Student Workbook

Manufacturing and Design Journal

California Education and the Environment Initiative
Science Standard 6.6.c.

Manufacturing and Design Journal

Name: _____

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Natural Formation of the Resource

↓

Extraction or Harvesting of the Resource

↓

Processing of Raw Material(s) from the Resource

↓

Manufacturing of Finished Products from Raw Material(s)

↓

Sale of Finished Products for Use

↓

Use of the Finished Products

↓

Disposal of the Finished Products (including reusing, recycling, and composting)

Raw Material	Natural Resource Category	Common Uses in Manufactured Products	Method of Extraction or Harvesting
Bauxite	Mineral ore	Aluminum objects	Surface mining
Clay	Mineral ore	Dinnerware, pottery, tiles for floors and walls, buildings	Surface mining
Copper	Mineral ore	Electrical wires, batteries, cookware, plumbing pipes, coins	Surface mining
Cotton	Plant	Thread, fabric, batting, oil (cottonseed), cottonseed meal (used in livestock feed)	Collecting the seed pod from the plant
Gelatin	Animal	Glue	Rendering animal bones
Graphite	Mineral ore	Pencil lead (which contains graphite, not lead), batteries, lubricants, and paint	Surface mining
Iron	Mineral ore	Frames for buildings, bridges, and other structures; tools; cookware; steel; batteries; and magnets	Surface mining
Leather	Animal	Clothing, bags, fasteners	Skinning the hide from dead livestock

Raw Material	Natural Resource Category	Common Uses in Manufactured Products	Method of Extraction or Harvesting
Limestone	Mineral ore	Fiberglass, building, roads, landscaping, and cement	Surface mining
Petroleum	Fossil fuels	Plastics, paints, synthetic fabrics (PVC), synthetic rubber, foams, thread	Deep drilling
Resin (rosin)	Plant	Shellacs, cements, musical instrument strings	Collecting the sap from living trees
Rubber (natural)	Plant	Tires, gaskets, insulation, elastic fabrics and fasteners, foams, hoses	Collecting the sap from living trees
Silica/Quartz	Mineral ore	Glass (and fiberglass), silicon for computer chips, jewelry, lenses, concrete, electronics, abrasives	Surface mining
Soda ash	Mineral ore	Glass (and fiberglass), and food sweetener	Underground mining
Tin	Mineral ore	Cans, containers, soldering material	Surface mining
Wood/timber/ pulp	Plants	Houses, floors, furniture, tools, paper	Cutting the stalk off the root (logging)

Name: _____

Congratulations! You are the new owner of a toy company that makes toys for young children. The first decision you will need to make in your new job is what new toy you want to add to your toy line. Your company can make one of the following kinds of toys:

- **Stuffed animal** or **action figure**
- **Sports equipment** (balls, rackets, clubs, bats, and others)

Over the next few lessons, you will design a plan to produce your toy. Your plan will include all stages of manufacturing. These stages will include extracting or harvesting the natural resources and raw materials you need, getting the resources to the factory, and putting the toy together.

Instructions: Follow these steps to get started.

1. Decide on the type of toy your company will make. Write the name and type of toy here:

_____

_____

_____

_____

_____

Name: _____

2. List the parts of your toy in the first column below. Make sure you include at least three parts. Using the **Origins Chart** on pages 3–4 as a guide, identify the raw materials and natural resources you might use to make each part of your toy. Try to think of at least two possible kinds of materials for each part. You will be able to change your choices later.

Parts of Toy	Natural Resources/Raw Materials Needed for Parts

Name: _____

My Toy Company Scoring Tool

Score	Performance
5	Student lists three toy parts and two natural resources for each part.
4	Student lists three toy parts and one or two natural resources for each part.
3	Student lists two toy parts and two natural resources for each part.
2	Student lists only one toy part and two related natural resources, or, Student lists two toy parts and only one natural resource for each part.
1	Student lists only one toy part and one related natural resource.

Name: _____

Instructions: Read each question and select materials to use in making a surfboard.

1. Which material do you want to use for your surfboard blank (deck, nose, rail, and tail)? (Check one.)

_____ Polyurethane foam is one of the easiest materials to shape. Decks made from polyurethane have a smooth finish, which surfers like. Polyurethane is also the least expensive of the materials used for the body of a surfboard. Polyurethane foam is made from petroleum, which is a fossil fuel.

