

PBIS



VEHICLES IN MOTION

As a student scientist, you will...

PBIS Learning Cycle Actions

**Ask
QUESTIONS**

PBIS Learning Cycle Actions

**APPLY
MEANING**

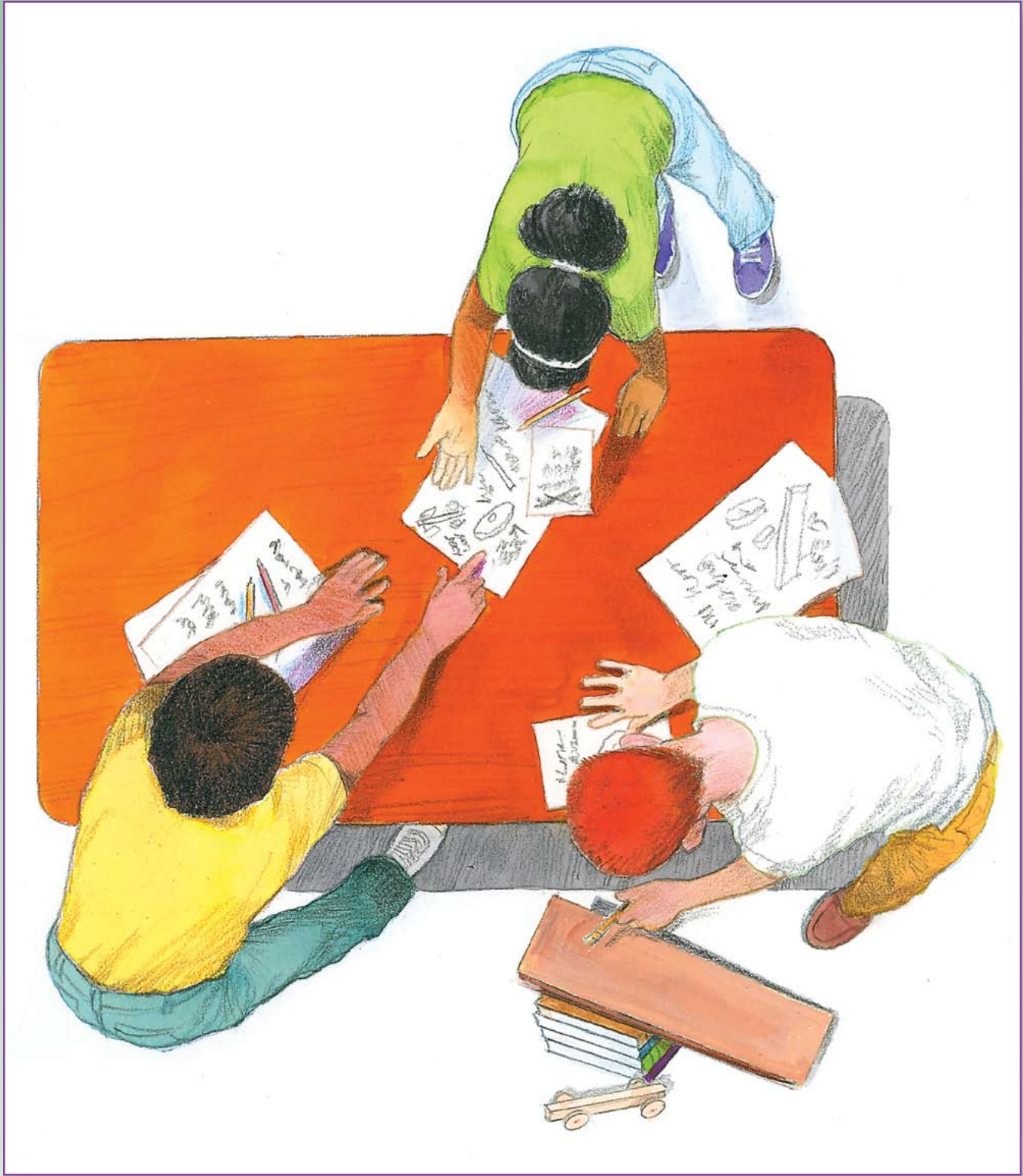
PBIS Learning Cycle Actions

Pursue
ANSWERS

PBIS Learning Cycle Actions

Make
MEANING

Share
ANSWERS



What's the Big Challenge?

Design and build a vehicle that will go straight, far, and fast, and carry a load.

