A little different than normal…

We will do the first part of the lecture in our desks, and then the rest of this PowerPoint will be done as you do the lab activity.

N50 – Titrations

Our last lecture of the year!

Target:

I can set up and perform a titration.

Link to YouTube Presentation: https://youtu.be/6owm822vyhI

What is titration?

A way to determine the concentration of an unknown substance.

- Uses the fact that acids and bases react with each other in “neutralization reactions”

- At the point where the neutralization reaction is finished
  # moles Acid = # moles Base

Key Terms

Titrand
The unknown solution you are interested in

Titrant
The solution with the known concentration

Equivalence Point
The point at which all the titrand has reacted with the titrant.
Moles Acid = # Moles Base

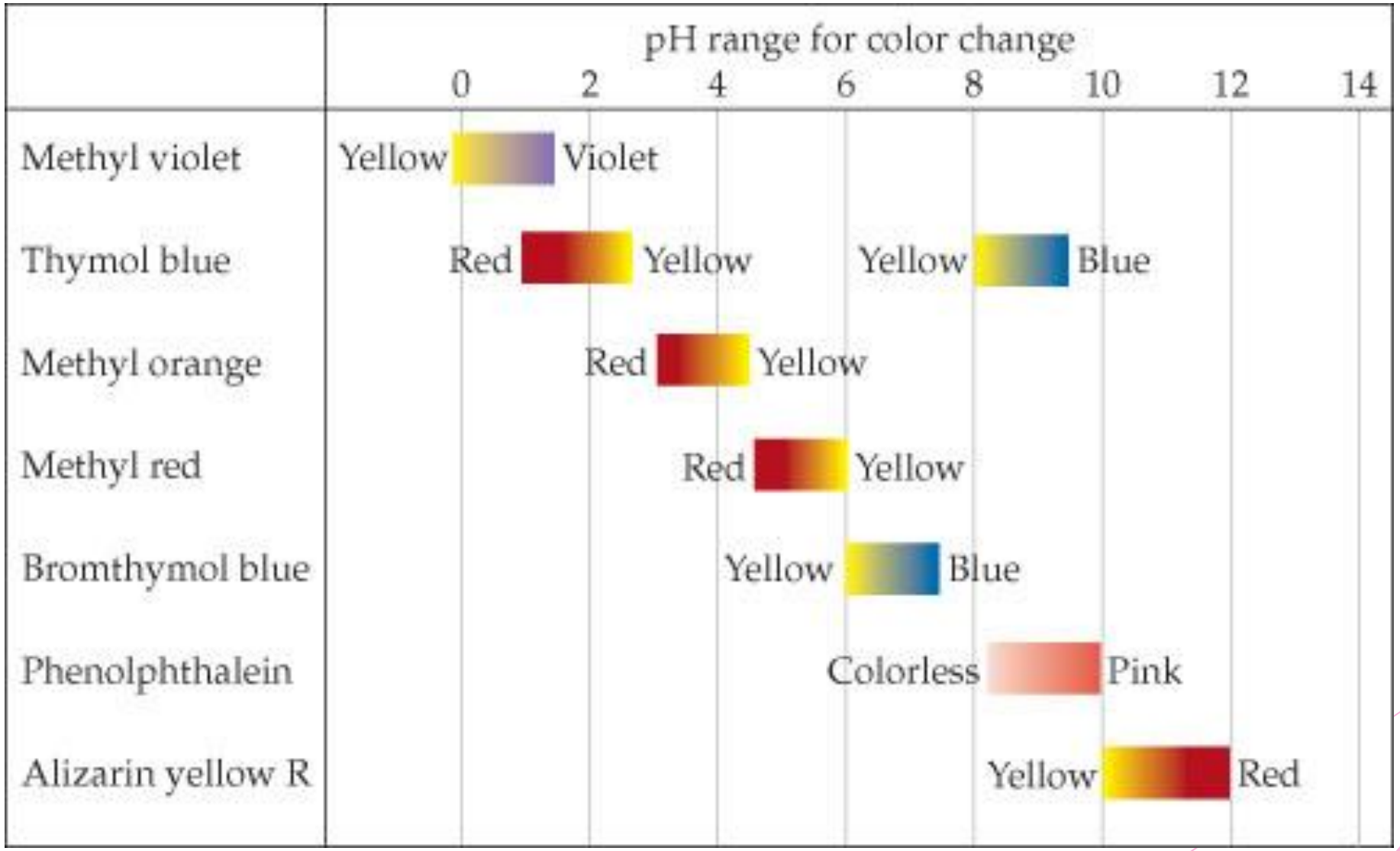
End Point
The point at which your titration *seems* finished during the lab – a color change happens for example

How do you know you reached the end point?

