# Great Science Adventures


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# Great Science Adventures

**Lesson 1**

# *What is work?*

## Tool Concepts:

- Work is related to force and motion.
- For work to take place, an object, or load, must move as the result of a force acting upon it in the direction of its movement.
- Work is defined as: force x distance = work. In this formula, force is equal to the weight of the load.
- Work is increased in two ways: an increase in the weight of the load and an increase in the distance moved.

**Teacher's Note:** On *Lots of Science Library Book #1*, page 14, the formula for work does not take into account the effect of friction on the load.

## Vocabulary Words:

work force load distance weight * motion *formula *physics

## Read: *Lots of Science Library Book #1.*

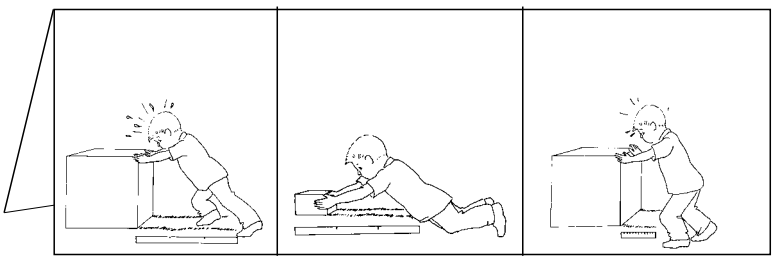
## Activities:

### Work – Graphic Organizer

**Focus Skill:** defining components
**Paper Handouts:** 8.5" x 11" sheet of paper, a copy of Graphics 1A–C
**Graphic Organizer:** Make a Hot Dog, 3 Tab Book. Draw/glue the picture for the work formula on each tab. Write/copy the formula across the top, as in the illustration below. Under each tab:

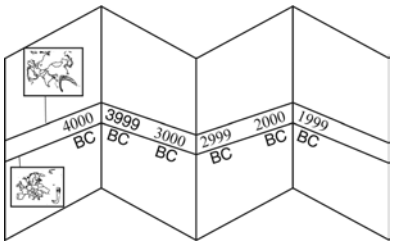
- ✎ Write clue words about each word in the formula: *force – push, pull; distance – inches, feet, meters, miles; work – force x distance=work.* Orally review the formula.
- ✎✎ Complete ✎. Write a sentence, using the clue words, explaining work.
- ✎✎✎ Describe each component in the work formula. Determine how work can be increased and use the formula to defend the explanation.

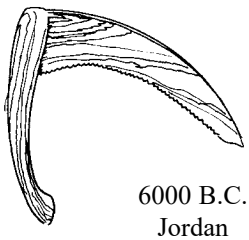
force x distance = work



**Paper Handouts:** 6 sheets of 12" x 18" papera copy of Graphics 1D–O
a copy of Tools in Time Graphics 1P–Q
**Graphic Organizer:** Make an Accordion Book with the paper. Follow the directions on page 5. Glue Graphics 1D at the middle of the first page of the Accordion Book. Glue 1E at the middle of the second page of the Accordion Book. Continue with Graphics 1F–O and the remaining pages.

Glue Tools in Time Graphics 1P and 1Q on the appropriate places in the Timeline Book. Copy the date of use on the picture. Draw a line from the graphic to the timeline and color the region where the tool was used. Add any other tools discovered in research to the Timeline Book.



6000 B.C.
Jordan

4500 B.C.
Yugoslavia

# Experiences, Investigations, and Research

Select one or more of the following activities for individual or group enrichment projects. Allow your students to determine the format in which they would like to report, share, or graphically present what they have discovered. This should be a creative investigation that utilizes your students' strengths.

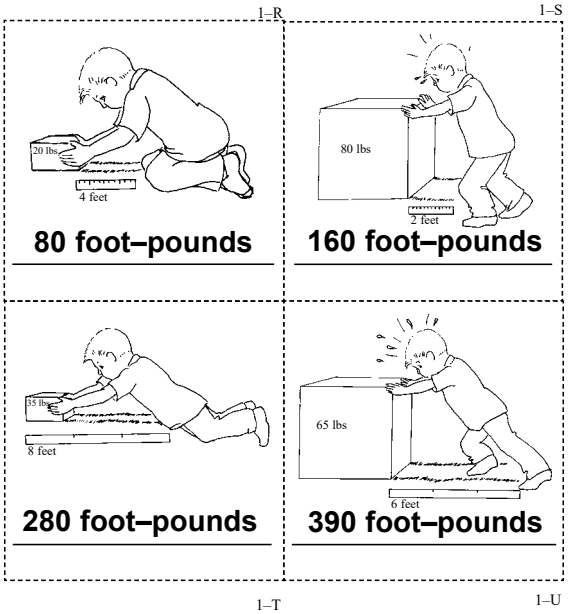
1. Make a list of the work you do in one day. Select one item on your list and describe it in individual steps, such as: pick up bowl, open cabinet, grab box, turn box to pour cereal in bowl, put box on shelf, etc.

