Follow the Bouncing Ball

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Topic

Identifying a direct relation

Time

2 hours

Safety

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

Materials

golf ball or Super Ball™
meterstick
cellophane tape
desk, table, or wall on which to tape stick
uncarpeted floor
calculator

Procedure

You will need a partner for this project.

1. Before you do any measuring, just drop the ball onto the floor a few times from different heights, and observe how high it bounces. Make a general statement about how the height from which you drop the ball relates to the height of the resulting bounce. Write your statement here: ____________________

   ____

   ____

2. Tape the meterstick vertically to the edge of a table or against a wall where there is room to bounce the ball in front of it (figure 1).
3. You will now do a procedure that will provide data about what some specific bounce heights are for some specific drop heights. One experimenter will drop the ball from a given height on the meterstick, while the other experimenter observes the height of the bounce that follows (figure 2). Practice this procedure about 10 times to get comfortable with it, and get used to repeating exactly the same motion each time you drop the ball. You don't want to throw the ball down with any extra force; just bring it to a predetermined height on the stick and let it drop easily out of your fingers to the floor. The person observing the bounce height will need to get accustomed to accurately finding the exact height the ball reaches on its first bounce. Practice this procedure until you feel that you are able to do it uniformly every time.

Figure 1

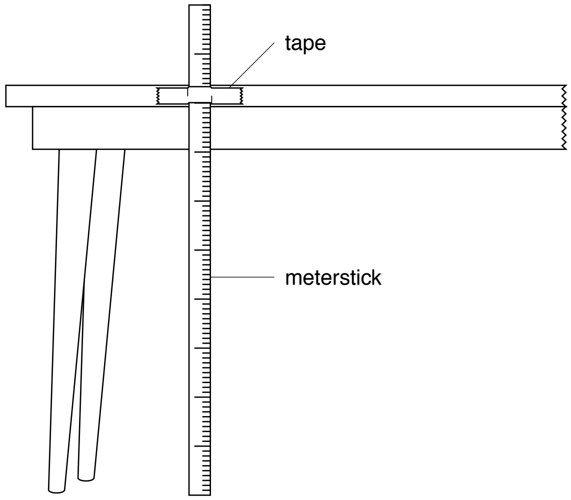
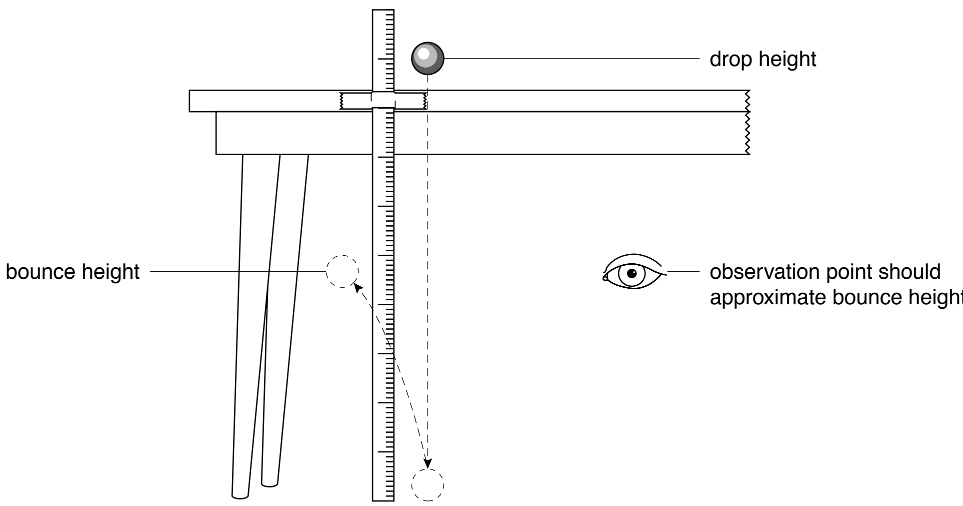


Figure 2



4. Pick a drop height and record it on data table 1. Drop the ball from this height 10 times, and record the height of its bounce each time in the space provided on data table 1.

DATA TABLE 1

Drop height *(D)* (cm)	Bounce height (cm) trials										Average bounce height *(B)* (cm)
	1	2	3	4	5	6	7	8	9	10	
1.											
2.											
3.											
4.											
5.											

5. Repeat step 4 four more times to complete data table 1. Choose drop heights that are at least 10 cm apart.
6. Add the 10 bounce heights for trial 1 together and divide by 10 to get the average bounce height for that drop height. Record this on data table 1. Repeat this procedure for trials 2 to 5.
7. Now you will experiment with the values you have obtained to see if any useful patterns emerge when you relate the values to each other in different ways. Each of the columns in data table 2 expresses a different mathematical relationship between drop height *D* and average bounce height *B*. Using the values for *D* and *B* you recorded in data table 1, fill in the resulting values for the relations in data table 2.

DATA TABLE 2

D, B	$D + B$	$D - B$	$D \times B$	$D \div B$	$D^2 \div B$	$D \div B^2$
1. __ , __						
2. __ , __						
3. __ , __						
4. __ , __						
5. __ , __						

8. You want to find a mathematical relationship that yields the same, or nearly the same, answer for every value of *D* and *B* you found through the experimental procedure. If you can find such a formula, then you should be able to use it to predict unknown data points With this in mind, look over the results in data table 2. Which manipulation yields the same or nearly the same answer each time?
9. If the answer is nearly the same each time, we can give it a letter, such as *k*, and write an expression such as *D* (' or 1 or 2 or 3) *B* = *k*. Do this with the relation you found that yielded a constant result to create an equation for the bounce of your ball. Now put your equation in the form *B* = *D* (' or 1 or 2 or 3) *k*. For example, if your original equation is *D* 2 *B* = *k*, divide both sides by *D* to put it in the form $B = k/D$.
10. Choose two new values for *D* that you did not test experimentally before. Plug them and your value for *k* into your new equation to come up with resulting values for *B*.
11. Test your predictions for *B* for the two new values for *D*, using the same procedure you used before, dropping the ball 10 times from each height, recording the bounce heights, and taking an average. Did your equation accurately predict how high the ball would bounce when dropped from the new heights?

What's Going On

The relation D/B should yield nearly the same value each time. The answer to step 10 is $D/B = k$, so $D = kB$ or $B = D/k$. The predicted values of B given by your equation should be pretty close to results obtained experimentally. The exact values will vary depending on the experimental setup.

Connections

Scientists use their observations about the relationship between physical events to create a mathematical expression of that relationship. Then the mathematical formula can be used to make exact predictions about how changing one of the related events will affect another. In this experiment, you looked for a mathematical expression of a direct relation between two observed physical events and tested your equation's ability to predict changes.

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