_____ Polystyrene foam is used to make the foam cups you might get at take-out restaurants in some cities. It is one of the most lightweight options available for building surfboards, which means that surfboards made from polystyrene float well in the ocean. Some polystyrene absorbs a lot of water, and polystyrene is not as strong as polyurethane foam. To make it stronger and more waterproof, manufacturers seal the outside of polystyrene blanks with fiberglass. But even a tiny hole in the fiberglass shell can ruin a surfboard. Polystyrene is also made from petroleum, a fossil fuel.

_____ Wood comes from plants and is a renewable resource. In well-managed forests, new trees are planted to replace older ones that are harvested, while protecting soil, air, fish, wildlife, and water resources. Wood is strong and floats, but a wood surfboard is a lot heavier than one made of foam. According to some surfers, wood boards do not perform as well as foam boards. It can also be more expensive to make a surfboard out of wood than out of foam.

_____ Biofoam is made from the sap of plants, which is renewable. This type of foam is easy to shape and has a smooth finish, but can vary in color and in how paint sticks to it. Biofoam can be mixed with polyurethane foam to make it stronger and more even in color.

2. Which material do you want to use for your surfboard stringer? (Check one.)

_____ Wood is a renewable resource with strength and flexibility, but it is expensive.

_____ Epoxy is made from petroleum, like polystyrene foam. It is easy to cut. Fiberglass is made from glass threads. Petroleum is a fossil fuel, and silica, which goes into the glass, is a mineral ore. Both are less expensive and lighter in weight than wood.

Name: _____

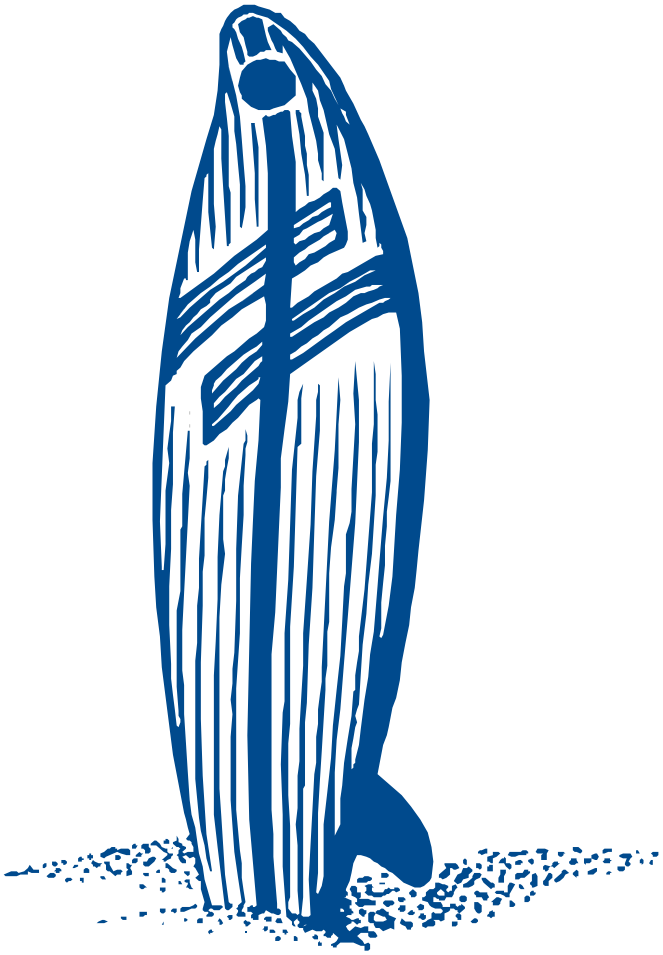
3. Which material do you want to use for your surfboard fin(s)? (Check one.)

_____ Epoxy manufacturers pour petroleum-based epoxy resin into molds and let it harden. Epoxy fins are lightweight and inexpensive.

_____ Fiberglass fins include layers of cloth made from glass thread are criss-crossed and pressed together. Fiberglass fins are strong.

_____ Carbon is actually graphite, a mineral ore. Manufacturers mold it into shape for lightweight, strong, and flexible fins, which bend but do not break.

