PLOT SUMMARY:

Potato the porcupine was rescued as a baby. She now lives in a zoo. Her keepers work hard to meet her needs and keep her happy.

ZOO HABITAT CHALLENGE:

Problem What problem will you solve?	**Challenge** What will you do?	**Criteria** What should the solution do to be successful?	**Constraints** What are the limits?
Potato the porcupine needs a new habitat at the zoo.	Design and build a model zoo habitat for Potato.	• The habitat should keep Potato safe and visible. • The habitat should include a warm den for sleeping, a climbing structure, fresh water, and a place for keepers to keep tools so Potato won't chew on them.	Use only the materials given.

OTHER POSSIBLE PROBLEMS AND CHALLENGES:

Students can use the *Universal Challenge Pages* (pages 104–107) to create solutions to any of the problems below or problems they identify themselves.

Problem	Potato likes to be held.
Possible Challenge	• Design a way for keepers to hold Potato without getting quilled.

Problem	Keepers need Potato to go into her crate.
Possible Challenge	• Design something to help the keepers safely get Potato to go into her crate.

Problem	Keepers want Potato to get exercise.
Possible Challenge	• Design enrichment toys for a porcupine.

MATERIALS:

Suggested: structural materials such as craft sticks, straws, unsharpened pencils, cardboard sheets and boxes, cardstock and index cards, paper and plastic cups and plates, empty food containers, paper towel and toilet paper rolls; natural materials such as sticks, leaves, and rocks; connecting materials such as glue, string, rubber bands, pipe cleaners, tape; paint

PREPARATION:

While students will not be testing their designs in this project, you will need a space for them to display their models so that everyone can examine them and give feedback.

LESSON PLAN:

1. Have students read the passage and discuss the problems they identified. Use these questions as prompts:
   - Have you ever seen a porcupine? What other animals have you seen?
   - Do you have a pet? How do you care for it?
   - What challenges do the zookeepers have in taking care of Potato? Did they solve any of them? How?
2. Introduce the Zoo Habitat Challenge by reading through the challenge pages together. Explain to students that they will be creating a model of a porcupine zoo habitat. Let students know that for this challenge they won't be testing their designs. They will design and build their model habitat to meet criteria, or requirements.
3. Ask students to use what they learned about porcupines in the reading to design a zoo habitat. Remind them that porcupines are great climbers and that they like to chew on wood and rubber. Because this is a model, they can use whatever materials they have access to, but they should label them to show what would be used in a full-size enclosure. For example, they can use craft sticks to build part of the enclosure, even though porcupines chew on wood, as long as they label them something like "metal poles" and paint them so they don't look like wood.
4. Show students the available materials and review the criteria and constraint. Give them time to think about the materials and complete the tasks for Step 1 (page 68). This will give them examples of floor plans to help them draw their own.
5. Give students time to prepare, brainstorm, plan, and build their zoo habitats. Circulate to observe and answer questions as students work on their solutions. Remind them to use the challenge pages to guide them as they work through the engineering design process.
6. Have students evaluate their models by checking them against the criteria, and then share their solutions with the class and get feedback from peers. Then they should revise and improve their designs.
7. When students have completed the challenge, have them show and explain their model zoo habitats to the class. Then have them fill out the reflection page.
8. If time, allow students to choose their own problem and testing setup and use the *Universal Challenge Pages* (pages 104–107) to complete their challenge.

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Directions: Read the passage and underline the problems the characters have to face. Write and/or sketch your ideas for solutions in the margins.

POTATO THE PORCUPINE

Potato the porcupine was found by the side of a road when she was a little baby porcupette. Her mother had been hit by a car. Potato was too young to take care of herself in the wild. Rescuers took her in and raised her. They named her Potato because she was about the size of a baked potato. She can't go back to the wild because she hasn't learned how to find food and avoid predators. Now, Potato lives in a small zoo where people can see her and learn about porcupines.

Potato has over 30,000 quills covering most of her body. Quills are hard, hollow hairs with barbed points on the end. Those hollow quills float, which makes porcupines good swimmers! No, porcupines cannot shoot their quills. When a porcupine feels threatened, it can slap at a predator with its tail. If the predator gets too close, it will get a face full of quills. The quills are not easy to remove. The barbed tip is like a tiny fishhook. It keeps the quill buried in the skin. As a defense mechanism, a porcupine's quills are very effective! Who would want a bite of that? The only place a porcupine is vulnerable it its soft, quill-less belly.

Potato's quills pose a challenge for the zookeepers. Quills grow like fur or hair, in one direction. You can pet a porcupine from front to back. But if you try to push a porcupine forward from behind, you'll get a handful of quills! This makes it a challenge to get Potato into her crate. Potato loves to be held, but keepers must wear thick, leather gloves when they carry her.

