Essential Question: How do we perform urinalysis and interpret the results?
LT: I can follow urinalysis testing procedures in order to diagnose possible conditions or diseases.
4.1.2b; 4.1.2c

In this activity, you will perform five important component tests of clinical urinalysis: color, pH, specific gravity, glucose, and protein. The Low, Normal, and High simulated urine samples are designed to produce results indicative of those characteristics. You will also be provided with two unknown simulated urine samples for urinalysis, and you will be asked to report and interpret the results.

Background
Urinalysis is used by doctors to assess various factors of urine, including color and pH, that could indicate disease. These factors are normally kept in balance by the **kidneys** as they filter blood and produce urine but may change under certain conditions like disease or medication use, or even with certain foods.
Normal urine colors range from various shades of light yellow, depending upon the concentration of **urobilin**, the urinary pigment. Certain foods, drugs, diseases, and amount of water intake can cause lighter or darker urine.

Table 1. Urine Color and Possible Causes

Color	Diet	Drugs	Disease
light yellow	normal	none	none
clear	increased fluid intake	alcohol	uncontrolled diabetes mellitus
yellow orange to orange	Carrots, decreased fluid intake	antibiotics, pyridium	bilirubin from obstructive jaundice
green	green food dyes, asparagus	diuretics	bacterial infection
red to red brown	beets	senna laxatives	hemoglobin in urine (various causes)
dark wine	beets	anti-inflammatory drugs	hemolytic jaundice
brown	rhubarb (large quantity), fava beans, severe dehydration	barbiturates	hemolytic anemia or liver disease; extremely strenuous exercise or muscle injury
brown-black	rhubarb (huge quantity), excessive sorbitol consumption	antidepressants	melanin pigment from melanoma (rare)

Table 2. Abnormal Urinalysis Results and Possible Causes

	Possible Causes	
Test Result	**Diet**	**Disease**
Low pH (<6)	high protein diet; cranberry juice	uncontrolled diabetes mellitus
High pH (>8)	diet rich in vegetables; dairy products	severe anemia
Low Specific Gravity (<1 .010)	increased fluid intake	severe renal damage
High Specific Gravity (>1 .026)	decreased fluid intake; loss of fluids	uncontrolled diabetes mellitus; severe anemia
Glucose Present	large meal	uncontrolled diabetes mellitus
Protein Present	high protein diet	severe anemia

The **pH** of a solution is a measure of its free hydrogen ion (H^+) concentration, which indicates acidity or alkalinity. A solution with a pH of 7 .0 is neutral. A solution with a pH less than 7 .0 is acidic, and a solution with a pH greater than 7 .0 is basic. Typically, the pH of normal urine is between 6 .0, which is slightly acidic, to 8 .0, which is slightly basic. Again, this normal balance can be upset by certain foods or disease.

Specific gravity is the density of a solution relative to water, which has a specific gravity of 1 .000. The specific gravity of normal urine ranges from 1 .010 to 1 .026. Specific gravity varies according to fluid intake but can also affected by disease.

Glucose (sugar) should not be detected in normal urine; its presence usually indicates **diabetes mellitus**, a severe metabolic disorder caused by defective carbohydrate utilization. The kidneys play a key role in glucose homeostasis and are able to reabsorb practically all glucose in their proximal convoluted tubules under normal conditions. If blood glucose is too high, as in diabetes, the kidneys will be unable to reabsorb all glucose, resulting in glucose presence in urine. Glucose may also be present in the urine after a big meal or during times of emotional stress.

A very small amount of **protein** is normally present in the urine. Any change in the color of a protein test strip indicates an elevated level of protein in urine. Diet and disease can affect protein levels in urine. For example, patients with severe **anemia**, a condition where the blood lacks an adequate number of red blood cells, usually excrete protein in their urine.

