Titration
1 ……
2……

Purpose:

- **Use dilution equation to make 0.1M HCl solution from 6M HCl solution**
- **Use titration of HCl and TRIS to check the molarity standardize of HCl solution**
- **Evaluate precision for molarity of HCl**
- **Determine the concentration of an unknown monobase through titration with standardized HCl**
- **Evaluate precision and accuracy of titration for MOH**

Reference:

(1) Kateley, L. J., *Introduction to Chemistry in the Laboratory, 20th Ed.*, Lake Forest College, **2021,** Experiment Titration 1, Appendix B_AccuracyErrorPrecision**.**

Standardization of HCl, water added first...

Dilution of Acid

- 400mL of 1M HCl from 6M HCL
- 7mL of 6M HCl and 393mL of deionized water , 200 ml water, acid, filled to 200 mL and stirred
- Stirred to evenly disperse acid

(.400L)(0.1M) =(xL)(6M) = 0.007L of 6M HCl = 7mL of 6M HCl and 393mL of deionized water

Preparation of the Buret with Dilute HCl

- Buret was rinsed three times with 5mL of dilute acid
- Buret was filled with dilute acid to starting volume between 0-1mL
- Dilute HCl was clear colorless solution

Preparation of the Flask with TRIS Base

For each trial

- Added 0.3000 to 0.4800 g of TRIS into untared flask
- Filled flask to approximately 50mL and swirrled to evenly distribute TRIS
- Added 2 drops of ethyl orange indicator to each flask turning the solution a golden yellow
- The vial of ethyl orange looked dark orange-red, akin to cranberry juice.
- Titrant HCl in buret, analyte TRIS in flask

Titration of HCL with TRIS

- 20mL of HCl rapidly drained from buret into flask
- Approximately 200 more drops of HCl added
- Solution in flask turned light orange-pink/ peach marking

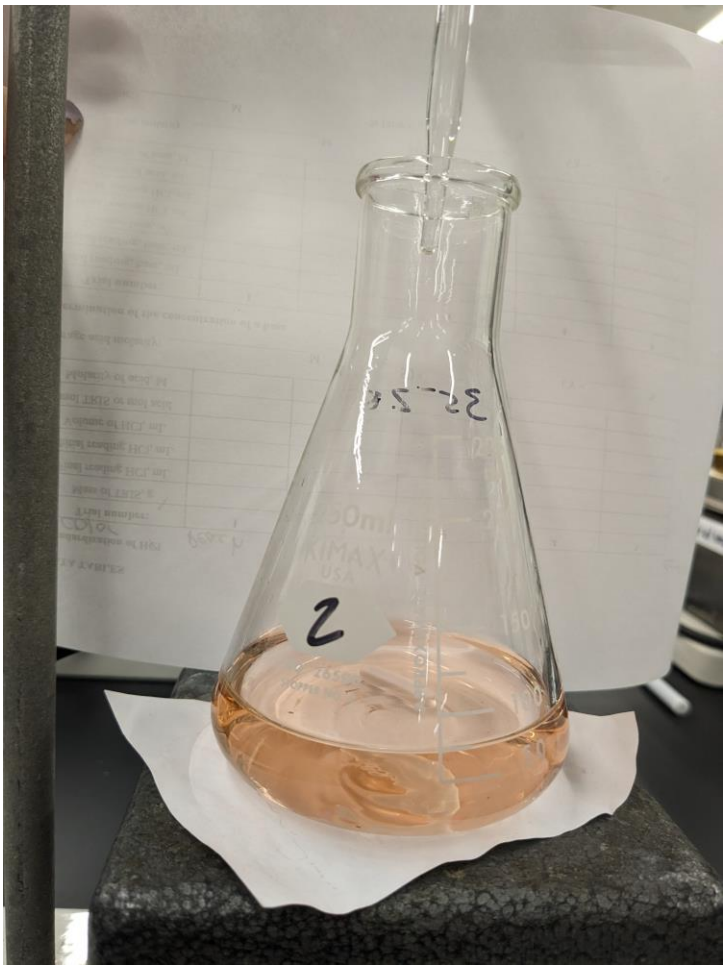


Figure 1. Endpoint of titration of HCl into TRIS

Calculations to determine M of HCl

- Moles of TRIS = g of TRIS/121.4 g/mol
- Total Volume HCl = Final Volume HCl - Initial Volume of HCl
- Molarity of HCl = mol of TRIS/acid/total L of HCl
- Average = (0.09729 + 0.09820 + 0.09338)/3 = 0.09629
- Standard Deviation = 2.56×10^{-3} = 0.0026 M
- CV = Standard Deviation/Average = 2.56×10^{-3}/0.09629 -= precision is resonable

