(Today's material deals with Problem Set 100)

Yesterday, we were talking about Detm. δpKHP

**TITRATION:** \( H^+ + OH^- \rightarrow H_2O + P^- \)

- Analyte: titrant
- (added in controlled fashion)
- Run is carried out 1:1 (1 H^+ to 1 OH^-)
- If stop run when both reactants are limiting reagents, reach condition called the Equivalence Point

Consider how we're going to do this:

- You can't work at the particle level, so you must scale up process but keep scorecard
- Scale up, throw in bundles of OH^- particles; marks on scorecard rep. moles of particles, still have 1:1 ratio of analyte : titrant
- Bundles of 6.02 x 10^23 turns out to be too big; instead, work at millimole level \( \Rightarrow \) if know millimoles OH^- = \( \frac{wt. \text{ in g}}{MW} \)

- If know conc. of OH^- (M \( \Rightarrow \) moles \( \frac{L}{mol} = \frac{mmoles}{ML} \))
  - Know vol. of soln. added
  - Then \( \left( \frac{\text{vol. ML}}{\text{conc. OH}^- \frac{mmoles}{ML}} \right) = \# \frac{mmoles \text{ OH}^-}{ML} \)

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So we actually control the volume in lab; need appropriate device, burette allows you to measure to 100ths place
can set all this up w/a single line set-up:

\[
\text{Titrant (OH\(^{-}\))} (\text{volume in mL}) (\text{conc.}, \text{mmolH}\text{OH\(^{-}\)/mL}) \left( \frac{1 \text{ mmol}}{1 \text{ mmolH}\text{OH\(^{-}\)}} \right) \left( \frac{1 \text{ KHP}}{1 \text{ mmolH}\text{OH\(^{-}\)}} \right) \left( \frac{204.23 \text{ mg}}{1 \text{ KHP}} \right) \left( \frac{100}{1 \text{ KHP wt. in mg}} \right) = \frac{\text{mg} \text{ KHP}}{\text{wt. sample}}
\]

\[
\text{rxn: } \text{HP}^{-} + \text{OH}^{-} \rightarrow \text{H}_2\text{O} + \text{P}^{-2}
\]

use rxn as conversion factor, be sure to i.d. species

\{
\text{# mmol titrant}
\}

\{
\text{# mmol H}^+
\text{(analytical)}
\text{recall}
\text{KHP} \rightarrow \text{K}^+ + \text{H}^+
\text{(format)}
\}

\{
\text{# mg KHP wt. KHP wt. sample}
\text{(100)}
\}

how good do these measurements need to be? good enough to get job done
typically, need 4 digits (-----)
this starts to put a restriction on you, can't be of quality than measurements
(sig figs is a sloppy way of dealing w/this issue & quality)
(conversion factors should not limit quality of what you do in the lab)

**Volume**

\text{Volume} \uparrow

\text{Meas'd w/ buret} \rightarrow \text{---}

**concentration**

\text{not a raw meas't}

is a processed meas't (came as result of a previous step)

\text{weigh out, put in some volume (mmol/mL)}

\text{need 4 digits, turns out can't know simply by weighing out}

\text{cd., get 10,000 mL volumetric flask}

\text{but problem is that in "NaOH" bottle is not 100% pure}

\text{God's M is 0.1000 M}

\text{the target conc. of NaOH}

(tenth molar)

\text{your value will fall in 0.09 M, but need to know 4 digs}
why not buy the "good stuff"?
NaOH reacts w/ everything, CO₂ in air, glass in bottle, its composition is uncertain.
-- So, we must go through a preliminary step, must titrate NaOH vs. something whose concentration is known to 4 digits.
-- KTP is a chemical you can get pure, that will stay pure, known as a Primary Standard

Remember the elf w/ the flag in his pocket? How do we know when to stop titration? When indicator ΔS. How know what indicator to use? Must be able to characterize soln. at equivalence point.

generically, Acid + Base ⇌ H₂O + Salt

\[ \text{really have a double arrow} \]
\[ \text{pH not necdy 7, } \]
\[ \text{wd. be case if only major rxns occur} \]
\[ \text{there will be conditions in which resulting pH may be } > 7 \text{ or } < 7 \]

in this KTP det'n. pH at equiv. pt is actually closer to 9