Examining Forces
Activity 1

Purpose

Along with examining forces, at this station you will be looking at your ability to collaborate and hold a discussion based on scientific concepts. You should learn the importance of obtaining input from multiple people.

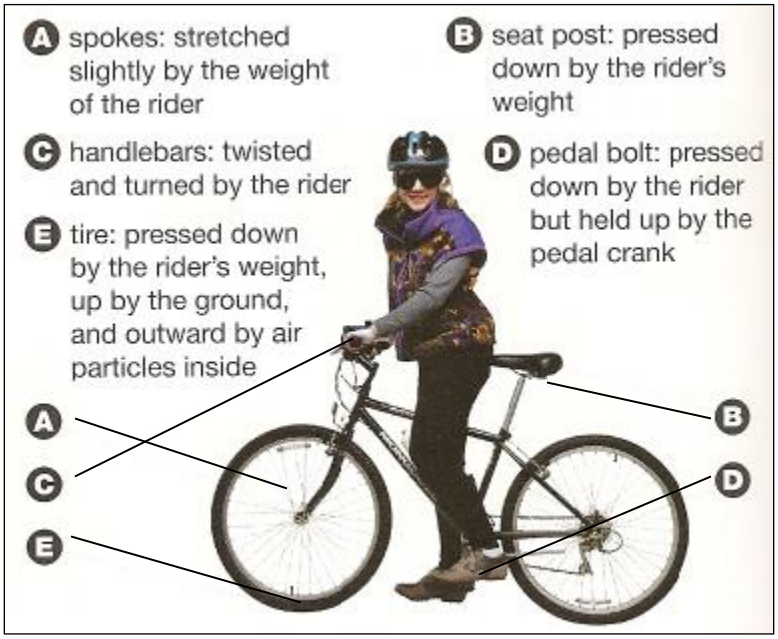
Equipment

- Blank Piece of Paper – to record observations and take notes
- Writing Instrument – to record observations and take notes
- Bike (if available)

Procedure

1. Set up a data table, similar to the one shown below, to record your observations for the five parts of the bicycle.
2. Give your data table a title.
3. Using the diagram of the bicycle provided fill out the data table based on the descriptions.

* Note, after completing the procedure and the discussion there is probably a lot of time left in class. You may wish to use this time to try to name more parts, not indicated already in your table. This will help you stay on task.



Observations

Part Name	Letter	What Causes the Force?	Type of Strength Needed

Discussion

1. True or false, only one force can act on any one part of a structure at a time. Discuss.
2. Identify a total of four additional parts (not labelled above) of the bicycle, that might fail because it has too little (one each), discuss these with your group:

    a. Tensile Strength
    b. Compressive Strength
    c. Shear Strength
    d. Torsion Strength

    i. Discuss what causes the force.
    ii. Discuss what could happen if it did not have enough of the type of strength you have indicated.

Examining Forces
Activity 2

Purpose

Along with examining forces, at this station you will be looking at the importance of taking your time when producing a hand-drawn diagram. It is not necessary to be an artist to be able to draw the straw, by looking very closely, and taking your time, you can produce a much more accurate drawing.

Equipment

- Blank Piece of Paper – to record observations and take notes
- Writing Instrument – to record observations and take notes
- Bendy Straw
- Popsicle Stick
- Safety Goggles
- Magnifying Lenses

Procedure

1. Make a data table with four quadrants, taking up at least half of a page, similar to the one on the back of this page.
2. Give your data table a title.
3. Place the unbent straw on your table and draw the pleated section, large and detailed, in the top left quadrant of your data table. Label this diagram "Compression."
4. Gently stretch the straw and then draw the pleated section, again, large and detailed, in the top right quadrant of your data table. Label this diagram "Tension".
5. Gently bend the straw so that it makes a right angle (90 degrees) and then draw, in detail, the pleated section in the bottom left quadrant of your data table. Label one side of the pleats "Tension" and the other side "Compression". You will need to decide which side is which – hint, look at your other two diagrams.
6. Everyone at your table is to put on safety goggles at this point.
7. Hold a popsicle stick straight in your hands. Place your thumbs in the bottom middle of the popsicle stick, and, holding the sides, gently and slowly push the middle of the popsicle stick upwards until it just starts to break – do not allow it to separate into two pieces.
8. Draw, in detail, the middle section of the popsicle stick, both before applying the force, and after applying the force, in the bottom right quadrant of your data table. Label the areas where tension occurred and where compression occurred.

   *Note: All observations for this activity are to be hand-drawn. You may take pictures to use as a reference to draw from, but it is expected that you complete the drawings by hand as well.

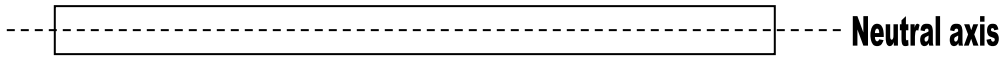
Observations

Note: Actual table should be much larger.

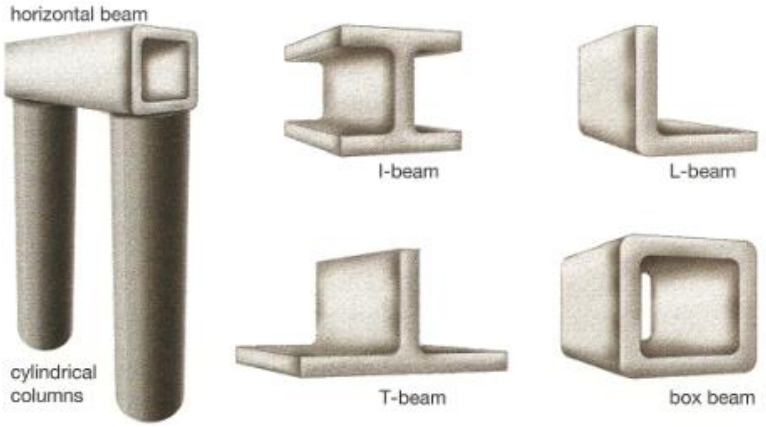
Discussion

1. The beams in the ceiling or floor of a building, when they bend under a load, are similar to the pleated straw or popsicle stick bend. Think about the spacing of the pleats, and how that would relate to the behaviour of the particles in the beam. Use this information to discuss the following:

    a. If a beam is supported on the ends, and a load is placed in the middle, it will bend down into a "smile" shape. The top of the bending beam is pushed together by compression and the bottom is pulled apart by tension.
        i. What is happening to the middle of the beam (its neutral axis – see diagram)?
        ii. As a result of the answer to the question above, how much force would be stressing the neutral axis?



    b. Look at the diagrams of different types of beams below. Why can the neutral axis of the beam be made of less material than the top or bottom? Use your answer from part "a" to help support your explanation.



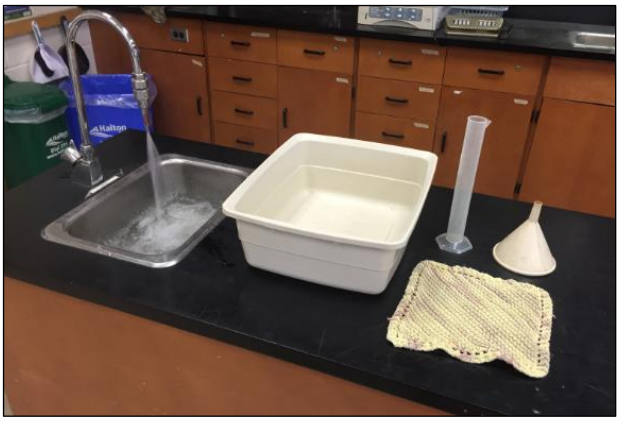
Examining Forces
Activity 3

Purpose

Along with examining forces, at this station you will be looking at the idea of experimental error. As you progress through this experiment, you should take note of all the things that go "wrong," both on a consistent basis, as well as differences from trial to trial.

