Design of a Reindeer Habitat for an Indiana Zoo

Grade Level:	**Total Time Required:**
6	~ 5-6 class sessions (45 minute each)

Prepared By: Şenay Purzer, Venkatesh Merwade, Brad Harriger, David Eichinger, and Erin Doherty

Lesson Objectives:

Students will be able to:

1. Define and give examples of biotic and abiotic factors in a reindeer habitat.
2. Identify requirements for a reindeer habitat.
3. Calculate the area needed for a reindeer based on the given constraints of space & habitat needs.
4. Justify decisions on the habitat such as the amount and location of water sources.

Indiana Standards:

6.LS.4 Investigate and use data to explain how changes in biotic and abiotic components in a given habitat can be beneficial or detrimental to native plants and animals.

6-8.E.1 Identify the criteria and constraints of a design to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Next Generation Science Standards:

S-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ET1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Mathematics Connections:
The design activity requires the students to perform the following mathematical calculations:

- **6.RP.1**
  Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
- **6.RP.2**
  Understand the concept of a unit rate a/b associated with a ratio a:b with b is not equal to 0, and use rate language in the context of a ratio relationship.

Concepts and Vocabulary

Term	***Defined by a scientist or engineer***	***Defined by a student***
Producer	Any organism capable of synthesizing organic material from inorganic compounds. They are formally referred to as *autotrophs* and are nearly all photosynthetically active organisms. Includes plants (both macro- and microscopic), protists such as algae, and some bacteria.	*Someone who makes something *A plant *An item able to make its own food
Consumer	Organisms of a food chain that receive their energy by consuming other organisms. They are formally referred to as *heterotrophs* (includes animals, bacteria, and fungi).	*Someone who buys something *An animal that kills another animal for food
Habitat	An ecological or environmental area that is inhabited by a particular species of organism (plant, animal, or others). It is the natural environment in which a population of organisms lives.	*Where an animal lives Or *The place where a single organism lives (instead of the entire population)
Biotic factor	Any living component that affects another organism, including animals that consume the organism in question, and the living food that the organism consumes.	*Something that is living in an environment
Abiotic factor	Any contribution to the environment that is nonliving (never living, not to be confused with dead). Examples would be temperature, amount of sunlight, pH of the soil and water, moisture, etc.	*Something that is dead in the environment *a nonliving factor in an environment
Population	A group of organisms of the same species that is occupying a given area	A group of people/organisms
Food chain	A sequence of organisms arranged in such a way that each group feeds on the group listed before it. The first group in the chain is always a producer.	
Niche	The position or function of an organism in a community of plants and animals.	What an animal does
community	A group of interdependent plants and animals inhabiting the same region and interacting with each other through food and other relationships	A place where people live
Surface Area	A measure of two-dimensional extent in space.	A measure how much space is covered.
Food web	a series of organisms related by predator-prey and consumer-resource interactions; the entirety of interrelated food chains in an ecological community.	A group of food chains

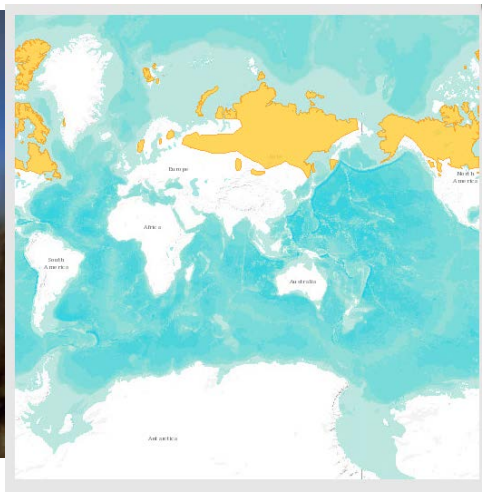
Equipment, Materials, and Tools

Materials		
4”x6” index cards	Glue	12” x 18” sheets of paper
Tape	Area shapes (appendix templates are available for duplication)	Copy paper in multiple colors to use for duplication of area shapes

Tools		
Rulers	Scissors	Scissors

Science Content - Basics

Reindeers: Habitat, Behavior, Food and Reproduction



Reindeers live in tundra (Canada, Norway, Greenland) and woodland (New England, Idaho, Washington, Finland, Russia)

Habitat and Food

Reindeer can be found in Arctic tundra and adjacent boreal forest. In summer, reindeer prefer to move upwards to higher altitudes to escape insects. During insect harassment time, condensed groups protect the animals inside the group from insects, which mostly attack animals on the outside of the group.

Reindeer are ruminants, having a four-chambered stomach. They mainly eat lichens in winter, especially reindeer moss. However, they also eat the leaves of willows and birches, as well as sedges and grasses. Reindeer drink water in the summer; reindeer like the brackish seawater in river estuaries. During winter, they eat snow and lick water from the top of ice formed on rivers.

Group structure and Reproduction

Reindeer live in families (females with calves), and herds. During rut, bulls try to keep harems in the same migratory herds, but often fail. Wood reindeer never form large herds in contrast to their tundra kin. Groups of wood reindeer comprise about 20-30 animals.

Gestation period	228 days
Young per Birth	1
Weaning	at about 6 months
Sexual Maturity	2.5 years
Life span	up to 20 years

Mating occurs from late September to early November. Males battle for access to females. Two males will lock each other's antlers together and try to push each other away. The most dominant males can collect as many as 15-20 females to mate with. A male will stop eating during this time and lose much of its body reserves.

Calves may be born the following May or June. Most mating occurs in October, with the births occurring in late May and early June. Born for speed, a caribou calf can follow its mother within one hour of birth. After 45 days, the calves are able to graze and forage but continue suckling until the following fall and become independent from their mothers.

Migration

The reindeer travels the furthest of any terrestrial mammal, walking up to 5,000 km a year, (although in Europe the animal does not migrate as far), and covering 1,000,000 km2. Normally travelling about 19-55 km a day while migrating, the caribou can run at speeds of 60-80 km/h. During the spring migration smaller herds will group together to form larger herds of 50,000 to 500,000 animals but during autumn migrations, the groups become smaller, and the reindeer begin to mate. During the winter, reindeer travel to forested areas to forage under the snow. By spring, groups leave their winter grounds to go to the calving grounds. Usual movements are walk, trot, and sometimes amble.

A reindeer can swim easily and quickly at 6,5 km/h but if necessary at 10 km/h, and migrating herds will not hesitate to swim across a large lake or broad river.

Predation

There are a variety of predators that prey heavily on reindeer; Golden Eagles and Sea eagles prey on calves and are the most prolific hunter on calving grounds. Wolverine will take newborn calves or birthing cows, as well as (less commonly) infirm adults. Brown bears (in the rare cases where they encounter each other). Polar bears prey on reindeer of all ages but are most likely to attack calves or weak animals.

