How Fast Is Your Toy Car?

Daniela Taylor

Topic

Motion, calculating speed

Time

1 hour

Safety

Please click on the safety icon to view the safety precautions.

Materials

Hot Wheels™ or Matchbox™ toy car
150-cm toy car track or grooved plastic molding from a hardware store
meterstick
stopwatch
books or other objects to support ramp
graph paper

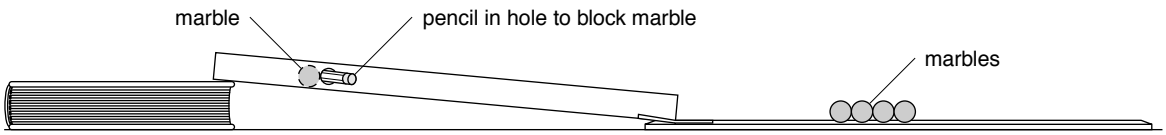
Procedure

This experiment is easier to do with a partner.

Part A: How Fast Does It Go?

1. Set up your track as shown in figure 1.

Figure 1



2. The level distance should be approximately 100 cm. Measure the level part of your track, and record the exact distance as *d* on data table 1.
3. Set the height of your ramp at 20 cm. Pile the books or other objects as necessary to support the ramp at this height.

DATA TABLE 1			
Trial	*d* (cm) (level distance)	*t* (sec) (time over level distance)	*S* (cm/sec) (*d*/*t*)
1			
2			
3			
4			
5			
			Average *S*:_____ cm/sec

4. Practice releasing the car from the top of the ramp and timing its trip across the level distance. You will time the car only while it is traveling on the level track, not on the ramp approach or on the floor past the track. When the rear wheels of the car reach the level track, start the watch and stop it when the rear wheels leave the track. If you are working with a partner, have one person release the car and the other person time its trip. Do several timed practice runs until you are getting fairly consistent times. Make sure you always start the car from the same place at the top of the ramp. Mark a release point with a pencil, and always line up to it the front wheels to increase accuracy.
5. When you are comfortable with the process, release the car and time its trip across the level track. Record this time on data table 1 under *t* for trial 1. Repeat 4 more times, and enter the times for trials 2 to 5.
6. Compute the speed of the car in each trial using the formula $S = d/t$, using the values you obtained for *d* and *t*. Record these speeds on data table 1 under *S* for each trial.
7. To obtain the car's average speed (*S*), add the values of *S* for the five different trials together and divide by 5. Record this on data table 1 under average speed.
8. To compare the speed of your toy car with that of the cars on the road, you will need to convert the average speed you recorded above in centimeters per second (cm/sec) to units of miles per hour (mph) and/or kilometers per hour (kph). To do this use the following procedures:

Conversion to mph:

There are 161,000 centimeters in a mile and 3,600 seconds in an hour. To convert a speed in cm/sec to mph, multiply by 3,600/161,000, or .022. The speed of your car in mph is thus:

Average speed from data table 1:_____ cm/sec 2 .022 =_____ mph

Conversion to kph:

There are 100 centimeters in a meter and 1,000 meters in a kilometer. So there are 100,000 cm in a kilometer. There are 3,600 sec in an hour. To convert a speed in cm/sec to kph, multiply by 3,600/100,000, or .036. The speed of your car in kph is thus:

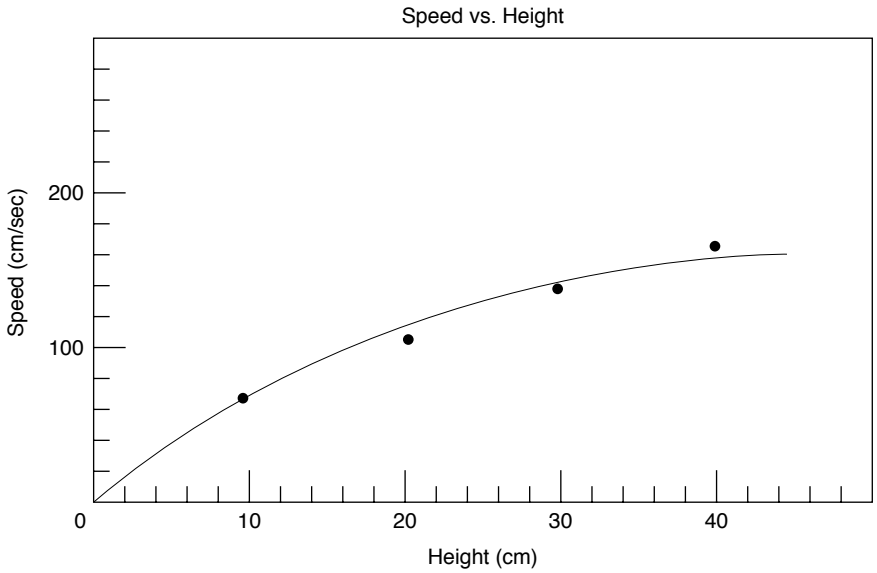
Average speed from data table 1:_____ cm/sec 2 .036 =_____ kph

DATA TABLE 2												
Ramp height (cm)	*d* (cm) Level distance traveled	Trial 1		Trial 2		Trial 3		Trial 4		Trial 5		Avg *S* (cm /sec)
		t (sec)	*S* (cm /sec)	*t* (sec)	*S* (cm /sec)	*t* (sec)	*S* (cm /sec)	*t* (sec)	*S* (cm /sec)	*t* (sec)	*S* (cm /sec)	
10												
20												
30												
40												

PART B: HOW DOES THE HEIGHT OF THE RAMP AFFECT THE CAR'S SPEED?

1. Lower the height of the ramp to 10 cm. Record on data table 2 the length of the level track under *d*.
2. Repeat steps 4 and 5 from Part A of the procedure. Record the times you get in seconds for the five trials in the spaces marked *t* on the line for the 10-cm ramp height.
3. Repeat step 6 of Part A of the procedure, recording each speed in cm/sec in the spaces provided. Find the average speed of the car released from the 10-cm ramp height by adding together the five values under *S* and dividing by 5. Record this average speed on the data table.
4. Change the height of your ramp to 30 cm and repeat the entire procedure. Change the height to 40 cm, and again repeat the procedure. Fill in the values you obtained in Part A of the procedure for the trials with the ramp height of 20 cm.
5. To better analyze the way in which the height of the ramp affected the car's speed over the level distance, you can make a graph of your findings. Graphing is a method used to show how one quantity (such as the change in height of release) is related to another (such as the car's speed). This relationship is found by keeping all quantities constant (using the same car, track, and stopwatch) except for the two in question. The quantity that is deliberately varied—in this case, the height of release—is called the *independent variable* and is plotted on the horizontal axis of the graph. The quantity that is changed as a result—in this case, the car's speed—is called the *dependent variable* and is plotted on the vertical axis. Using the values for ramp height and average speed you recorded on data table 2, make a graph of the changes in the car's speed, putting speed on the vertical axis and height on the horizontal axis. Plot the four points, then draw the best-fitting smooth line through all your points. See the sample graph in figure 2.

Figure 2



6. How fast did your toy car go in Part A of the procedure?
7. About how much faster do regular automobiles go than the speed in step 6 when traveling on highways?
8. How did the height of the ramp affect the speed of the car in Part B of the procedure?
9. What does the graph show about the relationship between the height of the ramp and the speed of the car?

What's Going On

The speed varies depending on the car model and the track. Speeds of about 2.5 to 3.5 mph, or 4.0 to 5.6 kph, are usual. On a highway where cars usually travel at about 50 to 60 mph, or 80 to 97 kph, they are going about 15 to 25 times faster than the toy car. Raising the ramp height increased the car's speed; lowering the ramp lowered the speed. The higher the ramp the faster the speed of the car.

Connections

Speed tells us how fast something is moving. It is defined as the distance *d* moved per unit of time *t* and expressed in the equation $S = d/t$. Two common units of speed are miles per hour and kilometers per hour, which are used on car speedometers. In this experiment, you determined the speed of a toy car after it rolls down a ramp and observed how changing the height and angle of the ramp affects its speed. If you have ever wondered just how fast your toy car can go, and how to compare its speed with the speed of your family car, this procedure is for you.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES