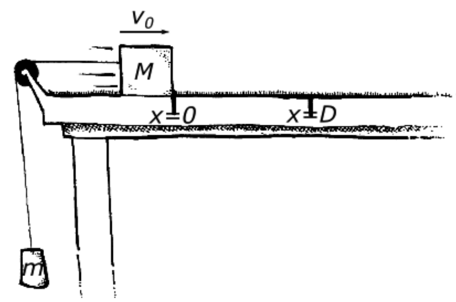
NAME ______________________________ DATE ______________

Scenario

In the diagram shown to the right a block of mass M has taken a quick hit from a bat. After the strike, its front end is at position $x = 0$ at time $t = 0$ and it is moving to the right with initial speed v_0. The block slides on a rough surface and is also connected to a hanging mass object of mass m by a string that passes over an ideal pulley. The front end of the block reaches position $x = D$ at time $t = t_1$, the instant that the block comes to rest. The block then returns to position $x = 0$ at time $t = t_2$, having a leftward speed v_2 at that time.

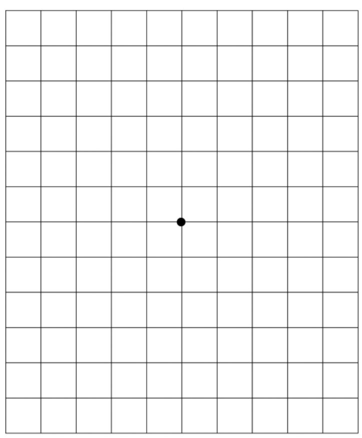


....

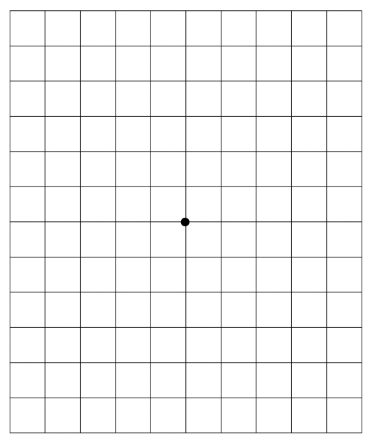
Using Representations

PART A: The dots below represent the block on the table during the interval $0 < t < t_1$ and $t_1 < t < t_2$. Draw free-body diagrams showing and labeling the forces (not components) exerted on the block during each of those intervals. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces. Each force should be a single arrow that originates on the dot.

