Chapter 4 Motion and Machines

Introduction

Motion and machines are discussed in Chapter 4. The chapter begins with a discussion of force, mass, and motion. ***Force*** is a push or pull, ***mass*** is the amount of matter in an object, and ***motion*** is described by ***speed, velocity,*** and ***acceleration***. Matter can be moved when the forces acting on it are unbalanced. When the forces acting on an object are balanced, no change in movement will occur. Sir Isaac Newton formulated three basic ***laws of motion***. These laws describe how objects move.

The section on ***machines*** begins with a discussion of work. ***Work*** is done when a force moves an object. Machines do not allow us to do less work. Machines make work easier by changing the amount, speed, or direction of forces. Some examples of simple machines are ***levers, inclined planes, screws, pulleys, wheels and axles,*** and ***wedges***. Complex machines contain two or more simple machines. No machine is 100% efficient; that is, work put into a machine is always greater than the work output.

Students Should Understand the Following Concepts

- Force is defined as a push or a pull. When forces acting on an object are balanced the object will be at rest, and when forces acting on an object are unbalanced the object will move.
- Mass is defined as the amount of matter that makes up an object. Weight is a measure of the gravitational pull on an object.
- Speed, velocity, and acceleration are some ways to describe the motion of an object.
- ***Newton's first law of motion*** states that an object at rest will remain at rest and an object in motion will remain in motion, unless a force acts on that object.
- ***Newton's second law of motion*** states that the acceleration of an object is directly related to the force applied to the object and inversely related to the mass of the object.
- ***Newton's third law of motion*** states that every action has an equal and opposite reaction.
- Work is done when a force moves an object.
- Machines allow work to be done using less force. The six simple machines are lever, inclined plane, pulley, screw, wheel and axle, and wedge.

Activities to Develop the Topic

Use one or more of the following activities to help review this unit with your students.

Set up a row of dominoes in front of the class. Ask the class to define force. Then, ask the class what forces are acting on the dominoes that are at rest. Tap the first domino, knocking down the row and ask the class what forces acted on the dominoes to cause them to fall.

Discuss the difference between mass and weight. Then put the following list on the board: classroom, 1000 meters underground, top of Empire State Building, moon, North Pole, and equator. Ask the students how the mass and weight of a person change at each of these locations. The person's mass is 450 kg and weight is 4400 N. Of course, the mass would remain the same (450 kg) at each location, but weight would differ [classroom (4400 N), 1000 meters underground (greater than 4400 N), top of Empire State Building (less than 4400 N), North Pole (greater than 4400 N), and equator (less than 4400 N)]. Remind students that the closer something is to Earth's center, the more it will weigh. The farther it is from Earth's center, the less it will weigh. Then ask how would your weight change if you were on the moon?

For homework, ask your students to identify an activity that demonstrates each of Newton's three laws of motion. The next day, have students read some of the activities and ask the class if they can identify which law the activity demonstrates. Praise students who identify unique activities.

Bring a rubber ball into the classroom and bounce it on the floor or off the wall, and ask your students, why did the ball come back to you? If they have difficulty answering, remind them that some force needed to be applied to the ball to cause it to change direction. If the students still have trouble answering the question, ask the question differently: "What applied the force to the ball, causing it to change direction?" Students should understand that the floor and wall are applying the force to the ball. Relate to the forces involved in walking: as you apply a force to the floor, the floor applies a force to your foot. This activity demonstrates Newton's third law of motion.

One more activity to try in this chapter is to ask students for homework to identify and make a list of simple machines they have at home. Encourage them to look around the kitchen and at the tools in their home. List the objects on the board and ask the students to identify to which simple machine category each object belongs.

