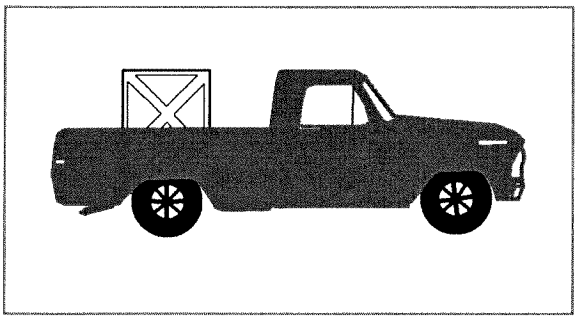
AP Physics 1 - Dynamics Test

MULTIPLE CHOICE SECTION

Directions: Mark only one answer for each question. Use $g = 10$ m/s^2 for simplicity.

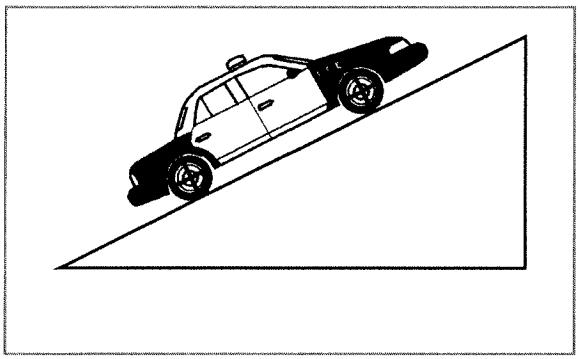
1.



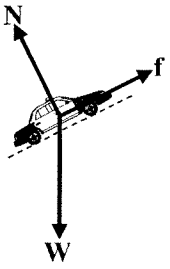
A truck traveling to the right with constant speed carries a box in its rear. The driver suddenly applies the brakes and the truck slows to a stop. The instant that the brakes are applied, the box slides toward the front of the truck. What force is responsible for the box sliding toward the front of the truck?

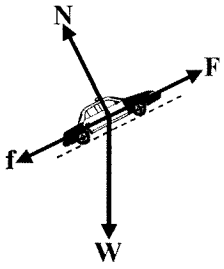
a. Weight
b. Inertia
c. Friction Force
d. There is no force that caused the box to slide forward.

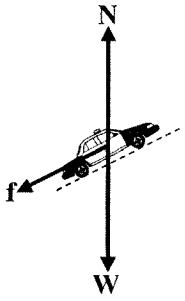
2.

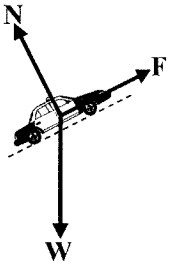


A car with good tires travels up a hill with constant speed. Let **W** represent the weight, **N** represent the normal force, and **f** represent the static friction force acting on the car. Any other external force on the car is labeled **F**. Which of the following diagrams correctly shows the forces acting on the car as it travels up the hill?

a. 

b. 

c. 

d. 

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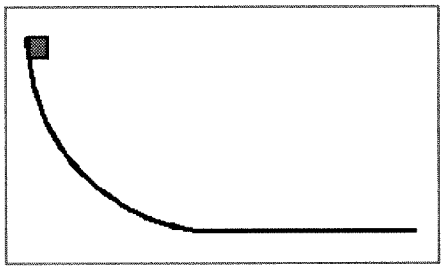
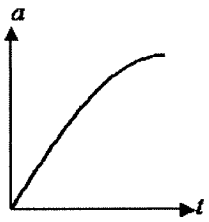
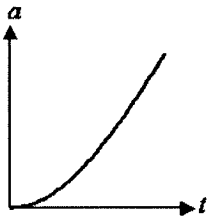
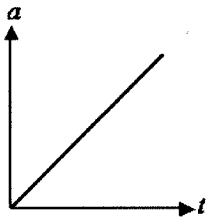
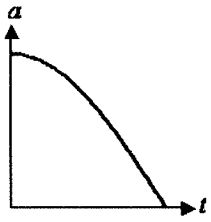


A block slides from rest down a frictionless quarter-circular incline as shown. Which of the following graphs represents the block's tangential acceleration as a function of time while the block is on the quarter-circle?

a. 

b. 

c. 

d. 

