Linear acceleration: principle

FizziQ activity · Middle school · 25 min

Scan to open in FizziQ

Moving a phone along its X axis, middle school students read the linear acceleration graph in FizziQ and link direction of motion, force and sign of acceleration.

Learning objectives

• Explore how the accelerometer responds to movements in different directions
• Discover that acceleration is positive during speed-up and negative during slow-down along the same direction
• Understand that acceleration is a vector quantity with magnitude and direction
• Identify the three phases of a typical movement: acceleration, constant velocity, deceleration
• Learn to interpret an acceleration-time graph and relate it to physical motion

Instruments and sensors

Linear acceleration (X-axis) · Absolute acceleration · Accelerometer

Materials

• Smartphone with the FizziQ application
• Clear space to carry out movements
• Note: the protocol remains adaptable to any comparable acceleration measurement tool.

Protocol

1. Open FizziQ and select the Linear Acceleration X sensor. This measures acceleration along the phone's horizontal axis, subtracting gravity.
2. Hold the phone flat in your hand with the screen facing up. Note that the X-axis points along the phone's long direction.
3. Start recording. While holding the phone still, observe the graph: it should show values near zero (no acceleration).
4. Now move the phone to the right with a quick push, then let it come to rest. Observe the graph: you should see a positive spike (acceleration) followed by a negative spike (deceleration).
5. Move the phone to the left with a quick push. Now the pattern is reversed: negative then positive.
6. Try a slow, gentle movement to the right. Compare the peak acceleration with the fast movement. The slow movement should show smaller peaks.
7. Try to move the phone at constant speed (no acceleration). The graph should return to zero during the constant-speed phase.
8. Perform a complete movement cycle: accelerate right, cruise at constant speed, decelerate to a stop. Identify all three phases on the graph.
9. Record the peak acceleration for movements of different speeds. Is the peak acceleration larger for faster movements?
10. Now tilt the phone so the X-axis points upward. Observe that the reading changes even without movement, due to gravity affecting the measurement.
11. Switch to Absolute Acceleration and compare with Linear Acceleration. Note that absolute acceleration includes gravity while linear acceleration subtracts it.
12. Summarize your findings: write three rules about how acceleration relates to the direction and speed of

movement.

Expected results

Students should observe clear patterns: moving right produces positive then negative acceleration; moving left produces negative then positive. Faster movements produce larger peak accelerations (typically 1-5 m/s² for hand movements, up to 10-20 m/s² for sharp jerks). During constant-speed motion, the linear acceleration returns to approximately zero. Tilting the phone causes the absolute acceleration to change even without movement, demonstrating the gravitational contribution. The three-phase pattern (accelerate, cruise, decelerate) should be clearly visible for deliberate, controlled movements.

Questions

- Why does slowing down produce an acceleration reading of opposite sign to speeding up?
- What is the difference between speed and acceleration?
- Why does the phone show non-zero acceleration even when tilted but stationary?
- What is the difference between linear acceleration and absolute acceleration?
- How does a MEMS accelerometer work? What is the role of the tiny suspended mass?
- Can you think of three applications of accelerometers in everyday technology?

Going further

- Explore all three axes (X, Y, Z) by moving the phone in different directions
- Attach the phone to a toy car and analyze the acceleration during push and release
- Record the acceleration during an elevator ride and identify the floor-to-floor acceleration pattern
- Investigate the accelerometer response during a car ride: identify braking, accelerating, and turning
- Compare the sensitivity of the accelerometer on different smartphones