Date: _____

Your Name: _____

New England Common Assessment Program

Released Science Inquiry Task

Force of Friction

2015

Grade 8

Student Answer Booklet

SCIENCE

Directions:

You will work on your own to organize and present your data, analyze and use your results, and explore other data that are presented. You may use the Word Bank below during this session.

Word Bank

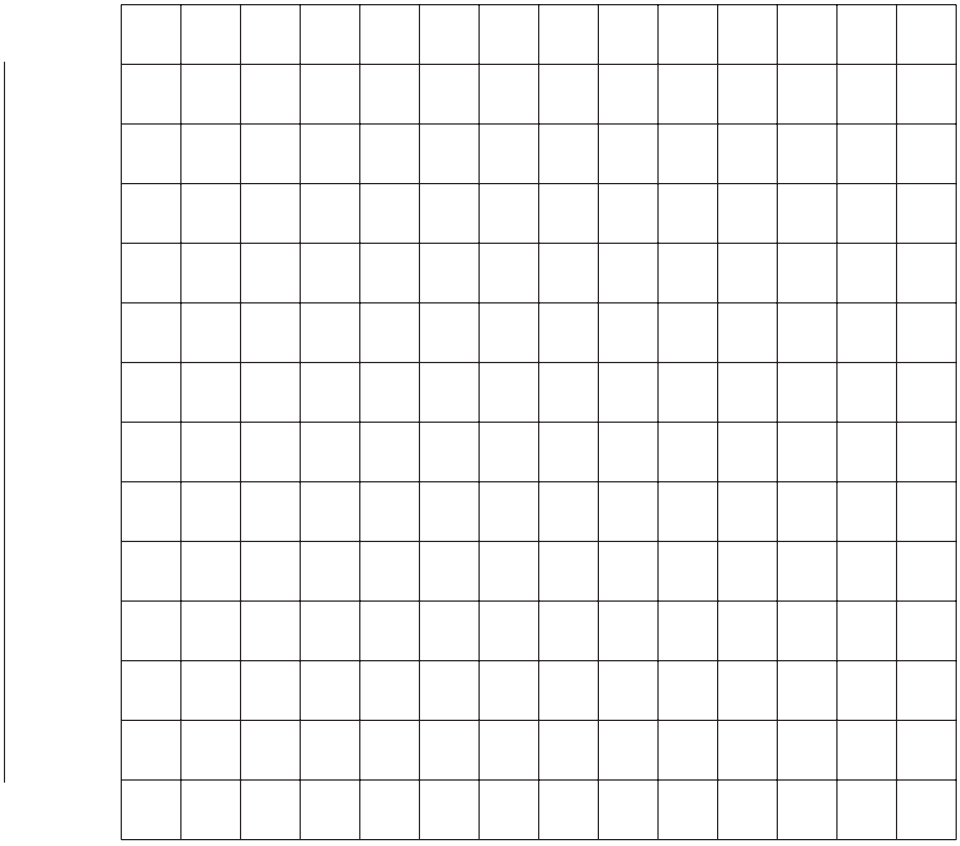
Applied force	an action that could cause an object to move, such as a push or a pull
Average (mean)	a typical number for a data set; a value that is found by dividing the sum of a set of terms by the number of terms Example: The average of 5, 5, and 8 is $\frac{(5 + 5 + 8)}{3} = 6$.
Curling	a sport in which players slide special stones across a sheet of ice toward a target area
Force of friction	when an object is pushed or pulled, the resistance that opposes the movement of that object
Shuffleboard	a game in which players use broom-shaped paddles to push weighted disks, sending them gliding down a long and narrow court toward a target area
Surface area (of a flat surface)	a number that describes the space inside a flat, or two-dimensional, surface Example: The area of a rectangle = length × width: Area = 5 cm × 6 cm = 30 cm^2.
Texture	the feel or appearance of a surface Example: A surface can be rough or smooth.
Trial	each time you repeat the same step of an investigation

Organizing and Presenting Your Data

1. Copy **Data Table 1** from page 5 of your Inquiry Booklet in the space below. **Be sure to double-check that you have copied the data table and then calculate the averages, rounding to the nearest tenth.**

Representing and Summarizing Your Results

2. Use the information in Data Table 1 to create a bar graph of the **average** force of friction needed to pull the wooden block across the three different surfaces.



Copy your prediction from page 4 of your Inquiry Booklet into the box below.

3. a. Is your prediction supported by the evidence from your investigation?

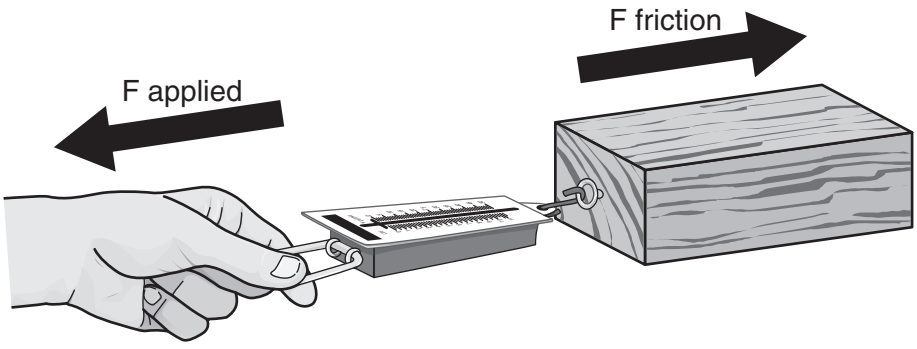
b. Explain why the evidence supports or does not support your prediction. Be sure to include specific pieces of evidence in your answer.

