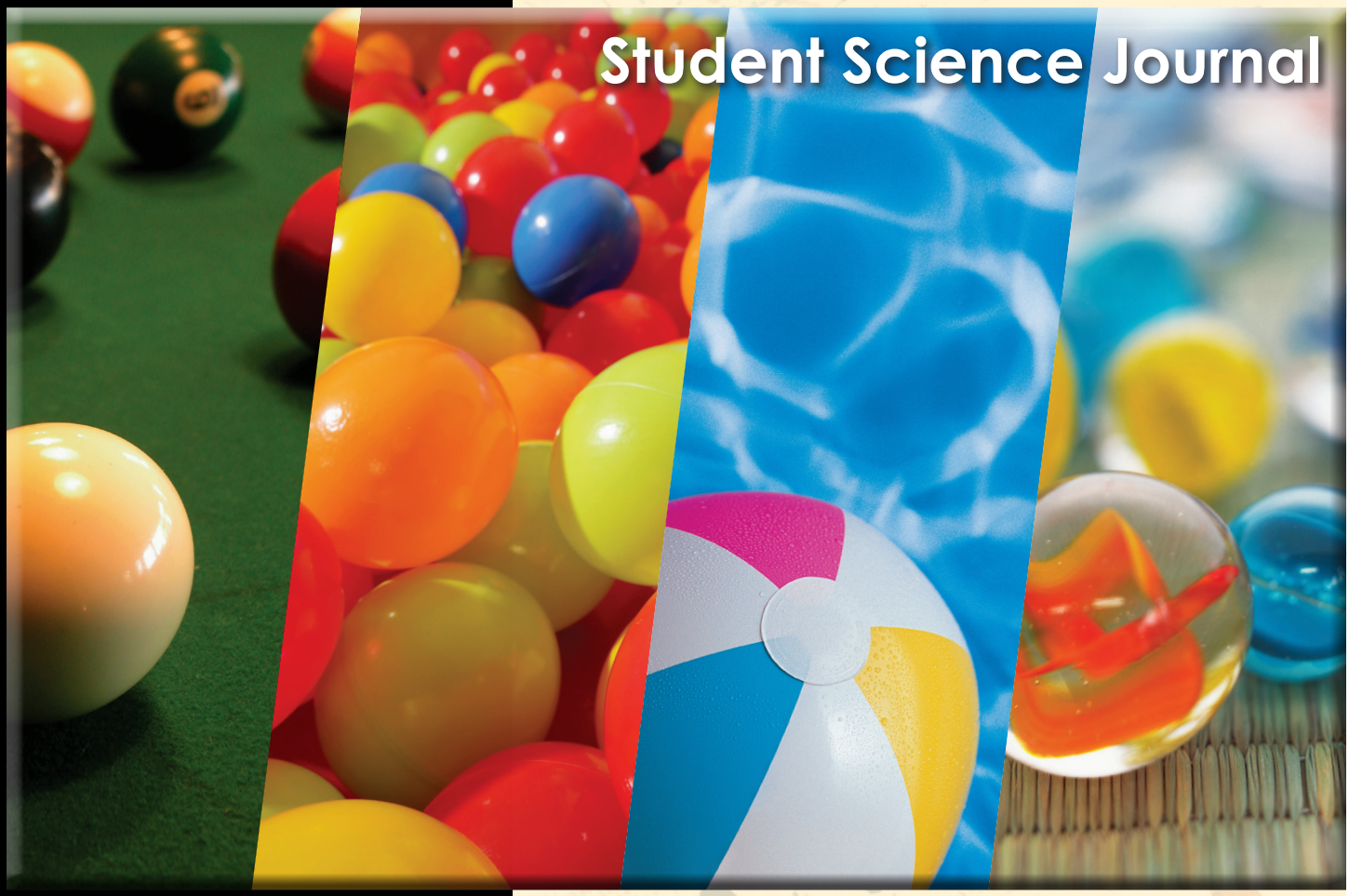
Toys Matter



Structure and Properties of Matter

Name: _____

BOCES 4 Science

Contents

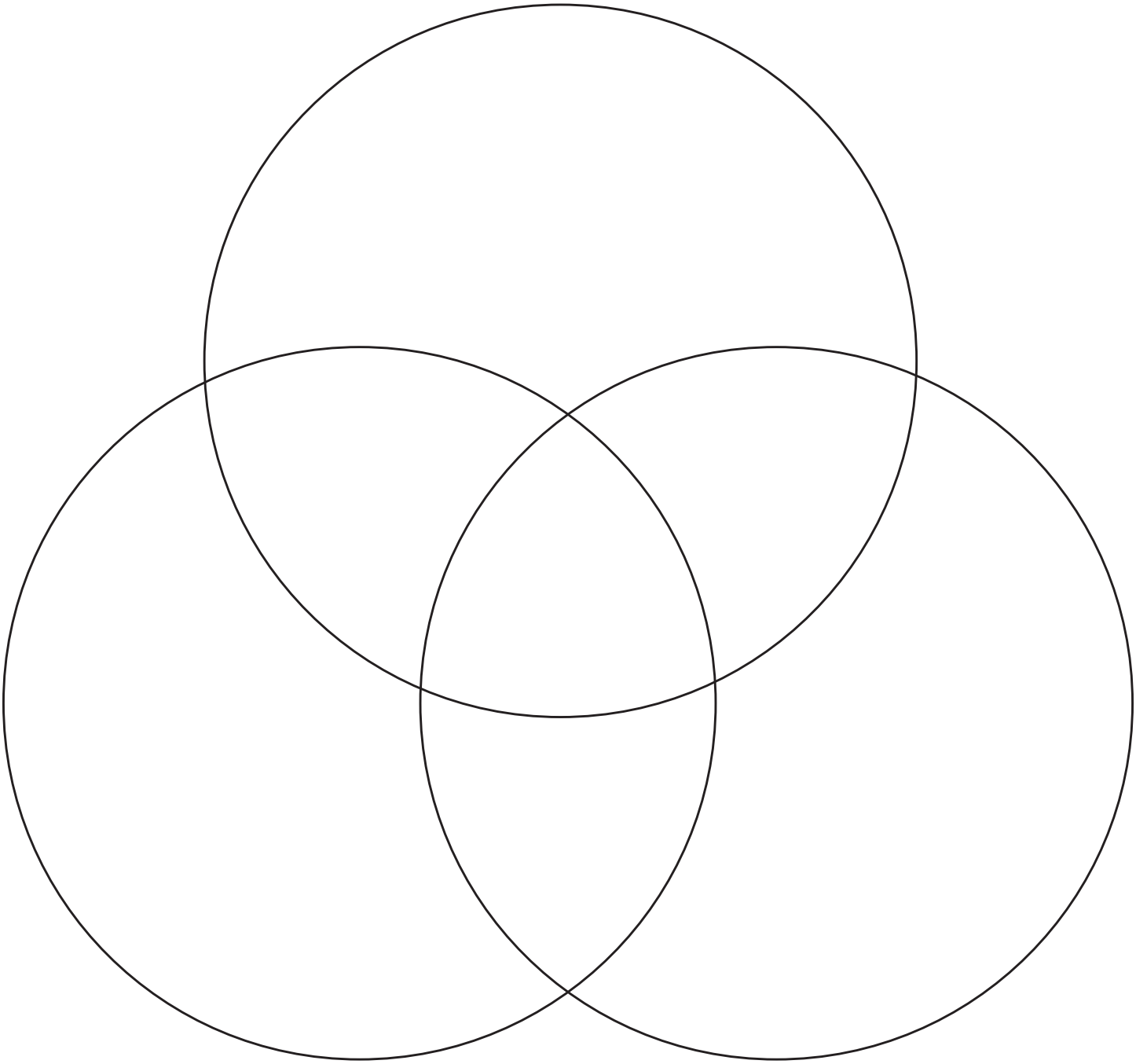
BOCES 4 Science

Monroe One Educational Services • Monroe 2–Orleans BOCES • Genesee Valley BOCES • Wayne-Finger Lakes BOCES

Lesson 1 - Matter Matters

A. Directions: Observe the 3 toy balls at your station using your senses and the tools provided. Record each ball's characteristics in the Venn diagram below.

Ball 2:_____

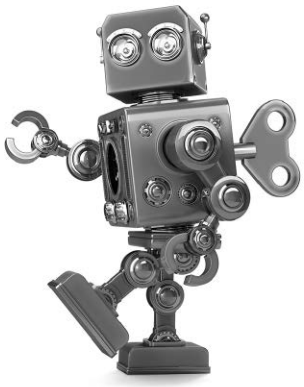


Ball 1:_____ **Ball 3:**_____

B. Directions: A **PROPERTY** is a characteristic of a substance. In the chart below, organize the characteristics from your Venn diagram into properties. An example has been provided.

EXAMPLE Property: **COLOR**	**Property 1:**	**Property 2:**
• Blue • Clear with pink sprinkles • Rainbow stripes		
Property 3:	**Property 4:**	**Property 5:**
Property 6:	**Property 7:**	**Property 8:**

Materials Engineering



What Materials Engineers Do
Materials engineers research, develop, and test materials to create a wide range of products, including toys, computer chips, aircraft wings, golf clubs, and medical devices. They study the properties of substances in order to create new materials.

Work Environment
Materials engineers work with computers and design equipment. They may work in offices, factories, or laboratories.

Duties
- Plan and test new projects with other engineers
- Prepare budgets and write reports
- Supervise technicians
- Monitor how materials perform and deteriorate
- Determine causes of product failure and develop new ways to overcome such failure
- Evaluate the impact of materials on the environment

How to Become a Materials Engineer
Students interested in studying materials engineering should take high school courses in science, math, and computer programming. Entry-level jobs in materials engineering require a college degree.

Important Skills
- Problem-solving
- Analyzing
- Speaking
- Writing

Pay
$94,610 annually, compared to $37,690 average wage

Lesson 2 - Take a Closer Look

Question: What will happen when water is added to Secret Sand?

Background: (Observe the Secret Sand using your senses. Create a labeled model based on your observations.)