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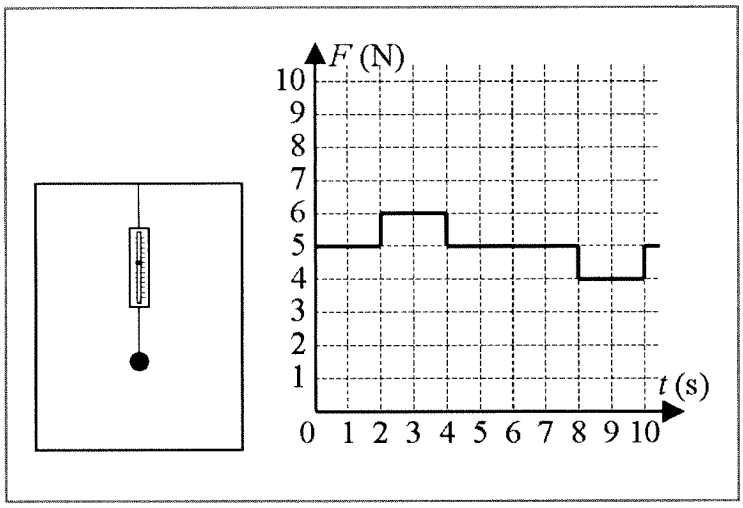
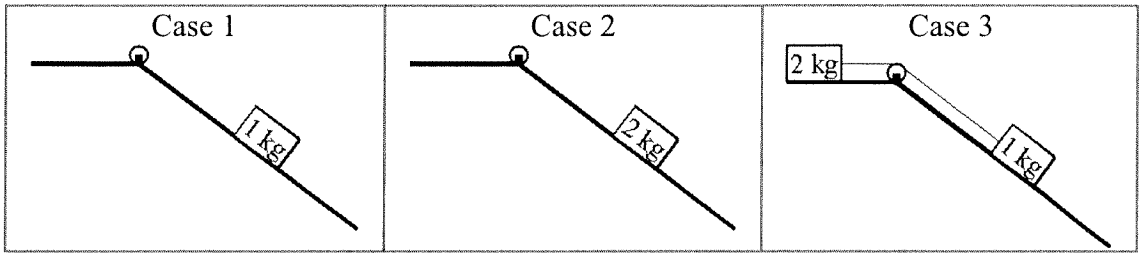


A known mass hangs from a force sensor inside of an elevator. As the elevator moves from the bottom floor to the roof-level of a building, the upward force acting on the mass is recorded as a function of time in the graph shown. Which of the following questions could NOT be answered by the data in the graph and the known mass?

a. What is the acceleration of the elevator as it leaves the ground floor?
b. What is the maximum speed attained by the elevator?
c. What is the approximate height of the building?
d. All of these questions could be answered by these data.

Questions 5-6: The diagrams below show three situations in which one or more blocks are set on a frictionless track. The frictionless track has an inclined section and a horizontal section. A pulley wheel separates these two sections. In Case 1, a 1 kg block is set at rest on the inclined section. Upon release, the 1 kg block has an acceleration of 6 m/s^2.

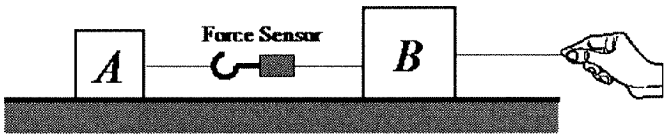


5. In Case 2, a 2 kg block is set on the inclined section and released from rest. What acceleration will the 2 kg block have as it slides down the incline?

   a. 2 m/s^2 b. 3 m/s^2 c. 4 m/s^2 d. 6 m/s^2

6. In Case 3, the 2 kg block is connected to the 1 kg block by a string. The 2 kg block rests on the horizontal section, the 1 kg block is held fixed on the inclined section, and the string passes over the ideal pulley. What acceleration will the system of blocks have the instant that the 1 kg block is released?

   a. 2 m/s^2 b. 3 m/s^2 c. 4 m/s^2 d. 6 m/s^2

7. 

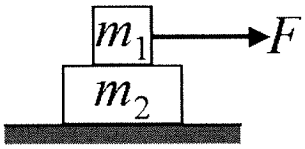
   Block *A* is attached to Block *B*, which is attached to a rope that is being pulled with constant force. There is a very light force sensor between the blocks that is oriented to measure the constant tension force on Block *A* in this case. The student wishes to verify Newton's Third Law. Which of the following should the student also do in order to gather appropriate data to verify Newton's Third Law?

   a. Change the orientation of the force sensor.
   b. Apply the same force on Block *A* in the opposite direction.
   c. Switch Blocks *A* and *B* in the experimental setup.
   d. Replace the rope with a spring.