The wolf is the most effective natural predator of adult reindeer, especially during the winter. As carrion, caribou are fed on by foxes, ravens and hawks.

Blood-sucking insects, such as black flies and mosquitoes, are a plague to reindeer during the summer and can cause enough stress to inhibit feeding and calving behaviors. The population numbers of some of these predators is influenced by the migration of reindeer.

References:

Large Herbivore Network (2012). Reindeer- Rangifer Tarandus. Retrieved from http://www.lhnet.org/reindeer/

Lesson Plan #1

Guiding Question – What does a Reindeer Habitat Look Like?

Time: 45 minutes

Note: This lesson requires students to conduct research using library and Internet sources. This may take up to 2 or 3 class sessions depending on students' prior experiences with conducting searches, access to the library sources, etc.

Procedure:

1. Start a whole class discussion focusing around the following key questions:
   What do you know about reindeers?
   What does a reindeer habitat look like?
   What biome would you find a reindeer in?
   What questions do you have about reindeer?

2. In this class you will create trading cards summarizing the biotic and abiotic components that exist in a Reindeer Habitat.
   What does the term, biotic, mean to you?
   What does the term, abiotic, mean to you?
   Can you give an example a biotic and an abiotic factor along the Wabash River?
   What do you think are examples of biotic and abiotic factors in a reindeer habitat?

3. Students will create four different trading cards. Each card must contain the following information:
   - Front of the card:
     - Name of a biotic or an abiotic component that is found in a Reindeer habitat
     - A picture or drawing
     - Where they are found on earth (location)
     - Description
   - Back of the card:
     - Important facts
     - What it needs from the habitat (needs) or how it helps the Reindeer habitat (purpose)

   Note: Students could prepare trading cards for:
   - *Reindeer or caribou*
   - *Lichens*
   - *Grass*
   - *Fern*
   - *Willow or birch*
   - *Biomes (e.g., tundra)*

4. Take students to the computer lab to research information about the reindeer and their habitat.

5. Students should research the characteristics of a Reindeer habitat and develop a list of biotic and abiotic components that exist in this habitat.

6. Each team should create 4 different trading cards

7. After students gather information, they can trade their card(s) with other students to compare your information and learn more about the topic.

8. Remind student to keep their trading cards to use in future classes. This will help them design a plan for the Reindeer habitat.

Possible Resources:

Reinder (Caribou)	http://www.sandiegozoo.org/animalbytes/t-reindeer.html
European Reindeer	http://www.torontozoo.com/ExploretheZoo/AnimalDetails.asp?pg=394
Smithsonian National Museum of Natural History	http://www.mnh.si.edu/arctic/html/caribou_reindeer.html
The Nature Conservatory	http://www.nature.org/newsfeatures/specialfeatures/animals/mammals/caribou.xml
Reindeer Lichen	http://www.arkive.org/reindeer-lichen/cladonia-mediterranea/#text=Threats

Sample Trading card

front

REINDEER & CARIBOU

(Figure retrieved from http://www.nature.org)

Locations: North America (Caribou Scandinavia and Russia (Reindeer)

Habitat: tundra, mountains, and woodlands

DESCRIPTION:
Reindeer: is a mammal that looks like a large deer and lives in cold climates.
Caribou: is larger than a reindeer and these are wild reindeers that live in the northern parts of North America.

back

IMPORTANT FACTS:
- Males: 20 -51 inch antlers; 200-700 lbs
- Females: 9 - 20 inch antlers;130-370lbs
- Antlers weigh up to 26 lbs
- They are social species.
- They are grazing herbivores.
- An average adult reindeer eats 9 to 18 pounds of vegetation a day.
- They are strong animals that can travel up to 1000 miles to find food
- Predators are bears, wolves, birds of prey

NEEDS or PURPOSE:
- In summer, they eat mosses, herbs, ferns, grasses, and leaves of shrubs and trees.
- In winter, they eat lichen and fungi by scraping the snow away with their hooves.

Lesson Plan #2
Guiding Question – How to Design/Plan a Reindeer Habitat for a Zoo?

Time: One 45 minute class session

Procedure:

1. "Your challenge for today is to design a layout for a zoo habitat that conforms to specific size and environmental constraints as outlined by the SLED design activity resource sheet."

2. Review the design activity student resource with students.
   Ask: *What is the goal?*
   Who is the user or client?
   What is the problem?
   What are the constraints?
   What materials will you use?

3. Form teams of 2 to 4 students. Review team rules and expectations (see examples below).
   a. Everyone contributes with all tasks
   b. Professional behavior
   c. Safety
   d. Everyone has a clear role.
      i. Example 1: Recorder, time keeper, materials gatherer, measurer
      ii. Example 2: Each student is in charge of a specific area: grass, water, rocks, and trees.

4. Have students work with their teams to design a layout of their habitat.

5. Supply each team with a piece of 18" x 12" rectangular construction paper. This paper represents the outline of the exhibit area at the zoo.

6. Students should calculate the area of each shape, and add their shapes to their paper to define their zoo habitat layout.

7. Once finished, have each group present their design to the class to discuss and justify how they met the design criteria.
   Ask: *Did your design meet the client's needs?*
   What are examples of abiotic and biotic factors within your design?
   What is one strength of your design?
   What is one weakness of your design?

Note for the teacher: Sample students' justifications for the specific design decisions they made:

- "According to the design criteria, more than half of the area should be covered by grass. Reindeers are herbivores and survive by eating grass or simple plants such as lichen."
- "It is important to include abiotic factors such as small and large rocks in our habitat. Rocks support survival of moss and lichen, which live or grow on them."
- "We located water/ponds away from each other so that Reindeers can access water as they graze at different locations."

Assessment

The following are possible sources of formative and summative assessment:

- Questions on Reindeer habitats (Lesson 1)
- Area calculations for various shapes (Lesson 2)

Lesson Extensions and Resources

Activity Extensions:
Note: this extension lesson uses the same context (Reindeer Habitat) but focuses on different science standards (heat transfer and properties of materials).

Time: two to three 45 minutes sessions

Objectives:

- Design and carry out an independent investigation on insulating materials
- Present findings and design a cold room habitat for the reindeer

Procedure:

1. "Your challenge is to build the most efficient cold room for reindeers that will retain the cold temperature inside. The efficiency of your room will be tested by measuring the room temperature over time"
2. Form teams of students (4-5). Review team rules and expectations.
    a. Everyone contributes with ideas
    b. Professional behavior
    c. Safety
    d. Everyone has a clear role. Example: Recorder, Time keeper, materials
3. Talk about insulation (real life examples: house, body, whales, etc.)
4. Describe the challenge is divided into two parts. In the first part, students will carry out an investigation to determine the best insulating material. In the second part, students will design a cold room.
5. Have students complete the Freeze Pop Insulation Lab (located in appendix).
6. Pass out and review the Design Challenge (located in appendix). Once students are finished, have them explain why their design was the best and how many reindeer they believe it could hold at one time.

