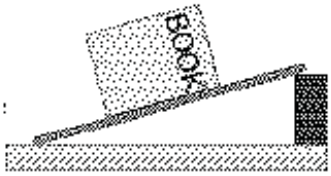
# APPENDIX D: INTERACTIVE TUTORIAL LECTURE *FRICTION AND TENSION*

- Pretest
- Interactive tutorial lecture worksheet

Pretest for interactive tutorial lecture *Friction and Tension*

PRETEST: FRICTION AND TENSION Name:_____

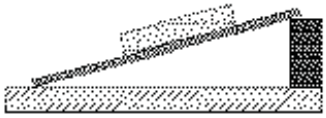
A student performs a few experiments with a book and a wooden incline.


In the first experiment, the student places the book on the incline as shown above right. The book remains at rest.

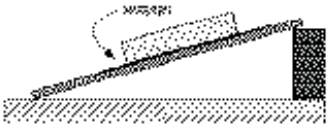
Next, the student performs a second experiment (shown below right) by making a single change to the previous setup. The book is placed on its back, on the same spot on the incline. (You are looking at the binding of the book.) The book remains at rest.

a. Is the friction force on the book by the incline in the second experiment *greater than*, *less than*, or *equal to* the friction force on the book in the first experiment? Explain your reasoning.



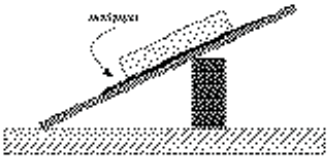
In a third experiment, the student makes another single change from the previous setup. This time, the book is placed on its back on top of a piece of sandpaper. The book remains at rest.

b. Is the friction force on the book by the incline in the third experiment *greater than*, *less than*, or *equal to* the friction force on the book in the second experiment? Explain your reasoning.



In a fourth experiment, the student makes another single change from the previous setup. The block that supports the incline on the far right is moved to the left, so that the incline makes a higher angle with the horizontal. The incline and the book remain at rest when the block is in the new position.

c. Is the friction force on the book by the incline in the fourth experiment *greater than*, *less than*, or *equal to* the friction force on the book in the third experiment? Explain your reasoning.



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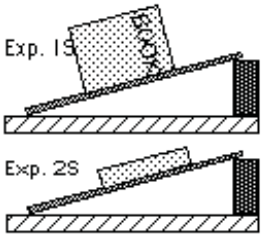
## FRICTION AND TENSION

### I. Surface Area

A. A student (named Sean) performs a few experiments with a book and a wooden incline. The book is shown in perspective at right.


In Experiments 1S and 2S, Sean places the book on the incline in two different orientations, as shown. In each case, the book remains at rest.

1. Is the magnitude of the friction force on the book in Experiment 2S *greater than*, *less than*, or *equal to* the magnitude of the friction force on the book in Experiment 1S? Explain your reasoning.




☞VOTE.

2. Record the results of the class vote here.

| Greater than | Less than | Equal to |
|---|---|---|
| % | % | % |

Friction forces can be categorized into two types: *static* friction and *kinetic* friction (or *sliding*) friction. A static friction force is one for which the two interacting objects do not move relative to one another.

B. In the space below, sketch a free-body diagram for the book in Experiment 1S.

Explain how you knew how large to draw the arrow that represents the friction force on the book.

How, if at all, would the free-body diagram for the book be different in Experiment 2S?

C. Reconsider your answer to part A above. Is it consistent with your results from part B? If not, how could you change your answer to part A to make it consistent with part B?

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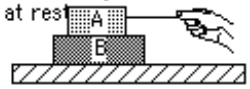
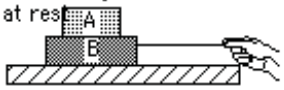
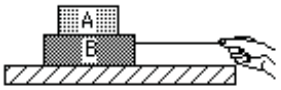
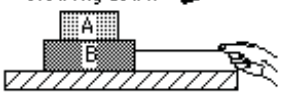
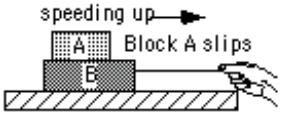
**IV. Determining the existence and direction of friction forces**

Block A is on top of block B, which is on a table. In each of the five cases depicted below, a person is pulling a string that is attached to one of the blocks. In the first four cases, block A does not slip on block B. Draw an arrow to represent the direction of the friction force described in each column of the table, and indicate whether it is *static* or *kinetic* friction. If any friction force is zero, write that explicitly.

| | Directions of friction forces: | | |
|---|---|---|---|
| | on A by B | on B by A | on B by table |
| blocks stay at rest   | | | |
| blocks stay at rest   | | | |
| constant speed →   | | | |
| slowing down →   | | | |
| speeding up →   | | | |

It is often said that "the friction force always opposes the direction of motion." Can you find any counterexamples to this statement in the cases above?