2. Weigh a load, move it a measured distance, and calculate the work completed with the formula. Increase the work with more weight or more distance. Calculate the work using the formula.

3. Calculate the work done on Graphics 1R–U, using the formula for work. Make up two work examples of your own. Draw pictures and complete the formula for each of your examples.

4. Investigate how resistance training can strengthen muscles.

5. Work and energy are measured in joules. Research the life of British physicist James Prescott Joule. Make a 4 Door Book. Label the tabs *Who, What, When,* and *Where.* Under each tab, write information found in the research.



# *What is friction?*

## Tool Concepts:

- Friction is a force that takes place when one surface slides against another.
- Friction is helpful to us in many ways. Friction allows us to slow down a car, grab an object, and stop when we are running.
- Friction makes work more difficult. Because of friction, we need to increase force for work to take place.
- Friction can be decreased in two ways: lubrication and wheels.

**Teacher's Note:** The labs for this program require the use of a force meter to quantitatively measure force needed to raise or move a load. The directions for a force meter are located in the Activity Section of this lesson. However a spring scale or fish scale may be purchased and used as a force meter for the labs. Since the force meters will be of different tensions, it is necessary for you to calibrate the meter to objects that can be used as a load in the labs.

A load can be two or more books tied together with string or a pound of flour in a secured plastic bag. To calibrate the force meter, find an object that registers a low level when being raised.

Remember the force meter is not a standardized measurement, so all labs that compare forces need to be performed with the same force meter.

## Vocabulary Words:

surface friction increase decrease wheels liquid *lubrication

## Read:

*Lots of Science Library Book #2.*

## Activities:

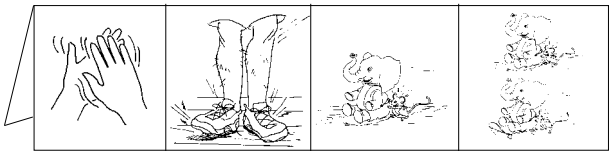
### Friction – Graphics Organizer

**Focus Skills:** acquiring information, explaining concepts
**Paper Handouts:** 8.5" x 11" sheet of paper, a copy of Graphics 2A–D
**Graphic Organizer:** Make a Small Question and Answer Book. Draw/glue Graphics 2A–D on the tabs as shown.

- Create friction by rubbing your hands together. Discuss it and under the first flap, write/copy clue words about friction: *heat, rub surfaces.* Run and stop on tile floor to experience friction. Discuss and write/copy words about how friction helps people: *stops, holds.* Discuss with students how friction affects work and write/copy words: *makes work harder.* Discuss with students how to decrease friction and make work easier: *lubrication,* or *liquids, wheels.*

✎✎ Under the first tab, describe friction. Under the second tab, explain how friction benefits people. Under the third tab, explain how it affects work. Under the fourth tab, list two ways that friction can be reduced, making work easier to complete.

✎✎✎ Complete ✎✎. List examples under each tab to reinforce the explanations.



## Investigative Loop – Experiencing Friction – Lab 2–1


Lab 2–1

**Focus Skill:** experiencing a concept
**Lab Materials:** cornmeal
**Paper Handouts:** 8.5" x 11" sheet of paper, a copy of Lab Graphics 2–1
Lab Record Cards (index cards or pieces of 3" x 4" paper)
**Graphic Organizer:** Make a Pocket Book. See page 2 for illustrations. This is the students' Lab Book. Glue Lab Graphic 2–1 on the left pocket.
**Question:** What is friction?
**Research:** Read *Lots of Science Library Book #2*. Review friction.
**Procedure:** Rub your hands together. Dip your hands in cornmeal and rub them together.
**Observations:** Describe how your hands felt when they were rubbed together without the cornmeal. Describe how they felt when you rubbed them with the cornmeal.
**Record the Data:** Label two Lab Record Cards, "Lab 2–1," and the date. On one Lab Record Card, write words or phrases describing your observations of the hand–rubbing without the cornmeal. On the other Lab Record Card, describe your observations of the hand rubbing with cornmeal.
**Conclusions:** Review the data and draw a conclusion about the differences in your observations.
**Communicate the Conclusions:** Label a Lab Record Card, Lab 2–1 and the date. Write your conclusion. Store all the Lab Record Cards in the left pocket of the Lab Book.
**Spark Questions:** Discuss questions sparked by the lab.
**New Loop:** Choose a question to investigate further or complete the New Loop below.

## Investigative Loop – Reducing Friction – Lab 2–2


Lab 2–2

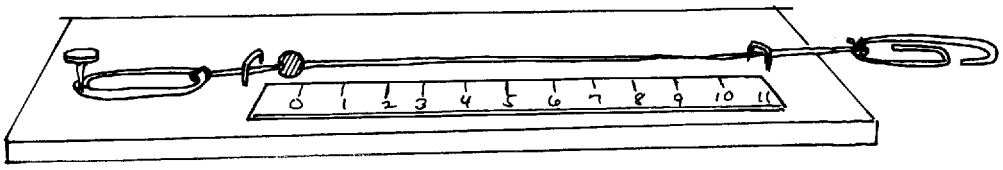
**Focus Skill:** experiencing a concept
**Lab Materials:** lotion
**Paper Handouts:** Lab Book, Lab Record Cards,
a copy of Lab Graphics 2–2
**Graphic Organizer**: Glue Lab Graphic 2–2 on the right pocket of the Lab Book.
**Question:** How can friction be reduced?
**Research:** Read *Lots of Science Library Book #2.* Review the question.
**Procedure:** Rub your hands together. Then put lotion on your hands and rub them together.
**Observations:** Describe how your hands felt when they were rubbed together without the lotion. How did they feel when you rubbed them with the lotion?
**Record the Data:** Label two Lab Record Cards "Lab 2–2," and the date. Write words or phrases that describe your observations without and with the lotion on your hands.
**Conclusions:** Review the data. Draw conclusions about the difference in your observations.
**Communicate the Conclusions:** Review the data and draw a conclusion about the differences in your observations. Label a Lab Record Card, "Lab 2–2," and write your conclusion. Store all the Lab Record Cards in the right pocket of the Lab Book.

**Spark Questions:** Discuss questions sparked by the lab.
**New Loop:** Choose a question to investigate further.
✎✎✎ Design Your Own Experiment: Select a topic based upon the experiences in these *Investigative Loops*. see page vi for more details.

## Force Meter

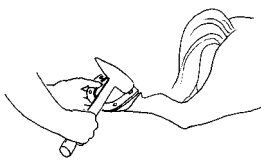
**Focus Skills:** following directions, measurements
**Activity Materials:** piece of wood (approximately 3" x 10"), rubber band, 12" piece of string, tack, two U-shaped nails, bead that will be held securely on the string, paper clip, metric ruler, piece of paper, hammer
**Activity:** Follow the directions below to make a force meter.

1. Tie one end of the string to the rubber band, using several knots.
2. Tack the rubber band to the end of the wood.
3. Hammer a U–shaped nail just under the rubber band and string connection, in line with the tack.
4. Thread the string through the bead and slide the bead to the rubber band.
5. Hammer a U–shaped nail at the other end of the wood, over the string.
6. Tie the paper clip to the string.
7. Cut the paper to fit on the wood, to the left of the string. Make the paper long enough to fit in-between the two U–shaped nails.
8. Use the ruler to make cm lines and label them 0, 1, 2, 3, etc. Glue the paper so that the bead is on the zero mark.
9. Attach the load to the paper clip and hold the wood as you pull. The bead will indicate the amount of force used to move the load. Reset the bead at zero before each pull.
10. Calibrate the force meter before it is used in the *Investigative Loops*. See the Teacher's Note in this lesson.




## Tools in Time – Timeline Book

**Paper Handouts:** Timeline Book, a copy of Graphics 2E–F
**Graphic Organizer:** Glue Graphics 2E and F to the appropriate places in the Timeline Book. Copy the date for use on the picture. Draw a line from the graphic to the timeline and color the region where the tool was used. Add any other tools discovered in research to the Timeline Book.



700 B.C.
Europe

6000 B.C.
France

# Experiences, Investigations, and Research

Select one or more of the following activities for individual or group enrichment projects. Allow your students to determine the format in which they would like to report, share, or graphically present what they have discovered. This should be a creative investigation that utilizes your students' strengths.