Name ______________________ Date ______________________

Class ______________________

Review of Chapter 4

1. An example of an applied force that changes the direction of motion of an object is
   (1) an acorn falling from a tree
   (2) a batter hitting a pitched baseball
   (3) a car stopping at a stop sign
   (4) a wind pushing a sailboat across a lake

2. The object with the greatest gravitational force acting on other objects is
   (1) an asteroid
   (2) Earth
   (3) the sun
   (4) the moon

3. As an object, such as a rocket, moves away from Earth, its mass
   (1) stays the same
   (2) decreases
   (3) increases
   (4) changes depending on the density of the object

4. Which quantity is measured in units of distance traveled per unit of time only?
   (1) motion
   (2) acceleration
   (3) velocity
   (4) speed

5. Acceleration of an object is determined with the formula
   (1) $a = \frac{v_s - v_f}{t}$
   (2) $a = \frac{v_f - v_s}{t}$
   (3) $a = \frac{v_f - v_s}{d}$
   (4) $a = \frac{v_s - v_f}{d}$

6. The tendency for an object to resist changes in its motion is called
   (1) velocity
   (2) inertia
   (3) friction
   (4) gravity

7. Newton's second law of motion states the relationship between
   (1) force, velocity, and acceleration
   (2) force, density, and acceleration
   (3) force, mass, and acceleration
   (4) velocity, mass, and acceleration

8. An example of Newton's third law of motion is
   (1) a car traveling at constant speed
   (2) a rocket blasting off a launch pad
   (3) wind blowing through the trees
   (4) a volleyball falling to the ground

9. The amount of work done when lifting a heavy box is determined by
   (1) the distance of motion and the force applied
   (2) the velocity of motion and the force applied
   (3) the distance of motion and the velocity of motion
   (4) the speed of motion and the force applied

10. Force is measured in the units called
   (1) kilograms
   (2) grams
   (3) newtons
   (4) meters per second

11. Scissors are an example of a first-class lever. The fulcrum of a pair of scissors is located at the
   (1) handle of each of the blades
   (2) screw connecting the blades
   (3) top-cutting blade
   (4) bottom-cutting blade

12. The wheel and axle is a simple machine. An example of a wheel and axle is
   (1) the steering system in a car
   (2) a carpenter's nail
   (3) a nutcracker
   (4) a pair of pliers

13. Compared with the amount of energy produced by a machine, the amount of energy put into a machine is always
   (1) less
   (2) more
   (3) equal
   (4) depends on the machine

14. Oil and ball bearings are used inside an automobile engine to reduce
   (1) pollution
   (2) combustion
   (3) mechanical energy
   (4) friction

15. What type of simple machine is an ax?
   (1) lever
   (2) wedge
   (3) pulley
   (4) inclined plane

16. After taking off, a jet plane accelerates from 200 miles per hour to 300 miles per hour. To accomplish this the jet plane must
   (1) increase the force on the plane
   (2) increase the mass of the plane
   (3) decrease the force on the plane
   (4) decrease the mass of the plane

17. The difference between velocity and speed is
   (1) velocity includes direction and speed does not
   (2) speed deals with direction and velocity does not
   (3) speed deals with time and velocity does not
   (4) velocity deals with distance and speed does not

18. When a Frisbee is tossed, it spins through the air. The force that brings the Frisbee to the ground is
   (1) air friction
   (2) gravity
   (3 deceleration
   (4) velocity

19. When small children start playing baseball, they use a tee when batting. The ball is placed on the tee; then the player hits the ball off the tee. This demonstrates Newton's first law of motion. The statement that best describes the example above is
   (1) every action has an equal and opposite reaction
   (2) an object in motion will remain in motion unless an outside force acts on the object.
   (3) a small mass is required to move a large mass
   (4) an object at rest will stay at rest unless acted on by a force

20. Inertia is the tendency of an object at rest to remain at rest or an object in motion to remain in motion. The object with the greatest inertia is
   (1) 100-kg stationary rock
   (2) 150-kg stationary rock
   (3) 200-kg stationary rock
   (4) 175-kg rock that is rolling down a hill