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Lesson 19

MOMENTUM

Teaching Time:

A Moment with Momentum

Have you ever ridden a bicycle really fast and then suddenly decided to stop? When you put the brakes on, did the bicycle keep going for a few more feet? If the bicycle were going slower, would it have stopped more easily and sooner? The answer is yes. Let's say you are running or, if you use a wheelchair, you are moving pretty fast. When you decide to stop, it takes a few more feet for you to slow down and eventually stop completely. Here's one more example using your bowling ball. What if you have your bowling ball up on a shelf alongside your soccer ball when the shelf starts to tip over? Both the bowling ball and the soccer ball are falling toward the floor. Which of the two balls do you think would be easier to stop? If you think it is the soccer ball, you are right. The reason is that the bowling ball has more momentum. It is momentum that keeps the bicycle moving even after you try to stop it. It is also momentum that

Scripture

Though the mountains move and the hills shake, My love will not be removed from you and My covenant of peace will not be shaken, says your compassionate LORD.

(Isaiah 54:10)

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Name It!

momentum
The tendency of an object that is moving to continue moving.

keeps you moving in a particular direction when you try to stop running. In this lesson, we will learn about how momentum is determined and its role in the mechanics of motion.

Defining Momentum

We can say that **momentum** is the tendency of an object that is moving to continue moving. From the examples above, we can already figure out that there are two things that define momentum. The first is the speed of the object. How fast an object is going is one important factor. The fast-moving bicycle has more momentum than a slower-moving one. The second factor in determining momentum is the mass of the object in motion. Think about that bowling ball falling from the shelf. It would be much more difficult to catch and stop a bowling ball than a soccer ball. That is because the bowling ball has much more mass. These two factors taken together allow us to figure out an object's momentum. The amount of momentum of an object is equal to the speed of the object multiplied by the mass of the object.

Momentum in Action

If we were actually bowling instead of catching a falling bowling ball, we could calculate the momentum of the ball. The object of bowling is to knock down as many of the 10 pins as possible with one or two throws of the ball. There has to be enough momentum in the moving ball to accomplish that. The ball must have enough velocity (speed) and mass as it impacts the heavy pins; otherwise, it will simply stop and not knock any pins over. A ball with a lower mass (weighing perhaps 6 pounds) needs to have enough speed so that it will have enough momentum that the pins won't be able to stop the ball. However, a heavier ball—one with more mass (weighing perhaps 16 pounds)—needs less speed to knock the pins down and not be stopped by them. The formula for calculating momentum

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can be used to figure out the momentum of the bowling ball. The heaviest bowling ball has a mass of 7 kilograms (16 pounds). Speed for a ball thrown by a good bowler is about 3 meters per second. Therefore, the momentum of the ball is calculated as 3 meters/sec × 7 kilograms = 21 kilogram-meters/sec at the time the ball hits the pins. An object with a mass that doesn't change can change momentum only by changing speed.

Another example illustrating momentum is a bullet fired from a gun. Our skin can't stop a bullet fired from a gun. You might think it can because the bullet is so small—its mass is very small compared to that of a bowling ball. The reason it goes through skin is that its speed is so high—it is traveling very fast. In the example of the bowling ball, its momentum comes mostly from its mass. For a bullet, its momentum is almost all from its speed.

Additional Notes

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Additional Notes

Review It

1. We can say that momentum is the _____ of an object that is moving to continue moving.
2. The two factors that define momentum are the _____ of the object and the _____ of the object in motion.
3. An object with a mass that doesn't change can change _____ only by changing speed.
4. The _____ of momentum of an object is equal to the speed of the object multiplied times the mass of the object.
5. A bullet has a lot of momentum because of its _____.

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Additional Notes

Hands-On Time:

Bowling with Momentum

We know that a bowling ball's momentum is based on its mass and speed. Going to a bowling alley is a good place to experience these concepts, either by participating or by observing. In this Hands-On Time, you are going bowling. You can either observe someone bowling or bowl yourself. By trying different weights of balls and throwing at different speeds, you can see for yourself the importance of momentum. When we think about the objective of bowling, we say the objective is to knock down the pins. From the perspective of the pins, the objective is to stop the ball. Unfortunately for the pins, the momentum of the bowling ball is usually enough to keep it going despite the heavy bowling pins' attempts to stand firm. As an alternative, line up various objects (such as shoeboxes or milk cartons) as obstacles at one end of a driveway or floor. Use balls of varying weights (masses) and try rolling them at different speeds to see if the momentum is sufficient to go past the obstacles.

