Answer Key

Directed Reading A

SECTION: MEASURING MOTION

1. Answers may vary. Sample answer: I cannot see Earth moving; yet I know it moves (revolves) around the sun.
2. A
3. D
4. reference point
5. They make useful reference points because they do not move.
6. Answers may vary. Sample answer: Yes, a moving object can be used as a reference point because it can be observed in relation to another moving object.
7. time
8. m/s, or meters per second
9. Answers may vary. Sample answer: Objects don't often travel at a constant speed.
10. Average speed is the total distance traveled divided by the total time taken to travel that distance.
11. The distances vary, because the speed is not constant.
12. The line representing actual speed per hour will usually not be straight, because speed usually changes. The line representing average speed over the entire time will be straight, as it represents average speed as if it were the same speed all the time.
13. They are traveling in different directions.
14. Velocity includes direction; speed does not include direction.
15. Add the velocities together.
16. Subtract the smaller velocity from the larger velocity. The resultant velocity is in the direction of the larger velocity.
17. Yes, a change in direction is acceleration, just as a change in speed is acceleration.
18. positive
19. negative acceleration; deceleration
20. average acceleration = (final velocity starting velocity)/time it takes to change velocity
21. A change in velocity means acceleration. The cyclist's velocity increased from 1 m/s south to 3 m/s south. So, the cyclist is accelerating.
22. A graph would show velocity changing as time passes.
23. Answers may vary. Sample answer: The graph's upward (positive) slope represents increasing velocity, which is what the roller coaster has as it travels downward.
24. Yes, it is always accelerating while it remains in a circle, because it is always changing direction.

SECTION: WHAT IS A FORCE?

1. force
2. force
3. newton
4. object
5. Answers may vary. Sample answer: I exert a force on a book when I pull it open; I exert a force when I push the buttons of a computer keyboard.
6. Answers may vary. Sample answer: When I sit on a chair, the force I exert on the chair does not make it move.
7. Answers may vary. Sample answer: The force that pulls magnets to refrigerators cannot be seen.
8. Answers may vary. Sample answer: The air held to Earth's surface by gravity cannot be seen.
9. net force
10. When both students apply force in the same direction, their forces are added together to determine a net force.
11. The dog on the left will win the tug-of-war, because the net force will be 2 N to the right.
12. whether the forces on the object are balanced or unbalanced
13. when the net force is 0 N
14. 0 N
15. You need an unbalanced force.
16. A soccer ball that has been kicked continues to roll on the ground long after the ball is kicked.

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SECTION: FRICTION: A FORCE THAT OPPOSES MOTION

1. The force of friction causes a ball to stop rolling.
2. friction
3. Answers may vary. Sample answer: the force pushing the surfaces together and the roughness of the surface
4. The hills and valleys of the surfaces come into closer contact and friction between the surfaces increases.
5. The weight of the larger book on the table creates more friction than the smaller book.
6. The amount of friction is greater between rough surfaces because rough surfaces have much more microscopic hills and valleys than smooth surfaces do.
7. Kinetic friction is friction between two moving surfaces.
8. Two types of kinetic friction are sliding kinetic friction and rolling kinetic friction.
9. Sliding kinetic friction is usually greater than rolling kinetic friction.
10. Answers may vary. Sample answer: applying the brakes on a bicycle
11. Answers may vary. Sample answer: putting a heavy piece of furniture on wheels and rolling it
12. Static friction occurs when force applied to an object does not cause the object to move.
13. kinetic friction
14. Answers may vary. Sample answer: The tires push against the ground to push the car forward.
15. Answers may vary. Sample answer: Friction harms the engine of a car by creating heat between moving parts and causing the parts to wear down.
16. a lubricant
17. Answers may vary. Sample answer: Use lubricants; switch from sliding kinetic friction to rolling kinetic friction; make surfaces that rub against each other smoother.
18. Answers may vary. Sample answer: Make surfaces rougher; increase the force pushing surfaces together.

