Forces & motion

Lesson 1 of 2: Motion is not the same as a change in motion

Grades 6-8 | 45 minutes per lesson | Standard

Template sample

LEARNING GOALS

- Distinguish motion from change in motion.

QUESTION 01 | fm-q1 | Unreviewed draft

In an ideal friction-free model, a cart is moving right. Net force becomes zero. Predict its motion over the next few seconds and explain.

It keeps moving right at the same velocity. Zero net force means no acceleration in this model, not automatic stopping.

- Preserves the existing velocity.
- Explains no change rather than no motion.

Goals: fm-o1

QUESTION 02 | fm-q2 | Unreviewed draft

A cart moves right while a constant net force acts left. Describe what happens first and what could happen later if the force continues.

It first slows while still moving right. If the force persists long enough, it can stop and then move left. Acceleration is leftward while velocity changes over time.

- Describes initial slowing.
- Allows later reversal under a continuing force.
- Distinguishes velocity from acceleration.

Goals: fm-o1

EXIT TICKET | fm-q3 | Unreviewed draft

Is this always true: a moving object must have a nonzero net force in its direction of motion? Give a counterexample.

No. A friction-free cart can move at constant velocity with zero net force.

- Rejects the universal claim.
- Provides a valid counterexample.

Goals: fm-o1

Source references (proposed partial standards connection):

https://www.nextgenscience.org/pe/ms-ps2-2-motion-and-stability-forces-and-interactions

https://github.com/phetsims/forces-and-motion-basics/blob/main/doc/model.md

Forces & motion

Lesson 2 of 2: Plan a fair comparison

Grades 6-8 | 45 minutes per lesson | Standard

Template sample

LEARNING GOALS

- Compare changes in motion while controlling mass or net force.
- Plan a one-variable investigation with meaningful measurements and controls.

QUESTION 01 | fm-q4 | Unreviewed draft

Plan a comparison of how mass affects changes in motion under the same net force. Specify what you change, measure, and control, and explain how the force is established.

Change mass and measure change in velocity over the same interval. Keep net force, initial velocity, method and reference frame fixed. Set force explicitly in a model; in a physical setup account for applied force and friction.

- Changes one intended variable.
- Measures change in motion over time.
- Explains meaningful controls and how net force is set or measured.
- Does not call a paper plan a completed experiment.

Goals: fm-o3

QUESTION 02 | fm-q5 | Unreviewed draft

A light cart receives a small push and a heavy cart a much bigger push. The heavy cart speeds up more. Why does this not show that more mass always causes more acceleration? Improve the comparison.

Both force and mass changed, so the effect of mass is not isolated. Control net force, time interval and initial conditions while changing mass; account for friction.

- Identifies confounding.
- Proposes a controlled comparison.
- Explains why changing both mass and force prevents a conclusion about mass alone.

Goals: fm-o3

EXIT TICKET | fm-q6 | Unreviewed draft

Two carts have different masses but equal constant net force, initial velocity and observation time. Which has the larger change in velocity? Name one condition to check.

The lower-mass cart. Check the force, interval, initial velocity or friction accounting so the stated comparison is meaningful.

- Chooses lower mass under the given conditions.
- Names a relevant control or check.

Goals: fm-o2

Source references (proposed partial standards connection):

https://www.nextgenscience.org/pe/ms-ps2-2-motion-and-stability-forces-and-interactions

https://github.com/phetsims/forces-and-motion-basics/blob/main/doc/model.md