Hypothesis: (Make a prediction: "If I do this, then I think this will happen because…" and explain why.)

If I add water to the Secret Sand,

then...

_____

_____

_____

because...

_____

_____

_____

Lesson 2 - Take a Closer Look *(cont.)*

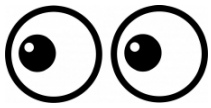
Investigation: DO NOT add water to the Secret Sand until you are instructed to do so. At that time, carefully pour your water into your cup of Secret Sand.

Data: (Draw a labelled model of your observations now that you have added water to the Secret Sand.)

Conclusion: (Follow the CER (Claim Evidence Reasoning) format to answer the question addressed in this investigation. Be sure to tie in what you have learned in this lesson.)

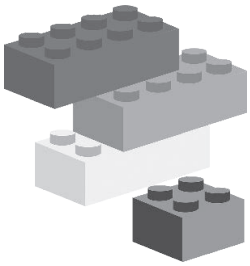
Lesson 2 - Take a Closer Look *(cont.)*

Directions: With a partner, complete these activities in any order at your own pace. Do your best to perform all 5 in the time provided.



Activity C	**Explore with the box of pepper and a magnet!**
What stuck with you?	
Activity L	**Magnify a piece of colored newsprint with a pocket scope!**
What stuck with you?	
Activity O	**Continually cut Floam® into smaller and smaller pieces using safety scissors!**
What stuck with you?	
Activity S	**Break, then smash, then submerge a sugar cube in water and shake!**
What stuck with you?	
Activity E	**Experiment with syringes and tubing!**
What stuck with you?	

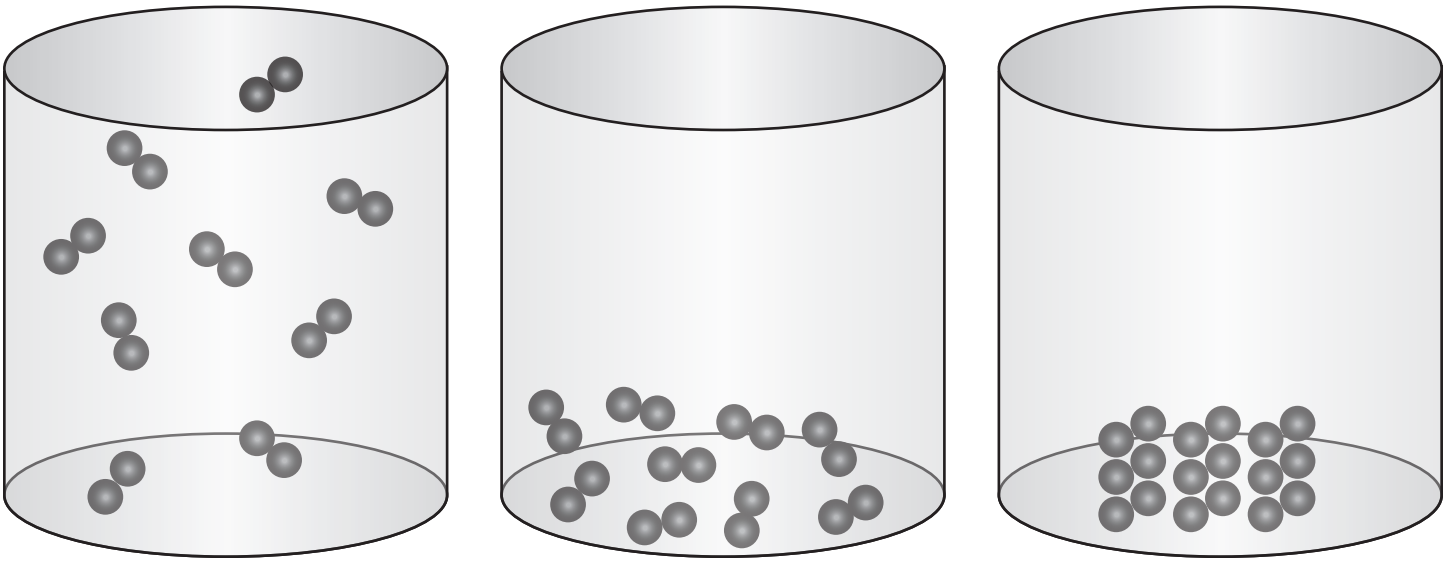
Directions:



1. Choose a toy that connects to one of the activities from this lesson. You may use the list below or your own example: **Magna Doodle®, Etch A Sketch®, invisible ink, LEGO® blocks**
2. Draw a labeled model of the toy that:
   - **a)** Describes how it is modeled after something in science
   - **b)** Demonstrates how matter is made of particles too small to be seen

Look, See, Wonder

Directions: LOOK at the model below. Label it with what you SEE (observations) and what you WONDER (questions).



Alka-Seltzer® Investigation

A. Directions:

1. Add water to ziplock bag.
2. Remove air from the bag.
3. Seal the bag, leaving an opening big enough for the Alka-Seltzer tablet to fit in.
4. Drop the Alka-Seltzer tablet into the bag.
5. Quickly seal the bag completely closed.
6. In the box below, draw a model and label it with your observations and questions.

