**Assignment V, HONS 157 (Honors Physics I)**
**Fall 2015**
**Due 9/25/15 at start of class**

As always, please put your answers on separate paper.

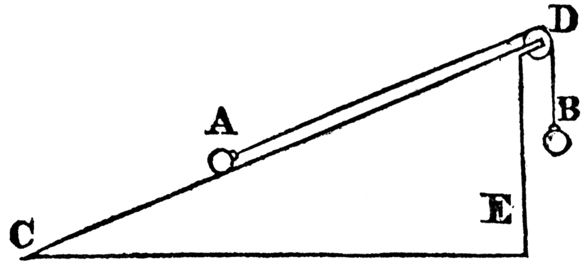
Note, you have a test coming up pretty soon. Though there are only a few problems that you have to turn in for this homework assignment, I *highly* suggest doing enough extra problems on your own that you are very comfortable with this material prior to the exam. In particular, I recommend you work as many problems as you can from chapters 2, 4, 5, and 6 from your text.

1. (Adapted from your text). An elevator is pulled upwards by a cable. The elevator with its single occupant have a combined mass of 2300 kg. When the occupant drops a pen, the pen's acceleration relative to the elevator is 7.40 $m/s^2$ downwards. What is the tension in the cable?

2. Watch the following two videos. (The version of the document on the course webpage has clickable links).
https://www.youtube.com/watch?v=JYtfq6qRrh8
https://www.youtube.com/watch?v=nDKGHGdXLEg
The two videos seem to contradict each other. Explain (in enough detail to be unambiguious) which video is wrong/misleading.

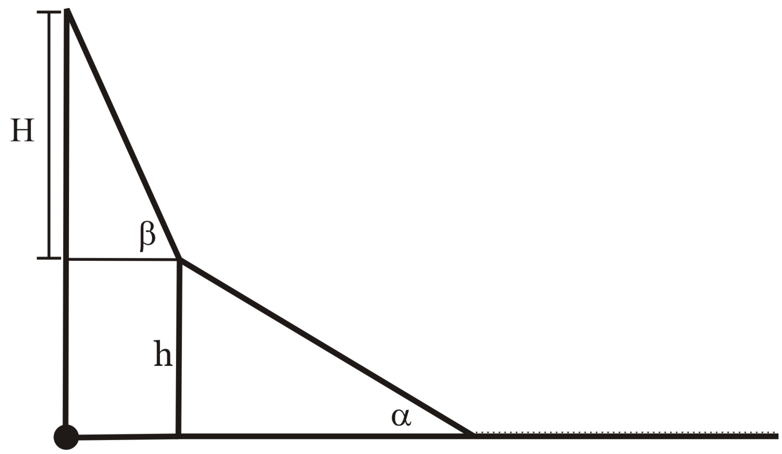
3. A mass of 10 kg is placed on an inclined plane. The largest angle the plane can make with respect to the horizontal without the mass moving is 24°.

    a) What is the coefficient of static friction between the plane and the mass?
    b) If the plane continues to have an angle of 24°, but a rope/pully/mass setup is connected to the mass on the plane, pulling it up the slope (as in the figure). What is the largest mass one could place at B so that the 10 kg mass at A still would not move?
    c) If the coefficient of kinetic friction was half the coefficient of static friction, what would be the acceleration of the 10 kg mass at A if a 12 kg mass was put at B?




4. The Earth orbits the sun once per year in an orbit that is approximately circular. What is the magnitude of the force that the sun must exert on the Earth to keep it in this orbit? (You likely will have to look up the mass of the Earth and the Earth-sun distance).

5. Examine the figure below. Let $H = 15$ m, let $h = 10$ m, let $\beta = 65°$ and $\alpha = 40°$. The surface of both wedges are frictionless, and the system is place on flat ground. Let the circle in the bottom left hand corner of the schematic be the origin.



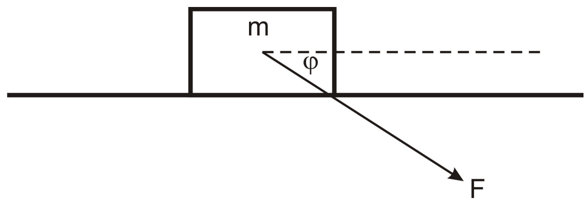

a) What is the horizontal distance between the origin and the end of the second wedge (where the angle $\alpha$ is marked)?

b) If a block of mass 12 kg is released from rest from the top of the upper wedge, what is the magnitude of the normal force on the block from the wedge when the block is halfway down the upper wedge?

c) If a block of mass 12 kg is released from rest from the top of the upper wedge, what is the speed of the block when it reaches the bottom of the lower wedge?

d) Assume that the flat ground the block slides on after leaving the wedges applies a constant frictional force of 30 N while the block continues to move. (This frictional force does not apply while the block is on the wedges). Ultimately, this frictional force will cause the block to come to rest some distance after sliding off the wedge. How far from the origin (in the lower-left corner of the figure) is the block when it comes to rest?

6. Examine the figure below. A box of mass $m$ is being dragged via an applied force of angle $\varphi$ below the horizontal. The coefficient of static friction between the box and the surface is $\mu_s$.



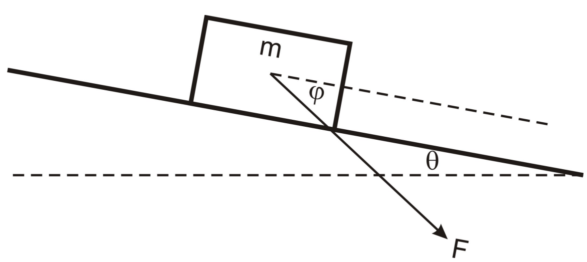

   a) If $m = 30$ kg, $\varphi = 25°$, and $\mu_s = 0.4$ – find the minimum magnitude of the force $F$ that will cause the box to move.

   b) Show that, for arbitrary $\mu_s$, $m$, and $\phi$, the minimum force required to move the box is given by the following expression:

$$F > \frac{\mu_s mg}{(\cos\varphi - \mu_s \sin\varphi)}$$

   c) Although it may not initially be obvious, there are some angles $\varphi$ for which it would be impossible to move the box at all, no matter how big $F$ is. (For example, with $\varphi$ near 90°, most of the applied force goes into increasing the normal force of the table onto the box, which allows the static frictional force to keep pace with any horizontal component of $F$ that attempts to move the box to the right.) Find an expression that identifies the critical angle $\varphi_\circ$ where it would take an infinite amount of force to move the box. (Any angle between 0 and $\varphi_\circ$ could move the box, if $F$ were large enough).

7. (Extra Credit). Examine the figure below. Derive a formula similar to the one in part (b) of the previous problem that identifies the minimum force required to pull the box down the incline. Again, assume that the box has mass $m$ and that the coefficient of static friction between the box and the surface is $\mu_s$. (As a check, your answer should match part (b) in the previous question when $\theta = 0$).



Additional recommended problems (for studying for the exam). (most of these are a little easier than exam problems will be). (Working more is always a good idea. There's nothing overly special about these, other than the fact that I read them and they looked ok to me).

- Chapter 1: 9, 19, 22, 30,53
- Chapter 2: 4, 11, 22, 27, 32, 41, 54, 83
- Chapter 3: 9, 18, 30, 64
- Chapter 4: 16, 28, 32, 38, 51, 62, 89, 108
- Chapter 5: Problems I already worked for you (3,6,10,14,18,26,32,36) + 42, 44, 51, 54, 57, 73, 87
- Chapter 6: 6, 9, 15, 30, 33, 36, 44, 57, 69, 86