Web Resources:
See above.

http://www.freenatureimages.eu/Animals/Mammalia,%20Zoogdieren,%20Mammals/Rangifer%20tarandus,%20Reindeer/index.html

Design Activity
Student Resource

SLED
Science Learning through Engineering Design

A Theme Park at Columbian Zoo

The Columbian Zoo, located in Lafayette, IN, is remodeling and they are planning to add a Reindeer exhibit. They need your help to create a "plan" for the new environment that not only supports life but also fits into a designated space at the zoo.

Criteria:

- Habitat should look realistic
- Includes at least two locations for each resource
- Maximizes the roaming area for deer
- You should use a variety of shapes to meet the accommodations
- Each Reindeer needs
  - 40 m^2 of water surface area
  - 120 m^2 of grass surface area
  - 20 m^2 of rock surface area
  - 20 m^2 of trees surface area

Constraints:

- The designated space has a rectangular shape 180x120 m^2
- The area must accommodate ten Reindeers

In your plan use the following scale:
1 inch (on construction paper) = 10 meters (in the actual habitat)

Note: images are retrieved from http://www.mnh.si.edu/arctic/html/caribou_reindeer.html

Grass

Shape	Shape number	Area Calculated	Location of the component	Justification for the location

Water

Shape	Shape number	Area Calculated	Location of the component	Justification for the location

Rocks

Shape	Shape number	Area Calculated	Location of the component	Justification for the location

Trees

Shape	Shape number	Area Calculated	Location of the component	Justification for the location

Equations for Area Calculations

Rectangle → Area= length x width

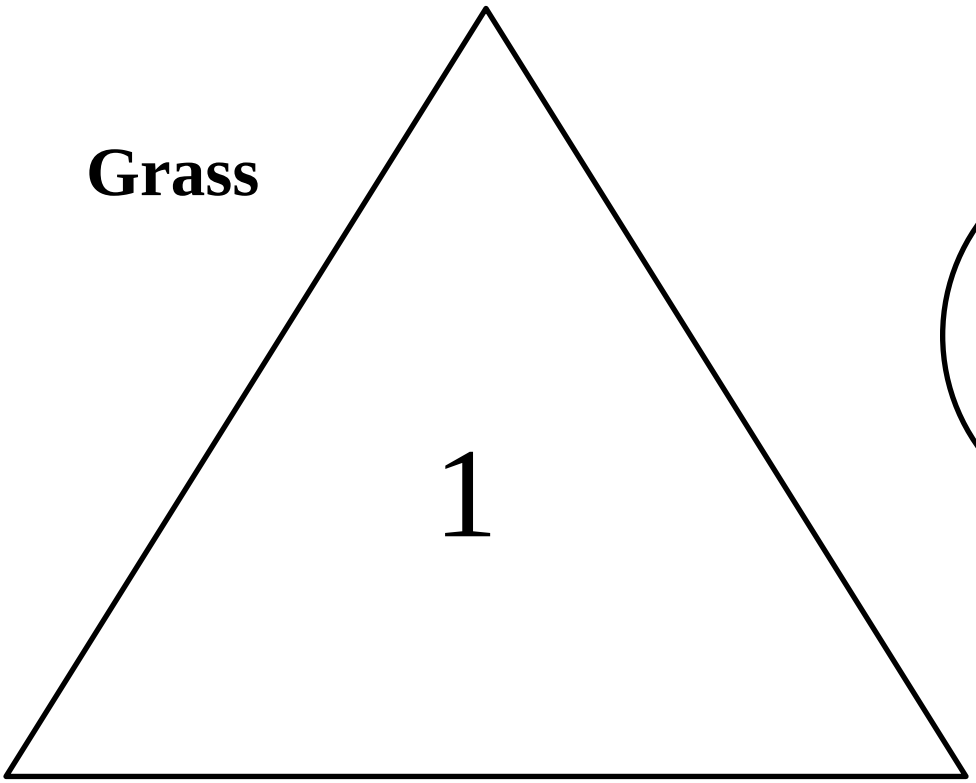
Parallelogram → Area= base x height

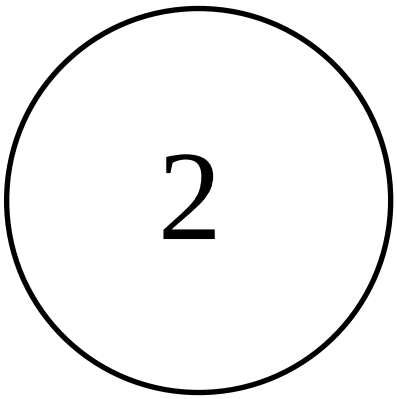
Triangle → Area= ½ x length x height

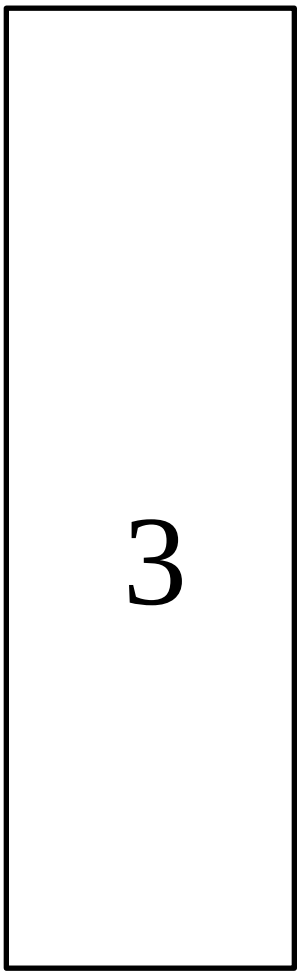
Trapezoid → Area= ½ x length x ($base_1$ + $base_2$)