Think of all the different kinds of vehicles people use. Some vehicles, such as fire trucks, need to carry heavy equipment. Other vehicles, such as race cars, need to move very fast. Hybrid cars, which use a combination of gas and electricity, are designed to travel long distances without using large amounts of fuel. People can both travel and sleep in a recreational vehicle (RV). As you can see, different vehicles are designed for different functions. People known as design engineers specialize in developing new products, such as vehicles, to meet specific needs.





What makes a jogging stroller different from a baby carriage? Both are designed to move a baby around safely. However, the jogging stroller is designed to be pushed while running, and the baby carriage is designed to be pushed gently while a baby sleeps.

In this Unit, you will be the design engineer of a small vehicle. This vehicle will have to carry out certain functions—it will have to go straight, far, and fast, and carry a load. As the design engineer, you will be using science knowledge to conduct investigations to determine how best to achieve the challenge. Then you will design and test a vehicle. You will modify your designs, and retest your vehicle to achieve the best possible performance. Like professional design engineers, you will report on your results and progress. To do the job well, you will need to learn about how forces affect motion.

Design engineers working on cars today must consider alternative fuels, the car's impact on the environment, and the safety of the passengers. This futuristic car is designed to run on electricity, and the cabin can rotate in a complete circle.



Have fun being a student design engineer!

Think About the *Big Challenge*

The vehicle that you design will have to:

- travel straight
- travel far
- travel fast
- carry a load

Your vehicle may need to:

- travel over hills of different sizes
- run on different surfaces

To accomplish this challenge, you will need to learn about forces and motion. You will need to figure out how to get objects to move if they are at rest (not moving) and how to keep them moving if they are already moving. You will also need to learn other science concepts that affect how a vehicle moves. As you apply these concepts to the design of your vehicle, you will also have to learn about what makes a fair test, how to measure and gather data, and how to revise your design.

Before you get started on any challenge, you need to organize your thinking. You will start this Unit by thinking about what you know, and do not know, about what makes objects move and what keeps them moving.

Get Started

Think about and record answers to the questions below. Do not worry about giving the correct answers. Just write down your thoughts, and give your best answers at this time.

1. What is motion? What causes motion?
2. What causes cars, bikes, skateboards, and wheelchairs to move if they are at rest?
3. What causes an object to change its motion—to turn, speed up, or slow down?

4. What causes an object to stop?

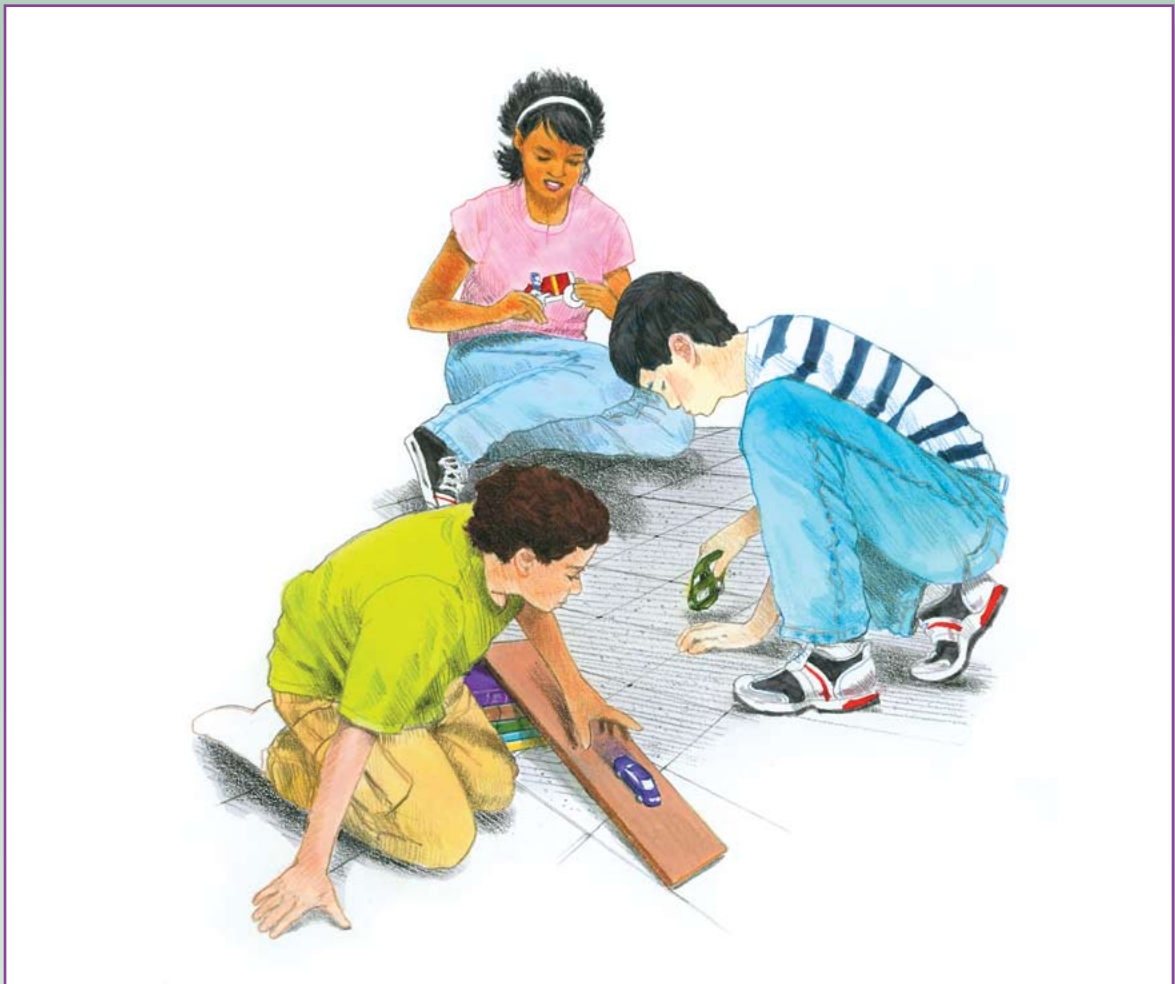
5. How can motion be measured?