B. Directions: Choose a question (one from the list or one of your own) and predict what you think will happen and why, taking into consideration what you learned today about phases and particles. You will get a chance to investigate this idea in a future lesson.

Question:

_____

_____

_____

Hypothesis: (Make a prediction: "If I do this, then I think this will happen because…" and explain why.)

If...

_____

_____

_____

then...

_____

_____

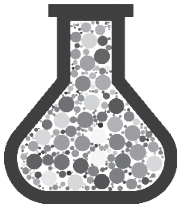
_____

because...

_____

_____

_____



1. Choose a toy.

_____

(Examples: bubbles, water gun, punching bag, balloons, etc.)

2. Circle its phase(s):

solid **liquid** **gas**

3. Explain why it is important that the toy is made from particles in this phase of matter.

4. Predict how the toy would act differently if it was made from particles in a different phase.

Task A. Volume of Regular-shaped Solids

Volume
The amount of space an object takes up

1. How many 1.0 cm cubes were needed to fill the container?

VOLUME = _____ cubic centimeters (cm^3)

2. Record the container's measurements in the chart below, then calculate its volume using the formula:

VOLUME = Length x Width x Height (L x W x H)

Volume of CONTAINER						
Length (cm)	**X**	**Width (cm)**	**X**	**Height (cm)**	**=**	**Volume (cm^3)**
	X		X		=	

3. Did the volume stay the same? (circle one) **YES** **NO**

4. Use the centimeter ruler to measure the length, width, and height of a block. Then, calculate its volume using the formula.

Volume of BLOCK						
Length (cm)	**X**	**Width (cm)**	**X**	**Height (cm)**	**=**	**Volume (cm^3)**
	X		X		=	

Task B. Using the Triple Beam Balance

Mass
The amount of material in an object

Directions: Use a triple beam balance to find the mass of your rectangular block, along with some small objects found around the classroom.

Object	Mass (g)
Rectangular Block	

Task C. Mass of Solids

1. Before opening the bag, rank the objects in order from lightest (1) to heaviest (3) in the table below based on your prior knowledge of the materials. This is your "Sight Prediction."

2. Open the bag and take turns putting the objects in your hand. Rank the objects in order from lightest (1) to heaviest (3) in the "Touch Prediction" column of the table based on how they feel.

3. Measure the mass of each object with the triple beam balance and record its actual mass to the nearest tenth of a gram (0.1 g).

Object Material	Sight Prediction	Touch Prediction	Actual Mass (g)
Wood			
Metal			
Plastic			

4. Make a summary statement about mass. Use evidence from what you found to support your argument.

_____

_____

_____

_____

_____

_____

Task D. Volume of Liquids

1. Predict if each container is holding an amount of water less than, more than, or equal to 35.0 mL. Record your predictions in the table that follows.

2. Measure the volume of the red and green water by pouring the water into the empty graduated cylinders. Record the measurements in the table.

Water Color	Prediction: 35.0 mL > = <	Actual Volume (mL)
Blue	=	35.0 mL
Red		
Green		

3. Why do you think the volume of each liquid looked different in different containers? Support your argument with evidence from what you have learned about liquids.

Task E. Mass of Liquids

1. Observe the materials provided.
2. Discuss how you can find the mass of the water.
3. Write or draw your group's plan in the space below.

4. When your plan is complete, raise your hand for a procedure card. Follow it using the workspace below:

Workspace

Task F. Volume of Irregular-shaped Solids

1. Observe the materials provided.
2. Discuss how you can find the volume of the pig.
3. Write or draw your group's plan in the space below.