SECTION: GRAVITY: A FORCE OF ATTRACTION

1. gravity
2. gravity
3. The force of gravity can change the motion of an object by changing its speed, direction, or both.
4. Since all matter has mass, and gravity is a result of mass, all matter is affected by gravity.
5. gravity
6. The mass of most objects is too small to cause a force large enough to move objects toward each other.
7. Earth has an enormous mass, so its gravitational force is very large. Therefore, objects are pulled by Earth's gravity toward Earth's center rather than being pulled by a smaller force of gravity toward its center.
8. The two questions were: (1) Why do objects fall toward Earth, and (2) what keeps the planets moving in the sky?
9. Newton proposed that the same unbalanced force that pulled an apple toward Earth was the same unbalanced force that kept the moon in orbit around Earth.
10. the law of universal gravitation
11. All objects in the universe attract each other through gravitational force. The size of the force depends on the masses of the objects and the distance between objects.
12. Answers may vary. Sample answer: Gravitational force increases as mass increases. An elephant has a larger mass than a cat does, so the amount of gravity between an elephant and Earth is greater than the amount of gravity between a cat and Earth.
13. Since the moon has less mass than the earth does, the moon's gravitational force is less than Earth's. Astronauts on the moon are not being pulled down by as much force as they would be on Earth.
14. Gravitational force is small between objects that have smxall masses and large when the mass of both objects is large.

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,15. Answers may vary. Sample answer: Gravitational force decreases as distance increases. I am 150 million kilometers away from the sun, and at this distance, the gravitational force between me and the sun is very small.
16. Answers may vary. Sample answer: Gravitational force is strong when the distance between two objects is small, but as the distance between two objects increases, gravitational force decreases rapidly.
17. C
18. A
19. A
20. Gravitational force is about the same everywhere on Earth, so the weight of an object is about the same everywhere. Since mass and weight are constant on Earth, the words mass and weight are often used to mean the same thing.
21. newton
22. kilogram
23. Answers may vary. Sample answer: grams and milligrams

Directed Reading B

SECTION: MEASURING MOTION

1. B
2. A
3. D
4. A
5. meters
6. speed
7. distance
8. speed
9. velocity
10. C
11. A
12. D
13. B
14. acceleration
15. positive
16. negative
17. deceleration
18. C
19. A
20. A
21. D

SECTION: WHAT IS A FORCE?

1. force
2. motion
3. newton
4. B
5. C
6. C
7. B
8. D
9. C
10. A
11. D
12. A
13. B
14. B

SECTION: FRICTION:

A FORCE THAT OPPOSES MOTION

1. A
2. D
3. B
4. D
5. D
6. A
7. B
8. C
9. A
10. C
11. A
12. C
13. B
14. A
15. A
16. A
17. B
18. D
19. A
20. A

SECTION: GRAVITY:

A FORCE OF ATTRACTION

1. B
2. D
3. C
4. B
5. B
6. B
7. C
8. A
9. C
10. C
11. D
12. A
13. B
14. C
15. D
16. B
17. D
18. A
19. B
20. B
21. A

Vocabulary and Section Summary

SECTION: MEASURING MOTION

1. motion: an object's change in position relative to a reference point
2. speed: the distance traveled divided by the time interval during which the motion occurred
3. velocity: the speed of an object in a particular direction
4. acceleration: the rate at which velocity changes over time; an object accelerates if its speed, direction, or both change

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SECTION: WHAT IS A FORCE?

1. force: a push or a pull exerted on an object in order to change the motion of the object; force has size and direction
2. newton: the SI unit for force (symbol, N)
3. net force: the combination of all of the forces acting on an object

SECTION: FRICTION: A FORCE THAT OPPOSES MOTION

1. friction: a force that opposes motion between two surfaces that are in contact

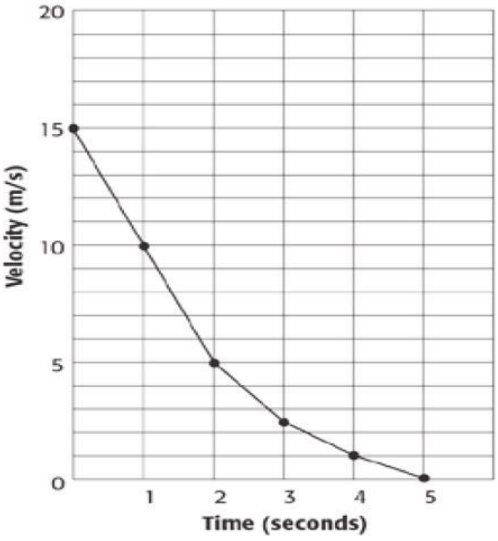
SECTION: GRAVITY: A FORCE OF ATTRACTION

1. gravity: a force of attraction between objects that is due to their masses
2. weight: a measure of the gravitational force exerted on an object; its value can change with the location of the object in the universe
3. mass: a measure of the amount of matter in an object

Section Review

SECTION: MEASURING MOTION

1. Sample answer: Motion is the change in position of an object relative to a reference point. Acceleration is the change in velocity over time.
2. Sample answer: The cat is moving with a speed of 1 m/s. The cat is moving with a velocity of 1 m/s to the east.
3. C
4. D
5. Speed does not include direction; velocity does.
6. the distance traveled and the time taken to travel that distance
7. Acceleration is the rate at which velocity changes.
8. 1.5 m/s
9. 3 m/s^2
10. It would be important to know the velocity because velocity includes direction. Knowing only the speed of a tornado would not tell the direction that the tornado is traveling. Knowing a tornado's direction of travel would allow people to avoid or escape its path.
11. The graph should show that the wolf has negative acceleration (slows down) until it comes to a stop.



