CONCEPT: TITRATION

1) Understanding Titrations

●*Titration*: lab technique that measures pH changes of acid/base solutions & determines _____ values & [weak acids].

□ Solution of _____ concentration (*titrant*) is gradually added to a solution of *unknown* concentration (*analyte*).

□ Titrant continuously added to analyte until _____ is reached (indicated by color change).

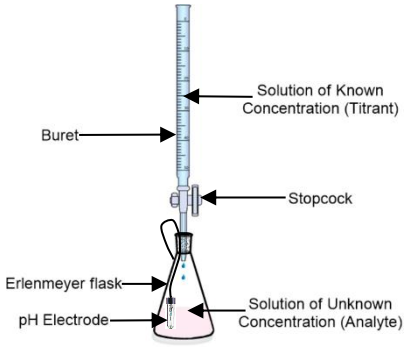
●Titration: used to determine: 1) concentration of acid/base in a solution.

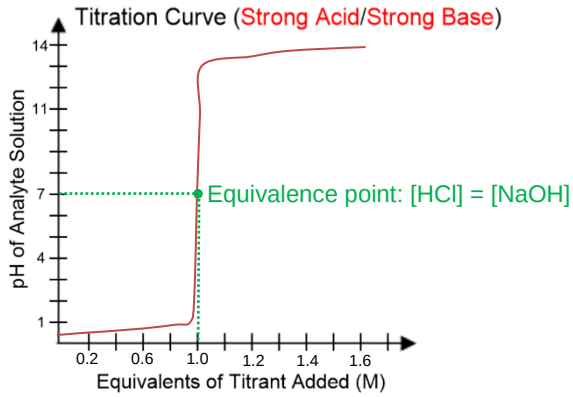
2) pK_a of a weak acid.

●*Titration curve*: plot of titration data with _____ pH on the y-axis & amount of _____ added on the x-axis.

□ *Equivalence point* (or endpoint): When moles of analyte present _____ moles of titrant added.

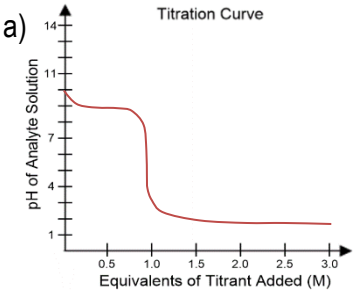
EXAMPLE: Titration of a Strong Acid with a Strong Base.



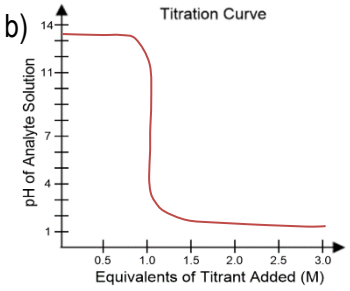


PRACTICE: Which of the following titration curves expresses the titration of a weak acid with a strong base?

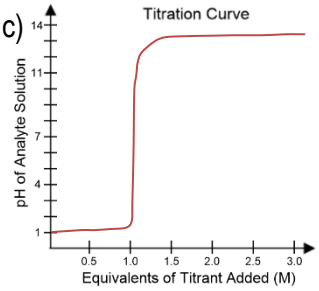
a)



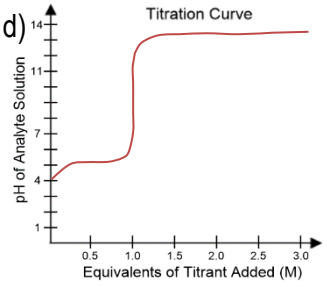
b)



c)



d)



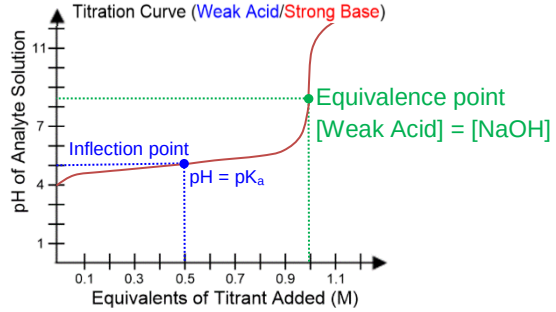
2) Titration of Weak Acids

●*Inflection point* (or midpoint): when _____ of the acid is neutralized the pH = pK_a of a *weak* acid.

□ Recall: When pH = pK_a, the [conjugate base] = [conjugate acid].

●*Equivalence* point does *not* always equal pH = 7 (it depends on $[H^+]$ when a molar equivalent of titrant is added).

EXAMPLE: Titration of a Weak Acid with a Strong Base.



Inflection Point	_____	_____ = _____ *For weak acids only.
Equivalence Point	Endpoint	[Analyte] = [Titrant]

CONCEPT: TITRATION

PRACTICE: You have an analyte solution of 50 mL of 0.2 M acetic acid (pK_a = 4.8). What volume of 0.05 M NaOH titrant needs to be added to get the final pH = pK_a?

a) 20 mL
b) 50 mL
c) 100 mL
d) 150 mL

3) Titration of Polyprotic Weak Acids

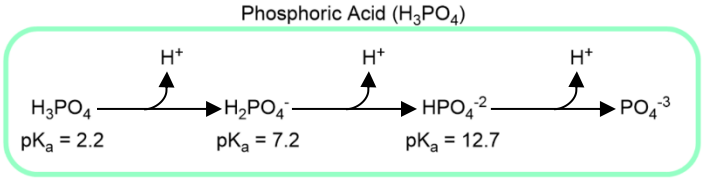
●Some acids are _____ (multiple acidic hydrogens) & have a pK_a value for each acidic hydrogen.

●The titration curves for polyprotic acids have _____ inflection & equivalence points (a set for each acidic H).

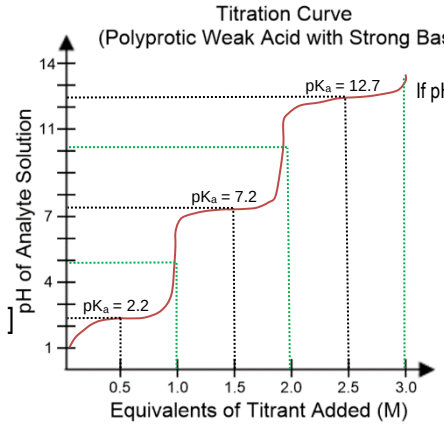
□ Each inflection point indicates a _____ value of a different acidic hydrogen.

●The Henderson-Hasselbalch equation is helpful to consider during a titration.

EXAMPLE:



If pH = 2.2: [ ] = [ ]



If pH = 12.7: [ ] = [ ]

If pH = 7.2: [ ] = [ ]

PRACTICE: Use the titration curve above. What is the predominate species in the solution of phosphoric acid at pH = 5?

a) H_3PO_4
b) $H_2PO_4^-$
c) HPO_4^{-2}
d) PO_4^{-3}

PRACTICE: Titration confirms an acetic acid solution to be 0.1 M. Calculate the pH. (acetic acid $K_a = 1.76 \times 10^{-5}$ M).

a) 2.1
b) 3.6
c) 2.9
d) 8.3