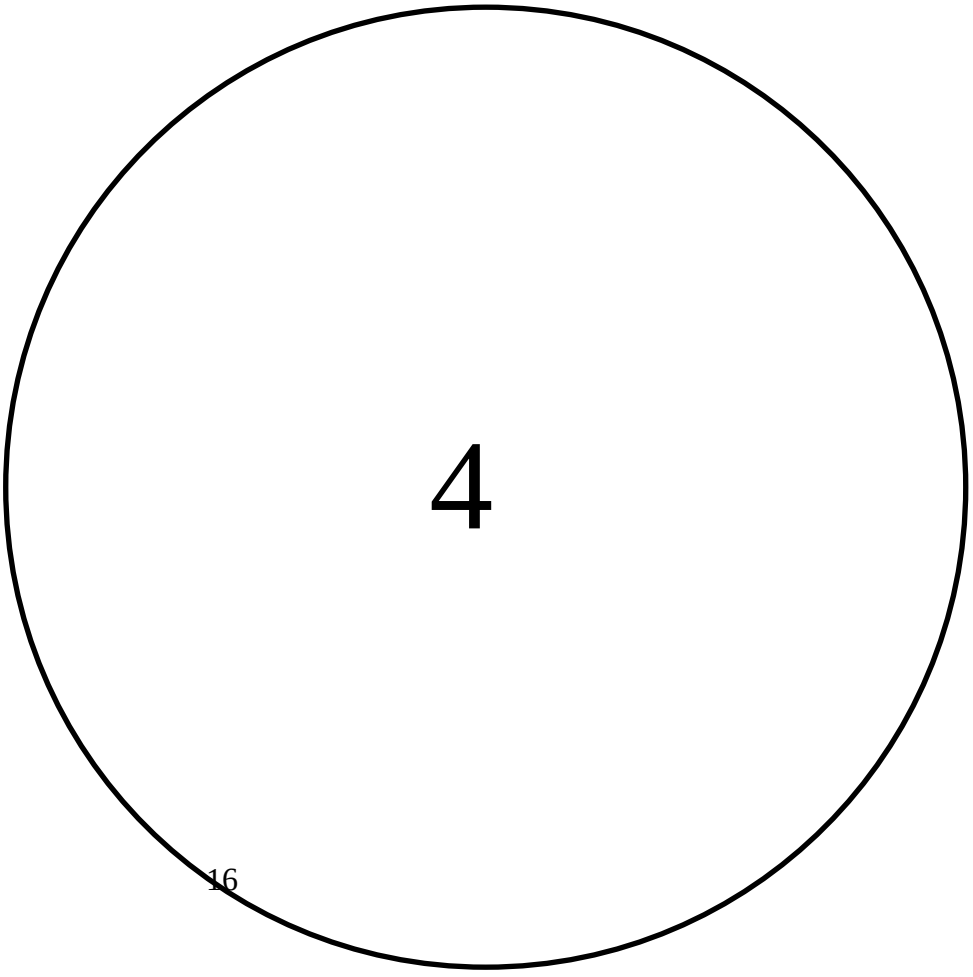
Circle → Area= πr^2

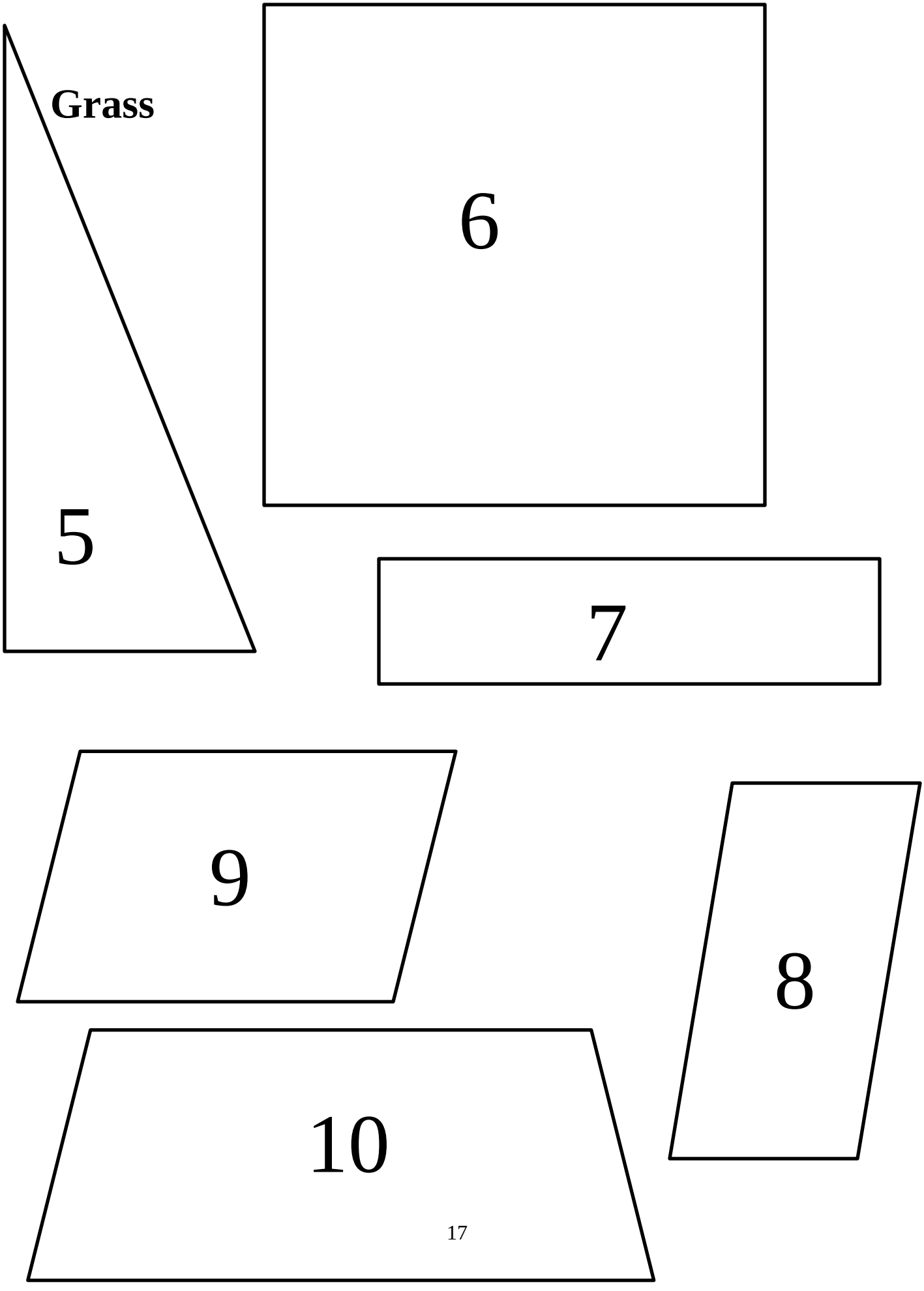
Grass



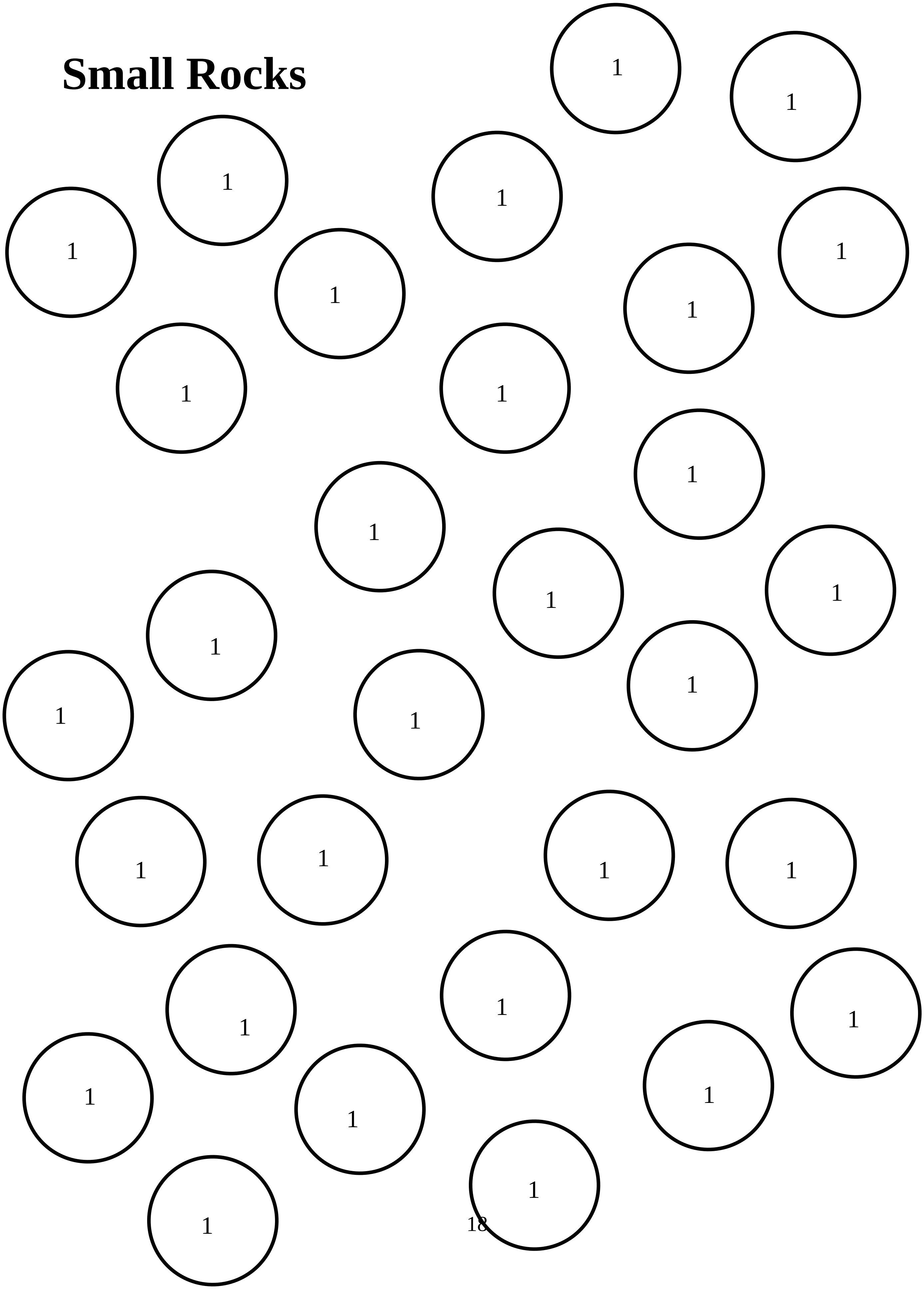




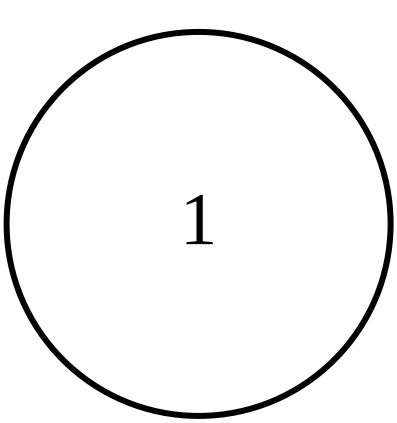


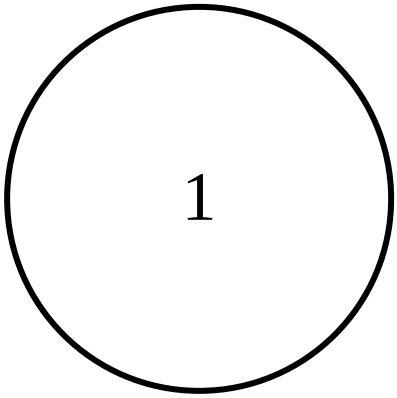

Grass
5
6
7
9
8
10

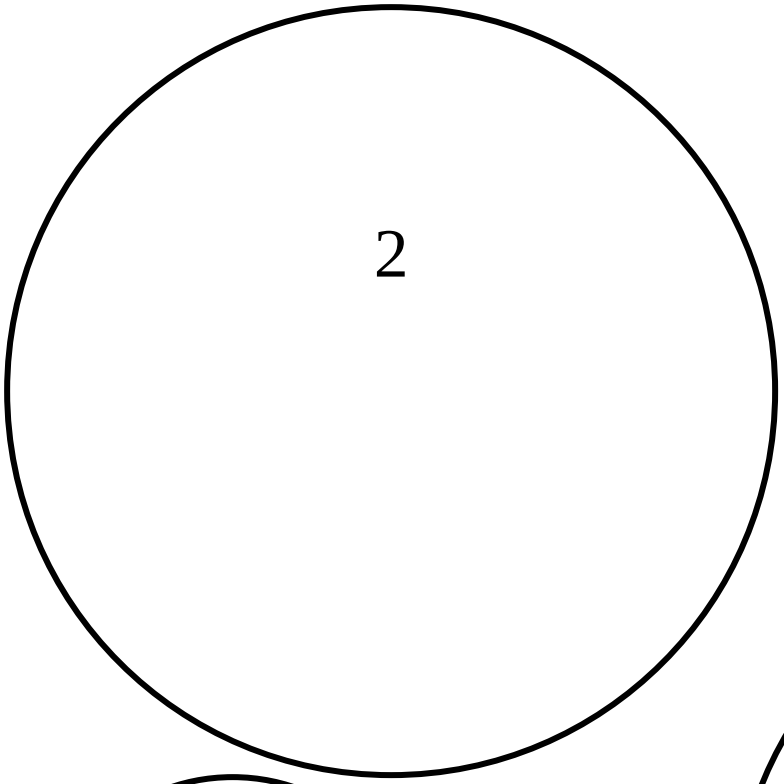
Small Rocks

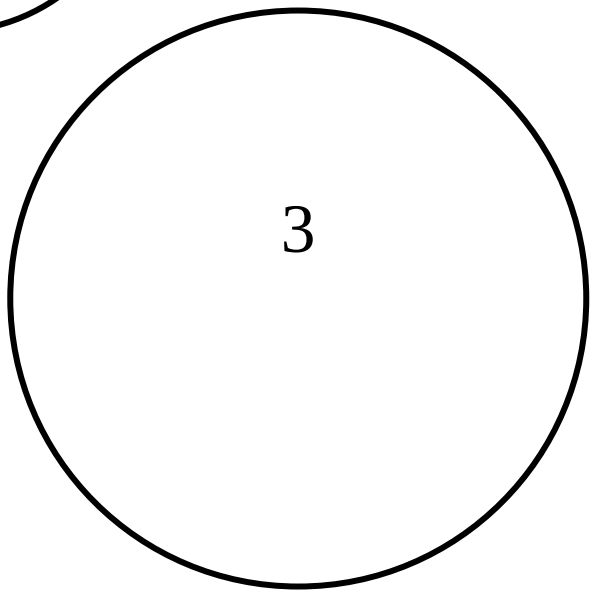


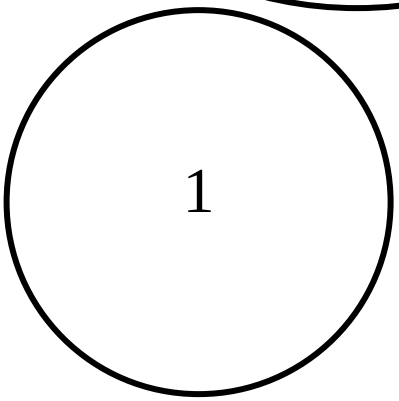
Large Rocks

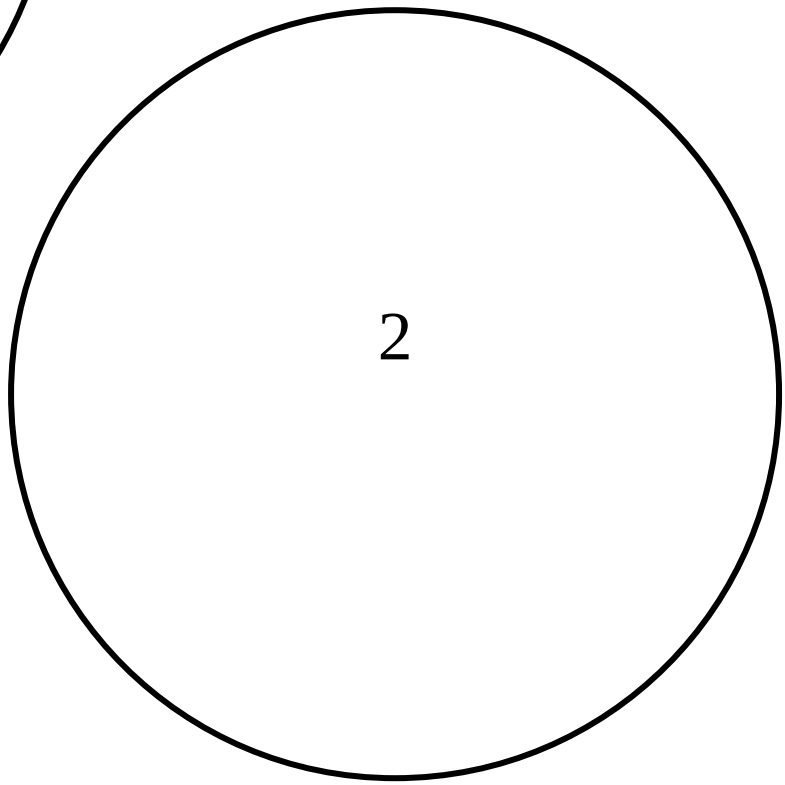




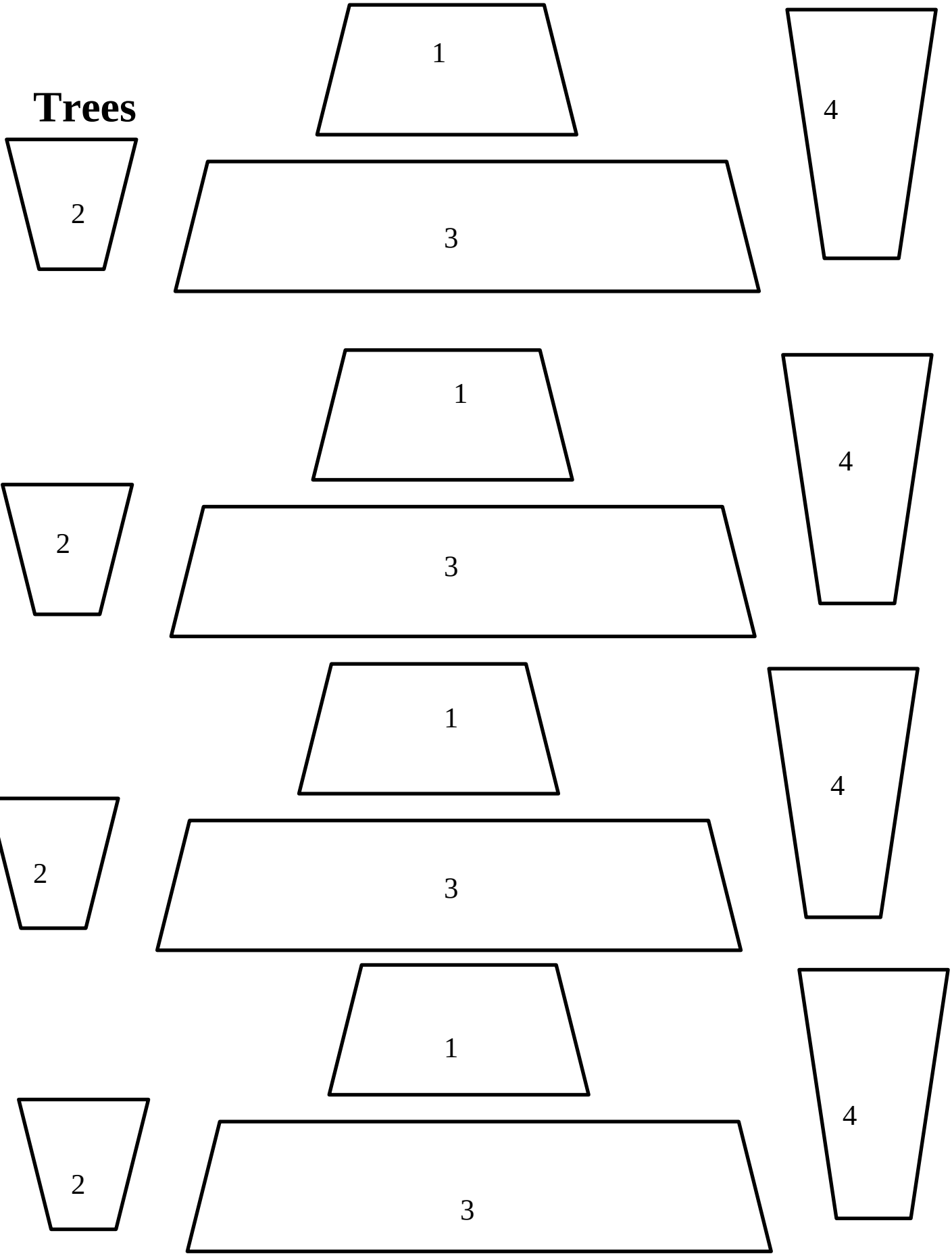




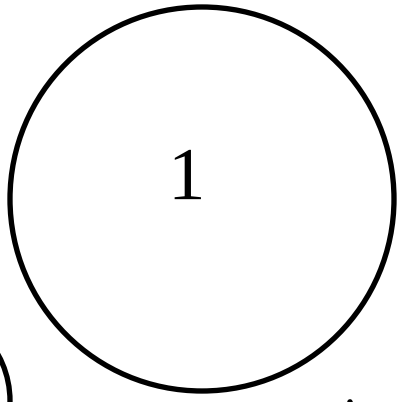


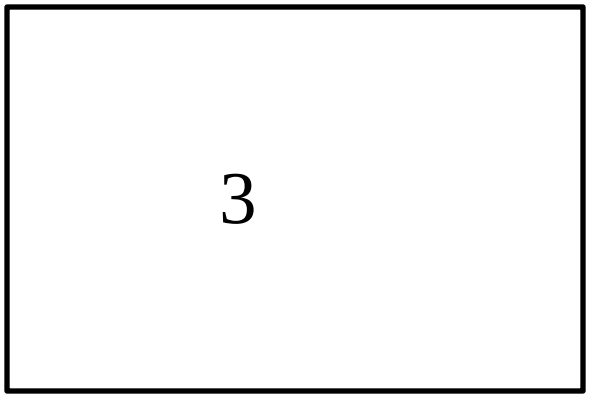


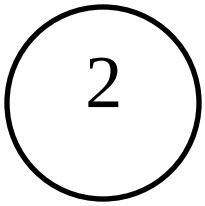
Trees

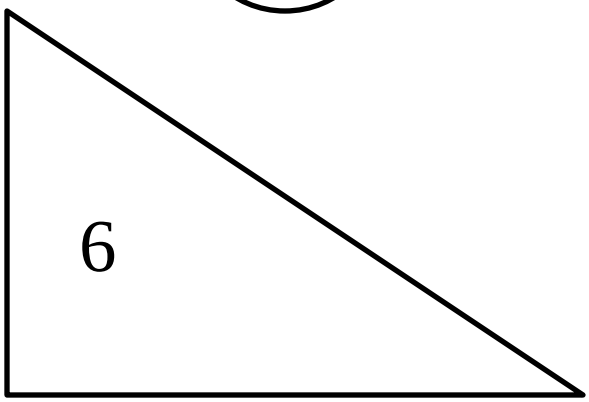


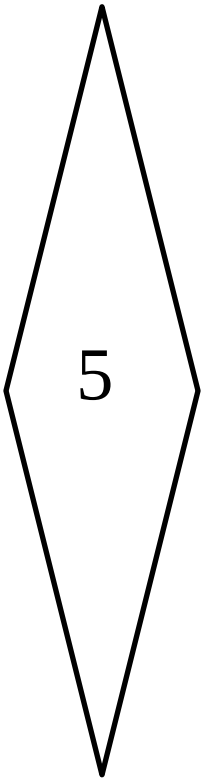
Water

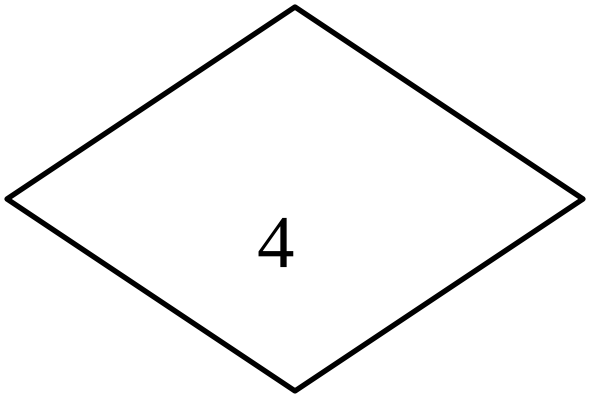


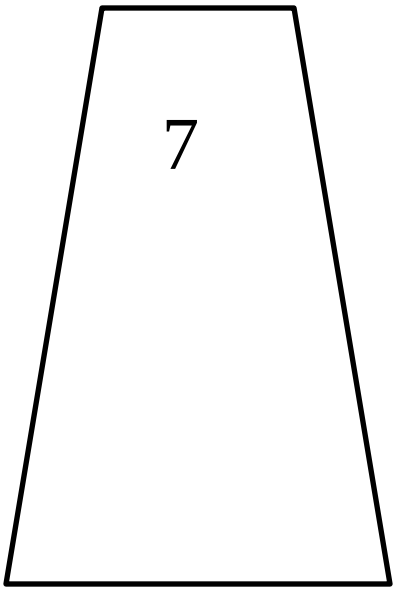


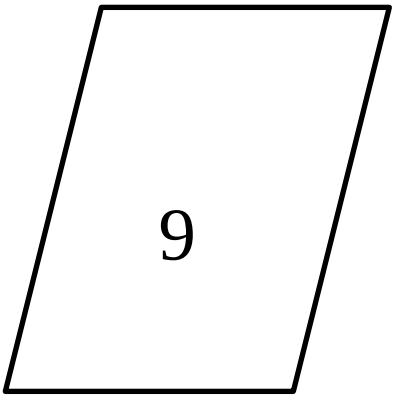


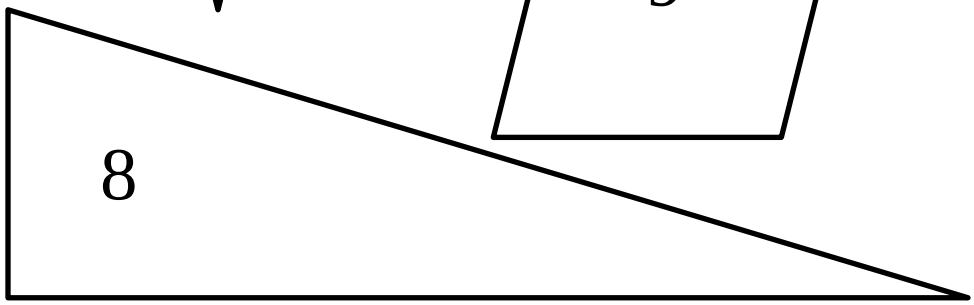


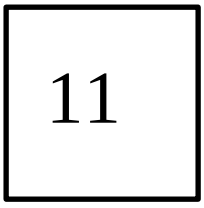


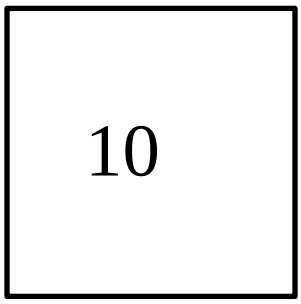


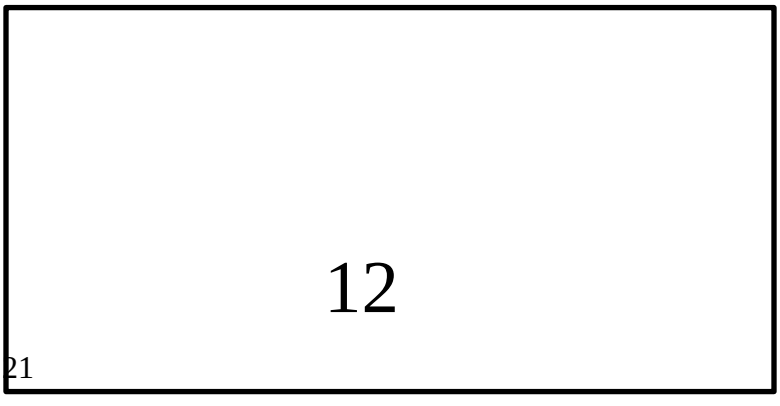












Reindeer Enclosure Design Reflection Questions

1. What is the best quality about your design and why?

2. What kind of job would someone have if they were designing a zoo enclosure?

3. Describe how your design of the zoo makes it the best choice when creating the enclosure.

