Name__________________

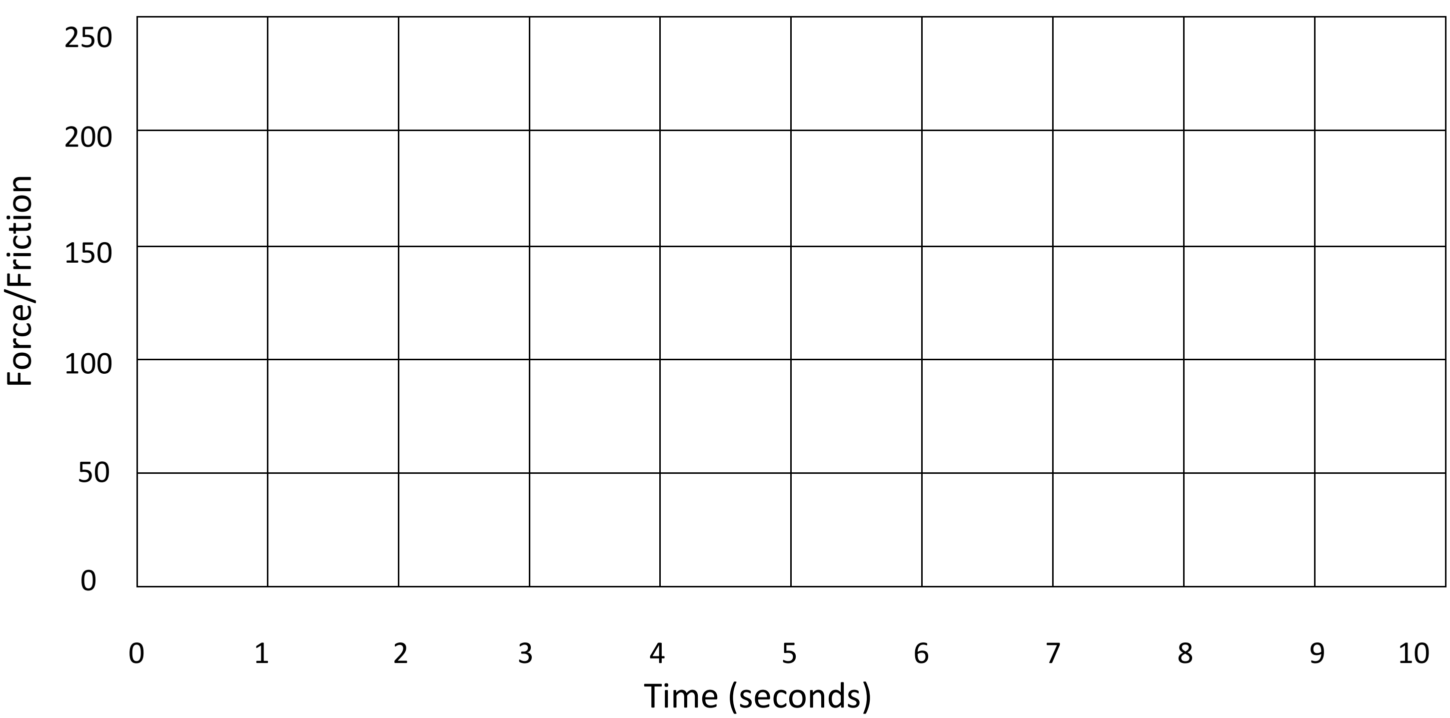
Who's An Engineer? Part I – Grip or Slip?

Very Little Friction (Slip)	Lots of Friction (Grip)

Experiment - How much friction?

Hypothesis: There will be MORE or LESS friction between the sled and the TENNIS BALLS than between the sled and the FLOOR.

Data:



New hypothsis/Conclusion: The data show that there was MORE or LESS friction between the sled and the TENNIS BALLS than between the sled and the FLOOR.

Explore Together

At today's meeting of Snapshot Science Club (K-2), we put on our physics/engineering caps and learned about the force of friction acting against movement. We brainstormed what exactly friction is by examining the grip on our shoes and passing around some sand paper.

Our experiment measured the force needed for a participant to pull themself with a rope across the floor while sitting on a sled. A device called a force plate was used to graph the force during the experiment. The graph was automatically plotted in view of the students during the test. This allowed them to model or see what was happening in real time!

