Lab 5: Liquids Measurement

BIOL-8

Name: ______________________ **Date:** ______________________

Objectives

By the end of this lab, you will be able to:

- **Use the LabQuest Mini** interface with Logger Pro to collect digital sensor data
- **Measure pH** of different liquids and explain what pH indicates
- **Measure conductivity** and relate it to total dissolved solids
- **Compare temperature** readings between a digital probe and an analog thermometer
- **Measure dissolved oxygen** and explain its biological significance
- **Use a colorimeter** to measure absorbance at multiple wavelengths
- **Measure turbidity** and explain how particle concentration affects light transmittance
- **Compare and contrast** the physical and chemical properties of two liquids

Introduction

Why This Lab Matters

In biology, understanding the physical and chemical properties of liquids is essential. Every living organism exists in a liquid environment — cells are bathed in interstitial fluid, blood carries dissolved gases and nutrients, and even the simplest microbe is sensitive to the pH, temperature, and dissolved oxygen of its surroundings. Clinicians measure these same properties daily: blood pH, electrolyte conductivity, dissolved oxygen saturation, and urine turbidity are all standard diagnostic tests.

Before you can work with living organisms in future labs, you need to **master the measurement tools** and develop **good lab hygiene habits**. Proper probe handling — rinsing between samples, calibrating before use, avoiding cross-contamination — is the same discipline required for aseptic technique when working with cultures, tissue samples, and body fluids. The habits you build today with tap water and lemon juice are the exact habits that protect both you and your specimens later.

What You Will Measure

In this lab you will use **six different Vernier probes** connected to a **LabQuest Mini** to characterize two liquids: **Pure Tap Water** and **Lemon Juice**. Here is a preview of every measurement you will make:

#	Probe (Device)	What It Measures	Units	Key Question
1	**pH Meter** (+ Dip pH)	Hydrogen ion concentration	pH (0–14)	How acidic or basic is the liquid?
2	**Conductivity Probe**	Total Dissolved Solids (TDS)	µS/cm	How many dissolved ions are present?
3	**Temperature Probe** (+ analog thermometer)	Temperature	°C	Are the liquids at the same temperature?
4	**Dissolved Oxygen Probe**	Dissolved Oxygen (DO)	mg/L	How much O_2 is available in the liquid?
5	**Colorimeter**	Absorbance at 430, 470, 565, 635 nm	Abs	Which wavelengths of light does the liquid absorb?
6	**Turbidity Probe**	Transmittance level	NTU / %T	How cloudy is the liquid?

Each probe reveals a different dimension of the liquid's character. Together, these six measurements build a comprehensive profile — the same approach used in clinical labs, water treatment facilities, and environmental field stations.

Predictions — Two Test Liquids

Before you begin, predict what you expect to see for each measurement. Fill in your predictions now — you will compare these to your actual results at the end of the lab.

Predictions

#	Measurement	Tap Water (predicted)	Lemon Juice (predicted)	Reasoning
1				
2				
3				
4				
5				
6				

How the Lab Works

Each group has a **LabQuest Mini** connected to a laptop via USB. We have a limited number of some probes, so they are **shared between groups**. Work through whichever probe is available at your station — there is no required order. Rotate through all six measurement stations until your data table is complete. The only rule: **always rinse the probe with distilled water and blot dry between samples** to avoid cross-contamination (precisely the same discipline you will use when handling biological specimens).

Setup

Materials

- LabQuest Mini interface (Vernier)
- Laptop with Logger Pro 3.16.2 installed
- USB cable
- Two beakers labeled "Tap Water" and "Lemon Juice"
- Wash bottle with distilled water (for rinsing probes between samples)
- Paper towels / Kim wipes

Connecting the LabQuest Mini

1. Plug the LabQuest Mini into the laptop via USB
2. Open Logger Pro 3.16.2
3. Connect the first probe to the LabQuest Mini — Logger Pro should auto-detect the sensor
4. Verify the probe is reading (the display should show live values)
5. Between samples: **always rinse the probe with distilled water and blot dry** before switching from one liquid to the other

---

Pre-Lab Questions:

1. Why is it useful to measure multiple different properties of a liquid rather than just one?

2. Which measurements do you expect to show the biggest difference between tap water and lemon juice? Why?

3. Why is it important to rinse probes with distilled water between samples?

Part 1: pH Meter

Learning Goal: *Measure pH using both the standard pH probe and the Dip pH sensor. Understand the pH scale and what hydrogen ion concentration tells us about a solution.*

What Is pH?

pH measures the concentration of hydrogen ions (H^+) in a solution. The scale runs from 0 (strongly acidic) to 14 (strongly basic), with 7 being neutral. Each whole number step represents a **10-fold** change in H^+ concentration.