4. What step of the engineering design process was this activity?

5. Why do you think this step is important when building an enclosure?

6. If you had time to redesign the layout, what changes would you make?

Name _____

Freeze Pop Insulation Lab

Your Challenge: To design a container that will hold insulation and a freeze pop and will keep the freeze pop frozen for 30 minutes.

Background: Insulators are used every day in many different ways to prevent the transfer of thermal energy. Name three different uses of insulators.

1.

2.

3.

Name three different materials that are used for insulators. (Do not use the word "insulation").

1. 2. 3.

Name three different materials that you could use for insulators/insulating.

1. 2. 3.

Problem: What kind of materials can be used to create an insulator that will keep an freeze pop frozen for 30 minutes?

Hypothesis:

Materials:

- -
- -
- -
- -

Procedures:

1.
2.
3.
4.
5.
6.

Observations:

Quantitative:

Measure melt height (cm)	Description of Freeze Pop
	Frozen Freeze Pop before experiment
	Frozen Freeze Pop after 30 minutes
	Melted Freeze Pop after 30 minutes

Qualitative:

Conclusions:

1. Do your results support your hypothesis?

2. Why do you believe you received the results you did?

3. Describe the errors your experiment may have had?

4. What limitations did you have to work around to complete this project?

5. What question(s) do you have now about insulation?

Design Challenge
Student Resource

SLED
Science Learning through Engineering Design

Designing a Cold Room

Reindeers love cold climate, however, the temperatures in Lafayette gets extremely hot during the summer. You have already created a habitat plan for reindeer at the Columbian Park Zoo, so your new challenge is to provide the ideal environment for the reindeers all year long.

Your team's task as engineers is to design the most efficient cold room for Reindeers so they can come and rest in this room to escape summer heat. Your room should use the least amount of cooling while maintaining a comfortable environment for reindeers inside the building.

Criteria:

- Create a cold room environment that will be added to your reindeer habitat
- Needs to hold at least five reindeers at a time.

Constraints:

- You only have $50 to spend
- The space requirement, for each reindeer, while in the cold room is 20 m^2.

Materials

Item	Cost
Small Box	$2 per box
Medium Box	$4 per box
Large Box	$6 per box
Aluminum Foil	$1 a foot
Plastic Wrap	$0.50 a foot
Straws	$1 for five straws
Cotton Balls	$2 for twenty pieces