Next, we predicted what the graph would look like if the sled were pulled along on a layer of tennis balls. This was our hypothesis. We tested our hypothesis and made a conclusion based on what the new line looked like on the graph. Ask your budding engineer to explain the results in their words.

Now that we have a basic understanding of friction, we are ready for the activity at our next meeting—we will build simple wind-up cars from easily-recycled, common materials and then test them with more or less friction between the wheels and the 'road' surface.

Since engineering is integral to virtually everything we use, one activity you can do with your child is to discuss how things are made to do what they do. Are there items you have around the house that you wish worked better? Share and discuss how different designs might work better. Build something together or take something apart and put it back together.

NEXT Meeting: Who's an engineer? (Part II)

<u>Prize drawing each meeting</u>…To encourage your child to share their experiences with you, after each Snapshot Science Club activity there will be a prize drawing. Participants simply need to bring back this sheet to Snapshot Science Club with your signature which indicates you have read the note and have discussed what they did with you. Their name will be put into a hat for a small prize related to science. There will be one winner each meeting.

Parent Signature ___________________________________

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Activity 4: Who's an Engineer (Part I)

Central Ideas – Students will understand that:

1. Engineers use science to design, build, and maintain useful things in the world, such as bridges, computers, cars, and shoes.
2. Friction is a force of resistance between the surfaces of two objects sliding against each other. Simply put, friction is grip NOT slip.
3. The level of friction depends on the properties of the materials in contact, ie. their shape, and abrasiveness, and mass.
4. A force plate can be used to graph and measure differences in friction between sliding surfaces in contact.

Key Science Concepts:
Friction, force, computer graph as a model, relationship between friction and force, experimental question/problem, hypothesis (testable prediction), measurement, data, table, conclusion

Key Process Skills - Students will:
Work as a team of scientists
Form a hypothesis/predict an outcome based on a similar event or previous experience
Use a force plate and computer to observe, model, measure, and record data
Data analyses - correlate more force (taller line on graph) with more friction
Form a conclusion based on the data and hypothesis

Standards: connections to the 3 dimensions of the Next Generation Science Standards -- see Appendix A.

Overview:
The much-needed addition of Engineering to the national science standards with the publication of the Next Generation Science Standards (2013) emphasizes the important connection between the design process and science. Engineers use the process of science to better understand the factors that affect their designs. One such factor is friction. Friction is the focus of both this Snapshot Science Club activity and the next one.

After a short discussion about what engineers do, students explore friction by considering a variety of situations and compare the soles of each other's shoes. Friction describes the force of resistance between the surfaces of two objects sliding against each other. The familiar terms of grip and slip are useful to help students remember what friction is—more friction is grip, less friction is slip. Two different grits of sand paper are passed around the group to further emphasize the idea of more or less friction. Students then draw something with little friction between surfaces and also something with lots of friction between surfaces.

In the experiment, students all team up to measure the force needed by a student to pull herself with a rope across the floor on a plastic sheet sled. The rope is tied to a Vernier force plate connected to a computer and projector. The system projects a real-time line graph that shows the change in force (Newtons) with time (10 seconds). Students draw the line onto the graph on their handout. This model is then used to make a prediction about how much force is needed if the person is sitting on a sled on top of a bunch of tennis balls while running the experiment. Their prediction/hypothesis is drawn as a line/curve onto their graph using a different color. If the prediction is more friction then the line is drawn above the data. If their prediction is less friction then the line is drawn below the data. The experiment is run again with tennis balls and then results are analyzed.

Materials:
(In order of appearance)

- Lab coat
- Student handout
- Pencils
- Markers or colored pencils
- Clipboards
- Sandpaper samples
- Experiment apparatus
  - Vernier force plate
  - Go-Link!
  - Rope
  - Plastic sheet sled
  - 50 tennis balls
  - Computer with USB port & Logger Lite installed
  - Projector hooked to computer
- Sample car kit
- Parts for each car kit (Figure-5)
  - Plastic sandwich bag (zip)
  - Toilet tissue tube (pre-punched)
  - 4 plastic milk caps (pre-drilled)
  - 2 axles (longer wood pieces)
  - 1 anchor (pointed wood piece)
  - Rubber band
  - 1 jumbo paperclip
  - 2 Wide rubber bands
- Prizes for drawing
- Bag with signed handouts