_____ Aluminum manufacturers form threads of aluminum (made from the mineral ore bauxite) into a cloth and sandwich cloth layers together for thickness and strength. Aluminum is the lightest material used in making fins.



Name: _____

Today's Task

Instructions: Create a blueprint for the toy you want to manufacture. Draw two views of your toy, a map view on this page and a profile view on page 11. Label the parts of your toy on each drawing.

Toy Name: _____

Map View (1 cell = 1 inch)

Name: _____

Profile View (1 cell = 1 inch)

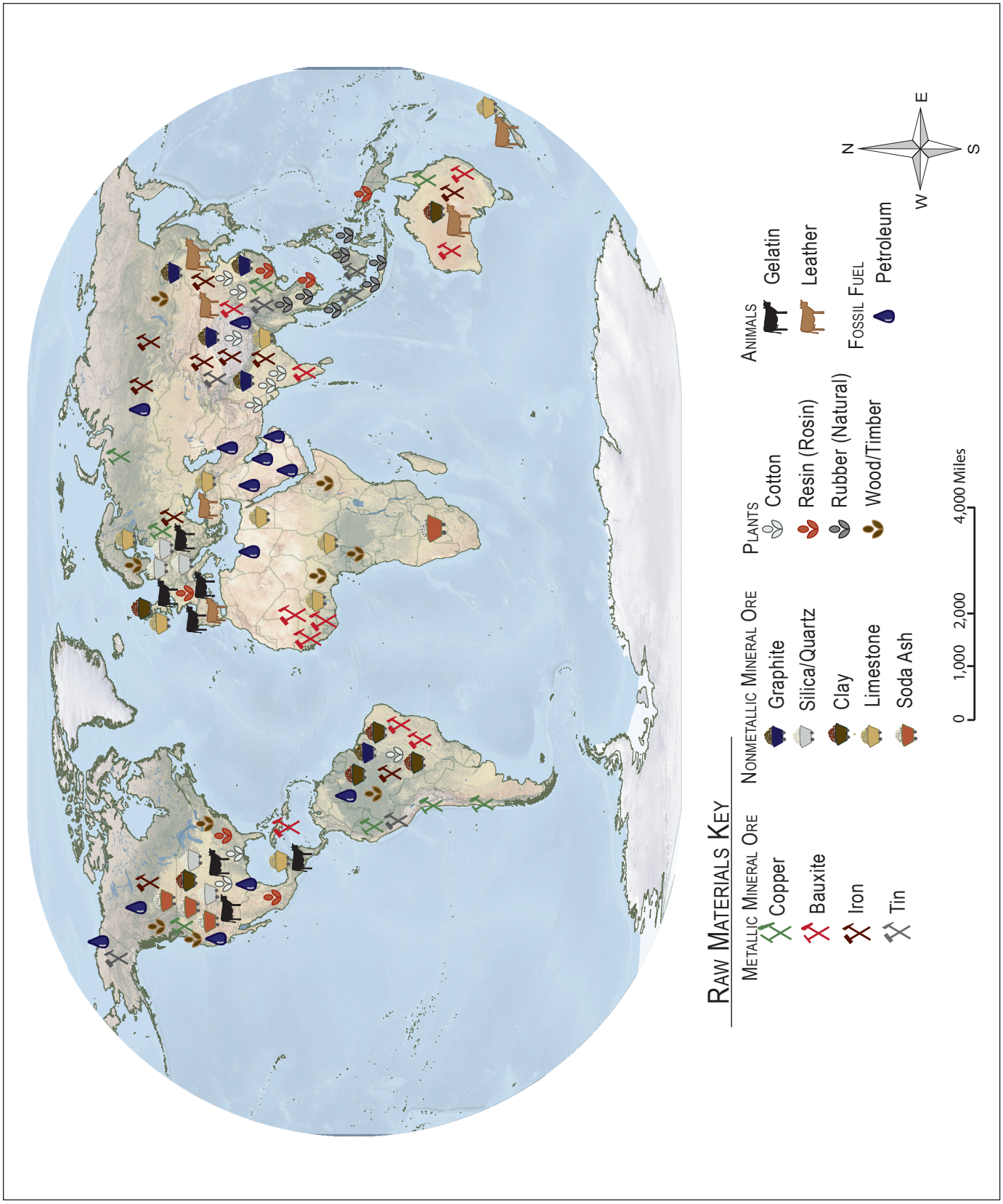
Name: _____

Instructions: List parts of your toy in the first column, include at least three. List the raw materials and natural resources needed for the parts in the second column.