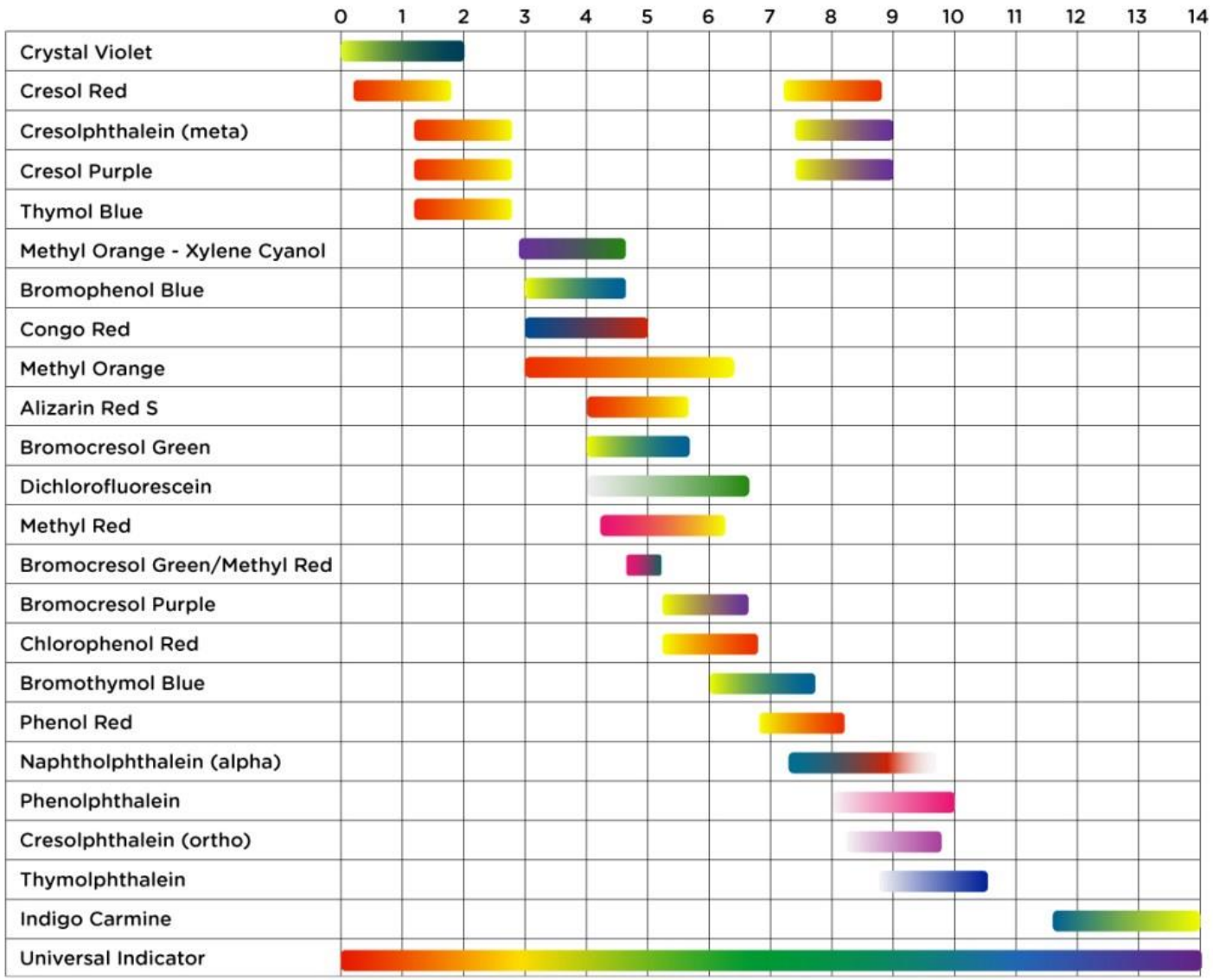
Use an **INDICATOR**

Turns colors based on pH – can show you visually when you have reached the end point.

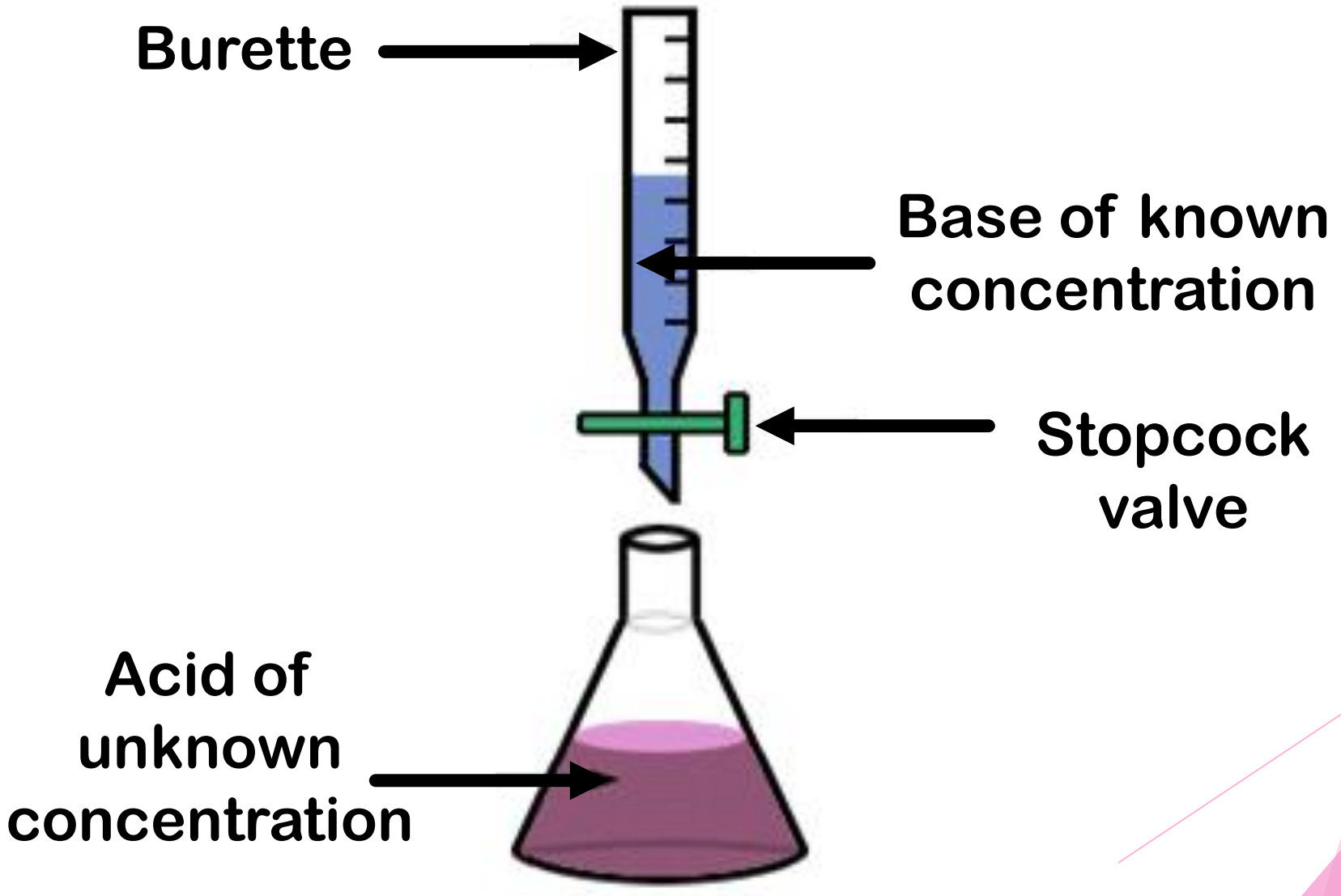
Pick the right indicator!

