neoCatalyst Labs

VIRTUAL LAB PLATFORM · CHEMISTRY

LAB K-3

Acid-Base Titration

STUDENT NAME	DATE COMPLETED	LAB TIME
Sample Student	**August 8, 2026**	**47 min**

LAB OVERVIEW

OBJECTIVE

Add base from a burette to determine an unknown acid concentration using neutralisation stoichiometry and equivalence point identification.

PROCEDURE SUMMARY

Added NaOH in increments to CH_3COOH solution; tracked pH; located equivalence point from maximum ΔpH; applied $C_1V_1 = C_2V_2$ to calculate concentration.

STANDARDS ALIGNMENT

NGSS HS-PS1-7 — Use mathematical representations to support conservation of matter.
AP Chemistry — Acid-base equilibria and titration.

TIME ON LAB

47 min actual · Target: 45 min

EXPERIMENTAL SETUP

ACID (ANALYTE — IN FLASK)

Acetic Acid

CH_3COOH · 0.100 M · 25 mL

BASE (TITRANT — IN BURETTE)

Sodium Hydroxide

NaOH · 0.100 M

INDICATOR

Phenolphthalein

Colourless → Pink at pH > 8.2

TITRATION TYPE

Weak Acid + Strong Base

pK_a of acid = 4.76

RESULTS SUMMARY

AVG EQ. VOLUME	PH AT EQUIVALENCE	CALCULATED CONC.	% ERROR
25.00	**8.73**	**0.1000**	**0.00%**
mL of NaOH	Theoretical: 8.73	M CH_3COOH	vs. 0.1000 M

TRIAL	EQUIVALENCE VOLUME (ML)	PH AT EQUIVALENCE
Trial 1	25.00	8.73

TRIAL	EQUIVALENCE VOLUME (ML)	PH AT EQUIVALENCE
Trial 2	25.00	8.73
Average	**25.00**	—
Spread (max-min)	0.00	—

✓ **Concordant results** — all trial equivalence volumes agree within 0.20 mL.

CONCENTRATION CALCULATION

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Given:
  C_base   = 0.1000 M
  V_base   = 25.00 mL  (average of 2 trials)
  V_acid   = 25.0 mL

Formula:  C_acid × V_acid = C_base × V_base
          C_acid = (C_base × V_base) / V_acid

Result:   C_acid = (0.1000 × 25.00) / 25.0
          C_acid = 0.1000 M

Theoretical:  0.1000 M
% Error:      |0.1000 - 0.1000| / 0.1000 × 100 = 0.00%
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TITRATION DATA — 2 TRIALS

#	VOLUME ADDED (ML)	TOTAL BASE (ML)	PH	ΔPH
TRIAL 1 — EQUIVALENCE POINT: 25.00 ML (PH 8.73)				
0	0.00	0.00	2.88	—
1	+2.00	2.00	3.70	+0.82
2	+2.00	4.00	4.04	+0.34
3	+2.00	6.00	4.26	+0.22
4	+2.00	8.00	4.43	+0.17
5	+2.00	10.00	4.58	+0.15
6	+2.00	12.00	4.73	+0.14

#	VOLUME ADDED (ML)	TOTAL BASE (ML)	PH	ΔPH
7	+2.00	14.00	4.86	+0.14
8	+2.00	16.00	5.01	+0.15
9	+2.00	18.00	5.17	+0.16
10	+2.00	20.00	5.36	+0.19
11	+2.00	22.00	5.63	+0.26
12	+0.50	22.50	5.71	+0.09
13	+0.50	23.00	5.82	+0.11
14	+0.50	23.50	5.95	+0.13
15	+0.50	24.00	6.14	+0.19
16	+0.50	24.50	6.45	+0.31
17	+0.10	24.60	6.55	+0.10
18	+0.10	24.70	6.68	+0.13
19	+0.10	24.80	6.85	+0.18
20	+0.10	24.90	7.16	+0.30
21	**+0.10**	**25.00**	**8.73**	**+1.57**
22	+0.10	25.10	10.30	+1.57
23	+0.10	25.20	10.60	+0.30
24	+0.10	25.30	10.78	+0.18
25	+0.10	25.40	10.90	+0.12
26	+0.10	25.50	11.00	+0.10
27	+0.10	25.60	11.07	+0.08
28	+1.00	26.60	11.49	+0.42
29	+1.00	27.60	11.69	+0.20
30	+1.00	28.60	11.83	+0.13
31	+1.00	29.60	11.93	+0.10

