

Zoe and the Robot Force Lab

Grade 6

science

robots

Students will be able to describe how balanced and unbalanced forces affect the motion of an object, using evidence from Zoe's robot experiments.

Name: _____

Date: _____

1. Zoe enters the robot lab. She pushes a small robot forward. A push is a type of force. True or False: A force can change the direction of a moving object.

2. Zoe sees the robot arm resting on the table. No forces are acting on it. Fill in the blank: When all forces on an object are equal, the forces are called _____ forces.

3. Zoe charges the energy cell. The robot arm gets two forces: a 10 N push left and a 10 N push right. Will the robot arm move? Explain using the word 'balanced.'

4. Zoe rewires the circuit board. Now the robot arm gets a 15 N push forward and a 10 N push backward. Are these forces balanced or unbalanced? What will the robot arm do?

5. Zoe tests the power core. It produces friction that slows the robot down. What type of force is friction — contact or non-contact? How does friction affect the robot's motion? Explain.

6. Zoe programs three robot arms. Arm 1 pushes right with 25 N. Arm 2 pushes left with 18 N. Arm 3 pushes left with 7 N. Zoe must find the net force. Is the system balanced or unbalanced? Predict what happens.

7. Zoe connects a new energy cell to the robot. The robot speeds up, then hits a wall and stops. Identify the type of force causing it to stop. Explain what happened to the net force at each stage — speeding up, then stopping.

8. Zoe has fixed the robot. In the real world, rockets in space have no air friction. A rocket fires its engine for 3 seconds and then turns it off. Zoe predicts the rocket will keep moving forever. Is she right? Use Newton's First Law and the idea of balanced and unbalanced forces to explain. How is this different from the robot on Earth?

Answer Key: Zoe and the Robot Force Lab

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Before Q6, pause and ask students to predict whether Zoe's robot arm will move based on the force values given. This activates prior knowledge of balanced vs. unbalanced forces from Q3 and Q5.

1. Zoe enters the robot lab. She pushes a small robot forward. A push is a type of force. True or False: A force can change the direction of a moving object.

Answer: Q1: Forces can push, pull, and change motion — this is core to NGSS.MS-PS2-1. True. A force can change the direction of a moving object. Example: Zoe pushes the robot left, and it changes direction. Answer = TRUE.

2. Zoe sees the robot arm resting on the table. No forces are acting on it. Fill in the blank: When all forces on an object are equal, the forces are called _____ forces.

Answer: Q2: When forces are equal in size and opposite in direction, they cancel out and the object does not move. The missing word = BALANCED. Answer: When all forces on an object are equal, the forces are called BALANCED forces.

3. Zoe charges the energy cell. The robot arm gets two forces: a 10 N push left and a 10 N push right. Will the robot arm move? Explain using the word 'balanced.'

Answer: Q3: 10 N left and 10 N right are equal and opposite. Equal and opposite forces cancel out — they are balanced. Balanced forces cause no change in motion. The robot arm will NOT move because the forces are balanced and cancel each other out.

4. Zoe rewires the circuit board. Now the robot arm gets a 15 N push forward and a 10 N push backward. Are these forces balanced or unbalanced? What will the robot arm do?

Answer: Q4: Compare the two forces — 15 N forward vs. 10 N backward. 15 N does not equal 10 N, so the forces are UNBALANCED. Net force = 15 N - 10 N = 5 N forward. Unbalanced forces cause a change in motion. The robot arm will move FORWARD because the forces are unbalanced, with a net force of 5 N forward.

5. Zoe tests the power core. It produces friction that slows the robot down. What type of force is friction — contact or non-contact? How does friction affect the robot's motion? Explain.

Answer: Q5: Friction only acts when two surfaces touch — that makes it a contact force. Friction acts opposite to the direction of motion. Friction is a CONTACT force. It slows the robot down by pushing against its direction of motion. This is an unbalanced force that reduces the robot's speed.

6. Zoe programs three robot arms. Arm 1 pushes right with 25 N. Arm 2 pushes left with 18 N. Arm 3 pushes left with 7 N. Zoe must find the net force. Is the system balanced or unbalanced? Predict what happens.

Answer: Q6: Add all forces in each direction first. Right: 25 N. Left: 18 N + 7 N = 25 N. Net force = 25 N right - 25 N left = 0 N. Zero net force means the forces are BALANCED. The robot arms will NOT move because all forces cancel out. The system is in equilibrium.

7. Zoe connects a new energy cell to the robot. The robot speeds up, then hits a wall and stops. Identify the type of force causing it to stop. Explain what happened to the net force at each stage — speeding up, then stopping.

Answer: Q7: Stage 1 — speeding up: the energy cell provides a forward force greater than friction. Forces are UNBALANCED — net force is forward, so the robot accelerates. Stage 2 — hitting the wall: the wall applies a large contact force (normal force) backward that is greater than the forward force. Forces become UNBALANCED in the opposite direction — net force stops the robot. The stopping force is a CONTACT force from the wall. At each stage, a change in motion means the forces were unbalanced.

- 8.** Zoe has fixed the robot. In the real world, rockets in space have no air friction. A rocket fires its engine for 3 seconds and then turns it off. Zoe predicts the rocket will keep moving forever. Is she right? Use Newton's First Law and the idea of balanced and unbalanced forces to explain. How is this different from the robot on Earth?

Answer: Q8: Newton's First Law states that an object in motion stays in motion unless an unbalanced force acts on it. In space there is no air friction — so once the engine turns off, there are no unbalanced forces acting on the rocket. Net force = 0 N. With balanced forces (zero net force), the rocket keeps moving at the same speed in the same direction forever. This is called inertia. On Earth, Zoe's robot slows down because friction (a contact force) acts as an unbalanced force against its motion. In space, that friction is gone. So Zoe IS correct — the rocket will keep moving indefinitely. This connects to the next big idea: gravity is the non-contact force that eventually curves a spacecraft's path, even in space. Mission complete — Zoe has proven that understanding forces explains motion everywhere, from the robot lab to outer space.