The Virginia Instructors of Physics
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MOMENTUM STATIONS

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Va. SOL:

PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes.

PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved

National Standards:

CONTENT STANDARD B: As a result of their activities in grades 9-12, all students should develop an understanding of

* Motions and forces
* Conservation of energy and increase in disorder
* Interactions of energy and matter

Topic/Concept

An introduction to momentum through 4 different “mini-stations”.

Materials

- Tennis ball cannon
- Photogate and LabPro or similar device
- “happy” and “unhappy” ball
- assortment of other balls – golf, marble, superball, billiard ball
- hotwheels track
- wooden block
- computer w/ internet

Safety Considerations

Flamable liquids, high speed projectile – instructor should operate tennis ball cannon at floor level.

Presentation

The student will go to 4 different stations and complete a set of experiments at each station. For safety considerations there is one Tennis Ball Cannon, and multiple setups of the other stations.

Momentum Stations

Conservation of Momentum with a Tennis Ball Cannon

Materials:

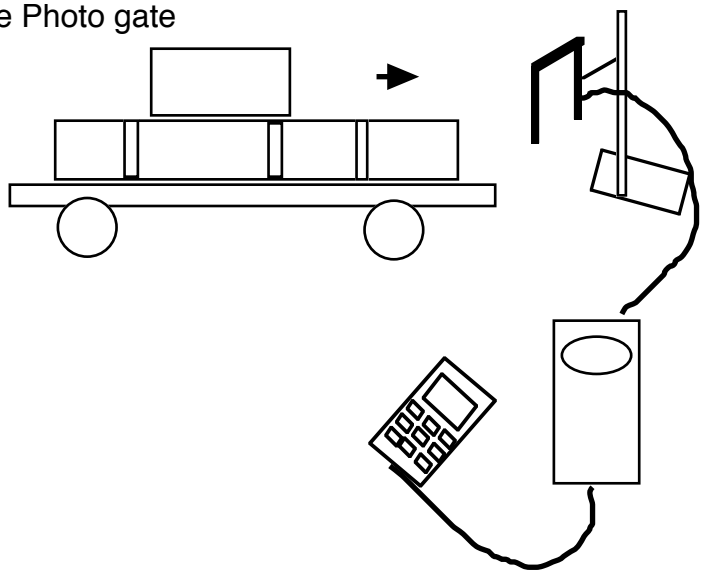
•Tennis Ball Cannon as described in **The Dick and Rae Physics Demo Notebook** on page M-562.

•TI-83 graphing calculator, CBL, and Venire Photo gate
•Index card
•Balance

Procedure:

1. Tape an index card to the top of the cannon so it resembles a fin.

2. Set up the equipment as shown in the diagram.



3. The photo gate is arranged so the index card passes through the photo gate. Ideally the card breaks the beam just as the ball exits the cannon. In reality, if the cart's friction is low the photo gate can be set back a bit.

4. Set up the photo gate system to record the time it takes the index card to to pass through the beam.

5. Instructor will prepare and fire the cannon. Student should prepare CBL system and take length & mass measurements.

CAUTION !
FLAMMABLE LIQUIDS!
GOGGLES!
HIGH SPEED PROJECTILE!

Questions

1. By measuring the length of the index card you can calculate the speed of the cannon. Show your work!

2. Now you need the mass of the cannon and the ball. You can then solve for the velocity of the ball using conservation of momentum. (Note: if Vcannon is + then Vball is -) Show your work!

Collision simulation

Use a computer and go to http://www.msu.edu/user/brechtjo/physics/airTrack/airTrack.html Run each of the simulations provided.

3. Show the math for each scenario that shows that momentum is conserved.

4. Show the math for each scenario that would allow you to investigate conservation of kinetic energy. What can you conclude?

Measuring Coefficient of Elasticity

Materials

- One bouncy & one non bouncy ball & one ball of another material
- Meter stick

Procedure

1. Hold the meter stick with the 0 cm mark on the floor.
2. Hold a ball with the bottom of the ball even with the 100 cm mark.
3. Drop the ball and measure the height that it bounces back up off of the floor.
4. Repeat this 10 times and determine the average.
5. Calculate the coefficient of elasticity.

$$\text{CoE} = \frac{\text{Bounce height}}{\text{Drop height}}$$

6. Repeat for the two other balls

Questions

5. What would a 100% elastic ball do? What would a 0% elastic ball do?
6. Under what conditions can you have 100% elastic collisions?
7. Is it possible to have 100% inelastic collisions? Give an example or two.
8. How does a physicist's definition of elastic differ from the everyday use of the term?

Elastic and Inelastic collisions

Materials

- one bouncy & one non bouncy ball
- small wooden block
- 3 sections of hot wheels track

Procedure

1. Set up the equipment as shown.

2. Allow the bouncy ball to roll down the hill and strike the block. Measure how far the block is shoved.
Record your observations of what the ball and block do as they collide.

3. Repeat the experiment with the non bouncy ball. Release it from the same height on the ramp. Measure how far the block is shoved. Record your observations of what the ball and block do as they collide.

NOTE - Since these balls are released from the same height they will impact the block with the same speed. The balls also have the same mass (well, close enough for our purposes here).

Questions

9. Which ball strikes the block with the greater force? How do you know?
10. Which ball has the greatest impulse during collision? How do you know?
11. Identify each of the collisions as elastic or inelastic.
12. Draw a before and after picture for each collision. Write the equation showing conservation of momentum for each collision.

Teacher Tips Regarding Lab

Follow all appropriate safety procedures with the tennis ball cannon. Tennis ball can exceed 60 mph.

Sources & References

The Dick and Rae Physics Demo Notebook
Happy and Unhappy balls can be bought from a variety of vendors