

Physics 161, Homework 4
Due 12:00 pm, Friday, March 14; No Exceptions
Lubna Rana, Sections 0201-0206

Read Chapter 5 by Monday, March 10; Start Ch 6 after that. Also, make sure you do *all* example problems in the chapter.

Short Answer Questions: S1, S2, S3, S4, S5: Problems P1 = Serway & Beichner Ch 5, P58, P2, P3, P4, P5.

Special Note: Please always:

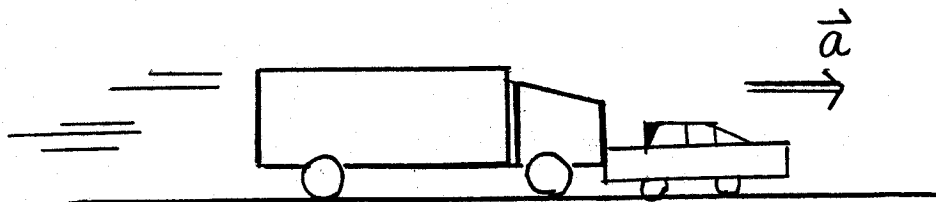
- 1). PRINT your name and SECTION NUMBER CLEARLY on the front page of your HW. Failure to do so will now cost you points.
- 2). STAPLE all your pages. It is your responsibility to make sure that your hw gets submitted in one piece.
- 3). DO ALL THE PROBLEMS IN ORDER.
- 4). Show complete work and write logically consistent explanations for ALL PROBLEMS to receive credit.
- 5). Write units next to all dimensionful quantities.

Short Answer Questions _____

S0a). Make sure you have read the special notes 1-5 above.

S0b). **A Note on Free-Body Diagrams:** The following problems all demand a neat and carefully drawn free body diagram. Remember that a free body diagram *isolates* each object of interest and shows forces acting only on it. In addition, an indication of your choice of coordinate system somewhere close to the free body diagram reduces the chance of mistakes.

S1). A large truck with mass m_1 pushes on a disabled car with mass $m_2 < m_1$, giving it a forward acceleration a . Each vehicle exerts a force on the other as a result of their contact interaction.

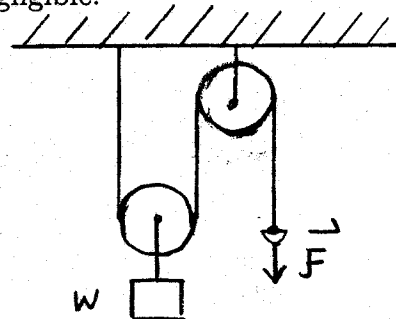


- a). Which vehicle exerts a greater force on the other?
 b). What is the *magnitude* of the force that the car exerts on the truck?

S2). Imagine that a person jumps off the floor. Draw free-body diagrams of the earth and the person at some instant while the person is beginning the jump (but hasn't yet left the floor). List the pair of forces (if any) are third law partners and explain your reasoning.

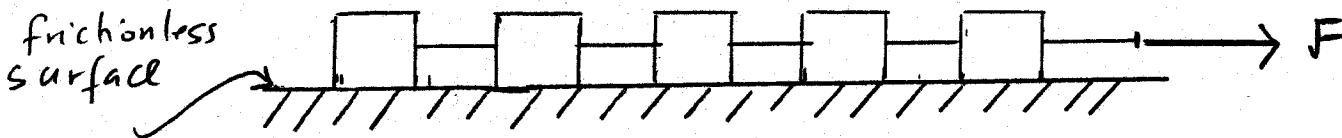
S3). The Figure shows a block of weight w suspended from one end of a rope passing over a pulley and then over a fixed pulley. (The masses of the rope and the pulley are negligible, and the friction forces are also negligible.

- a). What must be the magnitude of the downward force which a person must apply to the free end of the rope so as to keep the block suspended at rest.



- b). Through what distance must the person pull this rope in order to lift the block up by 1 meter.

S4). Consider the situation in which a line of identical objects connected to each other by "massless strings" is being accelerated by a force applied at one end as shown:



How does the net force acting on each successive object compare with the net force on the object to the right?

S5). A car travels at constant velocity along a level straight highway. Draw an accurate free body diagram for the car. Do not ignore air drag.

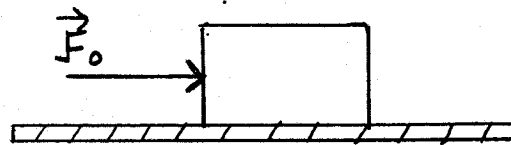
Problems

P1). Serway & Beichner Ch 5, Problem 58 (pg 146).

