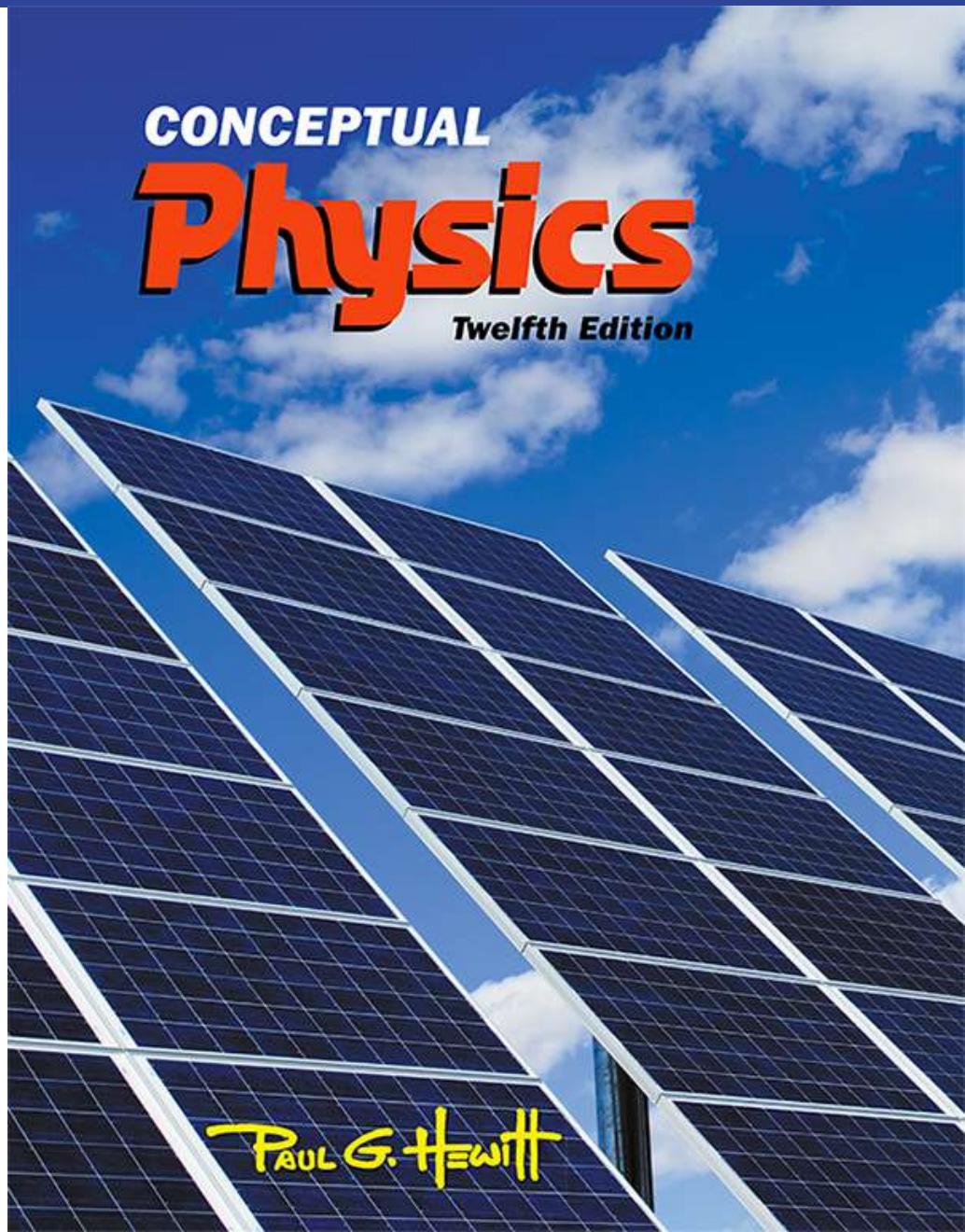
Section 5.3:
Action and Reaction on Different Masses.



An apple weighs 1 N.

Translation:
The Earth pulls an apple down with a 1 N gravitational force

What is the reaction force?

Which pull is stronger?

The apple is released. Why does the apple accelerate, but the Earth does not?

apple: $\mathbf{a} = \frac{F}{\_}$

Earth: $_{a} = \frac{F}{\_}$

Newton's Third Law of Motion
CHECK YOUR NEIGHBOR, Continued-1

When you step off a curb, Earth pulls you downward and you pull Earth upward. Why do you not sense Earth moving upward toward you?