Communicate

Share Your Ideas

Share your ideas with the class. Use examples with which everyone is familiar to illustrate your ideas. Also, make sure you understand the ideas of others. You may disagree with some ideas that are presented, but listen carefully. Remember, this discussion is not about right or wrong answers. It is about sharing everyone's ideas. As a class, you will then decide what words can be used to describe motion.



Messing About With Toy Cars

One way to understand more about a challenge and to identify what you need to investigate is by *messing about*. This is a process that scientists and engineers often use when they are considering a new problem. You will be *messing about* with toy cars, identifying what makes them move if they are at rest, and what causes them to slow down or stop. *Messing about* with toy cars will give you more ideas about the challenge and help you identify what you need to investigate.

Be a Design Engineer

Messing About

Messing about is an exploratory activity. That means it gives you a chance to become familiar with materials you are going to use. It also lets you figure out how the product you will be designing should work. When you *mess about*, you explore in a way that helps you know what investigations you will need to do later.

Materials

- 4 toy cars
- ramp
- surfaces
- **Messing About Observations: Toy Cars pages**
- vehicle mechanisms

Messing About Observations: Toy Car		0.0.1
Name: _____		Date: _____
Structure (top)	Parts List the parts of the toy car. How was the car built, or put together?	
Structure (underneath)	How do the parts interact with one another?	
Performance How far, fast, and in what direction does the toy car move? How does the movement or the direction of the toy car vary as you observe it?		
Mechanisms (how it works) What makes the toy car work? What is the function of each mechanism you have identified? Which parts of the car make up each mechanism, and how does each part help your car perform the way it does?		

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You will be examining several different types of toy cars to figure out how they work. Working with a group, you will make careful observations about the structure, performance, mechanisms, and design of each car. For each toy car your group examines, you will fill out a *Messing About Observations: Toy Cars* page. You will also draw sketches of the cars or important parts of the cars you examine.

Procedure

1. Each person in your group will examine every car. Begin by examining its structure.

Structure: The structure of a vehicle involves its frame and parts, how the parts are joined together to make up a whole car, and how the parts interact. Structure is something you can see when the car is at rest. Ask yourself these questions:

- What do you notice just by looking at the car from above and below?
- What materials were used to make the car?
- How was it built, or put together?
- What was the specific purpose of the toy car?

Record the information about the structure of each car on your *Messing About Observations: Toy Cars* pages.

2. Gather around your group's ramp and surfaces. Let each car run down the ramp and across each of the surfaces. Observe how each car performs.

Performance: A vehicle's performance is what you observe when the car is moving. Answer these questions to help you evaluate the performance of your car:

- How far does the car move?
- In what direction does it move?
- How fast does it move?
- What do you notice about its performance when you stand far away?
- What do you see when you look at the car up close?