1. List the positive and negative effects of friction on daily life.

2. About 20% of a car engine's power is used to overcome friction. Find out how much power is used to overcome friction in several other common machines. Graph your information.

3. Explain the following: *Because friction changes some machine energy to heat, the amount of output work is always less than the amount of input work.*

4. Research the cosmetic use of exfoliates and explain how exfoliates rely upon friction to work. Start with an internet search: "How do exfoliates work?" or "What's the difference between physical and chemical exfoliation?" You may think of other avenues to pursue as you research this topic.

# Great Science Adventures

**Lesson 3**

# *What are the types of friction?*

## Tool Concepts:

- Friction is greatest just before an object moves. This is called starting friction.
- Friction lessens when an object is in motion. This is called sliding friction.
- Friction lessens when an object rolls on wheels. This is called rolling friction.
- The amount of friction depends upon the amount of force between the two objects or surfaces. Therefore, heavier objects create more friction when being moved and lighter objects create less friction when being moved.

**Teacher's Note:** An alternative assessment suggestion for this lesson is found on pages 74–75. If Graphic Pages are being consumed, first photocopy assessment graphics that are needed.

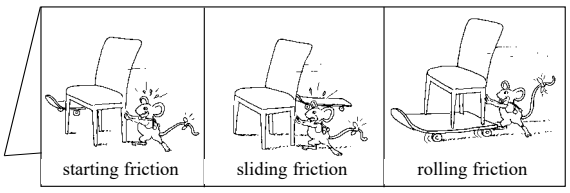
## Vocabulary Words: starting friction sliding friction rolling friction

## Read: *Lots of Science Library Book #3.*

## Activities:

### Types of Friction – Graphic Organizer

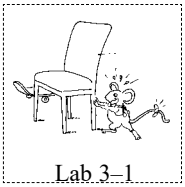
**Focus Skills:** comparing and contrasting, describing concepts
**Materials:** 8.5" x 11" sheet of paper, a copy of Graphics 3A–C
**Graphic Organizer:** Make a Hot Dog, 3 Tab Book.
On each tab, draw/glue Graphics 3A–C and label each tab.



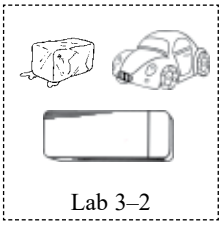

- ✎ Under each tab, write/dictate clue words about the amount of friction in each situation: *most friction, less friction, least friction.*
- ✎✎ Explain each type of friction under the appropriate tab and give common examples of each. Compare and contrast the amount of friction produced in each situation.
- ✎✎✎ Complete ✎✎. Research these types of friction and record the data under the appropriate tab.

### Investigative Loop – Compare Types of Friction – Lab 3–1

**Teacher's Note:** For the load in this lab, use books large enough to register on your force meter.
**Focus Skills:** measuring force, compare and contrast
**Lab Materials:** 3 yards of string, books used as a load, force meter


Lab 3–1

**Paper Handouts:** 8.5" x 11" sheet of paper, Lab Record Cards, Lab Book a copy of Lab Graphics 3–1
**Graphic Organizer:** Make a Pocket Book. Glue it side–by–side to the Lab Book. Glue Lab Graphic 3–1 on the left pocket of the Lab Book.
**Question:** How does friction affect the amount of force needed to move an object?
**Research:** Read *Lots of Science Library Book #3.* Review starting, sliding, and rolling friction.
**Prediction:** Predict the amount of force needed for each type of movement: starting, sliding, and rolling. "The starting movement will take more or less force than…"
**Procedure:** Place the books in a stack. Tie string around them to hold them in place. Attach a pulling string to it. Attach a force meter to the pulling string and pull the books, sliding them for several feet. Put the books on wheels or use several round pencils or pens to simulate wheels and pull them using the same method. If using pencils, ask one person to move the pencils from the back to the front of the books as they move.
**Observations:** Observe the force meter when the books start to move, when they are sliding, and when they are rolling.
**Record the Data:** Label three Lab Record Cards, "Lab 3–1," the date, and the type of action: starting, sliding, rolling. On each Lab Record Card, record the force measurements of each action.
**Conclusions:** Review the data collected. Compare the force needed to start the books moving to the force needed to keep them sliding, and to the force needed to move the books on wheels. Since the weight of the books is the same, the difference in the amount of force needed is a result of friction.
**Communicate the Conclusions:** Report the data on a bar graph. Explain the graph to one person who did not participate in the lab.
**Spark Questions:** Discuss questions sparked by the lab.
**New Loop:** Investigate one question further or create a New Loop using the above procedure on different surfaces: carpet, concrete, or tile.
Design Your Own Experiment: Select a topic based upon this *Investigative Loop* experience. See page vi for more details.