Parts of Toy	Natural Resources/Raw Materials Needed for Parts

Toy Design Blueprint Scoring Tool

Score	Performance
5	Student shows map and profile views of toy, labels at least three major parts, and lists at least two raw materials or natural resources to be used for each part.
4	Student shows map or profile view of toy, labels at least three major parts, and lists at least two raw materials or natural resources to be used for each part.
3	Student shows one view of the toy, indicates and labels three or more major parts, and lists one or two raw materials or natural resources to be used for each part.
2	Student shows one view of the toy, indicates and labels fewer than three parts, and/or lists only one raw material or natural resource to be used for each part.
1	Student draws the toy, but does not label parts or identify raw materials or natural resources.


Raw Materials Key
Metallic Mineral Ore
Copper
Bauxite
Iron
Tin
Nonmetallic Mineral Ore
Graphite
Silica/Quartz
Clay
Limestone
Soda Ash
Plants
Cotton
Resin (Rosin)
Rubber (Natural)
Wood/Timber
Animals
Gelatin
Leather
Fossil Fuel
Petroleum
0 1,000 2,000 4,000 Miles
N
W
E
S

Name: _____

Instructions: Complete the following tasks in the spaces provided. (1 point for completing each line)

Step 1: Write the names of three resources you need to make your toy on the lines labeled "Natural Resource #1," "Natural Resource #2," and "Natural Resource #3."

Step 2: Look at the **Resource Transportation Chart** on page 15. Find your resources on the chart and write the estimated distance on the line labeled "Distance transported."

Step 3: Circle your choice of how you will transport each resource to California.

Step 4: Add all the distances for a total estimate of how far the resources will travel.

Natural resource #1: _____

Distance transported (estimate in miles) = _____

Type of Transportation Needed (circle one):

Truck Train Aircraft Ship

Natural resource #2: _____

Distance transported (estimate in miles) = _____

Type of Transportation Needed (circle one):

Truck Train Aircraft Ship

Natural resource #3: _____

Distance transported (estimate in miles) = _____

Type of Transportation Needed (circle one):

Truck Train Aircraft Ship

Total estimated distance all cargo will travel: _____ miles

Raw Material	Source of Materials	Estimated Distance Transported (miles)
Bauxite	Brazil	6510 miles
Clay	California	100 miles
Copper	Arizona	700 miles
Cotton	Alabama	2125 miles
Gelatin	California	150 miles
Graphite	Arizona	700 miles
Iron	Minnesota	1560 miles
Leather	Texas	1540 miles
Limestone	California	200 miles
Petroleum	Texas	1700 miles
Resin (rosin)	China	6500 miles
Rubber (natural)	Venezuela	4306 miles
Silica/Quartz	California	150 miles
Soda ash	Montana	912 miles
Tin	New Mexico	1000 miles
Wood/timber	California	300 miles

Name: _____

Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Copper Extractor (Miner)

1. How do you do your job? What types of machines, materials, and energy do you use?

_____
_____
_____
_____
_____
_____
_____
_____
_____

2. What is the raw material that you extract?

_____

3. Is the raw material processed before it can be used? How?

_____
_____
_____
_____
_____
_____
_____

Name: _____

Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Cotton Harvester (Farmer)

1. How do you do your job? What types of machines, materials, and energy do you use?

_____
_____
_____
_____
_____
_____
_____
_____
_____

2. What is the raw material that you extract?

_____

3. Is the raw material processed before it can be used? How?

_____
_____
_____
_____
_____
_____
_____

Name: _____

Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Petroleum Extractor

1. How do you do your job? What types of machines, materials, and energy do you use?

_____
_____
_____
_____
_____
_____
_____
_____
_____

2. What is the raw material that you extract?

_____

3. Is the raw material processed before it can be used? How?

_____
_____
_____
_____
_____
_____
_____

Name: _____

Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Silica Extractor (Miner)