Common pH examples: battery acid (0.5), lemon juice (~2), vinegar (2.4), coffee (5), milk (6.5), pure water (7), baking soda (8.3), seawater (8), ammonia (11.5), drain cleaner (14).

Procedure

1. Connect the **pH probe** to the LabQuest Mini
2. Calibrate if instructed (Logger Pro may auto-calibrate)
3. Rinse the probe tip with distilled water and blot dry
4. Submerge the probe tip in the **Tap Water** sample — wait for the reading to stabilize
5. Record the pH value
6. Rinse the probe, blot dry, then submerge in the **Lemon Juice** sample
7. Record the pH value
8. If a **Dip pH** sensor is available, repeat the measurements and record those readings as well

Prediction

Before measuring, predict what difference you expect:

Liquid	Predicted pH	Reasoning
Tap Water		
Lemon Juice		

Data Collection

pH Measurements

#	Liquid	pH Probe Reading	Dip pH Reading (if available)
1			
2			

Analysis

1. How many times more acidic is the lemon juice compared to the tap water? (Hint: Each pH unit = 10× difference in H^+ concentration)

2. If the pH probe and Dip pH gave different readings, which do you think is more accurate? Why?

3. Why does lemon juice have a low pH? What chemical in lemons is responsible?

Part 2: Conductivity Probe (Total Dissolved Solids)

> ***Learning Goal:*** *Measure the electrical conductivity of each liquid and understand how dissolved ions affect a solution's ability to conduct electricity.*

What Is Conductivity?

Conductivity measures how well a solution conducts electricity. Pure water is a poor conductor, but dissolved ions (salts, acids, minerals) allow current to flow. Conductivity is measured in **microsiemens per centimeter (µS/cm)** and is directly related to **Total Dissolved Solids (TDS)**.

Procedure

1. Connect the **Conductivity probe** to the LabQuest Mini
2. Rinse the probe with distilled water
3. Submerge in **Tap Water** — wait for a stable reading
4. Record the value
5. Rinse, then submerge in **Lemon Juice**
6. Record the value

Prediction

Before measuring, predict which liquid will have higher conductivity and why:

Data Collection

Conductivity / TDS Measurements

#	Liquid	Conductivity (µS/cm)
1		
2		

Analysis

1. Which liquid had higher conductivity? What dissolved substances contribute to this?

2. Would distilled water have higher or lower conductivity than tap water? Explain.

3. Why is conductivity important in biological systems? (Think about nerve impulses and body fluids.)

Part 3: Temperature Probe

> ***Learning Goal:*** *Measure temperature using both a digital temperature probe and an analog thermometer. Compare the precision and convenience of each method.*

Procedure

1. Connect the **Temperature probe** to the LabQuest Mini
2. Place the digital probe in the **Tap Water** — wait for it to stabilize
3. Record the temperature in °C
4. Also measure the same sample with the **analog thermometer** and record
5. Repeat both measurements for the **Lemon Juice**

Prediction

Do you expect a temperature difference between the two liquids? Why or why not?

Data Collection

Temperature Measurements

#	Liquid	Digital Probe (°C)	Analog Thermometer (°C)
1			
2			

Analysis

1. Did the digital probe and analog thermometer agree? If not, what might account for the difference?

2. Which measurement method is more precise? Which is more practical for laboratory work?

3. Why is temperature an important variable to control or measure in biological experiments?

Part 4: Dissolved Oxygen Probe

> ***Learning Goal:*** *Measure dissolved oxygen (DO) in each liquid and understand why oxygen levels in water matter for living organisms.*

What Is Dissolved Oxygen?

Dissolved oxygen (DO) is the amount of oxygen gas (O_2) dissolved in a liquid, measured in **mg/L** (milligrams per liter). Aquatic organisms depend on DO for respiration. Factors affecting DO include temperature, salinity, and organic matter.

Procedure

1. Connect the **Dissolved Oxygen probe** to the LabQuest Mini
2. Allow the probe to warm up (the membrane tip needs time to equilibrate)
3. Gently stir the probe in the **Tap Water** to ensure fresh water contacts the membrane
4. Record the DO reading once stable
5. Rinse, then measure the **Lemon Juice**
6. Record the DO reading

Prediction

Which liquid do you predict will have more dissolved oxygen? Why?

Data Collection

Dissolved Oxygen Measurements

#	Liquid	Dissolved Oxygen (mg/L)
1		
2		

Analysis

1. Which liquid had higher dissolved oxygen? Does this match your prediction?

2. Fish need at least 4–5 mg/L of dissolved oxygen. Based on your readings, could fish survive in either liquid?

3. What factors would decrease the dissolved oxygen in a body of water?

Part 5: Colorimeter (Absorbance)

> ***Learning Goal:*** *Measure how much light each liquid absorbs at four different wavelengths, and understand what absorbance tells us about a liquid's composition.*

What Is Absorbance?