On-site preparation:

- Read Who's an Engineer (Part II) to know how this lesson and the next fit together!
- Prep car parts prior to arrival. *See Car Kit instructions (Figure-7)*
- Set up experimental area. Leave tennis balls hidden in box. (Figures-3-5)
- Set up Vernier force plate for lower range of measurement with the switch on the unit.
- Test computer, projector (if used), software & force plate.
- Plug force plate into Go-Link!, then Go-Link! into USB port of computer.
- Open Logger Lite software and Graph Options (see Figure-1). In order to match the scaling on the graph on the student handout, set up X axis between 0-10 seconds and Y between 0 and 250 N (see Figure-2). Change scaling for both axes to manual.

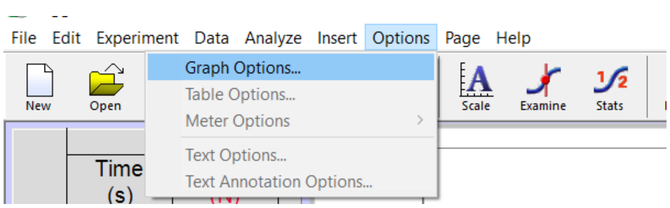

Figure-1

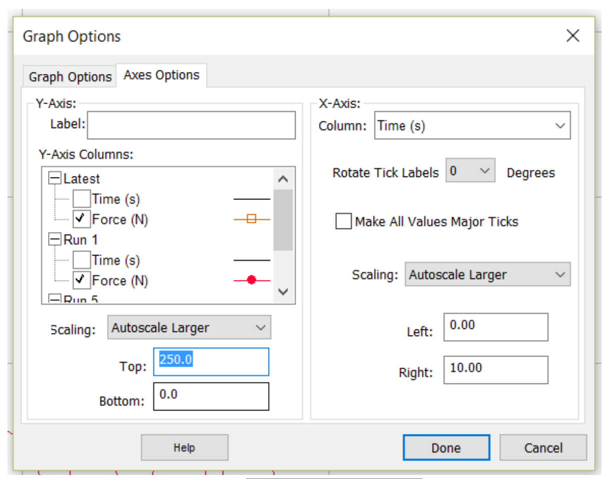

Figure-2

- Place handouts, clipboards, pencils, and sandpaper samples near gathering area.

Safety Considerations:

Watch for trip hazards with rope, cords, balls. Instruct students to pay attention for these on their arrival. The skewers used for the car kits can be sharp.

Instructional Plan/Procedure:

- Introduction to Engineering and Friction
  a. Greet the students and collect signed handouts. Place them in the prize drawing bag for later.
  b. Start with students sitting in a circle on the floor.
  c. Discuss - What is an engineer?
     i. Someone who uses science to design things to work a certain way.
     ii. Example designs – bridges, cars, tools, computers, glue-on sticky notes
  d. Engineers need to know about lots of forces. Friction is one such force.
  e. Discuss - What is friction? Friction is grip (between two surfaces)
  f. Observe examples of friction
     i. Look at your shoe soles. Which ones grip best or have the most friction?
     ii. Rub hands together. What happens? Friction causes objects to get warm.
     iii. Sandpaper – Ask students to decide which piece can produce the most friction. Keep the answer to yourself until everyone has had a chance to touch them. Pass one around and then the next one. Discuss results.
  g. Pass out pencils, handouts, and clipboards.
  h. Ask students to draw a picture of something with little friction (slippery) in the box on the left and something with lots of friction or grip in the box on the right.
  i. Ask a couple of students to share their picture ideas.
  j. Leave supplies at the gathering space.
  k. Instruct students regarding trip hazards.
  l. Move to experimental space.
- Experiment
  a. Explain the computer model & force plate set up. Push on the force plate to demonstrate how the force is shown to increase on the computer screen.
  b. Explain that the force plate will be used to measure how much force is needed for someone to pull them self across the floor. The teacher holds the force plate with the rope around it (see Figures-3-5). A student will sit on the sled with toes through the handles and pull them self along the floor from one end of the track to the other. *Tennis balls are not used at first**.