Forces during $0 < t < t_1$



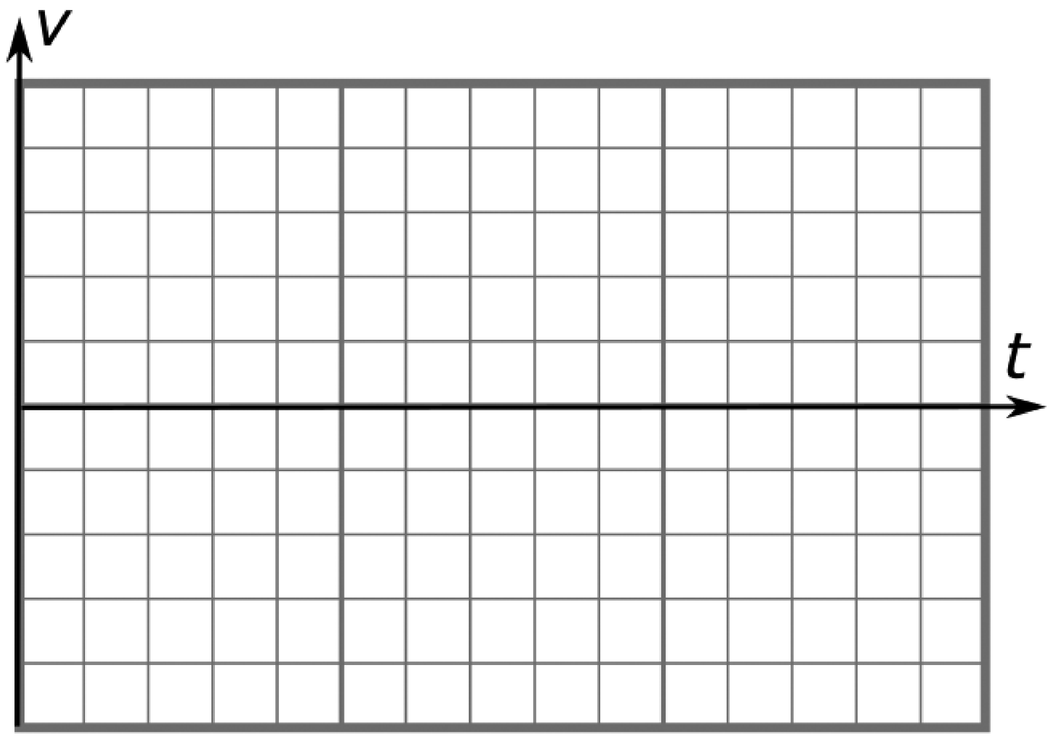
Forces during $t_1 < t < t_2$



Analyze Data

PART B: Is the magnitude of the block's acceleration greater before the block reaches $x = D$ or after? Explain your reasoning in terms of the forces that you drew in the above diagrams.

PART C: On the grid below, sketch a graph of the block's velocity as a function of time, taking right to be positive. Label the values v_0, t_1, and t_2 on the axes. Make sure that your graph is sketched to show that the block travels the same distance forward and backward.



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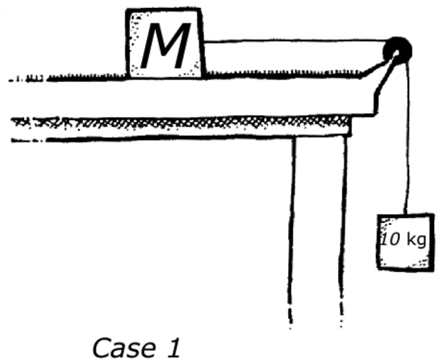
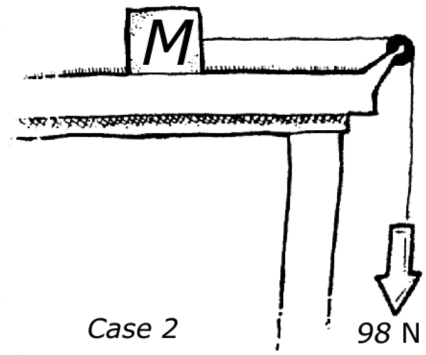




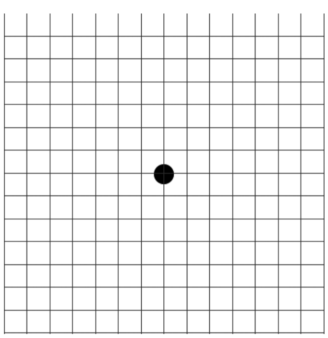
Scenario

In both cases shown above, a block of mass M is set on a rough table. The block is connected to a string that passes over an ideal pulley. In Case 1, the free end of the string is connected to a hanging object of mass $m = 10\ \mathrm{kg}$. In Case 2, the hanging object is removed and a person grabs the free end of the string and pulls with a constant force equal to $98\ \mathrm{N}$, the weight of the hanging object in Case 1. In both cases, the block is released from rest the same distance from the right edge of the table.

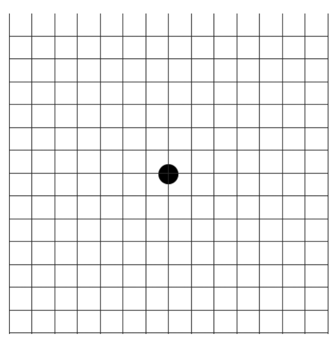
Using Representations

PART A: The dots below represent each object in Case 1. Draw the forces acting on those objects after the system is released. Use the grids to draw longer arrows to represent stronger forces. Assume that $m < M$. Recall that the system is accelerating.

