

SI Chemistry - Full Discipline Demo

Digital Titration of Acids and Bases - Beyond Labz

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Chemistry - Full Discipline Demo
Course	SI Chemistry - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

⚡ Analyte	Completely ionizes in water	1
⚡ Equivalence point	Moles of analyte = moles of titrant	2
⚡ Strong acid	Of known concentration in a titration	3
⚡ Titrant	Only partially ionizes in water	4
⚡ Titration	Changes color at a certain acidity/alkalinity value	5
⚡ Weak acid	Of unknown concentration in a titration	6
⚡ pH meter	Reads numerical values of acidity and alkalinity	7
⚡ pH indicator	A quantitative, volumetric technique used to determine an unknown concentration	8

Correct answers:

- 1 Strong acid 2 Equivalence point 3 Titrant 4 Weak acid
 5 pH indicator 6 Analyte 7 pH meter 8 Titration

Categorize each element as being true of a pH indicator or a pH meter.

pH Indicator	pH Meter
1	2

Elements to categorize:

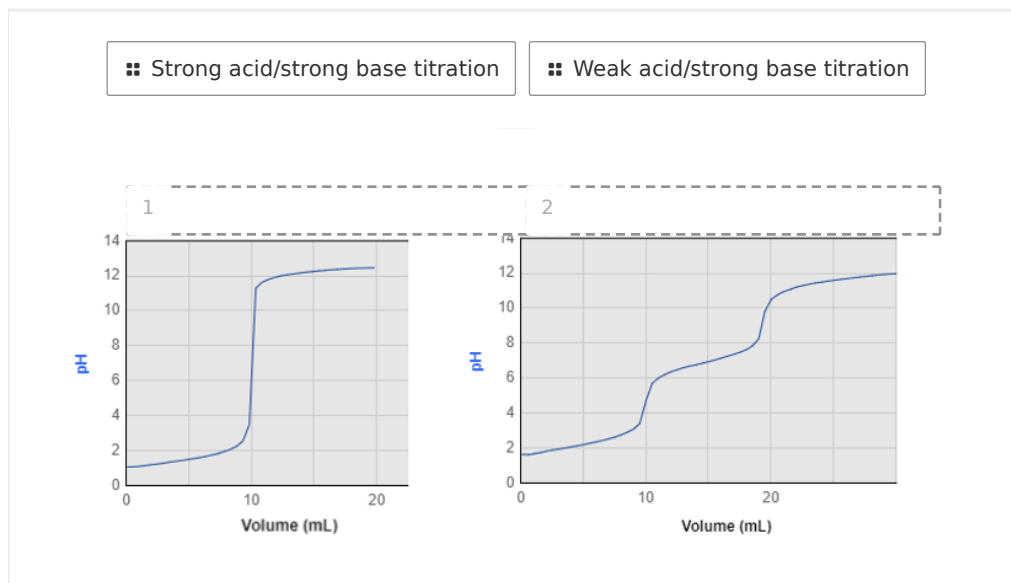
- Expensive
- Inexpensive
- Phenolphthalein is a common example
- Requires maintenance
- Electronic tool
- Quantitatively tracks pH values
- Additive for analyte solution
- Requires calibration
- Indicates only certain pH values
- Color-based measurement

Correct answers:

1 Inexpensive Phenolphthalein is a common example
Additive for analyte solution Color-based measurement
Indicates only certain pH values

2 Electronic tool Expensive Requires calibration
Quantitatively tracks pH values Requires maintenance

Label each titration graph.



Correct answers:

- 1 Strong acid/strong base titration 2 Weak acid/strong base titration

Exploration

Weak acids produce fewer H^+ ions in solution than strong acids.

- ☒ True ✓
- ☐ False

A titration is useful for determining the concentration of a given substance.

- ☒ True ✓
- ☐ False

During a titration, a known concentration of ____ is added to a(n) ____ of an unknown concentration.

- ☐ analyte; titrant
- ☒ titrant; analyte
- ☐ solvent; solute
- ☐ solute; solvent

✓

The equivalence point is the moment in a titration where exactly enough titrant has been added to completely react with the analyte.

- ☒ True
- ☐ False

✓

Phenolphthalein is often used as an indicator in strong acid/base titrations because the equivalence point is marked by the analyte changing color from ____ in acidic media to ____ in basic media.

- ☐ light yellow; purple
- ☐ bright pink; colorless
- ☒ colorless; magenta
- ☐ blue; green

✓

A weak acid completely ionizes in water to produce both an H^+ ion and a negatively charged counter ion.

- ☐ True
- ☒ False

✓

A graduated pipet is the most accurate type of pipet.

- ☐ True
- ☒ False

✓

Exercise 1

For the nitric acid titrations, if you had used the initial trial instead of the three accurate trials to calculate the concentration of nitric acid, would the calculated concentration be artificially high or low? Explain why this would be. (Hint: Try running the calculations using your initial trial and compare to the results from the accurate trials.)

Because the initial run involves overshooting how much base is required to neutralize the acid, the resulting concentration of acid would appear higher than it should be.

If the tip of the buret was not filled with NaOH before the initial volume of the buret was recorded, would the calculated concentration of the acid being titrated be artificially higher or lower than the true concentration? Explain why.

Because the dead space in the buret would appear to have been additional NaOH required to neutralize the acid, the acid would appear to take longer to neutralize, causing an artificially high concentration.

Compare your images of the graphs of the titrations of sulfurous acid and hydrogen cyanide to the endpoint volumes of the titrations as indicated by phenolphthalein (listed in Data Table 2). Why would trying to use an indicator to determine the concentration of a weak acid be misleading? Explain your answer.

Weak acids don't change pH according to the concentration of base in the same way strong acids do, so the point at which phenolphthalein changes color is not reflective of the moles of base being equal to the moles of weak acid.

Why is it important to do multiple trials of a titration, instead of only one trial?

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Which solutions were titrants and which were analytes in the simulation titrations in this exercise? Reference Data Tables 1-2 and the definitions of titrants and analytes in your answer.

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Was phenolphthalein an appropriate indicator for all titrations performed in this exercise? Reference Graphs 1-3 in your explanation of why or why not.

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Data Table 1: Strong Acid / Strong Base Titrations
(SAMPLE ANSWER BELOW)

Trial	Initial NaOH volume (mL)	Final NaOH volume (mL)	Total volume of NaOH used (mL)
Quick trial	0.00	~20	~20
Trial 1	0.00	19.05	19.05
Trial 2	0.00	19.02	19.02
Trial 3	0.00	19.08	19.08
		Average total volume NaOH (mL)	19.05
		Concentration HNO ₃ (M)	0.21
		Percent error (%)	

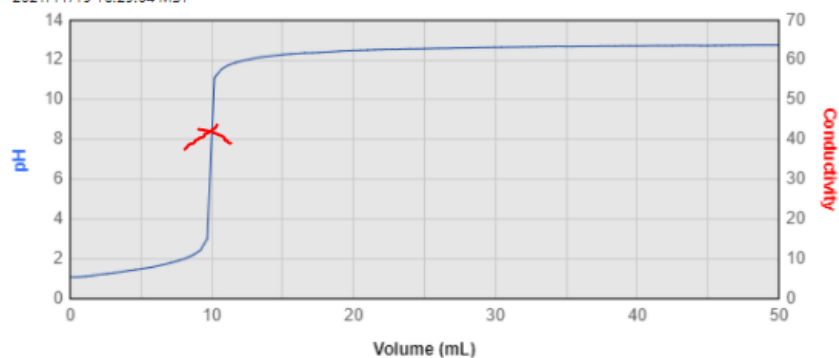
Data Table 2: Weak Acid / Strong Base Titrations
(SAMPLE ANSWER BELOW)

	Initial NaOH volume (mL)	Final NaOH volume (mL)	Total volume of NaOH used (mL)
H ₂ SO ₃ trial	0.00	18.92	18.92
HCN trial	0.00	1.52	1.52

Graph 1: Nitric Acid Titration
(SAMPLE ANSWER BELOW)

