

Forces Tell the Motion Story

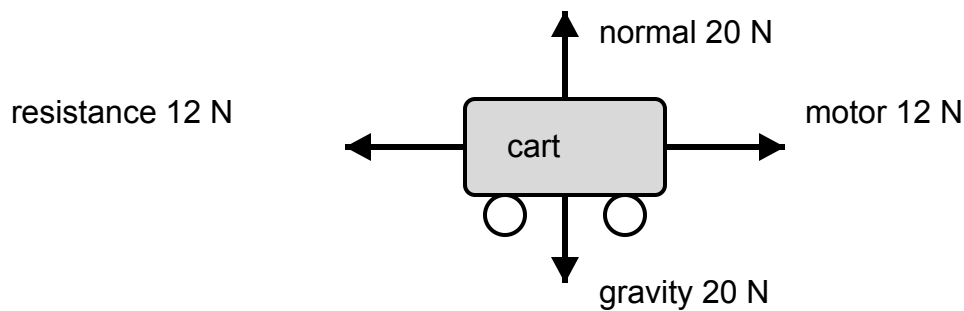
Use Newton's Laws to explain balanced and unbalanced forces

Name: _____ Date: _____

Part 1 - Balanced forces and constant velocity

Force reminder: Add all forces on one object to find net force. If net force is zero, an object can stay still or keep moving at constant velocity. This is Newton's First Law.

Classroom model - fictional data: A 2 kg battery cart is already moving right at 2 m/s on a level track. The motor pushes right with 12 N. Track resistance pushes left with 12 N. The diagram shows forces *on the cart*.



1. What is the cart's net force? Then use Newton's First Law to explain why its motion does or does not change. Include the phrase *constant velocity*.

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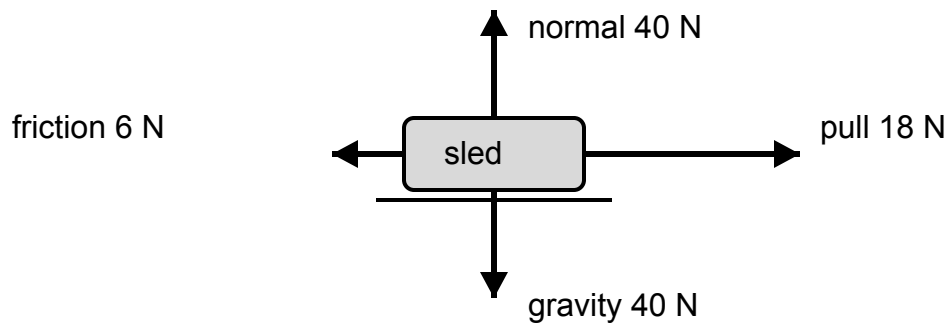
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Part 2 - An unbalanced force changes motion

Classroom model - fictional data: A 4 kg sled starts at rest on level snow. A pull pulls right with 18 N. Friction pushes left with 6 N. The normal force and gravity are each 40 N. These are all the forces on the sled.

Newton's Second Law: $F_{\text{net}} = ma$. Draw **one** arrow showing the net horizontal force in the blank box. Label its direction and magnitude. Then calculate acceleration.



Net-force arrow:

2. Calculate the sled's acceleration. Use units. Explain how Newton's Second Law predicts the change from rest.

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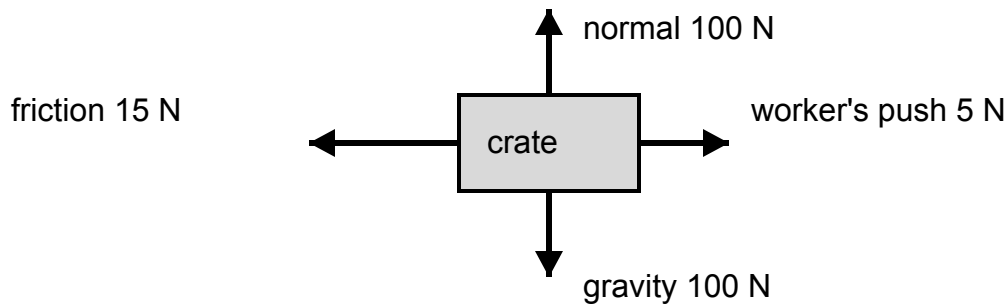
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Part 3 - Slowing down and action-reaction pairs