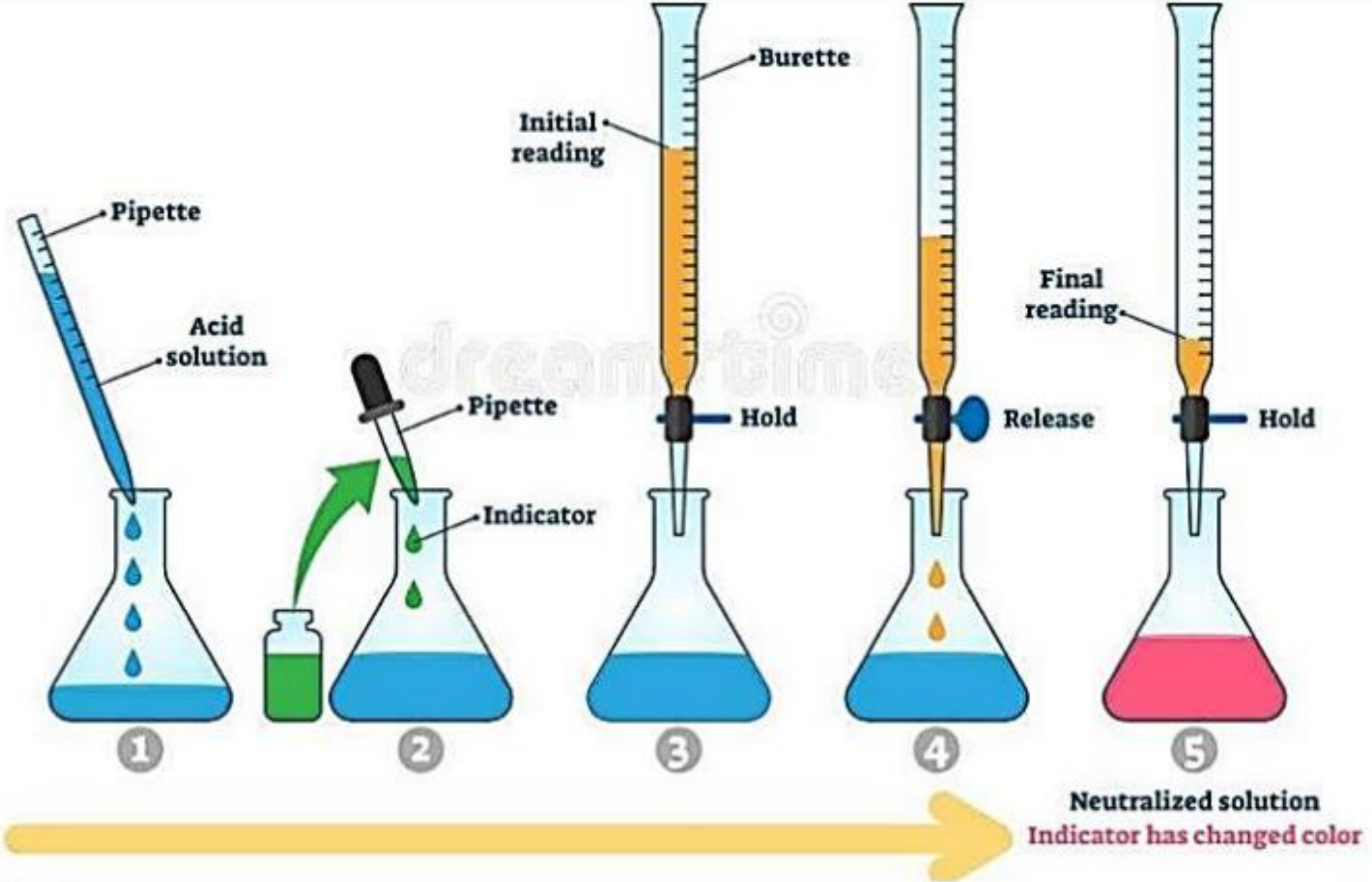


Pick the right indicator!