1. How do you do your job? What types of machines, materials, and energy do you use?

_____
_____
_____
_____
_____
_____
_____
_____
_____

2. What is the raw material that you extract?

_____

3. Is the raw material processed before it can be used? How?

_____
_____
_____
_____
_____
_____
_____

Name: _____

Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Wood Harvester (Logger)

1. How do you do your job? What types of machines, materials, and energy do you use?

_____
_____
_____
_____
_____
_____
_____
_____
_____

2. What is the raw material that you extract?

_____

3. Is the raw material processed before it can be used? How?

_____
_____
_____
_____
_____
_____
_____

Name: _____

Instructions: Look at the design blueprint(s) of your toy on pages 10–11 and select one natural resource that you will use in making your toy.

Fill in the information below about the extraction or harvesting method used to obtain that resource. Use information from the **Extraction and Harvesting Convention**. (5 points)

Natural resource needed:

_____

Method of getting the resource: (circle one)

Extraction or Harvesting

Describe how this resource is extracted or harvested:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

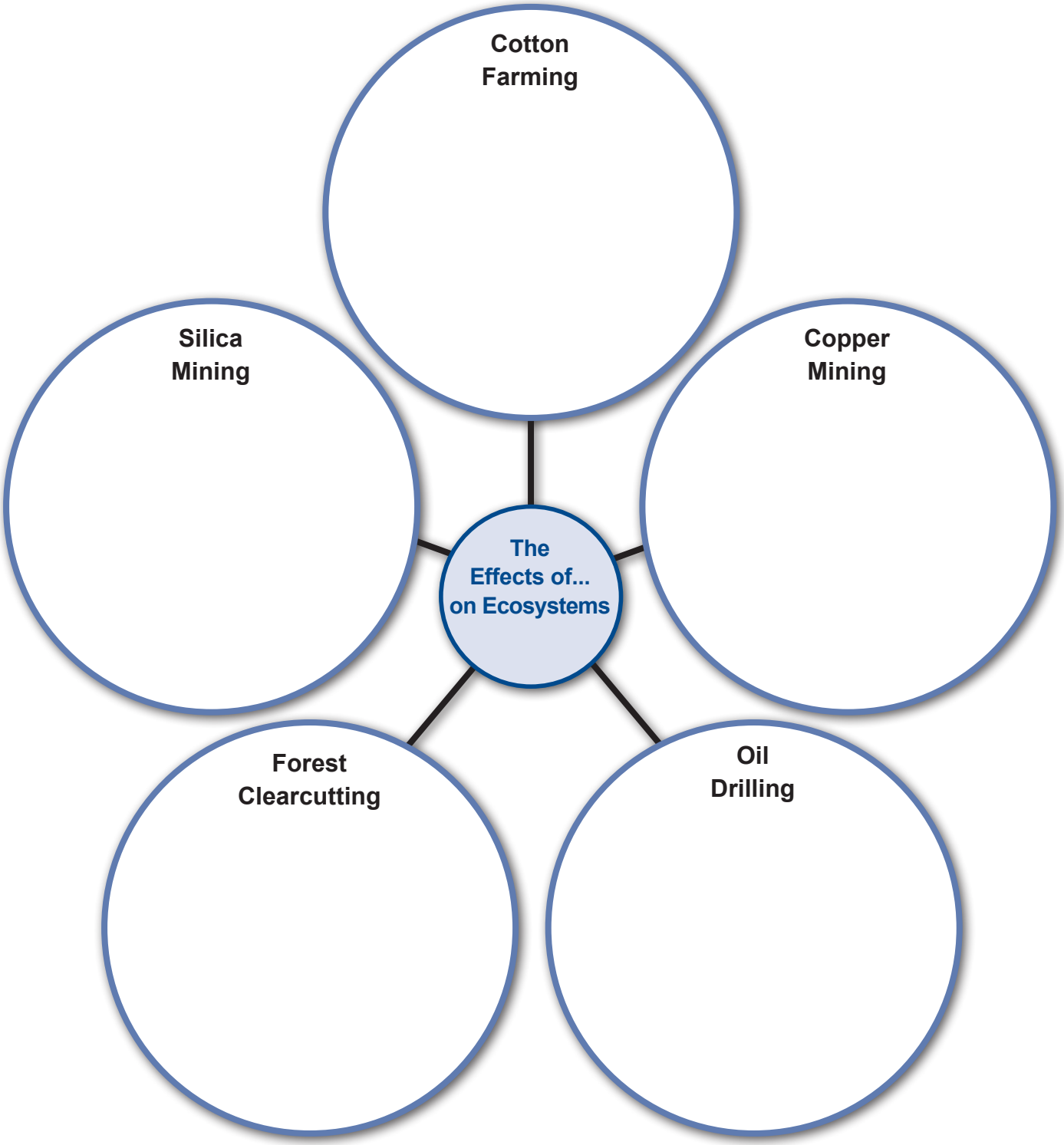
_____

_____

_____

Name: _____

Instructions: Take notes during the lesson on how these activities change ecosystems.



Name: _____

Instructions: Answer the following questions about how the creation of your toy could affect natural systems. Include at least two examples in each of your answers. (3 points each)

1. How can **extracting** or **harvesting** the resources used in your toy affect natural systems?

