2022-2023

Interactive Science Notebook

St. Andrew's Episcopal School

5th Grade Science

Name _____

Block _____

About this Notebook

This Interactive Science Notebook (ISN) contains all of the content you are expected to learn throughout the year. Your ISN is split into several sections:

- The **Table of Contents** shows each page of the ISN organized by our four main topics and by left/right side pages. For easy reference and organization, the four main topics are the same as those on the class webpage and in our science portfolios.
- In the **Content and Practice** section, even pages (right pages) include the content you will be expected to learn. Odd pages (left pages) will be for your output, a chance for you to practice new skills. Each of the four main topics begin with the skills you are expected to learn for that topic. Those skills will be practiced and graded on every assignment in your portfolio. As you master skills, you can check them off on the skills checklist.
- The **References** section includes formulas and equations, basic lab safety rules, commonly-used lab equipment, and a page for you to add anything else you might need to reference.

Throughout the ISN, look for **QR Codes** that can be scanned with a phone or tablet camera for additional content such as practice, explanations, examples, and more. Those QR code links can also be found on the class webpage.

5th Grade Science Main Webpage

Some QR codes and links on our website lead to password-protected content. The **password** is as follows: gosaints

ISN Table of Contents

Left Side (OUTPUT)	Right Side (INPUT)
Practice, Review, Diagrams, Foldables, Notes, or Reflections	Notes, Vocabulary, Testable Information

The Scientific Method

Properties of Matter

Chemical Interactions

Characteristics of Living Things

References

Skill	Description
Use the Scientific Method	Perform and apply the steps of the scientific method in order to solve a problem or answer a question.
Sub-Skills	**Indicators**
List and Describe Steps of the Scientific Method	□ List and describe the appropriate steps for solving a problem or answering a question using the Scientific Method.
Make Observations and Inferences	□ 1. Distinguish between quantitative observations, qualitative observations, and inferences. □ 2. Write clearly stated observations of a picture, video or other observable thing.
Draw and Label Scientific Diagrams	□ Draw and label scientific diagrams of an observable thing.
Design Testable Questions	□ 1. Change a non-testable question into a testable question. □ 2. Design a testable question with an independent and dependent variable that can be answered by designing and conducting an experiment.
Compose Hypotheses	□ Write a logical hypothesis to answer a testable question using the if-then-because format.
Identify Standards and Variables in Experiments	□ 1. Identify the independent, dependent, and controlled variables in an experiment. □ 2. Describe the standard in a controlled experiment.

THE SCIENTIFIC METHOD

Sub-Skills	Indicators
Gather and Analyze Data using Tables, Graphs, and Charts	☐ 1. Identify the main components (title, x- and y- axes, legend, and the data) of charts and graphs. ☐ 2. Develop data tables, graphs, and charts to gather, analyze, and interpret data. ☐ 3. Use graphs to make predictions in controlled experiments.
Draw conclusions	☐ 1. Use data to construct reasonable explanations. ☐ 2. Determine whether an experiment supported, partially supported, or did not support the hypothesis.
Communicate results	☐ 1. Develop and communicate experiment summaries and explanations using evidence. ☐ 2. Identify and communicate problems and areas for improvement in experiments.

Galileo's Famous Experiment

Date _____

Directions: Illustrate Galileo's famous experiment at each step of the Scientific Method.

1. Question	**2. Hypothesis**
3. Experiment	**4. Analyze**
5. Conclusion	**6. Communicate**

The Scientific Method

Scientific Method Flocabulary Video

The **scientific method** is a series of steps designed to guide all scientific inquiry (Figure 1).

1. **Question**: Ask a question that can be answered by conducting an experiment. Your question comes from a pattern or something unexplainable emerging from your observations.

2. **Hypothesis**: an idea or theory that is based on some evidence but has not yet been proven

3. **Experiment**: a test or procedure done for the purpose of learning or proving something

4. **Analyze**: to study the data and observations carefully or in detail.

5. **Conclusion**: a judgment that you form after considering all the evidence

6. **Communicate**: explain your results and whether or not your hypothesis was supported

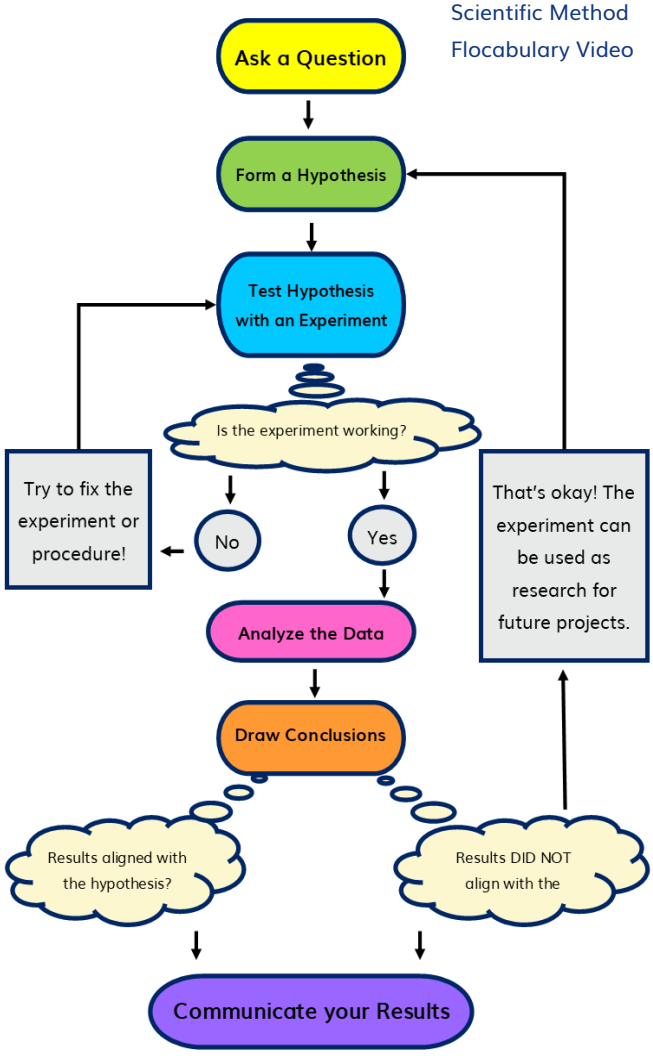


Figure 1: Scientific Method Flowchart.

Other Key Terms

Method: a way of doing something

Observe: to see, watch, notice, or measure closely

Support: to give evidence

Control: to incorporate a parallel experiment as a standard of comparison in a scientific study

Scientific Method Pear Deck

Date _____

YOUR CHOICE Activity

Directions: Make a drawing, comic, game, foldable, or some other activity that shows your understanding of observations and inferences.

Observation and Inference

Observation:

- basic information you get by seeing, feeling, hearing, tasting, smelling, or measuring
- the act of attentive watching, perceiving, or noticing using our 5 senses
- the data measured, collected, perceived or noticed, especially during an experiment

Obs. & Inf. Video

Inference:

- something you think is true based on observations
- a logical conclusion based on observations
- the 'story' or 'guess' about what happened or will happen

Observations can collect either qualitative or quantitative data (Figure 2).

Qualitative observations are observations made using your senses about qualities that can't be counted or measured, like color, flavor, texture, sound, etc.

Quantitative observations are observations made by counting or with tools. These observations are measurable, or quantifiable. Think "numbers".

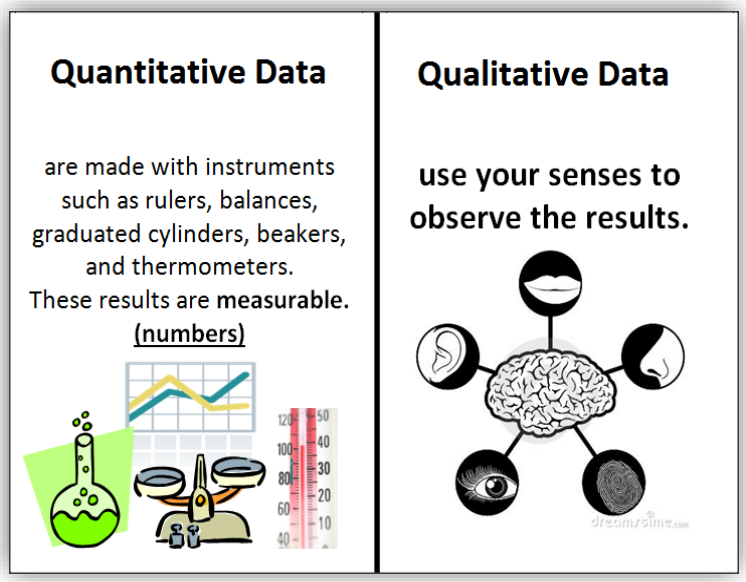


Figure 2: Data is the information gathered when making observations. Quantitative and qualitative data are compared in this figure.

Mystery Bag Observation

Date _____

Directions: For Observation 1, write a scientific observation paragraph based on senses OTHER than sight. Then, infer what the mystery item might be. For Observation 2, you'll remove the item from the bag and write a new observation adding what you can see and measure. Update your inference if you changed your mind.

Observation 1:

Observation 2:

Writing Scientific Observations

1. Keep it 3rd person - Avoid statements like “I observe,” “I see,” “I think”, “That’s why I believe…”, etc.
2. Include date, time, and location in your observation title
3. Use complete sentences and indent your paragraphs when possible.
4. Do a mental checklist of all your senses (What do you see? What do you hear? What do you smell? What can you taste? What do you feel?)
5. Consider what can be counted or measured.
6. If you have any figures or tables to support your observation, reference them directly in your text or include a reference to them in parentheses.

Example Observation:

Observation 1: June 27, 2022, 9:40am, Clinton, MS

The specimen (Figure 3) has a blue head with two eyes, an orange and green thorax 0.50 cm long, and an abdomen 2.35 cm long alternating blue, orange, and green colors. It has two clear, veined wings on each side of the body connected to the thorax. The wings are tipped with orange bars and are 3.25 cm long. They feel dusty. The abdomen has three appendages on the end. Two are 0.10 cm each and the third is between the others is 0.05 cm long. It has six legs. Based on my observations, I infer that the specimen is a dragonfly.

Figure 3: Insect, four wings with orange tips, blue elongated body.

Mystery Bag Diagram

Date _____

Directions: Return to the mystery box and remove the item. Using the rules for figures and diagrams, diagram the item from your mystery bag.

Figure 1:

Figures and Tables

A **figure** is a visual aid (drawings, pictures, graphs, diagrams, maps, or flow charts) used in scientific writing and presentations.

Tables organize lists of numbers or text in columns. Tables make writings easier to read by removing numeric or listed data from the text.

When making your own figures and tables, there are certain rules that must be followed:

For Figures and Tables:

- Figures and tables should be placed in your document in the order that they appear in your text, centered on the page, without text wrapping.
- Figure and table numbers should be referenced in your text.

For Figures Only:

- Figure numbers and descriptive captions should be left aligned below the figure.
- Figure captions need to be complete sentences with a period at the end.

For Tables Only:

- Table numbers and descriptive captions should be left aligned above the table.
- Table captions should be capitalized using Title Case.
- Tables should have labeled columns describing the data and including units.

Diagrams are a type of figure. They are drawings used to show the appearance, structure, or workings of something. Figure 4 shows a sample diagram.

They must follow all rules for figures while also following their own rules:

- Use neat and clear single-line drawing (no sketching or shading).
- Use labels with straight lines (not crossed).
- Add a scale to show the actual size of what you are observing.

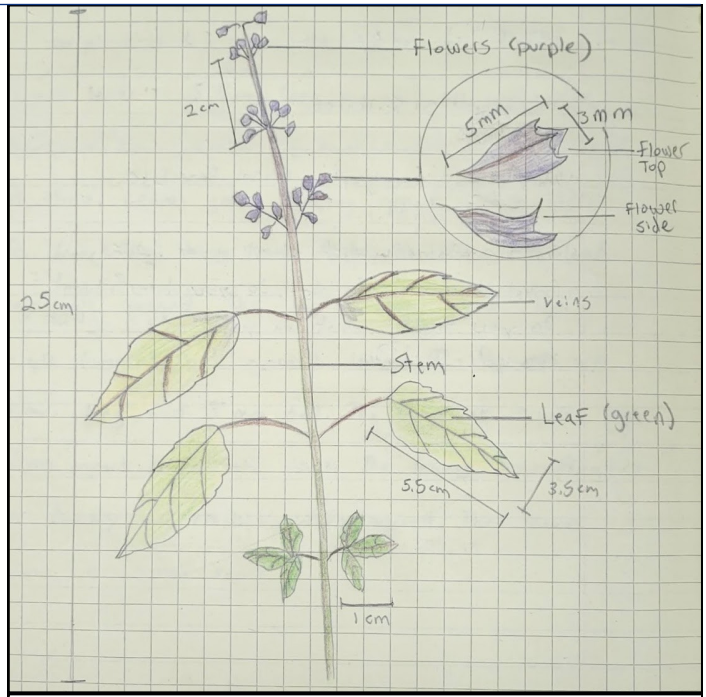
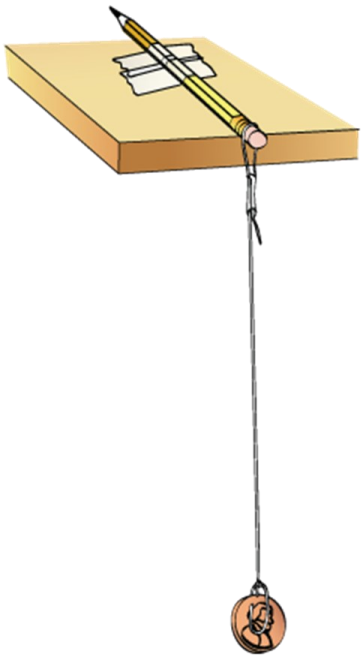


Figure 4: This plant found in the St. Andrew's Middle School courtyard has two different leaf arrangements and small purple flower clusters.

Swingers Summary

Date _____

Directions: Complete this summary of our pendulum experiment.



Name the five parts that made up our pendulum system:

_____

_____

Describe the standard pendulum system:

Length of the string: _____

Mass of the bob: _____

Angle of release: _____

Number of cycles in 15 seconds: _____

For the following questions, base your answers on the experiment we graphed:

What was the independent variable in the experiment?_____

What was the dependent variable in the experiment?_____

What variables were controlled in the experiment? _____

_____

Look at your graph. What is the relationship between the independent and dependent variables in this experiment? _____

_____

_____

_____

Systems, Variables, and Controlled Experiments

System: A set of objects that is working together. You often study the parts of a system one at a time to find out how they affect the whole system. We are investigating 4 systems: pendulums, boats, planes, and catapults.

Variable: A factor or condition that can change and might affect the outcome of an experiment.

Controlled experiment: An experiment in which one, and only one, variable is changed in order to assess its effect. A controlled experiment involves several investigations:

- First, you establish a standard system and observe its behavior.
- Then, you change just one variable (the independent variable) in the system, making sure all the others stay exactly the same (controlled) as they were in the standard system. In this way, when the outcomes are compared, any change in the outcome (the dependent variable) can be attributed to the variable that was changed.

Standard: The basic procedure used in a controlled experiment before changing any of the variables. It can also be thought of as the basic unmodified or unchanged system being investigated in an experiment.

Independent Variable: The variable that changes or is being tested in an experiment. It's the variable you know before the experiment begins.

Dependent Variable: The variable you observe or measure to determine if the independent variable had an effect. It's what you are trying to figure out.

Controlled Variables, or Controls/Constants: Variables you keep the same in an experiment. They do not change. A controlled experiment will have one independent variable, one dependent variable, and all other variables should be controlled, or remain unchanged.

Graphing Data Sets

Date _____

Directions: Graph both tables making sure you follow all the graphing rules.

Table 1: Mrs. Bernhardt Run Distance over Time

Time (seconds)	Distance Traveled (m)
0	0
1	10
2	22
3	28
4	40

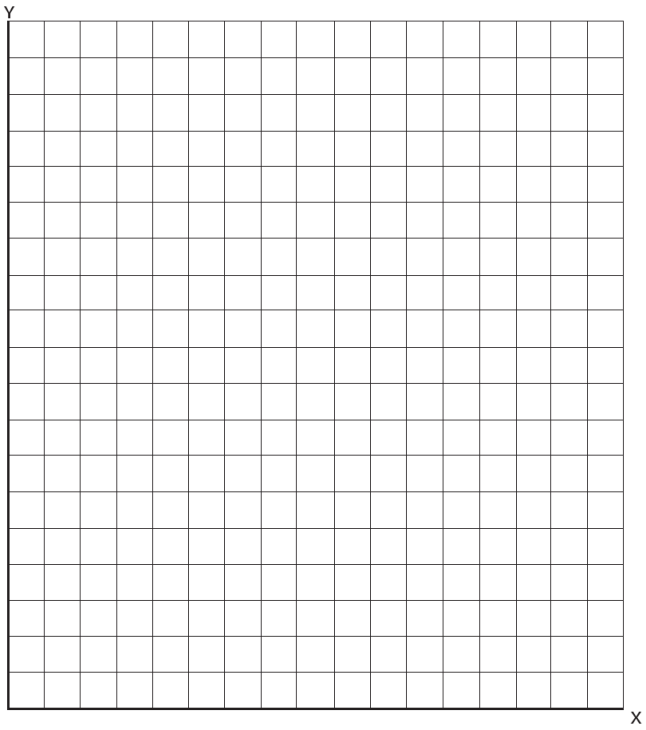
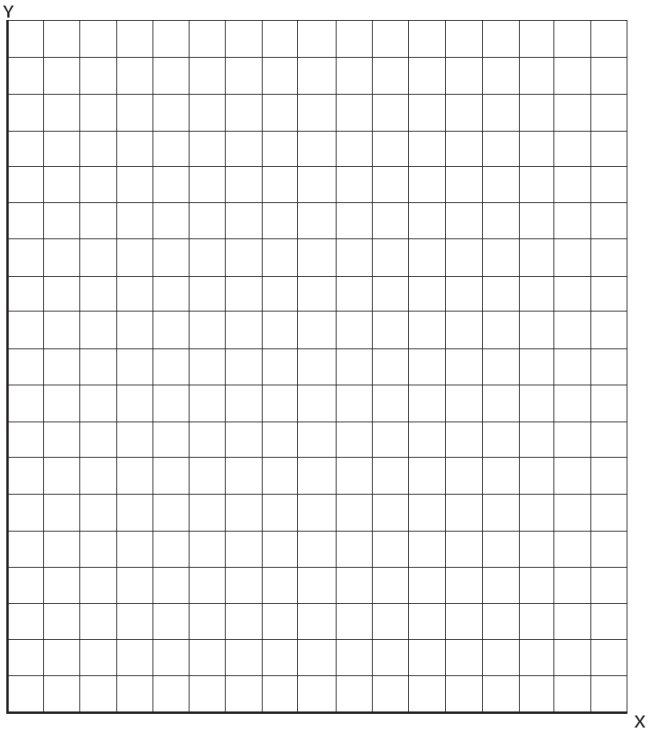


Table 2: Average Height of Girls by Age

Age (years)	Height (Inches)
1	30
2	33
3	37
4	39
6	45
8	51
10	55
12	59
14	63
16	64



Scatter Plot Graphs

A **Scatter Plot Graph** is a type of figure that shows the outcome of a series of experiments when a variable is changed by steps, or increments. It displays the relationship between an experimental variable (the independent variable) and an outcome (the dependent variable). Table 1 and Figure 5 show an example data set and graph. There are four rules to follow when creating your graph:

How to Graph Scatter Plots Sample Video

1. **Axes labels and direction:** Ensure you have put your graph the right way around. Your x axis should always show the independent variable labeled with units. Your y axis should always plot the dependent variable labeled with units. Number your graph using evenly spaced increments beginning with the origin, 0.