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Starting Volume of HCl (mL)	**0.32**	**0.49**	**0.35**	**N/A**
Final Volume of HCl (mL)	**33.21**	**38.29**	**32.82**	**N/A**
Total Volume of HCl (mL)	**32.89**	**37.70**	**32.47**	**N/A**
Mass of TRIS (g)	**0.3885**	**0.4494**	**0.3681**	**0.3841**

Moles of TRIS/HCl	**$3.200x10^{-3}$**	**$3.702x10^{-3}$**	**$3.032x10^{-3}$**	**$3.164x10^{-3}$**
Molarity of HCl (mol/L)	**0.09729**	**0.09820**	**0.09338**	**N/A**
Color	**Peach**	**Peach**	**Peach**	**N/A**

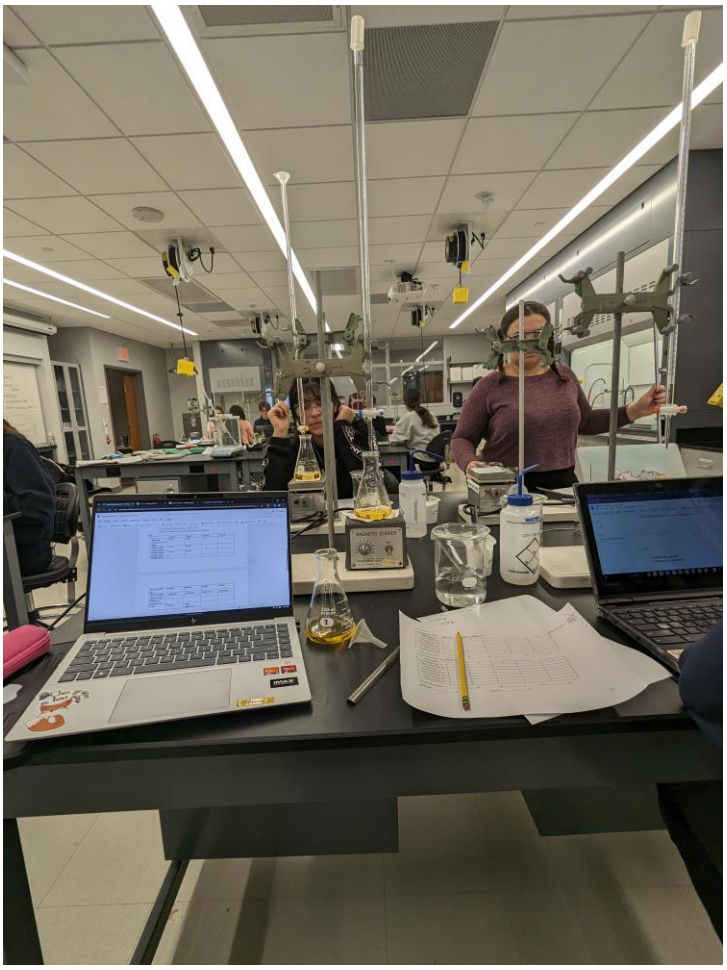


Figure 2. Buret set up for titration

Detect Concentration of Unknown Monobase C with Standardized 0.09629M HCl

$HCl + MOH \rightarrow MCl + H_2O$

Base was dispensed into flask and ethyl orange indicator was added

- Flasks filled with approximately 30mL of unknown base solution from communal buret
- 2 drops of ethyl orange indicator added and swirled to mix
- Solution turned golden yellow
- 20-30mL of HCl rapidly added to flask
- Endpoint indicated by solution turning pink-orange/ peach
- Titrant HCl in buret, anayte unknown base in flask

	Trial 1	**Trial 2**	**Trial 3**

Initial base (mL)	**0.21**	**0.32**	**0.32**
Final base (mL)	**30.29**	**30.34**	**30.41**
Total base (mL)	**30.08**	**30.02**	**30.09**

Base titrated with standardized 0.09629M HCl

	Trial 1	**Trial 2**	**Trial 3**
Initial HCl (mL)	**0.11**	**0.41**	**0.55**
Final HCl (mL)	**43.11**	**42.82**	**42.90**
Total HCl(mL)	**43.00**	**42.41**	**42.35**
Color	**Peach**	**Peach**	**Peach**