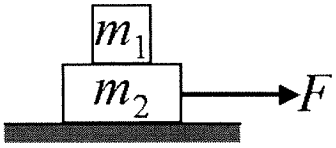
8. A student attempts to explain how a car accelerates forward by saying that "the car's engine exerts a forward force on the car." This statement is

   a. True, because a car without a working engine cannot accelerate forward.
   b. True, because the engine exerts a force on the car's wheels, making them turn.
   c. False, because the engine is not in direct contant with the wheels of the car.
   d. False, because a net force on the car must come from an object or system that is outside of the car.

9.



Case 1



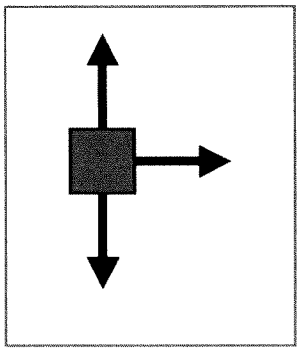
Case 2

A block of mass m_1 is initially at rest on top of a block of mass m_2, also at rest. There is noticeable friction between the blocks, but not between m_2 and the table. In case 1, a force F is applied to m_1, causing both blocks to accelerate and also slip against each other. In case 2, the same force F is instead applied to mass m_2, which again causes both blocks to accelerate and slip against each other. In which case does the acceleration of the m_1-m_2 center of mass have greater magnitude?

   a. Case 1
   b. Case 2
   c. Both the same
   d. Depends on which mass is greater

Directions: Mark two answers for each question.

10.



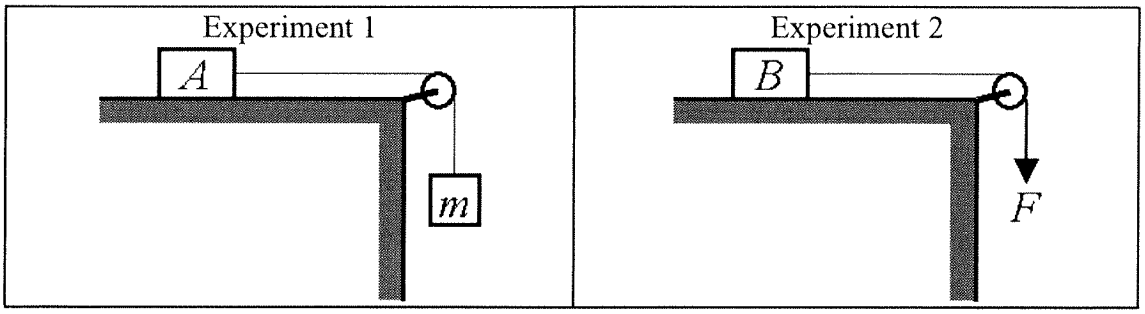
Three forces of equal magnitude act on the box shown. One force is upward, one downward, and one rightward. Which of the following statements must be true based on this information? Select two answers.

(A) The box must have a rightward component of velocity.
(B) The box has no vertical component of velocity.
(C) The acceleration of the box is directed to the right.
(D) The velocity of the box is changing with time.

FREE RESPONSE SECTION

11. (7 Points)

A student performs two experiments using identical boxes A and B. Both boxes are placed on horizontal tables with identical frictional properties and each table is fitted with an ideal pulley at one end. A rope is connected to the box in each experiment and the rope passes over the pulley. In Experiment 1, the free end of the rope is connected to a mass m. In Experiment 2, the free end of the rope is pulled with a force F such that $F = mg$ (the force F is the same strength as the weight of the mass m). Once each system is released, blocks A and B both experience an acceleration.



(a) On the diagrams below that represent block A and the mass m, draw and label forces acting on the blocks once the systems are released from rest and are accelerating. Recall that there is friction between both blocks and the table.

(b) Which block, upon being released from rest, experiences a greater magnitude of acceleration?

___ Block A ___ Block B ___ Both have the same acceleration.

In a well-organized paragraph-length response that may include equations and/or figures, explain your reasoning.

12. (12 Points)
A student is interested in high-performance racing. The student, while learning about high-performance racing, comes across a research document that claims that rubber materials experience a kinetic friction with concrete such that the frictional force is directly proportional to sliding speed.

(a) Would this claim be valid for materials such as wood, glass, and metal? If so, why? If not, why not?

The student wishes to experimentally test this claim. The student obtains a piece of tire rubber shaped like a rectangular prism and a long slab of concrete. The student has access to other materials commonly found in a high-school physics laboratory.

(b) i. What additional materials would the student need in order to perform the experiment?