2. **Plotting:** Plot your data carefully, marking your data points with a small dot.

3. **Show the Trend:** Do not play dot-to-dot. Only very rarely are data points connected in this way. More often, we are seeking the trend or pattern that our results show, for that we need a **LINE OF BEST FIT.** These lines pass through or near as many data points as possible. They can either be straight lines or a smooth curve. Look for the pattern to decide which is most appropriate.

4. **Title:** Give your graph a descriptive title that shows what you are comparing. Reminder: Though table titles go above the table, the title for figures like graphs goes below the graph with the figure number.

Common mistakes and how to avoid them:

- Thou shalt draw your graph in **pencil** with a **ruler**.
- Thou shalt **label your axes**.
- Thou shalt **always give units**.
- Thou shalt **not play dot-to-dot** with thy data points!

Table 1: Traffic Ticket Cost at Different Automobile Speeds over Limit

Amount over Speed Limit (mph)	Average Cost of Speeding Ticket (dollars)
5	50
10	100
15	130
20	175

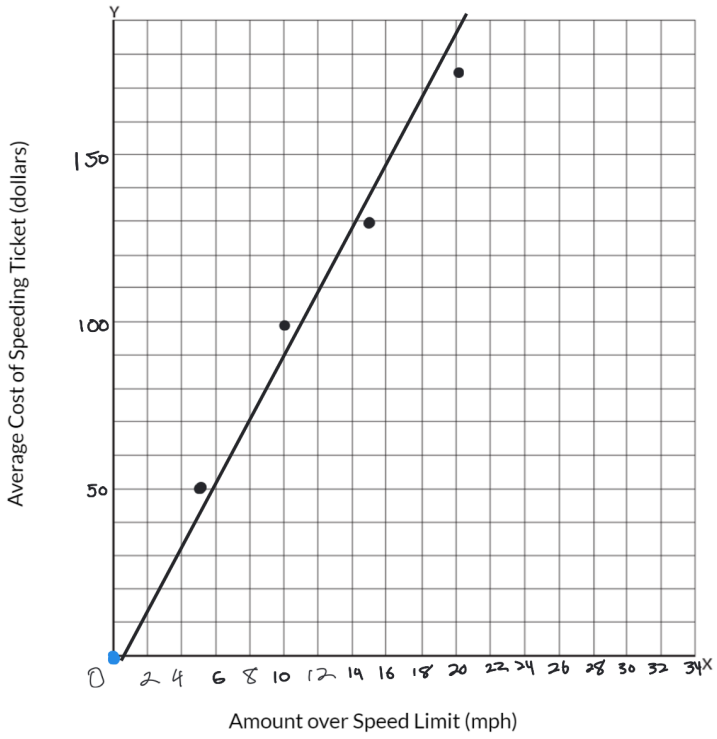


Figure 5: As the amount over the speed limit increases, the average cost of speeding tickets also increases.

Skill	Description
Measure and Calculate Properties of Matter	Use mathematics and measurement tools to determine length, area, volume, mass, and density of solid and liquid matter accurately and precisely.
Sub-Skills	**Indicators**
Model Place Value	□ Describe and model whole numbers, tenths, hundredths, and thousandths place values.
Convert Metric Measurements of Length, Mass, and Volume	□ 1. Determine the correct base units in the metric system for measuring length, mass, and volume. □ 2. Convert and scale metric measurements using the acronym KHDUDCM.
Measure Precisely and Accurately	□ 1. Determine exact vs. inexact, or approximate, measurements □ 2. Determine the number of significant figures in an measurement □ 3. Measure length, mass, and volume to the correct number of significant figures □ 4. Add, subtract, multiply, and divide measurements by rounding to the correct number of significant figures
Measure Length	□ 1. Describe or model the approximate magnitude of a kilometer, meter, centimeter, and millimeter □ 2. Use a ruler to measure length in centimeters and millimeters of any observable solid object. □ 3. Use a ruler and mathematical formulas to measure area in square centimeters.

PROPERTIES OF MATTER

Sub-Skills	Indicators
Measure Mass	□ 1. Describe or model the approximate magnitude and use of a gram and a kilogram. □ 2. Adjust and zero Triple-Beam Balances and Two-Pan Balances □ 3. Measure mass of solid matter in grams using triple-beam and two-pan balances □ 4. Measure mass of liquid matter in grams using triple-beam and two-pan balances, beakers, and the formula $m = m_{container\ and\ liquid} - m_{container}$
Measure Volume	□ 1. Describe or model the approximate magnitude and use of a liter, milliliter, and cubic centimeter. □ 2. Determine the best method and tools for finding the volume of solid or liquid matter □ 3. Measure volume of liquids in milliliters using graduated cylinders and beakers while accurately reading the meniscus. □ 4. Measure volume of rectangular prisms in cubic centimeters using rulers and the formula $v = l \times w \times h$ □ 5. Measure the volume in cubic centimeters of irregular solids using Archimedes' principle and the formula $v = v_f - v_i$ □ 6. 4. Use the correct units for volume in all measurements.
Calculate Density	□ 1. Calculate the density of matter using the formulate $d = m \div v$ □ 2. Demonstrate how density affects buoyancy

States of H_2O Date _____

Directions: Give the common names for H_2O in solid, liquid, and gaseous states. Then, using text and images for each of the different states of H_2O, describe as many properties (observations and unique uses and characteristics) you can think of and research!

Solid H_2O

Common Name: _____

Liquid H_2O

Common Name: _____

Gaseous H_2O

Common Name: _____

States of Matter

Figure 1: Solids, Liquids, and Gasses have different properties that affect flexibility, shape, volume, and compressibility.

Matter is anything that takes up space (has volume) and has mass. There are four basic **states of matter:** solid, liquid, gas, and plasma (Figures 1 and 2).

1. A **solid** has a definite shape and volume because the molecules that make up the solid are packed closely together and move slowly. Solids are often crystalline; examples of crystalline solids include table salt, sugar, diamonds, and many other minerals. Solids are sometimes formed when liquids or gases are cooled; ice is an example of a cooled liquid which has become solid. Other examples of solids include wood, metal, and rock at room temperature.

2. A **liquid** has a definite volume but takes the shape of its container. Examples of liquids include water and oil. Gases may liquefy when they cool, as is the case with water vapor. This occurs as the molecules in the gas slow down and lose energy. Solids may liquefy when they heat up; molten lava is an example of solid rock which has liquefied as a result of intense heat.

3. A **gas** has neither a definite volume nor a definite shape. Some gases can be seen and felt, while others are intangible for human beings. Examples of gases are air, oxygen, and helium. Earth's atmosphere is made up of gases including nitrogen, oxygen, and carbon dioxide.

4. **Plasma** has neither a definite volume nor a definite shape. Plasma often is seen in ionized gases, but it is distinct from a gas because it possesses unique properties. Free electrical charges (not bound to atoms or ions) cause the plasma to be electrically conductive. The plasma may be formed by heating and ionizing a gas. Examples of plasma include stars, lightning, fluorescent lights, and neon signs.

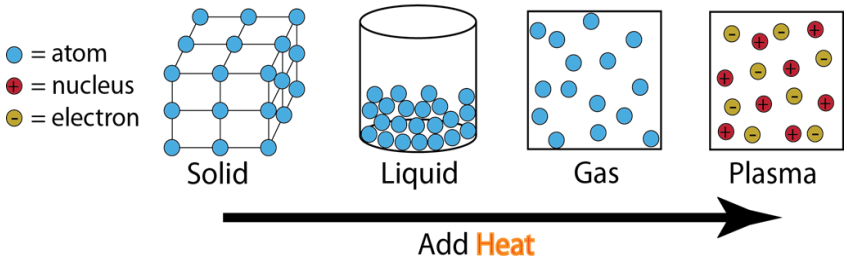


Figure 2: Heat must be added for matter to change phases.

Quantitative Properties of Matter Date _____

Directions: For each of the quantitative properties of matter, describe or illustrate a situation in which you might need to know it and how you would measure it. In the fifth box, list a new quantitative property of your choice and follow the same instructions.

1. **Weight:**

2. **Length**

3. **Area**

4. **Temperature**

5. _____

Properties of Matter

Substances are types of matter defined by a unique particle. A **particle** is the smallest piece of a substance that is still that substance (Figure 3).

Matter is made up of tiny particles called atoms (Figure 4). Matter must display both the mass and volume properties.

Different substances have different **properties**, or characteristics, that make them unique from other types of matter.

Figure 3: A particle of the substance water is one water molecule, H2O.

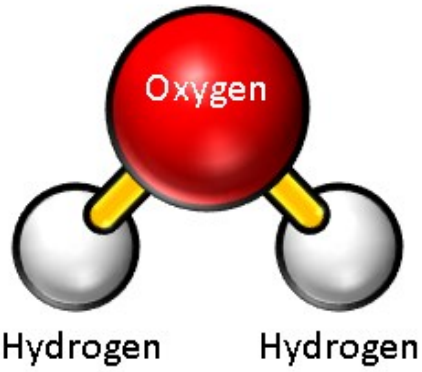


Figure 4: A molecule of water can be broken into an even smaller particles, hydrogen and oxygen atoms, but they no longer will retain the properties of water.

Table 1: Physical and Chemical Properties of Matter

Physical Properties	Chemical Properties
Color	Flammability
Texture	Toxicity
Odor	Ability to Rust
Temperature	Reacts with Acid
Conducts Heat	...AND MORE
Conducts Electricity	
Magnetic	
Boiling Point	
Melting Point	
State	
Mass	
Volume	
Density	

Like observations, properties can be quantitative or qualitative.

- **Quantitative properties** come from our quantitative observations. They are properties of matter that can be measured our counted!
- **Qualitative properties** come from our qualitative observations. They are properties of matter that can be observed but not measured!

Properties can also be physical or chemical (Table 1).

- **Physical properties** can be observed, measured, or changed without changing the substance itself.
- **Chemical properties** can be measured or observed only when matter undergoes a change to become an entirely different substance.

Describe That Decimal

Date _____

Directions: Pick one of the following decimals for the box "Write your decimal here."

Then, describe the decimal in detail by completing the page.

2.750 1.620 3.060 2.190 1.530

Example Page

Write a smaller decimal: <	Write your decimal here:	Write a larger decimal: <

Represent the decimal using a visual model:

Add your decimal to the place value chart:

Tens	Ones	•	Tenths	Hundredths	thousandths

Multiply by:

10 -

100 -

1,000 -

Divide by:

10 -

100 -

Round to the nearest:

Whole number -

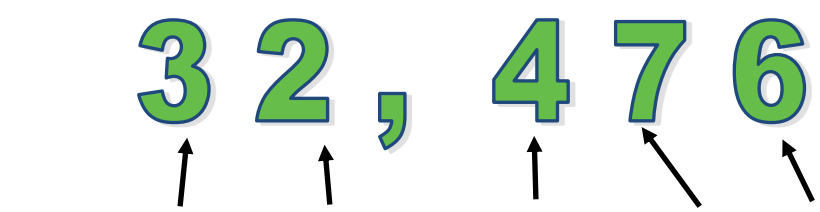
Tenth -

Write the decimal in expanded notation:

Place Value

Each digit in a number has a place value

The value of a digit depends on it's place, or position, in the number

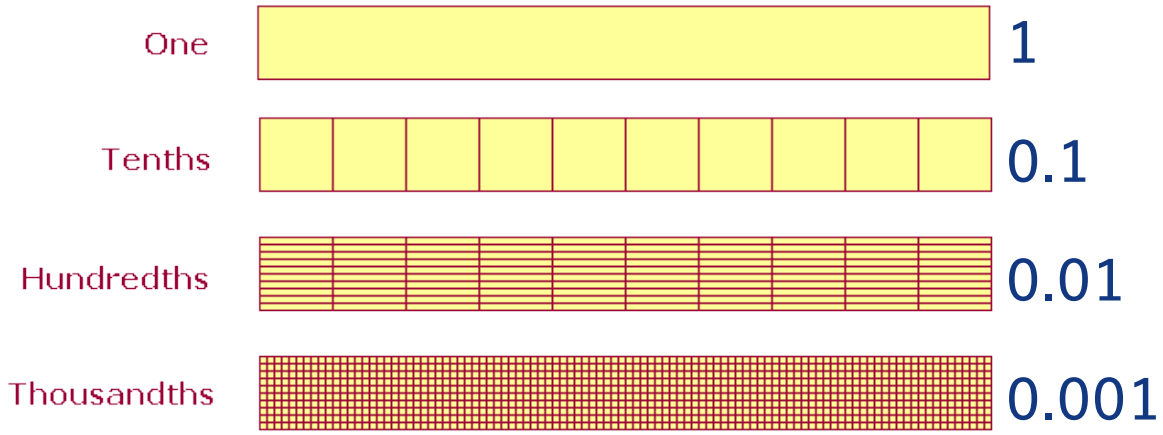


Decimals
BrainPOP Lesson

Decimal Place Value

Decimals name wholes and parts of a whole based on multiples of 10 (Figure 5).

Numbers can only have one decimal point. Digits to the left of the decimal point are whole numbers, and digits to the right represent parts a whole (Table 2).



- **Figure 5:** The further a digit is to the right of a decimal point, the smaller the place value is by 10.

Table 2: Place Value Location Examples

Tens	Ones	.	Tenths	Hundredths	Thousandths
2	1	.	2		
	5	.	4	1	
	2	.	0	6	5

Pick Ten Conversion

Date _____

Directions: Choose and complete 10 of the 16 conversions on your own for homework. Show your work. Correct yours and complete the remaining 6 as we check them in class.

1) 52.174 cm = _____ mm	2) 81.66 m = _____ cm
3) 93.6 cm = _____ dm	4) 416.8 hm = _____ km
5) 28 dm = _____ m	6) 55.7 m = _____ dkm
7) 38.68 dm = _____ mm	8) 8.94 km = _____ hm
9) 68.20 dkm = _____ dm	10) 7150 cm = _____ m
11) 19.8 m = _____ dm	12) 880 dkm = _____ hm
13) 63.71 km = _____ dkm	14) 42.33 hm = _____ m
15) 90.9 dm = _____ m	16) 17550 m = _____ km

Metric Units and Conversion

Scientists can observe countless properties of matter, and with many of them, they use **base units** that can be scaled larger and smaller in the metric system (Table 3).

Table 3: Base Units of Measurement in the Metric System

Base Units of measurements	Abbreviation	What it Measures
Meter	m	Length
Gram	g	Mass
Liter	L	Volume of liquids

Unit prefixes are used to scale the base units of measurements larger or smaller in multiples of 10. In Table 4, the unit abbreviations in orange are the most commonly used measurements of length, volume, and mass.

Table 4: Metric Unit Prefixes, Values, and Abbreviations

Prefixes	Value	Abbreviation	Length	Volume	Mass
Kilo-	1000 units	k-	km	kL	kg
Hecto-	100 units	h-	hm	hL	hg
Deka-	10 units	dk-	dkm	dkL	dkg
no prefix, base unit	1 unit		m	L	g
Deci-	0.1 units	d-	dm	dL	dg
Centi-	0.01 units	c-	cm	cL	cg
Milli-	0.001 units	m-	mm	mL	mg

Converting

When you add, subtract, multiply, or divide measurements that have different prefixes, you must convert them to have the same prefix. To convert, I prefer to use the acronym King Henry Doesn't Usually Drink Chocolate Milk! KHDUDCM is an easy way to remember the order of the prefixes by value (Figure 6)! Just follow these four steps:

Sample Problem

1. Add a decimal if one's not already present.
2. Determine starting point (what you already know) and end point (what you need to figure out) and move place values on chart.
3. Move the decimal in your measurement the same way, and place zeros above any place value where there isn't already a digit.
4. If you added zeros to the right of the measurement, remove the decimal (start and end with same number of sigfigs). Add unit.

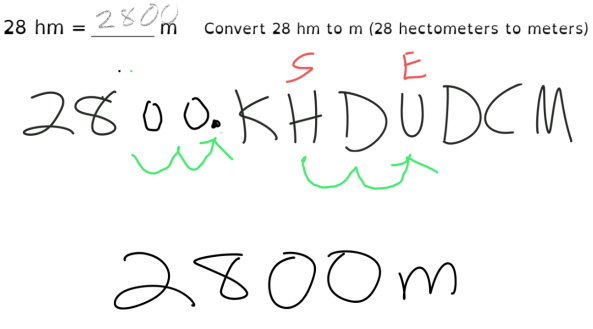


Figure 6: 28 hectometers is equal in length to 2800 meters.

