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Chemistry $\sim$ Ms. Hart Class: Anions or Cations

### 5.8 Strengths of Covalent Bonds - Lab \#14

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PURPOSE - To compare and contrast the stretching of rubber bands and the dissociation energy of covalent bonds.

## MATERIALS

- 1 (6-8oz) small can of food
- 1 ( $12-16 \mathrm{oz}$ ) medium can of food
- 1 (19-28 oz) large can of food
- 3 No. 16 rubber bands •1 paper clip
- 1 wire hanger $\bullet$ pencil
- metric ruler • lab packet
- 1 plastic bag
- calculator


## SETUP

1. Measure the length of the unstretched rubber bands (they are all the same length), and record this in your results section. Make sure to use the units of centimeters. Record the mass of each different sized can in the appropriate space on data Tables 1-3. Make sure to use the same three cans for the entire length of the experiment. (Note: the weight is on the label of the can).
2. Gently slide a paperclip onto one of the rubber bands (you should not need to bend or deform the paper clip to do this). Hang the rubber band (with the paperclip) on the hook from the coat hanger.
3. Place the small can of food in the plastic bag. Hang the bag with the can from the paper clip attached to the rubber band. Record the length of the rubber band with the weight of the can you used in Table 1. Repeat step with the other 2 cans of food, one at a time. (Be careful not to break the rubber band with the large can).
4. Slide an additional rubber band onto the paper clip, and then repeat Step 2, first using two rubber bands to connect the hanger and the paper clip. Record the length of the rubber band and the weights you used in Table 2. Repeat this process with three rubber bands and record the length of the rubber band and the weights you used in Table 3.
5. Calculate the Bond Length (length the rubber band was stretched in each trial) by subtracting the unstretched measurement (step $1^{\wedge}$ ) from the stretched measurement (*).

Example: If your unstretched length was 6.0 cm and your stretched length was 9.8, your "bond length" will be 9.8-6.0 $=3.8 \mathrm{~cm}$
6. Graph the Bond Length (x-axis) vs. the mass (y-axis) used for each number of rubber bands in Graph 1. (Your graph should have three separate lines, one for each number of rubber bands used.) REMEMBER to label all axes for all graphs and include appropriate scales and units!!
7. Draw the straight line that you estimate best fits the points for each set of data. (Your graph should have three separate lines.) The $\boldsymbol{x}$-axis and $\boldsymbol{y}$-axis intercepts of the lines should pass through zero, and the lines should extend past the last point in your graph.
8. Find the slope of the straight line. To do this, pick two coordinates ( $\mathrm{x}, \mathrm{y}$ ) on your line and use the formula for slope $=y_{2}-y_{1} / x_{2}-x_{1}$. Multiply this slope value by 40 to find the "bond strength" for each line (or each bond type - single, double or triple). Record this information in Table 4. We are doing this to test how much mass the bond could hold at 40 cm and therefore thinking about the strength of the bond!
9. On the second graph area, plot the type of bond (single, double, triple) versus the "Bond" energy.

Length of unstretched ${ }^{\wedge}$ rubber bands: $\qquad$ cm Table 1: Measured data - 1 rubber band

| Weight of Cans | Stretched length* (cm) | Bond length (cm) (stretched ${ }^{*}$ - unstretched ${ }^{\wedge}$ ) |
| :---: | :---: | :---: |
| Small weight: $\quad \mathbf{g}$ |  |  |
| Medium weight: $\quad \mathrm{g}$ |  |  |
| Large weight: __g |  |  |

Table 2: Measured data - 2 rubber bands

| Weight of Cans | Stretched length* (cm) | Bond length (cm) <br> (stretched* |
| :---: | :---: | :---: | :---: |
| Unnstretched^) |  |  |$|$

Table 3: Measured data - 3 rubber bands

| Weight of Cans | Stretched length* (cm) | Bond length (cm) (stretched* - unstretched ${ }^{\wedge}$ ) |
| :---: | :---: | :---: |
| Small weight: $\quad \mathrm{g}$ |  |  |
| Medium weight: $\quad \mathrm{g}$ |  |  |
| Large weight: $\quad$ _ g |  |  |

Graph 1: Title

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Slope of single bond line $=$
Slope of double bond line $=$
Slope of triple bond line $=$

Table 4: Slope from Best Fit lines on graph one multiplied by 4o!


ANALYSES AND CONCLUSIONS - write in complete sentences.

1. Assuming the rubber bands are models for covalent bonds, what can you conclude about the relative strengths of single, double, and triple bonds? (Use evidence from the lab to explain your answer).
2. Are bond length and bond strength related? Explain the relationship (i.e. are they directly proportional or inversely proportional, and use evidence from the lab). See the poster in class for how to write a trend!
3. How could you actually simulate (mimic, copy) the breaking of a bond using the materials from this lab? What would you expect to happen?
4. Which type of bond do you expect is most easily broken during chemical reactions (single, double, and triple)? Why? (Use the model of rubber bands and your answer to number 3 to help explain your answer).
5. This is only an approximation of how covalent bonds behave. How does the behavior of the rubber bands differ from that of real covalent bonds? Use the graphs below to answer questions a and b .

a) See the graph above for bond dissociation energy for carbon-carbon single, double, and triple bonds. How does this data compare to your model using the rubber band?
b) See the graph above for bond length for carbon-carbon single, double, and triple bonds. How does this data compare to your model of the rubber band?