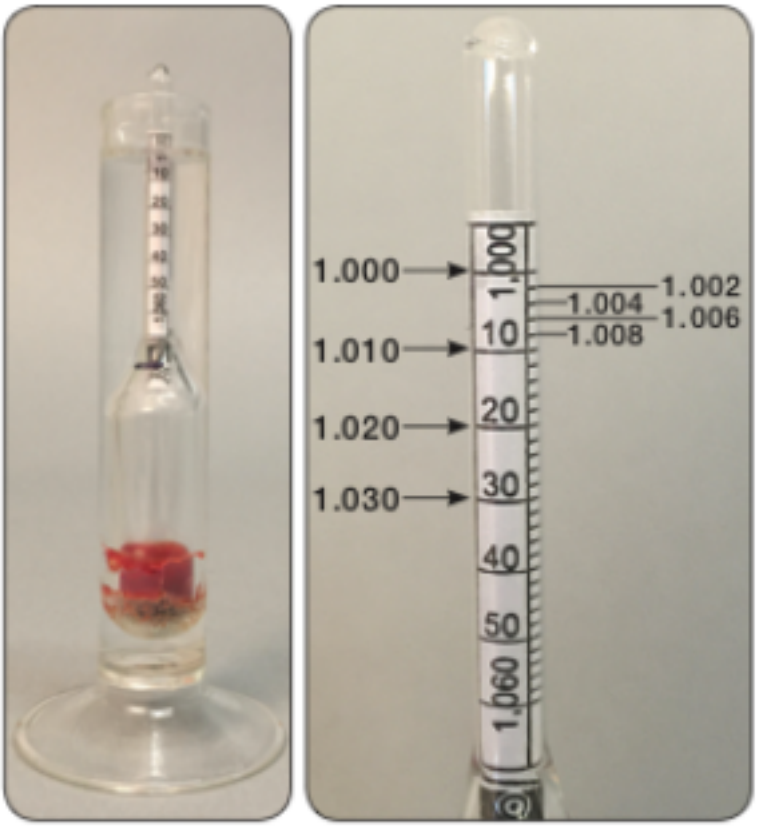

Figure 1.
(a) The specific gravity of a liquid can be determined using a hydrometer.
(b) The hydrometer you will be using in this investigation has a scale as seen here. Be sure to take readings at the bottom of the meniscus. The specific gravity of normal urine ranges from 1.010 to about 1.026.

Materials
-5 plastic specimen containers with simulated urine specimens -5 Urine Reagent strips -5 pH test strips -hydrometer and cylinder -pH color chart -absorbent paper towel **Safety Precautions: Simulated urine can irritate skin or eyes. Avoid contact with these chemicals and flush the affected area with water if contact does occur. Simulated urine also can stain clothing; avoid contact.

Procedure

1. Take three plastic urine specimen containers with 10 mL of simulated urine. The containers are labeled as follows: L (*Low)*, N (*Normal)*, and H (*High)*.
2. Place the containers of simulated urine on a piece of absorbent paper towel. Observe the samples and record the color of each sample in your Laboratory Data Table 1.
3. Use a pen or pencil to label one end of three of the pH test strips *L*, *N*, and *H*.
4. Holding the labeled end, dip the *L* strip into the Low sample. Shake off any excess liquid. Lay the pH strip in front of the Low sample on the absorbent paper towel. Repeat the process with the Normal (*N* strip) and High (*H* strip) samples.
5. Compare the color of the test trip to the pH color chart. In your Laboratory Data Table 1, record the pH of each sample as a number.
6. Label the plastic portion of three Urine Reagent strips *L*, *N*, and *H*, respectively.
7. Test each sample for glucose and protein using a Urine Reagent strip, as follows:
   a. Observe the color of the test squares that are attached at one end of the Urine Reagent strip. The greenish square nearest the tip will be used for testing the glucose in the sample; the yellow square will detect protein in the sample.
   b. Dip the end of the strip with the test squares into the urine sample, and then withdraw it. Run the end of the strip against the rim of the urine container to remove excess urine.
   c. Wait 30 seconds, then observe and record the color of the test squares.
   - *Green square:* A negative result produces no color change, indicating normal or low urine glucose. A darkening of the square indicates a higher than normal urine glucose level; the darker the color, the higher the glucose level. Record the result as *negative* or *positive*.
   - *Yellow square:* A negative result produces no color change, indicating the absence of protein in the urine. A green or blue color indicates the presence of protein in the urine sample. Record the result as *negative* or *positive*.
8. Measure the specific gravity of Simulated Urine Low by following the following steps:
   a. Rinse the urine hydrometer and jar thoroughly.
   b. Fill the cylinder ¾ of the way with the sample.
   c. Insert the hydrometer into the jar as shown in Figure 1 of the Prelab.
   d. Read the fluid level on the hydrometer scale and record the value in your Laboratory Data Table 1.
9. Repeat the specific gravity test for the Normal and High samples and record the results in your Laboratory Data Table 1. Be sure to carefully rinse the urine hydrometer and jar thoroughly between each sample.
10. Repeat the procedure for samples Unknown A and Unknown B. Analyze the color, pH, glucose, protein, and specific gravity of these samples, and record the results in your Laboratory Data Table 1.

