CASTLE Student View

Work Flow for Students

- **Before Lab**
  - Lab Comprehension Assessment
    - Students are given sections of the lab manual, in order, and answer both multiple choice and numerical answer questions about what they find in that section.
      - Students receive progressive feedback as they answer questions.
    - Students must complete the questions in one section to move on to the next.
    - Students can only view the entire experiment after they have completed all assessment sections.
  - Written Pre-Lab
    - The pre-lab becomes available after students complete the assessment sections.
    - Students write objective, hypothesis, variables, experimental outline and chemical hazards and waste sections for each part of an experiment.
    - Students have access to a pdf of their written pre-lab after it is completed.
- **During lab**
  - Students are asked questions (about the lab and what to do next), input data and do calculations throughout the lab.
    - Students receive progressive feedback throughout.
  - Students complete written post lab questions after they complete the experimental work.
  - The software compiles a pdf of the written pre-lab, post-lab data and written post-lab for the TA to view.

Student Login

CASTLE Login

Welcome to General Chemistry 1 Lab at the University at Albany

Login: bobsmith

Password: ***************

Sign In

Select an Experiment

Welcome back Bob! You have lab on Thursdays at 1:15 in CH-145 with Sarah Jones.

Which experiment would you like to work on?

Experiment Number	Experiment Name	Experiment Date	Lab Comprehension Assessment Complete	Pre-Lab Complete	Experiment Complete
5	Empirical Formula of Hydrated Copper Sulfate	10/8/2015	✓	✓	✓
6	Synthesis and Purity of Aspirin	10/15/2015	✓	✓	✓
7	Acid Base Titration	10/22/2015			

Student Selects Experiment 7

Bob, I see this is your first time working on Experiment 7. Lets get started with the key concepts. Remember, you will not have access to the entire experiment until you have completed the lab comprehension assessment.

Key Concepts:

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

Proceed

Volumetric Glassware

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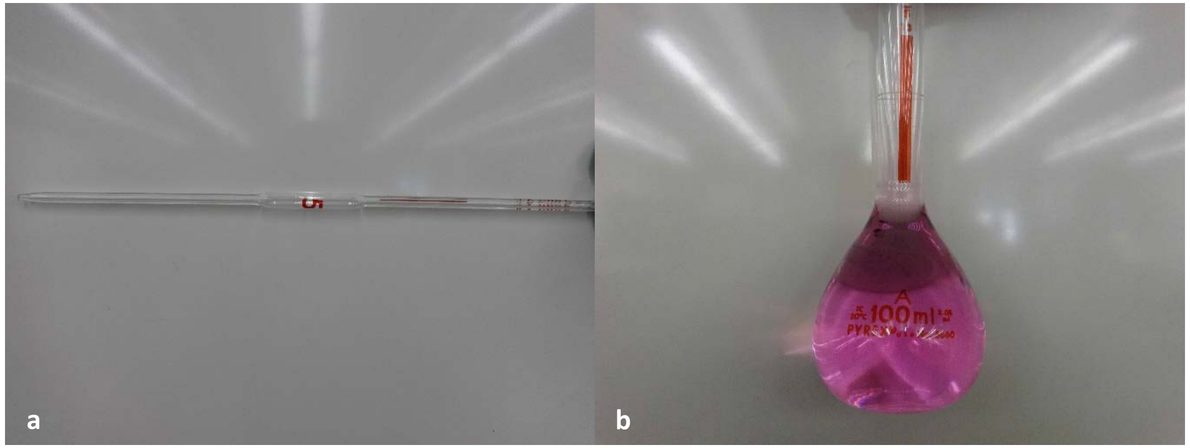
Picture 1. (a) 5.00 mL volumetric pipette. (b) 100.0 mL volumetric flask.



Volumetric glassware is filled with a liquid or solution so the bottom of the meniscus is even with the calibration line. The **calibration line** is a marking indicating the fill level of the volumetric glassware. Pictures 2a and 2b show the calibration lines for a 5.00 mL volumetric pipette and a 100.0 mL volumetric flask.

Students can go to whatever question they want, but it displays them in order.

Volumetric Glassware Question: **1** 2 3 4 5

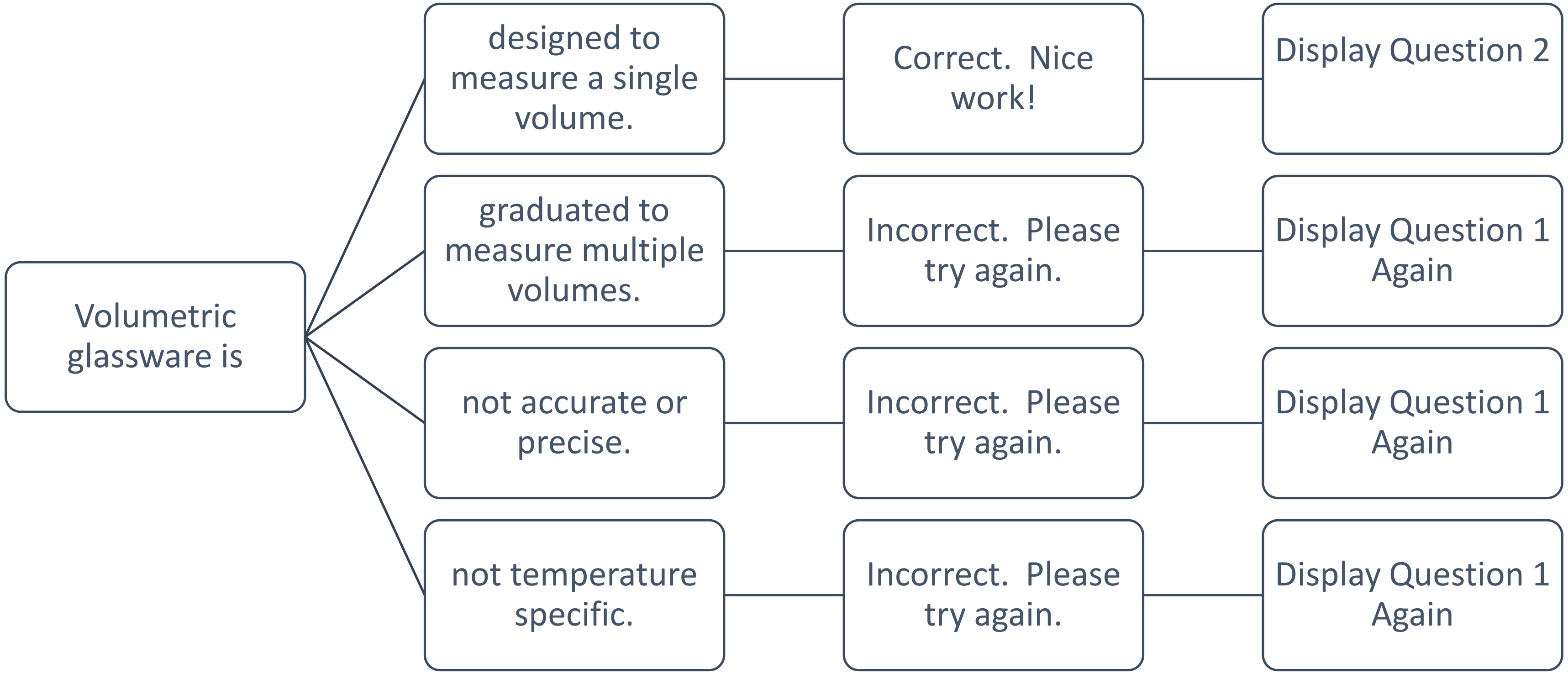
Volumetric glassware is

- ❑ designed to measure a single volume.
- ❑ graduated to measure multiple volumes.
- ❑ not accurate or precise.
- ❑ not temperature specific.

Submit

Multiple choice answers should be randomized so they are displayed in a different order each time.

Volumetric Glassware Question 1



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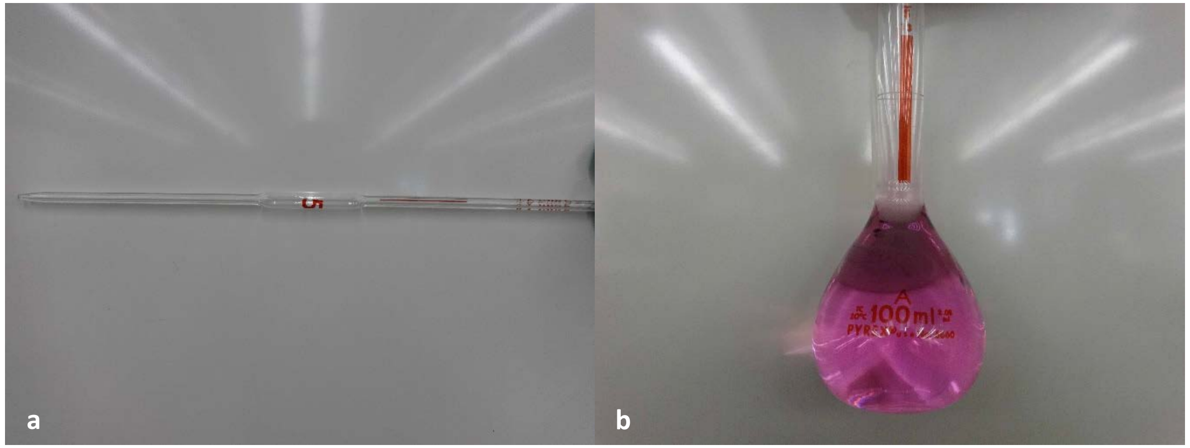

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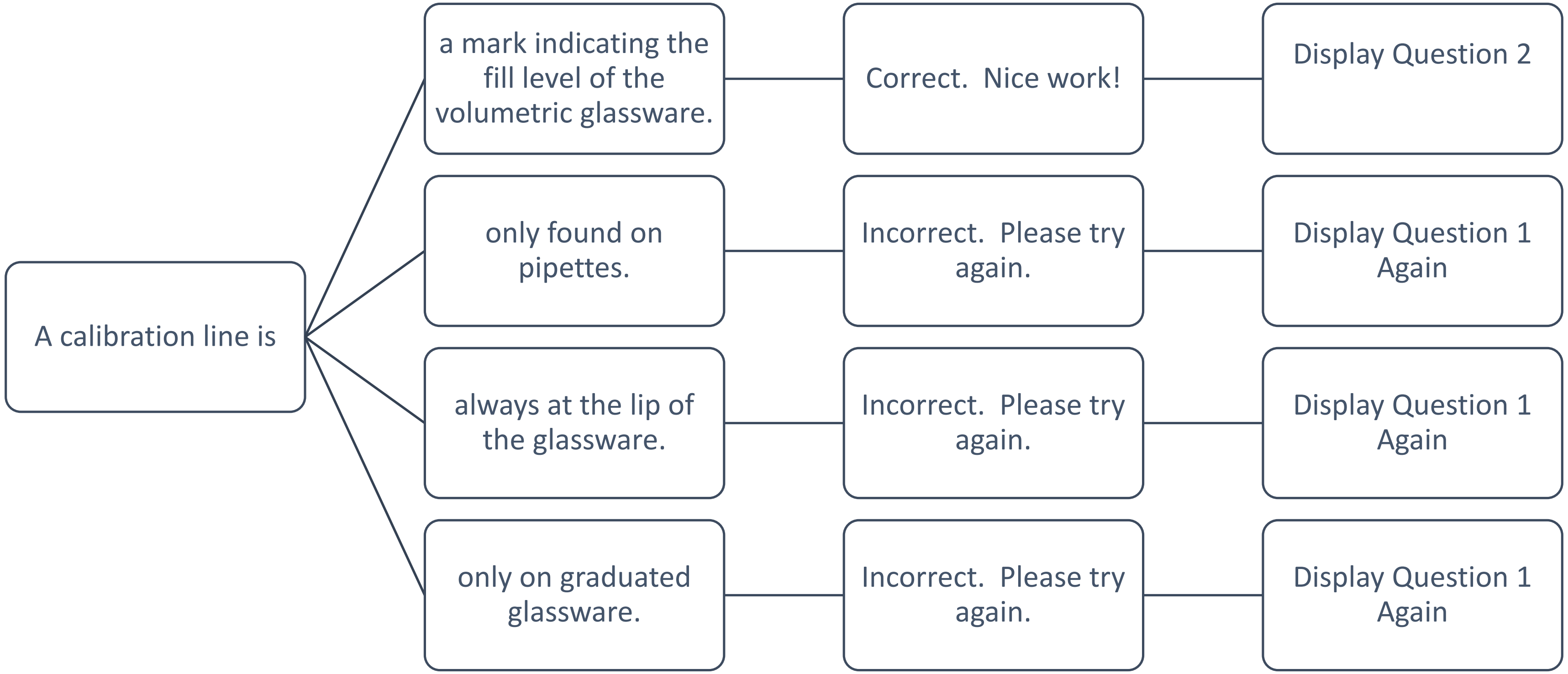
Volumetric Glassware Question: 1 **2** 3 4 5

A calibration line is

- ❑ a mark indicating the fill level of the volumetric glassware.
- ❑ only found on pipettes.
- ❑ always at the lip of the glassware.
- ❑ only on graduated glassware.

Submit

Volumetric Glassware Question 2



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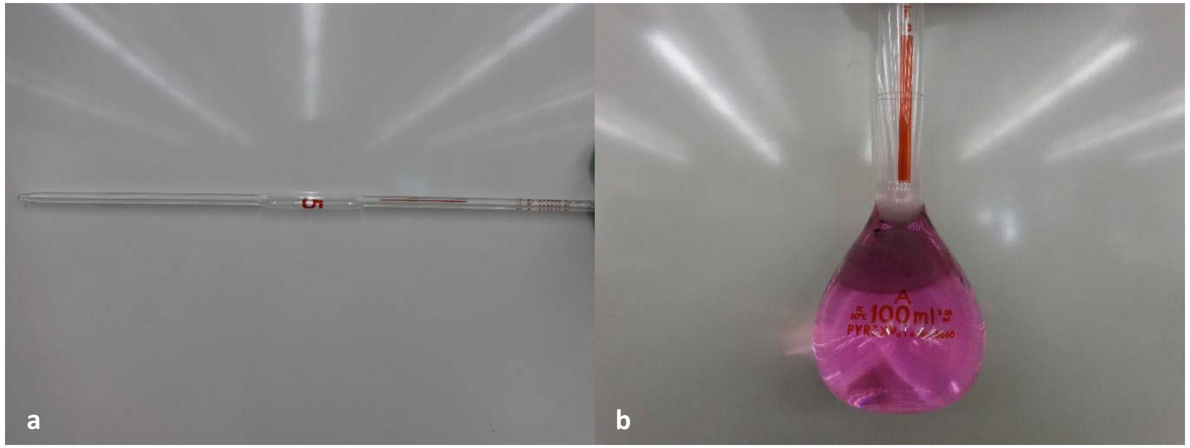

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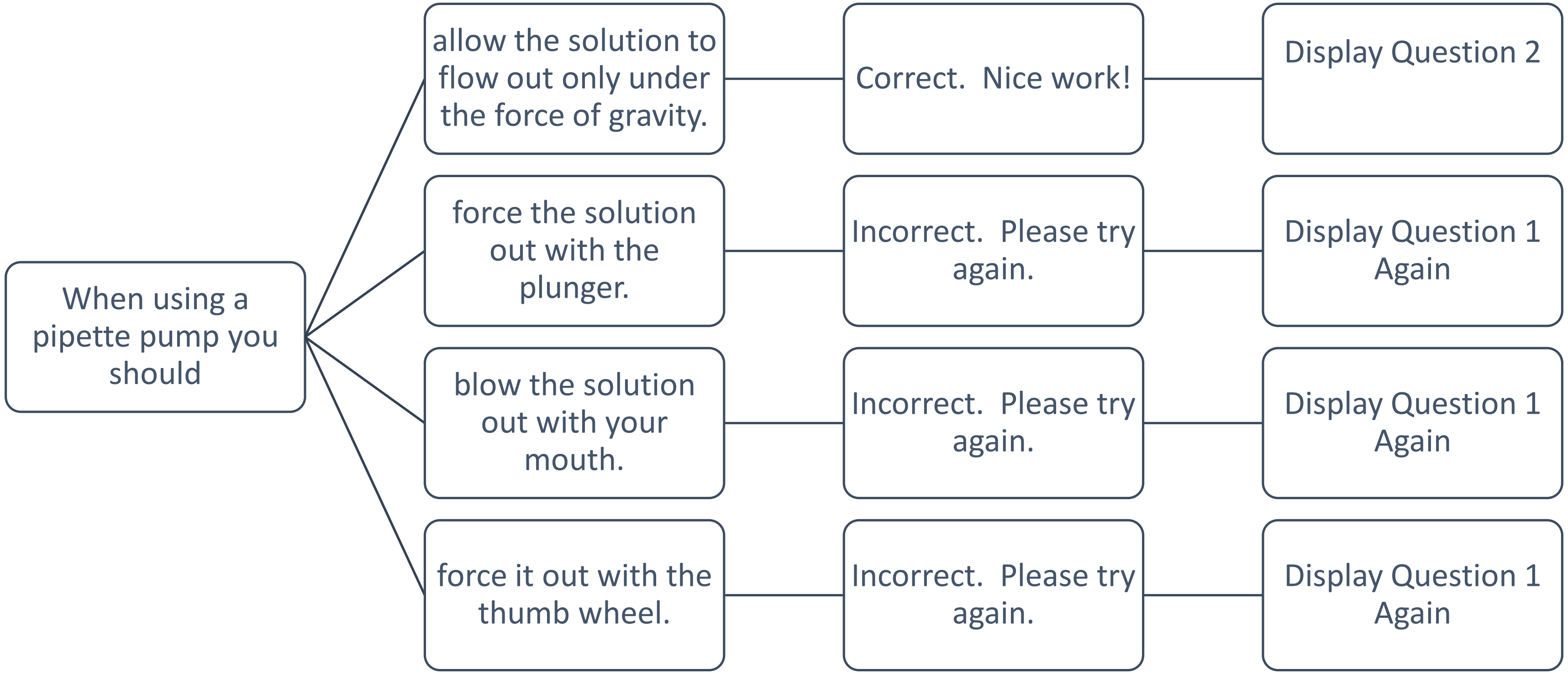
Volumetric Glassware Question: 1 2 **3** 4 5

When using a pipette pump you should

- ❑ allow the solution to flow out only under the force of gravity.
- ❑ force the solution out with the plunger.
- ❑ blow the solution out with your mouth.
- ❑ force it out with the thumb wheel.

