

Physics 161, Homework 6
Due 12:00 pm, Friday, April 4; No Exceptions
Lubna Rana, Sections 0201-0206

Read Chapter 7, Sections 7.1-7.5 by Monday, March 31. Make sure you do all the example problems in the chapter.

Short Answer Questions S1, S2, S3, S4, S5, S6; Problems P1 = Serway & Beichner Ch 7, P6; , P2, P3 = S & B Ch 7, P36; P4

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 questions and problems to receive credit.
- 5). Write units next to all dimensionful quantities.

Short Answer Questions: _____

S1. Understanding Newton's Second Law. The following problem is meant to remind you of the true meaning of Newton's Second Law. N2 says that a net force acting on an object causes an *acceleration* i.e., **a change in velocity**. It is not in general true that an object *moves* in the direction of the net force. The touchstone problem is the one with water in the bucket which doesn't spill even when inverted if its going around in a circle but does spill out of an inverted bucket at rest.

a). Suppose that the velocity of an object at some instant is zero but the total force on it is not zero. Is the object's velocity at a slightly later time then directed along the net force, opposite to it or neither?

b). Suppose that the net force acting on an object is directed *along* the object's velocity (fig S1(b)). At a slightly later time, is the magnitude of the object's velocity larger, smaller, or unchanged? Is the direction of this velocity the same or different? Indicate this velocity by a labeled arrow.

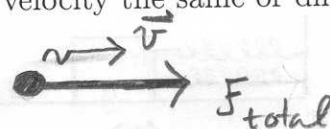
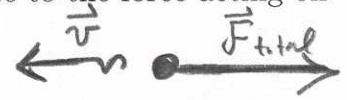


fig S1(b)

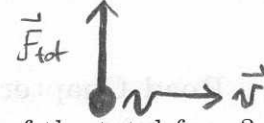
c). Suppose that the velocity of an object is directed opposite to the force acting on it (fig S1(c)). Answer the same questions as in part (b).

fig S1(c).



d). Suppose that the velocity of an object is directed *perpendicular* to the total force on it (fig S1(d)). Answer the same questions as in part (c).

fig S1(d).



e). Summary: Does an object always *move* in the direction of the total force? Does an object always *accelerate* in the direction of the total force?

S2). Suppose that two vectors \vec{A} and \vec{B} are such that $\vec{A} \cdot \vec{B} = 0$. (a). Is it necessarily true that either $A = 0$ or $B = 0$? (b). If neither \vec{A} nor \vec{B} is zero, what must be the angle between \vec{A} and \vec{B} ? (c) Give an example of a situation where neither the force acting on an object nor its displacement are zero but the work done by that force is zero.

S3). A stone A is thrown horizontally from the top of a cliff overlooking the ocean. Another stone B is thrown from this cliff with the *same* speed, but at an upward angle as shown in Fig S3. Assume air resistance to be negligible.

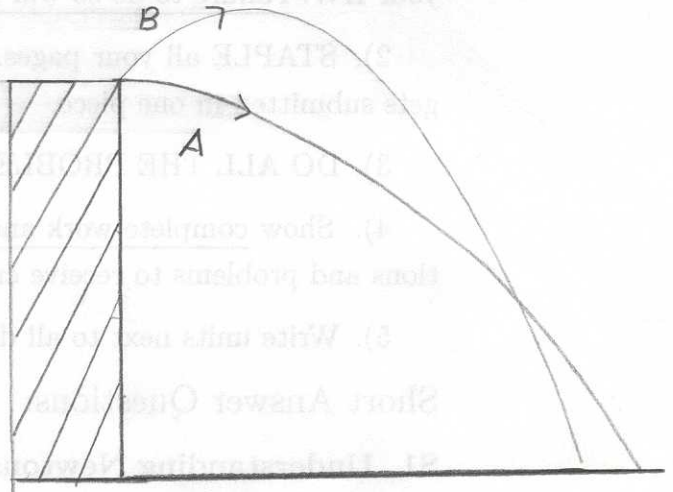


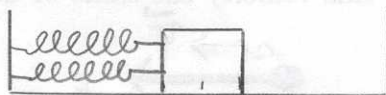
fig S3.

a). Is the speed with which stone B hits the water larger than, smaller than, or equal to the speed with which stone A hits the water. Why?

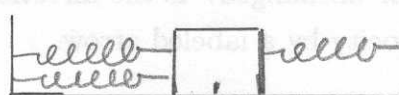
b). Is the magnitude of the vertical velocity component with which stone B hits the water larger than, smaller than or equal to the magnitude of the vertical velocity component with which stone A hits the water? Why?

S4). Fig. S4 shows three arrangements of a block attached to identical springs that are in their relaxed state when the block is centered as shown.

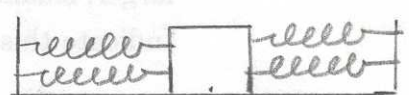
Fig S4.



(1)



(2)



(3)

(a). Rank the arrangements according to the magnitude of the net force on the block, largest first, when the block is displaced by distance d (i) to the right and (ii) to the left.

