SUGGESTED ACTIVITIES

(*Force*)

From *Invitations to Science Inquiry 2nd Edition* by Tik L. Liem:

Activity	Page Number	Concept
The Invisible Glue	340	Friction
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From *Harcourt Science* Teacher's Ed. Unit E: (For ALL grade levels)

Activity	Page Number	Concept
Measuring Pushes and Pulls	F57 (3rd grade text)	Force and Motion
Giving Directions	F5 (4th grade text)	Directions, Vectors
Pairs of Forces Acting on Objects	F11 (4th grade text)	Balanced Forces, Vectors
Forces on a Sliding Box	F21 (4th grade text)	Forces, Friction
Forces that Interact	F11 (5th grade text)	Forces

THE INVISIBLE GLUE

A. Question: *Can friction cause tension?*

B. Materials Needed:

1. A plastic or glass bottle with a long tapered neck.
2. A piece of thin rope, a small cork.

C: Procedure:

1. Preparation: Make a small ball (sphere) of the cork by cutting and filing until it just fits in the bottle neck (it should be a tiny bit larger so that you have to force the ball cork in the bottle).

2. Push the ball cork in the bottle and cover the bottle with paper or paint the whole bottle (so that it becomes opaque).

3. Now you are ready for the demonstration:

Hold the rope in your hand and say to the audience: “I have some invisible glue in this small bottle” (an empty small bottle), “I’ll dip the end of this rope in it and let it stick to this large bottle”.

4. Do the dipping and let the rope slide inside the opaque bottle, turn the bottle upside down, pull slowly at the rope until you feel some resistance, then turn the bottle right side up, keep the tension in the rope, and let the bottle hang from the rope. Let students make inferences.

D: Anticipated Results:

Students should observe the rope get stuck (“glued”) inside the bottle.

E: Thought Questions for Class Discussion:

1. What hypotheses/inferences can you make to explain the event?

After the students know about the cork ball:

2. What is the function of the cork ball?
3. Why does it have to be somewhat larger than the bottle neck?
4. What other material can we use instead of cork?
5. How can we get a regular cork that went in, out of a wine bottle?
6. What principle was used to carry this demonstration?

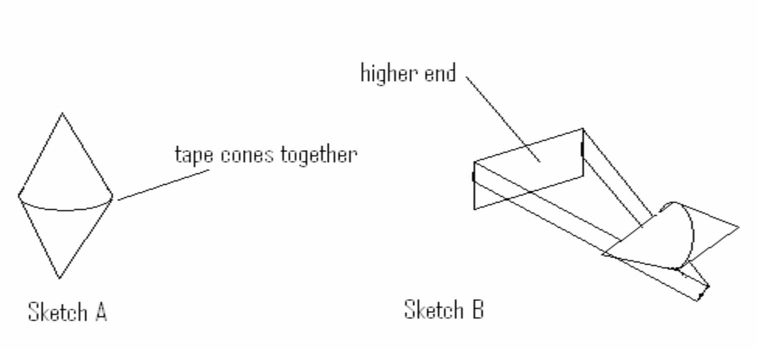
F: Explanation:

The reason why the bottle can keep hanging from the loose rope is friction. When the bottle is turned upside down, the cork ball roles in the bottle neck and pinches the rope against the side of the bottle. By pulling the rope, it pulls the cork in even tighter as the neck is tapered. The **friction** between the rope and the cork is greater than that between the glass and the cork, so the cork gets pulled a little further in the neck, thus pinching the rope. The rope can be pulled out of the bottle with a sharp yank. In place of the cork we can also use a rubber ball. A marble of a slightly smaller diameter than that of the bottle neck may also be used, but the rope has to be quite a bit thicker.

Making use of the same principle, we can take a cork out of an empty wine bottle with a cloth napkin. Get one of the corners of the napkin inside the bottle neck, let the cork roll over the napkin, slowly pull the napkin until the cork tightens in the neck, then pull hard on the napkin; the cork will pop out!

ROLLING UPHILL?

A. Question: *In what direction does gravity act?*



B. Materials Needed:

1. Strips of cardboard (about 3cm wide).
2. Paper cards and cello tape.

C: Procedure:

1. Make a cardboard ramp in the shape of a narrow V, and tape a wider cardboard strip to the open end of the V, so that this end will be about 2cm higher.
2. Construct two identical cones from the paper cards and tape them together. Make sure that the surface of the double cone is smooth (especially where it is taped).
3. Place the double cone on the lower and of the V-shaped ramp and give it a starting push toward the higher end.

D: Anticipated Results:

Students should be observant and see that the double cone is rolling downhill and not uphill.

E: Thought Questions for Class Discussion:

1. How can an object roll uphill?
2. Does the double cone actually end up higher above the table?
3. Would a cylinder roll up the V-shaped ramp?
4. What force made the double cone roll toward the open end of the V?
5. What would a sphere do on the V-shape ramp?