Porcupines are *arboreal.* This means they spend most of their time in trees. They have long, strong claws for climbing. Keepers set up a structure of thick branches in Potato's habitat. This gives her places to climb and explore. Potato also enjoys hanging upside down. It's like a playground climbing structure for porcupines!

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POTATO THE PORCUPINE

When the weather is cold, keepers put straw in a hollow log for Potato to crawl into. The problem is that she chews on the log!

Porcupines are *herbivores*, or plant eaters. In the wild, they eat leaves, pine needles, nuts, and fruit. In the zoo, Potato gets sweet potatoes, carrots, and lettuce. She also gets special pellets made for large rodents like porcupines and beavers. Like all rodents, a porcupine's front teeth are constantly growing. Chewing and gnawing on bark and wood keeps their teeth from growing too long. Keepers make sure Potato has plenty of browse to chew on. *Browse* is branches cut from trees and bushes. And keepers are careful not to leave their rakes and gloves in Potato's habitat. She will chew on anything made of wood or rubber!

Porcupines don't see very well, but they have a good sense of smell. To make sure she gets her exercise, keepers hide some of Potato's food around her habitat. She uses her nose to find yummy treats high up in the branches. She uses her long, strong claws to turn over logs and rocks to get food hidden underneath. Keepers also make sure Potato always has fresh water to drink.

Lately, Potato's keepers have noticed that she has been chewing on the wooden beams holding up her enclosure. They are worried that she could chew all the way through them. They don't want the whole thing to fall down! They are now making plans for a new habitat for Potato. She will have a long, happy life at the zoo.

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STEP 1: PREPARE FOR THE CHALLENGE

Problem What problem will you solve?	Challenge What will you do?	Criteria What should the solution do to be successful?	Constraints What are the limits?
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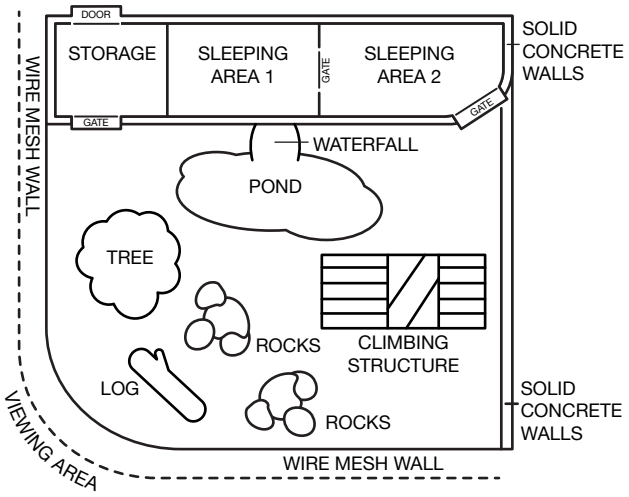
People who design zoo habitats must draw a floor plan of their design. A *floor plan* is a view as if you are looking down from above. Look at the floor plan of a bear zoo habitat and answer the questions below.

1. Highlight along the area where visitors can look in and see the bears.
2. Draw an **X** on the area where the keepers can store their tools.
3. Circle the gate where the bears can go from their sleeping area to the main enclosure.
4. What five things did the designers put in the bears' habitat to keep them busy?



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STEP 2: BRAINSTORM, PLAN, AND BUILD

1. Brainstorm design ideas to meet the criteria and constraint. Sketch and write at least three ideas on the back of this page. Think about the following:
   - What materials can you use for the enclosure that will keep Potato safe inside and will allow visitors to see her?
   - How big should the habitat be to include everything Potato needs? What shape will it be?
2. Think about which design ideas might work best. Circle the idea you will use. Why did you choose this idea?

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_____

3. Draw a floor plan of your zoo habitat design here. Label all of the materials you will use to build the model. In parentheses next to these labels, write what materials would be used in a real habitat.

4. Build your model zoo habitat!

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STEP 3: TEST, IMPROVE, AND SHARE

1. Check to see that your zoo habitat meets each criteria:
   - ☐ The enclosure will keep Potato safe inside.
   - ☐ Visitors can see Potato in her enclosure.
   - ☐ Potato has a warm place to sleep.
   - ☐ Potato has a structure to climb.
   - ☐ Potato has access to fresh water.
   - ☐ Keepers have a place to store tools where Potato can't chew them.
2. Does your zoo habitat design meet all the criteria? If not, how could you improve it?

3. Share your zoo habitat with classmates. How can you use their ideas to make it better?

4. Keep redesigning until your zoo habitat meets the criteria!

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STEP 4: REFLECT

1. How does your design meet each criteria?

The enclosure will keep Potato safe inside: _____

Visitors can see Potato in her enclosure: _____

Potato has a warm place to sleep: _____

Potato has a structure to climb: _____

Potato has access to fresh water: _____

Keepers have a place to store tools where Potato can't chew them:

_____

2. How did you improve your design?

_____

_____

_____

3. What was the hardest part about this challenge?

_____

_____

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4. What have you learned from this challenge?

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