Case 1: Block M



Case 1: Hanging object m



Argumentation

PART B: Angela and Dominique are observing this demonstration and note that the block accelerates in both cases. However, the block reaches the right edge of the table in less time in Case 2 even though the force on the string in this case is the same as the weight of the hanging object in Case 1.

i. This occurs because there is a different amount of tension in the two cases. Explain why the block reaches the end in less time in Case 2 in terms of the different tension force in each case.

ii. This can also be explained by considering systems. Let the system in Case 1 consist of both the hanging object and the block on the table. Let the system in Case 2 consist only of the block on the table. Explain how Newton's second law, when applied to these systems, predicts that the block in Case 2 reaches the end of the table in less time.

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Scenario

Dominique reads that race cars have wide tires because the increased area of contact between the tire and the road results in a stronger force of friction. She hypothesizes that the force of kinetic friction on an object is directly proportional to the area of the object in contact with the surface and wants to test this hypothesis.

Dominique and Blake take a long wooden plank and cut the plank into pieces that have different lengths but the same width and height. The students also have access to other equipment commonly available in a school physics laboratory.

Experimental Design

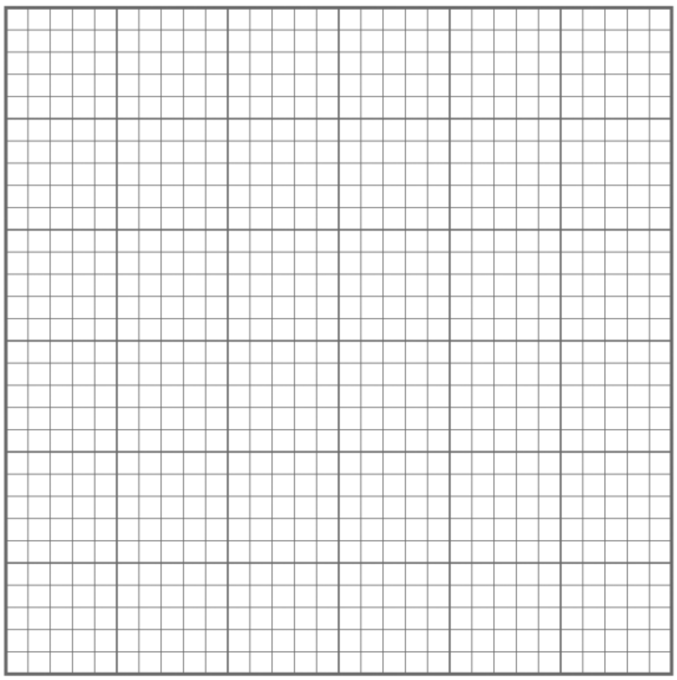
PART A: Explain how Dominique and Blake could determine the force of kinetic friction exerted on one of the wooden pieces.

<table>
<tr><td>What Needs to Be Measured and Algebraic Symbols</td><td rowspan="2">Procedure:</td></tr>
<tr><td>Labeled Diagram of the Setup</td></tr>
</table>

Block	***A***	***B***	***C***	***D***	***E***
Area [m^2]	0.0025	0.0050	0.0075	0.0100	0.0125
Volume [m^3]	0.00005	0.00010	0.00015	0.00020	0.00025
Kinetic Friction Force [N]	0.11	0.19	0.31	0.39	0.50

Analyze Data

PART B: On the grid, plot a graph of the data that could be used to test Dominique's SPECIFIC hypothesis. Label both axes with quantities, units, and an appropriate scale. Draw a best-fit line to the data.



PART C: Does the graph itself support Dominique's hypothesis? Why or why not?

Argumentation

PART D: There was a flaw in the procedure that renders the conclusion invalid. Briefly explain what this flaw was.