Assignment VII, PHYS 101 (Introductory Physics I)
Fall 2020
Due via pdf upload to OAKS prior to Thursday, October 22nd 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/7-problems-exercises
Problems from sections 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8

1. One of the reasons that Physicists spend a lot of time talking about springs is that it turns out the general behavior of a spring (force being proportional to distance from equilibrium and potential energy being proportional to the distance from equilibrium squared) is really common for things that – at least initially – don't seem like springs. If someone who is 90 kg stands on a book, the book might compress just a little bit. If the book compresses by 3 mm from that compression, what is the effective spring constant of the book?

2. A toy consists of a piece of plastic attached to a spring. The spring is compressed 3.00 cm and the toy is released. If the mass of the toy is 180 g and it rises to a maximum height of 85 cm, find the force constant of the spring.

3. Remember the projectile motion lab (with the cannons)? Let's say that when firing the ball bearings, the projectiles left the cannon moving at 5.2 m/s. Let's also say that the projectiles had a mass of 23 g (a total guess on my part).

   a) How much kinetic energy did the projectile have upon leaving the cannon?

   b) If the spring was compressed 4.6 cm to obtain the energy required to launch the projectile, what was the spring constant of the spring? (You may assume – though it isn't really true – that all of the spring energy went into kinetic energy of the projectile).

   c) If the spring needed to be compressed 4.6 cm to launch the projectile, how much force did you need to apply in order to load the cannon?

   d) If the higher setting (with the same spring) launched the projectile at 8.4 m/s, how far did you have to compress the spring for this setting?

4. A block of mass $m = 3.0$ kg is dropped from height $H = 72$ cm onto a spring with spring constant $k = 3100$ kg/s^2. What is the maximum compression of the spring beyond its equilibrium position? (You may assume the block starts interacting with the spring at floor-level, so the height of the spring is not a consideration). Hint – be careful; if you define the floor to be the position where gravitational potential energy is zero, then the gravitational potential energy is *not* zero when the spring is compressed!

5. A 4.2 kg block is accelerated from rest by a compressed horizontal spring of spring constant 732 N/m. The block leaves the spring at the moment the spring returns to its relaxed (equilibrium) length and then travels over a horizontal floor with a coefficient of kinetic friction $\mu_k = 0.17$. The frictional force stops the block in distance $D = 11.2$ m.

   a) What is the total work done by friction?

   b) What is the maximum kinetic energy of the block?

   c) What is the original compression distance of the spring?

   d) What was the initial velocity of the block right after breaking contact with the spring?

   e) What is the velocity of the block when it has traveled $D/2 = 5.6$ m from the spring?

6. Do two different observers necessarily agree on the kinetic energy of an object? Why or why not? If your answer is "no", give me an example of a scenario where two observers would disagree on the kinetic energy of an object.

7. A typical power-supply that runs a high-end desktop computer might use 750 Watts of power. The current average cost of electricity in South Carolina is 12.71 cents per kiloWatt-hour. Based on this, how much would it cost to leave this computer on non-stop for a year?

8. A 60W incandescent light bulb costs about \$1.50 and uses 60W of power when on. Amazon has a 4-pack of LED light bulbs that give off the same amount of light but only use about 9W of power at a unit price of \$3.65 each. Assuming electricity costs 12.71 cents per kiloWatt hour, how many hours would you have to use the light-bulb to hit the break-even point for these two options? (If you use the bulbs for longer than the break-even point, the LED light ends up being more affordable because you save more in electrical costs than the difference in purchase prices).