4. Identify what can be done to make your results more accurate. Explain why this change would make your results more accurate.

Kayla and Mason do the same investigation you did. Afterwards, they discuss their results. Mason says that forces always occur in pairs. When Kayla hears this, she remembers from her summer science camp that forces are described as either a push or a pull. Kayla explains that when she pulled on the spring scale, it demonstrated a "pull" force, which is called an **applied force**.

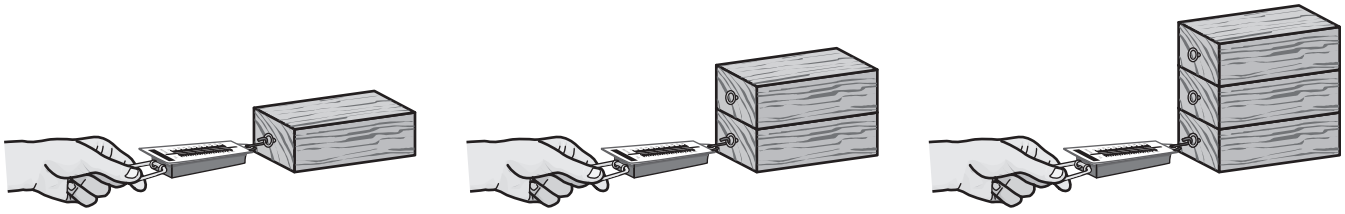
Mason asks Mr. Gregson, "What is the force in the opposite direction, and how is it different on the curling surface and on the shuffleboard surface?"

Mr. Gregson explains that the force in the opposite direction is the **force of friction**. Kayla shows Mason how to make a force diagram to show the two forces (F) acting on the wooden block, as shown below.



Kayla and Mason now understand that the force of friction on the icy surface of the curling court and the force of friction on the wooden surface of the shuffleboard court are different. However, Mason remembers from their research that the curling stone is much heavier than the shuffleboard disk. Mason wonders how mass affects the force of friction. Mason and Kayla discuss this and decide to do a new investigation to find out.

The mass of each block Mason and Kayla use is 145 g. This time, they use the tabletop surface, not wax paper, sandpaper, or a paper towel. They follow the exact same procedure as in the first investigation, but they use one, two, and three blocks stacked on top of each other, as shown below.



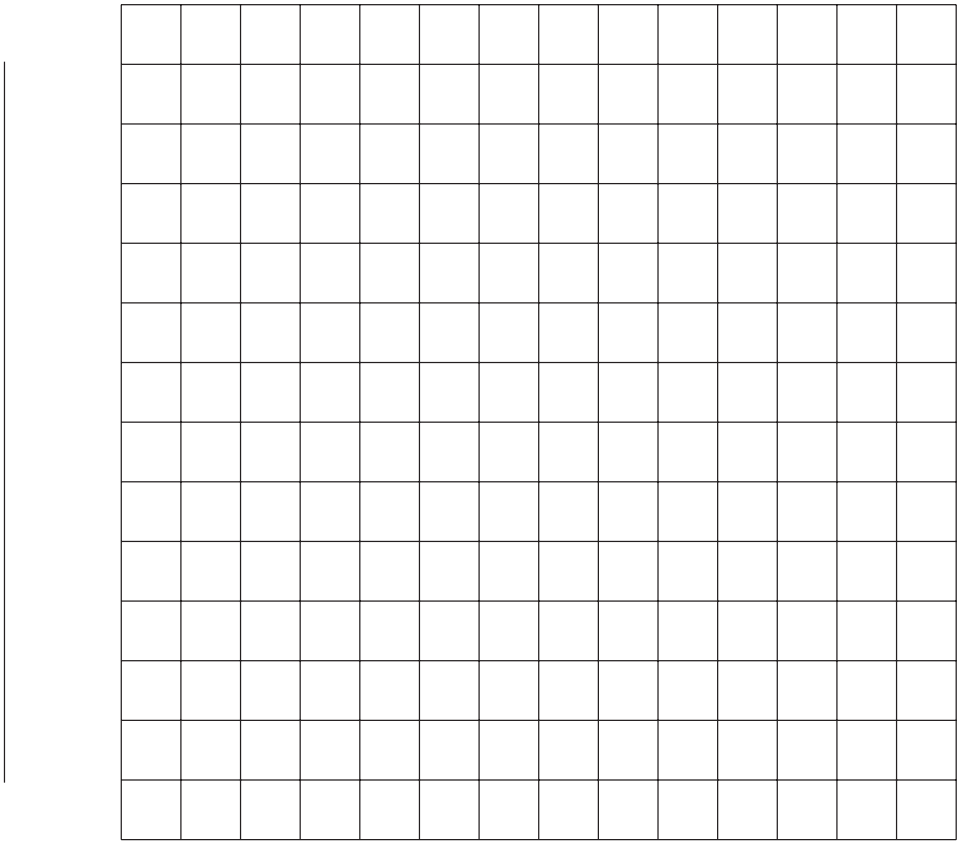
Data Table 2 shows their results.

Data Table 2: Effect of Mass on Force of Friction (Tabletop Surface)

Mass (g)	Force (N) Trial 1	Force (N) Trial 2	Force (N) Trial 3	Average Force (N)
145	0.35	0.40	0.40	0.4
290	0.60	0.70	0.75	0.7
435	1.05	1.20	1.25	1.2

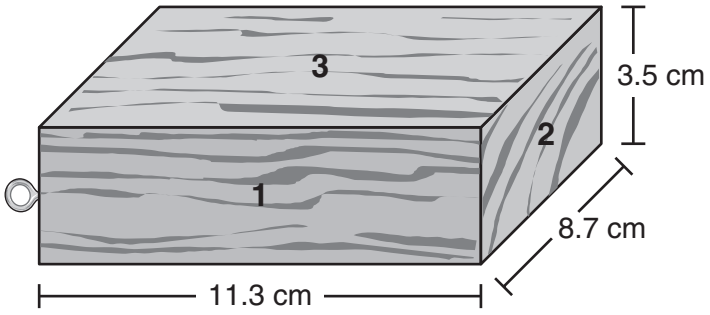
Analyzing Your Results

5. Use the data from Data Table 2 on page 7 to draw a graph that shows the relationship between mass (g) and **average** force of friction (N).



Now that they know how the type of a surface and mass affect friction, Kayla and Mason think about the information they found on the differences between the playing pieces of the two games. The students have one final question: **How does the surface area of a flat surface affect the force of friction?**

Kayla and Mason realize that each of their wooden blocks has three different-sized sides, making it easy to test the effect surface area has on the force of friction. The dimensions of their blocks are shown below.



Kayla and Mason think that as the area of the part of the block in contact with the tabletop surface increases, more force will be required to pull the block across the table. The students design a procedure to conduct three trials and record the data for all three sides. The average force of friction for each side is shown below.

Data Table 3: Effect of Surface Area on Force of Friction (Tabletop Surface)

Side	Surface Area (cm^2)	Average Force (N)
1	39.6	0.4
2	30.5	0.4
3	98.3	0.4

Kayla and Mason review the information they gathered from the three investigations to see how the variables of surface type, mass, and surface area affect the force of friction.

6. Identify which variable—surface type, mass, or surface area—had the greatest effect on the force of friction needed to pull the wooden blocks. Use evidence from Data Tables 1, 2, and 3 to explain your answer.

Kayla and Mason have tested the effect of surface type, mass, and surface area on the force of friction. The students discuss how the investigations relate to their original question about the sports: Why are the playing pieces in curling and shuffleboard so different?

Kayla and Mason made the table below to show characteristics of the two objects used in the sports.

Playing Pieces in Curling and Shuffleboard

Playing Piece	Curling stone	Shuffleboard disk
Mass of Playing Piece	17–20 kg	0.45 kg
Diameter of Playing Piece	29 cm	15 cm

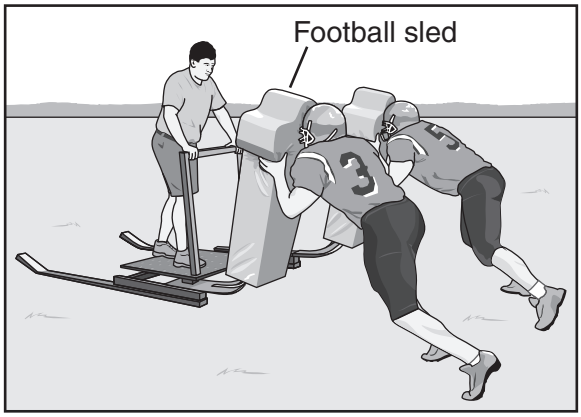
Kayla and Mason investigate the force of friction on the playing pieces by borrowing a curling stone and shuffleboard disk and testing their movement on a wooden floor.

7. Predict which playing piece, the curling stone or the shuffleboard disk, requires more force to travel a distance of 10 m on the wooden floor. Use evidence from Data Tables 2 and 3 and information from the story to explain your answer.

Applying What You've Learned

After cleaning up the science lab, Kayla and Mason notice that the football players are practicing on the football field. Kayla and Mason watch the football players use a football sled to train.

The players push the sled, and it moves with a slow, steady speed, carrying the coach with it, as shown below.



Kayla and Mason realize that what they have learned in their investigations could be applied to the football sled and to many other situations around them.

8. Describe how the coach could make the sled more difficult to push. Use **one** piece of evidence from the investigations to support your answer.

STOP