Record information about the performance of each car on your *Messing About Observations: Toy Cars* pages.

3. Examine the mechanisms of each car. You will be able to see the mechanisms of some cars by looking inside them. Other mechanisms will be on display in the classroom.

Mechanisms: Mechanisms are the working parts of a device that allow it to run. Each mechanism has a function, or a purpose. Answer the following questions about the mechanisms of your car:

- Which parts help your car perform the way it does?
- List all of its mechanisms.
- What is the function of each mechanism you have identified?

Record what you can determine about each car's mechanisms on your *Messing About Observations: Toy Cars* pages.

4. For each car, try to answer these questions:

- What makes the car move?
- What makes the car slow down or stop?
- What causes the car to go straight or make a turn?

Record the answers to these questions on the *Messing About Observations: Toy Cars* pages. Prepare to present your group's ideas to the class.

Communicate

Share Your Ideas

Share your observations and answers to the questions with the class. After everyone has had a chance to share this information, discuss what makes the different cars go, what makes them slow down or stop, and what makes them turn.

Group the cars into categories based on features they have in common. You may base the categories on similar structures, performance, or mechanisms. Give each category a name. Describe how the cars in each category are similar to one another and how they are different from cars in the other categories.



Reflect

You have now had an opportunity to *mess about* with different toy cars and observe how they move. Use what you have learned from this experience to answer the same questions you answered at the beginning of this section. Compare your new answers to your old ones, and see how they have changed.

1. What is motion? What causes motion?
2. What causes cars, bikes, skateboards, and wheelchairs to move if they are at rest ?
3. What causes an object to change its motion—to turn, speed up, or slow down?
4. What causes an object to stop?
5. How can motion be measured?

Identify Criteria and Constraints

criteria (singular criterion): goals that must be satisfied to successfully achieve a challenge.

constraints: factors that limit how you can solve a problem.

Any design challenge has two parts: **criteria** and **constraints**. Before you begin any design challenge, you must identify what the criteria and constraints are for your project.

Criteria	Constraints

Criteria are goals that must be satisfied to achieve the challenge. For example, your vehicle must travel straight and fast. Examine the challenge again and identify all of the criteria. One of the criteria is that you must build the car.

Constraints are factors that limit how you can solve a problem or achieve a challenge. For this challenge, one of the constraints is to use only the materials you are provided. Identify any other constraints of this challenge.

Work together as a class to identify the criteria and constraints for this design challenge. Record them on a chart or list.

Create a Project Board

When working on a challenge, you need to keep track of your progress, what you are learning, and what you still need to do. Throughout this Unit, you will be using a *Project Board* to do that. During classroom discussions, your teacher or one of the students will record the class's ideas on a class *Project Board*. At the same time, you will keep track of what has been discussed on your own *Project Board* page.

Design and build a vehicle that will go straight, far, and fast, and carry a load.				
What do we think we know?	What do we need to investigate?	What are we learning?	What is our evidence?	What does it mean for the challenge or question?

A *Project Board* has space to answer five guiding questions:

- What do we think we know?
- What do we need to investigate?
- What are we learning?
- What is our evidence?
- What does it mean for the challenge or question?

To get started on this *Project Board*, you need to identify and record the important design challenges you are addressing: *Design and build a vehicle that will go straight, far, and fast, and carry a load.*

What do we think we know?

In this column of the *Project Board*, you will record what you think you know about designing your vehicle. You probably have ideas now about how objects move, and what makes them slow down or stop. You also have ideas about how to make a toy car move. Record those ideas in this column. Think about concepts you may have learned in the past if you have studied these topics before. Even if it is a small fact or idea, talk about it and record it.

What do we need to investigate?

In this column, you will record what you need to investigate. As you *messed about* with different toy cars, you gathered some ideas about how different features of the design affected a car's performance. You may have already started wondering about how to design your vehicle to meet the criteria of the challenge. For example, you may be wondering how you can keep your vehicle from turning to one side or how you can make it carry a load. You might also have identified some things you are unsure about. And you might have found that you disagreed with others in your group or class about what causes movement or how you can measure motion. This second column is designed to help you keep track of ideas that are confusing as well as or concepts you do not yet know, but will be important for achieving the challenge.

Later in this Unit, you will return to the *Project Board*. For now, work with your classmates as you begin filling in the first two columns.