Equipment Needed

- none for the actual bowling
- balls of varying weight (for example, nerf ball, baseball, tennis ball)
- household objects such as shoeboxes or milk cartons

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Discovery Zone

Large ships, like cruise ships or oil tankers, cut their engines miles from shore and allow their momentum to carry them toward the port.

Think About It

1. Were you able to select a ball that had a mass low enough so that the ball was stopped by the pins or obstacles?

2. Were you able to throw a ball and achieve a speed low enough for the ball to be stopped by the pins or obstacles?

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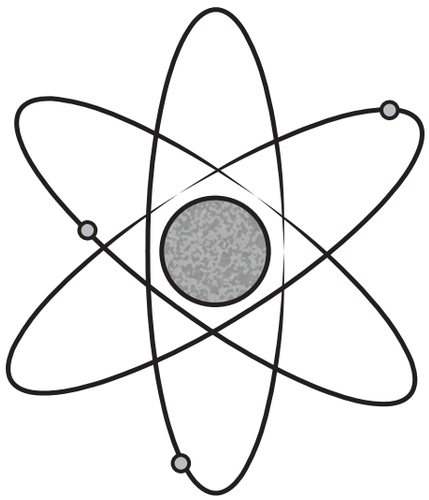

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Unit Four Wrap-Up

Show What You Know!

1. _____ is a big word that means things are moving. The opposite would be not moving or no motion.
   a. Motion
   b. Whoa Nelly
   c. Acceleration

2. Any object in motion (such as a person, a car, a ball, etc.) will have a _____ point and a _____ point.
   a. big, little
   b. starting, finishing
   c. high, low

3. An instantaneous speed is the _____ of an object at a given instant.
   a. speed
   b. acceleration
   c. force

4. Average _____ is the rate at which an object goes from a starting point to a finishing point.
   a. speed
   b. grade
   c. score

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5. Acceleration is a measure of how fast an object changes _____.
   a. socks
   b. speed
   c. direction

6. Rotation rate is a measure of how many times an object _____ around in a circular path in a given time period.
   a. rotates
   b. flies
   c. hops

7. _____ is short for revolutions per minute.
   a. AM
   b. RPM
   c. PM

8. The _____ is the time it takes for a rotating object to complete one single revolution.
   a. period
   b. vacation
   c. speed

9. The speed of an object _____ in a circle is another measure of importance in circular motion.
   a. traveling
   b. accelerating
   c. dancing

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10. Figuring out the distance around a _____ requires the use of a formula that includes a special number called pi.
    a. square
    b. circle
    c. triangle

11. _____ invented an important mathematical method called Calculus.
    a. Isaac Newton
    b. Fred Flintstone
    c. Abraham Lincoln

12. Newton's First Law states that an object that isn't moving at all will stay in that condition unless some _____ is applied to that object.
    a. cheese
    b. force
    c. gravity

13. Newton's Second Law states that when a force is applied to an object, it will _____.
    a. accelerate
    b. fall
    c. stop

14. Newton's Third Law states that when one object applies a force to a second object, the second object applies an _____ force back to the first object.
    a. equal
    b. mean
    c. gravitational

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15. When a rocket engine fires, the air actually _____ against the thrust of the rocket.
    a. pushes back
    b. pulls back
    c. files a lawsuit

16. A _____ is an object in motion that will not be accelerated further, except by the force of gravity.
    a. Newton
    b. projectile
    c. large pizza

17. Projectiles, once thrown, hit, or otherwise launched, will eventually fall back to _____.
    a. the moon
    b. Earth
    c. Mars

18. Once a projectile is launched (accelerated), the forward _____ achieved by the projectile will not increase.
    a. speed
    b. work
    c. timing

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19. The distance a projectile travels depends on three factors: the speed achieved by the projectile, the force of gravity, and the _____ at which the projectile was launched.
    a. angle
    b. time
    c. target

20. Trajectory is defined as the path of a _____.
    a. cheese pizza
    b. projectile
    c. proton

21. We can say that momentum is the _____ of an object that is moving to continue moving.
    a. tendency
    b. reluctance
    c. importance

22. The two factors that define momentum are the _____ of the object and the _____ of the object in motion.
    a. size, weight
    b. speed, mass
    c. cost, price

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23. An object with a mass that doesn't change can change _____ only by changing speed.
    a. socks
    b. momentum
    c. direction

24. The _____ of momentum of an object is equal to the speed of the object multiplied times the mass of the object.
    a. amount
    b. importance
    c. change

25. A bullet has a lot of momentum because of its _____.
    a. size
    b. speed
    c. temperature

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