**Heading**

**Purpose** To learn about reaction time as it relates to free fall.

**Background**

**Reaction time** is the time between a stimulus and a response. For example, the stimulus may be **visual** (you see something happen), **auditory** (you hear a sound), or **tactile** (you feel a touch). In each case, you are required to process the stimulus from your eyes, ears, or body in your brain, thus reacting or responding to the stimulus. The rather short amount of time this takes is called your reaction time.

Reaction time comes into play all the time – for instance, when you ride a bike. You might see another biker or pedestrian swerve in front of you, and you must quickly react to hit the brake. You might hear a horn or siren from the road and have to react quickly, or you might have to respond to a shout from an irate driver. Or you could just be walking down the street, and feel a bug land on you and want to quickly brush it off. *It could happen*. Each of these instances, and many more, many times each day, involve your reaction time; some more critically than others.

In today’s experiment, you will measure your reaction time as a function of distance, because when objects move through space, they also move through time. The faster something moves, the greater the distance it travels during a particular period of time. If you are riding your bike, and a bunny suddenly hops in front of you, your bike will continue to travel a certain distance during the time you spend processing the visual stimulus of the bunny. You may decide to hit the brake, after which your brain has to send the nerve signal to your foot. All of this takes time, during which you are barreling toward the poor little bunny. The quicker you react, meaning less time is taken, the shorter the distance traveled. Quick reaction times are especially desirable when driving cars, etc!

**Materials** Stop Watch Meter stick Calculator

**Procedures**

1. Obtain a meter stick, a scrap piece of paper, and a stop watch.
2. Measure from the ceiling DOWN exactly one meter and have a person mark that spot by holding their hand out at that distance from the ceiling.
3. Have another person wad up the piece of scrap paper and hold it up to the ceiling (carefully stand on a desk).
4. Another person will hold the stop watch and say “ready, set go” at a steady pace.
5. On “go” the timer starts the stop watch and the paper person releases the paper. At the moment the paper passes the held-out hand, stop the stop watch. Record the time to the nearest TENTH of a second. Calculate the speed of the falling paper using the equation given.
6. Repeat this THREE times and record all your results in the chart below to the nearest TENTH.

Speed = distance / time

(m/s) (m) (s)

|  |  |  |
| --- | --- | --- |
| Distance (m) | Time (s) | Speed (d/t) |
| 1 m |  | m/s |
| 1 m |  | m/s |
| 1 m |  | m/s |

1. Calculate the average speed of the paper falling from the ceiling to one meter below the ceiling. Add the three “speeds” from the chart and divide by 3.

Average Speed: \_\_\_\_\_\_\_\_\_m/s

8. Measure from the ceiling down to the floor and determine the distance (height of the room).

1. Have the “paper person” again hold the wadded piece of scrap paper up to the ceiling.
2. The “timer person” will hold the stop watch and say “ready, set go” at a steady pace.
3. On “go” the timer starts the stop watch and the paper person releases the paper. At the moment the paper hits the floor, stop the stop watch. Record the time to the nearest TENTH of a second.
4. Calculate the speed that the paper is traveling from the ceiling to the floor.
5. Repeat this THREE times and record all your results in the chart below to the nearest TENTH.

Speed = distance / time

(m/s) (m) (s)

|  |  |  |
| --- | --- | --- |
| Distance (m)  Average Speed: \_\_\_\_\_\_\_\_\_m/s | Time (s) | Speed (d/t) |
| m |  | m/s |
| m |  | m/s |
| m |  | m/s |

1. Calculate the average speed of the paper falling from the ceiling to the floor. Add the three “speeds” from the chart and divide by 3.
2. Copy the average speed you calculated in both procedure #7 and #14 below:

|  |  |
| --- | --- |
| Average Speed of Free Fall | |
| From ceiling to one meter | m/s |
| From ceiling to floor | m/s |

