Name: _____ Class: _____

Investigating Energy and Falling Motion

Background: When an object such as a ball falls, it accelerates and acquires kinetic energy, or energy of motion. If it does not reach terminal velocity, it acquires its maximum velocity and therefore its maximum kinetic energy just as it hits the ground. At that point, its motion is stopped and it is compressed. The kinetic energy is momentarily converted to potential energy, or stored energy. This potential energy is then converted back to kinetic energy as the ball bounces back. No ball will return to the exact height from which it was dropped because some of the kinetic energy is converted to other forms of energy, such as heat, when the ball strikes the ground. According to an important principal known as the law of conservation of energy, however, the total amount of energy does not change. In this investigation, you will describe the motion of a bouncing ball and examine how the ball demonstrates the law of conservation of energy. By plotting graphs, you will also examine how well different substances retain their original energy.

Problem: How can the motion of a bouncing ball be described and accounted for in terms of energy?

Materials: meterstick, tennis ball, ping-pong ball, sponge ball, air-filled rubber ball

Procedure:

1. Have one member of your group hold the meterstick upright with the zero mark on the floor, as shown in Figure 1.

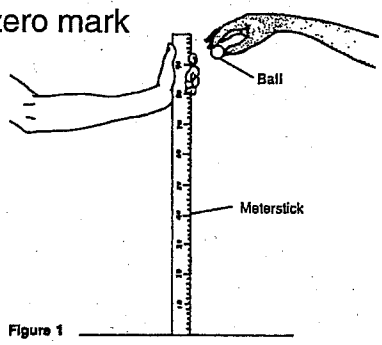


Figure 1

2. Have a second member of your group drop the tennis ball from the top of the meterstick in such a way that it does not touch the meterstick on the way down.

3. Have a third member of your group note the height of the first bounce. The bounce height should be called out to the third member of the group, who should record it in the Data Table. Let the ball continue to bounce and continue observing it for as long as you can. It may take several trials because the ball may tend to bounce away from the meterstick.

4. Repeat steps 1, 2, and 3 with the ping-pong ball, the sponge ball, and the air-filled rubber ball.

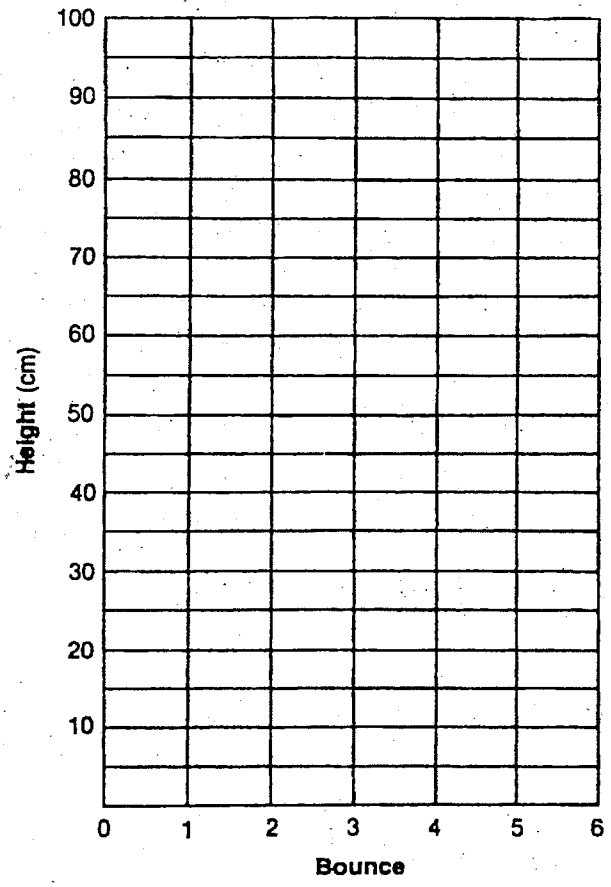
5. On graphs 1 though 4, plot the height of each bounce for each ball. Draw a curved line that best fits through the vicinity of the points. You will plot four graphs.

Observations

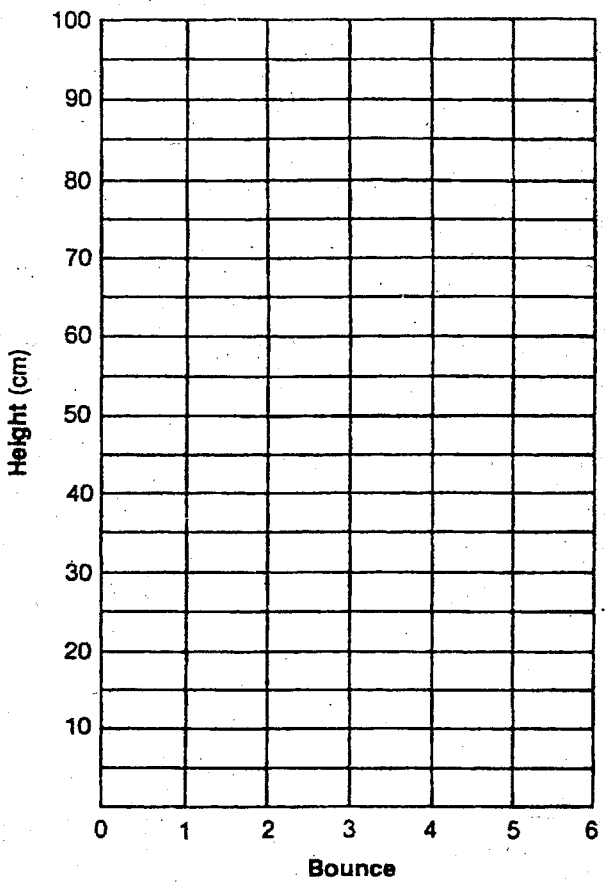
DATA TABLE

Type of Ball	First bounce	Second bounce	Third bounce	Fourth bounce	Fifth bounce	Sixth bounce
~~Tennis~~ Bouncey Ball						
~~Ping-pong~~ Golf						
Sponge						
Air-filled rubber ball						