4. When your plan is complete, raise your hand for a procedure card. Follow it using the workspace below:

Workspace

Task G. Gases

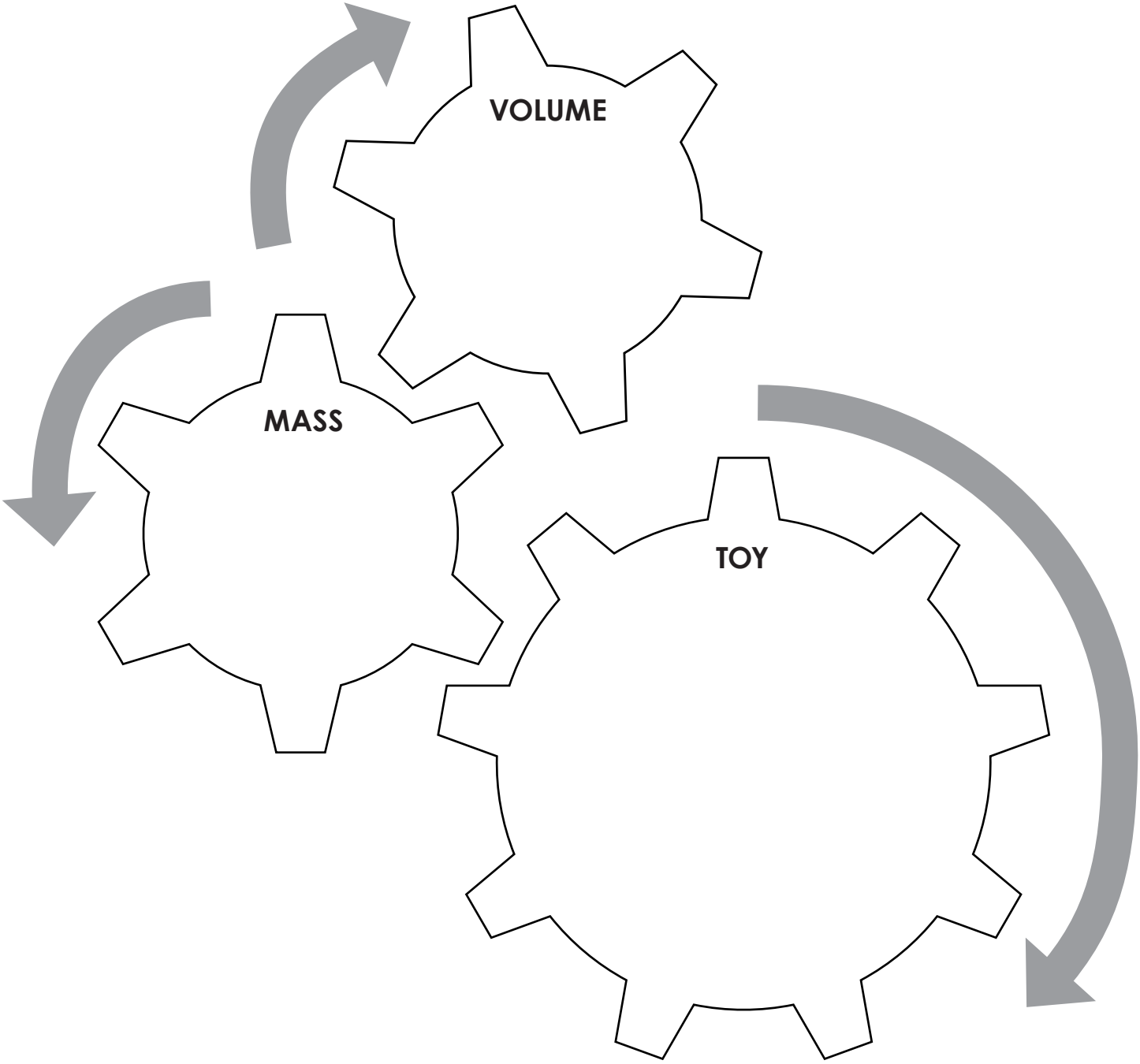
Braindump

Task H. Don't Lose Your Marbles!

Challenge
Prove a marble is matter in the workspace below using any or all of the materials provided!

Directions: Choose a toy, and explain why its properties of mass and volume are important to its function.

(EXAMPLES: marbles, bowling ball, kite, baseball bat, beach ball, etc.)



Physical Property

DEFINITION

Characteristic that can be observed without changing the chemical identity of a substance

EXAMPLES

Size
Color
Texture
Mass
Volume

Chemical Property

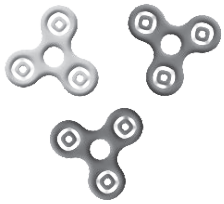
DEFINITION

Characteristic that describes a substance's ability to change into a new substance

EXAMPLES

Flammability
Ability to rust
Reactivity to acid

Station Rotation



Directions:

1. Observe properties of each object and classify them as physical or chemical.
2. Think about each object's function, and explain how its particular properties (rather than different ones) are related to its function.

Station #_____

Object 1:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Object 2:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Station #_____

Object 1:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Object 2:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Station #_____

Object 1:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Object 2:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Station #_____

Object 1:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Object 2:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Station #_____

Object 1:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Object 2:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Station #_____

Object 1:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Object 2:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Station #_____

Object 1:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Object 2:	
Properties	**Physical or Chemical?**
	P C
	P C
	P C
Function-Property Relationship:	

Directions: Choose a toy, and predict what would happen if you changed one of its physical or chemical properties.

1. Toy

2. Property to Change

3. Physical or Chemical?

4. Prediction

5. Explanation

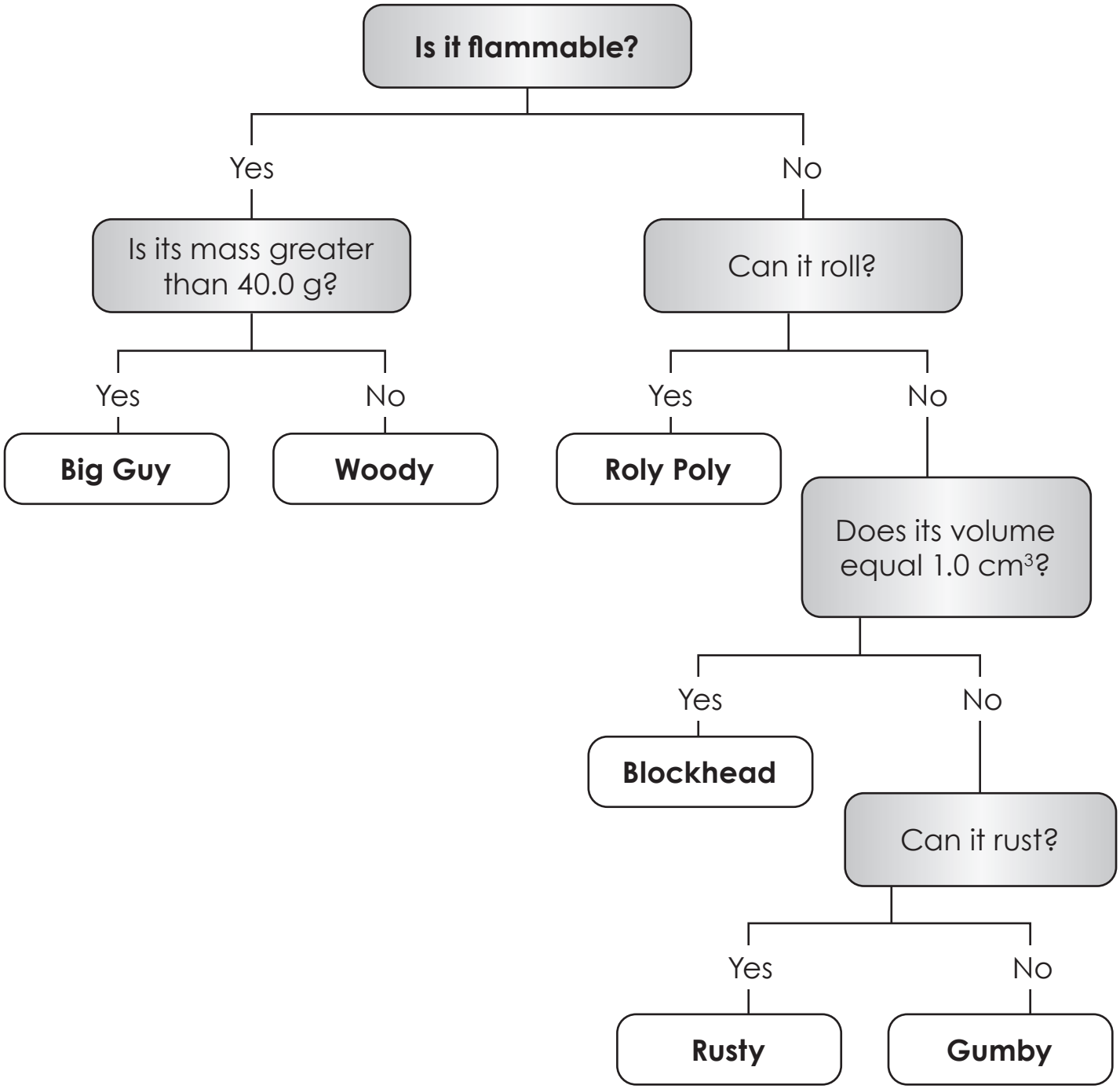
One Minute Write

Directions: Reflect on the activity you just completed. Think about why you might have done that and about other times when you might need to do something like that again in everyday life.

Dichotomous Key

Directions:

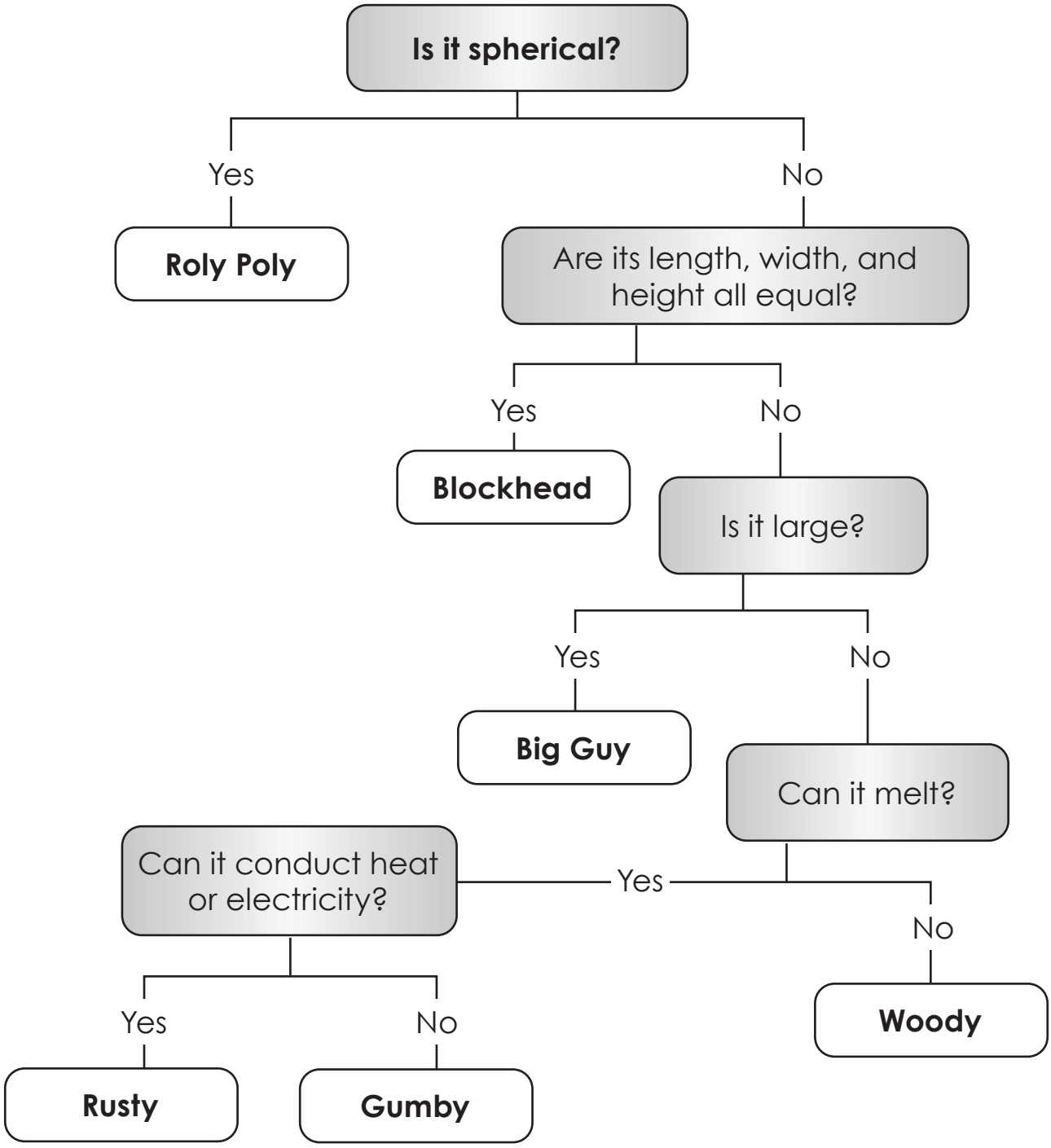
1. Choose an item.
2. Starting at the top, answer the "YES" or "NO" questions until you identify the item.
3. Repeat with the next item. In the end, each item should have its own, separate identity.