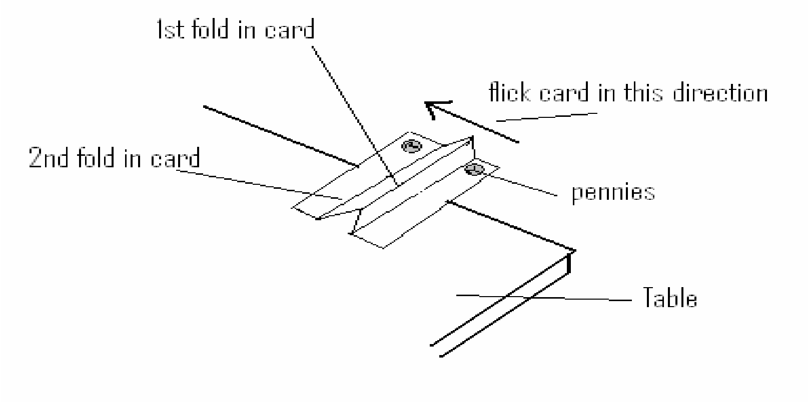
F: Explanation:

This demonstration invites the students to be very observant. It gives the illusion of the double cone rolling uphill. The fact that the double cone actually rolls downhill. It started higher above the table at the lower end of the V-shaped ramp and ends up lower above the table at the higher end of the ramp. It can be observed by fixing the eye on the tip of the double cone or actually measuring the distance between this point and the table top before and after the rolling.

It is because of the shape f the double cone and that of the ramp, that the object's center of gravity slightly gets lowered when rolling from the tip to the open end of the V-shaped ramp. A cylindrical shaped object would not be able to roll "uphill" on this ramp. A spherical shaped object, like a ball for instance, would be able to roll towards the higher end of the ramp, but drops down much sooner between the legs of the V-shaped ramp.

THE FALLING PENNIES

A. Question: *Do two objects which are falling, reach the floor at the same time?*



B. Materials Needed:

1. Two pennies (or other coins).
2. A paper card (3x5" / 7x12cm)

C: Procedure:

1. Fold the paper in half, then fold each side one-third from the end outward.
2. Place the pennies on each side of the center ridge of the card and hold one end on the table edge.
3. Now flick the ridge of the card to the side with the middle finger or your right hand. This will fling one penny about 5m away and at the exact same moment the other penny will drop straight to the floor.
4. Ask the students: " Which of the falling pennies will hit the floor first?" (Anticipated answer: "the straight falling one") Flick the card and listen to the click of the pennies hitting the floor.

D: Anticipated Results:

Students should only hear one click when both pennies fall because they reach the floor at the same time.

E: Thought Questions for Class Discussion:

1. Did you hear one or two loud clicks of the falling pennies?
2. What would it mean if you heard only one click?
3. Does the direction of a falling object have any influence on the speed or rate of fall?
4. What was disregarded in this demonstration?
5. What can we conclude from this demonstration about the rate of fall of objects with different initial directions?

F: Explanation:

As both pennies were released at the same moment, the force of gravity started to work on the pennies at the same time. The downward component of the forces working on each of the pennies is therefore the same, and thus also the acceleration they obtain, resulting in reaching the floor in exactly the same time. This is why only one loud click (first click) is heard of the two pennies falling, regardless of the initial horizontal force imparted on one of them. When one of the pennies is replaced with a marble, the same one click will result, implying that all objects fall with the same rate (in a vacuum). In our case the air resistance was disregarded, because of the relatively short distance of fall.

<u>WILL PAPER FALL LIKE A STONE?</u>

A. Question: *Why does paper take long to fall?*

B. Materials Needed:

1. A hard cover book.
2. A sheet of paper (the size of the book).

C: Procedure:

1. Drop a piece of paper to the floor from arm's height (it will slowly fall, moving from side to side).
2. Drop a book separately (or beside the paper) to the floor from the same height (it will drop like a stone).
3. Now place the paper sheet on the book. Ask the students: "With the same gravity working on the paper and the book, will the sheet of paper fall at the same rate as the book?" (Anticipated answer: "No").
4. Drop the book with the paper sheet on top of it (make sure that the paper's size is equal to or smaller than the book).

D: Anticipated Results:

Students should observe the difference in the rate of descent when the book and paper are dropped separately and when they are dropped together. When dropped by itself, the paper will take longer to fall than when dropped with the book.

E: Thought Questions for Class Discussion:

1. Why did the sheet of paper drop just as fast as the book when they were placed and dropped together?
2. Why did the sheet of paper drop slower than the book when they were dropped separately?
3. What would happen if the book were smaller than the sheet of paper and the two were dropped together?
4. What would happen of the sheet of paper were dropped in a vacuum tube?

F: Explanation:

Dropping the sheet of paper to the floor by itself will make it move from side to side and descend slowly, because of the **air resistance.** The book is heavy enough to overcome the air friction and it drops in that short distance as if there were no resistance. Together, our intuition says that the paper should fall behind the book in falling to the floor, but they fall at the same rate, because under the paper there is no air and thus no resistance. It is as if the paper fell in a vacuum.