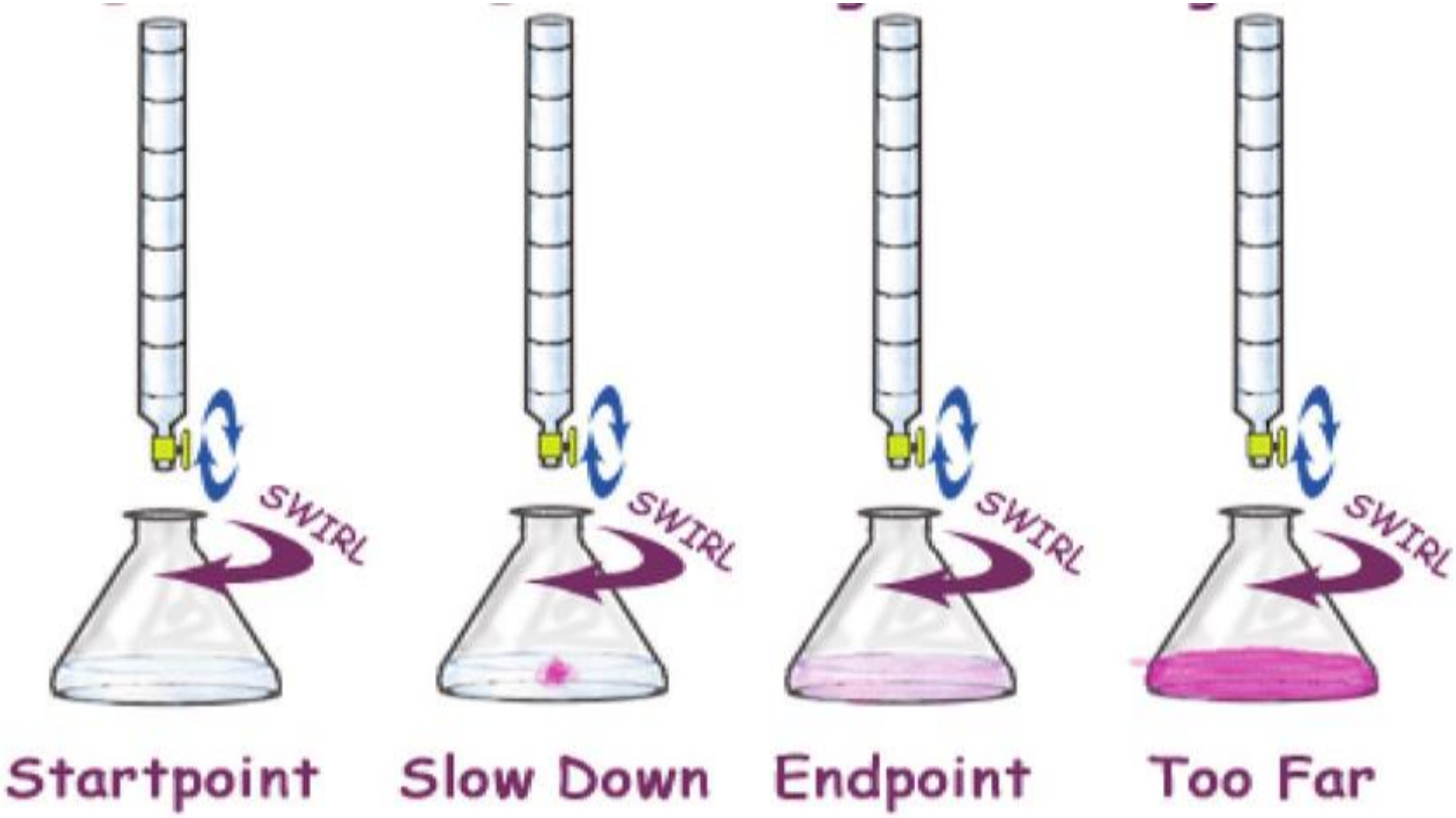


Lab Set Up

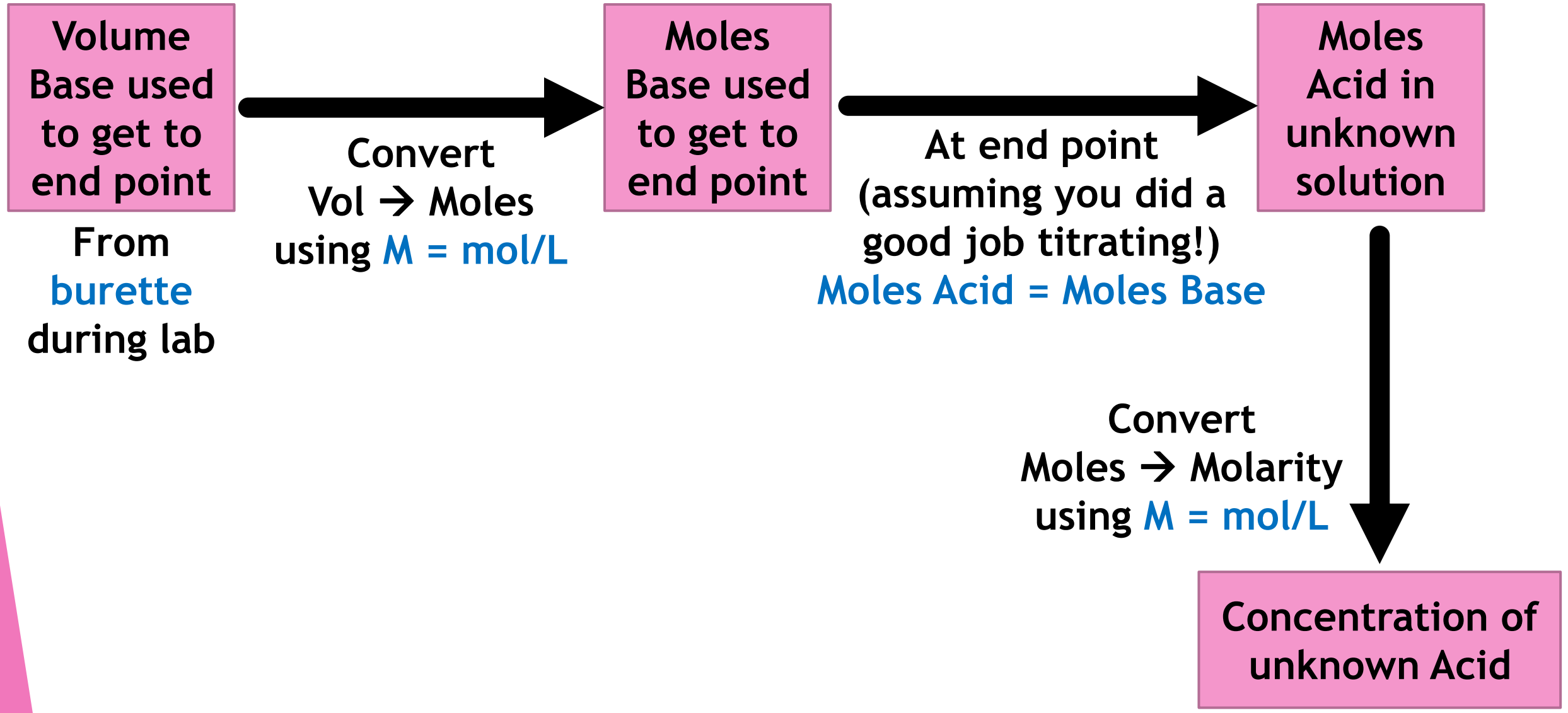

Burette
Base of known concentration
Stopcock valve
Acid of unknown concentration


Pipette
Acid solution
Pipette
Indicator
Burette
Initial reading
Hold
Release
Final reading
Hold
1
2
3
4
5
Neutralized solution
Indicator has changed color

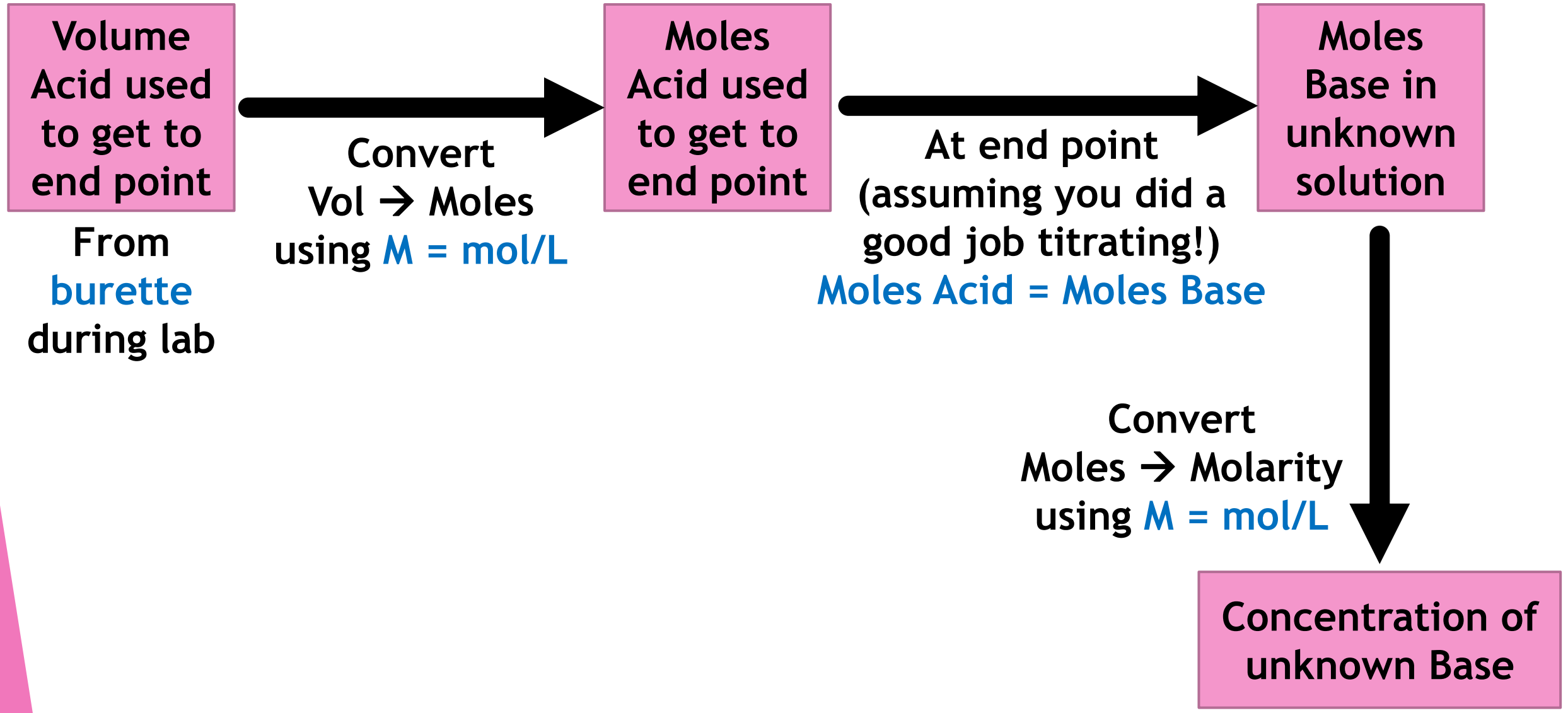
Careful! Don't go too fast!



So… Known [base] & unknown [acid]



So… Known [acid] & unknown [base]



Some things to be careful of…

- **mL versus L**

- **Stoichiometry – is it a 1:1 ratio H^+ : OH^- ?**
  Or is it 1:2, or 2:1, or 2:3, etc

  1 mol NaOH = 1 mol OH^-

  1 mole $Ca(OH)_2$ = 2 mol OH^-

- **End point and equivalence point are only identical if your titration is absolutely perfect. It never is, there are lab errors!**

Lab Activity Portion of Lecture

Instead of a practice problem just on paper, we are going to have our practice problem be an actual titration! On WS #14

Question #1: What is our titrand?

Question #2: What is our titrant?

Titrand = HCl – unknown [ ]
Titrant = NaOH – known [ ], 0.10 M

Lab Set Up

1) Make sure everything is rinsed with distilled water, and then rinse the burette with the titrant (NaOH).