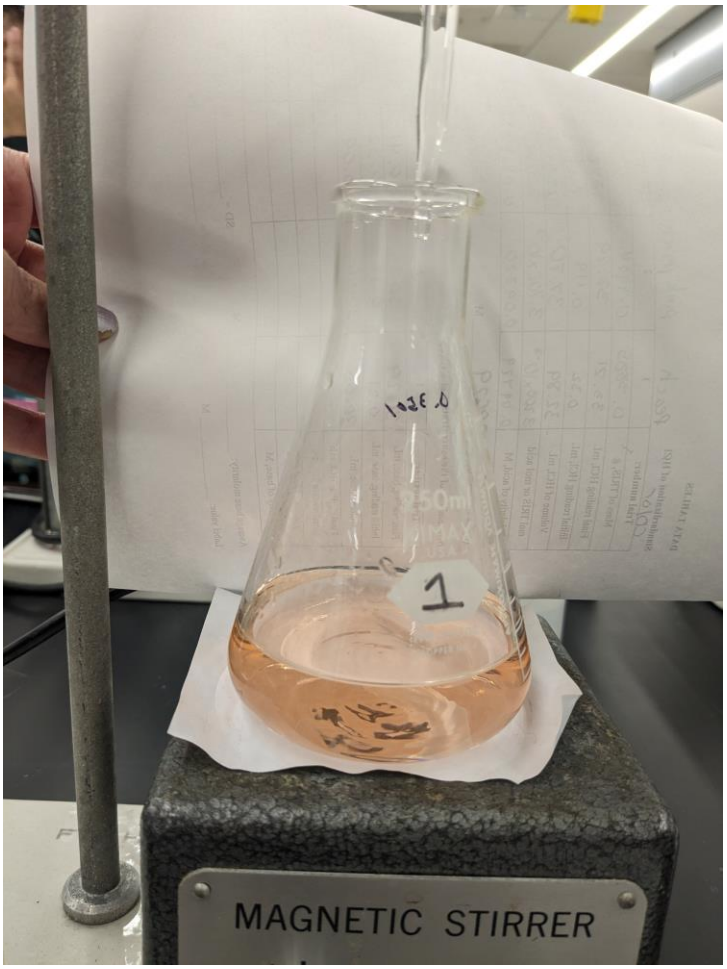


Figure 3. endpoint of titration of HCl into unknown base

Calculation for the Molarity of Unknow Base

	Trial 1	**Trial 2**	**Trial 3**
Moles of HCl/base	**4.140×10^{-3}**	**4.084×10^{-3}**	**4.078×10^{-3}**
Molarity of base (mol/L)	**0.1376**	**0.1357**	**0.1355**

HCl + MOH -> MCl + H_2O

Total base = Final base – initial base

Total HCl = Final HCl – initial HCl

Moles of HCl/base = Total HCl in L (Molarity of HCl)

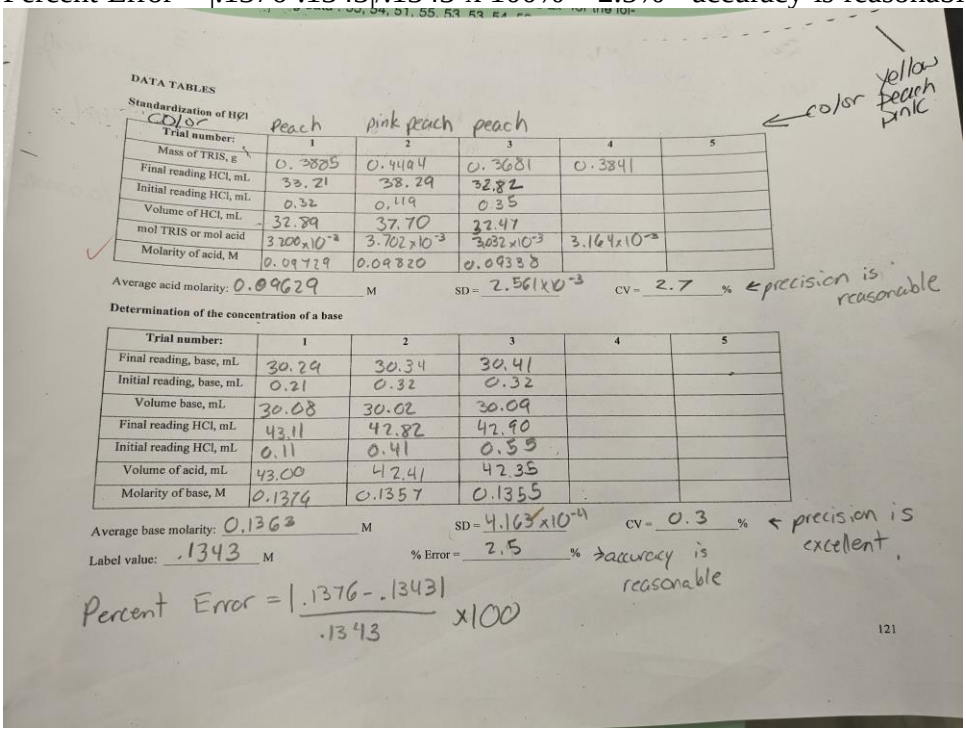
Molarity of base = Moles of HCl/base / Total base of L