A **colorimeter** sends a beam of light at a specific wavelength through a sample and measures how much light is absorbed. Clear solutions absorb very little light; colored or turbid solutions absorb more. Absorbance is measured in **Absorbance units (Abs)** — higher values mean more light is absorbed.

Available wavelengths on the Vernier Colorimeter: 430 nm (violet), 470 nm (blue), 565 nm (green), 635 nm (red)

Procedure

1. Connect the **Colorimeter** to the LabQuest Mini
2. Insert a cuvette of **distilled water** and calibrate (set as blank/zero) at each wavelength
3. Fill a cuvette with **Tap Water**, insert, and record absorbance at all four wavelengths
4. Fill a clean cuvette with **Lemon Juice**, insert, and record absorbance at all four wavelengths

Prediction

Which liquid do you expect to absorb more light? At which wavelength(s) do you expect the biggest difference?

Data Collection

Colorimeter Absorbance Measurements

#	Liquid	430 nm (Abs)	470 nm (Abs)	565 nm (Abs)	635 nm (Abs)
1					
2					

Analysis

1. At which wavelength did lemon juice absorb the most light? Why might this be?

2. Why does tap water have very low absorbance at all wavelengths?

3. Colorimeters are used in clinical labs to measure blood glucose and hemoglobin levels. Why is absorbance useful for measuring concentrations of substances?

Part 6: Turbidity Probe (Transmittance)

> ***Learning Goal:*** *Measure the turbidity (cloudiness) of each liquid and understand how suspended particles affect light transmittance.*

What Is Turbidity?

Turbidity measures how cloudy or opaque a liquid is, based on how much light can pass through it. It is typically reported in **NTU (Nephelometric Turbidity Units)** or as **percent transmittance (%T)**. Higher turbidity means more suspended particles scattering light.

Procedure

1. Connect the **Turbidity probe** to the LabQuest Mini
2. Calibrate with distilled water if instructed
3. Insert the **Tap Water** sample and record the reading
4. Insert the **Lemon Juice** sample and record the reading

Prediction

Which liquid do you predict will be more turbid? Why?

Data Collection

Turbidity Measurements

#	Liquid	Turbidity (NTU) or Transmittance (%T)
1		
2		

Analysis

1. Which liquid was more turbid? What causes the cloudiness?

2. Water treatment plants monitor turbidity closely. Why is high turbidity a concern for drinking water?

3. How does turbidity relate to the colorimeter absorbance measurements you took earlier?

Summary Data Table

Copy your measurements into the summary table below so you have all data in one place.

Liquids Measurement Summary

#	Measurement	Tap Water	Lemon Juice
1			
2			
3			
4			
5			
6			

Group Data Sharing

Share your results with the other group(s) and record their data below. This lets you compare whether different groups got similar readings.

Combined Group Data

#	Measurement	Our Tap Water	Their Tap Water	Our Lemon Juice	Their Lemon Juice
1					
2					
3					
4					
5					
6					

Conclusions

1. Which measurements showed the greatest difference between tap water and lemon juice? Which showed the smallest? Explain why.

2. Were your group's results similar to or different from the partner group's results? What might explain any differences you observed?

3. If you had a third unknown liquid, which single measurement would be most useful for identifying whether it is acidic, neutral, or basic? Why?

4. How might these measurement techniques be used in a medical or environmental context? Give at least two examples.

5. What new laboratory skills did you develop in this lab?

Quick Reference

Measurement Summary

Probe	What It Measures	Units	Typical Range
pH Meter	Hydrogen ion concentration	pH units	0–14
Conductivity	Dissolved ion content	µS/cm	0–20,000+
Temperature	Thermal energy	°C	-20 to 120
Dissolved Oxygen	O_2 in solution	mg/L	0–15
Colorimeter	Light absorbance	Abs	0–3+
Turbidity	Cloudiness / scatter	NTU	0–1000+

Key Relationships

Concept	Relationship
pH & H^+ ions	Lower pH = more H^+ = more acidic
Conductivity & dissolved ions	More dissolved ions = higher conductivity
Temperature & DO	Higher temperature = lower dissolved oxygen
Turbidity & absorbance	More particles = higher turbidity = higher absorbance

---

Connection to Module 05: Understanding how to measure and characterize liquids is fundamental to biology. Body fluids—blood, urine, cerebrospinal fluid—are all assessed by these same types of measurements (pH, electrolyte conductivity, dissolved gases). The techniques you practiced here with LabQuest Mini are directly analogous to those used in clinical laboratories and environmental monitoring.

Lab adapted for BIOL-8: Human Biology, Spring 2026