Length and Area

Date _____

Directions: For part 1, measure the length of each line to the nearest tenth of a centimeter or to the nearest millimeter. For part 2, find the area of each figure to the nearest tenth of a square centimeter. You may use a calculator. Show any work.

Part 1: Length

1. _____  cm

2. _____  mm

3. _____  mm

4. _____  cm

5. _____  cm

6. _____  mm

7. _____  cm

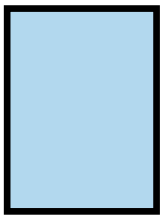
8. _____  mm

Part 2: Area

1. _____ cm^2

3. _____ cm^2

2. _____ cm^2



4. _____ cm^2

Ruler Rules

Rulers are used to measure Length, Area, and sometimes Volume.

- **Length** is a one-dimensional measurement of the distance from one end to the other of an object.
- **Area** is a two-dimensional measurement of the space occupied by a 2D figure, a flat shape, or the surface of an object. $Area = length\ x\ width$

There are two sides to most rulers—the Imperial and Metric sides (Figure 7).

1. In the **Imperial System**, length is measured in miles, yards, inches, and feet.
2. In the **Metric system**, length is measured in kilometers, meters, centimeters, and millimeters.

In science, we will always use the **Metric system** and measure lengths using the metric side of rulers and meter sticks. Begin your length measurements at the zero mark (Figure 8). Measure length in **centimeter** graduations and **millimeter** sub-graduations (Figure 9).

Abbreviations: Centimeters is abbreviated cm and millimeters is abbreviated mm.

How to Use a Ruler

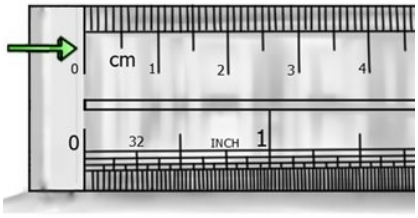


Figure 8: A ruler begins measuring away from the edge, at the zero mark.

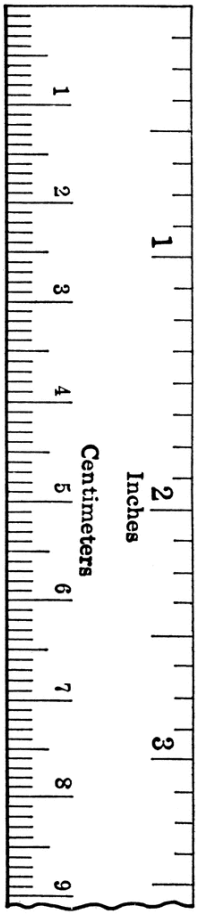


Figure 7: Rulers often have inches on one side and centimeters on the other.

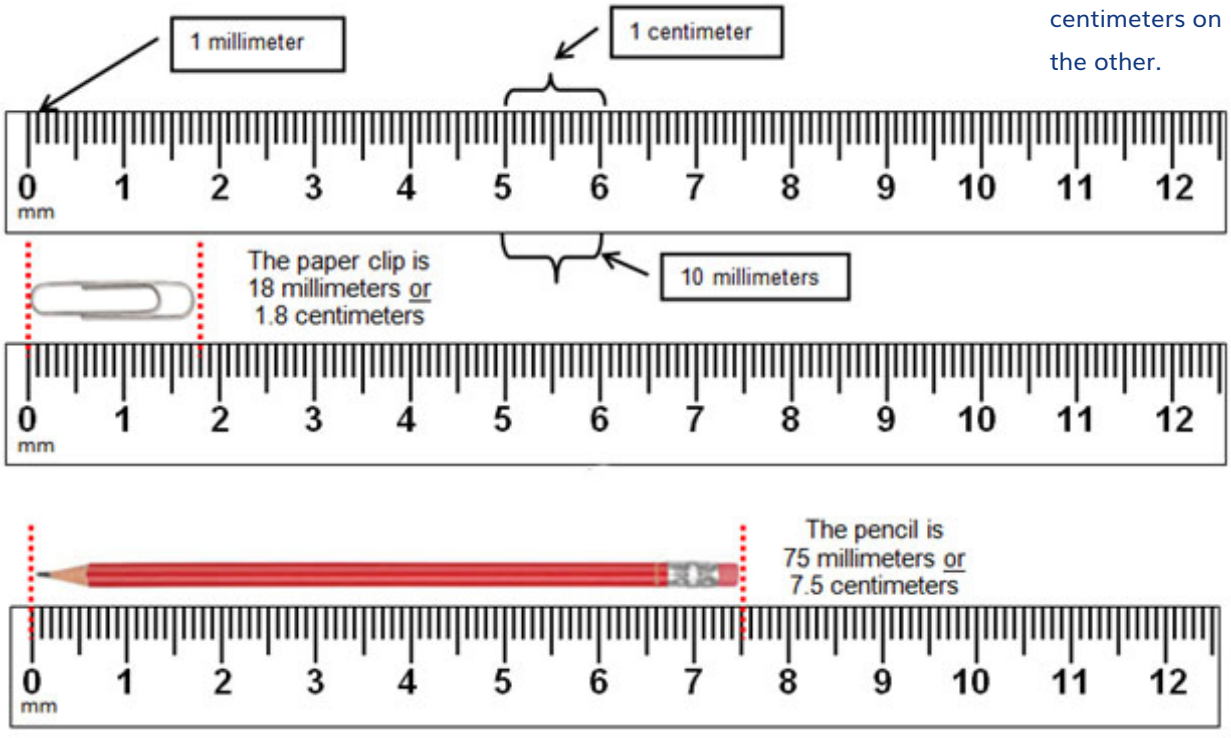


Figure 9: The first ruler shows that there are 10 millimeters in each centimeter. The second and third rulers show sample measurements of a paperclip and a pencil in both centimeters and millimeters.

YOUR CHOICE Activity

Date _____

Directions: Make a drawing, comic, game, foldable, or some other activity that shows your understanding of the concepts Exact, Inexact, Accuracy, and Precision.

Exact Numbers and Inexact Measurements

There are two sides kinds of measurements in the world— Exact and Inexact. **Exact** numbers are explored most in math, while scientists mostly work with **inexact** measurements.

1. **Exact** numbers are counts or defined numbers. Example: There are 12 eggs in a dozen, five fingers on a hand, 21 students in the classroom, 12 inches in a foot, and 24 hours in a day. Exact numbers can also be fractions, such as 1/2 is exactly 0.50 with infinite sigfigs.
2. **Inexact** numbers are measurements. Example: If I quickly estimate the width of notebook paper, I might get 20 cm. If I use a more precise measuring tool, like a ruler, I'll find the measurement is closer to 22 cm. If I am really precise, I might notice it's not quite 22 cm, but instead closer to 21.6 cm, and so on.

Accuracy and Precision

When measuring, it's important to be both accurate and precise (Figures 10 and 11)

Accuracy is how close a measurement is to the true or actual value of what's being measured. It's about being correct!

Precision refers to how close inexact measurements of the same item are to each other or how specific measurements are.

- Does the measurement have more decimal points? It's more precise (Table 5).
- Are a group of measurements close in range to each other? They are more precise.

Accuracy and Precision Video

Table 5: Low to High Precision Measurements

Less Precise	→	More Precise
10 m	10.5 m	10.56 m
12 m	9.8 m	10.52 m
9 m	10.3 m	10.55 m

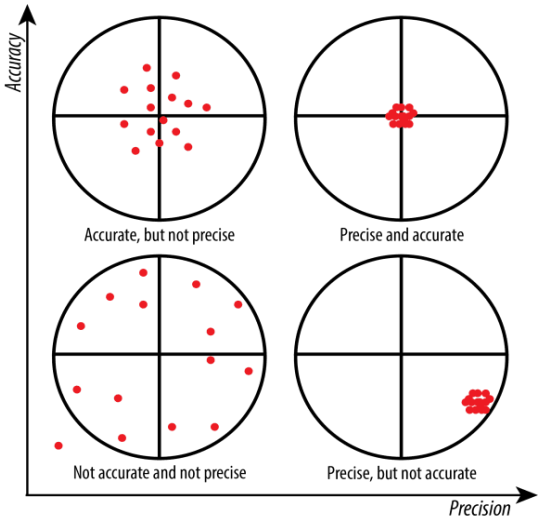


Figure 10: From left to right, precision increases. From bottom to top, accuracy increases.

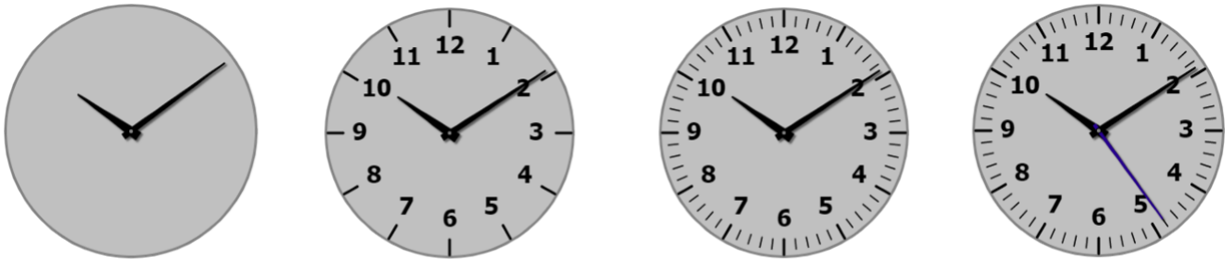
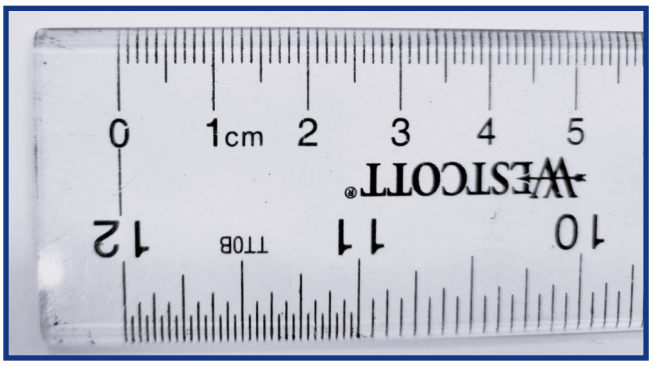


Figure 11: All of these clocks are equally accurate, but the precision increases from left to right.

Measuring with Significance!

Date _____

Directions: Use the ruler and measurement images to answer the questions.



1. What is the smallest increment (in centimeters) that can be precisely and accurately measured using the ruler on the left

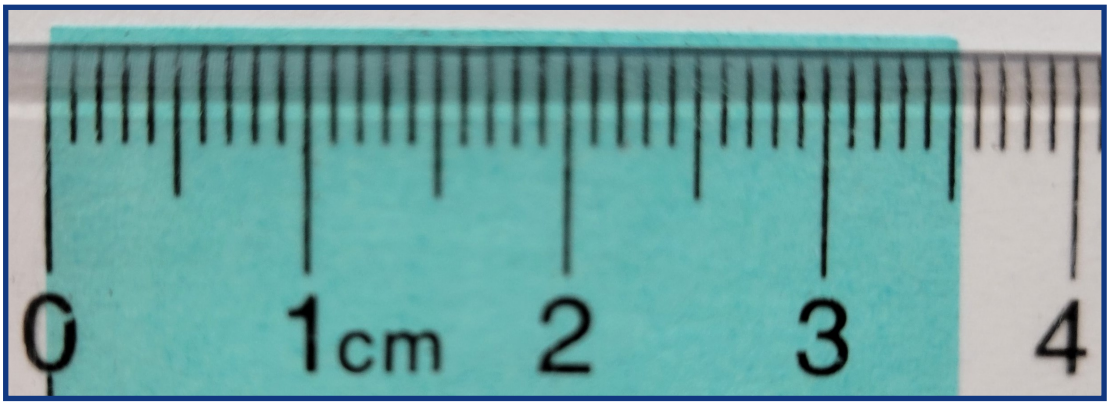
   _____

2. How could you measure a length that is between two of the smallest tick marks?

_____

_____

_____



3. Notice that the sticky note's length is between tick marks.

   A. How long is it at least, in centimeters? _____

   B. How long is just a bit too much? _____

   C. When measurements land between tick marks, you must estimate one additional digit. From 0 (exactly on the left tick mark) to 10 (exactly on the right tick mark), how far between tick marks does it look like the measurement goes? _____

   D. What is the length of the sticky note? Write the estimated digit in a different color than the certain digits. _____

Significant Figures

Significant figures are certain digits that have significance or meaning and give more precise details about the value of the number.

Significant figures include all the nonzero digits of a number and the zeros that are included between them. They also include final zeros that signify precision of measurement.

Measuring with Sigfigs Video

In any measurement, the number of significant figures is the number of digits believed to be correct by the person doing the measuring. It includes one estimated digit. It concerns precision only, not accuracy.

There are specific rules that must be followed to determine the precision, or number of sigfigs, in any measurement (Table 6).

Table 6: Rules for SigFigs

Rule	Example
1. Every **non-zero** digit is significant. Note: Remember that non-zero digits are numbers other than zero, numbers 1-9. Anywhere you see a digit that is not zero, count it; it is significant.	316 has 3 sigfigs
2. **Zeros in between non-zero digits** are significant	6.003 has 4 sigfigs
3. **Leading zeros** are NOT significant Note: Leading zeros are zeros before non-zero digits. That means if a number begins with zero, as with some decimals, they are not significant.	0.00035 has 2 sigfigs
4. **Trailing zeros** are ONLY significant in numbers with decimal points Note: Trailing zeros are zeros that appear behind non-zero digits. Trailing zeros are only significant when there is a decimal point in the number. No decimal point? Not significant.	35,000 has 2 sigfigs 35,000. has 5 sigfigs 0.03500 has 4 sigfigs
5. **Exact, or defined, numbers** have infinite sigfigs.	The speed of light is 299792458 m/s There are 100 cm in 1 m

SigFigs Rounding

Date _____

Directions: Complete the following problems using all significant figures rules. You may use a calculator and scratch paper. Show units in your answers.

How many significant figures do the following measurements have?

1. 1234 m _____
2. 0.023 L _____
3. 890 kg _____
4. 91010 m _____
5. 9010.0 cm _____
6. 1090.0010 g _____
7. 0.00120 km _____
8. 0.00030 hL _____
9. 1020010 mg _____
10. 780. cm _____
11. 1000 mm _____
12. 0.0001 kg _____

Perform the following calculations and round according to the rounding rules for addition and subtraction.

1. 8.2 mm + 2 mm = _____
2. 53.4028 g - 14 g = _____
3. 42.828 L + 67.4629 L = _____
4. 13.59 m + 23.25 m = _____
5. 39.3 cm - 0.804 cm = _____
6. 91.68 mL - 19.1 mL = _____

Perform the following calculations and round according to the rounding rules for multiplication and division. Division can be represented by either / or ÷ .

1. 7.6 g x 21.9 = _____
2. 38 L ÷ 7 = _____
3. 450 m / 114 s = _____
4. 2.15 cm x 100 = _____
5. 500,000 g / 5.002 = _____
6. 84 m x 31.221 s = _____

Rounding Rules

When **adding or subtracting**, round your answer to the fewest number of decimal places.

Example: Add 10.1 cm and 7.43 cm to find the total length of two measurements.

Chemquiz Sigfigs Practice

- 10.1 cm has one decimal place
- 7.43 cm has two decimal places
- 10.1 cm is the length with fewest decimal places, so when you calculate the answer, round your answer to one decimal place.
  - 10.1 cm + 7.43 cm = 17.53 cm. Round to one decimal place.

The combined length of the measurements to the correct number of significant figures is 17.5 cm

When **multiplying or dividing**, round your answer to the fewest number of significant figures.

Example: Multiply 4.93 cm by 6.027 cm to find the area of a rectangle.

- 4.93 cm has three significant figures.
- 6.027 cm has four significant figures.
- 4.93 cm is the length with fewest significant figures, so when you calculate the answer, round your answer to three significant figures.
  - 4.93 cm x 6.027 cm = 29.71311 cm^2. Round to three significant figures

The area of the rectangle to the correct number of significant figures is 29.7 cm^2

Weight on Other Worlds

Date _____

Directions: Answer the following questions and complete the table to figure out your weight on other celestial bodies! Show all units and follow SigFig rules. You may use Table 7 and a calculator. Check your work using the Weight on Other Worlds website.

1. What is your weight in pounds? _____

2. What equation should you use to calculate _____

3. What is your mass in kilograms? _____

Celestial Body	Mass (kg)	×	Gravity (m/s^2)	=	Weight (N)	×	0.225 lb/N	=	Weight (lb)
 Moon		×		=		×	0.225 lb/N	=	
 Jupiter		×		=		×	0.225 lb/N	=	
 Sun		×		=		×	0.225 lb/N	=	
 Pluto		×		=		×	0.225 lb/N	=	
 Venus		×		=		×	0.225 lb/N	=	

Mass and Weight

Mass is the measure of the amount of matter something has. It's the property that causes something to have weight. It's measured in grams (g) but of course can be scaled larger or smaller by adding prefixes (like kilogram and milligram). Mass isn't affected by gravity. It can be measured using balances (Figure 12).

Balance Notes:

- The balance must be zeroed, or tared, before measuring using the tare knob.
- Riders must lock into notches if present.
- Move the largest riders first.
- The pointer should swing equally along the "zero" marking.

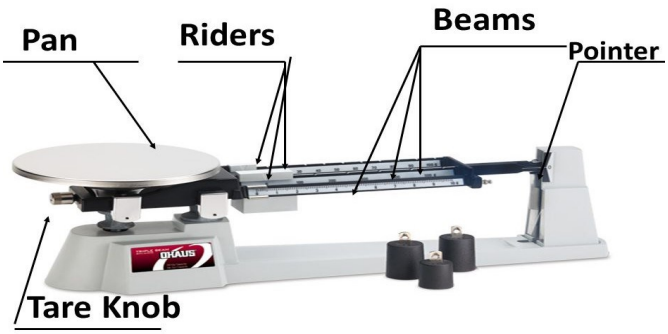


Figure 12: These are the main parts you must learn to use to measure mass with a triple-beam balance.