2) Clamp burette into burette clamp onto a ring stand

3) Fill burette with NaOH with a known concentration (0.10 M)

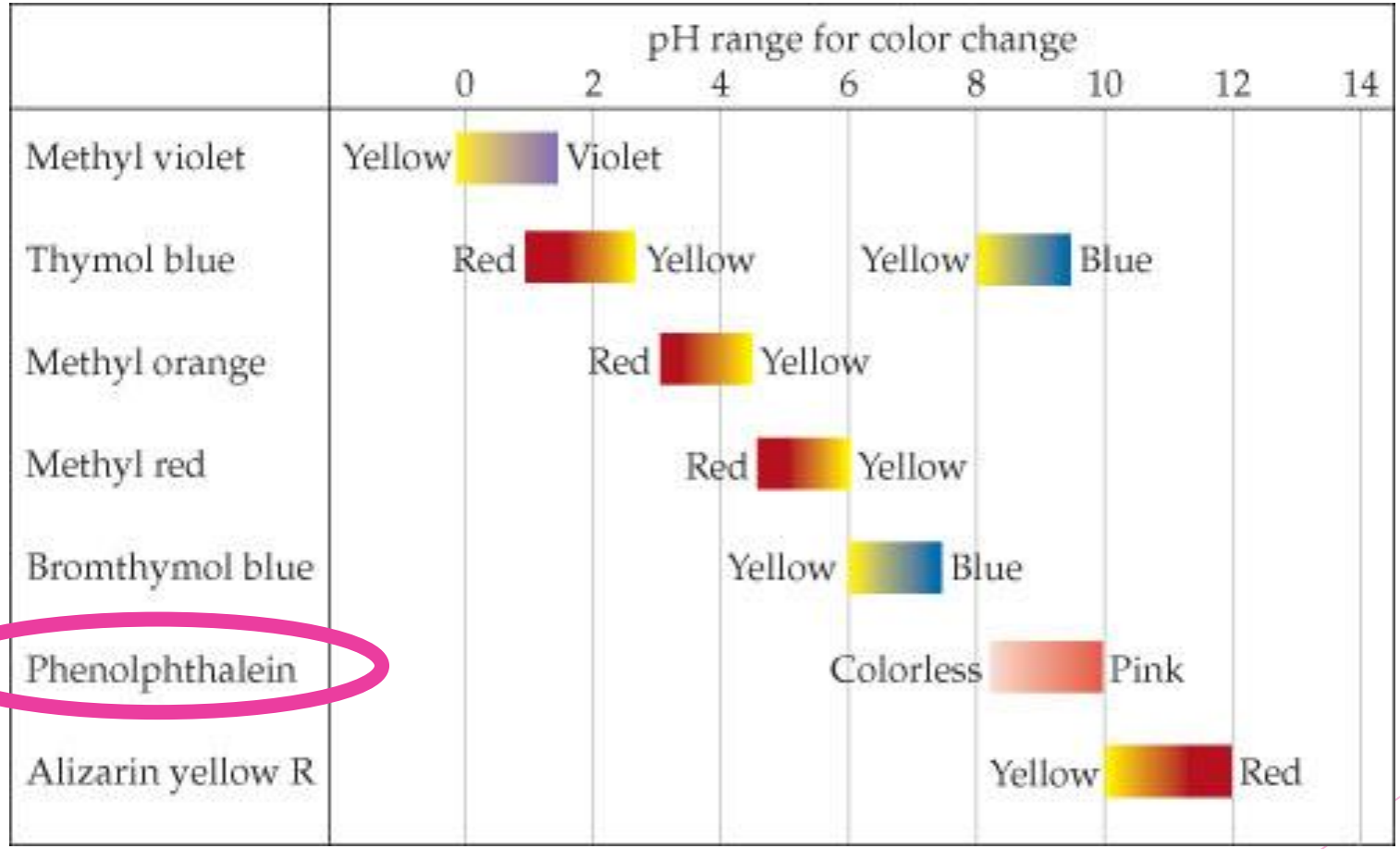
4) Put a beaker under burette and slowly open valve, letting some NaOH out until bottom of meniscus is reading at an easy to read value. Careful! Make sure that the entire tip of the burette is filled with NaOH.