Dichotomous Key

Directions:

1. Choose an item.
2. Starting at the top, answer the "YES" or "NO" questions until you identify the item.
3. Repeat with the next item. In the end, each item should have its own, separate identity.



Materials Engineer Challenge

Task: Design a dichotomous key that can help guide customers in identifying the toy ball that best meets their needs. Construct a series of "YES" or "NO" questions to sort the toy balls until every item has been separated.

Toys Matter Catalog Spec Sheet

Directions: Choose a Mystery Toy. Write 3 "YES" or "NO" questions, and circle the correct answer. Then, trade with a classmate and see if he or she can guess the toy!

Question 1

Yes No

Question 2

Yes No

Question 3

Yes No

Guess the Mystery Toy

Charting Changes

Directions: Choose 4 items to change. Chart the changes below.

Cause		Effect
	1	
	2	
	3	
	4	

Physical Change

DEFINITION

A change that does not form a new substance

EXAMPLES

Cutting
Folding
Freezing
Boiling
Dissolving

Chemical Change

DEFINITION

Process by which a new substance is formed

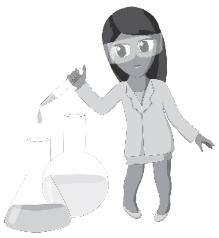
EXAMPLES

Nail rusting
Match burning
Cake baking
Banana rotting
Egg frying

INDICATORS

Color change
Temperature change
Gas bubble formation
Precipitate formation

Classifying Changes



Directions: As you follow the directions for each station, record your observations and inferences in the charts that follow.

Station 1

Penny, Salt & Vinegar

Directions:

1. Use a dull, dirty penny for this investigation.
2. Put the penny into the cup.
3. Sprinkle some of the salt onto the penny.
4. Add 4 – 5 drops of vinegar to the penny.
5. Wait for about 30 seconds.
6. Now, add more vinegar and observe what happens.

Station 1			
	Penny	**Salt**	**Vinegar**
Properties Before Investigation			
Observations During Investigation			
Properties After Investigation			
Type of Change	**Physical**	**Chemical**	
Evidence to Support Argument			

Station 2

Water, Epsom Salt & Washing Soda

Directions:

1. Fill two medicine cups ½ full of water.
2. Dissolve ½ a spoonful of Epsom salt in one cup of water.
3. Dissolve ½ a spoonful of washing soda in the other cup of water.
4. Now, begin pouring the Epsom salt mixture into the petri dish near one edge of the dish.
5. At the opposite edge of the petri dish, begin pouring the washing soda mixture.
6. Observe what happens when the two mixtures meet.

Station 2			
	Water	**Epsom Salt**	**Washing Soda**
Properties Before Investigation			
Observations During Investigation			
Properties After Investigation			
Type of Change	**Physical**	**Chemical**	
Evidence to Support Argument			

Station 3

Sugar Cube & Water

Directions:

1. Fill the medicine cup ¾ full of water.
2. Carefully place the sugar cube into the water.
3. Observe what happens.

Station 3		
	Sugar Cube	**Water**
Properties Before Investigation		
Observations During Investigation		
Properties After Investigation		
Type of Change	**Physical**	**Chemical**
Evidence to Support Argument		

Change Sort Card

Directions: After you have sorted the cards into Physical Change and Chemical Change categories, use the space below to explain your thinking.