Submit

Volumetric Glassware Question 3



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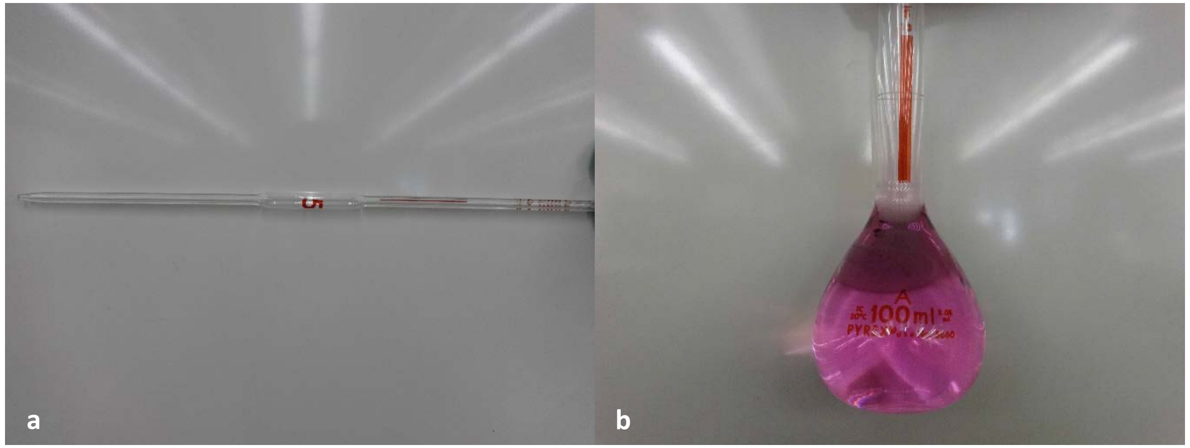

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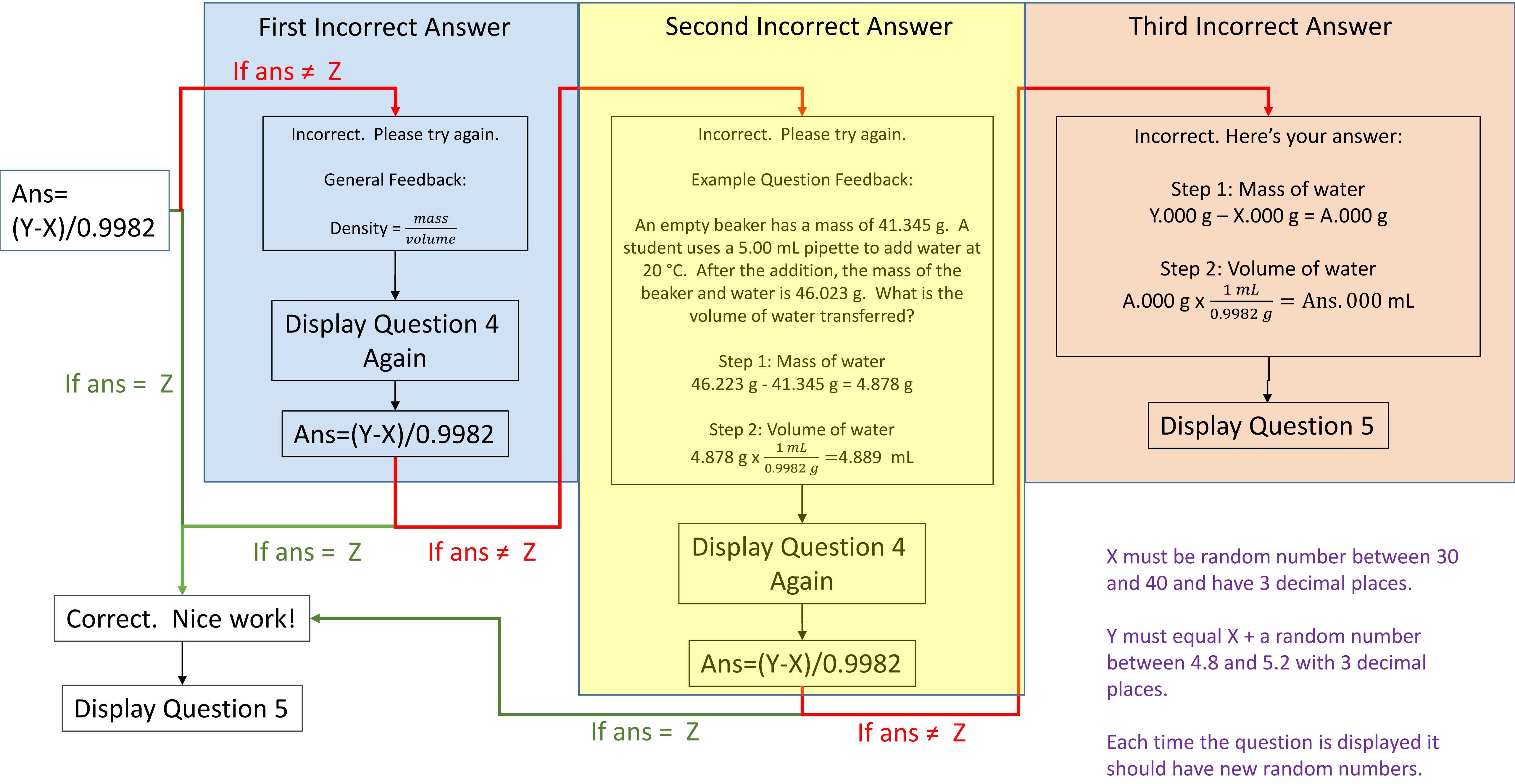
Volumetric Glassware Question: 1 2 3 **4** 5

An empty beaker has a mass of X.000 g. A student uses a 5.00 mL pipette to add water at 20 °C. After the addition, the mass of the beaker and water is Y.000 g. What is the volume of water transferred?

Z mL

Submit

X.000 and Y.000 means that numbers should be displayed to 3 decimal places.



First Incorrect Answer
Second Incorrect Answer
Third Incorrect Answer
Ans= (Y-X)/0.9982
If ans ≠ Z
Incorrect. Please try again.
General Feedback:
Density = $\frac{mass}{volume}$
Display Question 4 Again
Ans=(Y-X)/0.9982
If ans = Z
If ans = Z
If ans ≠ Z
Correct. Nice work!
Display Question 5
Incorrect. Please try again.
Example Question Feedback:
An empty beaker has a mass of 41.345 g. A student uses a 5.00 mL pipette to add water at 20 °C. After the addition, the mass of the beaker and water is 46.023 g. What is the volume of water transferred?
Step 1: Mass of water
46.223 g - 41.345 g = 4.878 g
Step 2: Volume of water
4.878 g x $\frac{1\ mL}{0.9982\ g}$ =4.889 mL
Display Question 4 Again
Ans=(Y-X)/0.9982
If ans = Z
If ans ≠ Z
Incorrect. Here's your answer:
Step 1: Mass of water
Y.000 g – X.000 g = A.000 g
Step 2: Volume of water
A.000 g x $\frac{1\ mL}{0.9982\ g} = \mathrm{Ans.000}$ mL
Display Question 5
X must be random number between 30 and 40 and have 3 decimal places.
Y must equal X + a random number between 4.8 and 5.2 with 3 decimal places.
Each time the question is displayed it should have new random numbers.

Volumetric Glassware

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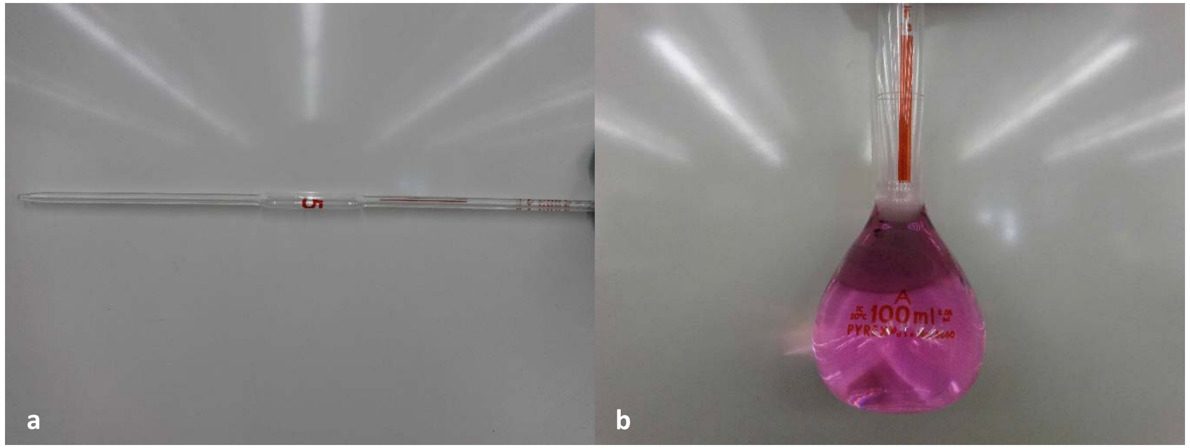

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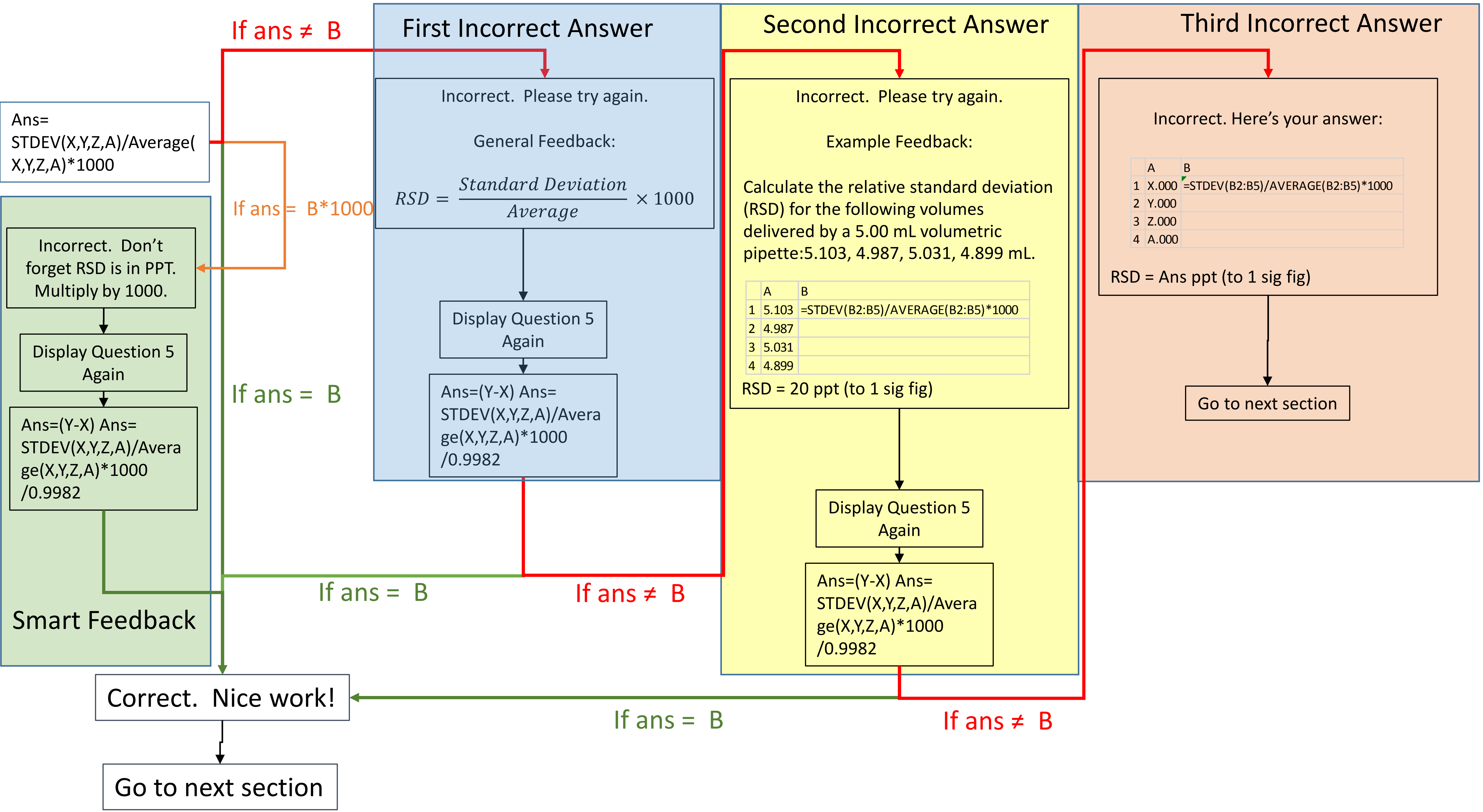
Volumetric Glassware Question: 1 2 3 4 **5**

Calculate the relative standard deviation (RSD) for the following volumes delivered by a 5.00 mL volumetric pipette: X.000, Y.000, Z.000, A.000 mL.

B ppt

Submit

X, Y, Z and A should each be a different random number between 4.8 and 5.2 with 3 decimal places.

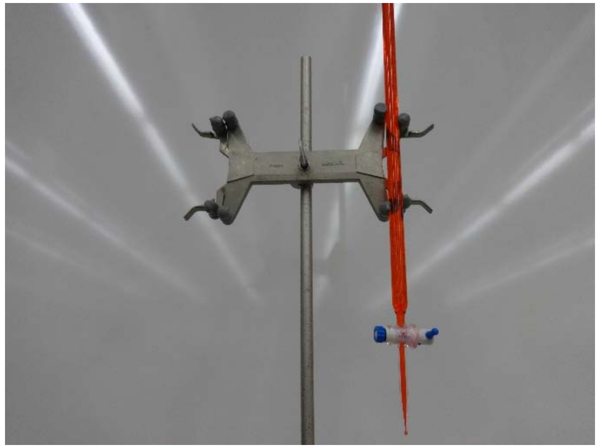


Ans=
STDEV(X,Y,Z,A)/Average(
X,Y,Z,A)*1000
If ans ≠ B
If ans = B*1000
If ans = B
First Incorrect Answer
Incorrect. Please try again.
General Feedback:
RSD = Standard Deviation / Average × 1000
Display Question 5 Again
Ans=(Y-X) Ans=
STDEV(X,Y,Z,A)/Avera
ge(X,Y,Z,A)*1000
/0.9982
Second Incorrect Answer
Incorrect. Please try again.
Example Feedback:
Calculate the relative standard deviation (RSD) for the following volumes delivered by a 5.00 mL volumetric pipette:5.103, 4.987, 5.031, 4.899 mL.
A
B
1 5.103 =STDEV(B2:B5)/AVERAGE(B2:B5)*1000
2 4.987
3 5.031
4 4.899
RSD = 20 ppt (to 1 sig fig)
Display Question 5 Again
Ans=(Y-X) Ans=
STDEV(X,Y,Z,A)/Avera
ge(X,Y,Z,A)*1000
/0.9982
Third Incorrect Answer
Incorrect. Here's your answer:
A
B
1 X.000 =STDEV(B2:B5)/AVERAGE(B2:B5)*1000
2 Y.000
3 Z.000
4 A.000
RSD = Ans ppt (to 1 sig fig)
Go to next section
Incorrect. Don't forget RSD is in PPT. Multiply by 1000.
Display Question 5 Again
Ans=(Y-X) Ans=
STDEV(X,Y,Z,A)/Avera
ge(X,Y,Z,A)*1000
/0.9982
Smart Feedback
If ans = B
If ans ≠ B
Correct. Nice work!
If ans = B
If ans ≠ B
Go to next section

Burette

Unlike volumetric glassware discussed above, a burette is graduated. A **burette** is a device to aliquot measurable volumes of a liquid and is shown in Picture 5. Notice that the burette is clamped to the ring stand using a burette clamp.

Picture 5. 50 mL burette clamped to a ring stand.



In an acid-base titration, the base, in this case sodium hydroxide solution, is added to the burette. It is very important that the burette is cleaned with water before the base is added. After the burette is cleaned with water, several (3-4) small portions (1-2 mL) of the sodium hydroxide solution should be used to rinse the burette before the burette is filled. In fact, all glassware, including volumetric glassware, should be thoroughly cleaned before a titration. Ideally, any glassware used to measure volume should also be rinsed with the solution of interest or dried before use. However, to save time, sometimes it may be necessary to use wet glassware in this course.

There are a few practical things to consider when using a burette. When the stopcock is perpendicular to the burette, it is off, as shown in Picture 6a. When the stopcock is parallel to the burette, it is on, as shown in Picture 6b. The stopcock is not a simple on–or-off device. It can be used to slowly dispense solution, including a single drop at a time, by adjusting the stopcock position.

Burette Question: **1** 2 3 4 5

In the acid- base titration performed in this experiment ________ is added to the burette.

- ❑ base
- ❑ acid
- ❑ water
- ❑ acetone

Submit

Answer: choice 1, base

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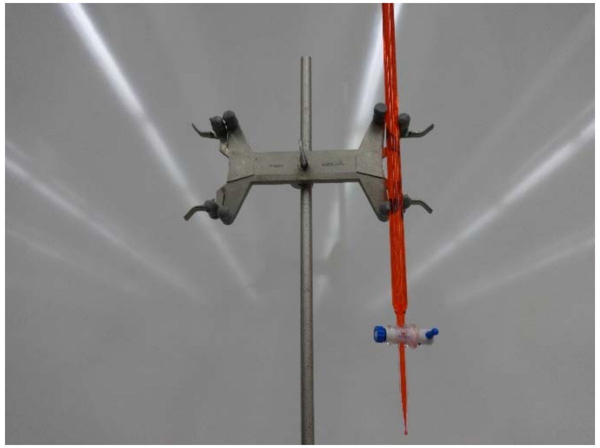

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Burette Question: 1 **2** 3 4 5

Which of the following statements is true?

- ❑ A burette is read from the top down and the absolute volume is not important.
- ❑ A burette is read from the bottom up and the absolute volume is not important.
- ❑ The absolute volume of liquid in the burette is important.
- ❑ When the stopcock is perpendicular to the burette it is open.

Submit

Answer: choice 1, A burette is read from the top down and the absolute volume is not important.

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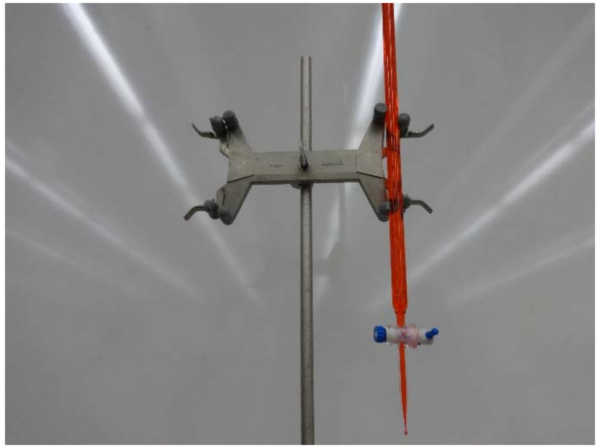

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Burette Question: 1 2 **3** 4 5

Before filling the burette with sodium hydroxide solution for the titration you must

- ❑ rinse the burette with several small portions of water, then several small portions of base.
- ❑ rinse the burette with several small portions of water.
- ❑ fill the burette completely with water, then fill it completely with base.
- ❑ use a brush and soapy water to clean the inside of the burette.

Submit

Answer: choice 1, rinse the burette with several small portions of water, then several small portions of base.

