WIND-UP WINNERS (1-1.5 Hours)

Addresses NGSS
Level of Difficulty: 1
Grade Range: 3-5

OVERVIEW

In this activity, students will investigate the motion of wind-up toys. Students will determine a method to measure the distance each toy travels in a measured amount of time. Speed will be quantified for multiple toys and students will predict which toy would win a race. Then the class will race the wind-up toys to test their predictions!

Topic: Describing Motion

Real-World Science Topics

- An evaluation of the motion of an object.
- A comparison between movements of different objects.

Objective

After completing this activity, students will be able to measure the distance travelled by an object, including non-linear motion. Students will also be able to calculate speed and use their calculations to describe motion and make comparisons.

NGSS Three-Dimensions

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-1) • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-PS2-2)	**PS2.A: Forces and Motion** • The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)	**Patterns** • Patterns of change can be used to make predictions. **Scale, Proportion, and Quantity** • Observable phenomena exist from very short to very long time periods.

WIND-UP WINNERS

Background Information

What is the difference between distance and displacement?

Distance is the length moved by an object. Displacement is the distance between an object's starting and ending position. For example, if a person runs around a quarter mile track, the distance travelled by the person is a quarter mile. The displacement, however, is zero because the person has the same starting and ending position. Distance is a scalar quantity. That means it does not include direction. Displacement is a vector quantity. That means it must include the direction between an object's starting and ending point. For example, 5 miles is a distance. Five miles north, is a displacement.

What is speed?

Speed is simply how fast an object is moving. It can be found by dividing the distance travelled by an object by the time it took for the object to travel that distance. The units for speed are a unit of distance over a unit of time. Examples include miles/hour, meters/second, and inches/minute. Speed does not indicate the direction in which an object is moving.

What is velocity?

Velocity is the displacement of an object divided by the time it took to move from the starting point to the ending point. Velocity is a scalar quantity. That means it includes the direction between the starting point and the ending point. The units for velocity are the same as the units for speed.

What is the difference between speed and velocity?

The words speed and velocity are often used interchangeably, because they often seem like the same thing. If an object is moving in a straight line and does not change direction, the speed and velocity will have the same numerical value. The only difference is that velocity must also include the direction in which the object is traveling. If an object is changing its direction, the speed and velocity become different. For example, if a person runs around a quarter mile track four times and it takes him 10 minutes, his speed is

$$\text{speed} = \frac{\text{distance}}{\text{Time}} = \frac{1 \text{ mile}}{10 \text{ minutes}} = 0.1 \text{ miles/minute}$$

His velocity is zero because his displacement is zero.

$$\text{velocity} = \frac{\text{displacement}}{\text{Time}} = \frac{0 \text{ miles}}{10 \text{ minutes}} = 0 \text{ mile/minute}$$

STEPS FOR *WIND-UP WINNERS*

Key Vocabulary

Distance – the length moved by an object
Displacement – the change in position of an object during a time interval, includes direction between starting and ending point
Scalar – a quantity that does not include direction
Vector – a quantity that includes magnitude and direction
Speed – the distance travelled by an object divided by the time it took to travel that distance; how fast an object is travelling
Velocity – the displacement of an object divided by the time elapsed; must include the direction between the starting and ending positions

Materials Needed for Activity

- 3 wind-up toys per group
- Stopwatches or clock
- Paper
- Rulers
- String
- *Wind-Up Winners Handout* (see attachment below) and pencils for each student

Teacher Preparation

- Collect wind-up toys. They can often be found at dollar stores and craft stores. If desired, request that students bring wind-up toys from home.
- Test the wind-up toys to determine how long it takes them to travel across a piece of paper.
- Gather all other materials.

STEPS FOR *WIND-UP WINNERS*

1. **Warm-up Activity:** Ask the class what the "scientific" word is for how fast an object is going. Tell them that today's topic is speed. Use the data below to create a matching activity on a smart board, white board, or with an opaque projector. Ask students to match each animal or object with the appropriate speed.

Cheetah	70 miles/hour
Snail	0.03 miles/hour
Cat	30 miles/hour
Earth on its orbit	70,000 miles/hour
Race car	200 miles/hour

   Tell the class that today they will learn how to measure speed.

2. Describe to the class the measurements they will be taking.

   a. Each group will be letting a wind-up toy walk on a piece of paper for 10 seconds. (You may choose to change the time interval, based on the speeds of your wind-up toys.)

   b. Solicit ideas from the class as to how they can measure the distance traveled by a wind-up toy during the 10 second time interval. Help the class arrive at a good method. An easy and effective method is to trace the path of the toy with a pencil while it walks. Then, use a string and ruler to measure the distance traveled. Use centimeters.

3. Allow students to take measurements for 3 toys. Tell them to record their measurements on the *Wind-Up Winners* Handout.

4. For each wind-up toy, students will calculate its speed. To do this, divide the distance travelled by the time it took to travel that distance.

5. Students will record their data on the *Wind-Up Winners* Handout and on a class data table. Use a promethean board, opaque projector, or white board to display the class data.

6. Use the class chart to determine the 4 fastest toys. As a class, predict which toy would win a race. Conduct a race including 4 or 5 of the fastest toys in order to test their prediction.

7. Discuss the results. The importance of direction may become apparent during the race. The fastest toy may not win! If a toy does not travel in a straight line, it may not win – even if it is travelling the fastest. Emphasize that, when describing motion, it is important to consider the direction of travel.

Extension Activity

Now that the students have learned the basic steps to determine speed, they can use those skills to measure their own speed. As a class, or in small groups, stretch out a measuring tape in a long hallway or outside. Use stopwatches to measure how long it takes students to crawl, walk, jog, and run the length of the measuring tape. Research the speeds of Olympic runners and various animals and compare their findings to their own speeds.

Sources

http://www.infoplease.com/ipa/A0004737.html
http://www.iop.org/activity/outreach/resources/pips/topics/earth/facts/

WIND-UP WINNERS
STUDENT HANDOUT

Name:

Date:

Description of Wind-Up Toy	**Distance Travelled** in centimeters	**Time**	**Speed** in centimeters per second
		10 seconds	
		10 seconds	
		10 seconds	

Choose a wind-up toy and write a description of that toy in the chart.

Measure the distance the wind-up toy travelled in 10 seconds. Use centimeters. Record the distance in the chart.

Divide the distance travelled by 10 seconds to determine the speed of the wind-up toy.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Repeat steps 1, 2, and 3 for two more wind-up toys.

Add your results to the class data table.

Make a prediction: If all of the wind-up toys were in a race, which would win?

Was your prediction correct? Why or why not?

Will the fastest toy always win the race?