Lab 3–2

## Investigative Loop – The Race – Lab 3–2

**Focus Skills:** predicting outcome, drawing conclusions
**Lab Materials:** ice cube, toy car, eraser, board or large book
**Paper Handouts:** Lab Book, Lab Record Cards, a copy of Lab Graphics 3–2
**Graphic Organizer:** Glue Lab Graphics 3–2 on the right pocket.
**Question:** Which object will move faster, and why?
**Research:** Read *Lots of Science Library Book* #3 and review friction.
**Predictions:** Predict which object will move the fastest on a board or book. "The _____ will move the fastest." Write the prediction on a Lab Record Card labeled "Lab 3–2."
**Procedure:** Put the board or large book on a stair or stack of books. Assign three people to hold an object in place at the top of the board. Instruct the holders to let go at the same time.
**Observations:** Watch the race. Which object reached the bottom of the board first? Second? Last?
**Record the Data:** Label a Lab Record Card "Lab 3–2," the date, and the first, second, and third place holders of the race. Record any other observations made during the race. Store cards in the appropriate pocket of the Lab Book.

**Conclusions:** Review the data. Draw conclusions about the order of the race.
**Communicate the Conclusions:** On a Lab Record Card, explain the conclusion. Option: Make a Half Book and write a newspaper article about this great race.
**Spark Questions:** Discuss questions sparked by the lab.
**New Loop:** Investigate one question further.
**Design Your Own Experiment**: Select a topic based upon this *Investigative Loop* experience. See page vi for more details.

**Tools in Time – Timeline Book**

**Paper Handouts:** Timeline Book, a copy of Graphic 3D
**Graphic Organizer:** Glue Graphic 3D to the appropriate place in the Timeline Book. Copy the date of use on the picture. Draw a line from the graphic to the timeline and color the region where the tool was used. Add any other tools discovered in research to the Timeline Book.


1000 B.C.
Northern Europe

# Experiences, Investigations, and Research

Select one or more of the following activities for individual or group enrichment projects. Allow your students to determine the format in which they would like to report, share, or graphically present what they have discovered. This should be a creative investigation that utilizes your students' strengths.

1. Using the Procedure in Lab 3–1, predict how changes will affect the forces needed to move the book. Put a large book on the bottom of the stack, then put a small book on the bottom of the stack. Measure the forces on the differently arranged stacks of books. Compare the results to your predictions. Can you make a generalization about the force needed for different types of loads?

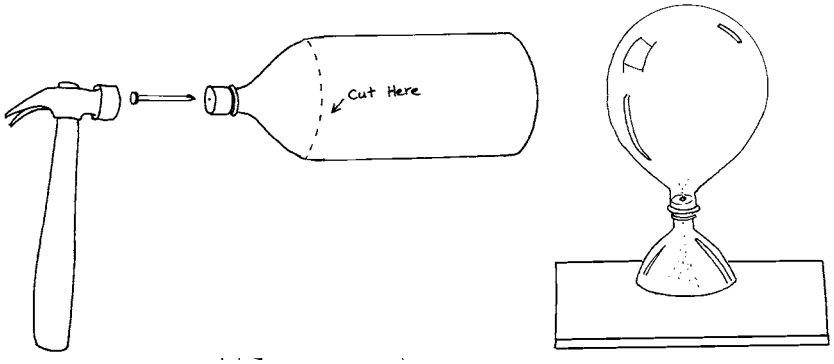
2. Read a biography on one of the following:

| | | |
|---|---|---|
| Isaac Newton | Leonardo da Vinci | Benjamin Franklin |
| James Watt | Michael Faraday | Thomas Edison |
| Alexander Graham Bell | The Wright Brothers | |

Make a 4 Door Book to report the *Who, What, When,* and *Where* of the inventor's life.

3. Explain the part friction plays in the following activities: ice skating, roller blading, sledding, and snow boarding.

4. Make a hovercraft. Cut off the top of a plastic bottle with scissors. Drill a small hole in the cap. Blow up a balloon and stretch it over the bottle cap. Push the hovercraft gently and it should glide. The cushion of air acts as a lubricant and reduces friction.



# Tools Concept Map

**Lessons 4–24**

**Numbers Refer to Lesson Numbers**