Assignment VI, PHYS 101 (Introductory Physics I)
Fall 2020
Due via pdf upload to OAKS prior to Thursday, October 15th at 9:25 AM

General instructions:
For this, and all other homework assignments, please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units. As always, if you have questions feel free to email me or send me a DM in the slack.

Suggested additional (ungraded) practice problems (Chapter 6): https://openstax.org/books/college-physics/pages/6-problems-exercises
Problems from sections 6.1, 6.2, 6.5

1. A giant flat circular disk of radius $R = 3.0$ m floats frictionlessly on the surface of a pond.

   a) When you first see the disk, it is completing 35 revolutions per minute. What is its angular velocity (in radians per second).

   b) By gently touching the top of the rotating disk, you can apply a "braking" effect, inducing an angular acceleration of -1.24 rad/s^2. If you do this, how long does it take the disk to completely stop spinning after you begin to touch it?

   c) Using the same "braking" method described in part (b) above, what is the total angular distance traveled (in *ROTATIONS*) between when you first started touching the disk and when it stopped spinning? (Your answer will not come out to an integer, so round your answer to the nearest hundredth of a rotation.)

   d) Before you started slowing down the disk, what was the centripetal acceleration of a point on the disk's outermost edge?

   e) Exactly 1.0 second after you started slowing the disk down, what was the tangential velocity at a point 1.3 meters from the center of the disk?

2. A dentist's drill can rotate pretty fast. Let's say that there is a circular "polishing disk" on the end of the drill that has a radius 4.0 mm. How many rotations per minute would the drill have to operate at so that the outer edge of the disk moves faster than the speed of sound? (Take the speed of sound to be 343 m/s).

3. The Earth's rate of rotation is very gradually slowing down. In 100 years, the duration of a day (a full rotation of the earth) has increased by about 0.85 s. Assuming the Earth's rotation continues to decrease at a constant rate, how long will it be (in current Earth years) until a day is 25 current Earth hours long?

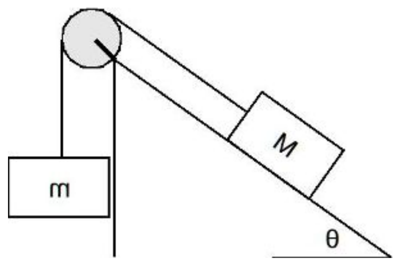
4. Jupiter has a mass of about 1.898×10^{27} kg. The sun has a mass of about 1.989×10^{30} kg. The average Jupiter-Sun distance varies a bit during Jupiter's orbit, but averages about 7.785×10^{11} m.

   a) There is a point somewhere between the sun and Jupiter where the gravitational pull from the Sun is exactly balanced by the gravitational pull from Jupiter in the opposite direction. How far from the center of Jupiter is this point? (where the Sun and Jupiter's gravitational pulls are equal and opposite?)

   b) There is another point – somewhere on the other side of Jupiter (further from the sun) where the gravitational pull from the Sun is exactly the same magnitude AND the same direction as the gravitational pull from Jupiter. (Essentially, Jupiter and the Sun pull objects at this point towards Jupiter with the same force). At that position, how far would an object released from rest at that point fall towards Jupiter in 1 minute?

The point of the problem below is to reinforce the notion that information that you have learned already by using Newton's Laws can be re-created by changing to an energy perspective. Thus, we are going to work this problem two different ways. To earn full credit on this problem, it is imperative that your work is clear because I am trying to help you see for yourself that you can get the same answer by completely independent means. TL;DR version – MAKE SURE TO SHOW ALL YOUR WORK ON THIS PROBLEM!

5. Consider the following set-up which, by now, is likely probably familiar – you have a crate of mass $M = 15$ kg on an inclined plane of wedge-angle 57°, attached by a frictionless, massless, and inextensible string to another mass of mass $m = 3$ kg. The coefficient of static friction between the wedge and the crate is 0.3 and the coefficient of kinetic friction between the wedge and the crate is 0.2.



a) Using your skills from previous assignments, determine all of the following: (i) the acceleration of mass M down the incline, (ii) the Tension in the string, (iii) the magnitude of the normal force on the crate of mass M, (iv) the frictional force on the crate of mass M,(v) the x (down-slope) component of the gravitational force on the crate of mass M, and (vi) the y (perpendicular to the slope's surface) component of the gravitational force on the crate of mass M.

b) Assuming that the crate starts with an initial down-slope velocity of 2.3 m/s and using your computed acceleration in part (a) above, determine the velocity of the crate 3.4 seconds later. (Assume the plane is physically long enough that the crate stays on the wedge surface the whole time).

c) Assuming the same scenario as outlined in part (b) above, determine how far the crate moves in that 3.4 seconds.

d) Calculate the work done by the down-slope component of the gravitation force on the crate over that distance computed in part (c)

e) Calculate the work done by the frictional force over the distance computed in part (c)

f) Calculate the work done by the tension over the distance computed in part (c)

g) Calculate the work done by the normal force over the distance computed in part (c)

h) Calculate the work done by the y (perpendicular to the slope's surface) component of the gravitational force on the crate of mass M over the distance computed in part (c).

i) Add up all of your answers to parts (d-h) to determine the total net work done on the crate in moving from its initial to final location.

j) Knowing that the total work done is the change in the kinetic energy, use energy considerations and your answer to part (i) to determine the final velocity of the mass M after 3.2 seconds. (Your answer SHOULD match your answer to part (b)).