BACK TO THE BIG QUESTION INTRODUCTION

Back to the Big Question

How Do Machines Help Move Large, Heavy Objects?

◀ *1 class period**

Overview

Students use spring scales to determine how much force is required to lift the weight representing the biologists' crate and to determine approximately how much force the thread representing their rope can bear. They update the *Project Board* with what they have learned and with new questions they need to answer to meet the challenge.

Materials

1 per group	1-kg mass
1 per group	spring scale (or force probe)
1 per class	class *Project Board*

Homework Options

Reflection

- **Science Content:** Based on how much force the thread you used can bear, how much force do you think you will need from a machine to lift the weight? *(The machine will need to contribute the difference between the force needed to lift the weight and the force the thread can bear. For instance, if it takes 15 N to lift the weight, and the string can only bear 5 N, the machine will need to contribute 10 N of force.)*

*A class period is considered to be one 40 to 50 minute class.

1 class period*

BACK TO THE BIG QUESTION IMPLEMENTATION

Learning Set 1

Back to the Big Question

How do machines help move large, heavy objects?

Think back to the construction site or video that you saw at the beginning of this Unit. You and your classmates discussed what each of the different types of machines might be used for. Large objects such as heavy metal beams, large piles of bricks, and big piles of dirt are difficult to move. That is because there are large forces of gravity and friction acting on them. It is not possible for people to move such heavy objects by themselves. A machine is able to apply a larger force than a person can. The machine can apply a force greater than the force of gravity or friction on the large, heavy object. Since the applied force is greater, there are unbalanced forces acting on the object. The object's motion changes. This is why people use machines to help them move big things.

Machines can be designed to move specific objects. For example, a bulldozer is designed to push dirt from one place to another, so it applies an unbalanced force along the ground. A backhoe is designed to dig holes, so it applies unbalanced forces downward to scoop up the dirt and then upward to lift it out of the hole. Smaller machines are designed the same way. A hammer, for instance, is designed to push a nail through wood. It applies a large unbalanced force to the head of the nail. A pair of scissors applies an unbalanced force to a very small point on a piece of paper, allowing the scissors to cut.

A hammer applies a large unbalanced force on the top of a nail to move the nail into the wood.

MBT 35

MOVING BIG THINGS

Learning Set 1

Back to the Big Question

Introduce the section to the students and focus their attention on the Big Question *and the challenge.*

Engage

Begin by asking students what is required to get something moving from rest. Tie this in with the need to have unbalanced force acting on the crate in the challenge to lift it up the cliff. Then ask if they can say how the machines they saw at the construction site or in the construction video used unbalanced forces. Discuss some ways machines use unbalanced forces. Examples are provided in the student text such as a hammer and scissors.

*A class period is considered to be one 40 to 50 minute class.

TEACHER TALK

"What do we need to get something moving from rest? (An unbalanced force.) You will need to keep this in mind when you try to solve the challenge of lifting the crate up the cliff."

Again connect this to the Unit challenge—students can design a machine that applies unbalanced forces to lifting the crate to the top of the cliff.

TEACHER TALK

"Think back to when we began this Unit and observed construction machines. Can you think of ways that they used unbalanced forces? How?

Other machines use unbalanced forces like the hammer and the scissor. How do you think these use unbalanced forces?"

NOTES

Explore

10 min.

Lead students through measuring how much force is required to lift a 1-kg mass, and how much force a thread can bear.

Explore

In this Unit, you determined the number of threads required to lift the weight to the top of the cliff. Maybe you found that it requires six or seven threads to avoid having the threads break. You could make the argument that each of these threads represents a certain amount of upward lifting force. You had to create a situation where the forces were unbalanced in the upward direction.

If these six or seven threads each represent a unit of force, the force of gravity must be equal to somewhere around five or six threads. You do not, however, measure force in *threads*. You measure force in newtons. Small forces can be measured with a device known as a *spring scale*.

Obtain a spring scale, the weight, and a loop of thread from before. Attach each of these to the spring scale and measure

- the amount of force required to lift the weight
- the amount of force the thread can handle just before it snaps.

These two numbers will be very important to you when you design your machine to help the biologists, Drs. Enrique, Susan, and Tanika. The measurement of the weight will tell you how much force is pulling down on the weight.

You learned during this *Learning Set* that the biologists need to create an unbalanced upward force to lift the crate up the cliff. You and your group have to do the same thing to the weight. Remember though, you only can use one single thread to apply the force to the weight. The difference between the force needed to lift the weight and the force at which the thread broke shows you how much force you will need to lift the weight. The machine you design will help supply that force.

In the next few *Learning Sets* you will learn how a machine might be able to help you make up the difference between these two force measurements.

△ Guide

Let students know that they will be measuring how much force is required to lift the mass representing the crate to the top of a model cliff. This time, however, they will use spring scales (or force probes) to measure the force required to lift the 1-kg mass. They should record this. Then let groups know that they will have to figure about how much each thread can bear by taking the force required to lift the 1-kg mass and dividing it by the number of threads they needed to lift the mass.