1. Are the two average speeds the same? What accounts for the difference?
2. Since we now know how a dropped object accelerates (*answer to #16*) as it falls, we can also figure out the time of fall by simply measuring the distance it falls. These relationships are governed by the equation:

**d = ½ g t2 or d = ½ a t2**

Where “g” = acceleration due to gravity and “a” = acceleration of an object

* **d** = the distance an object falls
* **g** = the acceleration due to gravity, 9.8 m/s2 or 980 cm/s2
* **t** = the time of fall in seconds

1. We can rework the above equation mathematically to calculate for time. This rearrangement looks like this:

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t = 2d/g

1. Remember, if you measure distance in meters, use 9.8 m/s2 for gravity. Whereas if you measure distance in centimeters, use 980 cm/s2 for gravity.
2. Have one person hold the meter stick vertically above their waist level so that the “zero” end is at the bottom.
3. Another person, the “grabber” opens their thumb and forefinger AT THE BOTTOM OF THE METER STICK, getting ready to catch the meter stick between their thumb and forefinger.
4. The object of this exercise is to let go of the meter stick and the “grabber” grabs it. Wherever you grab it on the meter stick is the distance of falling.
5. Predict which form of stimulus will give you’re the fastest reaction time: sight (visual), hearing (auditory), touch (tactile)?
6. The FIRST stimulus for reaction time you will measure is visual (sight). Have the person “grabbing” grab the meter stick as soon as they see the stick start to fall.
7. Use the middle of your grasp to grab the meter stick so that your results are consistent. Don’t try different ways of catching the stick. Record the distance the meter stick fell.
8. Be sure to record the unit of distance you used (meters or centimeters).
9. Repeat this procedure for five (5) trials.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SIGHT | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Average |
| Distance |  |  |  |  |  |  |
| Time (s) |  |  |  |  |  |  |

1. For each distance, use the equation given to calculate the time it took to fall that far. Record this in the chart above. SHOW WORK for the average distance.



t = 2d/g

1. Now have a partner try:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SIGHT | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Average |
| Distance |  |  |  |  |  |  |
| Time (s) |  |  |  |  |  |  |

1. For each distance, use the equation given to calculate the time it took to fall that far. Record this in the chart above. SHOW WORK for the average distance.



t = 2d/g

1. The SECOND stimulus for reaction time you will measure is auditory (hearing). Have the person “grabbing” CLOSE THEIR EYES and then grab the meter stick as soon as they hear “go” from the timer. Record the distance the meter stick fell and calculate the time.
2. Be sure to record the unit of distance you used (meters or centimeters).
3. Repeat this procedure for five (5) trials.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| HEARING | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Average |
| Distance |  |  |  |  |  |  |
| Time (s) |  |  |  |  |  |  |

1. Now have a partner try:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| HEARING | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Average |
| Distance |  |  |  |  |  |  |
| Time (s) |  |  |  |  |  |  |

1. The THIRD stimulus for reaction time you will measure is tactile (touch). Have the person “grabbing” CLOSE THEIR EYES and then grab the meter stick as soon as feel a touch on their shoulder. Record the distance the meter stick fell, and calculate the time.
2. Be sure to record the unit of distance you used (meters or centimeters).
3. Repeat this procedure for five (5) trials.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| TOUCH | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Average |
| Distance |  |  |  |  |  |  |
| Time (s) |  |  |  |  |  |  |

1. Now have a partner try:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| TOUCH | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Average |
| Distance |  |  |  |  |  |  |
| Time (s) |  |  |  |  |  |  |

**Conclusions and Questions**

Answer the following questions based on your data:

1. Who in your group had the fastest reaction time (the least amount of time taken to catch the meter stick).

Sight \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Sound \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Touch \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. For which type of stimulus (visual, auditory or tactile) was reaction time the best? Explain.
2. Does this match your prediction?
3. What might slow down your reaction time for each of the three stimuli?
4. How might you improve your reaction time?
5. How might reaction time affect experiments and results?