Mass Unit: gram, abbreviated g

- **Weight** is the measure of the amount of force acting on an object's mass due to gravity. It's commonly measured in Newtons (N), pounds (lb), and ounces (oz).

Because weight depends on gravity, the weight of an object will change if the gravitational force changes (like on another planet or in a vacuum). On earth, gravity is constant and 1 kg of mass weighs around 2.2 lbs. You can use those facts to convert between Kilograms and Pounds:

$$Mass(kg) = Weight(lb) \div 2.2\ {}^{lb}/_{kg} \quad \text{or} \quad Weight(lb) = mass(kg)\ x\ 2.2\ {}^{lb}/_{kg}$$

A **Newton** is a unit of force, or weight, that will accelerate one kilogram of mass one meter per second squared. It's the scientific standard of weight measurement. 1 N converts to around 0.225 lb, and 1 lb converts to around 4.448 N. We can use those values to convert between Newtons and Pounds:

$$Weight(N) = Weight(lb)\ x\ 4.488\ {}^{N}/_{lb} \quad \text{or} \quad Weight(lb) = Weight(N)\ x\ 0.225\ {}^{lb}/_{N}$$

In 1686, Sir Isaac newton developed three laws of motion, and the second law on force can be used to calculate weight. **Newton's second law** states "The acceleration of an object depends on the mass of the object and the amount of force applied." In equation form, it looks like this:

$$Force(N) = mass(kg)\ x\ accelearation({}^{m}/_{s})$$

In this statement, we can consider acceleration to be the acceleration of gravity, and force to be weight. We can rewrite the equation as:

$$Weight\ (N) = mass\ (kg)\ x\ gravity\ ({}^{m}/_{s})$$

Table 7: Acceleration of Gravity in Different Environments in m/s^2

Earth: 9.81 m/s^2	Moon: 1.62 m/s^2	Mars: 3.72 m/s^2	Vacuum: 0 m/s^2
Jupiter: 24.8 m/s^2	Sun: 274 m/s^2	Venus: 8.87 m/s^2	Pluto: 0.62 m/s^2

Weight on Other Worlds

Volume Variations

Date _____

Directions: At each station, describe that matter type and estimate the volume of space that the following objects or substances take up. Finally, find the actual volumes. If math is necessary to find the volume, show all of your work in the box for actual volume. Include the correct units on all measurements.

Object or Substance	**Description of Matter** liquid, rectangular prism, or irregular solid	**Estimated Volume**	**Actual Volume** show work if math is necessary to find the volume

Volume

Volume is the amount of three-dimensional space something occupies. It's measured different ways depending on the object or substance you are measuring.

The **units for measuring volume** are different depending on the state of matter you are measuring, cm^3 for solids and mL for liquids, and either one for gasses! 1 mL = 1 cm^3

Liquids are poured into precise measurement containers such as graduated cylinders. Then the volume can be read using the graduations and sub-graduations on the measurement tool (Figure 13).

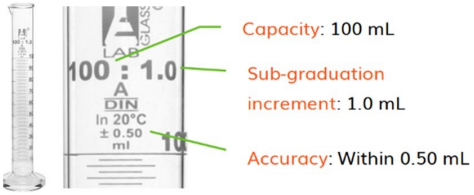


Figure 13: Graduated Cylinders are the best tool for measuring volume of liquids. They are precise and accurate! Read the top to determine if it's the best graduated cylinder for your needs.

A **meniscus** is the curved surface at the top of a column of liquid. When water is in a thin glass tube, it does not have a flat surface at the top. Instead, the top is convex (curved inward), making it necessary to read the volume at eye level at the bottom of the curve (Figure 14).

Volume Unit for Liquids: milliliter, abbreviated mL

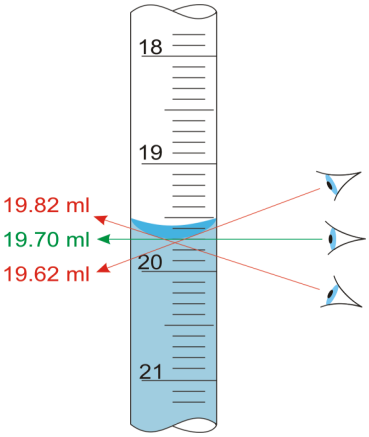


Figure 14: The volume should be read from the bottom of the meniscus.

Regular solids are objects that are geometrically shaped whose volume can be calculated using measurements of length and equations. Regular solids include cylinders, spheres, cones, pyramids, triangular prisms, and rectangular prisms.

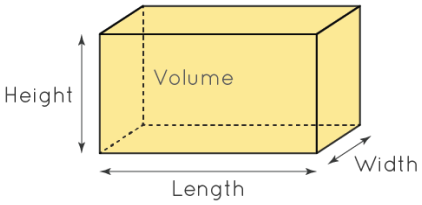


Figure 15: Length, Width, and Height are all unique measurements of a rectangular prism.

Rectangular Prisms are a type of regular solid (Figure 15). The volume of a rectangular prism is calculated using this equation:

$$Volume = length\ x\ width\ x\ height$$

Volume Unit for Solids: cubic centimeters, abbreviated cm^3

Irregular Solids are solid objects that are NOT geometrically shaped. The volume of these objects can be found using a property stated in Archimedes' Principle: If the object is completely submerged, the volume of fluid displaced (moved) is equal to the volume of the object.

This is called the **Water Displacement Method**:

1. Add water to a graduated cylinder and record the water volume.
2. Place the object in the graduated cylinder and record the total volume of the water and the object.
3. Subtract the water volume from the total volume to find the volume of just the object. Change units to cm^3 (Figure 16).

$$Volume = Total\ Volume - Water\ Volume$$

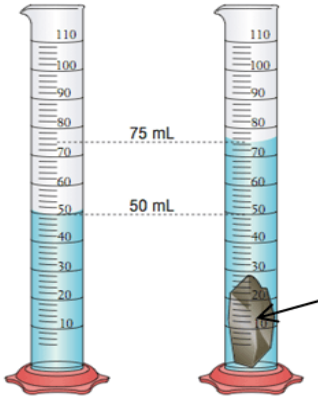


Figure 16: The volume of the rock can be found with the Water Displacement Method: V = 75mL - 50 mL, V = 25 cm^3

Density Drills

Date _____

Directions: Using the correct density formula, solve the problems. Follow SigFigs rules, show your work, and be sure to include units. You may use a calculator and scratch paper.

1. A block of aluminum occupies a volume of 15.0 mL and has a mass of 40.5 g. What is its density?

2. Mercury metal is poured into a graduated cylinder to exactly 22.5 mL. The mercury used to fill the cylinder has a mass of 305.4 g. From this information, calculate the density of mercury.

3. What mass of ethyl alcohol exactly fills a 200.0 mL container? The density of ethyl alcohol is 0.789 g/mL.

4. A rectangular block of copper metal has a mass of 1896 g. The dimensions of the block are 8.4 cm by 5.5 cm by 4.6 cm. From this data, what is the density of copper?

5. A flask with a mass of 345.8 g is filled with 225 mL of carbon tetrachloride. The combined mass of the flask and carbon tetra chloride is found to be 703.55 g. From this information, calculate the density of carbon tetrachloride.

6. Calculate the density of sulfuric acid if 35.4 mL of the acid has a mass of 65.14 g.

7. Find the mass of 250.0 mL of benzene. The density of benzene is 0.8765 g/mL.

8. A block of lead has dimensions of 4.50 cm by 5.20 cm by 6.00 cm. The block has a mass of 1587 g. From this information, calculate the density of lead.

9. 28.5 g of iron beads are added to a graduated cylinder containing 45.50 mL of water. The water level rises to the 49.10 mL mark, from this information, calculate the density of iron.

10. What volume of silver metal will have a mass of exactly 2500.0 g. The density of silver is 10.5 g/cm3.

Density

Density is a property of matter that can be used to help identify substances. It's also the property that causes matter to float or sink.

By definition, density is how compact the particles in a substance are. It's the relationship between an object's or substance's mass and volume— the more compact or squished together the particles are and the more mass the particles have, the higher the density.

The equation to calculate density is as follows: $$Density = \frac{Mass}{Volume}$$

Density Unit for Solids: grams per cubic centimeter, abbreviated g/cm^3

Density Unit for Liquids: grams per milliliter, abbreviated g/mL

Substance Identification

Density doesn't change with the sample size. It is constant, and every element on the periodic table has a different density! That's super useful for identifying unknown substances (Table 7). Gold, for instance, has a density of 19.3 g/cm^3, meaning every single cubic centimeter of pure gold will have a mass of 19.3 grams.

Table 7: Actual densities of various substances in g/cm^3

Substance	Density (g/cm^3)	Substance	Density (g/cm^3)
Copper	9.0 g/cm^3	Acrylic	1.16 - 1.19 g/cm^3
Brass	8.7 g/cm^3	Nylon	1.15 g/cm^3
Steel	8.0 g/cm^3	Oak	0.60 - 0.90 g/cm^3
Aluminum	2.7 g/cm^3	Pine	0.35 - 0.60 g/cm^3
PVC	1.39 - 1.42 g/cm^3	Poplar	0.35 - 0.50 g/cm^3

The formula for density can be rearranged to find other properties:

$$mass = Density \; x \; volume$$

$$volume = \frac{mass}{Density}$$

Using the volume formula, you can calculate that a 100 g crown of pure gold will have a volume of 5.18 cm^3 (Figure 17).

Figure 17: When balanced, Archimedes' crown and the pure gold had the same mass, but the crown displaced more water. It had a higher volume than the real gold, proving it wasn't real!

Float or Sink

Density causes matter to float or sink. Matter with higher densities sink below those with lower densities, and vice versa (Figure 18).

Pure liquid water at room temperature has a density of 1.000 g/mL, and anything with a density lower than that will float, while densities higher than that will sink!

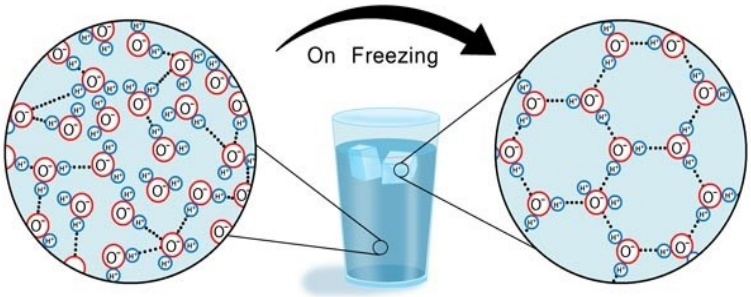


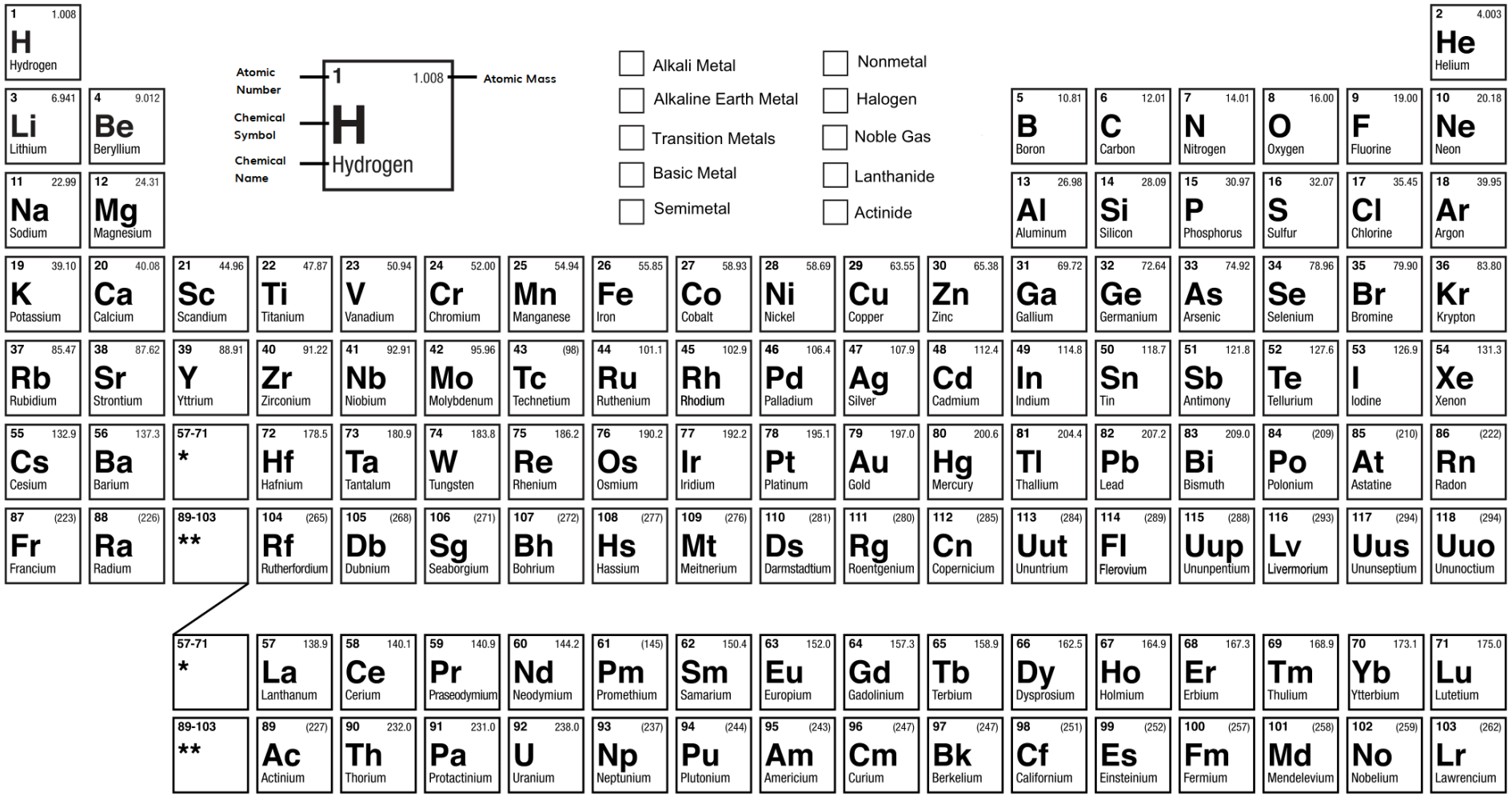
Figure 18: In liquid state, the bonds in water molecules are unstable, constantly breaking and reforming. When frozen solid, the bonds become stable, spacing them farther apart than the molecules in liquid water. The ice has a lower density than the liquid water, causing it to float.

Skill	Description
Describe Matter and its Interactions	Demonstrate understanding of the composition of matter, its properties, and how it interacts with stimuli.
Sub-Skills	**Indicators**
Model Matter Visibility	□ Develop a model to describe that matter is made of particles too small to be seen.
Analyze the Periodic Table	□ 1. Use the periodic table to determine an element's name, symbol, atomic mass, family, group, and period. □ 2. Use the periodic table to determine the number of protons, neutrons, and electrons in a neutral atom of any element. □ 3. Use the periodic table to determine the number of energy levels and valence electrons in an atom of any element in the first three periods.
Describe and Model Atomic Structure	□ 1. Create Bohr models of atoms for any of the first 18 elements □ 2. Describe the purpose of protons, neutrons, and electrons □ 3. Describe the location of the protons, neutrons, electrons, and the valence of an atom.
Describe and Model Molecular Structure	□ 1. Describe how atoms create either ionic or covalent bonds to form molecules □ 2. Create cross and dot diagrams for simple covalent bonds. □ 3. Create cross and dot diagrams for simple ionic bonds, including showing ionic charges.

CHEMICAL INTERACTIONS

Sub-Skills	Indicators
Identify Matter	□ Determine the identity of unknown matter by comparing properties you measure and observe to the actual properties of known materials.
Determine Physical vs. Chemical Change	□ 1. Describe the differences between chemical and physical properties. □ 2. Determine whether the mixing of two or more substances results in new substances.

The Periodic Table of the Elements



The Elements and Families

Element: a basic, pure substance that cannot be broken into simpler substances by chemical or physical processes. The smallest particle of an element is an atom.

Periodic Table of the Elements: an organization of the elements based on their properties.

Chemical Symbol: a representation of an element using specific letters. Symbols can contain one to two letters. The first letter will always be capitalized, and the second letter will always be lowercase.

Periods: Horizontal rows of the Periodic Table. Atoms of elements in the same period all have the same number of energy levels.

Groups: The vertical columns of the Periodic Table. Atoms in groups all have the same number of valence electrons.

"Bohr"ing Assignment

Date _____

Directions: Use your periodic table to complete each table. Then, color the PEN key. Finally, draw a Bohr model and label the valence for an atom of each element.

PEN Key: O Protons O Electrons O Neutrons

Helium - Chemical Symbol: _____		
Atomic Number		
Atomic Mass		
Number of Protons		
Number of Electrons		
Number of Neutrons		

Oxygen - Chemical Symbol: _____		
Atomic Number		
Atomic Mass		
Number of Protons		
Number of Electrons		
Number of Neutrons		

Sodium - Chemical Symbol: _____		
Atomic Number		
Atomic Mass		
Number of Protons		
Number of Electrons		
Number of Neutrons		

Atoms

An **atom** is the smallest particle of a substance that has all the properties of the substance. All atoms are made of protons, neutrons, and electrons. Protons and neutrons are found in the atomic **nucleus**, the center of the atom. Electrons are found in the electron **cloud**, a space surrounding the nucleus (Figure 1). The cloud contains the electron **orbitals** (pathways where electrons can be found) that make up different **energy levels (shells)** (Figure 2).

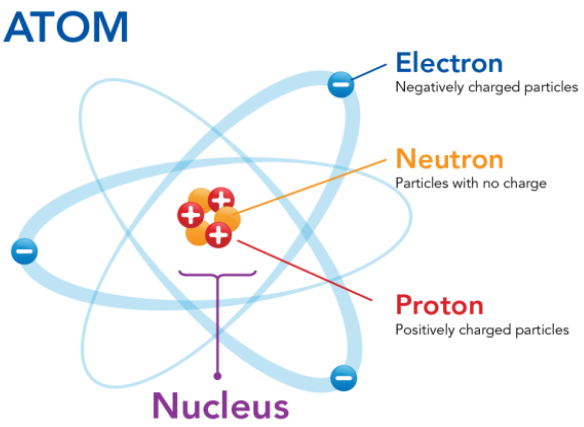
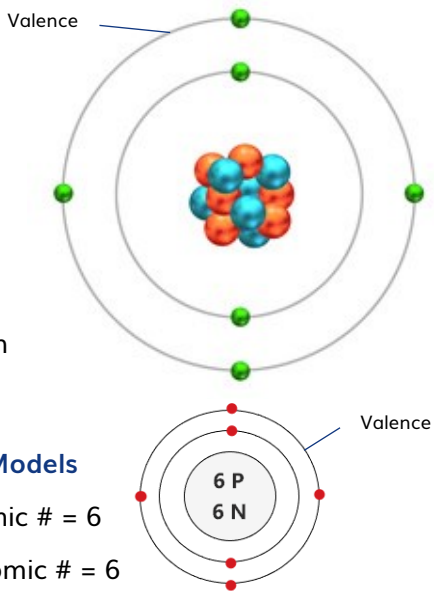


Figure 1: An atom is made up of protons, neutrons, and electrons. The electrons in the electron cloud different exist in different energy levels!

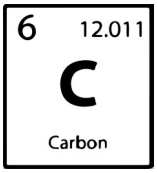
- **Protons** are positively charged particles in the nucleus of an atom. The number of protons in an atom determines what element it is. The atomic number of an element indicates the number of protons an atom of that element has.
- **Neutrons** are neutral particles in the nucleus of an atom that add mass to an atom. Atoms of the same element can have different numbers of neutrons creating different **isotopes**, stable or radioactive versions of the element with slightly different physical properties. An atom's neutron count is equal to an it's atomic mass minus it's atomic number.
- **Electrons** are much smaller, negatively charged particles located in orbitals and energy levels in the cloud. The outermost energy level of an atom is called the **valence**, and this is where electrons form the bonds that create molecules. The number of electrons in a neutral atom is equal to the number of protons.

Bohr Models

Atoms and molecules are too small for scientists to directly observe, so they use **models and diagrams** to study their properties, structures, and behaviors. **Bohr models** allow us to study, at a basic level, an atom's structure.



Carbon Bohr Models



- Protons = Atomic # = 6
- Electrons = Atomic # = 6
- Neutrons = Mass - Atomic # = 6

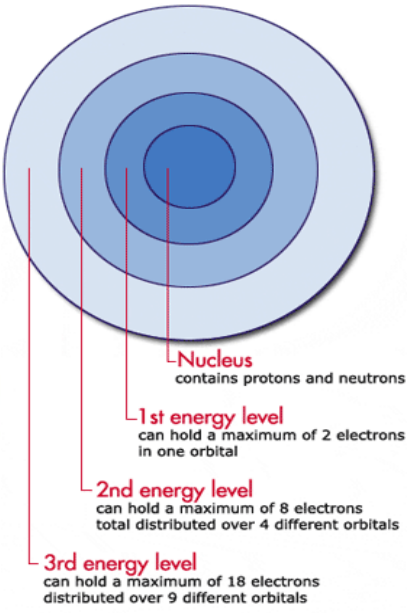


Figure 2: Each energy level can hold a maximum number of electrons in and orbitals. Electrons must gain energy to move to higher energy levels, and they release energy to move to lower energy levels.

Model Mania

Date _____

Directions: Create four different models of a molecule of the greenhouse gas methane, CH_4, Work lightly with pencil before finishing in color. Keep it neat!

Cross and Dot Diagram of Methane	Lewis Structure Model of Methane
Ball-and-Stick Model of Methane	**Space-Filling Model of Methane**

Molecules and Bonds

Molecules: Two or more atoms joined tightly together by a force called a **bond**. During **chemical reactions**, atoms of starting substances, **reactants**, rearrange to form new substances, **products**.

Valence Electron: an electron of an atom in the valence that can be transferred to or shared with another atom to form a molecule.

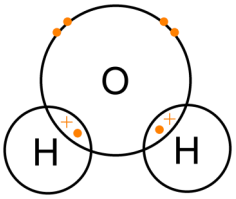
Octet Rule: the tendency of atoms to prefer to have eight valence electrons.

The **stability** of atoms depends on whether or not their valence is full or satisfies the Octet Rule.

- **Stable atoms:** If the valence of an atom is full or meets the octet rule, the atom is stable. It will not form any more bonds. Noble Gases rarely form bonds because they are already stable.
- **Unstable atoms** have unfilled valences or don't meet the octet rule. They will form bonds with other atoms to become stable, and in the process, they will become part of a molecule.

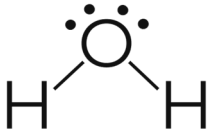
Ionic and Covalent Bonds Video

Atoms and molecules are too small for scientists to directly observe, so they use **models and diagrams** to study their properties, structures, and behaviors.



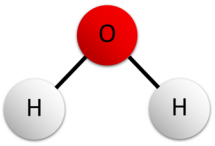
A **cross and dot** diagram can model the bonding in simple ionic and covalent molecules.

- The valence of each atom is drawn as a circle.
- Circles overlap where there is a covalent bond.
- Electrons from one atom are drawn as dots, and electrons from another atom as crosses.



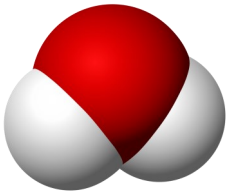
Lewis Structure models are used to describe and visualize covalent molecules.

- Lewis structures are used to show the bonds between atoms as well as the electrons surrounding certain atoms.



A **ball-and-stick** model is used to show the 3D shape of molecules.

- Ball-and-stick models help better understand how each atom is connected in a molecule.
- Ball-and-stick models also show relative bond lengths and bond angles.



Space-filling models are 3D models representing the connection of atoms in a molecule.

- Atoms are placed directly on each other (without the use the visible bond lines).
- The sizes of the atoms are proportional to their actual sizes (thus oxygen will look larger than hydrogen due to it having more energy levels and a larger mass).

Covalent Bond Cross and Dot

Date _____

Directions: Create cross and dot diagrams showing how electrons share to form bonds in the following four molecules. Show all six steps of your work:

Cross and Dot Diagram of H_2	Cross and Dot Diagram of O_2
Cross and Dot Diagram of NH_3	**Cross and Dot Diagram of H_2O**

Covalent Molecules and Bonds

Covalent Bond: A chemical bond formed when electrons are **shared between two or more nonmetals**. These electrons are simultaneously attracted by the two atomic nuclei. (Figure 3)

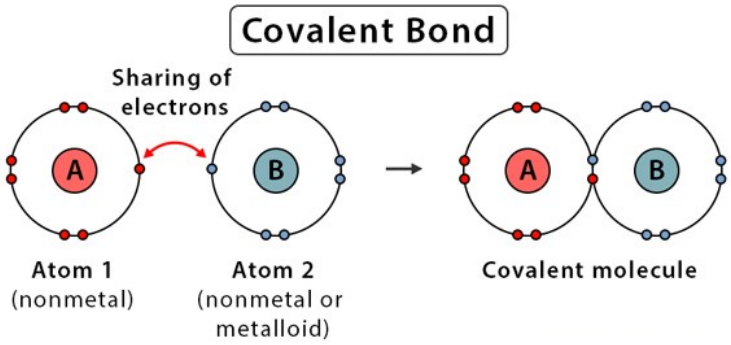
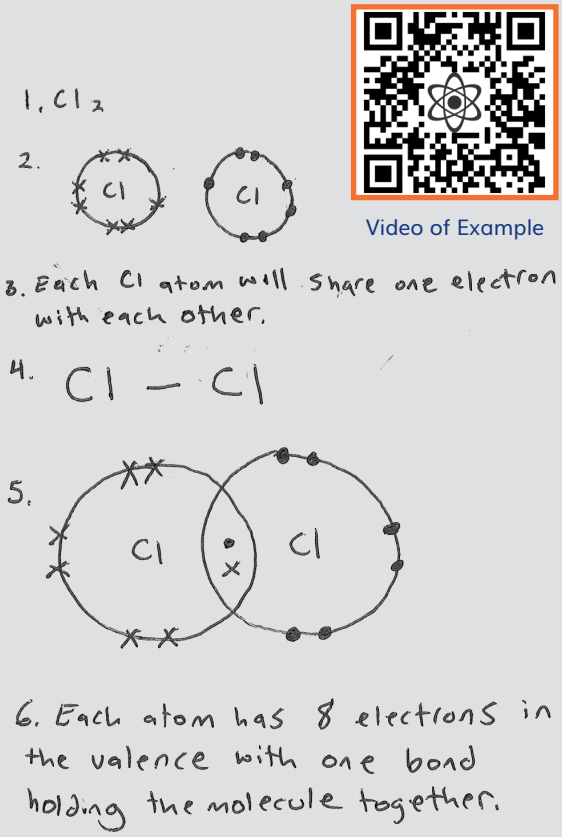


Figure 3: Shared electrons located in the space between the two nuclei are called **bonding electrons**, and the bonded pair is the "glue" that holds the atoms together into molecules.

In chlorine gas (Table 1), the two chlorine atoms in the chlorine molecule are joined by a shared pair of electrons. Each chlorine atom has seven valence electrons in the third energy level and requires one more electron to form a stable electron configuration. Each chlorine atom contributes one electron to the bonding pair shared by the two atoms. The remaining six valence electrons of each chlorine atom are not involved in bonding and are concentrated around their respective atoms. These valence electrons, usually shown as pairs of electrons, are called nonbonding electrons, or **unshared electrons**.

Table 1: How to Create Cross and Dot Diagrams of Covalent Bonds

Steps	Example: Cl_2 (Chlorine Gas)
1. Write the **chemical formula**. 2. Work out **how many electrons** are in the valences and **draw them** using Xs for one type of atom and Os for other types of atoms. 3. Figure out **how many electrons need to be shared** 4. **Sketch a simple model** to work out the order in which the atoms are connected. 5. **Share the electrons** with overlapping valences (new drawing). 6. **Check your work**. Count the number of electrons each atom has to make sure the valences are full or at 8 electrons. Make sure the electrons are always in pairs. A bond is a dot and a cross.	 Video of Example

Ionic Bond Cross and Dot

Date _____

Directions: Create cross and dot diagrams showing how ions form bonds in the following four molecules. Show all six steps of your work:

Cross and Dot Diagram of LiF	Cross and Dot Diagram of $MgCl_2$
Cross and Dot Diagram of MgO	**Cross and Dot Diagram of BeO**

Ionic Molecules and Bonds

- **Ionic Bond**: A chemical bond formed between two ions with opposite charges, a cation and an anion. Ionic bonds form when a **metal gives up one or more electrons to a nonmetal** (Figure 4).
- **Ion**: an atom with an electrical charge, which means it has a different number of protons than it has electrons. Two types: **cation** and **anion** (Figure 5).

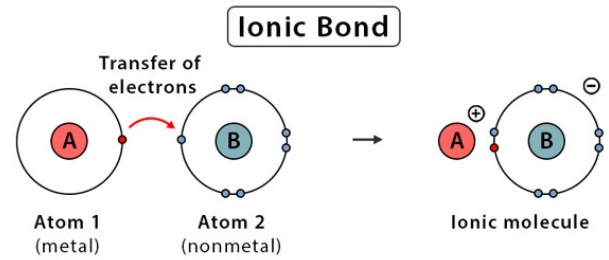


Figure 4: An ionic bond is a type of chemical bond that generates two oppositely charged ions. In ionic bonds, the metals lose electrons to become positively charged cations, whereas the nonmetals accept those electrons to become negatively charged anions.

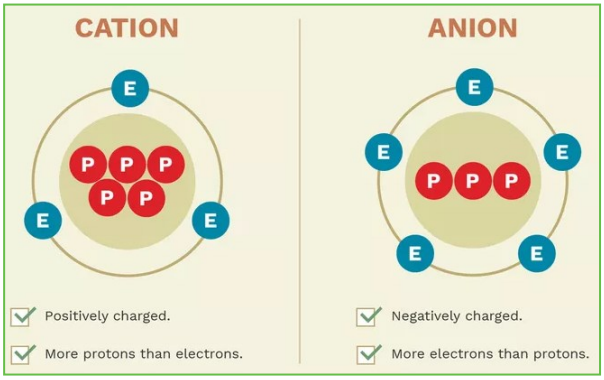
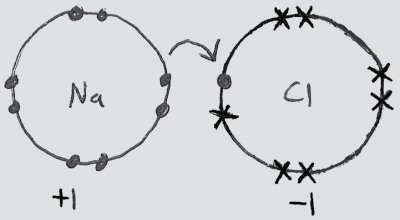


Figure 5: Cations are positively charged with more protons than electrons, and anions are negatively charged with more electrons than protons.

Table 2: How to Create Cross and Dot Diagrams of Ionic Bonds

Steps	Example: NaCl (Table Salt)
1. Write the **chemical formula**. 2. Work out **how many electrons** are in the valences, and **draw them** using Xs for one type of atom and Os for other types of atoms. 3. Figure out **how many electrons each atom will gain or lose**. Metals will lose and nonmetals will "steal" electrons. 4. **Sketch a simple model** to work out the order in which the atoms are connected. 5. **Draw the model**. Include the new valences, the direction of the electron movement, and the new ionic charge. (new drawing). 6. **Check your work**. Count the number of electrons each atom has to make sure the valences are full or at 8 electrons. Make sure the ionic charges are opposite but equal.	1. NaCl 2.  Video of Example 3. Sodium (Na) will transfer its valence electron to chlorine (Cl). Na loses 1, Cl gains 1. 4. Na – Cl 5.  6. each atom has 8 electrons in their valences, and the ionic charges are opposite and equal.

Skill	Description
Describe Living Organisms' Basic Needs and Functions	Demonstrate understanding of living organisms' basic needs and functions, including getting and using energy, reproduction, adaptation, and behavior.
Sub-Skills	**Indicators**
Describe the Cell Energy Cycle	□ 1. Describe that energy in animals' food was once energy from the sun. □ 2. Create models showing photosynthesis and cellular respiration as a cycle dependent on each other.
Describe Adaptation and Natural Selection	□ 1. Explain using evidence how variations increase some individuals' probability of surviving and reproducing in an environment. □ 2. Model how natural selection may lead to increases and decreases of specific traits in populations over time.
Describe Asexual and Sexual Reproduction	□ 1. Describe and model how asexual reproduction results in genetically identical offspring and sexual reproduction results in offspring with genetic variation. □ 2. Describe the advantages and disadvantages of asexual and sexual reproduction.
Describe Plant and Animal Behaviors	□ Construct a scientific explanation based on evidence for how environmental and genetic factors influence the behavior of organisms.

CHARACTERISTICS OF LIVING THINGS

Skill	**Description**
Describe the Hierarchy of Living Things	Demonstrate that an organism's body is composed of increasingly smaller parts that work together.
Sub-Skills	**Indicators**
Describe and Model Cell Structure and Function	□ 1. Provide evidence that all living things are made of cells; either one cell or many different numbers and types of cells. □ 2. Develop and use a model to describe the function of a cell and ways the parts of cells contribute to the function.
Describe Cell, Tissue, and Organ Interactions	□ Describe how specialized cells work together to form tissues and organs that are specialized for particular bodily functions.
Model Interdependence of Organ Systems	□ Model how organ systems depend on each other to maintain homeostasis in multicellular organisms.

YOUR CHOICE Activity

Date _____

Directions: Make a drawing, comic, game, foldable, or some other activity that shows your understanding of the eight basic characteristics of living things.

Characteristics of Living Things

Organisms are living things, and living things have all of the following characteristics:

1. They are **made up of cells** and have **structures**, body or cell parts that do a certain "job" for an organism. The **function** is the "job" that a structure does or the purpose that it serves (Figure 1).

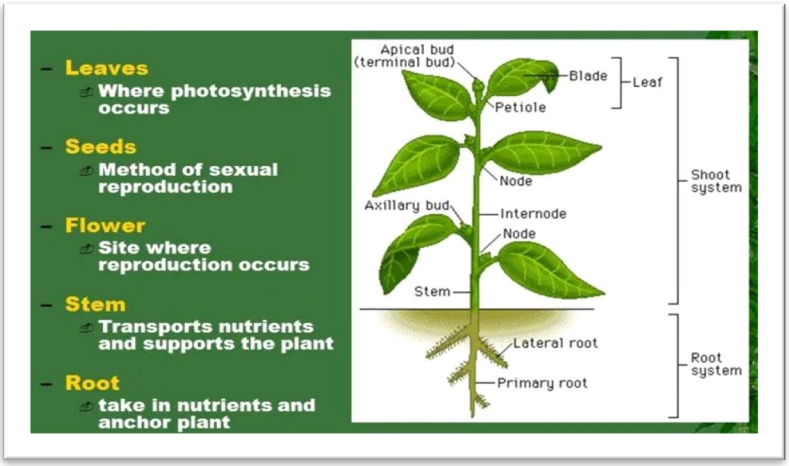


Figure 1: *These five main plant structures all have different functions!*

2. They **have adaptations**— traits, behaviors, or structures that help them survive in their surroundings, and as a species, they **evolve** (Figure 2).

Figure 2: Peppered Moths have a camouflage adaptation.

3. They **have behaviors**. A behavior is something an organism does in response to a stimulus (Figure 3).
4. They **contain genetic code (DNA)**.
5. Organisms **grow and develop**.
6. They **get and use energy**.
7. They **reproduce**, or create new organisms.

Homeostasis BrainPOP

8. They **maintain homeostasis**, a stable internal environment even when external conditions change dramatically.

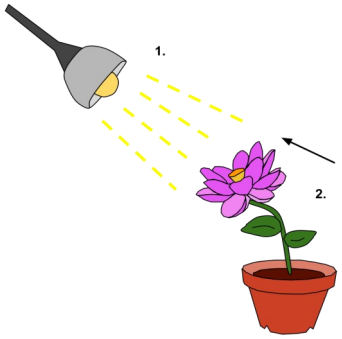


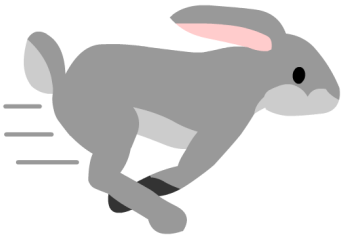
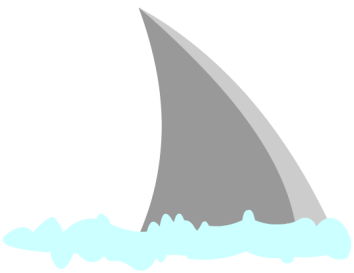
Figure 3: Plants respond to light by bending!

- If something can meet all of these qualifications, it is living, and it will also have **basic individual survival needs**: water, nutrients (from food), oxygen, sunlight, space, shelter, and the right range of temperature.

Pressures and Variations

Date _____

Directions: Watch the BrainPOP video titled "Natural Selection". Then, for each organism, list one or more of its environmental pressures (stuff that limits a population of living things). Then describe some of the variations it has evolved in response to those pressures. You may use the Internet or other resources to find out more.

	Environmental Pressures	Variations
 **Giraffe**		
 **Rabbit**		
 **Cactus**		
 **Shark**		

Adaptation and Variation

Natural selection: the process by which favorable inherited adaptations become more common over time. Charles Darwin hypothesized that natural selection was the main pathway to biological evolution. Natural selection assumes the following:

Natural Selection BrainPOP Video

1. More organisms are born than can survive and reproduce.
2. Organisms compete for limited resources and survival.
3. There are variations between organisms, and these variations can be inherited.
4. Some variations make an organism more likely to survive and reproduce. Over time, favorable variations will spread throughout a population, while unfavorable variations become less frequent.

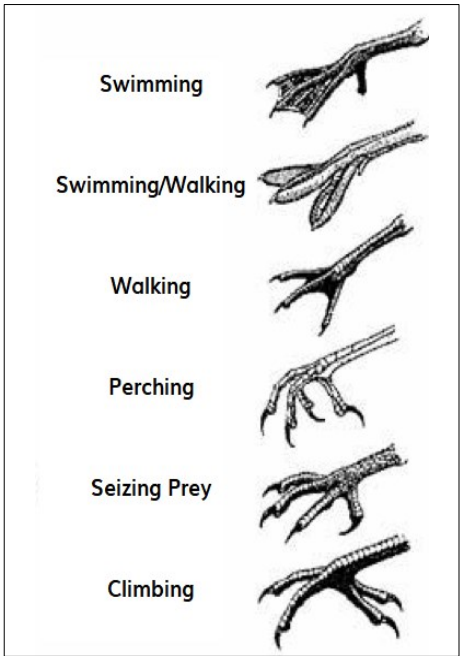


Figure 4: These bird feet adaptations evolved to suit very different environments!

Biological evolution: change in the inherited traits of a population of organisms that occurs over many generations (Figure 4).

- **Misconception alert**: Biological evolution refers to changes in populations of organisms over time, but does not imply *how* these changes have taken place. In spite of a variety of criticisms, natural selection is considered by most biologists to be the primary system driving evolution to take place.

Artificial selection: the selection *by humans* of animals, plants, or other organisms to breed together.

- Artificial selection is also known as selective breeding.
- Breeders use artificial selection to ensure the continuation of desirable traits and to develop new varieties (Figure 5).

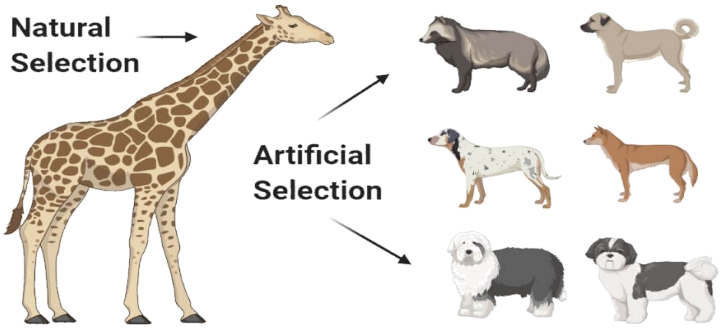


Figure 5: Giraffes evolved their long necks naturally as taller trees became a natural food source. Humans decided which dogs to breed with each other, however, based on traits they felt were desirable.

The Energy Cycle

Date _____

Directions: Observe the similarities and differences between cellular respiration and photosynthesis. Then, illustrate these two processes as a cycle, showing how plants and animals rely on each other to get and use energy.

Getting and Using Energy

Cellular respiration: the process by which organisms use oxygen to break down food molecules (glucose) to produce chemical energy for cell functions (Figure 6). This process takes place in the mitochondrion within plant AND animal cells.

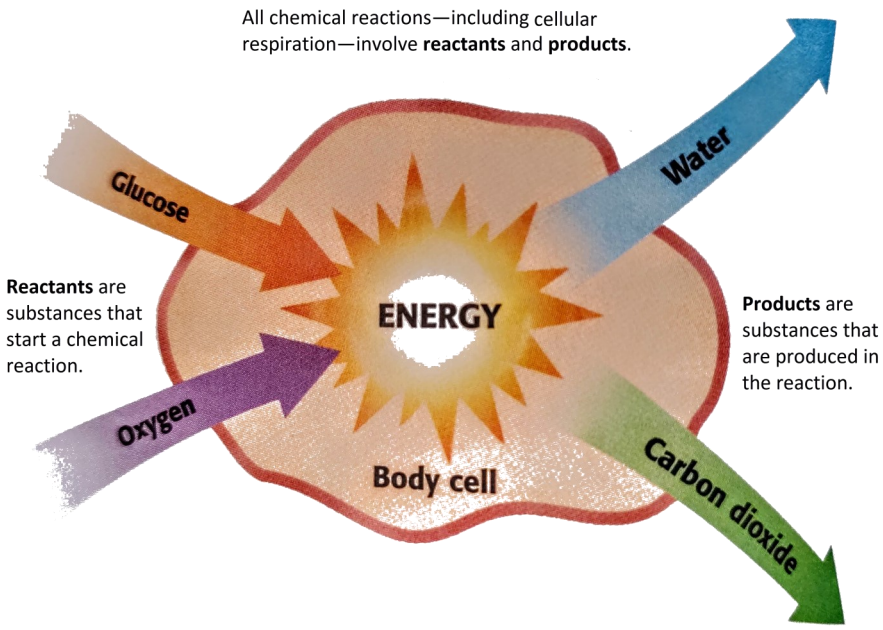


Figure 6: In cell respiration, glucose and oxygen enter the mitochondrion in the cell to create ATP energy and two waste products, water and carbon dioxide, which the cell removes from the body.

Photosynthesis: The process by which organisms, usually plants, use the energy in sunlight to convert carbon dioxide and water into their own food (Figure 7). Photosynthesis takes place in the chloroplasts within plant cells.

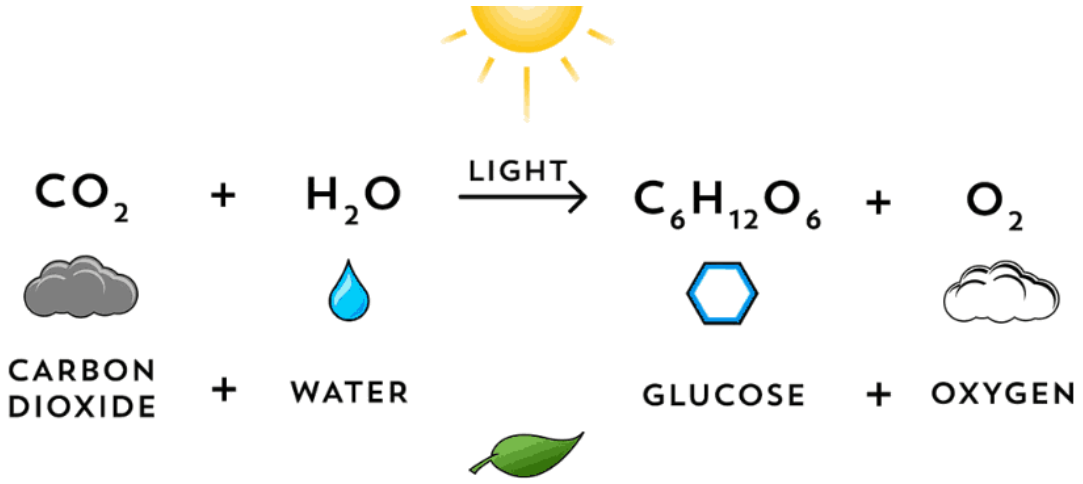


Figure 7: In photosynthesis, the chloroplasts take in two reactants, carbon dioxide and water, and using the radiant energy gathered from the sun, the chloroplasts convert it to glucose and oxygen. Those products then move to the mitochondrion so that cell respiration can begin and the plant can grow (get larger) and reproduce (produce fruit and seeds). Excess oxygen is released back into the air.

Comparing Offspring

Date _____

Directions: Compare and contrast sexual vs. asexual reproduction. You may use text and drawings.

	Asexual Reproduction	Sexual Reproduction
Number of Parents		
Genetic diversity compared to the parents		
Complexity of organism that uses this method		
Advantages		
Disadvantages		
Examples of organisms that use this method		

Reproduction

Asexual Reproduction: a biological process by which an organism creates a genetically similar copy of itself without the combination of genetic material with another organism. There are three methods of asexual reproduction:

1. **Binary fission:** The process that bacteria use to divide into new organisms. They simply replicate DNA and split in two at the same time!
2. **Budding:** The parent "buds" an offspring on itself. It falls off and grows into a new genetically identical organism.
3. **Fragmentation:** The parent organism breaks into fragments, or pieces, and each fragment develops into a new organism.

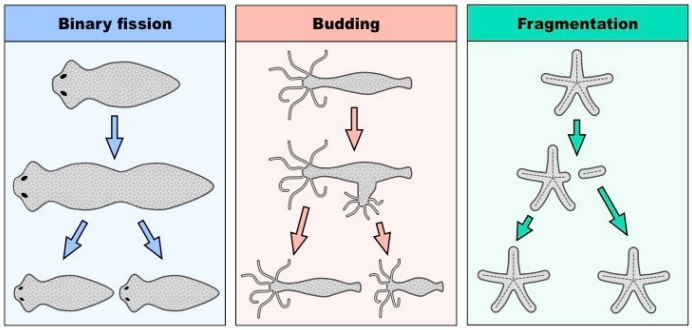


Figure 8: Simple organisms can reproduce asexually using three different methods!

Sexual Reproduction is the uniting of two gametes, usually from two different parents, to make a new organism. The offspring are diverse and unique (Figure 10)!

- **Gametes:** reproductive cells that typically have half the chromosomes of other cells.
- **Zygote:** a fertilized egg that will keep dividing into a multicellular offspring.

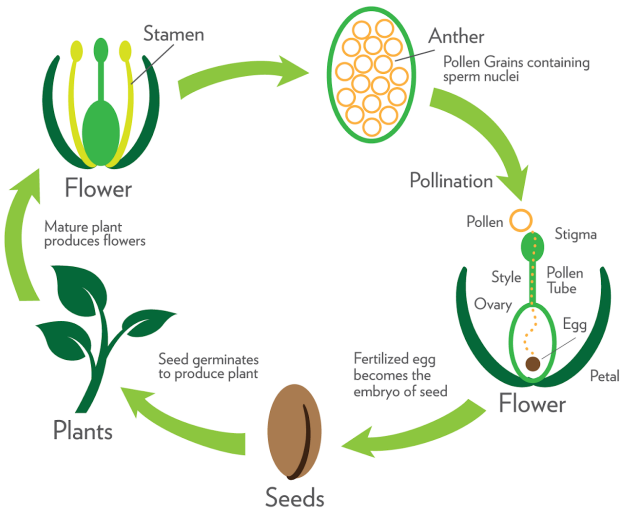


Figure 9: Sexual reproduction occurs in plants. Did you know that some plants have male and female parts, and other plants are entirely male or female?

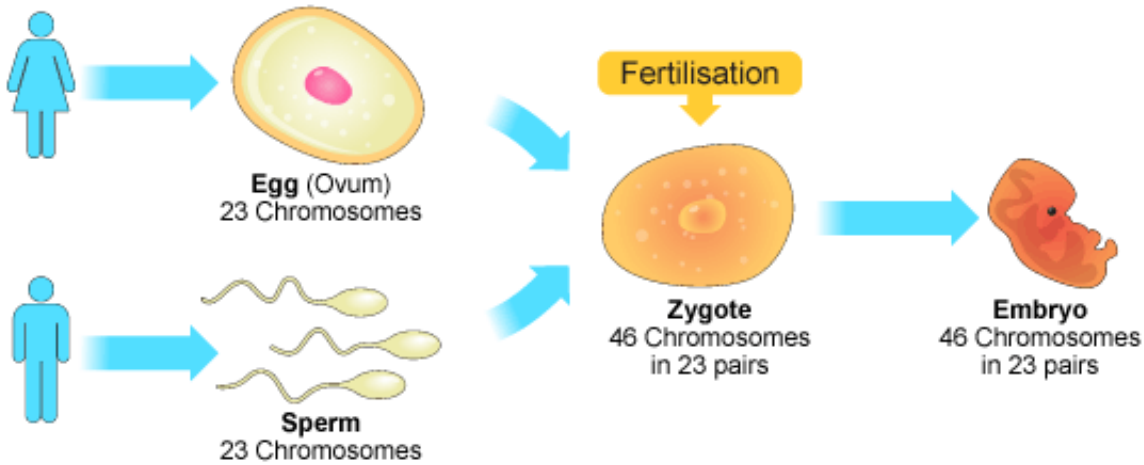


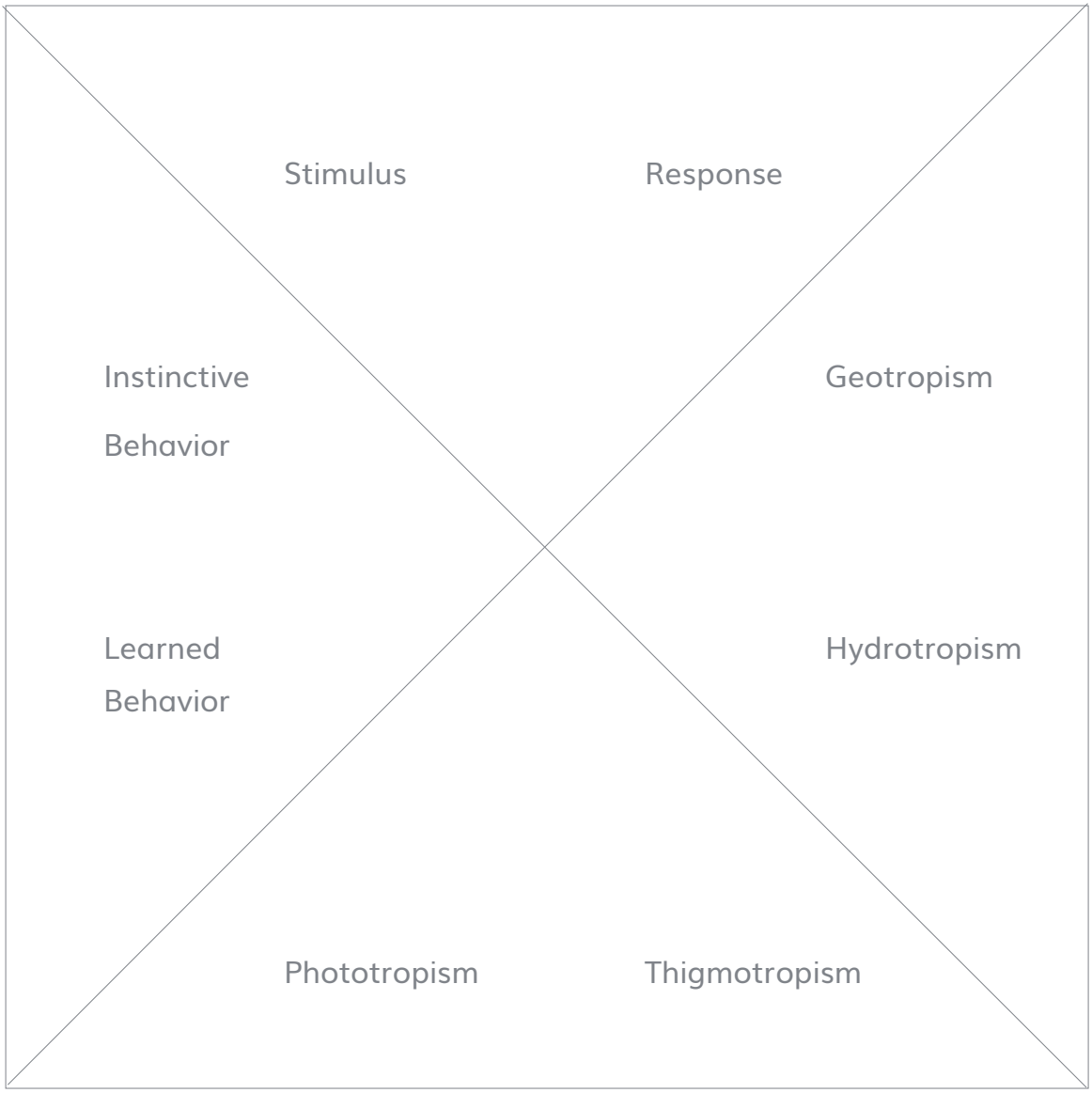
Figure 10: Sexual reproduction in animals requires gametes from a male an female organism. Once the male gamete (sperm) and female gamete (ovum) meet during sex, they merge to form a zygote that eventually becomes an embryo!