Lab Set Up continued…

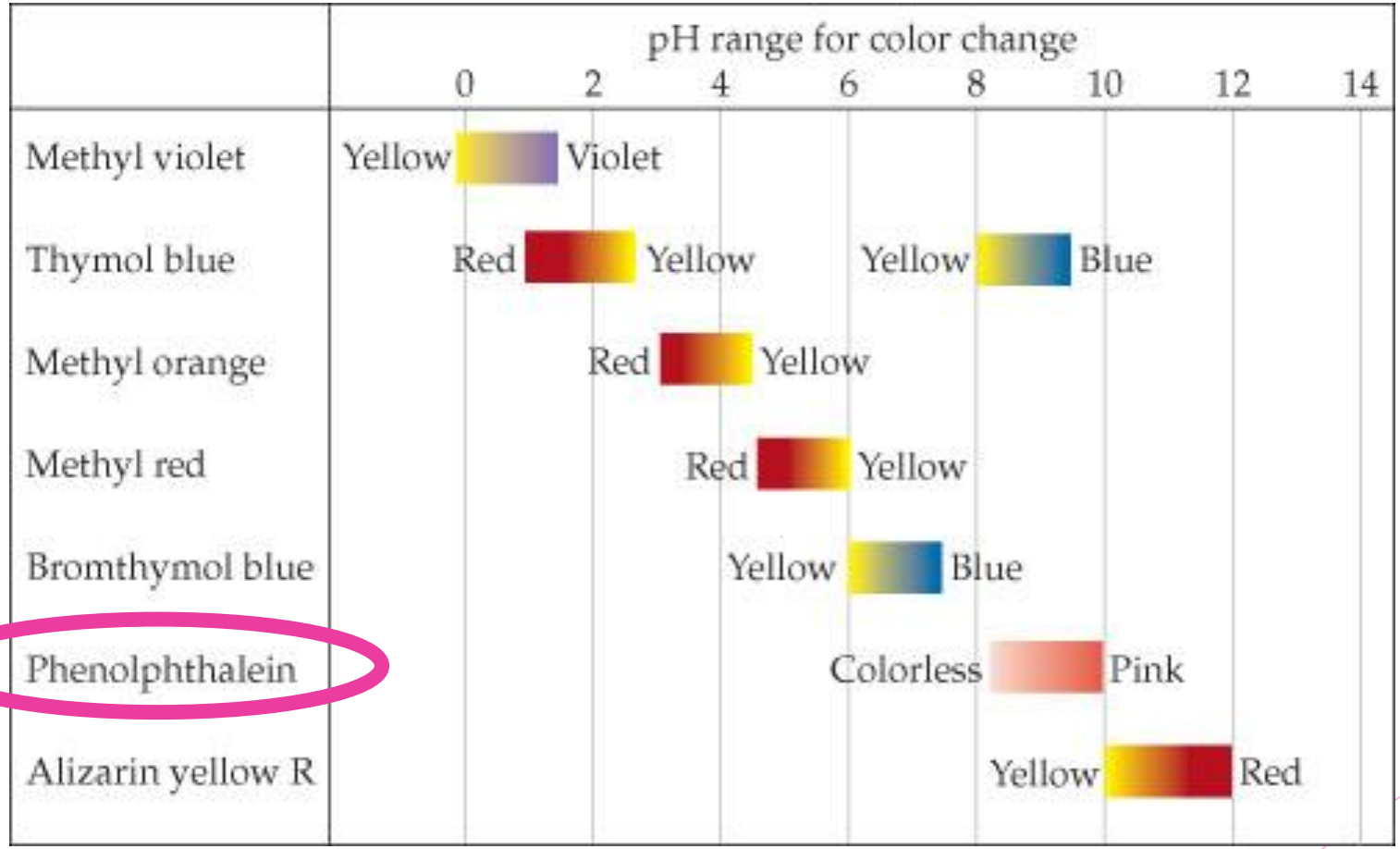
5) Using a graduated cylinder, put a known volume of your titrand (unknown concentration HCL) into an Erlenmeyer flask.

6) Add a small amount of appropriate indicator to the flask (phenolphthalein).

Question #3: Which indicator should we pick? Our unknown will be in the 7-10 range.



Question #4: What color shift do you expect to see for this indicator? From __ → ___.



How many trials to do?

Do **FOUR** trials (typically)

1st Trial – Rough trial – "Quick and dirty" Just a rough estimate so you have an idea of when you need to start slowing down. **DON'T include this trial when averaging your data!**

2nd – 4th Trials – Real ones – Be careful!

Set up your Data Table

	Titration of Unknown HCl Solution with Phenolphthalein			
	[ ] of Titrant:		Volume of Titrand Used:	
	Rough Trial	**Trial #1**	**Trial #2**	**Trial #3**
Name				
Burette Starting Volume (mL)				
Burette Ending Volume (mL)				
Volume of Titrant Used (mL)				

Every group needs to do one rough trial, and each person will do a real trial. Four people in a group = Four trials. Make the right number of columns in your table!

Set up your Data Table

	Titration of Unknown HCl Solution with Phenolphthalein			
	[ ] of Titrant: 0.10 M		Volume of Titrand Used: 5 mL	
	Rough Trial	Trial #1	Trial #2	Trial #3
Name				
Burette Starting Volume (mL)				
Burette Ending Volume (mL)				
Volume of Titrant Used (mL)				

Titration Lecture Videos

1) **What is a titration?** FuseSchool
https://youtu.be/tIbD8MG1qMM

2) **Setting up and Performing a Titration.** CarolinaBiological
https://youtu.be/sFpFCPTDv2w

3) **How to Prepare a Burette for a Titration.** Wits University
https://youtu.be/Lr1nLTCqZvM

4) **How to Read the Volume off a Burette.** Wits University
https://youtu.be/qdmp4_Nwd-Q

5) **What is a Titration and how is it performed?** Wits University
https://www.youtube.com/watch?v=YqfvRBJ-iPg

6) **Acid Base Equilibrium.** Bozeman Science
https://youtu.be/l5fk7HPmo5g

Set up your lab station

Burette's are already clamped in for you, and filled with NaOH

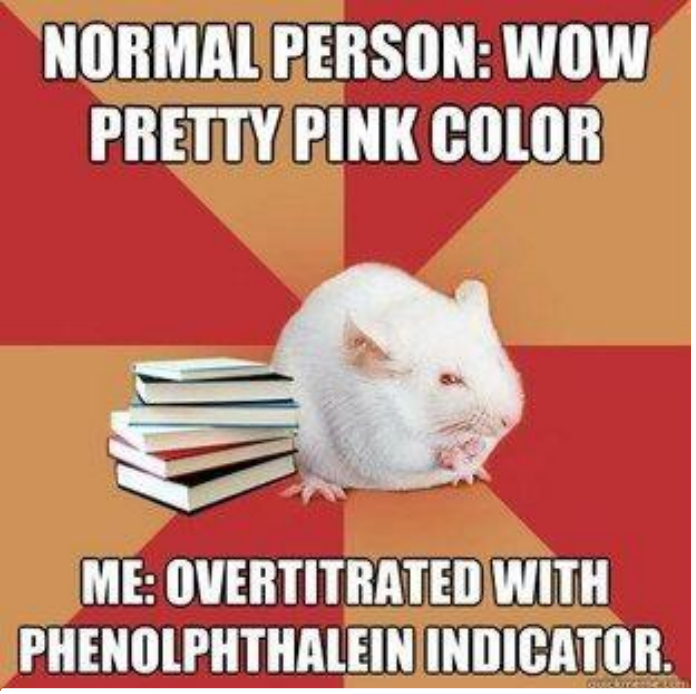
– not super safe to fill them, so I did it for you.