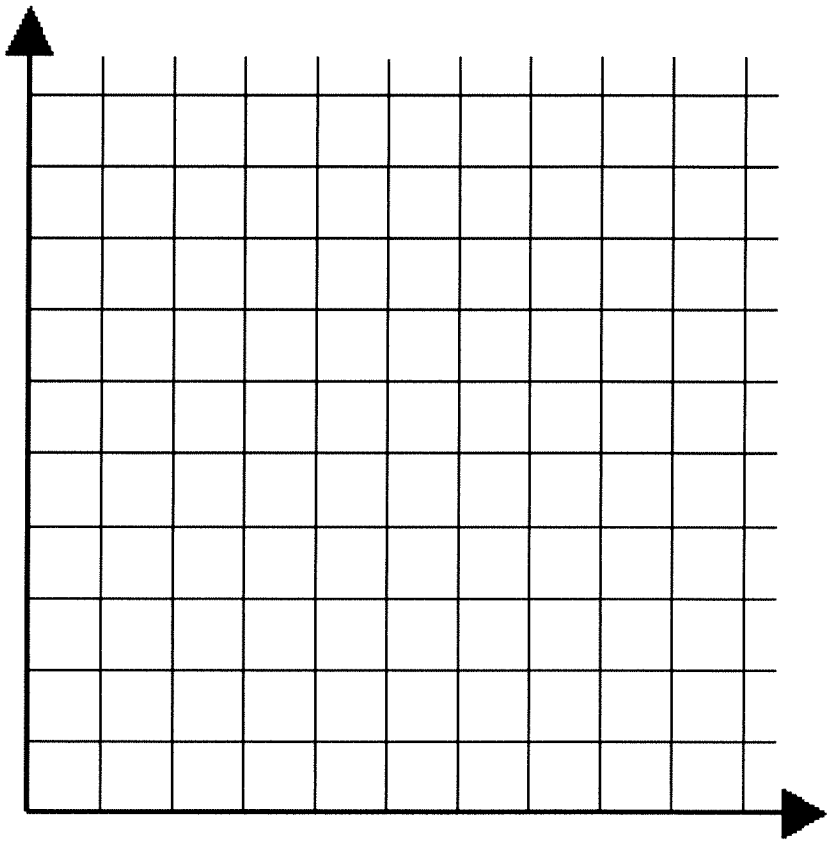
ii. Outline a procedure that the student could follow to collect data that would be needed to test the claim. Be sure to explain how the materials listed above are used to make measurements. Include a labeled diagram.

(c) Explain how the student would analyze the data in order to test the claim.

(d) The data taken by the student are shown below on the data table.

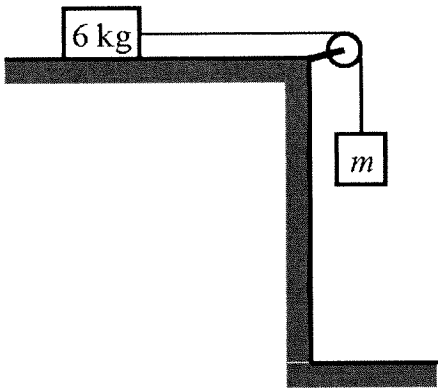
Sliding Speed (m/s)	5.0	10.0	15.0	20.0	25.0	30.0
Frictional Force (N)	1.74	2.76	3.61	4.37	5.07	5.73

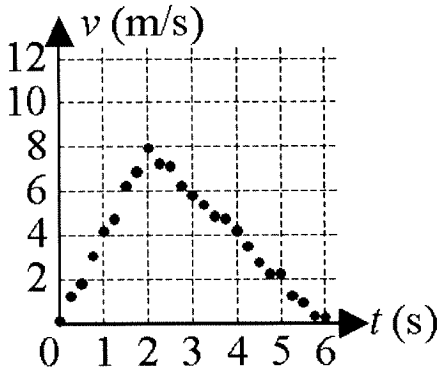
i. Plot the data on the axes below. Draw a best-fit line or curve.



ii. Do the data support the claim that the frictional force is directly proportional to sliding speed? Why or why not?

13. (7 Points)





A 6 kg block is set on a rough table and connected to a hanging mass by a string that passes over an ideal pulley. The system is released from rest at time $t = 0$, and the block speeds up as the mass falls. Once the mass strikes the floor, the block comes to rest again. A student uses measurement apparatus to collect data of the block's velocity as a function of time. The data are shown in the graph above right.

Calculate each of the following. For each part, explain how you use the graph and given information along with physical principles to make your calculation.

(a) The strength of the friction force acting on the block as it slides

(b) The strength of the tension force of the string after the system is released but before the hanging mass strikes the floor

(c) The amount of hanging mass