Physical Change

Which card? _____.

Explain your thinking and be sure to give specific evidence to support your claim.

_____

_____

_____

_____

_____

_____

Chemical Change

Which card? _____.

Explain your thinking and be sure to give specific evidence to support your claim.

_____

_____

_____

_____

_____

_____

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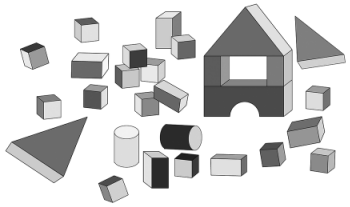
Lesson 7 - Change Challenge *(cont.)*

Directions: Pick a toy that changes as you play with it. Describe the change, and identify whether it is **physical** or **chemical**. Explain your reasoning.

(EXAMPLES: play dough, invisible ink, LEGO blocks, light up/glowing toy, etc.)



Toy

Change

Physical **OR** **Chemical**

(circle one)

Explain

Lesson 8 - Conservation Conundrum

DAY 1: Vinegar and Baking Soda

P: Predict

Based on past experience, predict what you think will happen when vinegar is mixed with baking soda.

O: Observe

Draw a labeled model of your observations. Your model should indicate whether the demonstration showed a **physical** or **chemical** change and explain why.

DAY 2: Alka-Seltzer

Q: Question

With your partner, write a research question testing the Law of Conservation of Matter by making a change to the Alka-Seltzer investigation.

I: Investigate

Procedure:
Data:

E: Explain

Follow the CER (Claim Evidence Reasoning) format to answer the question addressed in this investigation.

Lesson 8 - Conservation Conundrum *(cont.)*

Directions: Physically change the shape of your play dough, and draw it below. Then, answer the question that follows.

1. Play dough before:

2. Play dough after:

3. How does this change relate to the Law of Conservation of Matter?

Lesson 9 - Master Materials Engineer Exam (MMEE)

Day 1 Task: With a partner, choose one of the Toys Matter Bouncy Ball Recipe Cards. Complete the Evaluation Form below as you follow the recipe to create your bouncy ball.

Evaluation Form: RECIPE CARD # _____				
	Water	**Borax**	**Glue**	**Cornstarch**
Properties Before Investigation				
Observations During Investigation				
Properties After Investigation				
Type of Change	**Physical**		**Chemical**	
Evidence to Support Argument				

Day 2 Task: You must create a new, better bouncy ball by making one change to the recipe card you followed. Use your Evaluation Form to guide you, and document your work so that others can re-create your bouncy ball. Be sure to demonstrate the knowledge you built throughout this training program as you engage in the engineering design process. Good luck!

Ask: What is the problem?

Imagine: Brainstorm ideas.

Plan: Choose an idea.

Create: Build it!

Experiment: Test it!

Improve: How did it work?

TOYS MATTER

Job Application for Materials Engineer

Self-Evaluation				
Rate yourself on your performance throughout this training program:				
0	**1 Novice**	**2 Developing**	**3 Effective**	**4 Highly Effective**
Comments:				

Qualifications
Summarize what you have learned here at Toys Matter.

Mission Statement
Describe what you can do if hired as a Materials Engineer.

Glossary

Chemical change – process by which a new substance is formed; indicators include: color change, temperature change, gas bubble formation, precipitate formation.

Chemical property – characteristic that describes a substance's ability to change into a new substance; flammability, ability to rust, reactivity to acid.

Dichotomous key – a tool that allows the user to determine the identity of items in the natural world; consists of a series of choices that lead the user to the correct name of a given item; "dichotomous" means "divided into two parts".

Gas – phase of matter in which the particles are moving fastest and furthest apart; has no definite volume or shape.

Law of Conservation of Matter – matter can neither be created nor destroyed; the mass of an object or collection of objects never changes, no matter how the parts are rearranged.

Liquid – phase of matter in which the particles are able to move around; has a definite volume but no definite shape.

Mass – the amount of material in an object.

Matter – anything that has mass and volume (takes up space).

Particle – a tiny piece of matter.

Phase – form or state of matter; solid, liquid, gas.

Physical change – a change that does not form a new substance.

Physical property – characteristic that can be observed without changing the chemical identity of a substance; size, color, texture, mass, volume.

Property – a characteristic of a substance; i.e. color, shape, texture, etc.

Solid – phase of matter in which the particles are closest together; has a definite volume and shape.

Volume – the amount of space an object takes up.

Notes

Notes

	0	1 Novice	2 Developing	3 Effective	4 Highly Effective
1. I can develop a model to describe that matter is made of particles too small to be seen.					
Lesson 2					
Lesson 3					
2. I can measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances the total amount of matter is conserved.					
Lesson 8					
3. I can make observations and measurements to identify materials based on their properties.					
Lesson 1					
Lesson 4					
Lesson 5					
Lesson 6					
4. I can conduct an investigation to determine whether the mixing of two or more substances results in new substances.					
Lesson 7					
Lesson 9					

BOCES 4 Science

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