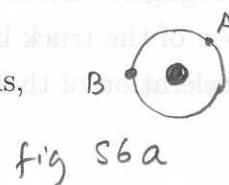
b). Rank the arrangements according to the work done on the block by the spring forces, greatest first, when the block is displaced by distance d (i) to the right and (ii) to the left.

S5). Spring A is stiffer than spring B, that is $k_A > k_B$. The spring force of which spring does more work if the springs are compressed (a) the same applied force.

S6). Artificial satellites can move in various orbits around the earth while they are acted on by the gravitational force due to the earth. a). Suppose a satellite moves around the earth in a circular orbit such as that shown in fig S6a.

i). As the satellite moves from point A to B newline along its orbit, is the work done on the satellite by the earth's gravitational force positive, negative or zero?

ii). According to the work-kinetic energy equations, does the speed of the satellite increase, decrease or remain unchanged.



b). Answer questions (i) and (ii) above for the elliptic orbit shown in fig S6b.

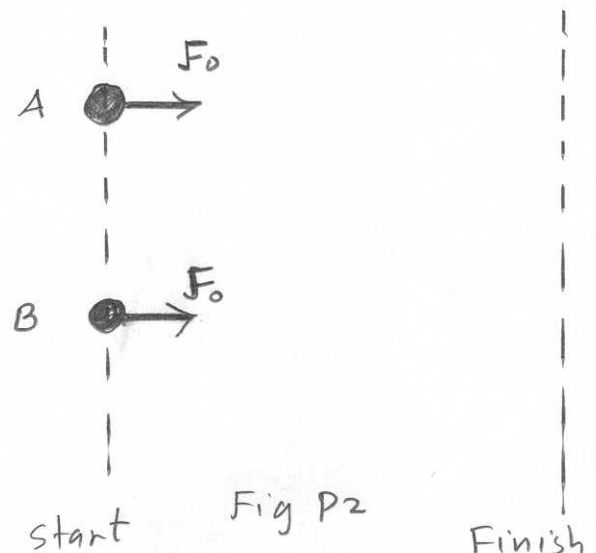
Problems:

P1). Serway & Beichner, Chapter 7, Problem 6.

P2). Two pucks A and B are at rest on a level frictionless table. $m_B = 3m_A$. At $t = 0$, both pucks are located at the first dotted line as shown in Fig P2. The same constant force is exerted on each puck until each one crosses the second dotted line.

a). Compare the kinetic energy of the two pucks at the instant each one passes the second dotted line.

b). At the instant each puck crosses the second dotted line, find the ratio of their speeds v_B/v_A .



- c). Which one crosses the second dotted line first? Or do they both arrive at the same time?

P3). Serway & Beichner, Chapter 7, Problem 36

P4). Fig. P4 shows a truck, of mass M , sitting at rest on horizontal ground. A flexible cable, attached to the truck, passes over a pulley A fastened to the edge of a pit, passes over a movable pulley B, and has its other end attached to a ledge. (The cable and pulley have negligible masses and friction is also negligible. Bags of gravel can be attached to the movable pulley B.

- a). What must be the magnitude of the force exerted by the truck's cable while a bag of mass m is being lifted up from the pit with constant speed?
- b). Now suppose that before the bag is attached to the pulley the truck is at rest with its engine off and doesn't have its brakes on. Assume that the truck is free to roll with negligible friction on the horizontal ground. What would be the resulting acceleration of the truck if a bag of mass m is attached to the pulley B. What would be the acceleration of the bag? Express your answers in terms of m , M , and g .

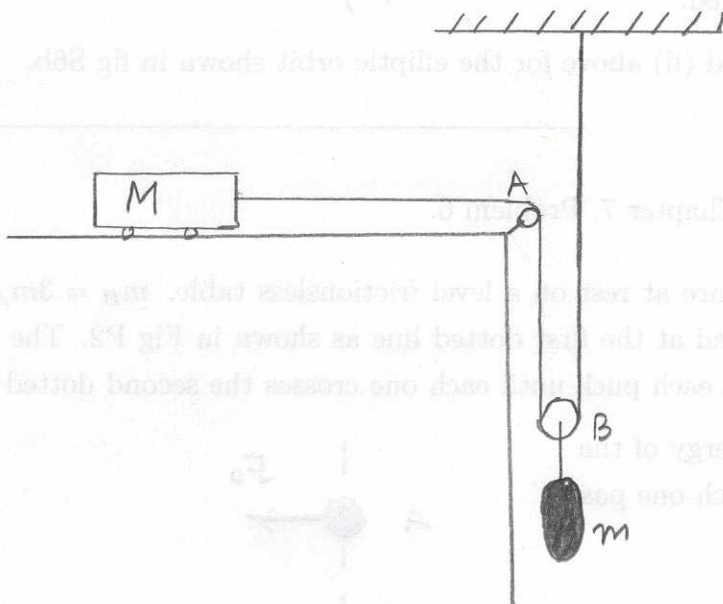


Fig P4.