

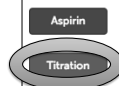
Chem 108: Class/ Lab Week 13

- **Optional Bonuses:**
Contact Tracing
OSU-Inspark Calorimetry
OSU-Inspark Titration
- **Required Lab Assignments:**
 1. Titration Screen Experiment (Royal Society of Chemistry)
 2. DVC Acid-Base Titration (Simulation)
<https://forms.gle/Wh4arki3jSTaCSzj9>
DVC Laboratory Manual Acid & Base Titration Experiment
<https://chemconnections.org/general/chem108/Titration%20Procedure-pp.91-93.pdf>

Assignment 1: Titration Screen Experiment

<http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2>

Screen experiments



LearnChemistry
Enhancing learning and teaching

Find your user name for login here:

<http://chemconnections.org/general/chem108/Lab/RSC%20Titration/Titration%20Unknowns%202020f.html>

<http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2>

Experiments home Titration home Register Log in

Titration screen experiment

Quickstart
Log in Log in
Register

This resource has been developed in partnership with Learning Science and the University of Bristol.

Find your user name for login here:
<http://chemconnections.org/general/chem108/Lab/RSC%20Titration/Titration%20Unknowns%202020f.html>

<http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2>

Screen experiments Logged in as: RRusay
Badges earned 0 / 4

Titration

<p>Titration level 1 Not started Determine the concentration of hydrochloric acid in a contaminated stream by performing a strong acid - strong base titration.</p> <p>Start this level ></p>	<p>Titration level 2 Determine the amount of aspirin in a batch of tablets by performing a weak acid - strong base titration.</p>	<p>Titration level 3 Determine the concentration of ammonia in a consignment of hair product by performing a strong acid - weak base titration.</p>	<p>Titration level 4 Determine the amount of iron in a batch of diet supplement tablets by performing a redox titration.</p>
---	--	--	---

Find your user name for login here:
<http://chemconnections.org/general/chem108/Lab/RSC%20Titration/Titration%20Unknowns%202020f.html>

Background

Titration screen experiment:
The contaminated stream

Lorry = Truck

BREAKING NEWS
Lorry Crash Causes Acid Spill
Lorry carrying over 1,000 litres of hydrochloric acid. Conservation site at risk as nearby river contaminated.

First watch this video about titration and then click "Next" to review your knowledge.

Background

Iron Mountain & the Sacramento River? pH = -3.6


Titration screen experiment:
The contaminated s

BREAKING NEWS
Lorry Crash Causes Acid Spill
Lorry carrying over 1,000 litres of hydrochloric acid. Conservation site at risk as nearby river contaminated.

First watch this video

Background

Titration screen experiment:
The contaminated stream



Titration:

BREAKING NEWS
Lorry Crash Causes Acid Spill
and work out how acidic the river has become.

First watch this video about titration and then click "Next" to review your knowledge.

Only Titration level 1 is to be completed; the lab book then downloaded and submitted as an e-mail attachment.

Logged in as: rjr
Badges earned 0 / 4

Screen experiments

Titration

Titration level 1
Score: 290 / 1000
Determine the concentration of hydrochloric acid in a contaminated stream by performing a strong acid - strong base titration.

Continue level >
Restart this level >
Download lab book

Titration level 2
Determine the amount of aspirin in a batch of tablets by performing a weak acid - strong base titration.

Titration level 3
Determine the concentration of ammonia in a consignment of hair product by performing a strong acid - weak base titration.

Titration level 4
Determine the amount of iron in a batch of diet supplement tablets by performing a redox titration.

<http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2>

Complete Titration level 1 through Titration Analysis & Review; Download lab book when completed and submit as an attachment before due date (See course calendar).

<http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2>

log book (1,000 possible points)

Download log book and send as e-mail attachment to: rrusay@dvc.edu

Subject:
RSC
Titration

In the e-mail body: Provide your name plus RSC User Number

<http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2>

Chem 108: Class/ Lab

Week 13

Assignment 2:

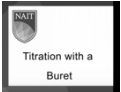
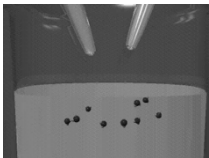
DVC Acid-Base Titration (Simulation)
<https://forms.gle/Wh4arki3jSTaCSzj9>
 DVC Laboratory Manual Acid & Base Titration Experiment
<https://chemconnections.org/general/chem108/Titration%20Procedure-pp.91-93.pdf>

Find your unknown acid letter code [A-P] and data here:

<http://chemconnections.org/general/chem108/Lab/RSC%20Titration/Titration%20Unknowns%202020f.html>

Complete:
<https://forms.gle/Wh4arki3jSTaCSzj9>


<https://www.youtube.com/watch?v=9Dk82xLvNE>
Neutralization Reactions
 Titration
<http://chemconnections.org/general/movies/acidbasetitration.mov>

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

$$H_3O^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

Neutralizations / Titrations



Chem 108 titration: phenolphthalein indicator
 General Chemistry-Titration Curves

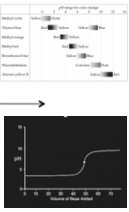
Aqueous Reactions: Neutralization
 Net Ionic Equations

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$
 strong acid base salt water

$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$
 $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$
 $NaCl_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$

$Na^+_{(aq)} + OH^-_{(aq)} + H^+_{(aq)} + Cl^-_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$
 $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

Titration end point pH > 7



Equivalence point: pH = 7

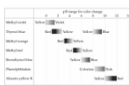
Aqueous Reactions: Neutralization
 Net Ionic Equations

$CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$
 weak acid base salt water

$CH_3COO^-_{(aq)} + H^+_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow CH_3COO^-_{(aq)} + Na^+_{(aq)} + H_2O_{(l)}$
 $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

Same Net Ionic Equation (NIE) for any neutralization
 Eg. H_2SO_4 $2 H^+_{(aq)} + 2 OH^-_{(aq)} \rightarrow 2 H_2O_{(l)}$

Equivalence point: pH = ?

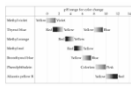


Aqueous Reactions: Neutralization
 Salt in this case is a Weak Base

$CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$
 weak acid base salt water

$CH_3COO^-_{(aq)} + H_2O_{(aq)} \rightarrow CH_3COOH_{(aq)} + OH^-_{(aq)}$
 + $Na^+_{(aq)}$ + $Na^+_{(aq)}$

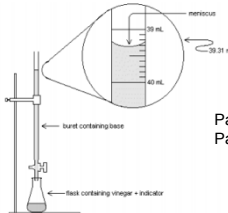
Titration End point pH > 7



Equivalence point: pH = ?

Acid-Base Titration

<https://www.youtube.com/watch?v=9Dk82xLvNE>



Part 1: Standardization will NOT be done.
 Part 2: Experimental data is provided

Equipment

From the stockroom:
 plastic 1 L bottle
 50 mL buret
 buret clamp
 25 mL vol. pipet and bulb

From the common drawer:
 ring stand

From your drawer:
 funnel
 125 mL flask
 250 mL flask
 2 beakers (one for waste)
 wash bottle

Chem 108: Lab Week 13

Part 1 has been done for you.
The molarity of NaOH is known.

Name: _____
Section: _____

Report Form - Acid Base Titration

Part 1-Standardization of NaOH Solution

Molarity of HCl used						
Titration	1	2	3	4	5	6
Base buret, final reading (mL)						
Base buret, initial reading (mL)						
Volume of base used (mL)*						
Molarity of NaOH (M)*						
Average molarity of NaOH*						M 0.2240

Show the calculations for each of the entries in the Data Table marked with * on the calculations page for one titration.

Record and use the molarity, 0.2240M.

<https://chemconnections.org/general/chem108/Titration-Unknown%20form-pg.95.pdf>

Chem 108: Lab

Part 2: Week 13

Each of you have been assigned a separate unknown acid.
[A-P] Experimental data is provided.