P2). **Friction force exerted on a box:** A box which has mass of 2.0kg , lies at rest on a horizontal table. Its coefficient of static friction with the table is 0.60 , its

coefficient of kinetic friction is 0.40. A person pushes on this box with a horizontal force of magnitude F_0 , as indicated in the figure below:

- a). Suppose that a force which has a magnitude $F_0 = 10N$ is applied at $t = 0$.



(1) What then is the magnitude of the friction force exerted on the box by the table?

(2). Is the resulting acceleration of the box zero, to the right, or to the left?

(3). Is the resulting velocity zero, to the left, or to the right?

b). At a short instant $t = t_b$ later, the person increases the magnitude of the applied force so that $F_0 = 13N$. What now are the answers to the questions in part (a)?

c). At time $t = t_c > t_b$, the person decreases the magnitude of the applied force to its previous value $F_0 = 10N$. What now are the answers to questions in part (a)?

P3). Block at rest on the side of a pushed cart:

Fig P3 shows a cart pushed to the right along the horizontal floor. A small block B is in contact with the vertical right side of the cart. The coefficient of static friction between this block and the side of the cart is μ_s . The claim is that if the cart is pushed with a large enough force and its acceleration is large enough, the block can remain at rest relative to the cart without falling off.

- a). Before answering parts (a) and (b), first figure out what required to keep the block from falling. In other words, which force must be large enough to prevent the block from falling.

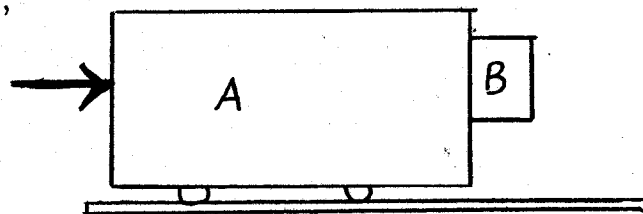


Fig P3.

b). How large must be the acceleration?

You are allowed to use the following quantities in your final answer for a: g , μ_s , m_A and m_B , although you may or may not need all of them.

c). If m_B is larger, is the required acceleration larger, smaller or the same?

P4). Box lying on an accelerating truck:

A box of mass M lies on the floor of a truck, as indicated in Fig P4. The coefficients of static and kinetic friction between the box and the truck's floor are μ_s and μ_k respectively.

a). When the truck speeds up after starting from rest, what is the direction of the friction force exerted on the box by the floor of the truck?

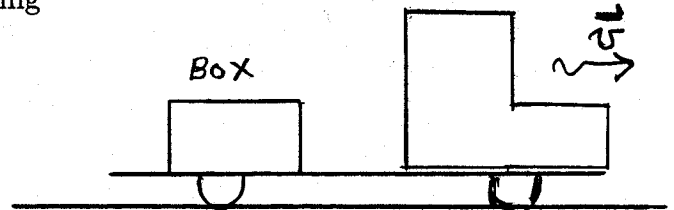


Fig P4.

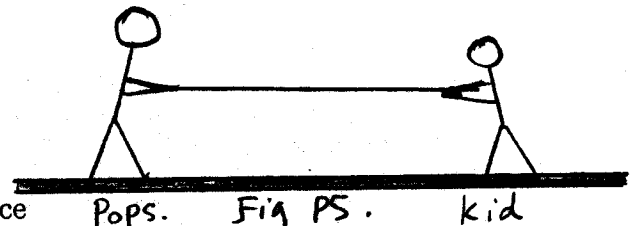
b). What is the maximum permissible magnitude of the truck's acceleration (relative to the road) so that the box does not slide relative to the floor of the truck? Express your answer in terms of specified quantities and g .

c). Suppose that $\mu_s = 0.30$ and $\mu_k = 0.25$. If the box has a mass of 25kg , what is the maximum numerical magnitude of the permissible acceleration?

d). If the mass of the box is less than 25kg , would the maximum permissible magnitude of the truck's acceleration be larger, smaller, or the same as in the previous case?

P5). Tug of War A father and his son, standing on level ground, engage in a tug of war by pulling on a horizontal rope, as shown in the figure. The father has a mass of 10kg and the son has a mass of 30kg .

a). Suppose that the father and the son both stay at rest relative to the ground.



1). How does the magnitude of the force exerted on the rope by the father compare with the magnitude of the force applied by the son? Explain.

2). How does the magnitude of the force exerted on the father by the rope compare with the force exerted on the son by the rope? Explain.

3). Is the magnitude of the force exerted on the boy by the rope larger than, smaller than or equal to the magnitude of the horizontal force exerted on the boy by the ground? Why?

4). Is the magnitude of the force exerted on the father by the rope larger than, smaller than or equal to the magnitude of the horizontal force exerted on the boy by the ground? Why?

b). Suppose that the father remains at rest relative to the ground but pulls hard enough to accelerate the rope and the boy towards him. Answer the same questions as in part (a).