The Force of Friction

- We will be completing a formal lab report on the force of friction

- You will record a rough draft of the investigation in your science notebook

- Your final draft must be typed, double spaced, and have standard margins – due beginning of 2nd quarter – exact date TBD.
The Force of Friction

- There are many types of friction
  - Rolling friction
  - Sliding friction
  - Static friction
  - Air friction

- We will be investigating sliding friction within this lab
Surface Type
Weight (# of blocks)
Surface Area (each side of the block)
Force of Friction Lab Report

- Jigsaw Investigation

The Force of Friction Lab investigation is divided into 3 sections
  - Surface Type (6.1)
  - Weight (6.2)
  - Surface Area (6.3)

Lab Group Assignments

- Surface Type (6.1)
  - Lab Groups 1, 2, 3
- Weight (6.2)
  - Lab Groups 4, 5, 6
- Surface Area (6.3)
  - Lab Groups 7, 8, 9

Check for Understanding
Teacher Demo
Dynamic Equilibrium means a Constant Velocity
- NO acceleration; NO unbalanced forces
- NO acceleration means NO change in speed
  - This means the forces are balanced
    - The force of the hand equals the force of sliding friction!

The spring scale measures the strength of the hand and at a steady speed this pulling force is balanced/equal to the resisting frictional force.
Create a Rough Draft

The Force of Friction

- **Purpose**: How does surface type, weight, and surface area affect the force of sliding friction?

- **Background Research**:
  1. Take bulleted notes as you view the friction PowerPoint.
  2. Table talk and think about what we just discussed.
  3. Organize your notes into a well-written summary.

- Write 1-2 paragraphs of information regarding friction and underline the 5 most significant pieces of information.
Is friction occurring when you are playing indoor soccer? Explain your answer.

Yes, between the ball and ground, ball and foot, feet and ground, ball and net... and the list goes on!

Friction always causes 3 things to occur: (USE THE HINTS AT THE BOTTOM TO HELP!)

- Produces heat
- Slows objects down
- Wears down surfaces

Rub your hands together... what do you feel?
Check the soles of your shoes, what do you see?
What do brakes do for a bike and car?
Friction
What do all of these activities have in common?

Rolling Friction
Rolling Friction

- **Rolling friction** is friction that occurs between surfaces in motion in which one of the surfaces is a wheel, roller, or ball.

  Examples:
  - Riding a bike – tires and ground
  - Bowling – ball and lane
What do you notice about all of these items?
Static Friction

- **Static friction** is friction that occurs when the surfaces in contact are at rest (not in motion).

Examples:
- A book resting on a desk.
- A potted plant sitting on a sidewalk.
What do all of these activities have in common?

Sliding Friction

Curling

Ice Hockey

Shuffleboard
Sliding Friction

- **Sliding friction** is friction that occurs when solid surfaces slide over one another.

Examples:
- Writing – pencil point and paper
- Combing your hair – surface of comb and strands of hair

ROLLING friction is usually LESS than sliding friction.
What do all of these activities have in common?

- Air Hockey
- Water Skiing
- Hang Gliding
- Wind Sailing

Fluid Friction
Fluid Friction

**Fluid friction** is friction that occurs when objects move across or through a fluid.

Examples:
- Swimming – swimmer’s body and surface of water
- Greasing a squeaky door hinge – now the 2 hinge parts are sliding across a fluid (the grease)
Check for Understanding

Which type of friction is it?

- Pulling a wagon.
- Swimming in the ocean.
- Pushing a box across the floor.
- A vase sitting on a table.
- Riding a bike.
- A seagull soaring through the air.
Fluid Friction

- **Air resistance** is an example of fluid friction caused by the particles that make up air.
- It causes a falling object to slow down.
- **Examples:**
  - Throwing a frisbee – frisbee is slowed down by air resistance
  - Skydiving – parachute is slowed down by air resistance
Fluid Friction cont.

- FLUID friction is usually LESS than sliding friction.
- Lubricants change sliding friction to fluid friction.
- **Lubricants** are slippery substances.

- **Grease** for motor parts in a car
- **Cooking oil** so food won’t stick to bottom of pan
- **Wax** on bottom of surf board to make it move faster through water
Which type of friction is this picture an example of?

Rolling Friction
Which type of friction is this picture an example of?

Fluid Friction
Which type of friction is this picture an example of?

Sliding Friction
Which type of friction is this picture an example of?

Static Friction
Which type of friction is this picture an example of?

Sliding Friction
Which type of friction is this picture an example of?

Fluid Friction
Which type of friction is this picture an example of?

Rolling Friction
Which type of friction is this picture an example of?

Static Friction
Which type of friction is this picture an example of?

Sliding Friction
Which type of friction is this picture an example of?

Rolling Friction
Wrap-up

What kind of friction is occurring between a pencil and desktop when you flick the pencil? _______rolling______

Which has more friction? Sliding or Fluid friction? _______sliding______

Which affect of friction can you feel on a tire after you rode it for 20 minutes? _______heat_______

Friction from the rubber soles of your shoes and the floor allows you to do what when playing basketball or indoor soccer? (an affect of friction) _______Slow down and stop______

Because of which affect of friction makes you have to sharpen your pencil after writing with it for a while? _______Wearing away______
Create a Rough Draft

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Force of Friction Lab Report

- **Hypotheses:**

  1) If the **surface type** of an object is varied from smooth to coarse/rough, then the force of sliding friction will _____, because... _____.

  2) If the mass and thereby **weight** of an object is increased, then the force of sliding friction will _____, because... _____.