Behavior Foldable

Date _____

Directions: Create a foldable with the labels below. Then, illustrate examples of the different types of behaviors on the inside of the flaps. See the Behavior Foldable Video Instructions for details. When it's complete, glue it on the outline below.

Behavior Foldable Video Instructions



Behaviors

Behavior: a way in which an organism acts, moves, or functions

Instinctive behavior: a behavior that an animal inherits from its parents (hibernation, migration, playing dead, etc.)

Learned behavior: a behavior that an animal develops by observing other animals or by being taught (animals doing tricks taught by humans, classical and operant conditioning)

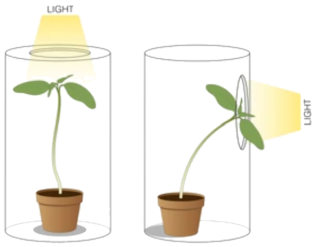
Figure 11: The stimulus of smelling a bad odor causes an instinctive response to cover our nose (and sometimes gag)!

Stimulus: a thing or an event that makes an organism function or act in a certain way

Response: what the organism does when it senses the stimulus (Figure 11). Plants have a special name for this response. A **tropism** is a plant's response to a stimulus. There are four types of tropisms that plants exhibit both positively and negatively.

Tropism Types

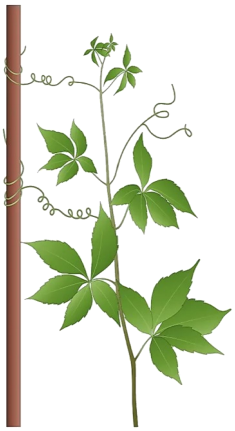
Positive tropism: when a plant grows or moves towards a stimulus. **Negative tropism:** when a plant grows or moves away from a stimulus



Phototropism

1. **Phototropism:** the growth of a plant toward or away from a light source

2. **Geotropism:** the growth of the parts of plants with respect to the force of gravity (shoots grow upward while the roots grow downward)

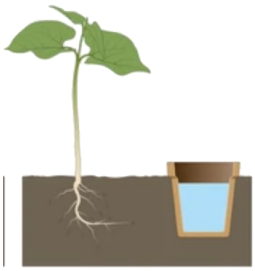


Thigmotropism

3. **Hydrotropism:** the growth or turning of plant roots toward or away from moisture.

4. **Thigmotropism:** the turning or bending of a plant in response to a touch stimulus.

Geotropism



Hydrotropism

Pick a Part

Date _____

Directions: Pick one of the parts within the first four levels in the Hierarchy of Living Things. Be specific (like if you pick a tissue, indicate which type). Describe this part's function and role as it relates to the organism and the other levels in the Hierarchy. Using detailed scientific writing and at least one figure with correct labeling.

Organism Physiology and Organization

Physiology is the study of how living organisms and their parts function.

Organisms can be simple, made up of single cells, or they can be complex multicellular organisms like humans. A complex multicellular organism is made up of many increasingly smaller parts that work together to maintain homeostasis (Figure 12).

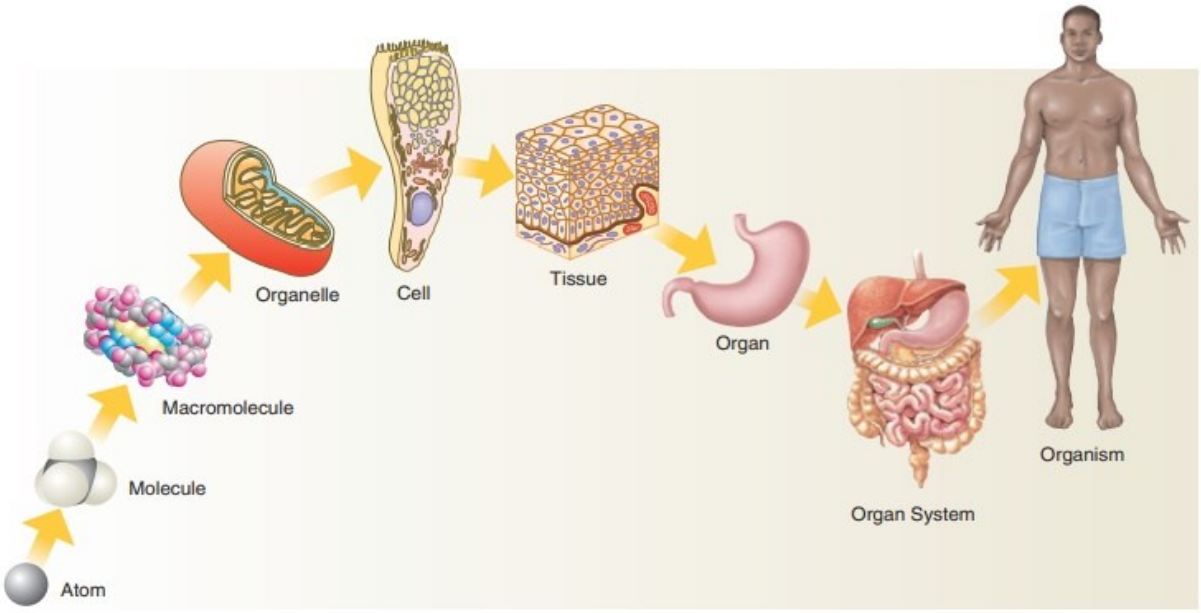


Figure 12: An organism is made up of increasingly smaller parts going all the way back to nonliving organelles, macromolecules, molecules, and atoms. Once you get to the living cell, there are five stages in the Hierarchy of Living Things!

A **hierarchy** is a system of organization in which groups are ranked above others according to importance and levels of complexity.

There are five stages in the **Hierarchy of Living Things** with the final stage, the Organism, being the most complex as it is made up of all the other stages (Figure 13).

Hierarchy of Living Things Video

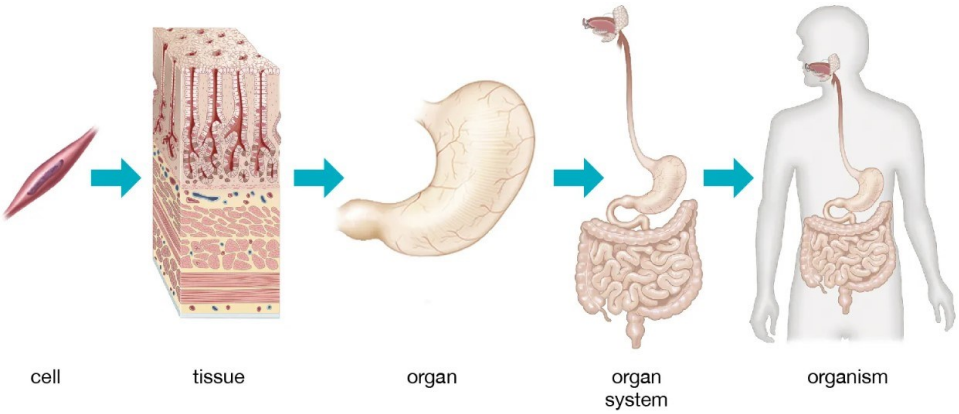


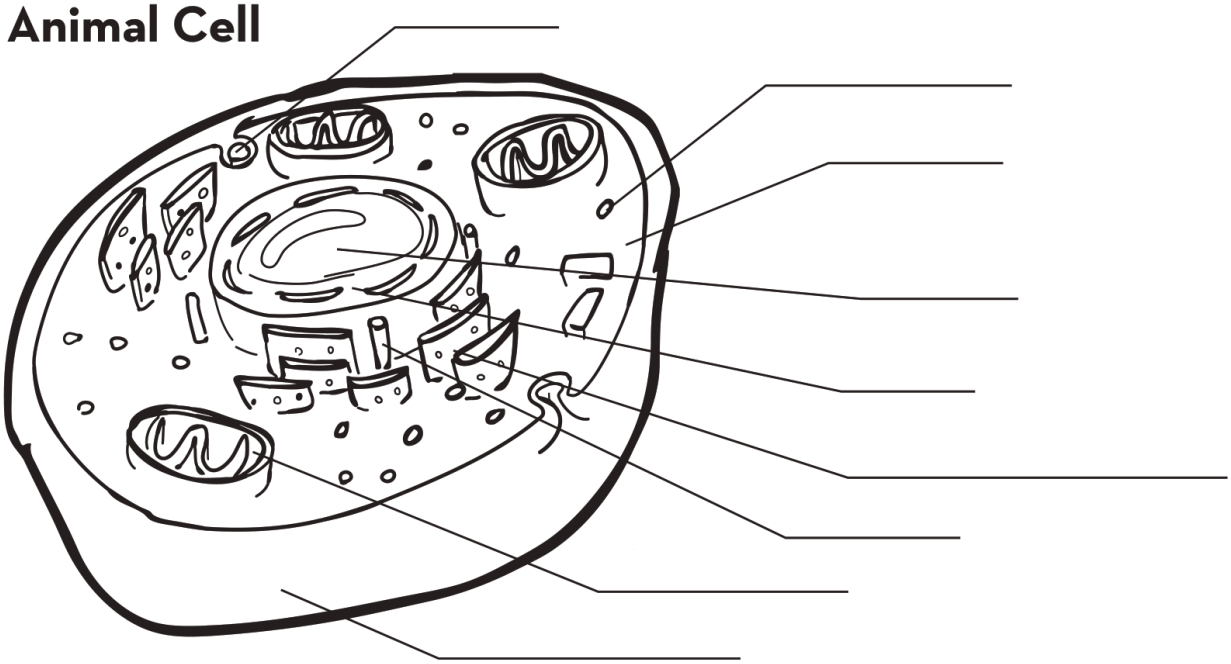
Figure 13: The five stages in the Hierarchy of Living Things begin with the smallest living part of an organism, the cell. In stage 2, cells come together to form tissues. In stage 3, tissues come together to form organs. In stage 4, organs work together to form organ systems. In the final stage, stage 5, the organ systems work together to form a complete organism.

Cell Organelles

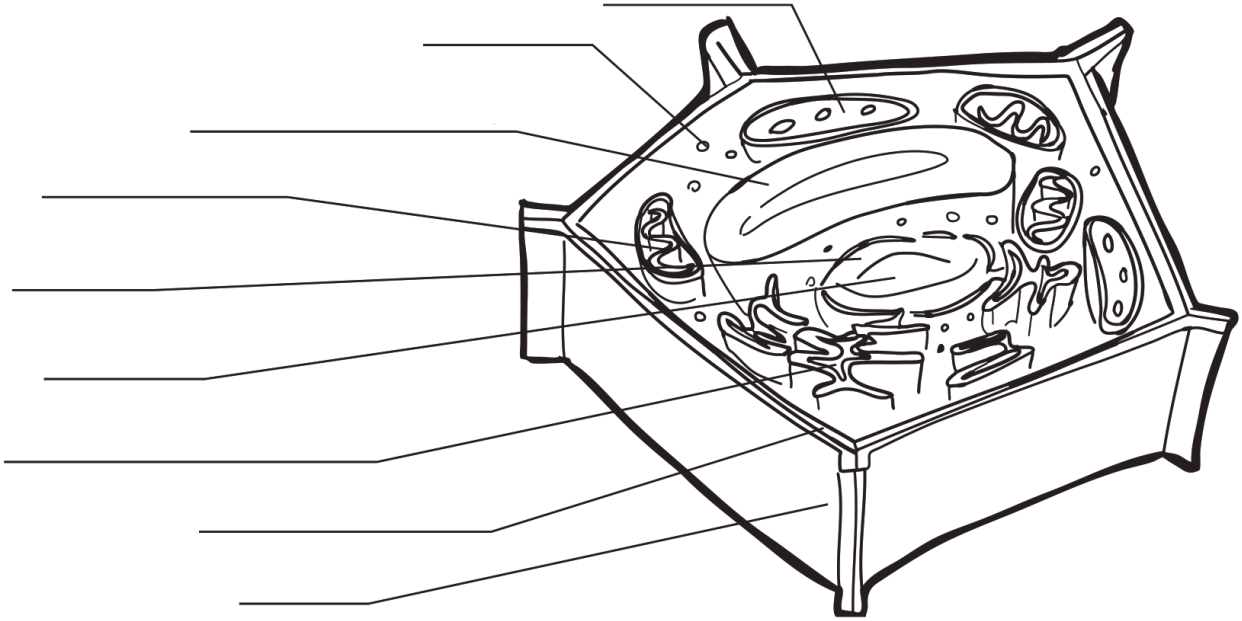
Date _____

Directions: Label and color the organelles (cell structures) in the plant an animal cells. Add the color of the organelle to the key on the right-side page, as well.

Animal Cell



Plant Cell



Cell Structures and Functions

Cell: The smallest living part of an organism made up of organelles. In multicellular organisms, cells represent Stage 1 of the Hierarchy of Living Things.

Prokaryote: Archaea and bacteria cells which do not have a cell nucleus and lack other things eukaryotes (cells with a true nucleus) have.

Eukaryote: Animal, plant, fungi, and protist cells that are typically a lot bigger and more complex than prokaryotic cells. They have a defined cell nucleus which houses the cell's DNA.

Prokaryotic vs. Eukaryotic Cells Video

Prokaryotes and Eukaryotes:

- **Cell Membrane:** The membrane that surrounds the cell and controls movement of substances into and out of the cell
- **Cytoplasm:** a jellylike "soup" that fills most of the cell. Other cell structures float in it. It is mostly water.
- **Ribosomes:** structures that make different things the cell needs to function, like proteins.

Eukaryotes Only:

- **Nucleus:** The control center of the cell - It holds the DNA and uses chromosomes to instruct the rest of the cell what to do next.
- **Vacuoles:** Storage spaces for water, nutrients, and wastes.
- **Mitochondria:** "Powerhouse" of the cell. They combine oxygen and glucose to release energy using Cellular Respiration.
- **Lysosomes:** Structures that clean up the place getting rid of waste and other unwanted substances that may get into the cell.
- **Golgi Apparatus:** Packs and ships proteins to different parts of the cell.
- **Endoplasmic Reticulum (ER):**
  - **Rough ER:** Ribosomes attach to it, and it produces and transports protein
  - **Smooth ER:** Detoxifies cells and makes lipids (fats)

Plant cells only:

- **Chloroplasts:** Structures that make food for the plant by combining carbon dioxide, water, and the energy from sunlight (photosynthesis).
  - **Chlorophyll:** A green substance in the chloroplasts that captures the energy in sunlight.

Prokaryotes, Plants, Fungi, some Protists:

- **Cell Wall:** A rigid outer covering of a plant cell that gives the cell a boxy shape.

Animal Tissue Locations

Date _____

Directions: Draw and label where you can find the four types of animal tissues. Include all three types of muscle tissues.

Epithelial Tissue	Nervous Tissue
Smooth, Cardiac, and Skeletal Muscle Tissues	**Connective Tissue**

Animal Tissues

Tissues are groups of cells that work together to perform certain functions. Some tissues are under voluntary control, and others are under involuntary control. Tissues represent Stage 2 of the Hierarchy of Living Things.

An action under **voluntary control** is controlled by an individual's conscious will (lifting an object, standing on toes, speaking)

An action under **Involuntary control** is a reflex or action NOT controlled by an individual's will (a yawn, a blink, breathing, digesting food). It's automatic.

Four Tissue Types (Figure 14)

Epithelial tissue forms the protective coverings and linings of surfaces in and on the animal's body (examples: skin, lining of hollow organs like blood vessels, stomach, lungs, kidneys).

Nervous tissue works to receive and to send information throughout the body. (examples: brain, spinal cord, nerves).

Muscle tissue is responsible for movement and is composed of bundles of muscle cells called fibers that can contract and relax. There are three types of muscle tissue found in different parts of the body (Figure 15):

1. **Smooth Muscle:** found in the walls of hollow organs, blood vessels, airways, and the diaphragm and is NOT under voluntary control
2. **Cardiac Muscle:** found only in the heart and is NOT under voluntary control
3. **Skeletal Muscle:** moves the skeleton and IS under voluntary control

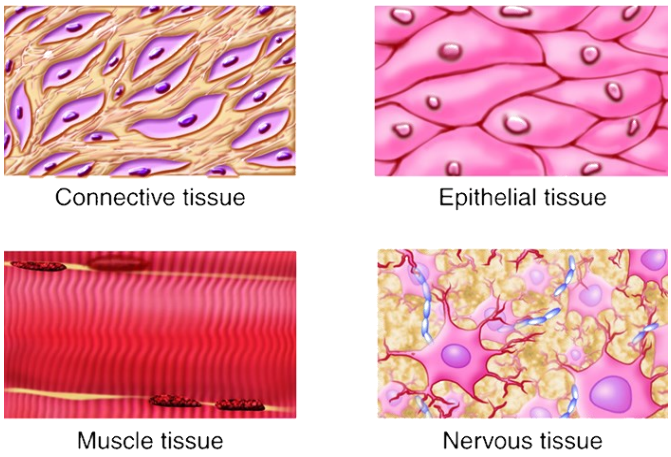


Figure 14: Magnified image of cells making up different tissues.

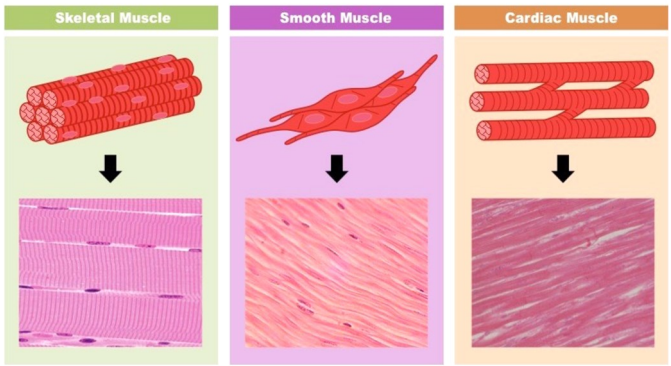


Figure 15: The three muscle tissues are found in different locations, serve different purposes, and when magnified, the tissues organizations vary drastically!

Connective tissue protects, supports, and connects the parts of the animal's body (examples: bone, ligaments, tendons, cartilage, blood).

YOUR CHOICE activity

Date _____

Directions: Make a drawing, comic, game, foldable, or some other activity that shows your understanding of plant tissues.