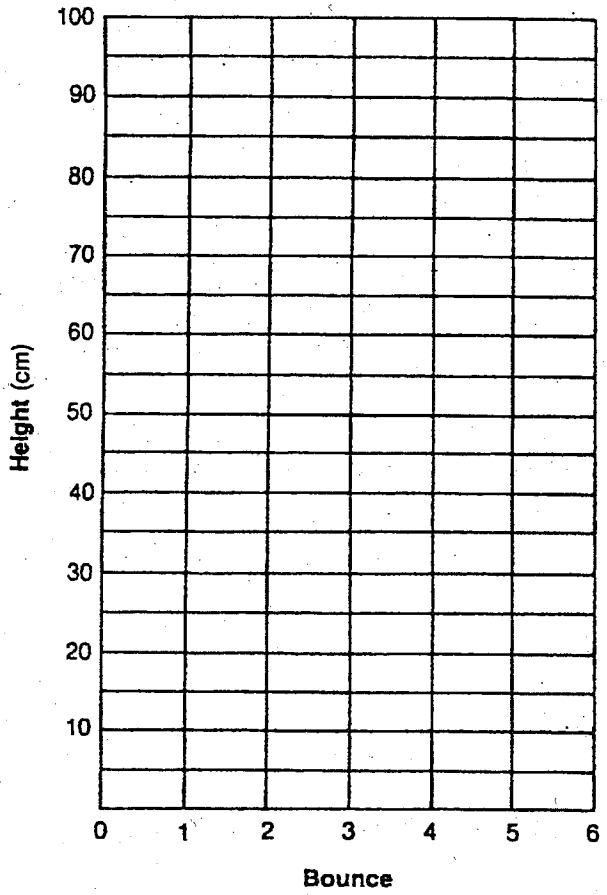
GRAPH 1 Tennis Ball



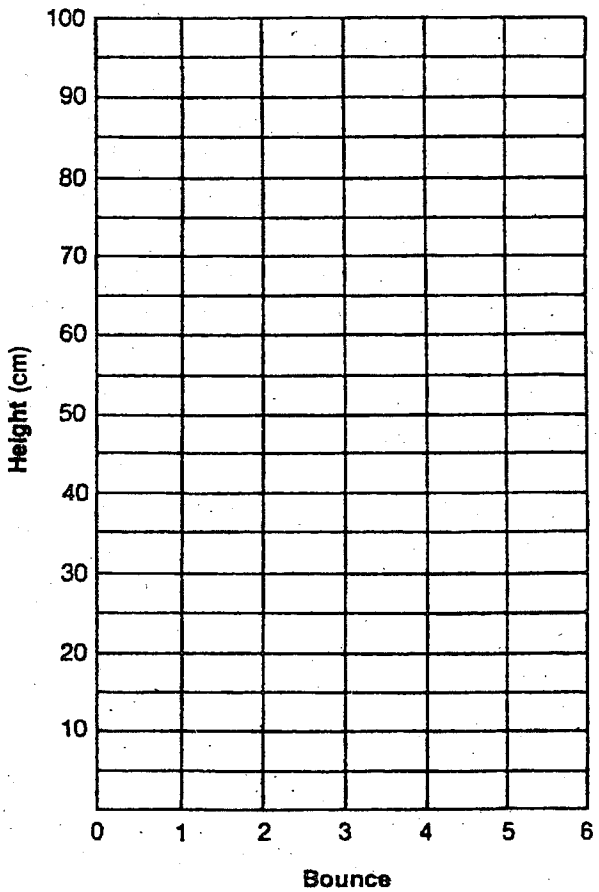
GRAPH 2 Ping-Pong Ball



GRAPH 3 Sponge Ball



GRAPH 4 Rubber Ball



Conclusions:

1. Which ball retained the greatest percentage of its kinetic energy on each bounce?

2. Explain the shape of each line on the graphs. Why were they similar?

3. What type of ball seems to bounce the least? Why?

4. Why can't a ball bounce higher than the height from which it is dropped?

5. Suppose you had carried out this investigation using a carpeted floor. How would your results have been affected?

6. Explain your answer in question 5.

7. What do you think would happen to the kinetic energy if a ping-pong ball collided with a sponge ball?

Coefficient of Restitution

The coefficient of restitution (denoted by the symbol ***c*** in our formulas) is a measure of the elasticity of the collision between ball and racquet. Elasticity is a measure of how much bounce there is, or in other words, how much of the kinetic energy of the colliding objects before the collision remains as kinetic energy of the objects after the collision. With an inelastic collision, some kinetic energy is transformed into deformation of the material, heat, sound, and other forms of energy, and is therefore unavailable for use in moving.

A perfectly elastic collision has a coefficient of restitution of 1. Example: two diamonds bouncing off each other. A perfectly plastic, or inelastic, collision has ***c*** = 0. Example: two lumps of clay that don't bounce at all, but stick together. So the coefficient of restitution will always be between zero and one.

To find the coefficient of restitution in the case of a falling object bouncing off the floor use the following formula:

$$c = \sqrt{\frac{h}{H}}$$

c = coefficient of restitution (dimensionless)

h = bounce height

H = drop height

Calculate the coefficient of restitution for each of the different types of balls.

Type of Ball	Drop Height	1st Bounce Height	Coefficient of Restitution