Part 2-Determination of Unknown Acid

Unknown code						
Average Molarity of Base from Part 1						0.2240 M
Titration	1	2	3	4	5	6
Base buret, final reading (mL)						
Base buret, initial reading (mL)						
Volume of base used (mL)*						
Molarity of unknown acid (M)*						
Average molarity of unknown (M)*						M

Find your unknown letter code & link to data here:

<http://chemconnections.org/general/chem108/Lab/RSC%20Titration/Titration%20Unknowns%202020f.html>

<https://chemconnections.org/general/chem108/Titration-Unknown%20form-pg.95.pdf>

Chem 108: Lab Part 2: Week 13

25.00 mL of $M_{H^+aq} = ?$



Part 2-Determination of Unknown Acid

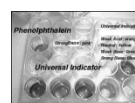
Unknown code						
Average Molarity of Base from Part 1						0.2240 M
Titration	1	2	3	4	5	6
Base buret, final reading (mL)	22.88	42.03	19.73	38.92	19.35	38.44
Base buret, initial reading (mL)	0.42	22.88	0.11	19.66	0.29	19.29
Volume of base used (mL)*						
Molarity of unknown acid (M)*						
Average molarity of unknown (M)*						M

Show the calculations for each of the entries in the Data Table marked with * on the calculations page for one titration.

Example using hypothetical experimental data.

Chem 108: Lab Part 2: Week 13

25.00 mL of $M_{H^+aq} = ?$



Calculate average of trials #2-6

Average of trials #2-6 = 19.25 mL

Part 2-Determination of Unknown Acid

Unknown code						
Average Molarity of Base from Part 1						0.2240 M
Titration	Rough Trial	2	3	4	5	6
Base buret, final reading (mL)	22.88	42.03	19.73	38.92	19.35	38.44
Base buret, initial reading (mL)	0.42	22.88	0.11	19.66	0.29	19.29
Volume of base used (mL)*	22.46	19.15	19.62	19.26	19.06	19.15
Molarity of unknown acid (M)*						
Average molarity of unknown (M)*						M

Show the calculations for each of the entries in the Data Table marked with * on the calculations page for one titration.

First remove trial #1 "rough trial" and any of #2-6 that is NOT within +/- 0.20 mL of the average for the volume of base used.

Chem 108: Lab Part 2: Week 13

25.00 mL of $M_{H^+aq} = ?$



Part 2-Determination of Unknown Acid

Unknown code						
Average Molarity of Base from Part 1						0.2240 M
Titration	Rough Trial	2	3	4	5	6
Base buret, final reading (mL)	22.88	42.03	19.73	38.92	19.35	38.44
Base buret, initial reading (mL)	0.42	22.88	0.11	19.66	0.29	19.29
Volume of base used (mL)*	22.46	19.15	19.62	19.26	19.06	19.15
Molarity of unknown acid (M)*						
Average molarity of unknown (M)*						M

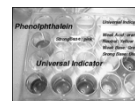
Show the calculations for each of the entries in the Data Table marked with * on the calculations page for one titration.

Average of trials #2-6 = 19.25 mL

Remove any trial that is NOT within +/- 0.20 mL of the average for the volume of base used.

Chem 108: Lab Part 2: Week 13

$V_{H^+aq} = 25.00$ mL



Part 2-Determination of Unknown Acid

Unknown code						
Average Molarity of Base from Part 1						0.2240 M
Titration	Rough Trial	2	3	4	5	6
Base buret, final reading (mL)	22.88	42.03	19.73	38.92	19.35	38.44
Base buret, initial reading (mL)	0.42	22.88	0.11	19.66	0.29	19.29
Volume of base used (mL)*	22.46	19.15	19.62	19.26	19.06	19.15
Molarity of unknown acid (M)*						
Average molarity of unknown (M)*						M

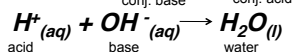
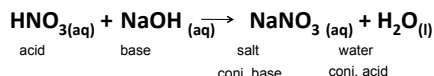
Show the calculations for each of the entries in the Data Table marked with * on the calculations page for one titration.

$$?M_{H^+} = [M_{OH^-} \times V_{OH^-} / V_{H^+}]$$

Calculate the Molarity of unknown for each trial and overall average

Unkown Acid Neutralization

Net Ionic Equation/ Calculation



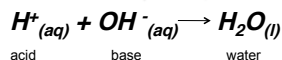
25.00 mL of $M_{\text{H}^+}(\text{aq}) = ?$ (unknown monoprotic nitric acid solution) was titrated with a sodium hydroxide solution, $M_{\text{OH}^-} = ? 0.2162 \text{ M}$. It required 24.20 mL as an average of three trials which were within $\pm 0.20 \text{ mL}$ to reach a faint pink color.