Average = 0.1376 + 0.1357 + 0.1355 = 0.1363

Standard Deviation = 4.163×10^{-4} = 0.004

CV = Standard Deviation/ Average = 0.3% - precision is excellent

Percent Error = |.1376-.1343|/.1343 x 100% = 2.5% - accuracy is reasonable



DATA TABLES

Standardization of HCl

Trial number:	1	2	3	4	5
Mass of TRIS, g	0.3885	0.4404	0.3681	0.3841	
Final reading HCl, mL	33.21	38.29	32.82		
Initial reading HCl, mL	0.32	0.119	0.35		
Volume of HCl, mL	32.89	37.70	32.47		
mol TRIS or mol acid	3.200×10^{-3}	3.702×10^{-3}	3.032×10^{-3}	3.164×10^{-3}	
Molarity of acid, M	0.09729	0.09820	0.09338		

Average acid molarity: 0.09629 M SD = 2.561×10^{-3} CV = 2.7 %

Determination of the concentration of a base

Trial number:	1	2	3	4	5
Final reading, base, mL	30.29	30.34	30.41		
Initial reading, base, mL	0.21	0.32	0.32		
Volume base, mL	30.08	30.02	30.09		
Final reading HCl, mL	43.11	42.82	42.90		
Initial reading HCl, mL	0.11	0.41	0.55		
Volume of acid, mL	43.00	42.41	42.35		
Molarity of base, M	0.1374	0.1357	0.1355		

Average base molarity: 0.1363 M SD = 4.163×10^{-4} CV = 0.3 %

Label value: .1343 M % Error = 2.5 %

Percent Error = $\frac{|.1376 - .1343|}{.1343} \times 100$

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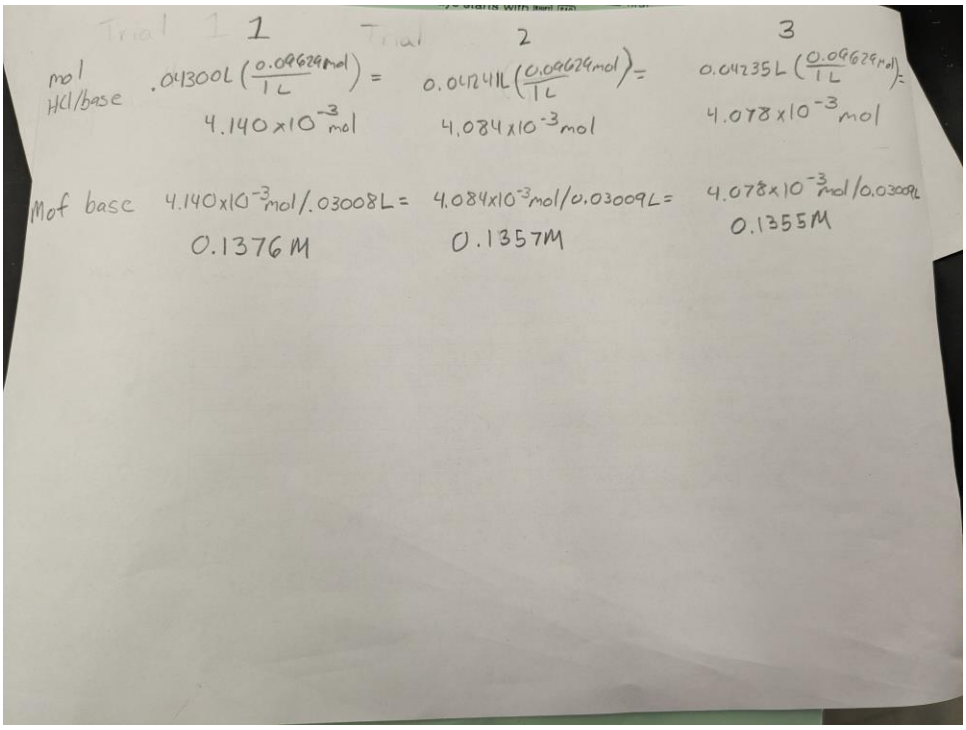

	Trial 1	Trial 2	Trial 3
mol HCl/base	$.04300L\left(\frac{0.09629mol}{1L}\right) =$ $4.140\times10^{-3}mol$	$0.04241L\left(\frac{0.09629mol}{1L}\right) =$ $4.084\times10^{-3}mol$	$0.04235L\left(\frac{0.09629mol}{1L}\right) =$ $4.078\times10^{-3}mol$
Mof base	$4.140\times10^{-3}mol/.03008L =$ $0.1376M$	$4.084\times10^{-3}mol/0.03009L =$ $0.1357M$	$4.078\times10^{-3}mol/0.03009L$ $0.1355M$