_____

_____

_____

_____

_____

_____

2. How can **transporting** the resources to the factory that makes your toy affect natural systems?

_____

_____

_____

_____

_____

_____

3. How can **making** your toy in a factory affect natural systems?

_____

_____

_____

_____

_____

_____

Name: _____

4. How can **transporting** the finished toy to stores affect natural systems?

_____

_____

_____

_____

_____

_____

5. Can your toy affect natural systems after it is used? How?

_____

_____

_____

_____

_____

_____

Name: _____

Instructions: Draw an input-output diagram like the one you just created with the class. You may use any of the information in this **Manufacturing and Design Journal** to help you.

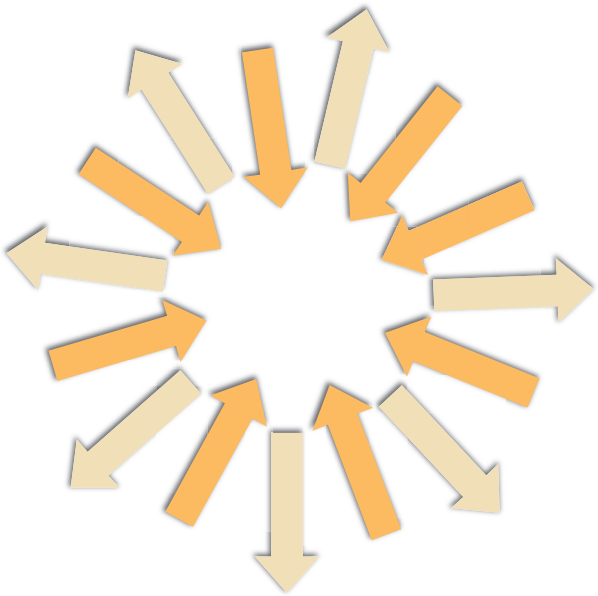
Think about:

Inputs	Outputs
▪ natural resources ▪ raw materials ▪ energy ▪ money	▪ changes to water, land, plants, or animals ▪ leftover materials, emissions

Write the name of your toy in the circle on the next page.

For each **input** you can think of for your toy, draw an arrow pointing *toward* the circle. On the arrow, write what the input is. Show as many inputs as you can.

On the next page, make a diagram like the one below. Draw arrows pointing *away* from the circle for each **output** you can think of. On each arrow, write what the output is. Show as many outputs as you can.



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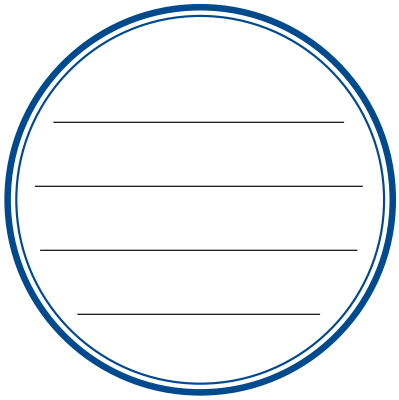

Unit Title: **Made from Earth: How Natural Resources Become Things We Use**
Grade: **6**

Science Standard 6.6.c.

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