A. Earth is fixed, so it cannot move.
B. Earth can move, but other objects on it prevent it from moving.
C. It moves, but by an imperceptible amount.
D. None of the above.

Newton's Third Law of Motion
CHECK YOUR ANSWER, Continued-1

When you step off a curb, Earth pulls you downward and you pull Earth upward. Why do you not sense Earth moving upward toward you?

C. It moves, but by an imperceptible amount.

Explanation:

The force you exert on Earth is just as much as the force Earth exerts on you. You move more than Earth does because Earth's mass is enormously greater than your mass. Earth's tiny motion is less than you can perceive. (Can you accept what you can't see?)

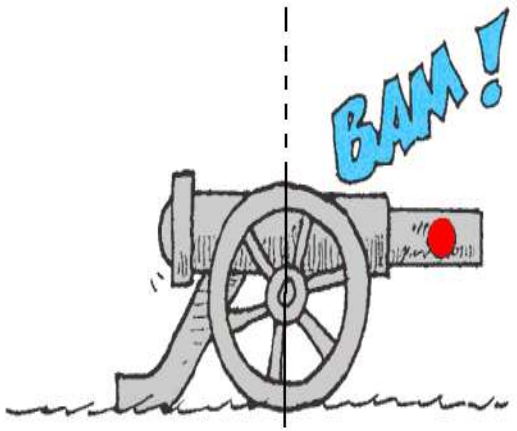
Newton's Third Law of Motion, Continued-3

- Action and Reaction on Different Masses
  - Cannonball: $\frac{F}{m} = a$
  - Cannon: $\frac{F}{m} = a$
- The same force exerted on a small mass produces a large acceleration.
- The same force exerted on a large mass produces a small acceleration.

Newton's Third Law of Motion
CHECK YOUR NEIGHBOR, Continued-2

When a cannon is fired, the accelerations of the cannon and cannonball are different because the

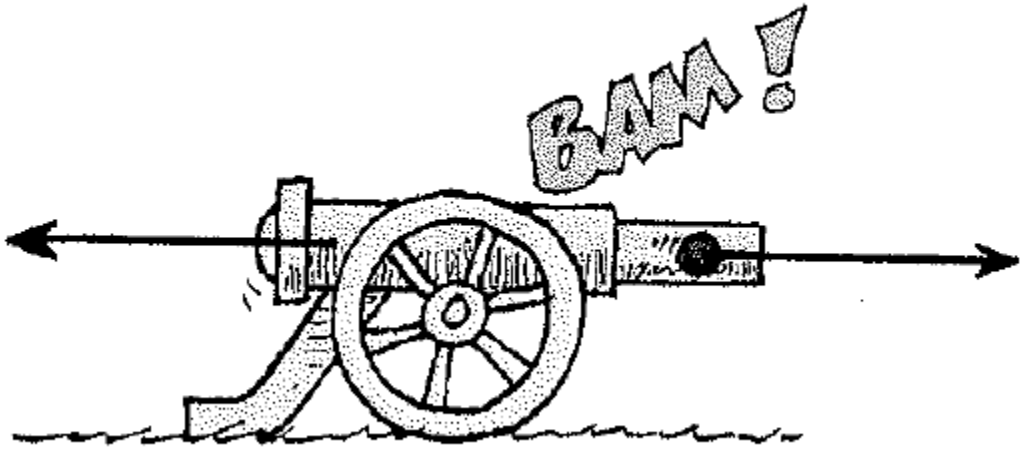
A. forces don't occur at the same time.
B. forces, although theoretically the same, in practice are not.
C. masses are different.
D. ratios of force to mass are the same.

