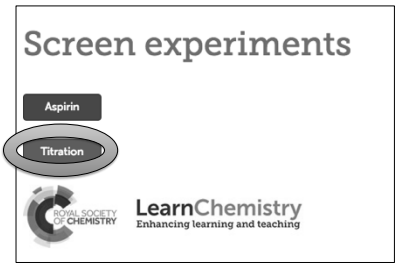
Chem 108: Class/ Lab

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

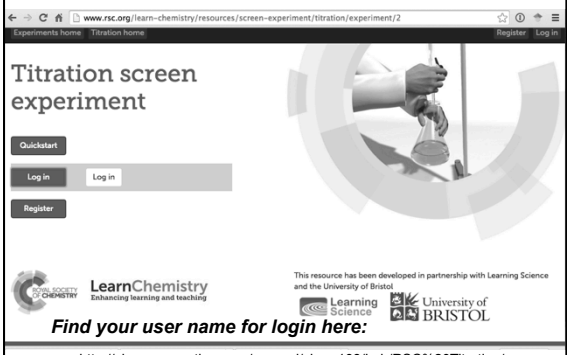
http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2



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



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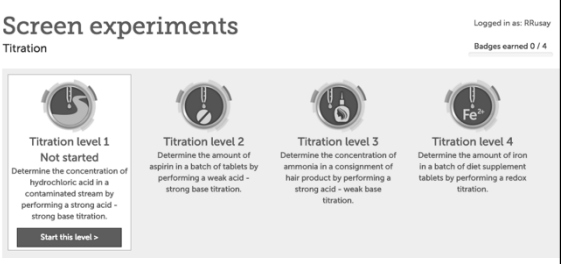


Find your user name for login here:

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

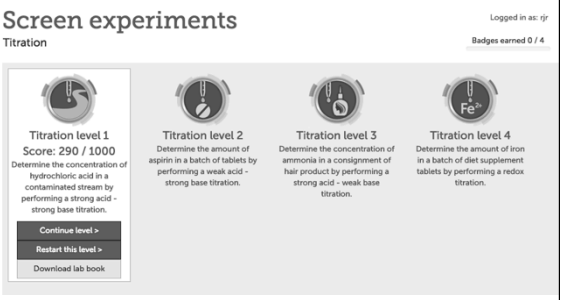
Background

Background

Iron Mountain & the Sacramento River? pH = -3.6

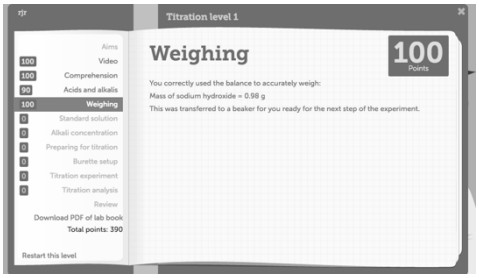
Background

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



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).



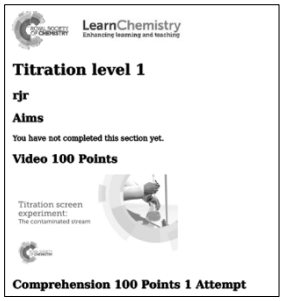
http://www.rsc.org/learn-chemistry/resources/screen-experiment/titration/experiment/2

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*



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Chem 108: Class/ Lab

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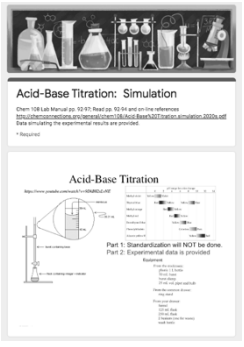
Assignment 2:

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

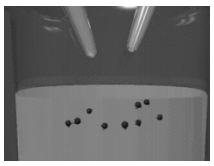


https://www.youtube.com/watch?v=9DkB82xLvNE

Neutralization Reactions

Titration

http://chemconnections.org/general/movies/acidbasetitration.mov



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

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

Neutralizations / Titrations

Chem 108 titration: phenolphthalein indicator
General Chemistry-Titration Curves

Aqueous Reactions: Neutralization

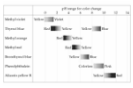
Net Ionic Equations

$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

strong acid — base — salt — water

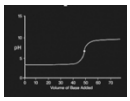
Titration end point pH > 7

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



$Na^+_{(aq)} + OH^-_{(aq)} + H^+_{(aq)} + Cl^-_{(aq)} \longrightarrow$

$Na^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$



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

Equivalence point: pH = 7

Aqueous Reactions: Neutralization

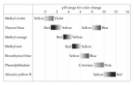
Net Ionic Equations

$CH_3COOH_{(aq)} + NaOH_{(aq)} \longrightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$

weak acid — base — salt — water

$CH_3COO^-_{(aq)} + H^+_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \longrightarrow$

$CH_3COO^-_{(aq)} + Na^+_{(aq)} + H_2O_{(l)}$



Titration end point pH > 7

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

Same Net Ionic Equation (NIE) **for any neutralization**

Eg. H_2SO_4 $\quad 2\ H^+_{(aq)} + 2\ OH^-_{(aq)} \longrightarrow 2\ H_2O_{(l)}$

2

Equivalence point: **pH = ?**

Aqueous Reactions: Neutralization

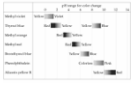
Salt in this case is a Weak Base

$CH_3COOH_{(aq)} + NaOH_{(aq)} \longrightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$

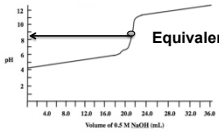
weak acid — base — **salt** — water

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

salt $Na^+_{(aq)}$ $\quad$ $Na^+_{(aq)}$



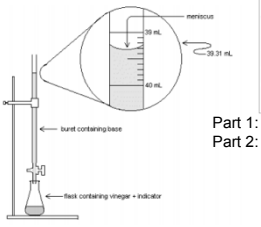
Titration End point pH > 7

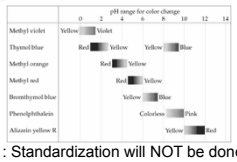


Equivalence point: **pH = ?**

Acid-Base Titration

https://www.youtube.com/watch?v=9DkB82xLvNE





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

https://www.youtube.com/watch?v=9DkB82xLvNE

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			example			
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			example			
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 $M_{H+\,aq}$ *= ?*

Average of trials #2-6 = 19.25 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	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.

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			example			
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

$HNO_{3(aq)} + NaOH_{(aq)} \longrightarrow NaNO_{3\,(aq)} + H_2O_{(l)}$

acid base salt water

conj. base conj. acid

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

acid base water

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

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

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

Unkown Acid Neutralization

Net Ionic Equation/ Calculation

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

acid base water

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

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

$$= \frac{0.2162\ mol_{OH-} \times 0.02420\ L_{OH-} \times 1\ mol_{H+}}{L_{OH-} \times 0.02500\ L_{H+} \times 1\ mol_{OH-}} = 0.2093\ M_{H+}$$

Chem 108: Lab

Part 2: Week 13

$V_{H+\,aq}$= 25.00 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	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)*		0.1716		0.1726	0.1708	0.1716
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.

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

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

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

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

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

1 H_2SO_4 2 2

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

$?M_{H+} = [M_{OH-} \times V_{OH-} / V_{H+}]\,[?\ mol_{H2SO4} / ?\ mol_{OH-}]$

https://forms.gle/Wh4arki3jSTaCSzj9

Complete & Submit:
https://forms.gle/Wh4arki3jSTaCSzj9