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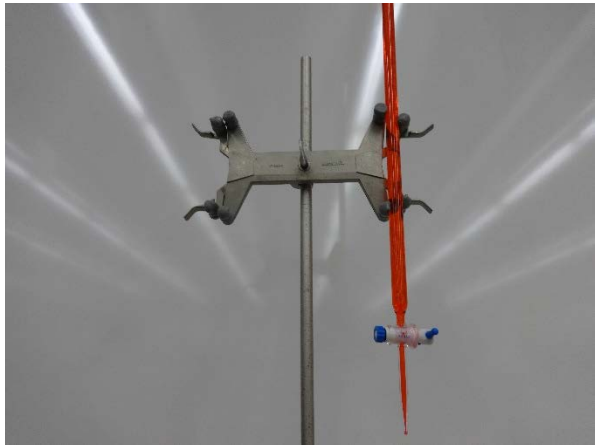

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Burette Question: 1 2 3 4 **5**

After filling the burette with sodium hydroxide, but before you begin the titration you must

- ❑ remove the air bubble in the tip by turning the burette flow on and then read the burette.
- ❑ read the burette and then remove the air bubble in the tip by turning the burette flow on.
- ❑ read the burette.
- ❑ remove the air bubble in the tip by turning the burette upside down and shaking it and then read the burette.

Submit

Answer: choice 1, remove the air bubble in the tip by turning the burette flow on and then read the burette.

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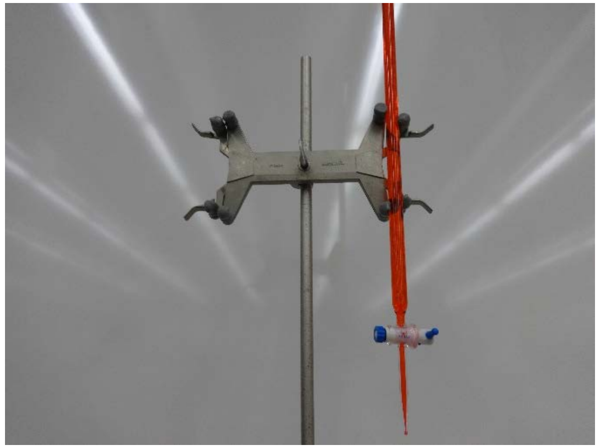

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Burette Question: 1 2 3 4 **5**

The volume reading for the burette must have _____ decimal places.

- ❑ zero
- ❑ one
- ❑ two
- ❑ three

Submit

This question should not be randomized.

Answer: choice 3, two

After this question proceed to the next section.

Acid- Base Titration

Now that we are familiar with the glassware used for titrations we can further discuss the theoretical and practical aspects of the titration itself. In a **titration**, a solution of known concentration, often called the **standard solution** (a titrant), is added to a solution with an unknown concentration to determine the unknown concentration or quantity of solute in the unknown. In an acid-base titration, one of the solutions is acidic and the other is basic. A neutralization reaction occurs when the solutions are added together.

In this experiment, you will perform an acid-base titration by reacting a sodium hydroxide solution of known concentration (titrant) with a hydrochloric acid solution in order to determine the concentration of the hydrochloric acid solution as shown in Reaction 1. An acid-base reaction, such as that of hydrochloric acid and sodium hydroxide, is a double-displacement reaction, where the hydrogen ion from the acid replaces the sodium ion in sodium hydroxide, and the sodium ion replaces the hydrogen in the acid. The end result is water (from the hydrogen and the hydroxide ions) and a salt (from the sodium and the chloride ions).

To begin the experiment, a 0.100 M sodium hydroxide solution is prepared. You should start by calculating what volume of a 5M sodium hydroxide solution (stock solution) is needed to make a 100 mL of 0.100 M sodium hydroxide solution. This volume is added into a 100.0 mL volumetric flask and then water is added to the calibration line. Next, the hydrochloric acid solution is made by adding approximately 3.5 mL of 3M hydrochloric acid into a 125 mL Erlenmeyer flask containing about 25 mL of water and filling to the 50 mL line. Remember; never add water to concentrated acid solutions! It is important to add the acid to an Erlenmeyer flask already containing a substantial amount of water (in this case about 25 mL). It is also important to note that the glassware used to make or dilute the HCl is not very accurate. Since the volumes are not accurate, they will not be used to find the concentration of the acid. Instead, the titration data will be used to find the concentration of the acid.

Reaction 1. Hydrochloric acid reacting with sodium hydroxide.

$$HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl\,(aq) + H_2O\,(l)$$

Acid-Base Titration Question: **1** 2 3 4 5

How much X.00 M NaOH solution is required to make Y.0 mL of a Z.000 M solution?

A mL

Submit

Answer: $ans = \frac{Y \times Z}{X}$

X should be a random number between 3 and 7 with 2 decimal places.

Y should be a random number between 200 and 500 with 1 decimal places.

Z should be a random number between 0.1 and 0.2 with 3 decimal places.

Smart Feedback

None for this question

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

$C_1V_1 = C_2V_2$

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

How much 8.00 M NaOH solution is required to make 350.0 mL of a 0.400 M solution?

$C_1V_1 = C_2V_2$

Where:
C_1 = 8.00 M
V_1 = unknown variable
C_2 = 0.400 M
V_2 = 350.0 mL

Plugging in:

$$8.00 \times V_1 = 0.400 \times 350.0$$
$$V_1 = 17.5\ mL$$

Third Incorrect Answer

Incorrect. Here's your answer:

$C_1V_1 = C_2V_2$

Where:
C_1 = X.00 M
V_1 = unknown variable
C_2 = Z.000 M
V_2 = Y.0 mL

Plugging in:

$$X.00 \times V_1 = Z.000 \times Y.0$$
$$V_1 = Ans.0$$

Acid- Base Titration

Now that we are familiar with the glassware used for titrations we can further discuss the theoretical and practical aspects of the titration itself. In a **titration**, a solution of known concentration, often called the **standard solution** (a titrant), is added to a solution with an unknown concentration to determine the unknown concentration or quantity of solute in the unknown. In an acid-base titration, one of the solutions is acidic and the other is basic. A neutralization reaction occurs when the solutions are added together.

In this experiment, you will perform an acid-base titration by reacting a sodium hydroxide solution of known concentration (titrant) with a hydrochloric acid solution in order to determine the concentration of the hydrochloric acid solution as shown in Reaction 1. An acid-base reaction, such as that of hydrochloric acid and sodium hydroxide, is a double-displacement reaction, where the hydrogen ion from the acid replaces the sodium ion in sodium hydroxide, and the sodium ion replaces the hydrogen in the acid. The end result is water (from the hydrogen and the hydroxide ions) and a salt (from the sodium and the chloride ions).

To begin the experiment, a 0.100 M sodium hydroxide solution is prepared. You should start by calculating what volume of a 5M sodium hydroxide solution (stock solution) is needed to make a 100 mL of 0.100 M sodium hydroxide solution. This volume is added into a 100.0 mL volumetric flask and then water is added to the calibration line. Next, the hydrochloric acid solution is made by adding approximately 3.5 mL of 3M hydrochloric acid into a 125 mL Erlenmeyer flask containing about 25 mL of water and filling to the 50 mL line. Remember; never add water to concentrated acid solutions! It is important to add the acid to an Erlenmeyer flask already containing a substantial amount of water (in this case about 25 mL). It is also important to note that the glassware used to make or dilute the HCl is not very accurate. Since the volumes are not accurate, they will not be used to find the concentration of the acid. Instead, the titration data will be used to find the concentration of the acid.

Reaction 1. Hydrochloric acid reacting with sodium hydroxide.

$$HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl\,(aq) + H_2O\,(l)$$

Acid-Base Titration Question: 1 **2** 3 4 5

In an acid base titration the endpoint and the equivalence point differ because

- ❑ the endpoint is where the indicator changes color and the equivalence point is where the moles of acid and base are equal.
- ❑ the endpoint is where the moles of acid and base are equal and the equivalence point is where the indicator changes color
- ❑ the endpoint is where the titration should be stopped and the equivalence point is where the water in the flask and in the burette is the same.
- ❑ the endpoint is where the moles of acid and moles of water are the same and the equivalence point is where the moles of base and moles of water are the same.

Submit

Answer: choice 1, the endpoint is where the indicator changes color and the equivalence point is where the moles of acid and base are equal.

Acid- Base Titration

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Reaction 1. Hydrochloric acid reacting with sodium hydroxide.

$$HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl\,(aq) + H_2O\,(l)$$

Acid-Base Titration Question: 1 2 **3** 4 5

The acid-base titration in this experiment is complete when

- ❑ a single drop of base in the burette causes the solution in the flask to turn and stay pink.
- ❑ a single drop of acid in the burette causes the solution in the flask to turn and stay pink.
- ❑ 12.0 mL of base in the burette has been added to the flask.
- ❑ the pH meter reads 7.0.

Submit

Answer: choice 1, a single drop of base in the burette causes the solution in the flask to turn and stay pink.

Acid- Base Titration

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Reaction 1. Hydrochloric acid reacting with sodium hydroxide.

$$HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl\,(aq) + H_2O\,(l)$$

Acid-Base Titration Question: 1 2 3 **4** 5

It is possible to tell you are near the endpoint of the titration because

- ❑ the pink color persists longer and longer.
- ❑ the volume of the solution increases as more base is added.
- ❑ the temperature of the solution begins to increase.
- ❑ the indicator begins to precipitate out of solution.

Submit

Answer: choice 1, a single drop of base in the burette causes the solution in the flask to turn and stay pink.

Acid- Base Titration

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Reaction 1. Hydrochloric acid reacting with sodium hydroxide.

$$HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl\,(aq) + H_2O\,(l)$$

Acid-Base Titration Question: 1 2 3 4 **5**

The initial burette reading in a titration was X.00 mL and the final burette reading was Y.00 mL. If 10.00 mL of HCl was titrated and Z.000 M NaOH was used in the titration, what is the concentration of the acid?

A M

Submit

Answer: $ans = \frac{\left(\frac{(Y-X)}{1000}\right)\times Z}{0.01}$

X should be a random number between 1 and 10 with two decimal places.

Y should X plus a random number between 10 and 15 and should have 2 decimal places.

Z should be a random number between 0.1 and 0.2 with 3 decimal places.

Smart Feedback

If a = ans * 1000

Incorrect. Don't forget the volume must be in liters.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

At the endpoint of the titration the moles of acid and moles of base can be considered equal. Determine the moles of base and use the balanced chemical equation to find the moles of acid and then the concentration of the acid.

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

The initial burette reading in a titration was 10.31 mL and the final burette reading was 23.27 mL. If 10.00 mL of HCl was titrated and 0.413 M NaOH was used in the titration, what is the concentration of the acid?

Volume of NaOH used:

23.27 – 10.31 =12.96 mL

Concentration of HCl

$$0.01296\ L \times \frac{0.413\ mol\ NaOH}{1\ L} \times \frac{1\ mol\ HCl}{1\ mol\ NaOH} \times \frac{1}{0.01000\ L} = 0.5352\ M$$

Third Incorrect Answer

Incorrect. Here's your answer:

Volume of NaOH used:

Y.00 – X.00 =B.00 mL

Concentration of HCl

$$\frac{B}{1000} L \times \frac{Z.000\ mol\ NaOH}{1\ L} \times \frac{1\ mol\ HCl}{1\ mol\ NaOH} \times \frac{1}{0.01000\ L} = ans\ M$$

Congratulations Bob, you have completed the lab comprehension assessment questions! Its time to move on to the written pre-lab. You now have access to review the entire experiment at any time. Remember, you cannot begin the lab until you have completed the written pre-lab. Which part would you like to complete first.

- ❑ Volumetric Glassware
- ❑ Acid-Base Titration

Submit

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

Volumetric Glassware

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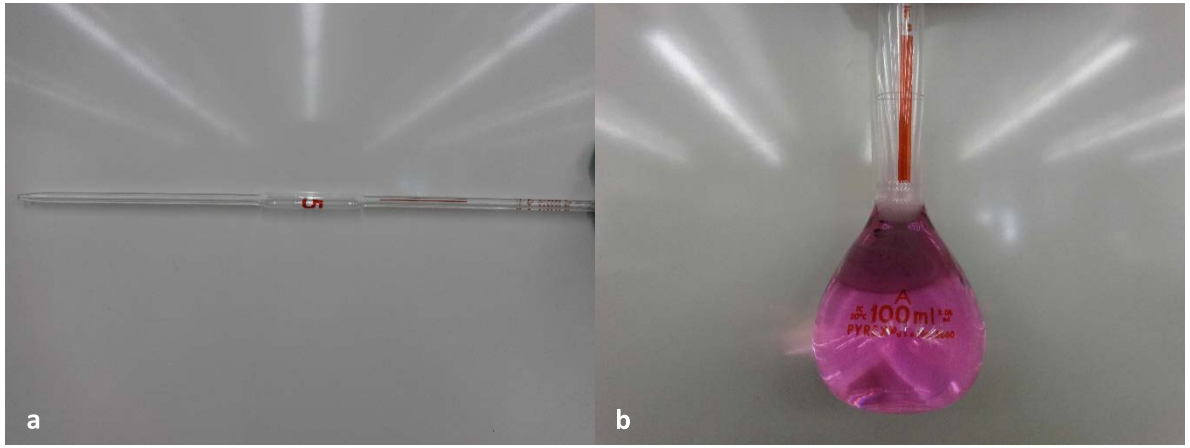

Volumetric Glassware Written Pre-Lab:

Objective

Hypothesis

Variables

Experiment Outline

Chemical Hazards

Volumetric Glassware: Objective

Submit

Key Concepts

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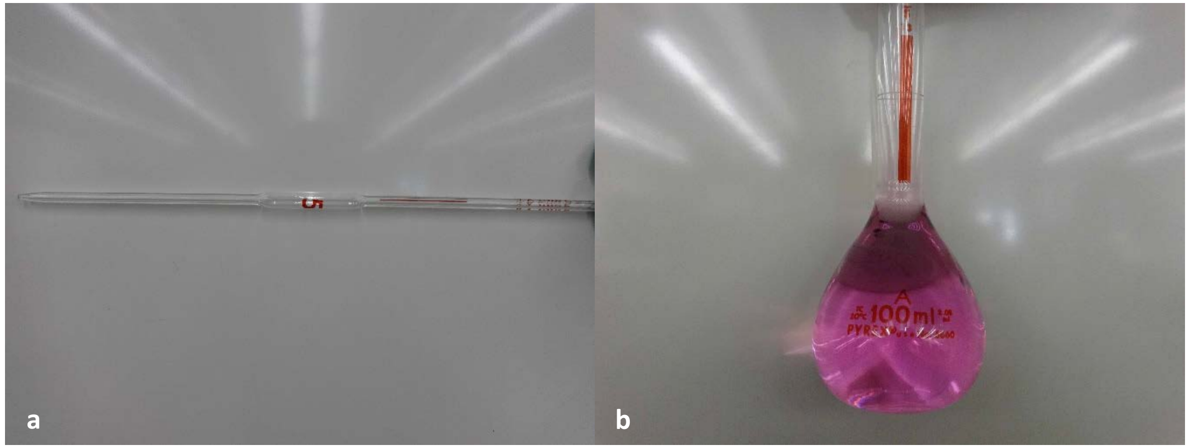

Volumetric Glassware Written Pre-Lab:

Objective
Hypothesis
Variables
Experiment Outline
Chemical Hazards

Volumetric Glassware: Hypothesis

Submit

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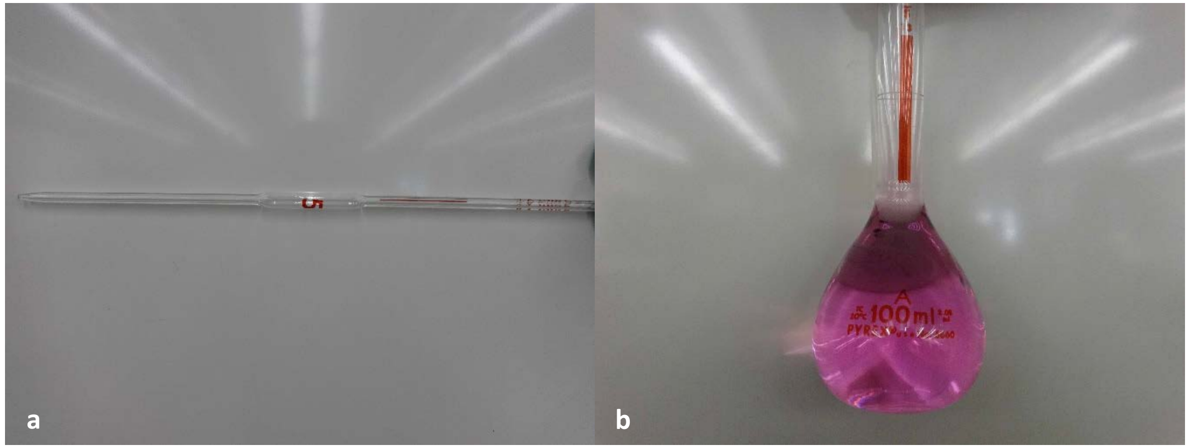

Volumetric Glassware Written Pre-Lab:

Objective
Hypothesis
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Volumetric Glassware: Variables

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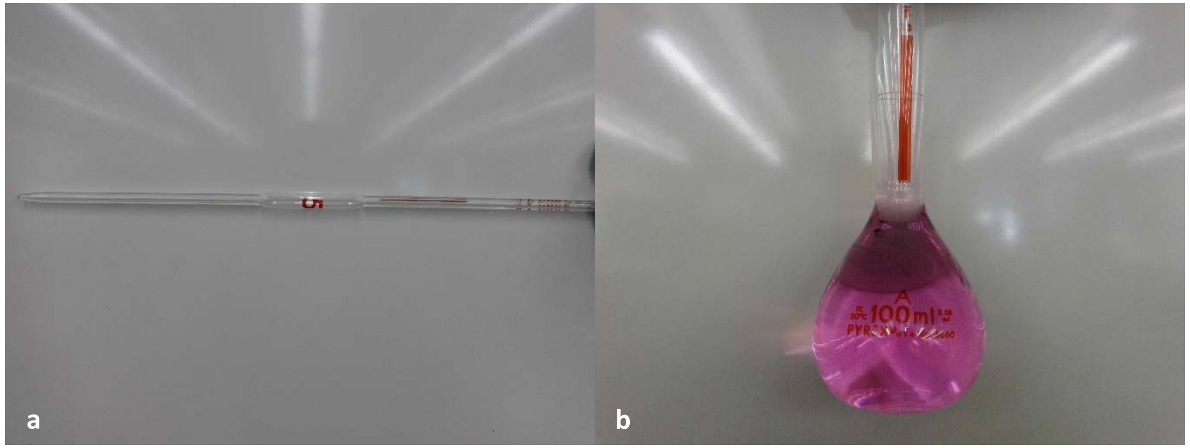

Volumetric Glassware Written Pre-Lab:

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Volumetric Glassware: Experiment Outline