Prelab Questions

1. What are the normal results for urine tests in regards to:

a. color: **b.** pH: **c.** specific gravity: **d.** glucose: **e.** protein:

2. What test results would you expect from a person with diabetes mellitus?

a. color: **b.** pH: **c.** specific gravity: **d.** glucose: **e.** protein:

3. Using this hydrometer scale, mark and label the upper and lower boundaries of the normal range of the specific gravity of urine.

Laboratory Data Table 1

	Simulated Urine Samples				
Urine Test	**Low**	**Normal**	**High**	**Unknown A**	**Unknown B**
Color					
pH					
Specific Gravity					
Glucose					
Protein					

Conclusion Questions

1. Place an asterisk next to all abnormal results in the Laboratory Data Table 1. Using Table 1 and Table 2 of the Prelab, determine which disease(s), if any, may be indicated by the urine test results for Unknown A and Unknown B and why.
2. In a clinical setting, urine is often examined under a microscope. What information about a patient's health might be gained through this type of examination?
3. Clinical Application: What urinalysis results would you expect for someone being treated for a bacterial infection like strep throat, assuming he or she follows the doctor's orders? (Doctor's orders: amoxicillin, 2×/day; lots of bed rest; drink lots of fluids.) What is your reasoning for each factor? *Use Tables1 and 2 from the background page.

Factor	**Result**	**Reasoning**
Color		
pH		
Specific Gravity		
Glucose		
Protein		

4. Arthritis symptoms include swelling, pain, stiffness and decreased range of motion in joints. Anti-inflammatory drugs are used to help decrease inflammation/swelling of joints. As a pharmacist, what side effect warning might you give someone starting a new medication to treat the signs and symptoms of arthritis?
5. Can any of these urine tests definitively diagnose diabetes? Why or why not? If not, why would a doctor ever order a urinalysis?

	3	2	1
Prelab Questions	All prelab questions are answered correctly. There are no major errors.	Most prelab questions are answered correctly. There are no more than 3 major errors.	Few prelab questions are answered correctly. There are more than 3 major errors.
Data Table	Data is recorded thoroughly and accurately. There are no major errors.	Most data is recorded thoroughly and accurately. There are few major errors.	Little data is recorded thoroughly and accurately. There are many major errors.
Draw Conclusions	Conclusion is thorough. Specific evidence and reasoning are included. There are many thorough, thoughtful, and relevant reflections that communicate clinical applications.	Conclusion is general. Specific evidence/reasoning is limited. There are several thorough, thoughtful, and relevant reflections that communicate clinical applications.	Conclusion is incomplete. Specific data evidence/reasoning is not used. There are few thorough, thoughtful, and relevant reflections that communicate clinical applications.

Participation					
I often contributed good ideas that were relevant to the topic and task. I came to meetings prepared. I did my share of the work.	4	3	2	1	I seldom contributed good ideas. Sometimes I was talking off-task. I did not come to meetings prepared. I did not do my share of the work.
Working with Others					
I often compromised and cooperated. I did take initiative when needed and/or listened and respected the ideas of others.	4	3	2	1	I seldom compromised and cooperated. I did not take initiative when needed and/or did not listen and respect the ideas of others.
Product					
My part of the task is complete and accurate. My work was submitted on time.	4	3	2	1	I did not complete my part of the task. The information I presented was inaccurate and/or not done correctly. It was not completed on time.
Understanding Content					
I can speak about the topic and group work knowledgeably. I can sum-up the lesson.	4	3	2	1	I do not understand what I did in my group. I did not ask or answer questions. I cannot sum-up the lesson.