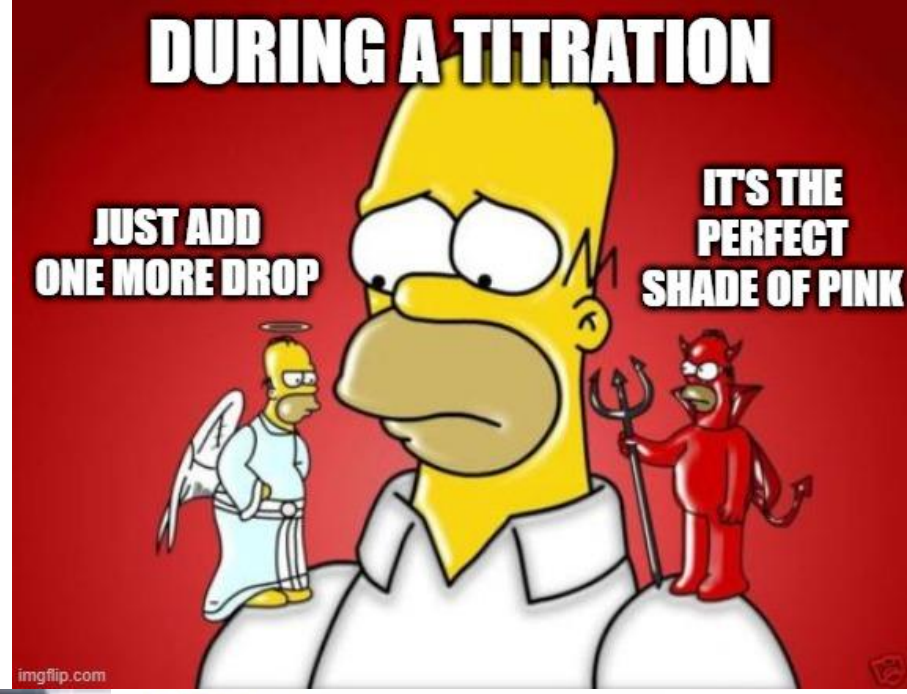
Perform Rough Trial

	Titration of Unknown HCl Solution with Phenolphthalein			
	[ ] of Titrant: 0.10 M		Volume of Titrand Used: 5 mL	
	Rough Trial	Trial #1	Trial #2	Trial #3
Burette Starting Volume (mL)				
Burette Ending Volume (mL)				
Volume of Titrant Used (mL)				

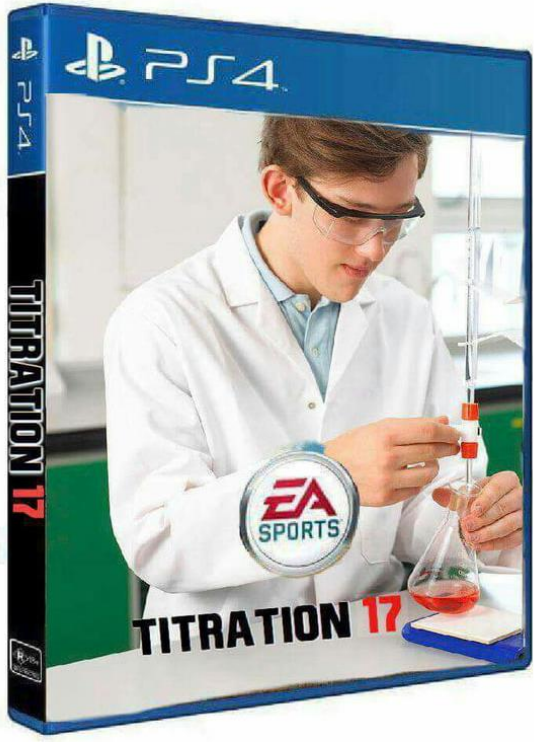
Each person does their trial

	Titration of Unknown HCl Solution with Phenolphthalein			
	[ ] of Titrant: 0.10 M		Volume of Titrand Used: 5 mL	
	Rough Trial	Trial #1	Trial #2	Trial #3
Burette Starting Volume (mL)				
Burette Ending Volume (mL)				
Volume of Titrant Used (mL)				





When your titration turns bright pink, and the professor starts walking towards you...



The perfect game doesn't exi-

Calculate how many moles of NaOH you used

Molarity = Moles / Liters

From burette in the lab

Moles NaOH used = Volume used x Molarity NaOH

Known [ ] given to you

$$\text{Moles} = \text{L} \times \frac{\text{mol}}{\text{L}}$$

$$\text{Moles NaOH} = \frac{\text{x mL}}{} \left| \frac{\text{1L}}{\text{1000 mL}} \right| \frac{\text{Y mol}}{\text{1 L}}$$

Calculate the unknown concentration of the acid

At End Point → Moles NaOH = Moles HCl

Molarity = Moles / Liter

Same as mol NaOH used!

$$\text{Molarity Acid} = \frac{\text{Moles Acid}}{\text{Liters Acid Used}}$$

The amount in your Erlenmeyer flask!

Come check what your unknown concentration of Acid was!

Calculate the % error for each person's acid – let's see which person had the most accurate titration per group!

Average your group member's answers together – report % error of averaged data on the whiteboard – let's see which group had the best titration skills!

YouTube Link to Presentation

- https://youtu.be/6owm822vyhI