Titration Image

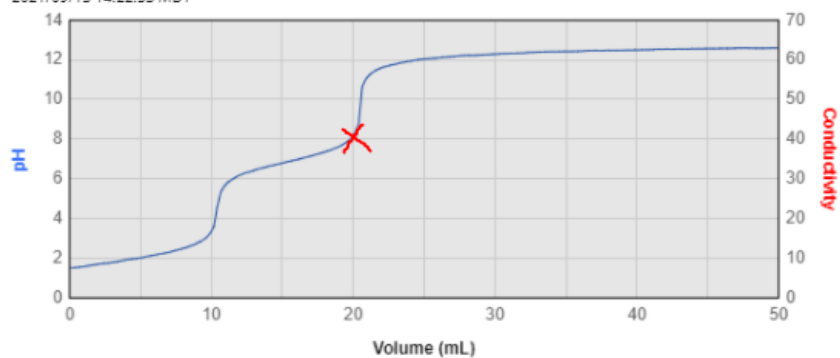
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Graph 2: Sulfurous Acid Titration
(SAMPLE ANSWER BELOW)

Titration Image

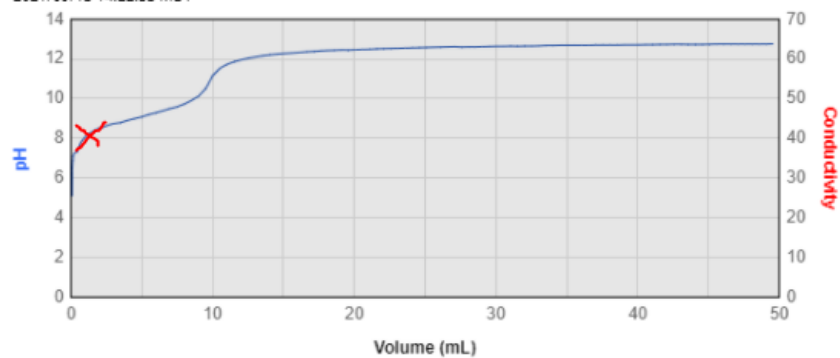
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Graph 3: Hydrogen Cyanide Titration
(SAMPLE ANSWER BELOW)

Titration Image

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Competency Review

Titration is a technique where a solution with a known concentration is added to a solution of an unknown concentration until the equivalence point is reached.

- ☒ True
- ☐ False



During a titration, the solution with the unknown concentration is called the ____.

- ☒ analyte
- ☐ indicator
- ☐ titrant
- ☐ equivalence point



The moment in a titration where exactly enough titrant has been added to completely react with the analyte is called the ____.

- ☐ neutral point
- ☐ titration point
- ☒ equivalence point
- ☐ None of the above



When added to a solution of strong acid, phenolphthalein ____.

- ☐ changes color
- ☒ is colorless
- ☐ is magenta
- ☐ The answer cannot be determined without further information.



A strong acid completely ionizes in water to produce OH^- ions.

- ☐ True
- ☒ False

✓

The volume of titrant used during a titration will always be exactly the same throughout three trials.

- ☐ True
- ☒ False

✓

A titration between strong acid and strong base is being measured by both pH meter and phenolphthalein indicator in a lab simulation. The pH meter shows a pH of 7.31, but the indicator is colorless in solution. The pH of this solution is ____.

- ☐ below 7.0
- ☒ 7.31
- ☐ 8.31
- ☐ unable to be determined; there is something wrong with either indicator or pH meter

✓

A sample (25.000 mL) of a strong acid of unknown strength is titrated by a strong base with a concentration of 0.1526 M. The titration reaches the equivalence point after 15.25 mL of base is added. The concentration of the unknown acid is ____.

- ☐ 0.2502 M
- ☐ 0.002498 M
- ☐ 0.4003 M
- ☒ 0.09309 M

✓

It is appropriate in the titration of hydrogen cyanide, a weak acid, with sodium hydroxide, a strong base, to use an indicator like phenolphthalein to find the equivalence point.

☐ True

☒ False



The most accurate type of pipet is the _____.

☐ graduated pipet

☐ transfer pipet

☒ volumetric pipet

☐ None of the above.



Extension Questions

A student did not read the directions to the experiment properly and mixed up where to place the NaOH solution and the vinegar. He put the vinegar solution of unknown concentration in the buret and the NaOH solution of known concentration in the beaker. He then added a drop of the phenolphthalein to the solution in the beaker.

Does the student need to empty out all of the solutions and start over again or can he go ahead and run the titration? If he runs the titration using the solutions as given above, what should he expect to see happen for results?

(SAMPLE ANSWER BELOW)

The student does not need to start over; he could run the titration in reverse. The solution in the beaker (containing the NaOH and the phenolphthalein) will initially be pink. The color will begin to fade as the titration proceeds and will turn colorless at the equivalence point.