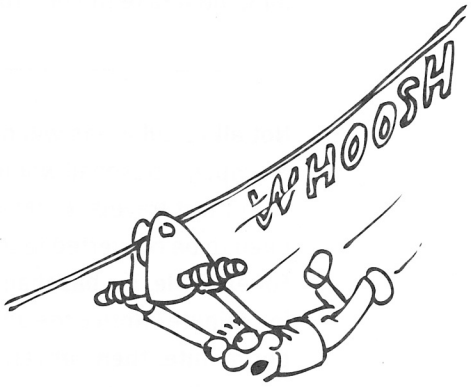
Name: _____ Date: _____

Zip-a-Dee-Doo-Dah

GOAL

- Make a zip line that will carry an object a specific distance (about 10 ft across) and be able to stop at a specific location without damaging or dropping the object. Every team that accomplishes this challenge will be declared victorious!



MATERIALS

- String
- Paper clips
- Cardboard tubing
- Paper cups
- Index cards
- Metersticks or yardsticks

TIME TO CREATE

- 20 minutes

INDIVIDUAL ACTIVITY

Read and respond to the following questions:

1. Author H. G. Wells (1866–1946) wrote many novels that are classics in the science fiction genre, such as *War of the Worlds*, *The Time Machine*, and *The Island of Dr. Moreau*. In his novel *The Invisible Man*, written in 1897, Wells introduces his readers to the concept of a zip line. Today's zip lines are generally used for recreational purposes; however, zip lines also provide useful services. Name one way in which zip lines can be used to assist others.

   _____

   _____

2. When we talk about speed, we often use words like "really fast" or "kind of slow," but many times we need to be able to measure the actual speed of a moving object. If you know the distance the object travels and how long it takes to get there (time), you can calculate the actual speed of an object. Read the following and figure out the formula for measuring the speed of an object. Traveling at a speed of 9 miles per hour, it took John 5 hours to ride his bicycle 45 miles.

   First write the problem as an equation:

   _____ = _____ ___ _____

3. There is a mathematical equation that works for calculating the speed of an object. The equation to calculate speed of an object is: _____

4. Try your equation out on finding the speed of the boat.
   Speed of boat = _____mph, Distance of travel = 60 miles, Time = 2 hours

5. What is the opposite of multiplication? _____ Change the order of the formula in order to calculate the distance Henry traveled given the speed and time. Traveling at 5 miles per hour in 3 hours, Henry walked a distance of _____ miles.
6. Calculate the time the dog traveled with information providing the speed and distance: How long did it take the dog to travel 48 miles if he went at a speed of 12 mph? _____

_____

7. Not all calculations will have the same units of hours to hours and minutes to minutes. For example, a baseball would not typically travel for an hour. If you know the speed in hours, but the object travels for less than a minute, you would need to convert the units. Hours might need to be converted to minutes, minutes might need to be converted to seconds, and so on. For example, if a baseball traveled 90 feet in 3 seconds, how many feet would it have traveled in 1 minute? Notice the units. Because 60 seconds = 1 minute, figure out the speed in seconds per minute, then convert to how fast the ball would travel in 1 minute. Speed of the ball = _____ ft/min, Distance of travel = 90 ft, Time = 3 seconds.
8. For today's team challenge, you will design and create a zip line. You will also calculate the speed of an object traveling on a zip line. Use the video that you watch as a class for practice.

   Calculate the speed of the zip line in the video: _____

   Convert to feet per minute: _____

9. How does the height of one side of the line affect the speed of the object?_____

   _____

   _____

10. Calculate the velocity of a spool of thread traveling along an angled string:
    Distance = 10 ft, Time = 5 sec; Speed = _____ ft/sec
    _____ ft/min
    _____ ft/hr
    _____ mi/hr

11. Conserving energy is helpful when engineering a zip line. At the top of the line, you can use gravitational potential energy, and at the bottom, friction can help to transform the gravitational potential energy to kinetic energy. To allow for maintaining a desired speed, most zip lines level off a bit after the initial drop. Once you reach the desired speed, the angle needs to match the force of friction. When this happens, you will maintain your current speed.

    How will you include a source of friction in your zip line? _____

    _____

    _____

TEAM CHALLENGE

Participants will work together in teams of two or three for 20 minutes to make a 10-ft zip line that will carry an object and stop at a given point without dropping or damaging the object. Every team that accomplishes this challenge will be declared victorious!

When the teacher starts the time, your team will have exactly 20 minutes to gather your materials and build your zip line. Once your teacher signals that time is up, you must stop working immediately. Any team that continues to work after time has been called may be disqualified.

Start Time _____:_____ + 20 Minutes = _____:_____ End Time

Experiment with the height until you find the lowest height that would enable the object to travel smoothly all the way to the end. Measure this height, calculate the speed, and record it in the chart. Remember: Speed = Distance/Time. Experiment with the height until you find the one that enables you to best achieve your goal. You may only use one height for your zip line in the class challenge.

Lowest Height of String:	Hightest Height of String:
Speed:	Speed:
Distance:	Distance:
Time:	Time:

After the team challenge, complete the following questions:

1. What was your team's object's fastest time?_____

   What was the height for this time?_____

2. What was the lowest height for your team's zip line?_____

   What was the time for this height?_____

3. Write a brief summary of the relationship between height, time, and speed.

   _____

   _____

4. Consider the following information:
   - Newton's First Law states that as an object travels down the zip line, it builds forward speed. It will continue at that speed until a force acts on it, such as hitting the stopping points.
   - Acceleration means that an object's speed increases as it falls due to Earth's gravitational pull.
   - The object's stored (potential) energy changes to motion (kinetic) energy as it falls.

In thinking about this information, how could you improve your team's zip line?

_____

_____

_____

_____

_____

_____