SECTION: FRICTION: A FORCE THAT OPPOSES MOTION

1. Sample answer: Friction is a force that works against the motion of an object.
2. A
3. Friction occurs because the microscopic hills and valleys of two touching surfaces stick to each other.
4. As the roughness of the surface increases, the friction between the surfaces increases.
5. As the force pushing two surfaces together increases, the friction between the surfaces increases.
6. Friction can be increased by making surfaces rougher and by increasing the force pushing the surfaces together.
7. The two kinds of friction are kinetic friction and static friction. Sample answer: An example of kinetic friction is the friction that happens when you slide a chair across the floor. An example of static friction is the friction that keeps an eraser sitting on a tilted book from sliding down.
8. The sponge has a layer of plastic bristles on it to make it rougher. The rough bristles increase the friction between the sponge and the surface being cleaned. The increased friction helps clean pots and pans.
9. Answers may vary. Sample answer: Friction is harmful because it causes tire tread to wear down and causes the brakes to wear down. Friction is helpful because it helps the wheels grip the road and helps your feet and hands stay on the pedals and handlebars.
10. Answers may vary. Sample answer: Static friction is useful when you lean against a table for support. The table does not move because of static friction between the feet of the table and the floor.

SECTION: GRAVITY: A FORCE OF ATTRACTION

1. Sample answer: Gravity is a force of attraction between objects that is due to their masses.
2. Sample answer: The mass of the astronaut is the same whether he is on Earth or in space. The weight of a small apple is about 1 N.
3. A
4. The law of universal gravitation states that all objects attract each other through gravitational force and that the size of the gravitational force between objects depends on their masses and the distance between them.
5. The greater an object's mass, the larger the gravitational force it exerts on other objects.
6. As the distance between objects increases, the gravitational force between them decreases. As the distance between objects decreases, the gravitational force between them increases.
7. Mass and weight are often confused because they both are constant on Earth and the terms *mass* and *weight* are sometimes used to mean the same thing.
8. On Jupiter, the object's mass would be 70 kg and its weight would be 1577.8 N.
9. Sample answer: You can tell your friend that there must be gravity in space because gravity holds the planets in orbit around the sun.
10. Your weight would change if you landed on Mars because the gravitational force on Mars is different from the gravitational force on Earth. But, your mass would not change because the amount of matter in your body would not change.

Chapter Review

1. Friction
2. newton
3. net force
4. velocity
5. weight
6. B
7. D
8. C
9. C
10. C
11. Motion occurs when an object changes position over time when compared with a reference point (an object that appears to stay in place).

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12. Acceleration can occur simply by a change in direction. Thus, no change in speed is necessary for acceleration.
13. Mass is the amount of matter in an object, and its value does not change with the object's location. Weight measures the gravitational force on an object, so it can change as the amount of gravitational force changes.
14. a. 12 m/s
    b. 12 m/s east
    c. 2.5 m/s^2 south
15. An answer to this exercise can be found at the end of the Teacher Edition.
16. Accept all reasonable answers. Sample answers: Use a handcart or dolly to take advantage of rolling kinetic friction. Polish the floor to reduce sliding kinetic friction.
17. The car's gas pedal is pressed by the driver to increase the car's speed. Since the scientific meaning of the term *acceleration* can include slowing down and even changing direction, *accelerator* is not an accurate term for this device.
18. It is helpful for pilots to know wind velocity because velocity includes direction. Pilots need to know the wind's speed and direction so that they will know whether the wind is blowing in the same direction as the plane (which could increase the plane's resultant velocity and lead to an earlier arrival time) or in a different direction than the plane (which might lead to a later arrival).
19. The graph shows positive acceleration. Velocity increases as time passes.
20. a. 3 N to the left
    b. 5 N up
    c. 8 N to the right

Reinforcement

BUG RACE

1. 20 cm
2. 3.5 s
3. 20 cm ÷3.5 s =5.7 cm/s
4. 20 cm
5. 3.5 s
6. 20 cm ÷3.5 s=5.7 cm/s
7. My bug was traveling at a constant speed. For my bug, average speed did not change over time, so the graph of distance traveled over time is a straight line.

FRICTION ACTION

1. Answers may vary. Sample answer: Yes; Jenny met Steve's challenge. The friction between the turning wheels of her bike and the ground was rolling kinetic friction. The sliding of the brakes on the wheels of the bicycle was an example of sliding kinetic friction. The friction that kept Jenny's feet on the bike pedals was static friction.

A WEIGHTY PROBLEM

Weight

- spring scale
- measure of gravitational force exerted on an object
- constant on Earth
- changes when gravitational force changes
- expressed in newtons
- on the moon, is 1/6 of that on Earth

Mass

- balance
- amount of matter in an object
- constant on Earth
- never changes
- measured in kilograms
- remains the same when gravitational force changes

Critical Thinking

1. I need to know the speed and direction the river is moving in order to determine where I should enter the river so that I exit south of my entry point.
2. I need to know the total distance and direction I should move through the woods. I also need to know the type of terrain I will be crossing.
3. Answers may vary. The following samples may be in the right column: **First box:** Swimming directly across the river, I will end up north of my desired location. **Second box**: This part of my mission will take me much longer to complete than it would if the terrain were flat.

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