

8 Friction

Name _____

Lab

Inquiry/AP Physics

Today we will be investigating and identifying factors which affect the frictional force between two objects. At your lab station you will find three wooden blocks, a spring scale, a surface board, a mirror, a metal plate and various masses. You will perform this lab **at your lab station**.

Pick an area of the table where you will conduct **all** of the trials. You will be placing various surfaces and objects at **that same exact location** and pulling them in the **same exact way** for each experiment. Start by placing the sandpapered wooden block on the surface board and 500 grams on top of the block. (This is experimental situation **A** in the table.) Slide the hook of the spring scale through the hook on the block and gently pull the block forward using the spring scale. Get the block moving at a reasonable but constant speed. Why should you keep the scale **parallel** with the table top?

Record the maximum scale reading **after** you begin pulling the block but **before** the block moves forward. This data should be recorded in the "Static" column in the table. Also record the maximum scale reading while the block is **moving** at a **constant speed** in the "Kinetic" column in the table. Be sure to make three measurements.

Complete the table. The same person should pull the block in all the trials, and he or she should try to maintain the same velocity when pulling the block. *Be careful to always place the required mass on each block as you experiment with it.*

Do not ever place the sandpaper block on the mirror, nor the mirror block on the metal plate.

Table I

	Block Type	Surface	Mass on Top (g)	Reading 1 (N)		Reading 2 (N)		Reading 3 (N)		Avg. Reading (N)	
				Static	Kinetic	Static	Kinetic	Static	Kinetic	Static	Kinetic
A	sand-paper	surface board	500								
B	mirror	mirror	500								
C	mirror	surface board	500								
D	plain wood	mirror	500								
E	plain wood	metal plate	500								
F	plain wood	surface board	500								
G	plain wood	surface board	750								
H	plain wood	surface board	1000								

THE IDEA ALL ANSWERS SHOULD BE COMPLETE SENTENCES

1. How much of the block's weight is the spring scale supporting when you pull the block horizontally? **Justify your answer.**

2. Before you took the static reading, you were pulling on the block yet it did not move. What is preventing the block from sliding?

3. Before it began to slide, and then later when it was sliding but at a constant speed, how does the amount of tension force in the scale compare to the amount of frictional force? Justify your answer.

4. Given your answers to questions 2 and 3, what then is one factor that directly controls the amount of frictional force?

5. Look at experiments F, G, and H. In general, which are larger - the "Static" or the "Kinetic" values?

6. Still looking at F, G, and H, state what effect weight has on the readings.

7. Look at the average data for experiments A, C, and F. Does the *type of surface on the block* affect the scale readings?

8. Look at the average data for experiments D, E, and F. Does the *surface the block is moving over* affect the scale readings?

CONCLUSION

9. The purpose of this lab was to identify factors which affect the frictional force between two surfaces. In answering questions 4-8, you have noted five such factors. Carefully state, in several complete sentences, the five factors **shown by this experiment** to affect friction.

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Lab Expansion: FRICTION COEFFICIENTS

AP Physics B

10. Question 6 asked how weight and friction were related. If we assume (and we will test this idea below) that if the weight doubles the friction then doubles, and so forth, what is the mathematical terminology for the relationship between weight and friction?

11. Weight is merely equal in size to the force we're actually interested in: the force that presses two surfaces together. What is a more general term for the perpendicular force that a surface applies to an object?

12. Combine the ideas of answers 10 and 11 into a single proportionality and express that idea in symbols.

Any proportionality can be converted into an equality (changing \propto into $=$) by inserting a constant, called the proportionality constant. The proportionality constant for your answer to question 11 is usually written as the Greek letter "mu" (μ) and is called the **coefficient of friction**.

13. Restate the proportionality of question 11 as a **SCALAR equation**, using μ for the proportionality constant.

$$F_f = \underline{\hspace{2cm}}$$

You are first going to calculate the coefficients of **static** friction (μ_s) for experiments A through H. You must therefore first determine the normal force for each situation. Weigh each block and record the data under "Block Weight" in Table II below. Then calculate the total normal force for each situation and record that in Table II.

Next focus your attention on the average **STATIC** friction forces in **Table I** (we'll address the kinetic forces later). Calculate the μ_s by dividing those readings by the total weight shown in **Table II**. Record the results in Table II. Note that friction coefficients **do not have any units**. This is because they are ratios, and ratios never have units.

Table II

Experiment		Block Weight (N)	Weight of Mass on Top of Block (N)	TOTAL Normal Force (N)	Coefficient of Friction		CLASS AVG. μ_s
					STATIC μ_s	KINETIC μ_k	
A	Sandpaper block on surface board		4.90				
B	Mirrored block on mirror						
C	Mirrored block on surface board						
D	Plain wooden block on mirror						
E	Plain wooden block on metal						
F	Plain block on surface board + 500 grams						
G	Plain block on surface board + 750 grams	7.35					
H	Plain block on surface board + 1000 grams	9.80					

- 14a. Look at the static coefficients of friction for experimental situations F through H. Would you say that the coefficient is **significantly** affected by normal force? (Do the variations in the data show a rising or falling trend? Are the differences large enough to be more than experimental error?)

- 14b. *Skip this question until you have the class average μ_s for trials F, G, and H.*
Do the **class average** μ_s show a strong rising or falling trend as normal force increases?

If normal force and frictional force truly are in direct proportion, then any change in normal force should cause a proportional change in frictional force. This should leave μ unchanged. So your answer to #14b either supports or refutes the proposition in question 10.

15. Look at the static coefficients for experimental situations A through F. Are they similar?

16. What does your answer to question 15 tell you about surface types and coefficients of friction?

Now use the average KINETIC friction force data from **Table I** to compute **kinetic friction coefficients** for experiments F, G, and H. Enter the results in **Table II**.

17. Compare the coefficient of friction computations from the "Static" and "Kinetic" columns for experiments F through H. What does your data tell you about the effect of motion on friction coefficients?

EXPANSION CONCLUSION

The purpose of this expansion was to identify factors which affect the **coefficient of friction** (μ) between two surfaces. Your answers to questions 13-16 will help you form the necessary conclusions.

18. In the space below, state what factor(s) do NOT affect μ .
DON'T CONFUSE μ WITH FRICTIONAL FORCE. ANSWER IN COMPLETE SENTENCES.

19. Next state what factors DO affect μ , and describe *how* they change it (what about that factor causes μ to increase or decrease?) ANSWER IN COMPLETE SENTENCES
