

## Section 3: Motion and Force

### Preview

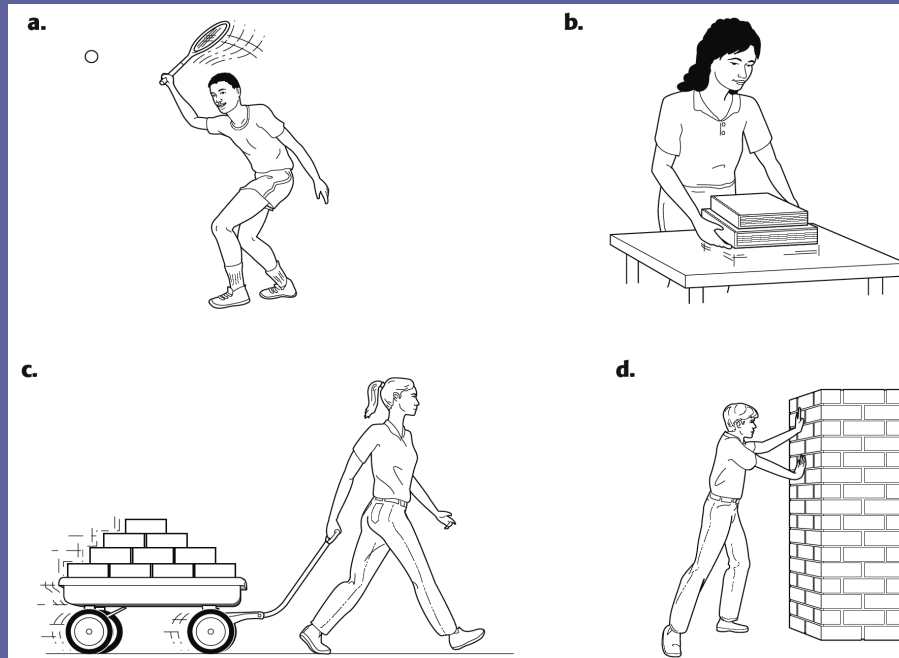
- Key Ideas
- Bellringer
- Fundamental Forces
- Balanced and Unbalanced Forces
- The Force of Friction
- Friction and Motion

## Key Ideas

- › What do scientists identify as the fundamental forces of nature?
- › What happens when there is a net force acting on an object?
- › What force always opposes motion?
- › Why is friction sometimes necessary?

## Bellringer

In some cases, an applied force is balanced by an opposite force, and there is no change in motion. In other cases, an applied force is not balanced by an opposite force, and the result is acceleration in the direction of the applied force. **Look at the following illustrations, and identify the forces and motion in each one.**



## Bellringer , *continued*

1. In one drawing, no motion is likely to occur. Which drawing is it?
2. In which diagram are the forces clearly balanced? How does this relate to your answer to item 1? If more force is exerted by the person, does the opposite force increase to match the new force, stay the same, or decrease?
3. Suppose there is enough friction in the wheels of the wagon in diagram c to balance the force with which the wagon is pulled. How will this affect the motion of the wagon?

## Fundamental Forces

- › What do scientists identify as the fundamental forces of nature?
- › These forces are the force of gravity, the electromagnetic force, the strong nuclear force, and the weak nuclear force.
  - The strong and weak nuclear forces act only over a short distance.
  - The force of gravity is a force that you feel every day.
  - Other everyday forces, such as friction, are a result of the electromagnetic force.

## Fundamental Forces, *continued*

- Fundamental forces vary in strength.
  - The fundamental forces vary widely in strength and the distance over which they act.
- Forces can act through contact or at a distance.
  - Pushes and pulls are examples of *contact forces*.
  - *Field forces* (like the force of gravity) do not require that the objects touch each other.
  - Both contact and field forces can cause an object to move or to stop moving.

## Balanced and Unbalanced Forces

- › What happens when there is a net force acting on an object?
- › Whenever there is a net force acting on an object, the object accelerates in the direction of the net force.
- *net force*: the combination of all forces acting on an object

## Balanced and Unbalanced Forces, *continued*

- Balanced forces do not change motion.
  - Forces are balanced when the net force is zero.
  - Example: For a light hanging from the ceiling (at rest), the upward force due to tension in the cord balances the downward force of gravity.



## Balanced and Unbalanced Forces, *continued*

- Unbalanced forces do not cancel completely.
  - Forces are unbalanced when the net force is greater than zero.
  - The object will accelerate in the direction of the net force.
  - Example: If you push a box to the east and your friend pushes the box to the north, the box will accelerate in a northeasterly direction.

