# Newton in Models

Read Newton's findings, then show how models explain them.

**PHS.5.1** "Research the scientific contributions of Newton and use models to communicate Newton's principles."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline three scientific contributions Newton made. Circle the words that describe a model for each contribution, then give each contribution and its matching model the same number.

### From Carts to Moonlight

1. In 1687, Isaac Newton published *Principia*, which brought together ideas about motion in three laws. Picture a wheeled cart rolling across a level floor. In a force model, an arrow points forward for a push, while an arrow points backward for friction. If the forces balance, the cart keeps a constant velocity, including staying still, rather than speeding up. A greater unbalanced forward force produces greater acceleration when the cart's mass stays the same. Newton's laws also predict that when a hand pushes the cart, the cart pushes back on the hand with an equal, opposite force.

2. Newton also proposed universal gravitation: every mass attracts every other mass. Consider the Moon moving around Earth. In a model, draw the Moon's velocity arrow along its path and a gravity arrow toward Earth's center. Earth's pull continually changes the Moon's direction, so its path bends instead of continuing in a straight line. The Moon pulls Earth too, with an equal, opposite gravitational force. A circular sketch can help show the changing direction, although the Moon's real orbit is slightly elliptical. Newton used the same gravitational principle to explain falling objects and the motion of planets.

3. Newton's work extended beyond motion and gravity. In experiments with glass prisms, he sent a narrow beam of sunlight through a prism and observed a range of colors. He showed that white light contains colors that a prism separates because different colors bend by different amounts. To model his finding, draw one incoming white-light ray and several outgoing colored rays spreading apart. This ray model tracks the paths of light, but it does not show every feature of light. Newton published his studies of light in *Opticks* in 1704, giving later scientists experiments they could test.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. In the cart model, what happens to the cart's motion when its force arrows balance? What changes when the forward force is greater?

2. Describe the two arrows you would draw to model the Moon's motion. How do they help explain its curved path?

3. How can a ray model communicate Newton's finding about white light and a prism?

4. What force principle appears in both the hand-and-cart model and the Earth-and-Moon model? Identify the paired forces in each.

## 3 YOUR TURN

Your own words

A swimmer pushes off a wall at the right end of a pool. Sketch the swimmer and wall with two labeled force arrows for their interaction, then write two sentences explaining how your model shows one of Newton's principles.

ANSWER KEY

# Newton in Models

HIGH SCHOOL · PHS.5.1

## PART 1 · READ AND MARK

Underline three scientific contributions Newton made. Circle the words that describe a model for each contribution, then give each contribution and its matching model the same number. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | In the cart model, what happens to the cart's motion when its force arrows balance? What changes when the forward force is greater? | **Balanced forces leave the cart at a constant velocity, which can be zero. A greater unbalanced forward force gives it greater acceleration if its mass stays the same.** |
| 2 | Describe the two arrows you would draw to model the Moon's motion. How do they help explain its curved path? | **Draw a velocity arrow along the Moon's path and a gravity arrow toward Earth's center. Earth's gravitational pull continually changes the Moon's direction, bending its path.** |
| 3 | How can a ray model communicate Newton's finding about white light and a prism? | **Show one incoming white-light ray and several outgoing colored rays that spread apart because different colors bend by different amounts.** |
| 4 | What force principle appears in both the hand-and-cart model and the Earth-and-Moon model? Identify the paired forces in each. | **The paired forces are equal and opposite. The hand pushes the cart while the cart pushes the hand; Earth pulls the Moon while the Moon pulls Earth.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

Sketch: swimmer at left, wall at right; rightward arrow on wall labeled swimmer pushes wall; leftward arrow on swimmer labeled wall pushes swimmer
Newton's third law explains the paired forces. The forces are equal in size, opposite in direction, and act on different objects.

Accept equivalent wording for constant velocity, including rest. In the swimmer model, look for opposite arrows on different objects and an explanation that identifies Newton's third law.