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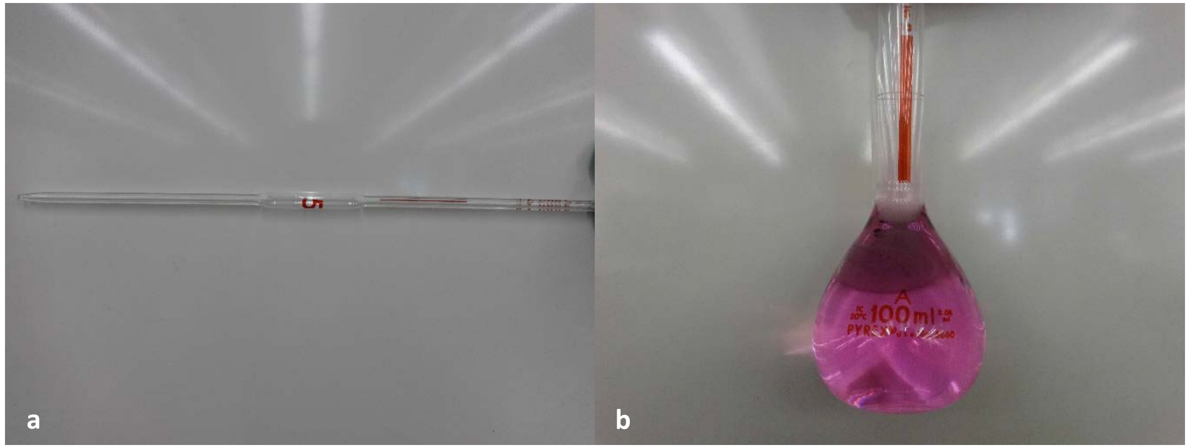

Volumetric Glassware Written Pre-Lab:

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Volumetric Glassware: Chemical Hazards

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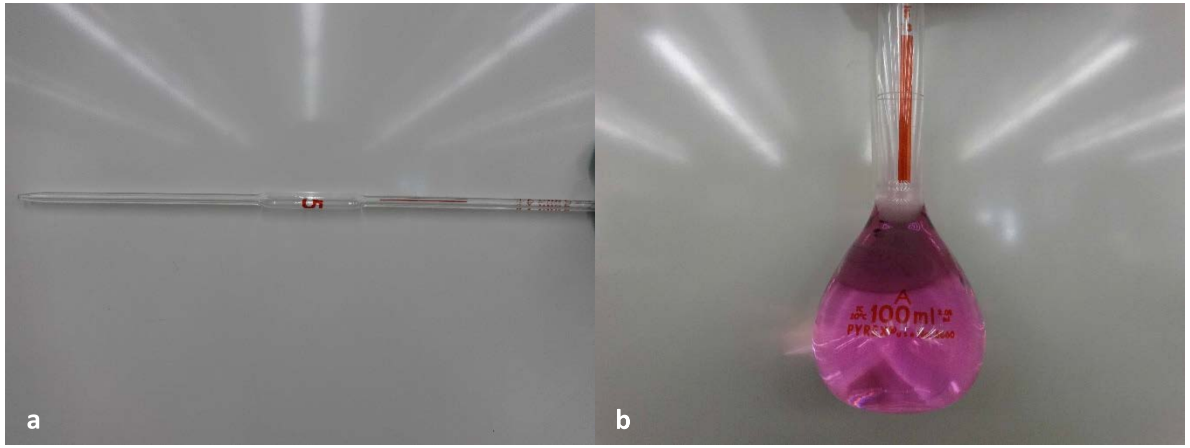

Acid-Base Titration Written Pre-Lab:

Objective

Hypothesis

Variables

Experiment Outline

Chemical Hazards

Volumetric Glassware: Objective

Submit

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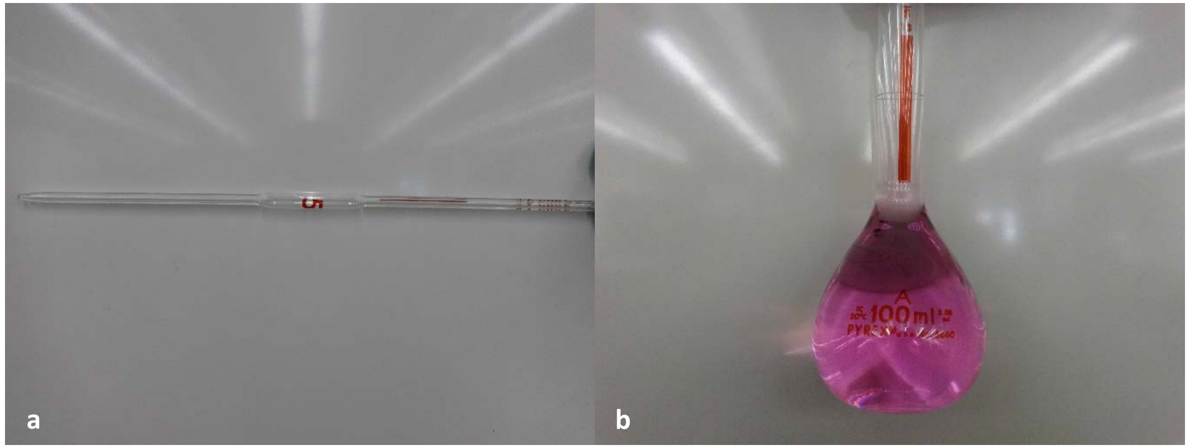

Acid-Base Titration Written Pre-Lab:

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Volumetric Glassware: Hypothesis

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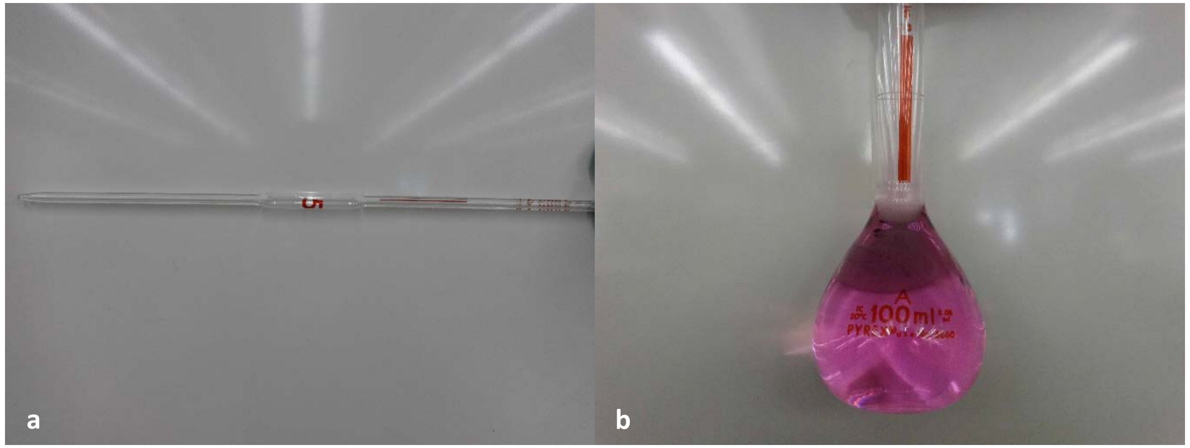

Acid-Base Titration Written Pre-Lab:

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Volumetric Glassware: Variables

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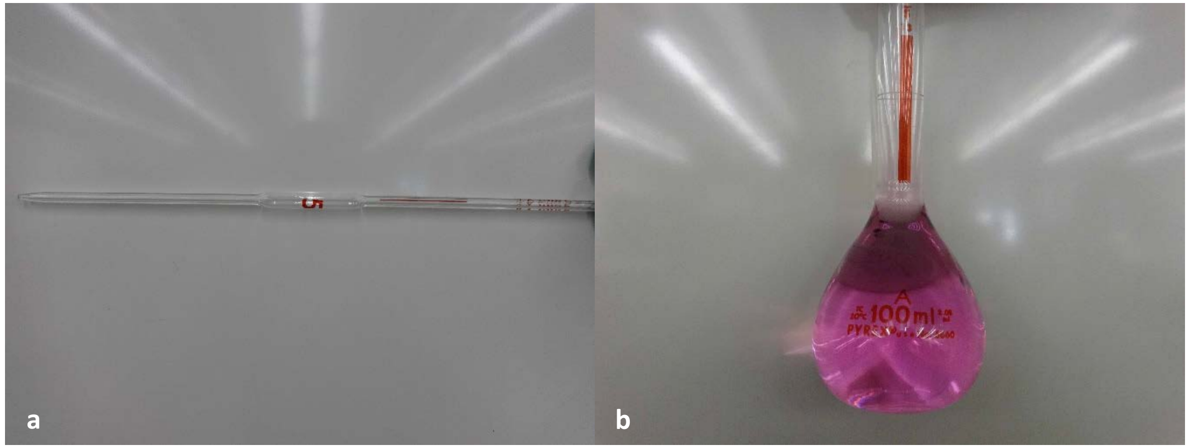

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Volumetric Glassware: Experiment Outline

Submit

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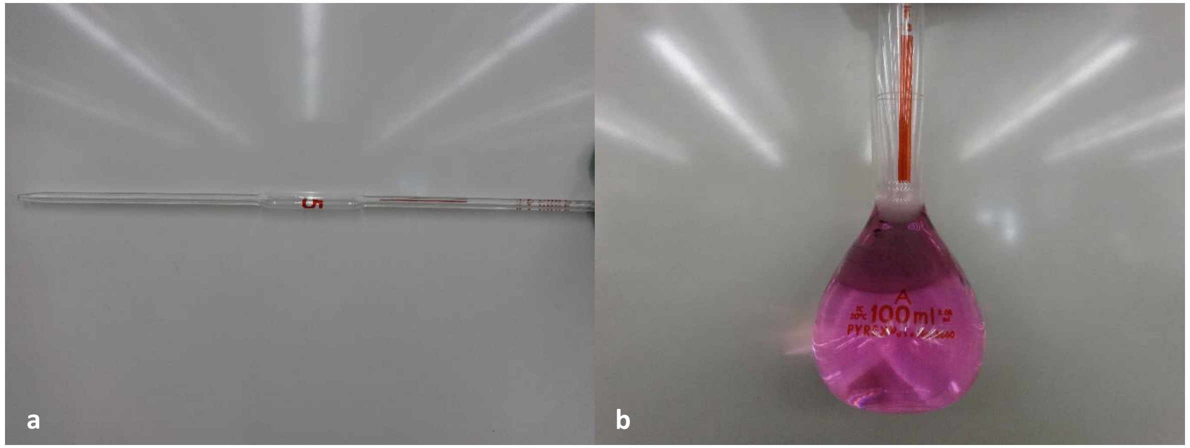

Acid-Base Titration Written Pre-Lab:

Objective
Hypothesis
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Experiment Outline
Chemical Hazards

Volumetric Glassware: Chemical Hazards

Submit

Select an Experiment

Welcome back Bob! You have lab on Thursdays at 1:15 in CH-145 with Sarah Jones.

Which experiment would you like to work on?

Experiment Number	Experiment Name	Experiment Date	Lab Comprehension Assessment Complete	Pre-Lab Complete	Experiment Complete
5	Empirical Formula of Hydrated Copper Sulfate	10/8/2015	✓	✓	✓
6	Synthesis and Purity of Aspirin	10/15/2015	✓	✓	✓
7	Acid Base Titration	10/22/2015	✓	✓	

Select a section

Which section would you like to start with?

- ❑ Part 1: Volumetric Glassware
- ❑ Part 2: Acid-Base Titration

Submit

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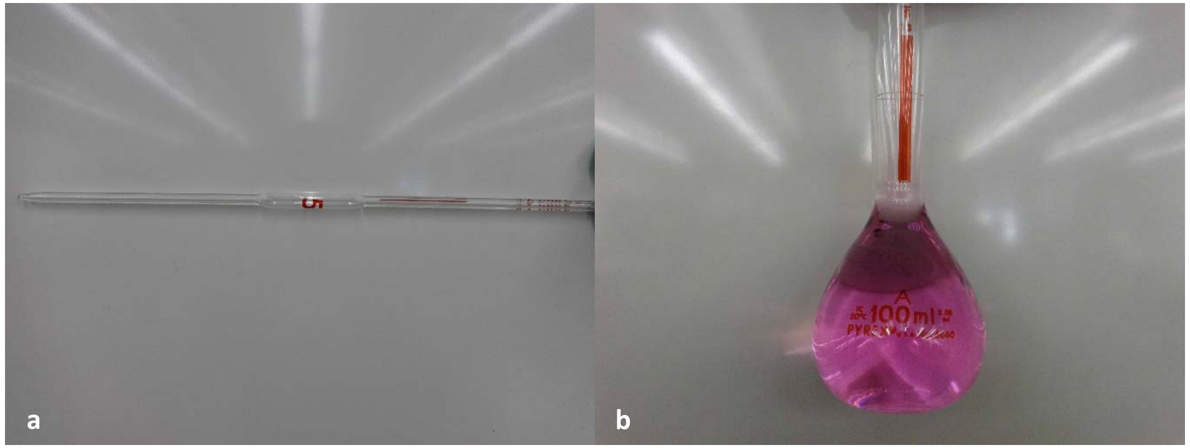

Experiment

Pre-Lab

Toggle between Experiment and Written Pre-Lab

Students must answer the questions in order and can go back but no jump ahead.

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Are you wearing your goggles and a lab coat?

- ❑ yes
- ❑ no

Submit

Answer: choice 1, yes

Key Concepts

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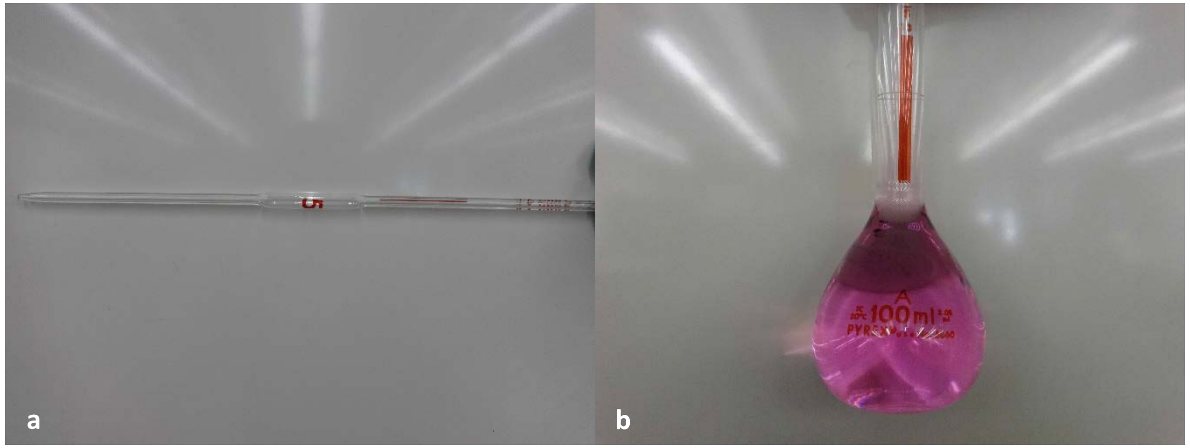

Experiment | Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15

What would you like to record the mass of first?

- ❑ An empty 50 mL Erlenmeyer flask
- ❑ An empty weigh boat.
- ❑ An empty 5 mL volumetric pipette.
- ❑ An empty 100 mL volumetric flask.

Submit

Answer: choice 1, An empty 50 mL Erlenmeyer flask

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

Volumetric Glassware

Before discussing acid-base titrations, we will look at a few types of glassware you have not used previously in this course. Titrations require the use volumetric glassware and burettes. **Volumetric glassware** is calibrated to contain an accurate and precise volume at the specified temperature. Typically glassware is calibrated at 20 °C which is around room temperature. Most volumetric glassware is labeled with its calibration temperature. Unlike the graduated glassware you have used in the past, volumetric glassware is designed to measure a single volume. There are two types of volumetric glassware used in this experiment, a 5.00 mL volumetric pipette as shown in Picture 1a and a 100.0 mL volumetric flask shown in Picture 1b.

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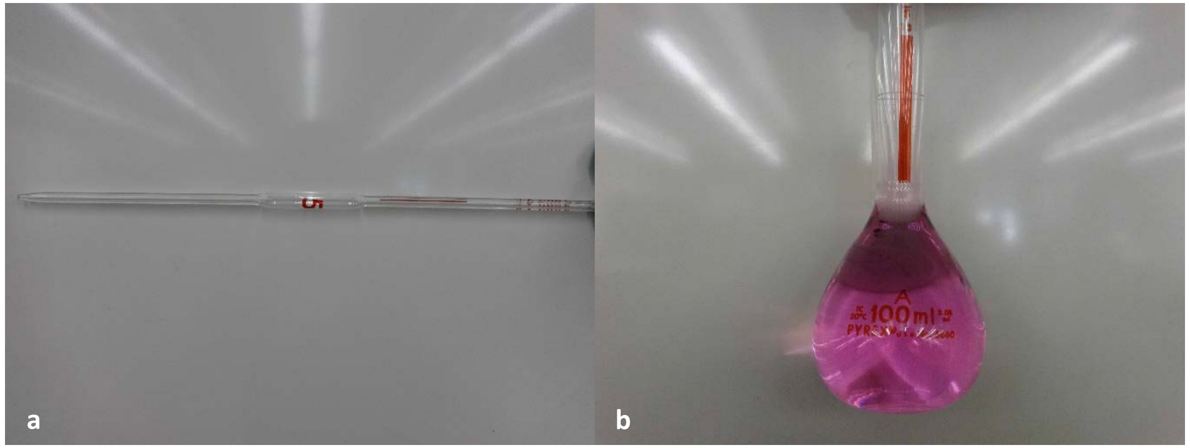

Experiment

Pre-Lab

Volumetric Glassware Experiment
Question: 1 2 **3** 4 5 6 7 8 9 10 11 12 13 14 15

What is the mass of the flask?

emptyflask g

Submit

Test: emptyflask<20 g.

If yes: Congratulations you are on the right track.

If no: Please double check the mass of the flask.
Then repeat.

Key Concepts

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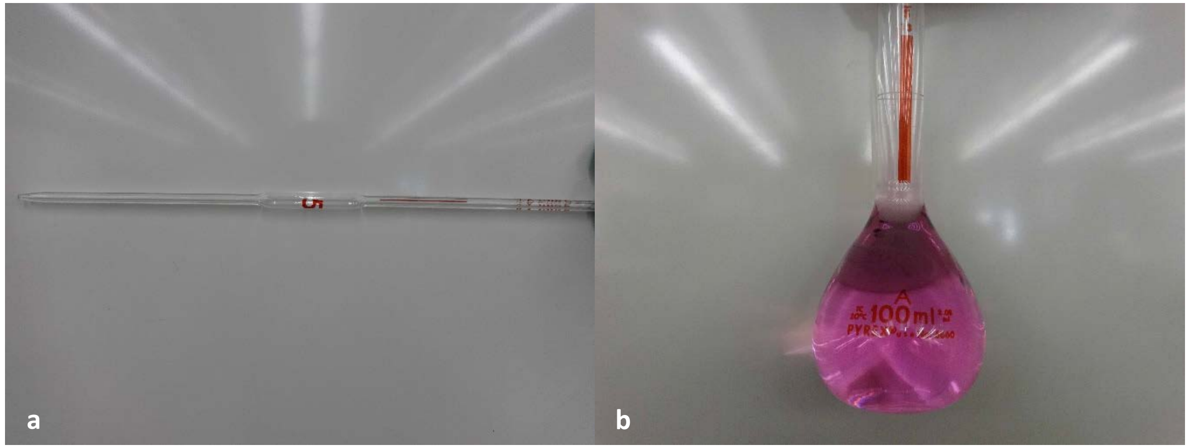

Experiment

Pre-Lab

Volumetric Glassware Experiment
Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Next we ________ and then record the mass again.