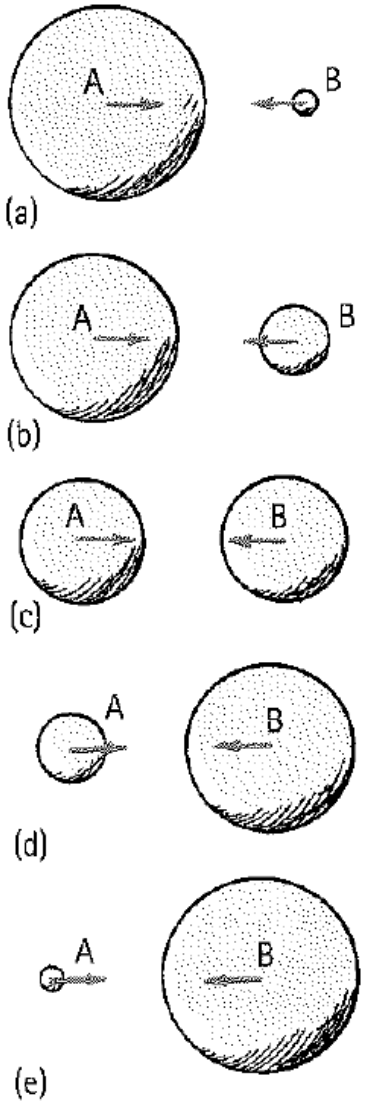


Newton's Third Law of Motion
CHECK YOUR ANSWER, Continued-2

When a cannon is fired, the accelerations of the cannon and cannonball are different because the

C. masses are different.





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bug hits windshield

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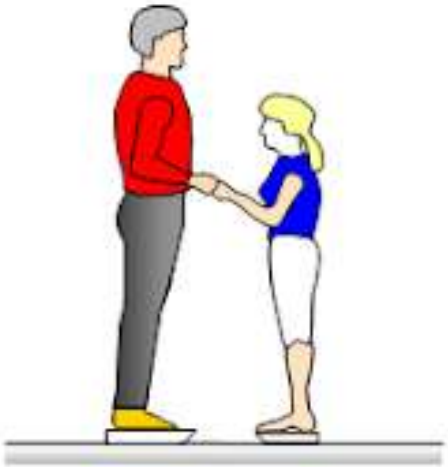


Figure 2(a)

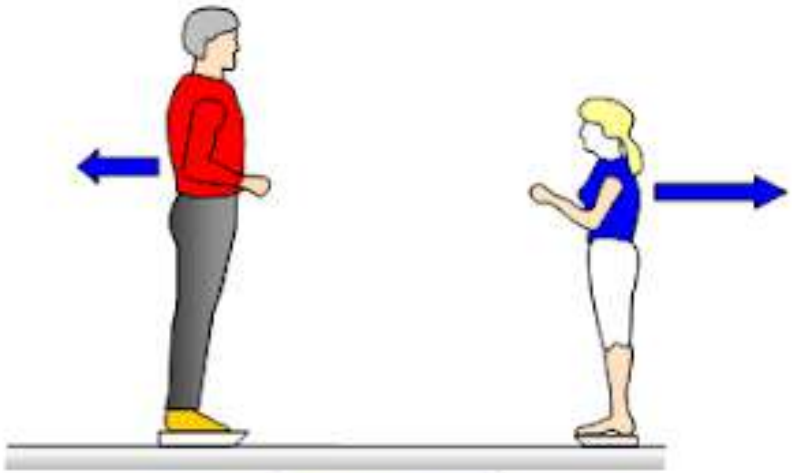


Figure 2(b)

Newton's Third Law of Motion
CHECK YOUR NEIGHBOR, Continued-3

Consider a high-speed bus colliding head-on with a flying bug. The force of impact splatters the unfortunate bug over the windshield. Which is greater, the force on the bug or the force on the bus?

A. Bug
B. Bus
C. Both the same amount.
D. Cannot say

Newton's Third Law of Motion
CHECK YOUR ANSWER, Continued-3

Consider a high-speed bus colliding head-on with a flying bug. The force of impact splatters the unfortunate bug over the windshield. Which is greater, the force on the bug or the force on the bus?

C. Both the same amount.

Comment:

Although the forces are equal in magnitude, the effects are very different. Do you know why?

Newton's Third Law of Motion
CHECK YOUR NEIGHBOR, Continued-4

Two people of equal mass on slippery ice push off from each other. Will both move at the same speed in opposite directions?

A. Yes
B. Yes, but only if both push equally.
C. No
D. No, unless acceleration occurs.

Newton's Third Law of Motion
CHECK YOUR ANSWER, Continued-4

Two people of equal mass on slippery ice push off from each other. Will both move at the same speed in opposite directions?

A. Yes

Explanation:

In whatever way they push, equal-magnitude forces acting on equal masses produce equal accelerations; therefore, both undergo equal changes in speed.