Equipment

- Blank Piece of Paper – to record observations and take notes
- Writing Instrument – to record observations and take notes
- Wash Cloth
- Bucket
- Graduated Cylinders
- Funnel
- Towels



Procedure

1. Make a data table, similar to the one shown on the back of this page, to record your observations.
2. Give your data table a title.
3. Place the wash cloth in a full sink of water.
4. Remove the wash cloth and, while holding it over the bucket, squeeze out as much water as you can WITHOUT twisting it.
5. Pour the water, from the bucket, into the graduated cylinder and record the volume of water.
    - There may be more water than the capacity of the graduated cylinder, how could you handle this issue?
6. Repeat steps 3 to 5, however this time twist the towel, but not squeeze it, to get as much water out as you can.
7. At this point you are to use any remaining time to try more methods, not indicated already in the procedure. Follow steps 3 through 5 multiple times, altering your method each time.

* Water spilled on the floor is very slipper. Please use the towels, provided at your station, to clean up any spills as they happen. Do not wait until you are done to do so.

Observations

Method	Amount of Water (mL)	Type of Force

Discussion

1. What type of force are you applying in each situation? Record your answer in your data table.
2. How does the amount of water removed relate to the reduction in the spaces in a substance? What type of force reduces the space in a substance the most? Discuss this with your group.

Examining Forces
Activity 4

Purpose

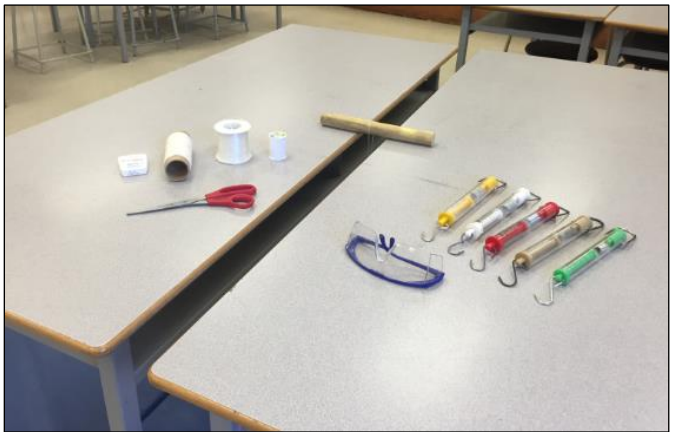
Along with examining forces, at this station you will be looking at safety, and the steps necessary to ensure that all members of an activity stay safe. This can be accomplished through constant communication and clarification of precautions prior to working.

Equipment

- Blank Piece of Paper – to record observations and take notes
- Writing Instrument – to record observations and take notes
- Thick Dowel
- ~15 cm Length Each - Thread, Fishing Line, Dental Floss and String
- Variety of Spring Scales
- Safety Goggles
- Large Gym Mat

Procedure

1. Make a data table, similar to the one shown on the back of this page, to record your observations.
2. Give your data table a title.
3. Tie each of the four materials (thread, fishing line, dental floss and string) into individual loops. Be sure the knot is tight.
    - If you are having difficulties with this – cannot make the knot, the knot is slipping – ask for assistance.
4. Place two desks approximately 2 cm apart with a gym mat underneath the gap.
5. Place one of the loops over the dowel, and place the dowel between the two desks (see picture below).



6. Everyone in your group is to put on safety goggles at this point,
7. Use the spring scale to pull the loop down until the material breaks.
    - Only pull a spring scale to 90% of its maximum capacity.
8. Record the force that was needed to break the material.
    - You may find that more than 45 N of force is needed (maximum force you may apply to the largest spring scale), if this is the case, attach 2 spring scales to your loop and pull on both with one hand. Watch the scale on one of the spring scales, and then double it when the material fails.
9. Repeat steps 5 through 8 for each of the materials.
10. Choose one material and braid three pieces of that material together. Repeat steps 5 through 8 with the braided material.

Observations

Material	Break Force (N)

Discussion

1. True or false, a piece of yarn or rope made by twisting several fibres together has much higher tensile strength than a single fibre. Discuss.