SECTION: WHAT IS A FORCE?

1. Sample answer: A force is a push or a pull that can change the motion of an object. The net force is the combination of all forces acting on an object.
2. D
3. Unbalanced forces occur when the net force on an object is not 0 N; balanced forces occur when the net force equals 0 N. Unbalanced forces cause a change in an object's motion; balanced forces cause no change.
4. Sample answer: Pulling on the door of a cabinet causes the door to open.
5. Sample answer: A book resting on a table has balanced forces acting on it.
6. For any push to occur, something has to receive that push. So, the force of the push acts on the object receiving the push. The same is true for any pull.
7. 10 N east
8. If you do not know the directions of the forces, you won't know whether to add the forces or to subtract them.
9. Sample answer: Your feet push on the pedals, your body pushes down on the seat, and your fingers pull on the brakes.

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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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4. Answers may vary. Sample answer: Resultant velocity will depend on my velocity and the velocity of the river. Because the river flows north, I should walk to a point south of my desired location, then swim across the river.
5. Answers may vary. Students must specify speed and direction. Answers should address concepts such as velocity.

Section Quizzes

SECTION: MEASURING MOTION

1. D
2. B
3. A
4. C
5. A
6. C
7. B
8. D

SECTION: WHAT IS A FORCE?

1. B
2. A
3. C
4. D
5. C
6. A
7. B
8. B

SECTION: FRICTION: A FORCE THAT OPPOSES MOTION

1. A
2. A
3. C
4. D
5. B
6. D
7. C

SECTION: GRAVITY: A FORCE OF ATTRACTION

1. B
2. C
3. A
4. B
5. D
6. A
7. C
8. B

Chapter Test A

1. E
2. D
3. F
4. H
5. I
6. C
7. G
8. D
9. B
10. C
11. A
12. D
13. C
14. A
15. C
16. B
17. C
18. A
19. D
20. B
21. A
22. B
23. A
24. C
25. C

Chapter Test B

1. motion
2. force
3. velocity
4. friction
5. weight
6. D
7. B
8. C
9. A
10. D
11. Mass is the amount of matter in an object, and weight is a measure of gravitational force experienced by the object. Mass is constant, while weight may change with location.
12. To determine average speed, divide the total distance by the total time taken to travel that distance.
13. Speed is distance over a period of time, and velocity is speed with direction. The difference between speed and velocity is that speed does not have direction, while velocity does have direction.
14. Unbalanced forces produce change in the motion of objects. In moving objects, unbalanced forces can change the motion. In non-moving objects, unbalanced forces can start motion.
15. Subtract 1.8 m/s from 1.5 m/s. Divide that by the 180 seconds that it took the hiker to get to the top of the hill. We know the answer will be negative, because the final speed is slower than the initial speed.
16. Answers may vary. Sample answers: reducing friction—lubricating the moving parts of a bicycle or skateboard to reduce wear on them; helpful friction—the static friction of your shoe on a bicycle pedal, which allows you to pedal effectively
17. The gravitational force between me and the Earth is large. The gravitational force of the sun affects me much less than it affects the Earth. The gravity between the sun and planets is large because the objects have large masses. If the sun's gravitational force did not have such an effect on the planets, the planets would not stay in orbit around the sun.

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18. The student's weight on the moon would be 70 N, which is 1/6 × 420 N.
19. Kyle achieved the greatest average speed during the interval between 5 minutes and 10 minutes. The distance traveled during this interval (2 km) was greater than the distance covered in any other 5-minute interval.
20. Kyle probably stopped. He did not travel any distance in this interval.