$M_{\text{H}^+}(\text{aq}) = ?$

$$?M_{\text{H}^+} = [M_{\text{OH}^-} \times V_{\text{OH}^-} / V_{\text{H}^+}] [? \text{ mol}_{\text{H}^+} / ? \text{ mol}_{\text{OH}^-}]$$

Unkown Acid Neutralization

Net Ionic Equation/ Calculation



25.00 mL of $M_{\text{H}^+}(\text{aq}) = ?$ (unknown monoprotic acid solution) was titrated with a sodium hydroxide solution, $M_{\text{OH}^-} = ? 0.2162 \text{ M}$. It required 24.20 mL as an average of three trials which were within $\pm 0.20 \text{ mL}$ to reach a faint pink color.

$$?M_{\text{H}^+} = [M_{\text{OH}^-} \times V_{\text{OH}^-} / V_{\text{H}^+}] [? \text{ mol}_{\text{H}^+} / ? \text{ mol}_{\text{OH}^-}]$$

$$= \frac{0.2162 \text{ mol}_{\text{OH}^-} \times 0.02420 \text{ L}_{\text{OH}^-} \times 1 \text{ mol}_{\text{H}^+}}{\text{L}_{\text{OH}^-} \times 0.02500 \text{ L}_{\text{H}^+} \times 1 \text{ mol}_{\text{OH}^-}} = 0.2093 M_{\text{H}^+}$$

Chem 108: Lab

Part 2: Week 13

$$V_{\text{H}^+ \text{ aq}} = 25.00 \text{ mL}$$

Part 2—Determination of Unknown Acid

Unknown code		example	
Average Molarity of Base from Part 1		0.2240 M	
Titration	Rough Trial	2	3
Base buret, final reading (mL)	22.88	42.03	19.73
Base buret, initial reading (mL)	0.00	22.88	0.11
Volume of base used (mL)*	22.88	19.15	19.62
Molarity of unknown acid (M)*	0.1716	0.1726	0.1708
Average molarity of unknown (M)*		0.1716	M

Show the calculations for each of the entries in the Data Table marked with * on the calculations page for one titration.

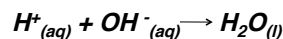
$$?M_{\text{H}^+} = [M_{\text{OH}^-} \times V_{\text{OH}^-} / V_{\text{H}^+}]$$

Calculate the Molarity of unknown for each trial and overall average

QUESTION

A 35.00 mL sample of a monoprotic acid of unknown concentration was titrated with 42.30 mL of 0.2250 M KOH. What is the concentration of the unknown acid?

- A. 0.0930 M
- B. 0.3030 M
- C. 0.2719 M
- D. 0.1356 M
- E. 0.3720 M

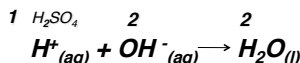


$$?M_{\text{H}^+} = [M_{\text{OH}^-} \times V_{\text{OH}^-} / V_{\text{H}^+}] [? \text{ mol}_{\text{H}^+} / ? \text{ mol}_{\text{OH}^-}]$$

QUESTION

A 35.00 mL sample of sulfuric acid (a di-protic acid) of unknown concentration was titrated with 42.30 mL of 0.2250 M KOH. What is the concentration of the unknown acid?

- A. 0.0930 M
- B. 0.3030 M
- C. 0.2719 M
- D. 0.1356 M
- E. 0.3720 M



$$?M_{\text{H}^+} = [M_{\text{OH}^-} \times V_{\text{OH}^-} / V_{\text{H}^+}] [? \text{ mol}_{\text{H}_2\text{SO}_4} / ? \text{ mol}_{\text{OH}^-}]$$

<https://forms.gle/Wh4arki3jSTaCSzj9>

Complete & Submit:

<https://forms.gle/Wh4arki3jSTaCSzj9>