- ❑ add 5 mL of water with a volumetric pipette
- ❑ fill the flask with water
- ❑ add 5 mL of water with a graduated cylinder
- ❑ place the flask in the oven to dry

Submit

Answer: choice 1, add 5 mL of water with a volumetric pipette

Key Concepts

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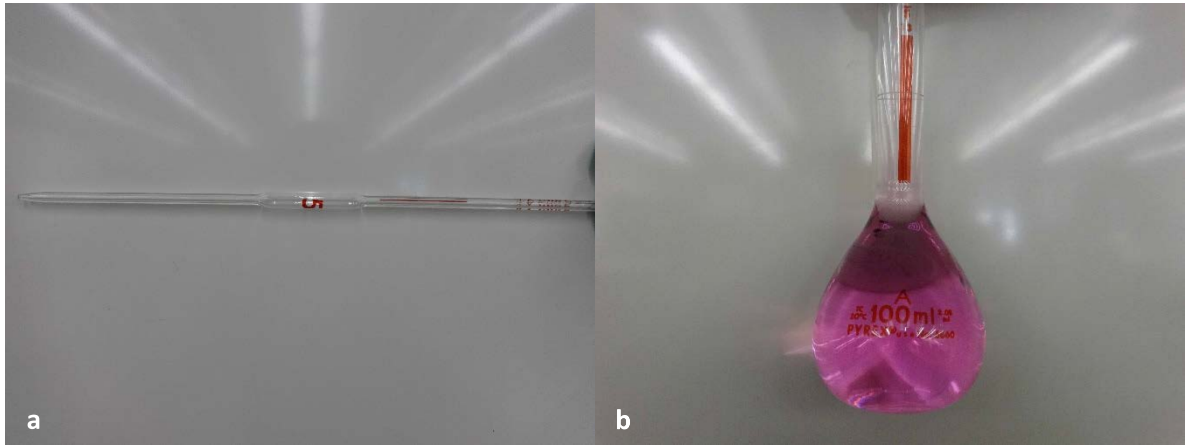

Volumetric Glassware Experiment
Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

What is the mass of the flask?

masstrial1 g

Submit

Test: masstrial1=emptyflask + between 4.8 and 5.2.

If yes: Congratulations you are on the right track.

If no: Please double check the mass of the flask.
Then repeat.

Experiment

Pre-Lab

Behind the scenes the software builds a table.

	A	B	C
1	Trial	Initial Mass (g)	Final Mass (g)
2	1	emptyflask	masstrial1
3	2	masstrial 1	
4	3		
5	4		
6	5		

Key Concepts

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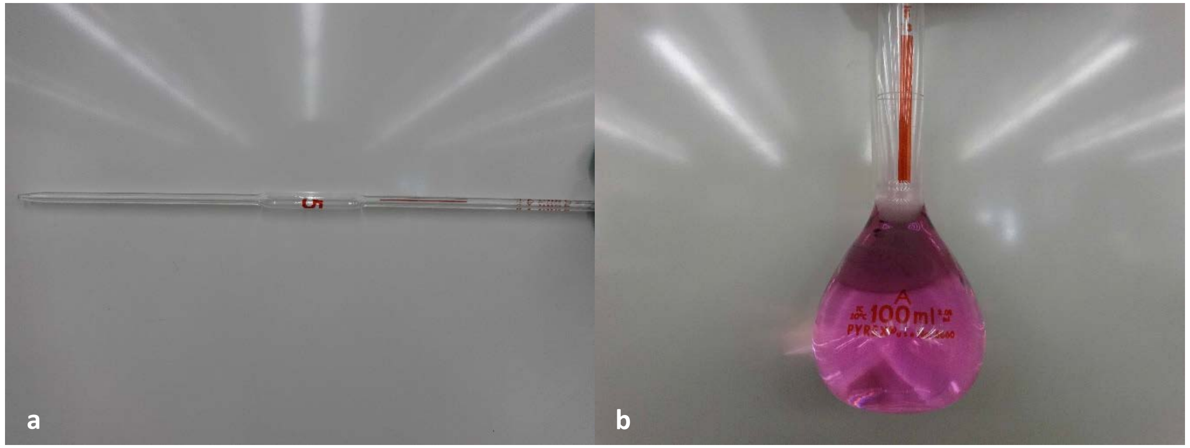

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

How would you like to proceed?

- ❑ Do not empty the flask between trials. Repeat this procedure and add water with the volumetric pipette over four more trials.
- ❑ Empty the flask between trials. Record the mass of the empty flask between trials.
- ❑ Empty the flask and this time add two portions from the volumetric flask before recording the mass again.
- ❑ Determine the standard deviation for trial 1.

Submit

Answer: choice 1, Do not empty the flask between trials. Repeat this procedure and add water with the volumetric pipette over four more trials

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

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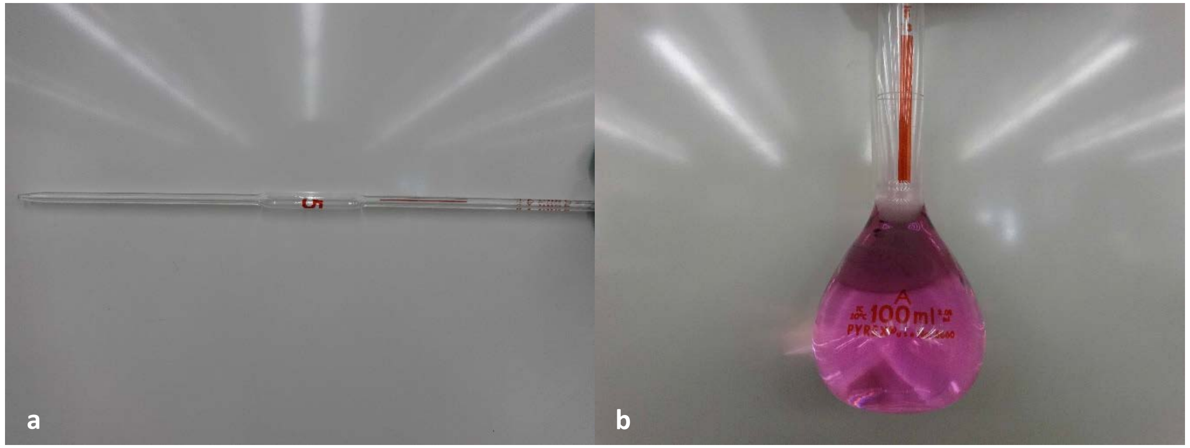

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

If there is an error at any time you can record a new initial mass.

Mass of flask and water for trial 2	masstrial2	g	Submit / New Initial Mass
Mass of flask and water for trial 3	masstrial3	g	Submit / New Initial Mass
Mass of flask and water for trial 4	masstrial4	g	Submit / New Initial Mass
Mass of flask and water for trial 5	masstrial5	g	Submit / New Initial Mass

Each time test: masstrial2=masstrial1 + between 4.8 and 5.2.

If yes: Congratulations you are on the right track.

If no: Please double check the mass. Then repeat.

Behind the scenes the software builds a table.

	A	B	C
1	Trial	Initial Mass (g)	Final Mass (g)
2	1	emptyflass	masstrial1
3	2	masstrial1	masstrial2
4	3	masstrial2	masstrial3
5	4	masstrial3	masstrial4
6	5	masstrial4	masstrial5

If the student needs to repeat the initial mass, the variable should change to masstrail1A for example.

Key Concepts

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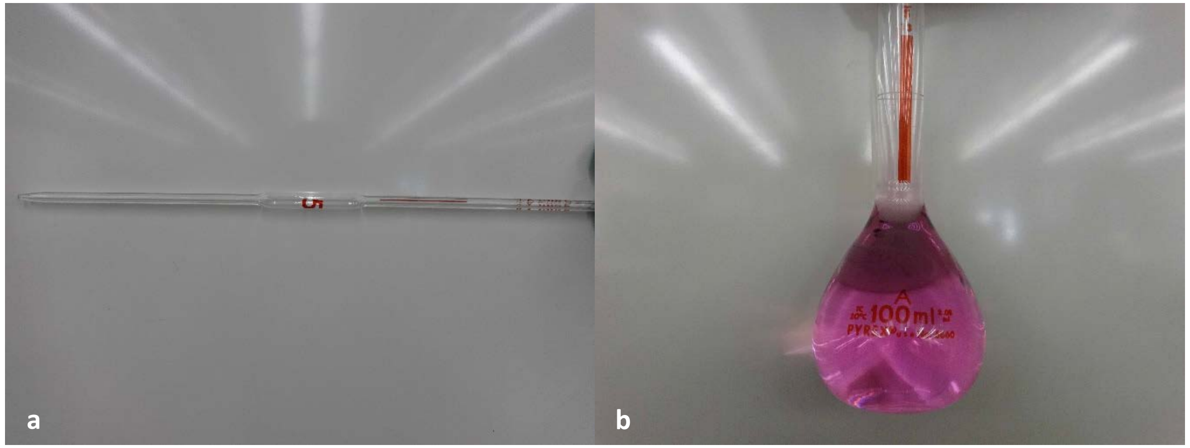

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Here is your data.

	A	B	C
1	Trial	Initial Mass (g)	Final Mass (g)
2	1	emptyflass	masstrial1
3	2	masstrial1	masstrial2
4	3	masstrial2	masstrial3
5	4	masstrial3	masstrial4
6	5	masstrial4	masstrial5

Export to CSV

Students table should have their numbers. If possible they should be able to export it to a csv file to manipulate in Excel.

What else do you need to record to find the volume of the water for each trial.

- ❑ temperature
- ❑ conductivity
- ❑ pH
- ❑ absorbance

Submit

Answer: choice 1, temperature

Key Concepts

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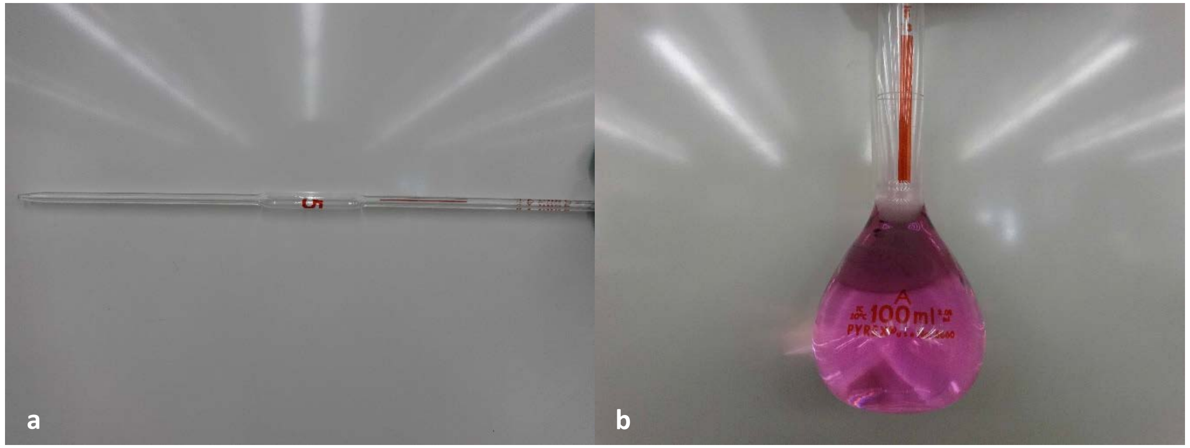

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

What is the temperature of the water (to the nearest degree) and the density at that temperature

temp °C

density g/mL

Submit

Test: temp = between 18 and 27

Test density matches temp on table.

Temperature (°C)	Density (g/mL)	Temperature (°C)	Density (g/mL)
18.00	0.9986	23.00	0.9975
19.00	0.9984	24.00	0.9973
20.00	0.9982	25.00	0.9970
21.00	0.9980	26.00	0.9967
22.00	0.9977	27.00	0.9965

If yes: Congratulations you are on the right track. Now use Excel to do the calculations.

If no: Please double check the temperature and density. They must match the table in the lab manual.
Then repeat.

Key Concepts

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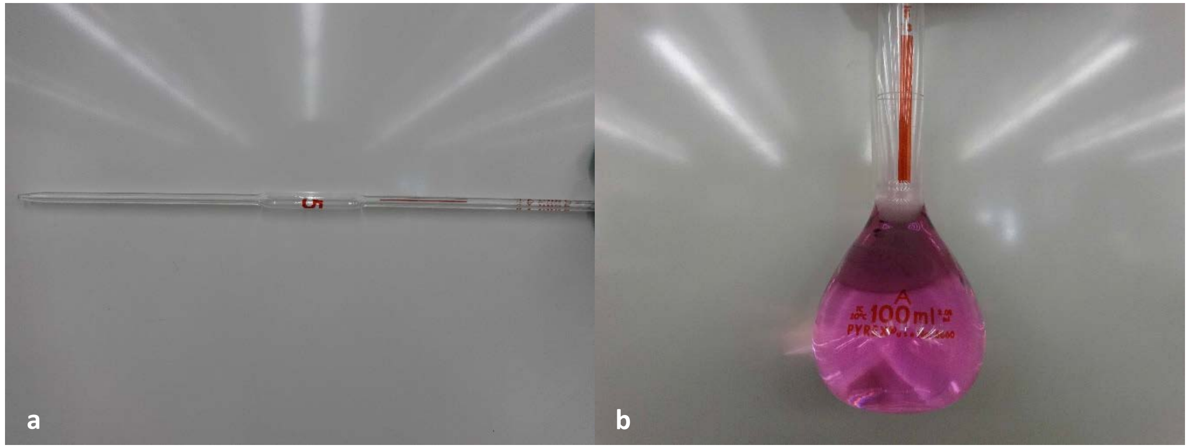

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

What is the volume of water transferred in trial 1.

ans mL

Submit

Compute all values in table as follows.

ans = mass1

	A	B	C	D	E	F	G	H
1	Trial	Initial Mass (g)	Final Mass (g)	Mass of Water (g)	Volume of Water (mL)	Average (mL)	RSD (ppt)	Precent Error
2	1	emptyflask	masstrial1	mass1=C3-B3	vol1=D2/density	avg=AVERAGE(E2:E6)	stdev=stvdev(E2:E6)/F2*1000	PE=ABS(F2-5)/5*100
3	2	masstrial1	masstrial2	mass2=C4-B4	vol2=D3/density			
4	3	masstrial2	masstrial3	mass3=C5-B5	vol3=D4/density			
5	4	masstrial3	masstrial4	mass4=C6-B6	vol4=D5/density			
6	5	masstrial4	masstrial5	mass5=C7-B7	vol5=D6/density			

Smart Feedback

If ans = (masstrial1-massemptyflask)*density

Incorrect. You should not multiply the mass and the density to find the volume.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

Step 1:
Find the mass of the water in the flask by difference.

Step 2: Hint, Density = $\frac{mass}{volume}$

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

A student used a 10.00 mL volumetric pipette to add 20 °C water to a flask with a mass of 47.238 g. After the water was added the mass was 57.134 g. What is the volume of water added to the flask.

Step 1: Find the mass of the water in the flask by difference.

57.134 g – 47.238 g = 9.896 g

Step 2: Find the volume of water using a density of 0.9982 at 20 °C.

$$9.896\ g\ \times \frac{1\ mL}{0.9982\ g} = 9.914\ mL$$

Third Incorrect Answer

Incorrect. Here's your answer:

Step 1: Find the mass of the water in the flask by difference.

masstrial1 g – emptyflask g = mass1 g

Step 2: Find the volume of water using a density of density at temp ° C.

$$mass1\ g\ \times \frac{1\ mL}{density\ g} = vol1\ mL$$

Key Concepts

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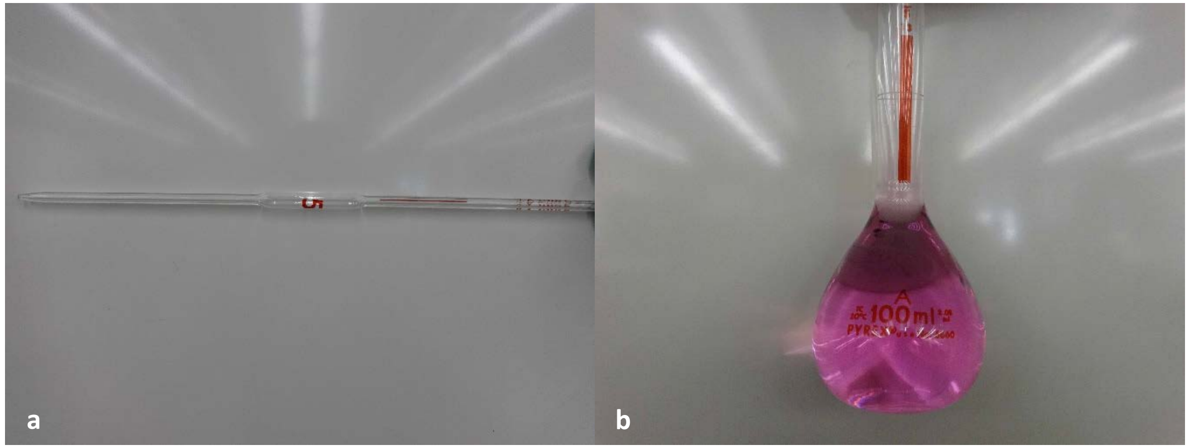

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

What is the average volume of water transferred.

ans mL

Submit

ans = avg

Smart Feedback

If ans = average(C2:C6)

(this is the average mass)

Incorrect. Remember we are looking for the average volume, not the average mass.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

$$Average = \frac{sum\ of\ the\ volumes\ of\ all\ trials}{number\ of\ trials\ (5\ in\ this\ case)}$$

Average is a function in Excel!

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

Over 3 trials the student found the following volumes: 1.01, 0.98, 1.01, 1.02 and 0.98 mL. What is the average volume?

Use the average function in Excel!

E	F
Volume of Water (mL)	Average (mL)
1.01	=AVERAGE(E2:E6)
0.98	
1.01	
1.02	
0.98	

The average is 1.0 mL

Third Incorrect Answer

Incorrect. Here's your answer:

In Excel

E	F
Volume of Water (mL)	Average (mL)
vol1	=AVERAGE(E2:E6)
vol2	
vol3	
vol4	
vol5	

Key Concepts

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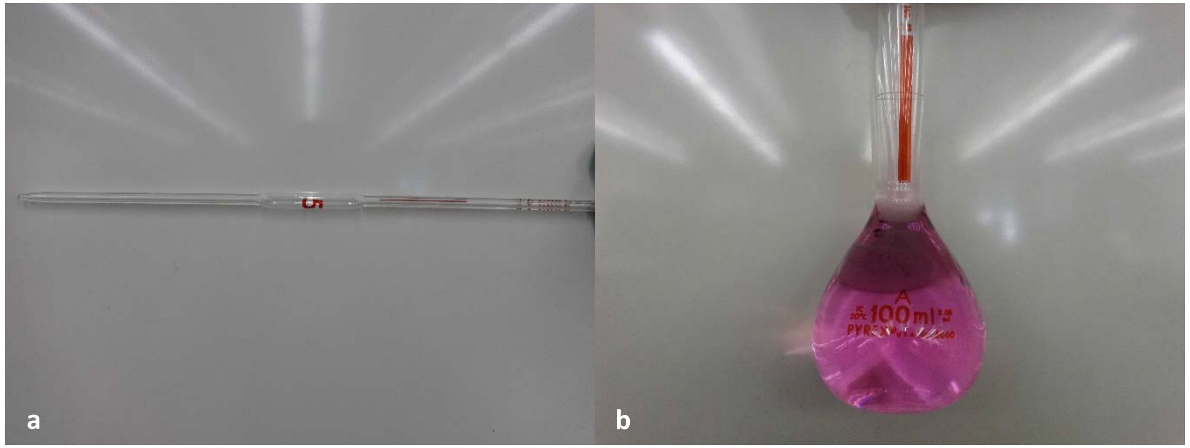

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

What is the RSD (ppt) for your volumes?

ans ppt

Submit

ans = RSD

Smart Feedback

If ans = RSD/1000

Incorrect. Don't forget RSD is in PPT. Multiply by 1000.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

Use the Excel Appendix for help calculating RSD.