⬡ Get Going

Distribute the masses and spring scales. Have groups measure the amount of force needed to lift the weight, and the approximate amount of force per thread. They should record the measurements and save them for later.

△ Guide and Discuss

Hold a brief discussion, polling students for their results and emphasizing that the difference between the force needed to lift the 1-kg mass and the force a thread can bear is the amount that the machine they design will need to lift.

NOTES

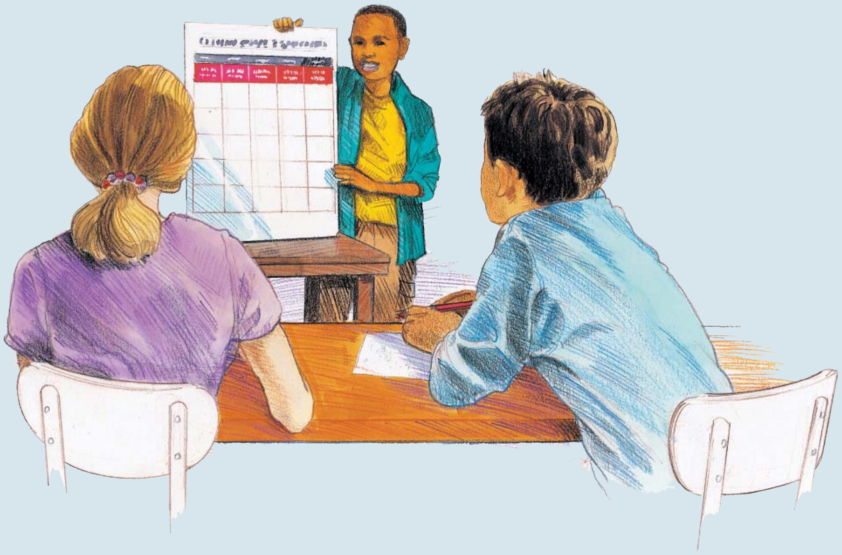
Update the *Project Board*

10 min.

Update the Project Board *with what they learned in this* Learning Set *and any questions students have about how machines can make lifting the crate easier.*

Update the *Project Board*

Your teacher may have your class return to your *Project Board* to update any questions or ideas you have posted. You now can post some information in the *What are we learning?* column. Be sure to give the evidence you collected to support what you say you have learned about forces and how objects move.



META NOTES

Students may describe the claims listed here as many separate claims rather than combining them. That is O.K., as long as they have correctly described the ideas about balanced and unbalanced forces and how they affect motion.

△ Guide

Remind students of the five columns of their *Project Board: What do we think we know? What do we need to investigate? What are we learning? What is our evidence?* and *What does it mean for the challenge or question?*

Then let students know that they are going to update columns three and four.

TEACHER TALK

"You have learned a lot about forces and what is required to get things moving from rest during this *Learning Set*. This information should be on your *Project Board*. You will be focusing on filling out column 3: *What are we learning?* or our claims, and column 4: *What is our evidence?*

In other words, what claims can we make and what is our evidence for these claims?"

Record the items students suggest on the class *Project Board*.

◇ Evaluate

Make sure the following ideas—written in students' words, not necessarily the language below—are on the *Project Board*.

- **Column 3 Claim:** An unbalanced force causes an object to change its speed or direction.
- **Column 4 Evidence:** We observed that when we applied unbalanced forces to a mass, it moved from rest. We also observed that when our teacher applied an unbalanced force to a ball he/she made the ball change its speed and/or direction. (Students might mention the bucket or any other demo you did in class. All observations from demonstrations and investigations are evidence)
- **Column 3 Claim:** Balanced forces do not cause an object to change its speed or direction.
- **Column 4 Evidence:** We observed that when we applied balanced forces to a mass, it did not move from rest.
- **Column 3 Claim:** One thread for our model can bear about ____ newtons. The amount of force needed to lift the 1-kg mass is about 10 N.
- **Column 4 Evidence:** We measured that we need ____ threads to lift the 1-kg mass. We measured using a spring scale that the force needed to lift the mass is about 10 newtons. This means that about _____ threads are needed to lift 10 newtons so each thread can lift approximately _____ newtons.

△ Guide

Then ask students if there is anything they need to investigate to help them solve the challenge.

TEACHER TALK

"Now that we know a little more about how forces make things move, what more do you think we need to learn to design a machine that can help move the crate up the cliff?

Would answering these questions get you closer? Is there anything more we should be asking?"

Record these in the What do we need to investigate? column of the *Project Board*.

Teacher Reflection Questions

- What evidence do you have that students have begun to think about the challenge in terms of balanced and unbalanced forces?
- How were you able to connect what students have been learning to the challenge? How were you able to help students come up with good questions about how a machine can help lift the crate in the challenge?
- How did you get students to contribute to the discussion of what to put on the *Project Board*? What other ideas do you have?

NOTES