Newton's Third Law of Motion
CHECK YOUR ANSWER, Continued-5

The apple-orange system will move with constant speed if

C. a force equal and opposite to the friction force occurs.

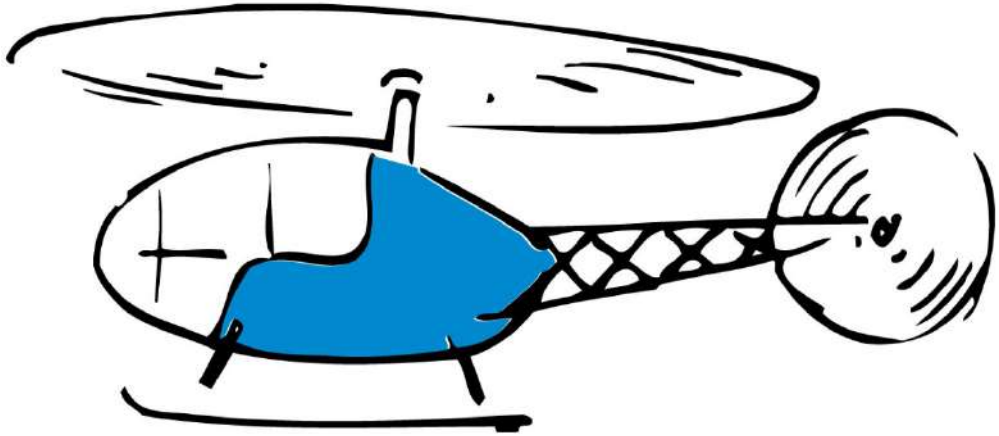
Comment:

Such a force may be floor friction on the cart wheels, or even a force produced by an opposing wind.

Newton's Third Law of Motion
CHECK YOUR NEIGHBOR, Continued-6

Consider the flight of a helicopter. When lift is greater than the helicopter's weight, the helicopter

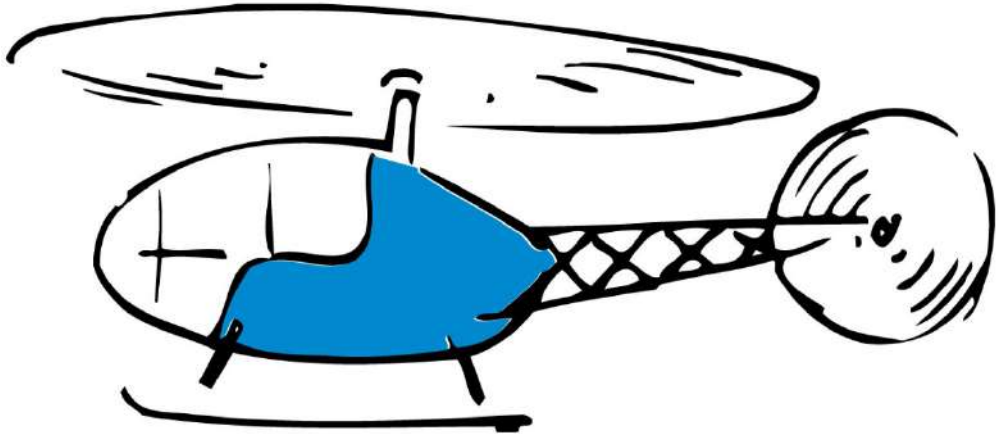
A. moves downward.
B. moves upward.
C. hovers in midair.
D. None of the above.



Newton's Third Law of Motion
CHECK YOUR ANSWER, Continued-6

Consider the flight of a helicopter. When lift is greater than the helicopter's weight, the helicopter

B. moves upward.



Newton's Third Law of Motion
CHECK YOUR NEIGHBOR, Continued-7

A bird flies by

A. flapping its wings.
B. pushing air down so that the air pushes it upward.
C. hovering in midair.
D. inhaling and exhaling air.

Newton's Third Law of Motion
CHECK YOUR ANSWER, Continued-7

A bird flies by

B. pushing air down so that the air pushes it upward.

Summary of Newton's Three Laws of Motion

- Newton's first law of motion (the law of inertia)
  - An object at rest tends to remain at rest; an object in motion tends to remain in motion at constant speed along a straight-line path.
- Newton's second law of motion (the law of acceleration)
  - When a net force acts on an object, the object will accelerate. The acceleration is directly proportional to the net force and inversely proportional to the mass.
- Newton's third law of motion (the law of action and reaction)
  - Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first.