Chapter Test C

1. A
2. D
3. D
4. C
5. D
6. C
7. D
8. B
9. A
10. F
11. E
12. H
13. G
14. accelerating
15. increasing
16. a force
17. a newton
18. gravity
19. a kilogram
20. friction
21. A
22. D
23. B

Standardized Test Preparation

READING

Passage 1

1. C
2. I
3. B

Passage 2

1. B
2. F
3. D

INTERPRETING GRAPHICS

1. C
2. G
3. B

MATH

1. C
2. H
3. A
4. G

Vocabulary Activity

1. C
2. E
3. J
4. F
5. H
6. K
7. D
8. M
9. A
10. G
11. L
12. I
13. O
14. B
15. N

SciLinks Activity

1. Answers may vary. Sample answer: A batter on a baseball team hopes to get a line drive into right field. She knows the wind velocity is strong to the east, and the batter's box faces north. She figures the wind velocity would cause balls hit along the right field line to drift foul. She changes the direction of her stance at the plate, shifting slightly to the west to compensate for the effects of the wind.
2. Answers may vary. Sample answer: Writing on the chalkboard at school is easy because of the friction of the chalk sliding across the board. Without friction, this would not bepossible.
3. The slope shows the acceleration of the object, either positive or negative.

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Performance-Based Assessment

TEST THE HYPOTHESIS

2. Answers may vary. Sample answer: 8.5 seconds
3. Answers may vary. Sample answer: The distances are 30 cm to the outer mark and 15 cm to the inner mark. Each of these measures is the radius.

ANALYZE THE RESULTS

4. Sample answer: $2 \times 3.14 \times 30$ cm = 188.4 cm; $2 \times 3.14 \times 15$ cm = 94.2 cm. The outer mark travels 188.4 cm, and the inner mark travels 94.2 cm.
5. Answers may vary. Sample answer: 188.4 cm $\times$ 10 = 1884 cm; 94.2 cm $\times$ 10 = 942 cm. The outer tape traveled 1884 cm, and the inner tape traveled 942 cm.
6. Answers may vary, depending upon the time in Question 2. Sample answer: 1884 cm $\div$ 8.5 s = 221.6 cm/s; 94.2 cm $\div$ 8.5 s = 110.8 cm/s. The outer tape traveled at 221.6 cm/s. The inner tape traveled at 110.8 cm/s.
7. The inner tape completed 10 revolutions in the same time as the outer tape but had less distance to travel. Therefore, the inner tape had a lower speed.
8. Answers may vary, depending upon the time in Question 2. Sample answer: 8.5 s $\div$ 10 rev = 0.85 s/rev; 0.85 s $\div$ 2 = 0.425 s
9. Answers may vary, depending upon the time in Question 2. Sample answer: 221.6 cm/s $\times$ 1 km/100,000 cm $\times$ 3,600 s/h = 8.0 km/h

Detecting Acceleration

ANALYZE THE RESULTS

1. The bottle stops accelerating (it is moving with a constant speed), so the cork shows zero acceleration.
2. The cork will move opposite to the motion of the water. As the bottle accelerates forward, the water sloshes backward, which makes the cork move forward. The cork will always move in the direction of acceleration.
3. As the car begins accelerating forward, the balloons will move forward because the air in the car moves backward. When the car reaches a steady speed, the balloons will move back to stand straight up.

APPLYING YOUR DATA

The cork will also travel in a circle, staying closest to the side of the bottle nearest the center of the circle.

The Friction 500

PROCEDURE

7. Answers may vary. Sample answer: The sandpaper surface had the most friction because it is the roughest. A heavier car would result in even more friction between the car and the surface because the force pushing the surfaces together would be increased. (Note: If students start the car from the same spot, the mass of the car will not affect the distance it travels on a given surface.)

Reducing Friction

PROCEDURE

3. Less force was needed in step 2 because the friction was reduced by changing sliding kinetic friction to rolling kinetic friction.
6. The jar was harder to open with the soap. The soap was a lubricant that reduced the friction between my hands and the jar.
7. Friction is helpful when trying to open a jar. Friction is harmful when trying to push books across the table.

Built for Speed

ANALYZE THE RESULTS

1. Answers may vary.
2. Answers may vary. Students should analyze their procedure and that of others.
3. Answers may vary. Students may consider factors such as battery life, the age of the spring in wind-up vehicles, the testing surface, or the wheels of the vehicle.

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APPLYING YOUR DATA

Procedures may vary but should show a clear understanding of how the condition could affect the vehicle's speed.

Relating Mass and Weight

ANALYZE THE RESULTS

2. Sample answer: Weight is a measure of the gravitational force on an object. Weight depends on mass. Because an object's mass never changes, its weight on Earth never changes. The straight line of the graph illustrates the direct relationship between mass and weight.

Science Friction

ANALYZE THE RESULTS

1. Static friction was the largest. Rolling friction was the smallest.
2. Answers may vary. Students may mention conducting more trials, using different objects or surfaces, or using the spring scale more carefully.

DRAW CONCLUSIONS

3. Answers may vary but should show consideration of the experimental procedure.

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