Figure-3. Force plate

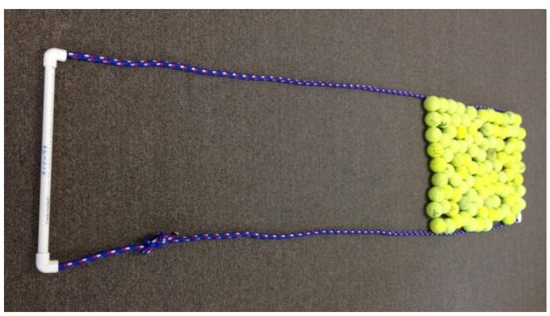

Figure-4. Track with tennis balls*

Figure-5. Student in ready position

  c. Pick a volunteer to perform experiment. Everyone may get at least one chance to try after the experiment, depending on cooperation and time.
  d. Pick a volunteer to start data collection on computer. Briefly instruct student how to start.
  e. Position onlookers in a safe area away from any trip hazards, but within view of graphing software.

f. Perform a practice run or two. Ask if volunteers are ready and be sure other students are watching the graph. Use a countdown such as “On your mark, get set, go” to sync the science team’s effort. It may be useful to instruct the computer volunteer to press “select” a second before “go”. This way the entire run will be collected, even if the sled rider pulls too soon.

g. Be sure to store each experiment trial in order to compare the runs/trials with each other (see Figure-6). After a run, choose experiment>store run. If the run was not successful, you can choose experiment>clear run instead.

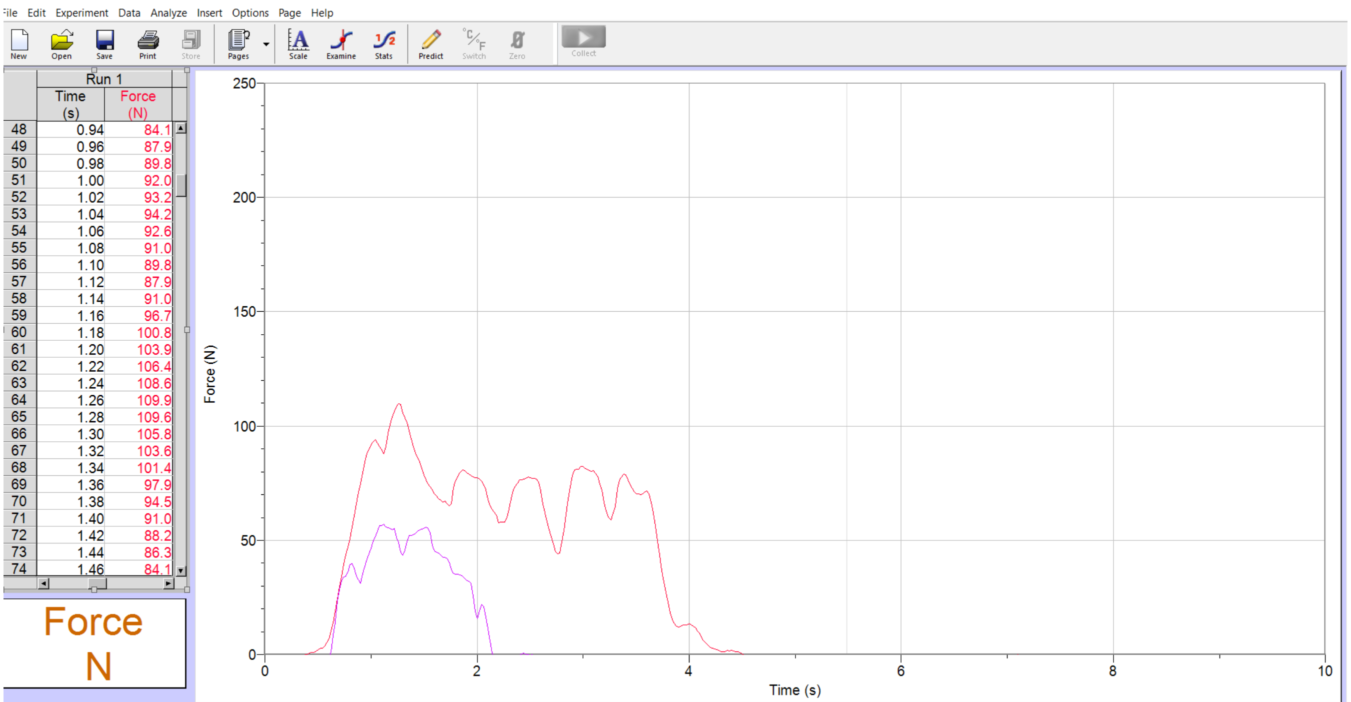

Figure-6. Force plate data showing run on carpet (red/top) and run on tennis balls (purple/bottom).

