Friction Lab - Make-up

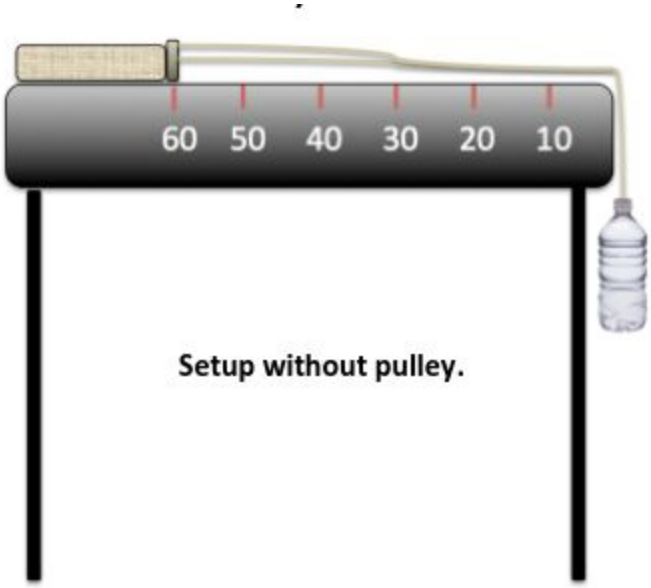
MATERIALS

70 sheet spiral notebook, small water bottle, yarn/string, timer, tape

PROCEDURE

Set Up

1. Place a small piece of tape every 10 cm from the table edge. See image.
2. Place the spine of the spiral notebook at the 60 cm tape mark facing the 10 cm tape mark.
3. Cut a 200 cm (2m) piece of yarn.
4. Open the notebook and loop the yarn around the inside spine of the notebook.
5. Thread the ends of the string through the top of the bottle cap and tie a knot to secure the bottle. The bottle should be as high up as it can be.
6. Give a SMALL tug to make sure the bottle doesn't fall off of the string.
7. Test to see if the bottle will hit the ground before the notebook gets to 10 cm. If it does, tie the yarn higher up.



Setup without pulley.

Part A: Control Run

8. Use the data table on the next page for the 3 different volumes of water you will test. Adjust the volumes as necessary. The notebook should move the 50 cm within 5 seconds. If it doesn't, add water in 25 mL increments until it does.
    a. 100mL
    b. 125mL
    c. 150mL
9. Fill the bottle with the first volume of water. Use the graduated cylinder.
10. Screw the cap with the string onto the water bottle, holding the bottle (do not let the bottle hang yet).
11. Practice releasing the bottle (make sure yarn has tension) with the notebook at the 60 cm spot.
12. When you are ready to collect data, start the stopwatch at the moment the water bottle is released.
13. Stop the watch when the spine of the notebook reaches the **10cm mark**.
14. Record the time on the worksheet, along with any observations.
15. Repeat each volume of water **three times**.
16. Repeat 9 -13 for each volume of water
17. **Before you do the calculations, do Part B. See instructions on page 3**

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PART A: CONTROL RUN

1. Use the data below

Volume	Distance	Trial 1 time(s)	Trial 2	Trial 3	Avg time	Speed (m/s)
100 mL	50 cm [0.5 m]	2.63	2.44	2.54		
125 mL	0.5 m	1.47	1.47	1.63		
150 mL	0.5 m	1.13	1.05	1.04		

$$a = \frac{v - u}{t}$$

a = acceleration
v = final velocity
u = initial velocity
t = time taken

Calculations

velocity = speed

Initial = beginning

$$Speed = \frac{distance\ (meters)}{Time\ (seconds)}$$

1. How far (in meters) did the book travel from the 60cm to 10 cm mark?

_____

2. Calculate the **speed** for each of the volumes of water.
3. Calculate the average **acceleration** for each volume of water using the formula. Round to the nearest 0.001.

Volume of Water	Speed (m/s)	Acceleration (m/s^2)
100mL		
125mL		
150mL		

1. Find the mass of the bottle in water first in grams, then convert to kilograms (kg). If the empty bottle is 10g and 1.0 mL of water is equal to 1.0 g, fill in the table below. $Kilograms = \frac{grams}{1{,}000}$
2. Remember that **F=ma (Force = Mass x acceleration)**

Volume of Water	Mass of water & bottle (g)	Mass in kg	Force of bottle (kg m/s^2)
100mL			
125mL			
150 mL			

PART B: ADDING A RUNWAY

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Part B: Adding a Runway

1. Choose one of the following materials to test as a “runway” underneath the book
    a. aluminum foil
    b. copy paper
    c. wax paper
    d. plastic wrap
2. Will the runway cause your book to move faster or slower than Part A? Record your Hypothesis

    I predict that _____ will_____

    _____because _____

    _____

    _____

0

3. Use the data below

Volume	Distance	Trial 1 time(s)	Trial 2	Trial 3	Avg time	Speed (m/s)
150 mL	50 cm [0.5 m]	3.65	3.78	3.62		

ANALYSIS QUESTIONS

1. When you put more mass (water) into the bottle, what happens to the force? Explain

    _____

    _____

    _____

    _____

2. Draw force diagrams for:

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a. the notebook in Part A

b. the notebook in Part B.

c. the bottle

You do not need to calculate the forces, but remember to include all arrows for all of the forces present on the objects.

3. Was your hypothesis correct for Part B? Compare your results for Part A & B.

_____

Force and Motion: Explore evidence that the change in an object's motion depends on force and mass.

	Proficient (3)	Close to Proficient (2)	Developing (1)
	❑ Solid knowledge of force. ❑ Lab is complete and data is collected. ❑ Runway material is tested and data is collected.	❑ Some knowledge of force ❑ Some information is incorrect ❑ Work is incomplete or needs more detail.	❑ Lab is mostly incomplete and/or incorrect.