Newspaper	$2 a page
Duct Tape	$3 a yard

Materials Chart

Material	**Cost**	**Number Purchased**	**Total Cost**
Small Box	$2 per box		
Medium Box	$4 per box		
Large Box	$6 per box		
Aluminum Foil	$1 a foot		
Plastic Wrap	$0.50 a foot		
Straws	$1 for five straws		
Cotton Balls	$2 for twenty pieces		
Newspaper	$2 a page		
Duct Tape	$3 a yard		

Total Spent: _____

OTHER DOCUMENTS

Engineering Vocabulary

Term	***Defined by a scientist or engineer***	***Defined by a 5th or 6th grade student***
Criteria	Functions, attributes, capabilities, characteristics, or qualities that a solution, product, process, or service are expected to meet.	Requirements you need to meet
Constraints	Limitations to a given problem solution space that limits certain design alternatives. The design constraint must be met.	Something that restricts your ideas or keeps an idea from becoming real.
Optimization	The selection of a best element from some set of available alternatives by maximizing or minimizing an expected outcome.	Making something better and more efficient than it was before
Trade-offs	Trade-offs has to be made when solving problems involving competing criteria or constraints. This process involves losing one quality or aspect in return for gaining another quality or aspect and requires a decision-making process that evaluates both the upside and downside of a particular choice.	Giving something away to get something back
Prototype	A representation of a product or process. An early sample or model built to test a concept or process.	A small and simple model
Variables/ Parameters	The factors that can be manipulated to affect the results of an experiment.	Something you can change or measure in an experiment

Expectations and Checklist for Student and Teacher Evaluation

Student Name: _____
TEAM Name: _____

	Student Evaluation	Teacher Evaluation
Technical Quality	❑ Measurements and calculations are accurate ❑ Final solution meets design criteria and constraints	❑ Measurements and calculations are accurate ❑ Final solution meets design criteria and constraints
Scientific & technical Communication	❑ Student uses of scientific and engineering vocabulary in explanations & justifications. ❑ Justifications are based on data and/or reasoning	❑ Student uses of scientific and engineering vocabulary in explanations & justifications. ❑ Justifications are based on data and/or reasoning
Teamwork	❑ All team members have clear roles. ❑ Everyone is participating and engaged.	❑ All team members have clear roles. ❑ Everyone is participating and engaged.