Plant Tissues

There are three types of plant tissues: Dermal, Ground, and Vascular (Figure 14).

Dermal tissues make up the outer layer of all plant organs—stems, roots, leaves, and flowers. Dermal tissues prevent excess water loss and protect the plant from invasion by insects and microorganisms.

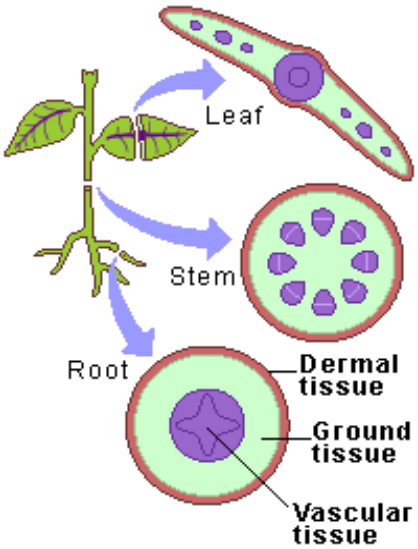


Figure 14: The three types of plant tissues are found in different locations of a plant's leaf, stem, and root.

Ground tissues include support, storage, and photosynthetic tissues and make up most of a plant's mass. There are three types of ground tissue: Parenchyma, Collenchyma, and Sclerenchyma (Figure 16)

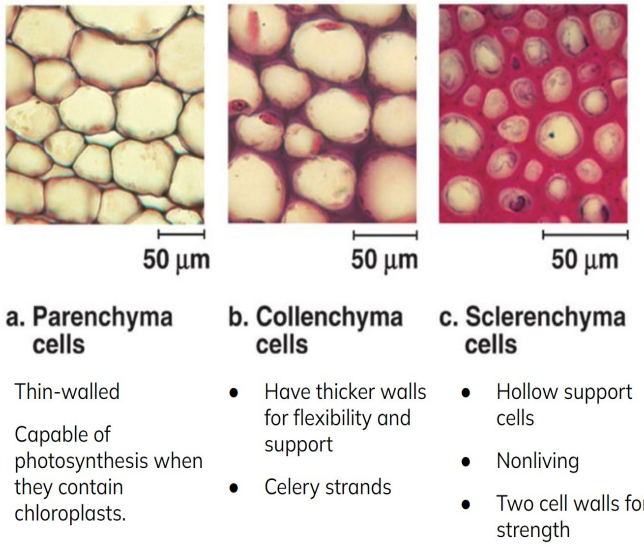


Figure 16: The three types of ground tissues are compared at the cellular level in these images.

1. **Parenchyma** tissue makes up the internal layers of leaves and the outer and innermost layers of stems and roots; it also forms the soft tissues of fruits.

2. **Collenchyma** tissue is similar to parenchyma, but its cells have thick deposits of cellulose in their cell walls. Collenchyma is found mainly in the outer layers of stems and in leaves.

3. **Sclerenchyma** tissue is composed of hard, woody cells that provide support and strength to the plant.

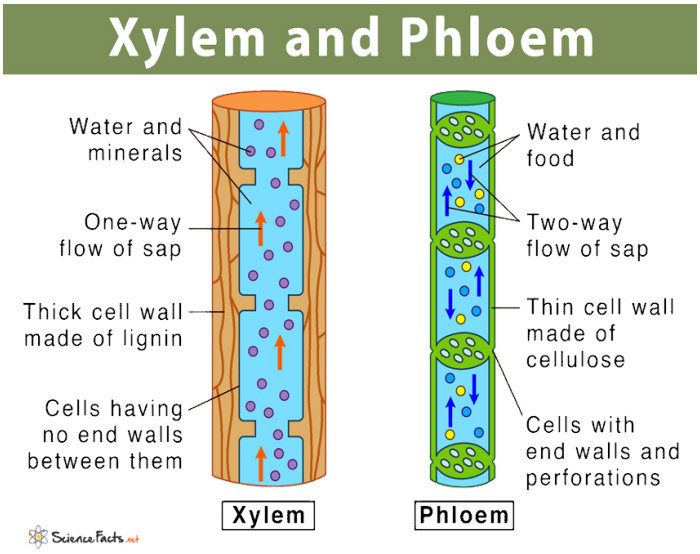


Figure 17: The two types of vascular tissue are similar to human veins and arteries. They water and nutrients in one-way paths.

Vascular tissues transport water, minerals, and food to different parts of the plant. There are two types: Xylem and Phloem (Figure 17).

1. **Xylem** is the dead tissue that helps transport water and minerals from the soil up to the rest of the plant

2. **Phloem** is the living tissue that carries food, glucose, created in the leaves and other sites of photosynthesis to the rest of the plant.

Organ Diagrams

Date _____

Directions: Label and color the major organs for animals and plants using the codes listed below.

Major Animal Organs

Lungs – blue

Large intestines – yellow

Small intestines – yellow

Stomach – yellow

Brain – purple

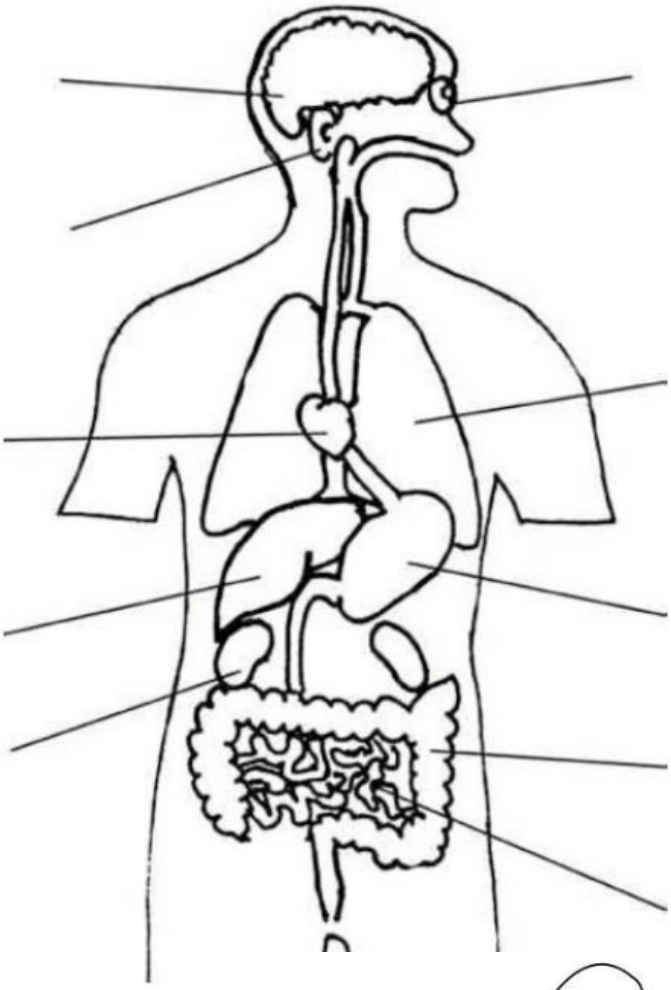
Heart – red

Kidneys – green

Liver – brown

Eyes – light blue

Ears - orange



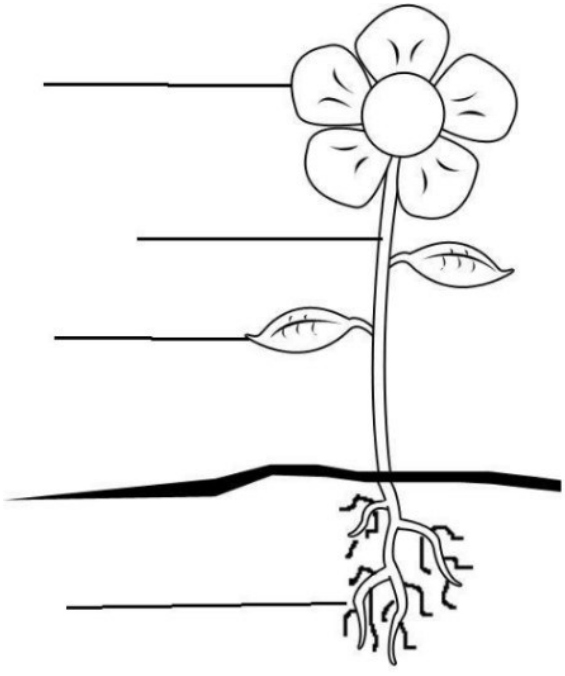
Major Plant Organs

Roots - brown

Stem - Green

Leaves - Green

Flower – Your choice



Animal and Plant Organs

Organs are parts of an organism made of two or more tissues grouped together that perform vital body functions. Organs represent Stage 3 of the Hierarchy of Living Things. There are around 78 organs in the human body (Figure 18). These organs work together in groups called **Organ Systems** to perform bodily functions.

Major Animal Organs

Brain: Controls all thoughts, memory, and voluntary and involuntary actions

Heart: Pumps blood throughout the body

Lungs: Adds oxygen to and removes carbon dioxide from the blood.

Stomach: Takes in food and produces chemicals to begin breaking it down

Intestines: Absorb nutrients and water from foods

Kidneys: Filter blood and produce urine

Liver: Removes toxic materials from the blood

Skin: Protects the inner body, retains moisture, controls temperature, and senses pleasant and painful stimuli

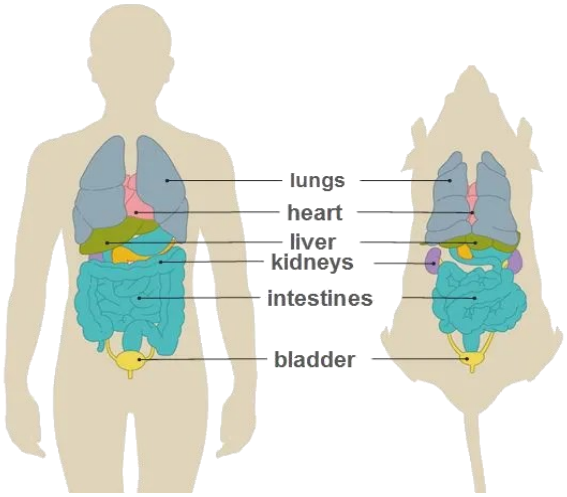


Figure 18: Most animals share many of the same organs. Rats are great models for human research due to their similar organ arrangement and functions!

Major Plant Organs

Roots: Take in water and minerals from soil, hold the plant in the soil, and store extra food.

Stems: Hold plant and leaves upright towards the sunlight and transport water, glucose, and minerals around the plant

Leaves: Perform photosynthesis to make food for the plant

Flowers, Seeds, and Fruit: organs responsible for reproduction

Plant Pressings

Date _____

Directions: After your plant press is finished, carefully tape it to this page. Label the plant organs on the right side of the page, and label the organ systems on the left side.

Plant Organ Systems

An **Organ System** is a group of two or more organs that work together to perform a vital body function. Organ systems are in Stage 4 of the Hierarchy of Living Things.

There are two plant organ systems: The root and the shoot systems (Figure 19).

1. The **Shoot System** supports the plant, performs photosynthesis, and transports sap.
2. The **Root System** takes in water and nutrients from the soil and transports them to the shoot system.

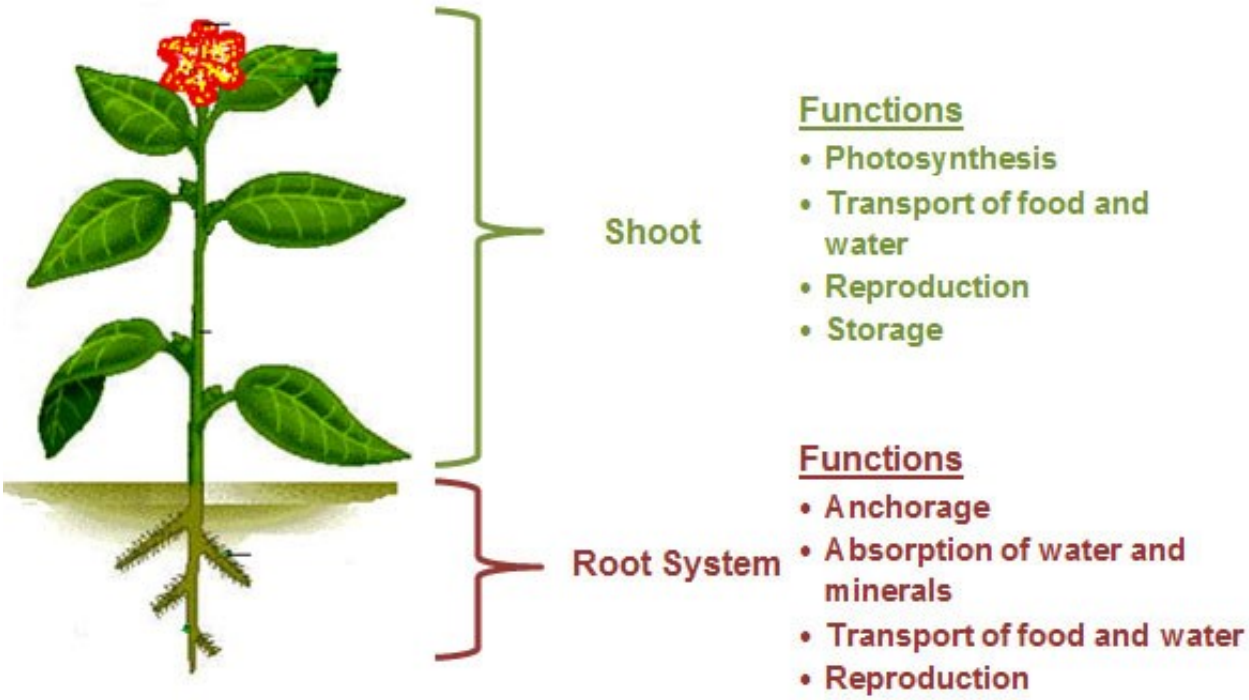


Figure 19: The root system is made up of the root organs, and the shoot system is made up of the stem, leaves, flowers, fruit, and seeds.

Organ Systems Foldable

Date _____

Directions: Use the instructions and the handouts in class to create a Human Body Systems foldable.

Human Organ Systems

There are twelve human organ systems. We will learn about seven of them (Table 1).

All 12 Animal Organ Systems

Table 1: Seven Major Human Organ Systems, Their Organs, and Their Functions.

System	Main Organs	Functions:
Skeletal system	Bones	• Supports your body and gives it shape • Protects your internal organs • Helps you move • Stores substances • Makes blood Cells
Muscular system	Muscles	• Moves your body parts • Moves food through your digestive system • Pumps blood through your circulatory system • Makes you breathe
Digestive system	Mouth, esophagus, stomach, small intestine, liver, gall bladder, pancreas, large intestine, rectum, anus	• Breaks down food into simple substances that your cells can use • Gets rid of solid wastes from digestion
Excretory system	Kidneys, ureters, bladder, urethra, skin, lungs	• Removes liquid waste and waste gases
Respiratory system	Mouth, nose, trachea, bronchi, lungs	• Takes in oxygen from the air you breathe • Gest rid of waste gases (CO_2 and Water Vapor)
Circulatory system	Heart, arteries, veins, capillaries	• Moves blood throughout your body • Delivers nutrients and oxygen to all cells • Removes carbon dioxide and wastes from cells • Helps fight disease
Nervous system	Brain, spinal cord, nerves, sense organs	• Controls all other systems in your body • Receives information about your environment • Stores memories • Allows you to think

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Formulas and Equations

Area

$$area = length\ x\ width$$

Volume

$$volume = length\ x\ width\ x\ height$$

$$volume = total\ volume - water\ volume$$

$$volume = \frac{mass}{Density}$$

Mass

$$mass(kg) = Weight(lb) \div 2.2\ {}^{lb}/_{kg}$$

$$mass = Density\ x\ volume$$

Density

$$Density = \frac{mass}{volume}$$

Force and Weight

$$Force(N) = mass(kg)\ x\ accelearation\ ({}^{m}/_{s})$$

$$Weight\ (N) = mass\ (kg)\ x\ gravity\ ({}^{m}/_{s})$$

$$Weight(N) = Weight(lb)\ x\ 4.488\ {}^{N}/_{lb}$$

$$Weight(lb) = mass(kg)\ x\ 2.2\ {}^{lb}/_{kg}$$

$$Weight(lb) = Weight(N)\ x\ 0.225\ {}^{lb}/_{N}$$

Photosynthesis

$$6CO_2 + 6H_2O \xrightarrow{Light} C_6H_{12}O_6 + 6O_2$$

Cell Respiration

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

Lab Tools

Glassware

Beaker

Graduated cylinder

Test tube

Weighing devices

Triple-beam balance

Two-pan balance

Spring scale

Digital scale

Misc. equipment

Pipette

Syringe

Well tray

Basin

Funnel

Observation Equipment:

Proscopes

Magnifying Lens

Measuring Temperature

Mercury thermometer

Digital thermometer

Measuring Distance

Rulers

Meter stick

Tape measure

Hodometer

Caliper

Measuring time

Pendulum

stopwatch

Measuring volume

Graduated cylinder

Overflow container

Syringe

Lab Safety

General Guidelines

• Do not perform any unauthorized experiments.

• No food or drink in the lab space.

• Always be aware of your surroundings and ensure that you can't accidentally knock something over (e.g. books and binders can easily break glassware). Lab equipment can be very expensive.

• Always keep your hands away from your face while in the lab and wash your hands after any experiments where hazardous chemicals are used.

• Your lab space should look exactly like how you arrived, and should be clean and dry once your are completed.

• You should know the names of every piece of lab equipment you are expected to use in that particular lab; failure to do so may result in you not participating or receiving credit for that lab.

• Be respectful of your classmates; disruptive behavior will not be tolerated.

• Accidents happen. If glass breaks or something occurs, please inform the teacher. Broken glass should always be discarded in cardboard glass disposal containers. Find that disposal in each room.

Safety Equipment

• You will occasionally use mild acids and should know where the eye wash station is.

• When applicable, safety goggles and/or aprons should be worn. Your teacher will let you know when/if those items are necessary.

Your Notes:

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