Classroom model - fictional data: A 10 kg crate is sliding right at 4 m/s across a level floor. A worker pushes the crate right with 5 N, but friction pushes left with 15 N. The upward normal force and downward gravity are each 100 N.

The arrows below are forces **on the crate**. Arrow lengths are not drawn to scale; use the labels.



3a. What is the net horizontal force? Explain what happens to the crate's rightward motion while it is still sliding right.

3b. Complete this Newton's Third Law pair: the worker pushes the crate 5 N to the right; the _____ pushes the _____ 5 N to the _____. Why are these not balanced forces on the crate?

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Answer key - Force and motion

1. Net force is 0 N. Horizontally, 12 N right and 12 N left cancel; vertically, 20 N up and 20 N down cancel. Because the net force is zero, Newton's First Law says the cart continues right at constant velocity (2 m/s). It does not speed up, slow down, or turn.
 2. Student arrow: right, labeled 12 N. Calculation: $F_{\text{net}} = 18 \text{ N} - 6 \text{ N} = 12 \text{ N right}$. $a = F_{\text{net}}/m = 12 \text{ N}/4 \text{ kg} = 3 \text{ m/s}^2$ right. From rest, the sled accelerates right, so its velocity begins increasing rightward. The 40 N vertical forces cancel.
 - 3a. Net horizontal force is 10 N left: 15 N left - 5 N right. The crate is moving right but has leftward acceleration, so it slows down while it continues moving right. A response that says it immediately moves left is incomplete/incorrect.
 - 3b. The **crate** pushes the **worker** 5 N to the **left**. These forces act on different objects: the worker's force acts on the crate, and the crate's force acts on the worker. They are a Third Law action-reaction pair, not balanced forces on the crate. On the crate, normal force and gravity are a balanced pair because both act on the crate and sum to zero.
- Scoring guide:** 1 point each: correct net force/direction; correct law-based motion explanation; correct calculation where requested; correct different-objects explanation in 3b. Suggested total: 10 points. Accept equivalent wording that preserves direction, zero versus nonzero net force, and the stated initial motion.

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Teaching notes and companion guide

Materials and setup: Supply one printed or digital three-page student worksheet and a pencil to each student. No additional materials are needed. Before students begin, display or read the page order only; do not add arrows or solve a model. The force diagrams and fictional classroom data are supplied on the student pages.

Teaching script (read aloud): “Each diagram shows forces on one named object. First read the object's initial motion. Combine forces by direction to find net force. Zero net force can mean constant velocity, not only rest. For a Third Law pair, name the two different objects receiving the forces.”

Observation method: During independent work, use a three-item checklist. (1) In Part 1, listen/look for “0 N” and “constant velocity.” (2) In Part 2, check for a single 12 N rightward resultant arrow and 3 m/s^2 right. (3) In Part 3, check that the student says “slows while moving right” and places the reaction force on the worker, not on the crate. Prompt students who omit the initial-motion detail: “What direction is it moving at the start?” Do not supply the answer.

Brief follow-up: Ask students to point to two forces that balance on the crate (normal and gravity) and then to say why the worker-crate pair differs. Reinforce: balanced forces are considered on one object; Third Law forces are on different objects.

Source credit: Georgia Standards of Excellence, S8P3.b, “Construct an explanation using Newton's Laws of Motion to describe the effects of balanced and unbalanced forces on the motion of an object.”
<https://lessonmakerpro.com/standards/ga-science/s8p3-b>