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

Over 3 trials the student found the following volumes: 1.01, 0.98, 1.01, 1.02 and 0.98 mL. What is the RSD?

Find RSD in Excel.

E	F	G
Volume of Water (mL)	Average (mL)	RSD (ppt)
1.01	1.0	=stvdev(E2:E6)/F2*1000
0.98		
1.01		
1.02		
0.98		

The RSD is 20 ppt.

Third Incorrect Answer

Incorrect. Here's your answer:

In Excel

E	F	G
Volume of Water (mL)	Average (mL)	RSD (ppt)
vol1	=AVERAGE(E2:E6)	=stvdev(E2:E6)/F2*1000
vol2		
vol3		
vol4		
vol5		

Key Concepts

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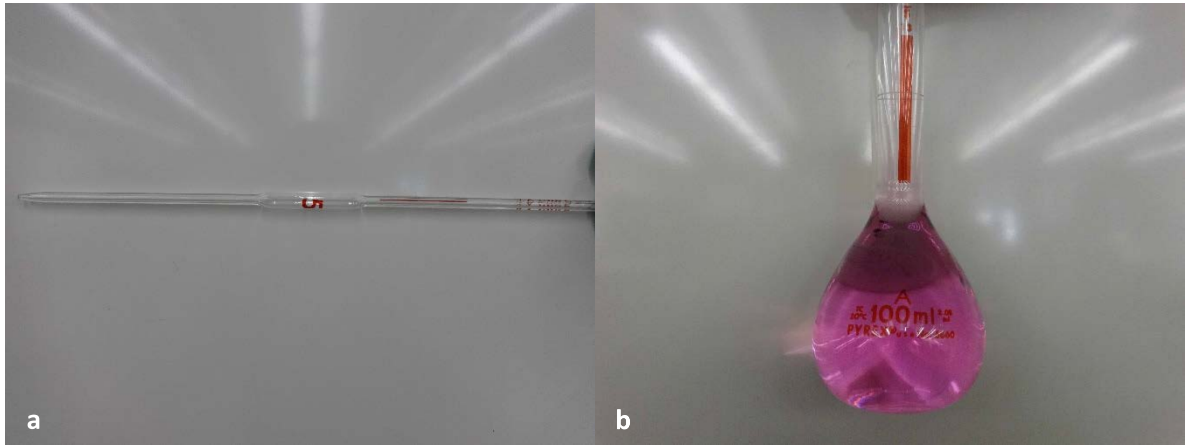

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

What is the percent error for your average volume?

ans %

Submit

ans = PE

Smart Feedback

If ans = PE/100

Remember the percent error is reported as a percentage. Please multiply by 100.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

Use the Excel Appendix for help calculating percent error. Be sure to calculate the error of your average value.

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

Over 5 trials the student found the following volumes: 1.01, 0.98, 1.01, 1.02 and 0.98 mL. What is the percent error if the student was using a 1.00 mL volumetric pipette.

Percent Error.

E	F	G	H
Volume of Water (mL)	Average (mL)	RSD (ppt)	Precent Error
1.01	1.0	20	=ABS(F2-5)/5*100
0.98			
1.01			
1.02			
0.98			

In this example there is no error in the average.

Third Incorrect Answer

Incorrect. Here's your answer:

In Excel

E	F	G	H
Volume of Water (mL)	Average (mL)	RSD (ppt)	Precent Error
vol1	=AVERAGE(E2:E6)	=stvdev(E2:E6)/F2*1000	=ABS(F2-5)/5*100
vol2			
vol3			
vol4			
vol5			

Key Concepts

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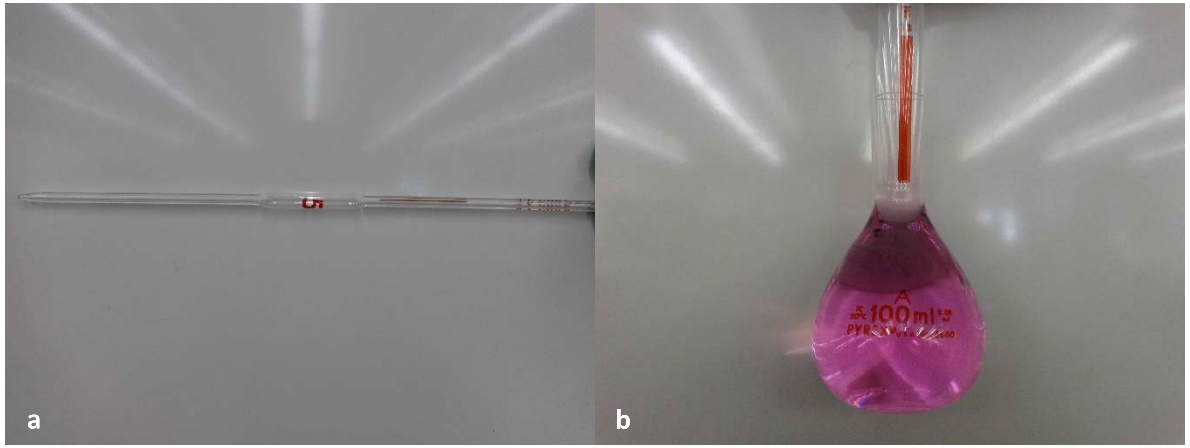

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

You found an RSD of RSD ppt and a percent error of PE %.

Is your data precise? Explain.

Submit

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

Volumetric Glassware

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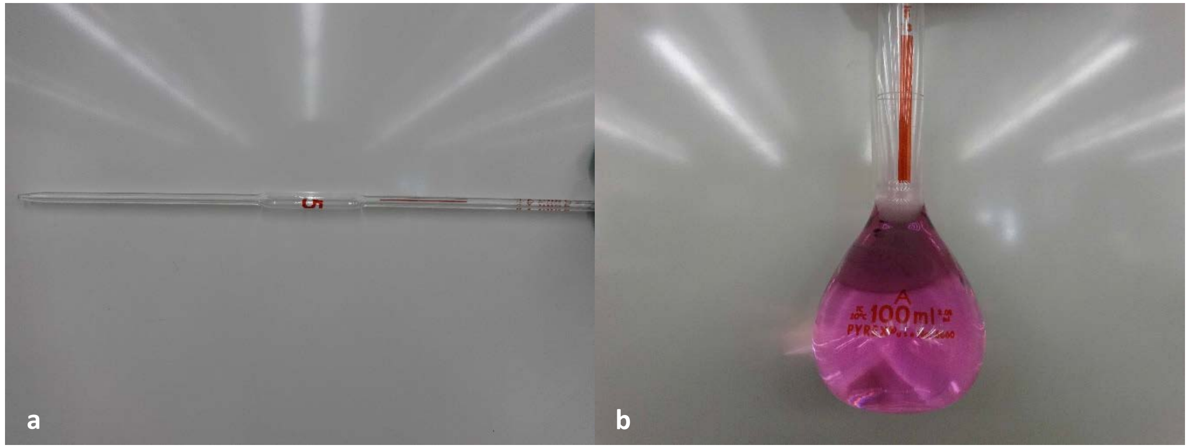

Experiment

Pre-Lab

Volumetric Glassware Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

You found an RSD of RSD ppt and a percent error of PE %.

Is your data accurate? Explain.

Submit

Congratulations you completed a section.

Where would you like to go next?

- ❑ Part 1: Volumetric Glassware
- ❑ Part 2: Acid-Base Titration

Submit

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

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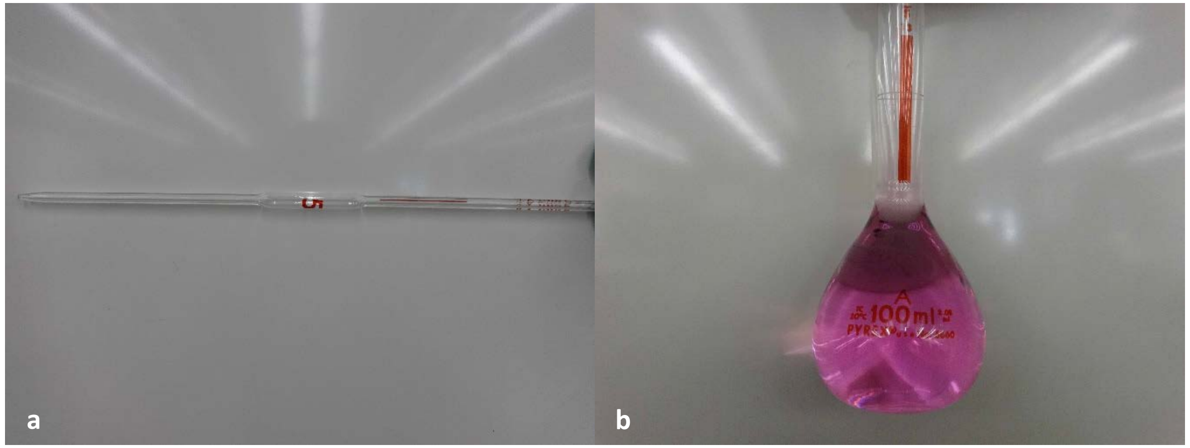

Experiment

Pre-Lab

Toggle between Experiment and Written Pre-Lab

Students must answer the questions in order and can go back but no jump ahead.

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Are you wearing your goggles and a lab coat?

- ❑ yes
- ❑ no

Submit

Answer: choice 1, yes

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

Volumetric Glassware

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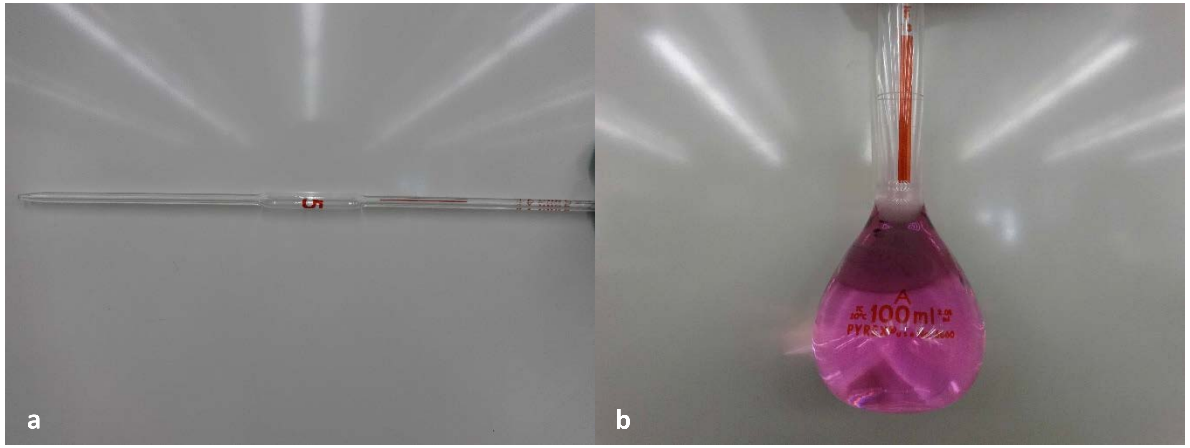

Experiment

Pre-Lab

Acid-Base Titration Experiment
Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15 16

What should you do with the waste at the end of this section of the experiment?

- ❑ Mix it together and pour it down the drain. We will use equal amounts of acid and base. When mixed together it will make salt water.
- ❑ Put it in acid waste.
- ❑ Put it in base waste.
- ❑ Put it in organic waste.

Submit

Answer: choice 1, Mix it together and pour it down the drain. We will use equal amounts of acid and base. When mixed together it will make salt water.

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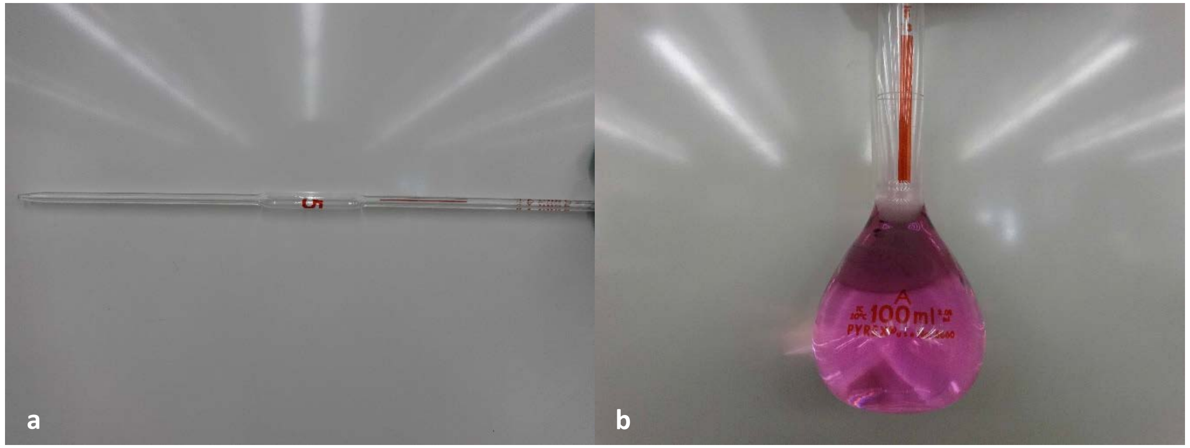

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 **3** 4 5 6 7 8 9 10 11 12 14 14 15 16

Which of the following is true.

- ❑ Sodium hydroxide and hydrochloric acid are both corrosive and must be handled with care.
- ❑ There are no dangerous chemicals in this lab.
- ❑ Sodium hydroxide is corrosive but hydrochloric acid is not.
- ❑ Hydrochloric acid is corrosive by sodium hydroxide is not.

Submit

Answer: choice 1, Sodium hydroxide and hydrochloric acid are both corrosive and must be handled with care.

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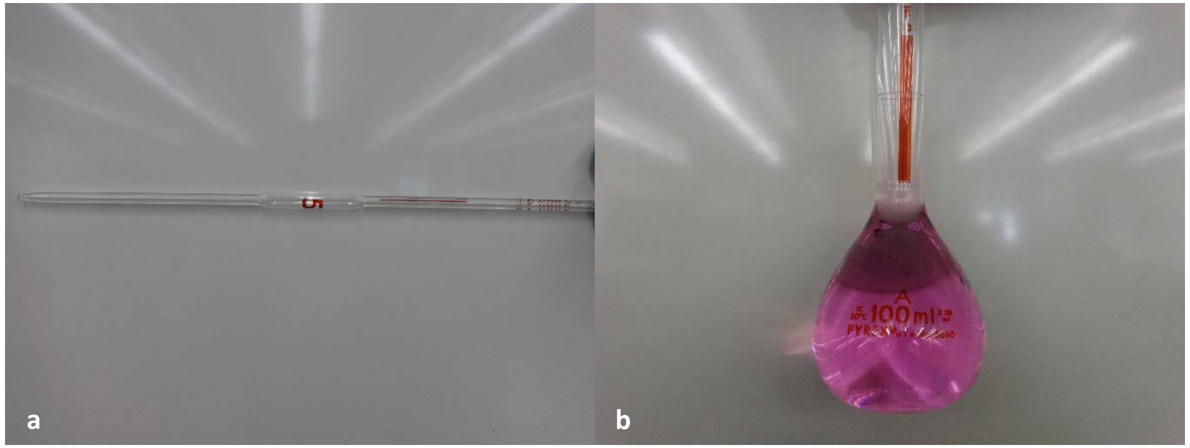

Experiment

Pre-Lab

Acid-Base Titration Experiment
Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15 16

Where would you like to begin?

- ❑ Dilute 5.00 M NaOH to make 0.100 M NaOH.
- ❑ Dilute 8.00 M NaOH to make 0.500 M NaOH.
- ❑ Make NaOH solution from solid NaOH pellets.
- ❑ Dilute 0.100 M NaOH to make 2.0 M NaOH.

Submit

Answer: choice 1, Dilute 5.00 M NaOH to make 0.100 M NaOH.

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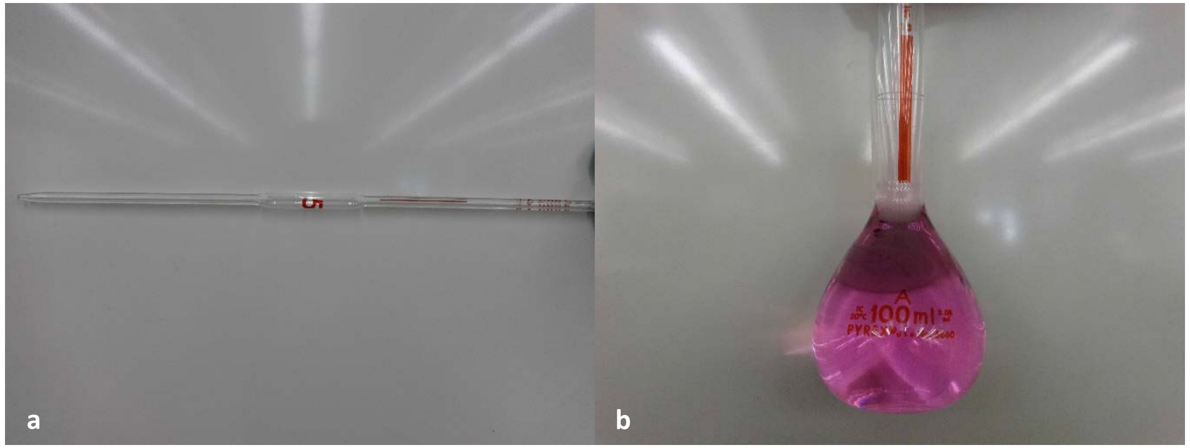

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15

What size volumetric flask should be used to dilute the 5.00 M NaOH to make 0.100 M NaOH?

