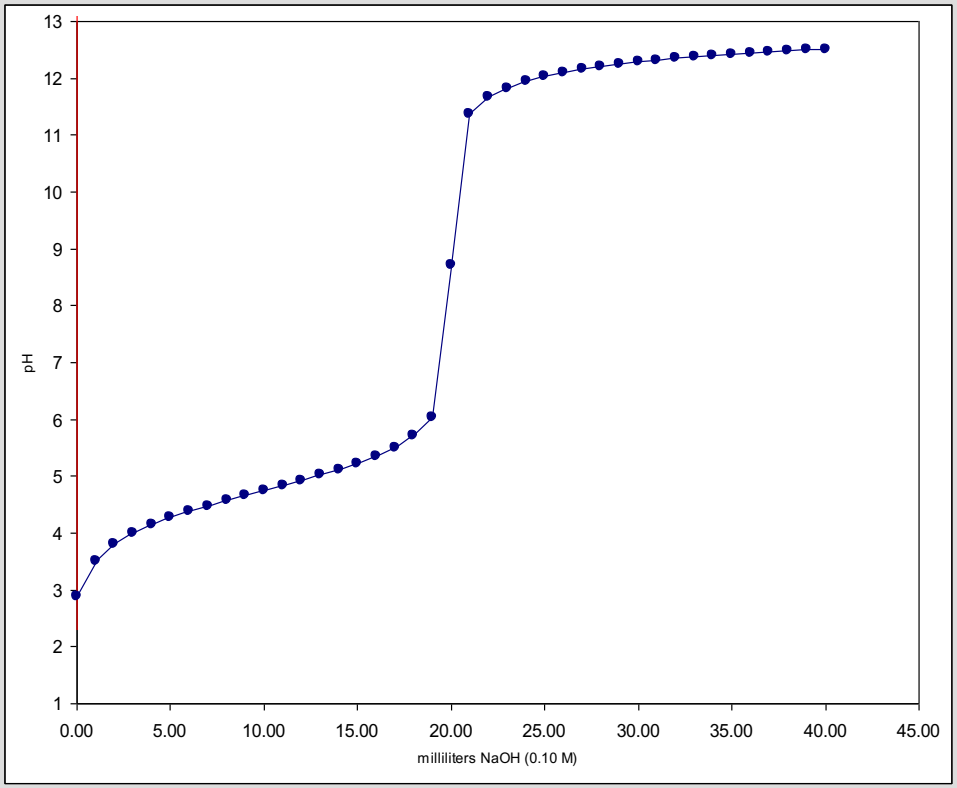


Comparing Results

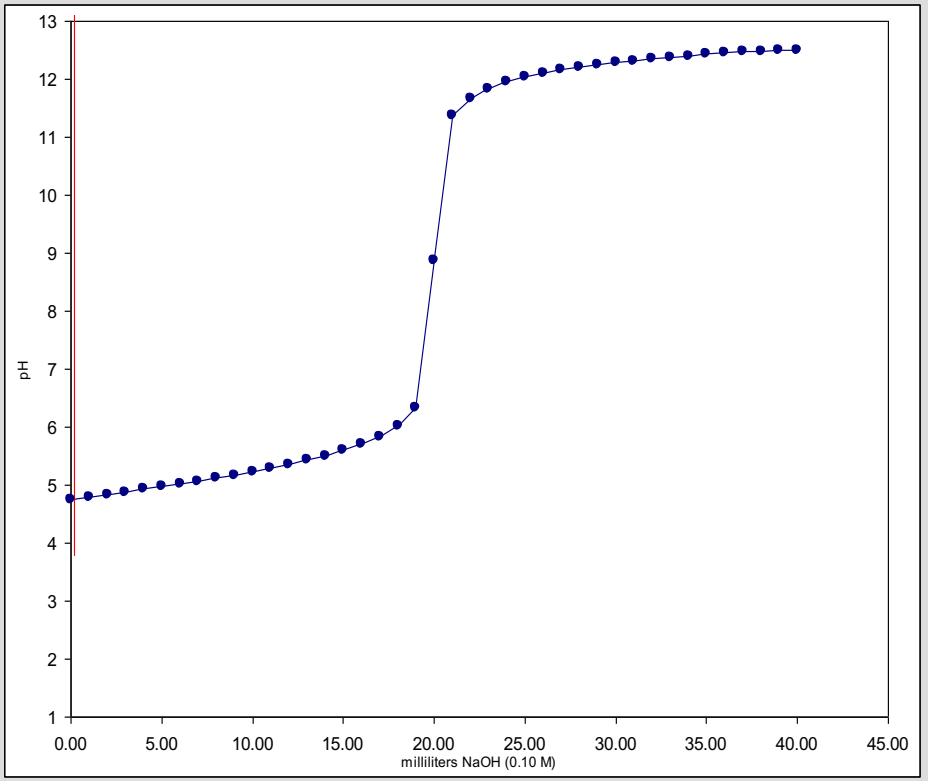


Comparing Results

Unbuffered



Buffered



- In what ways are the graphs different?
- In what ways are the graphs similar?

Henderson-Hasselbalch Equation

$$pH = pK_a + \log\left(\frac{[A^-]}{[HA]}\right) = pK_a + \log\left(\frac{[base]}{[acid]}\right)$$

$$pOH = pK_b + \log\left(\frac{[BH^+]}{[B]}\right) = pK_b + \log\left(\frac{[acid]}{[base]}\right)$$

Calculate the $[H^+]$ in a solution that is 0.10 M in NaF and 0.20 M in HF. ($K_a = 7.2 \times 10^{-4}$)

A 7.2E^{-4} M

B 2.0 M

C 1.4E^{-3} M

D 0.20 M

E none of these

$$pH = pKa + Log\frac{[Base]}{[Acid]};$$

$$pH = -log[7.2E^{-4}] + log\frac{[0.1M]}{[0.2M]}$$

$$= 2.84 \gg [H^+] = \mathbf{0.00144}M$$