#	VOLUME ADDED (ML)	TOTAL BASE (ML)	PH	ΔPH
32	+1.00	30.60	12.00	+0.08
33	+1.00	31.60	12.07	+0.06
34	+1.00	32.60	12.12	+0.05
35	+1.00	33.60	12.17	+0.05
TRIAL 2 — EQUIVALENCE POINT: 25.00 ML (PH 8.73)				
0	0.00	0.00	2.88	—
1	+2.00	2.00	3.70	+0.82
2	+2.00	4.00	4.04	+0.34
3	+2.00	6.00	4.26	+0.22
4	+2.00	8.00	4.43	+0.17
5	+2.00	10.00	4.58	+0.15
6	+2.00	12.00	4.73	+0.14
7	+2.00	14.00	4.86	+0.14
8	+2.00	16.00	5.01	+0.15
9	+2.00	18.00	5.17	+0.16
10	+2.00	20.00	5.36	+0.19
11	+2.00	22.00	5.63	+0.26
12	+0.50	22.50	5.71	+0.09
13	+0.50	23.00	5.82	+0.11
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15	+0.50	24.00	6.14	+0.19
16	+0.50	24.50	6.45	+0.31
17	+0.10	24.60	6.55	+0.10
18	+0.10	24.70	6.68	+0.13
19	+0.10	24.80	6.85	+0.18

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20	+0.10	24.90	7.16	+0.30
21	**+0.10**	**25.00**	**8.73**	**+1.57**
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23	+0.10	25.20	10.60	+0.30
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ANALYSIS QUESTIONS

QUESTION 1

At what volume of base did the colour change occur? How does this compare to your recorded equivalence point?

The endpoint is where the indicator changes colour; the equivalence point is where moles of acid exactly equal moles of base. They are close but not identical — phenolphthalein turns just past true equivalence, which is why the indicator is chosen so its range overlaps the steep part of the curve.

QUESTION 2

What was the pH at the equivalence point? Was it 7, above 7, or below 7? Explain why.

The pH at equivalence was above 7 because this is a weak acid titrated with a strong base. The conjugate base produced hydrolyses in water and raises the pH, so equivalence sits basic rather than neutral.

QUESTION 3

Concentration calculation — show your work using $C_1V_1 = C_2V_2$.

Using C1V1 = C2V2 with the averaged equivalence volume, the acid concentration works out close to the stated value. Averaging two concordant trials reduces the effect of a single misread drop.

QUESTION 4

Why does the pH change slowly at the beginning, rise dramatically near equivalence, then level off?

The buffer region is the flat stretch before equivalence, where added OH- is consumed converting HA to A- and the pH changes only slowly. Once the acid is used up the solution has no buffering left, so pH climbs sharply.

QUESTION 5

Explain why the equivalence pH is above 7 for CH_3COOH + NaOH. What conjugate base is formed?

Phenolphthalein is appropriate here because its transition range sits in the steep basic region where this titration crosses equivalence. Methyl orange would change far too early and give a low reading.

CONCLUSION

Two concordant trials gave a consistent equivalence volume, and the calculated concentration agreed closely with the expected value. The main source of error is judging the exact drop at which the colour persists.

CHALLENGE QUESTIONS

CHALLENGE 1

You performed a titration where 24.8 mL of 0.100 M NaOH neutralised 25.0 mL of HCl. If you repeated the experiment with NaOH diluted to 0.090 M, predict whether the equivalence point would be at a smaller or larger volume and by approximately what factor. Explain using $C_1V_1 = C_2V_2$.

A more concentrated titrant would reach equivalence in fewer millilitres, making each drop worth more pH and the endpoint harder to pinpoint.

CHALLENGE 2

Compare the titration curves of a strong acid/strong base pair versus a weak acid/strong base pair at the same concentrations and volumes. Describe at least 3 specific differences and the chemistry behind each.

Overshooting past the endpoint means the recorded volume is too high, so the calculated acid concentration comes out too high as well.

CHALLENGE 3

Phenolphthalein changes colour between pH 8.2–10.0. For a weak acid/strong base equivalence pH of 8.7, explain why it is appropriate and what error it introduces. Name one system where it would be inappropriate and recommend a better alternative.

A pH meter removes the subjective colour judgement and lets you locate equivalence from the steepest slope rather than from an indicator.

VERIFICATION & SIGNATURES

I verify that **Sample Student** completed **Lab K-3: Acid-Base Titration** independently on the date indicated. This lab addresses **NGSS HS-PS1-7** (mathematical representations supporting conservation of matter in acid-base reactions) and constitutes approximately **1.0 credit hours** of chemistry laboratory work.

STUDENT SIGNATURE & DATE

PARENT / INSTRUCTOR SIGNATURE & DATE

REPORT ID

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