Forces

Table of Contents

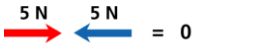
Motion

The Nature of Force

- A force is a push or a pull.
- Like velocity and acceleration, a force is described by its strength and by the direction in which it acts.
- The strength of a force is measured in the SI unit called newton (N).

Motion - The Nature of Force

- The combination of all forces acting on an object is called the net force.



Forces may cancel each other and produce no net force.

Motion - The Nature of Force

- Unbalanced forces can cause an object to start moving, stop moving, or change directions.
- Unbalanced forces acting on an object result in a net force and cause a change in the object's motion.
- Balanced forces are equal forces acting on one object in opposite directions.
- Balanced forces acting on an object do not change the object's motion.

Motion - The Nature of Force

Unbalanced Forces in the Same Direction When two forces act in the same direction, the net force is the sum of the two individual forces. The box moves to the right.

Unbalanced Forces in the Opposite Direction When two forces act in opposite directions, the net force is the difference between the two individual forces. The box moves to the right.

Balanced Forces in Opposite Directions When two equal forces act in opposite directions, they cancel each other out. The box doesn't move.

Motion

Friction and Gravity

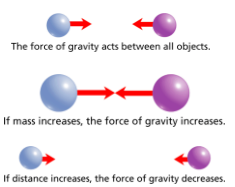
- The force that two surfaces exert on each other when they rub against each other is called friction.
- The strength of the force of friction depends on two factors:
  1. How hard the surfaces push together.
  2. The types of surfaces involved.

Motion

1. Static Friction – the friction that acts on objects that are not moving.
2. Sliding Friction – occurs when two solid surfaces slide over each other.
3. Rolling Friction – occurs when an object rolls across a surface.
4. Fluid Friction – occurs when a solid object moves through a fluid.

Motion

- Gravity is a force that pulls objects toward each other.
- The law of universal gravitation states that the force of gravity acts between all objects in the universe.
- Two factors affect the gravitational attraction between objects:
  1. Mass
  2. Distance

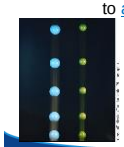


Motion - Friction and Gravity

- Mass is a measure of the amount of matter in an object.
- The force of gravity on a person or object at the surface of a planet is known as weight.

•When the only force acting on an object is gravity, the object is said to be in free fall.

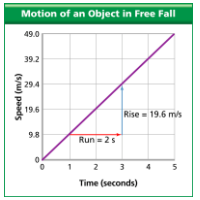
•In free fall, the force of gravity is an unbalanced force, which causes the object to accelerate.



- Acceleration due to gravity is **9.8 m/s²**.
- This means for every second an object is falling, its velocity increases by **9.8** meters per second (m/s).

Math Analyzing Data

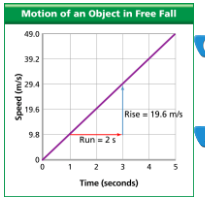
Free Fall



Use the graph to answer the following questions.

Math Analyzing Data

Free Fall



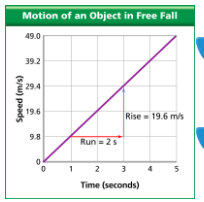
Interpreting Graphs:

Q. What variable is on the horizontal axis? The vertical axis?

A. Time is on the horizontal axis, and speed is on the vertical axis.

Math Analyzing Data

Free Fall



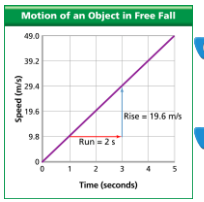
Calculating:

Q. Calculate the slope of the graph. What does the slope tell you about the object's motion?

A. The slope is 9.8. The speed increases by 9.8 m/s each second.

Math Analyzing Data

Free Fall



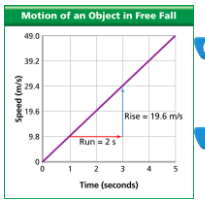
Predicting:

Q. What will the speed of the object be at 6 seconds?

A. 58.8 m/s

Math Analyzing Data

Free Fall

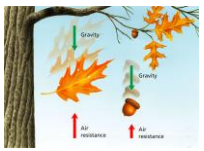


Drawing Conclusions:

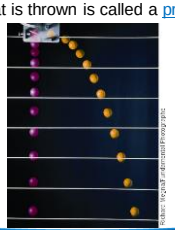
Q. Suppose another object of the same size but with a greater mass was dropped instead. How would the speed values change?

A. The speed values would not change.

- Falling objects with a greater surface area experience more air resistance.
  - This is why a leaf falls more slowly than an acorn.
- Air resistance increases with velocity.
- The greatest velocity a falling object reaches is called terminal velocity.



An object that is thrown is called a projectile.



Target Reading Skill

Comparing and Contrasting

As you read, compare and contrast friction and gravity by completing a table like the one below.

	Friction	Gravity
Effect on motion	Opposes motion	Pulls objects toward one another
Depends on	Types of surfaces involved, how hard the surfaces push together	Mass and distance
Measured in	Newtons	Newtons

End of Slide

Math Sample Problem

Calculating Force

A speedboat pulls a 55-kg water-skier. The force causes the skier to accelerate at 2.0 m/s^2. Calculate the net force that causes this acceleration.

Read and Understand

What information have you been given?

Mass of the water-skier (**m**) = **55 kg**

Acceleration of the water-skier (**a**) = **2.0 m/s^2**

Math Sample Problem

Calculating Force

A speedboat pulls a 55-kg water-skier. The force causes the skier to accelerate at 2.0 m/s^2. Calculate the net force that causes this acceleration.

Plan and Solve

What quantity are you trying to calculate?

The net force (F) = __

What formula contains the given quantities and the unknown quantity?

a = F/**m** or F = **m** X **a**

Perform the calculation.

F = **m** X **a** = **55 kg** X **2.0 m/s^2**

F = 110 **kg** • **m/s^2**

F = 110 N

Math Sample Problem

Calculating Force

A speedboat pulls a 55-kg water-skier. The force causes the skier to accelerate at 2.0 m/s^2. Calculate the net force that causes this acceleration.

Look Back and Check

Does your answer make sense?

A net force of 110 N is required to accelerate the water-skier. This may not seem like enough force, but it does not include the force of the speedboat's pull that overcomes friction.

Math Practice

Calculating Force

Practice Problem

Q. What is the net force on a 1,000-kg object accelerating at 3 m/s^2?

A. 3,000 N (1,000 kg X 3 m/s^2)

Math Practice

Calculating Force

Practice Problem

Q. What net force is needed to accelerate a 25-kg cart at 14 m/s^2?

A. 350 N (25 kg X 14 m/s^2)