- ❑ 50 mL
- ❑ 100 mL
- ❑ 250 mL
- ❑ 500 mL

Submit

Answer: choice 1, 100 mL

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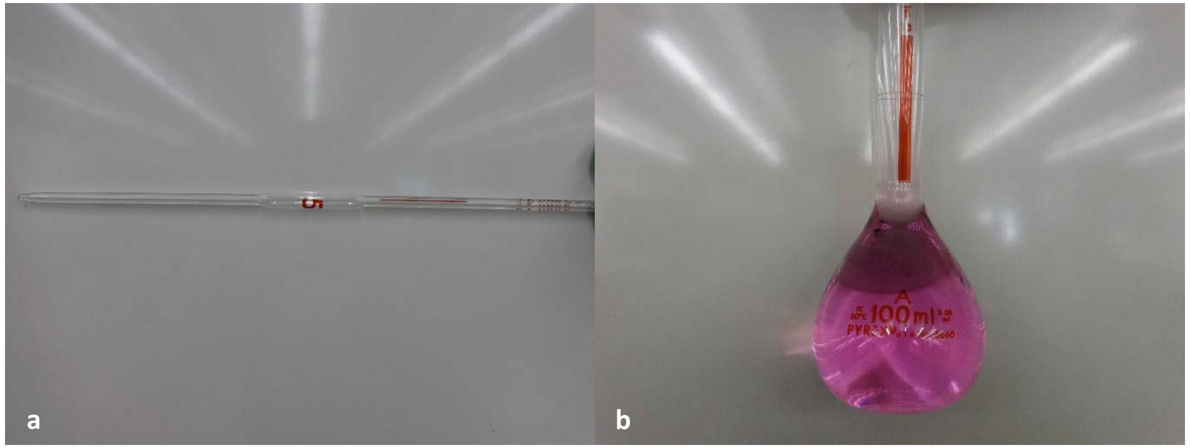

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15

How much 5.00 M NaOH should be used to make 100.0 mL of 0.100 M NaOH.

ans mL

Submit

ans = 5.00 mL

Smart Feedback

None for this question

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

$C_1V_1 = C_2V_2$

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

How much 8.00 M NaOH solution is required to make 350.0 mL of a 0.400 M solution?

$C_1V_1 = C_2V_2$

Where:
C_1 = 8.00 M
V_1 = unknown variable
C_2 = 0.400 M
V_2 = 350.0 mL

Plugging in:

$$8.00 \times V_1 = 0.400 \times 350.0$$
$$V_1 = 17.5\ mL$$

Third Incorrect Answer

Incorrect. Here's your answer:

$C_1V_1 = C_2V_2$

Where:
C_1 = 5.00 M
V_1 = unknown variable
C_2 = 0.100 M
V_2 = 100.0 mL

Plugging in:

$$5.00 \times V_1 = Z.000 \times Y.0$$
$$V_1 = 5.00\ mL$$

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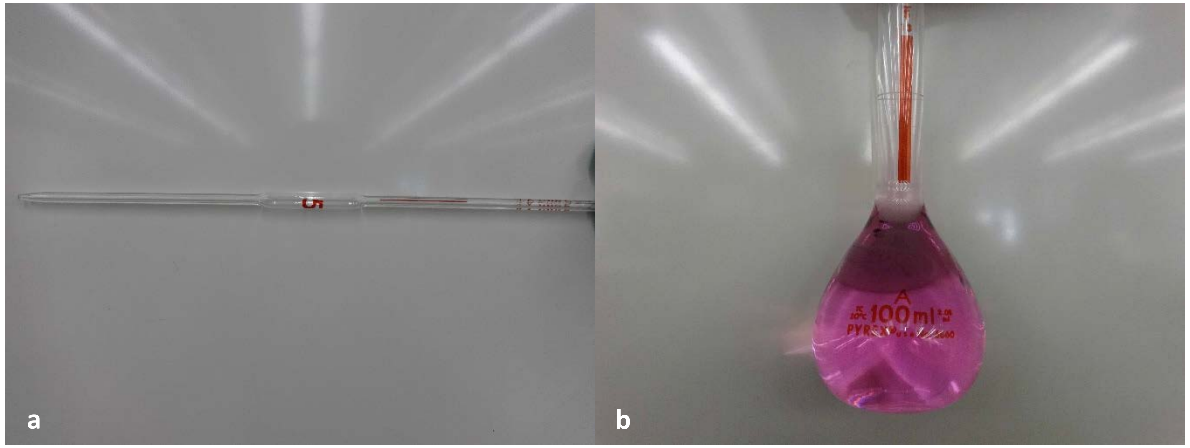

Experiment

Pre-Lab

Acid-Base Titration Experiment
Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15 16

Next you will make the acid solution by diluting 3.5 mL of 3 M HCl to 50 mL in a 125 mL Erlenmeyer flask. What safety precaution should you keep in mind?

- ❑ Never add water to acid. Add 3.5 mL of 3 M HCl to about 25 mL of water then fill to 50 mL.
- ❑ Never add acid to water. Add 3.5 mL of 3 M HCl to the flask first.
- ❑ Acid and water don't mix. Add 3.5 mL of 3 M HCl to the base.
- ❑ Acid and base don't mix. Add 3.5 mL of 3 M HCl and titrate directly without diluting.

Submit

Answer: choice 1, Never add water to acid. Add 3.5 mL of 3 M HCl to about 25 mL of water then fill to 50 mL.

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

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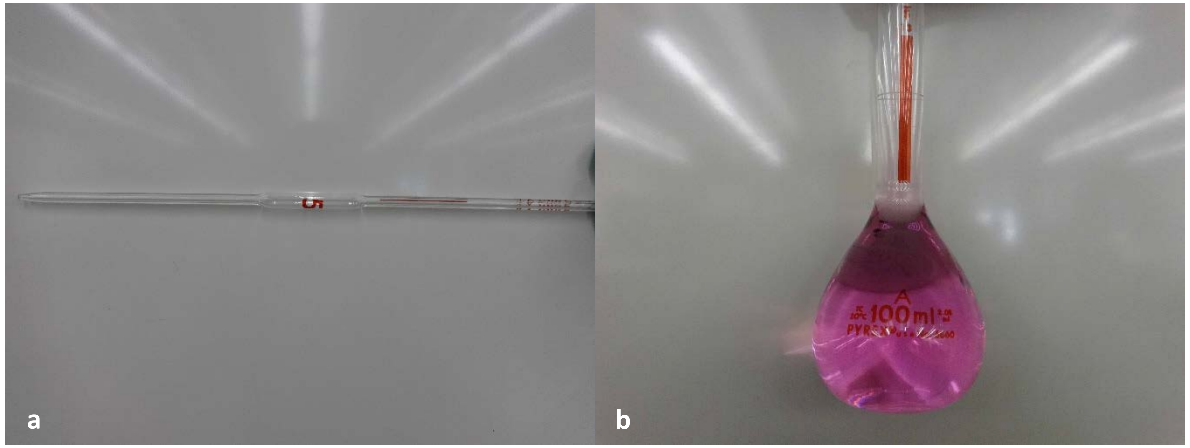

Experiment

Pre-Lab

Acid-Base Titration Experiment
Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15 16

Which correctly describes a proper titration for this experiment.

- ❑ 5.00 mL of diluted HCl is added to the Erlenmeyer flask. The indicator, phenolphthalein is then added to the Erlenmeyer flask. 0.100 M NaOH is added to a cleaned burette.
- ❑ 5.00 mL of 0.100 M NaOH is added to the Erlenmeyer flask. The indicator, phenolphthalein is then added to the Erlenmeyer flask. Diluted acid is added to a cleaned burette.
- ❑ 25.00 mL of diluted HCl is added to the Erlenmeyer flask. 0.100 M NaOH is added to a cleaned burette. The indicator, phenolphthalein is then added to the burette.
- ❑ 25.00 mL of 0.100 M NaOH is added to the Erlenmeyer flask. Diluted HCl is added to a cleaned burette. The indicator, phenolphthalein is then added to the burette.

Submit

Answer: choice 1, 5.00 mL of diluted HCl is added to the Erlenmeyer flask. The indicator, phenolphthalein is then added to the Erlenmeyer flask. 0.100 M NaOH is added to a cleaned burette.

Key Concepts

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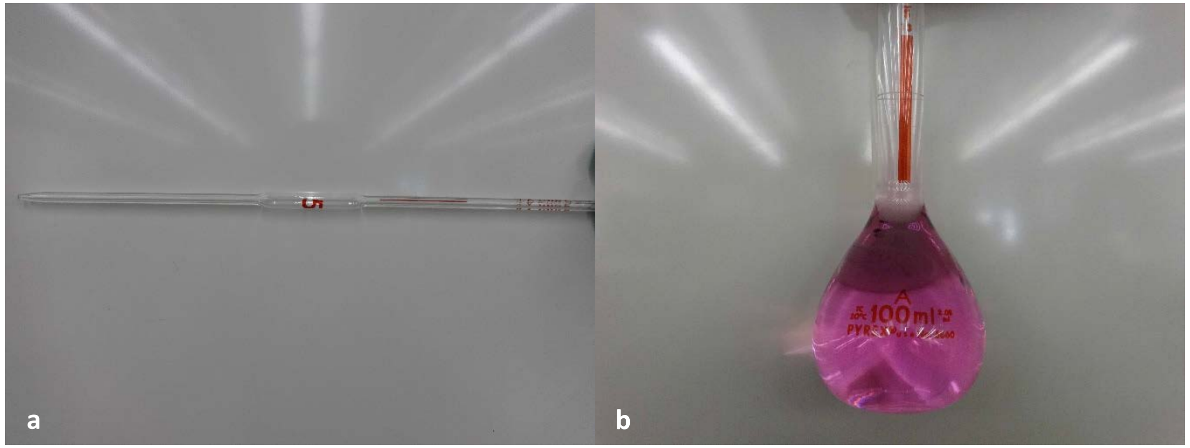

Experiment
Pre-Lab

Acid-Base Titration Experiment
Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15

Which of the following statements is true.

- ❑ A labeled waste beaker should be made to catch any rinsing's from the burette.
- ❑ Before adding 0.100 M NaOH to the burette, the burette should be rinsed with several small portions of water, then base.
- ❑ After the burette is filled it, any air bubbles should be removed by fully opening the stopcock.
- ❑ The initial, and all other burette readings should be to two decimal places.
- ❑ All of the above.

Submit

Answer: choice 5, All of the above.

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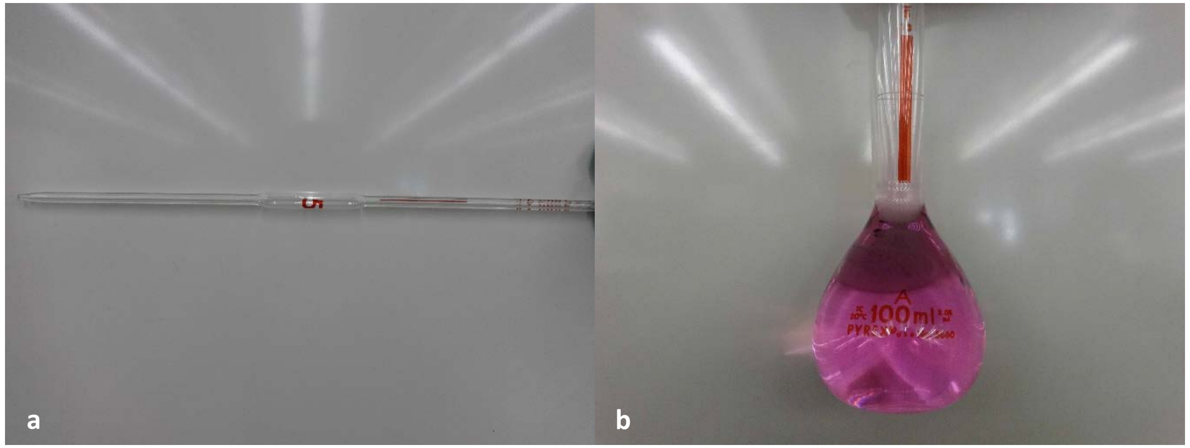

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15 16

What is the initial burette reading?

t1initial mL

Submit

Behind the scenes the software builds a table.

	A	B	C
1	Trial	Initial Burette Reading (mL)	Final Burette Reading (mL)
2	1	t1initial	
3	2		
4	3		
5	4		

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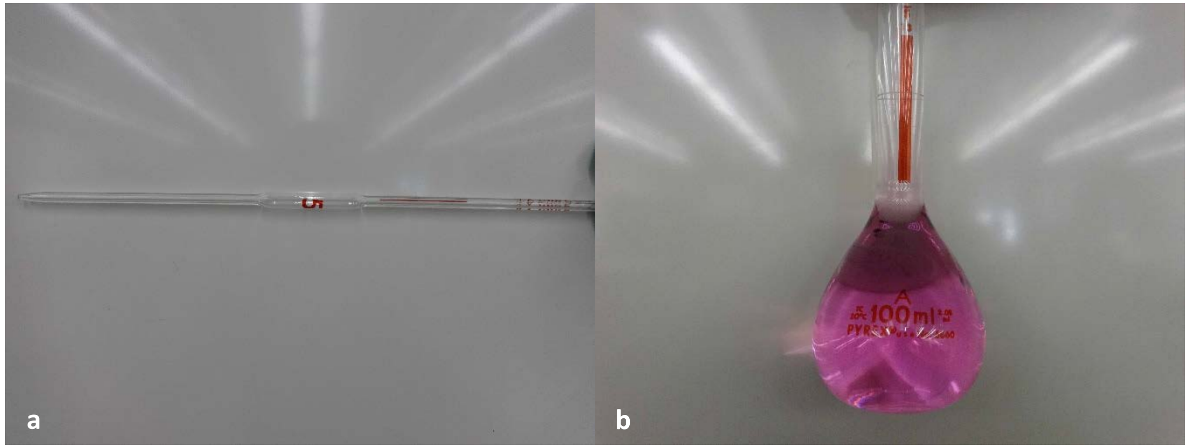

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 14 14 15 16

Perform the titration so the last drop turns the solution in the Erlenmeyer flask pink.

What is the final burette reading after the titration?

T1final mL

Submit

Each time test: t1final=t1initial + between 6 and 14

If yes: Congratulations you are on the right track.

If no: Please double check your titration value. Is the reading correct? Was the solution over titrated? Are the HCl and NaOH solutions the proper concentration.

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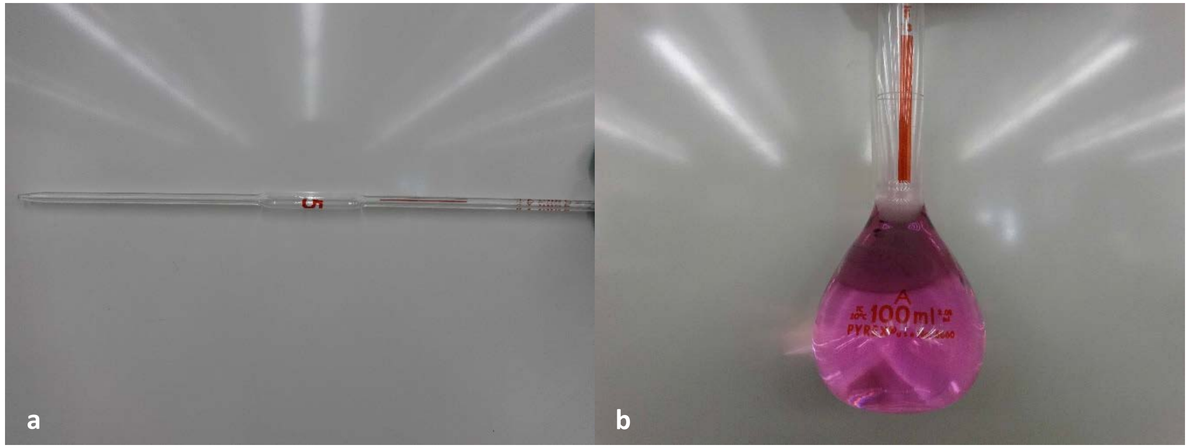

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

If there is an error at any time you can record a new initial or final volume.

Final burette reading trail 2 t2final mL Submit New Initial Volume

Final burette reading trail 3 t4final mL Submit New Initial Volume

Final burette reading trial 4 t4final g Submit New Initial Volume

Each time test: t2final=t1final + between 6 and 14

If yes: Congratulations you are on the right track.

If no: Please double check your titration value. Is the reading correct? Was the solution over titrated? Are the HCl and NaOH solutions the proper concentration.

Behind the scenes the software builds a table.

	A	B	C	D	E		
1	Trial	Initial Burette Reading (mL)	Final Burette Reading (mL)	Volume of NaOH Used in Titration	Molarity of HCl (M)	Average Molarity (M)	RSD (ppt)
2	1	t1initial	t1final	volt1=B2-C2	MHClt1=D2/1000*.1/0.005	avg=average(e2:E5)	RSD=G2/STDEB(e2:E5)*1000
3	2	t1final	t2final	volt2=B3-C3	MHClt2=D3/1000*.1/0.005		
4	3	t2final	t3final	volt3=B4-C4	MHClt3=D4/1000*.1/0.005		
5	4	t3final	t4final	volt4=B5-C5	MHClt4=D5/1000*.1/0.005		

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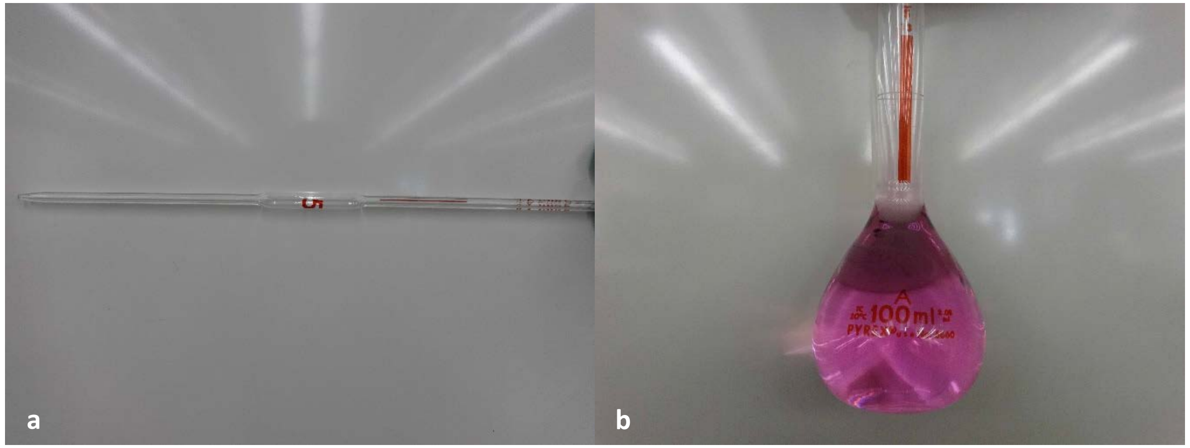

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Here is your data.

	A	B	C
1	Trial	Initial Burette Reading (mL)	Final Burette Reading (mL)
2	1	t1initial	t1final
3	2	t1final	t2final
4	3	t2final	t3final
5	4	t3final	t4final

Export to CSV

Students table should have their numbers. If possible they should be able to export it to a csv file to manipulate in Excel.

What is the concentration of HCl for trial 1?

ans M

Submit

Ans = MHClt1

Smart Feedback

If a = ans * 1000

Incorrect. Don't forget the volume must be in liters.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

At the endpoint of the titration the moles of acid and moles of base can be considered equal. Determine the moles of base and use the balanced chemical equation to find the moles of acid and then the concentration of the acid.

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

The initial burette reading in a titration was 10.31 mL and the final burette reading was 23.27 mL. If 10.00 mL of HCl was titrated and 0.413 M NaOH was used in the titration, what is the concentration of the acid?