  3) If the **surface area** of an object is increased, then the force of sliding friction will _____, because... ______.
Force of Friction Lab Report

Variables:

- **Independent Variable**: *(what you are testing)*
  - Surface Type (smooth to coarse/rough) – (Lab Groups 1-3)
  - Weight (# of blocks) – (Lab Groups 4-6)
  - Surface Area (each side of the block) – (Lab Groups 7-9)

- **Dependent Variable**: *(what you are measuring)*
  - Force of Sliding Friction (measured in Newtons)

- **Constants**: *(what you keep the same)*
  - The constants are the two variables that your group is NOT testing. For example, if you are testing Surface Type then you keep constant the weight and surface area.
Force of Friction Lab Report

Materials:
- 1-4 Wooden Blocks
- 0-2.5 Newton Spring Scale
- 0-10 Newton Spring Scale
- 1 piece of waxed paper
- 1 piece of paper towel
- 1 piece of fine sandpaper
- 1 piece of coarse/rough sand paper
- 1 rubber band
- Masking tape
Force of Friction Lab Report

Procedures:

- Look at the provided Data Table
- Review 6.1, 6.2, and 6.3
  - Pages 50-53
- List all of your procedures for your experiment only as a numbered set of specific directions (at least 6 steps)
  - 1) Gather materials.
  - 2) Calibrate the force meter.
  - 3)...

Lab Group Assignments

- Surface Type (6.1)
  - Lab Groups 1, 2, 3
  - Page 50
- Weight (6.2)
  - Lab Groups 4, 5, 6
  - Page 51
- Surface Area (6.3)
  - Lab Groups 7, 8, 9
  - Page 52
Results Section:
- **Data Table:** (use the provided data sheet)

- **Graph:** *(GET A RULER!)*
  - After you complete data gathering, arrange into a graph
  - Be sure to use a ruler, include a title, and properly label
    - Independent Variable on the x-axis
    - Dependent Variable on the y-axis
  - Title Example:
    - The Dependence of Sliding Friction on Surface Area

- **Scientific Drawing:**
  - Produce a scientific drawing *on the back of the data sheet*
  - Be sure to use a ruler, include a title, and properly label
Force of Friction Lab Report

Data Analysis:
- Surface Type Analysis:
  - Skip 9 lines of space
- Weight Analysis:
  - Skip 9 lines of space
- Surface Area Analysis:
  - Skip 9 lines of space

In each Analysis:
- Describe any trends/patterns in the data.
- What was the relationship between the variables tested?
  - Positive relationship (both variables increase)
  - Negative relationship (one variable increases and the other decreases)
  - No relationship (variables do not affect on another)
- Cite data from the experiment and explain how it supports the relationship.

For your final draft – create 3 data analysis paragraphs beginning with a topic sentence, e.g. “In our investigation we tested the dependence of sliding friction on... (surface type/weight/surface area).”

Start at your lab station
On your teacher’s direction... Rotate to the next wall and complete multiple trials of the experiment. Record qualitative and quantitative data. Rewrite the data into 3-4 sentences per the directions below.
Conclusion: (review “How to Write a Lab Report” for all sections of the formal lab report)

- Begin the summary paragraph with a topic sentence that is related to the problem statement.
  - i.e. “In our investigation we found that sliding friction is dependent upon __________ and ________, but is not dependent on ___________.

- Describe all the steps of the experiment in sequential order.
  - Do NOT copy the procedures; explain the gist of the procedures.
  - *Take a look at your procedures and explain the gist of what you did for your 1 experiment.*

- Conclude if the data supports or rejects the hypothesis by citing actual data and/or trends.
  - Restate all 3 hypotheses.
  - Explain if each hypothesis was supported with your data.
  - Cite actual data validating or rejecting your prediction within each hypothesis.

- Describe what you have learned about your purpose or problem statement.
  - What did you learn about the dependence of sliding friction on surface type, weight, and surface area?
  - What did you learn about friction? Is there more than one type? – Explain.

- Discuss the kind of errors that may have occurred during the investigation.
  - Human error?
  - Mechanical error?

- Explain how the experiment is related to real life situations.
  - Look at your bellwork over the last several days.
    - How can the force of friction be helpful/harmful?
    - What real-world products involve friction?
    - How can you apply friction to your daily life?
Reflection Questions

- Answer as part of your rough draft the reflection questions
  - A, B, and C on page 53 in your science notebook

**Reflecting on What You’ve Done**

Write answers to the following questions in your science notebook:

A. What have you learned about friction in this lesson? In your science notebook, summarize in several paragraphs what you have learned about the force of friction. In your summary, include factors that affect frictional force and explain how you measure it.

B. In this lesson, you measured sliding friction. Why does the force on the spring scale measure the force of friction while the block moves at a steady speed?

C. Suppose you used ice as a surface for the block to slide on. What results would you get in this lab? Consider results for all three variables—surface type, weight of the block, and surface area.
Future Research:

- Briefly explain how the experiment could be expanded upon, or describe a new related experiment that would be interesting to investigate.
- Should be a paragraph of 3-8 sentences.
Abstract - (similar to a conclusion; contains motivation and creativity)
• This section is only included in a formal lab report and is located at the beginning of the final report. The abstract should contain approximately 150 - 250 words in paragraph form and contain five distinct parts. Think of this an advertisement to read your report.

1. Introduction/Motivation
• Pull the reader into your writing.
• Why should the reader be interested in your report?
• Be engaging and creative!

2. Problem Statement
• What problem are you trying to confront?
• State the problem or purpose statement and explain.
• State the hypothesis and explain.

3. Methods
• What experimental methods did you use to complete the investigation?
• Should be a brief summary of the procedures – the gist.

4. Results
• What did you find out?
• Briefly describe the data analysis and trends of the investigation.

5. Conclusions
• What did you learn from your results?
• Restate your hypothesis/predictions and explain if it was supported or rejected.
• Explain how this investigation relates to the real world.