h. Trial 1 – If the practice run looks good, store it according to g. above, and move on.
   i. Point out the peak on the graph and tell the students what the highest force is.
   ii. Students will now get their clipboards and draw the curve on their handout with their pencil. The curve does not need to show every peak and valley, as long as the general trend and approximate peak height is close.

i. Hypothesis – Ask students to predict whether more or less force will be needed if the sled were on balls.
   i. Have them circle their hypothesis on the handout.
   ii. Ask students “If it takes more force to pull the sled on the tennis balls, will the next curve be higher or lower than the first trial?” (higher)
   iii. Students should use a marker or different color to draw a prediction curve on their graph.

j. Trial 2 – Put the tennis balls in the track as shown in Figure-4.
   i. Run trial 2 with the same volunteers in place for consistency.
   ii. Store the run according to g. above.
   iii. Students use a third color or different mark to draw the trial 2 results on their graph.

k. Conclusion – Ask students to circle their New Hypothesis/Conclusion.

- Preparation for Next Meeting
    a. Show the students a finished car that they will build and test at the next meeting.
    b. Put kits together (see Figure-7)
    c. Pass parts around the table one at a time. Ask students to repeat the number and name of the parts to help them remember when the parts actually get to them. Students should put the parts in the bag as they receive them:
        i. Ziploc sandwich bag
        ii. 2 axles
        iii. 4 milk tops
        iv. 1 anchor
        v. 1 narrow rubber band for power
        vi. 1 paper clip
        vii. 1 tube
        viii. 2 wide rubber bands
    d. Have students put their names on the tubes. If time permits, they could also decorate them. The 4 axle holes are on the bottom of the car body (tube). The front axle holes are closer to the end of the tube.

- If time permits, give everyone a turn to pull themselves on the sled from balls to floor for comparison.
- Prize Drawing

Car Kit Preparation Instructions – Who's an Engineer (Part II)

- Use the paper tube template for the car frame (toilet tissue tube). Mark locations of the holes with a pen and then use a single-hole punch for the axle holes and a small awl for the anchor holes. Anchor holes should be smaller than the diameter of the skewers to insure a tight fit.
- Cut skewers into axles and anchors using a twig clipper (hand sized). Axles should be about 8-cm and anchors should be about 6-cm. Anchors should have a dull point to help easily place them in the car body. Clip or sharpen points as needed, but keep them dull/blunt.
- Pre-drill a hole in center of each milk top. The hole should be slightly smaller than diameter of the skewers.

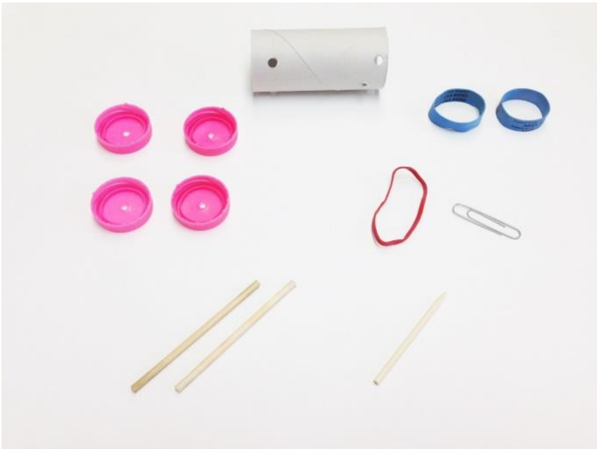

Figure-7

References:

Burton, Bill. 2012. Experiencing Friction in First Grade. Science & Children. Volume 50 Number 2 pp. 68-72

Logger Lite Software. Freeware available at http://www.vernier.com/downloads/