# Visual Concept: Force



## The Force of Friction

- › What force always opposes motion?
- › The force of friction always opposes the motion.
- **friction:** a force that opposes motion between two surfaces that are in contact

## The Force of Friction, *continued*

- Static friction is greater than kinetic friction.
  - **static friction:** the force that resists the initiation of sliding motion between two surfaces that are in contact and at rest
  - **kinetic friction:** the force that opposes the movement of two surfaces that are in contact and are moving over each others

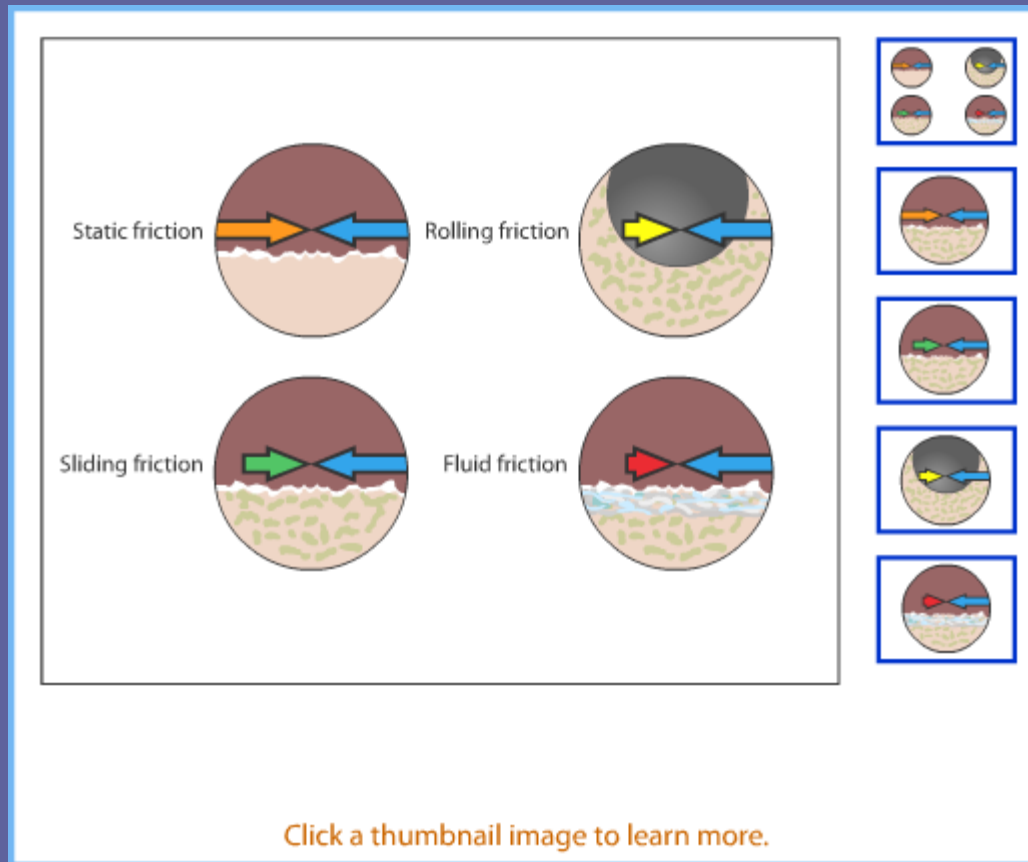
## Visual Concept: The Force of Friction



## The Force of Friction, *continued*

- Not all kinetic friction is the same.
  - *sliding friction*: when objects slide past each other
  - *rolling friction*: when a rounded object rolls over a flat surface
  - in general, rolling friction < sliding friction

# Visual Concept: Types of Friction



## Friction and Motion

- › Why is friction sometimes necessary?
- › Friction is necessary for many everyday tasks to work correctly.



## Friction and Motion, *continued*

- Unwanted friction can be lowered.
  - using low-friction materials, such as nonstick coatings on cooking pans
  - using *lubricants*, such as motor oil, wax, and grease
- Helpful friction can be increased.
  - scattering sand on icy roads to keep cars from skidding
  - wearing textured batting gloves when playing baseball to make it easier to grip the bat

### Visual Concept: Ways to Reduce or Increase Friction



The connecting rod on the bottom has worn out from too much friction.

Play ▶

< Back

Next >

Preview 🏠

Main 🏠

## Friction and Motion, *continued*

- Cars could not move without friction.
  - Without friction between the tires and the road, the tires would not be able to push against the road and the car would not move forward.
  - The force pushing the car forward must be greater than the force of friction that opposes the car's motion.
  - Because of friction, a constant force must be applied to a car just to keep it moving at the same speed.

## Friction and Motion, *continued*