Volume of NaOH used:

23.27 – 10.31 =12.96 mL

Concentration of HCl

$$0.01296\ L \times \frac{0.413\ mol\ NaOH}{1\ L} \times \frac{1\ mol\ HCl}{1\ mol\ NaOH} \times \frac{1}{0.01000\ L} = 0.5352\ M$$

Third Incorrect Answer

Incorrect. Here's your answer:

Volume of NaOH used:

Y.00 – X.00 =B.00 mL

Concentration of HCl

$$\frac{volt1}{1000} L \times \frac{0.100\ mol\ NaOH}{1\ L} \times \frac{1\ mol\ HCl}{1\ mol\ NaOH} \times \frac{1}{0.005\ L} = MHClt1\ M$$

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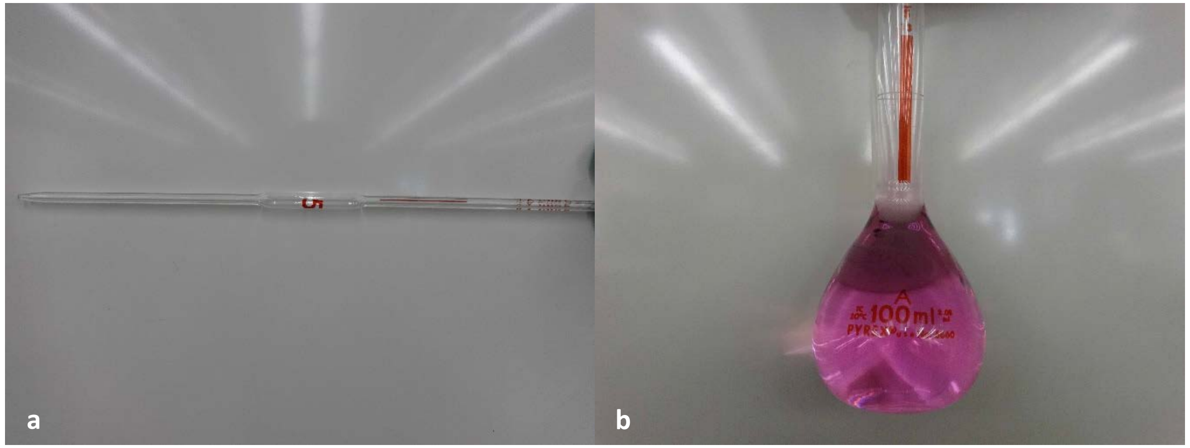

Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

What is the molarity of HCl for each trail? It may be easier to use Excel for the calculations.

What is the HCl concentration for trial 2?

anst2 M Submit

What is the HCl concentration for trial 2?

anst3 M Submit

What is the HCl concentration for trial 2?

anst4 M Submit

Anst2 = MHClt2
Anst3 = MHClt3
Anst4 = MHClt4

Smart Feedback

If a = ans * 1000

Incorrect. Don't forget the volume must be in liters.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

At the endpoint of the titration the moles of acid and moles of base can be considered equal. Determine the moles of base and use the balanced chemical equation to find the moles of acid and then the concentration of the acid.

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

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Third Incorrect Answer

Incorrect. Here's your answer:

Volume of NaOH used:

Y.00 – X.00 =B.00 mL

Concentration of HCl

$$\frac{volt1}{1000} L \times \frac{0.100\ mol\ NaOH}{1\ L} \times \frac{1\ mol\ HCl}{1\ mol\ NaOH} \times \frac{1}{0.005\ L} = MHClt1\ M$$

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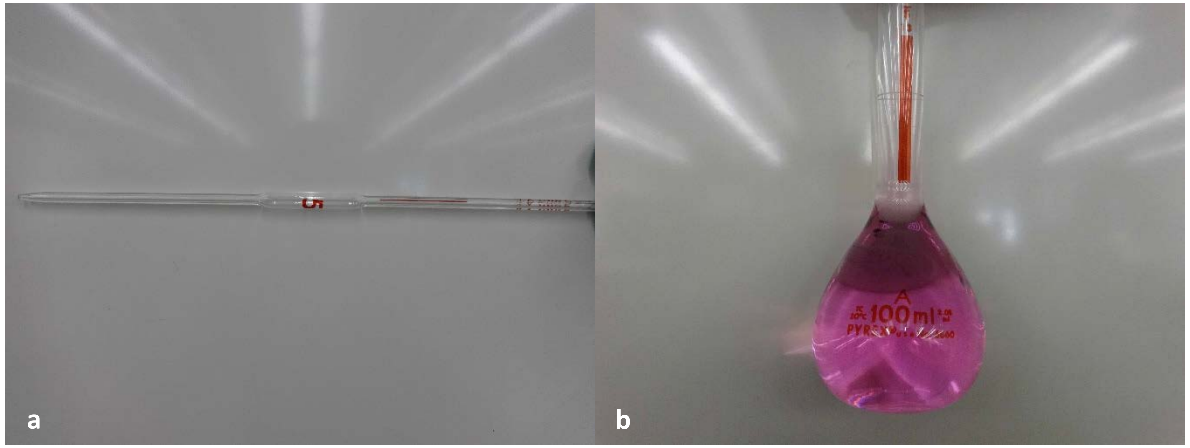
Picture 1. (a) 5.00 mL volumetric pipette. (b) 100.0 mL volumetric flask.



Experiment

Pre-Lab

Acid-Base Titration Experiment

Question: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

What is the RSD for your titration data?

ans ppt

Submit

Ans = RSD

Smart Feedback

If ans = RSD/1000

Incorrect. Don’t forget RSD is in PPT. Multiply by 1000.

First Incorrect Answer

Incorrect. Please try again.

General Feedback:

Use the Excel Appendix for help calculating RSD.

Second Incorrect Answer

Incorrect. Please try again.

Example Feedback:

RSD is a statistical funtion that can be calculated for any set of data. Here is an example.

Over 3 trials the student found the following volumes: 1.01, 0.98, 1.01, 1.02 and 0.98 mL. What is the RSD?

Find RSD in Excel.

E	F	G
Volume of Water (mL)	Average (mL)	RSD (ppt)
1.01	1.0	=stvdev(E2:E6)/F2*1000
0.98		
1.01		
1.02		
0.98		

The RSD is 20 ppt.

Third Incorrect Answer

Incorrect. Here’s your answer:

In Excel

E	F	G
Molarity of HCl (M)	Average Molarity (M)	RSD (ppt)
MHClt1	=AVERAGE(E2:E5)	=F2/STDEV(E2:E5)*1000
MHClt2		
MHClt3		
MHClt4		

Key Concepts

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

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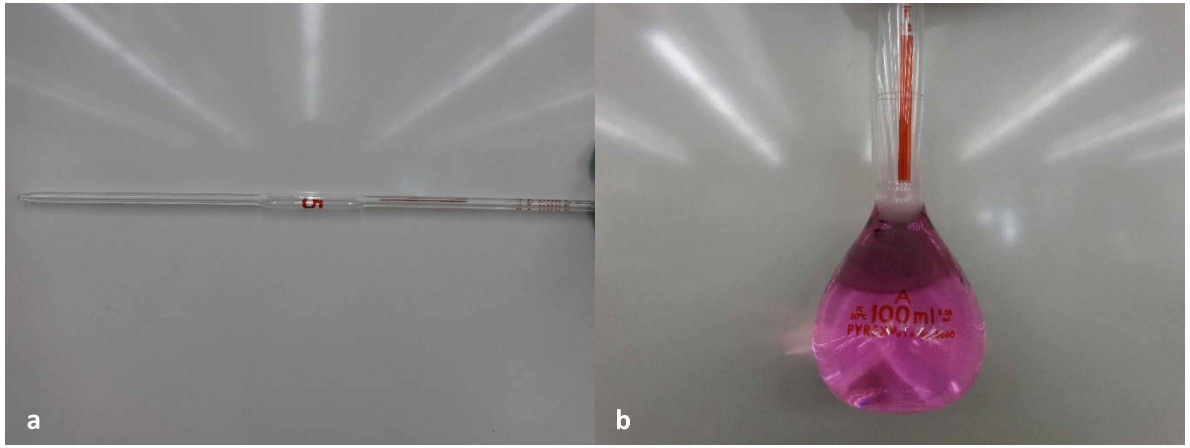

Experiment

Pre-Lab

You found an RSD of RSD ppt.

Is your data precise? Explain.

Submit

Congratulations you completed the experiment. Remember, your post-lab questions are due in 48 hours.

Where would you like to go next?

- ❑ Part 1: Volumetric Glassware
- ❑ Part 2: Acid-Base Titration
- ❑ **Post-lab Questions**

Submit

Behind the scenes the software should compile the students post-lab. It should include the data from the tables and caclulations. It need not include questions about what to do next.

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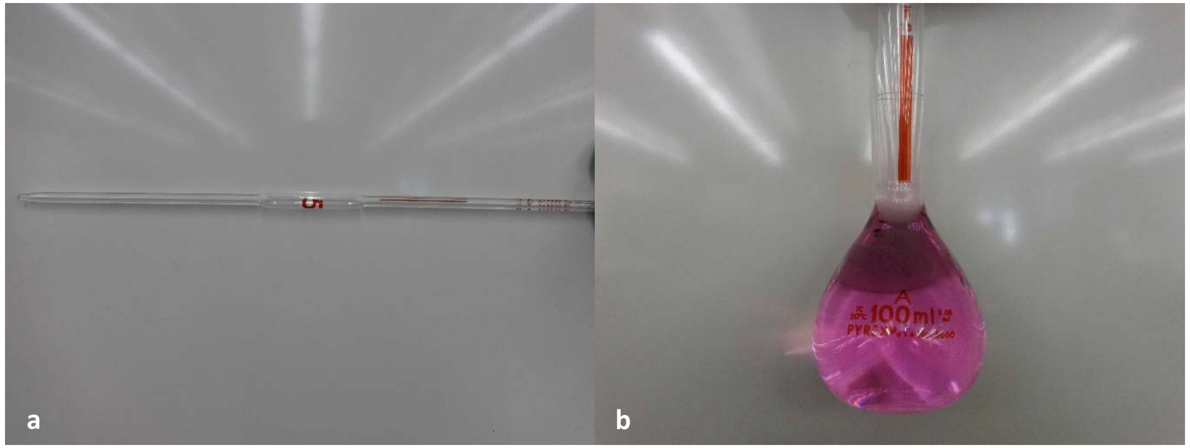

Experiment 7 Post Lab Questions

Question: **1** 2 3 4 5

Reflect on two key concepts you learned in the lab.

Key Concepts:

After completing this experiment, you are responsible for understanding: the use of volumetric glassware, indicators, endpoints, acid-base reactions and titrations.

Submit

Experiment | Pre-Lab | Lab Report

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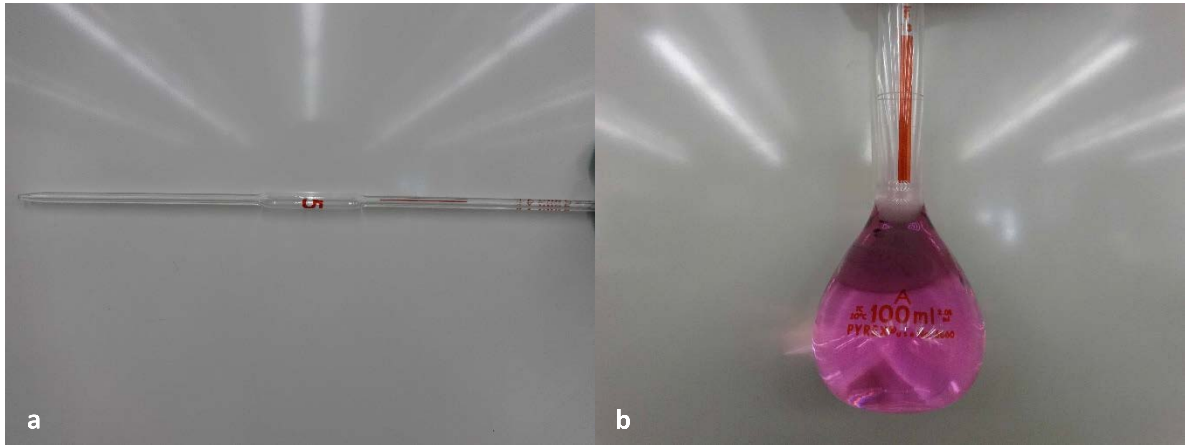

Experiment | Pre-Lab | Lab Report

Experiment 7 Post Lab Questions

Question: 1 **2** 3 4 5

Reflect on any scientific errors or possible improvements associated with the experiment. What could be done to perform the experiment better?

Submit

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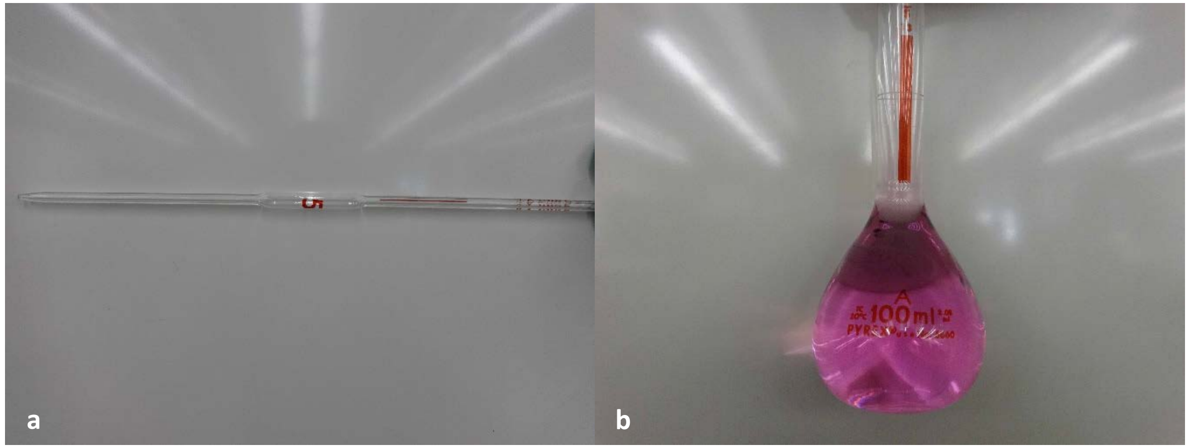

Experiment

Pre-Lab

Lab Report

Experiment 7 Post Lab Questions

Question: 1 2 **3** 4 5

You used the equation below to calculate the amount of 5.00 M NaOH required to make 0.100 M NaOH. Solve for the equation in terms of V_1.

$C_1V_1 = C_2V_2$

Submit

Ans = $V_1 = \frac{C_2V_2}{C_1}$

No feedback is required for these questions.

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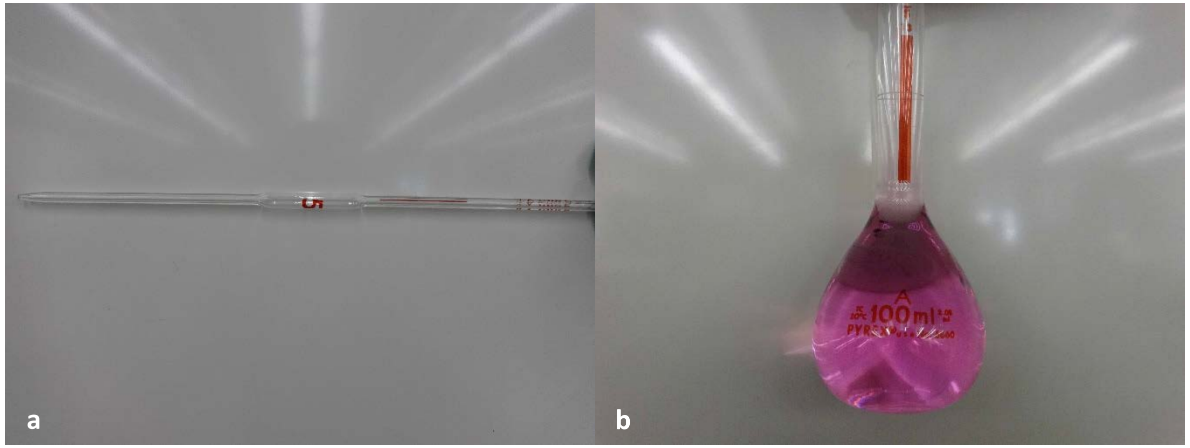

Experiment

Pre-Lab

Lab Report

Experiment 7 Post Lab Questions

Question: 1 2 3 **4** 5

A student got the following HCl molarities: 0.201, 0.205, 0.203, 0.199 M. If the actual molarity was 0.200 is the data accurate? Precise? Explain. Be sure to calculate the RSD and percent error and use the values in your explanation.

Submit

Acid- Base Titration

Now that we are familiar with the glassware used for titrations we can further discuss the theoretical and practical aspects of the titration itself. In a **titration**, a solution of known concentration, often called the **standard solution** (a titrant), is added to a solution with an unknown concentration to determine the unknown concentration or quantity of solute in the unknown. In an acid-base titration, one of the solutions is acidic and the other is basic. A neutralization reaction occurs when the solutions are added together.

In this experiment, you will perform an acid-base titration by reacting a sodium hydroxide solution of known concentration (titrant) with a hydrochloric acid solution in order to determine the concentration of the hydrochloric acid solution as shown in Reaction 1. An acid-base reaction, such as that of hydrochloric acid and sodium hydroxide, is a double-displacement reaction, where the hydrogen ion from the acid replaces the sodium ion in sodium hydroxide, and the sodium ion replaces the hydrogen in the acid. The end result is water (from the hydrogen and the hydroxide ions) and a salt (from the sodium and the chloride ions).

To begin the experiment, a 0.100 M sodium hydroxide solution is prepared. You should start by calculating what volume of a 5M sodium hydroxide solution (stock solution) is needed to make a 100 mL of 0.100 M sodium hydroxide solution. This volume is added into a 100.0 mL volumetric flask and then water is added to the calibration line. Next, the hydrochloric acid solution is made by adding approximately 3.5 mL of 3M hydrochloric acid into a 125 mL Erlenmeyer flask containing about 25 mL of water and filling to the 50 mL line. Remember; never add water to concentrated acid solutions! It is important to add the acid to an Erlenmeyer flask already containing a substantial amount of water (in this case about 25 mL). It is also important to note that the glassware used to make or dilute the HCl is not very accurate. Since the volumes are not accurate, they will not be used to find the concentration of the acid. Instead, the titration data will be used to find the concentration of the acid.

Reaction 1. Hydrochloric acid reacting with sodium hydroxide.

$$HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl\,(aq) + H_2O\,(l)$$

Experiment 7 Post Lab Questions

Question: 1 2 3 4 **5**

The initial burette reading in a titration was X.00 mL and the final burette reading was Y.00 mL. If 10.00 mL of HCl was titrated and Z.000 M NaOH was used in the titration, what is the concentration of the acid?

A M

Submit

Answer: $ans = \dfrac{\left(\frac{(Y-X)}{1000}\right)\times Z}{0.01}$

X should be a random number between 1 and 10 with two decimal places.

Y should X plus a random number between 10 and 15 and should have 2 decimal places.

Z should be a random number between 0.1 and 0.2 with 3 decimal places.