Physics 1010 Homework 6 (22+ points)
Due by midnight on Monday Oct 15

1.) [2pts] HW Correction: Each week you should review both your answers and the answer key for the previous week's homework. Often (including this week) you will get to submit one homework correction. Select one problem for which you had the wrong answer. In the text box below, 1) identify the question number you are correcting, 2) state (copy) your original wrong answer, 3) explain where your original reasoning was incorrect, the correct reasoning for the problem, and how it leads to the right answer. If you got all the answers correct!!! bling bling... state which was your favorite / most useful homework problem and why.

2.) [0.5pt] Review Bernoulli's equation and perhaps helpful, visit the Fluid simulation (http://phet.colorado.edu/en/simulation/fluid-pressure-and-flow) for the following few questions.

If you have a beaker (or reservoir) of stationary water that is open at the top, what happens to the pressure as you drop further down in the liquid (e.g. what happens if you're a scuba diver in the beaker)?

a) pressure is constant
b) pressure increases
c) pressure decreases
d) can't tell

3.) [0.5pt] What happens if you stay at the same depth, maybe half way down, in the beaker/ reservoir, but replace the water with something that is more dense (say honey). What happens:

a) pressure is constant
b) pressure increases
c) pressure decreases
d) can't tell

4.) [1pt] Why?

5.) [0.5pt] What happens to water that flows out of a pipe at constant pressure (or constant flow rate), and then enters a restriction in the pipe (e.g. goes from a fat pipe to a thin pipe, but the pressure in the fat part of the pipe stays the same):

a) it stays at the same pressure and velocity
b) the velocity goes up and the pressure goes down
c) the velocity goes down and the pressure goes up
d) the velocity goes up and the pressure goes up
e) the velocity goes down and the pressure goes down

6.) [1pt] Explain this in terms of Bernoulli's equation.

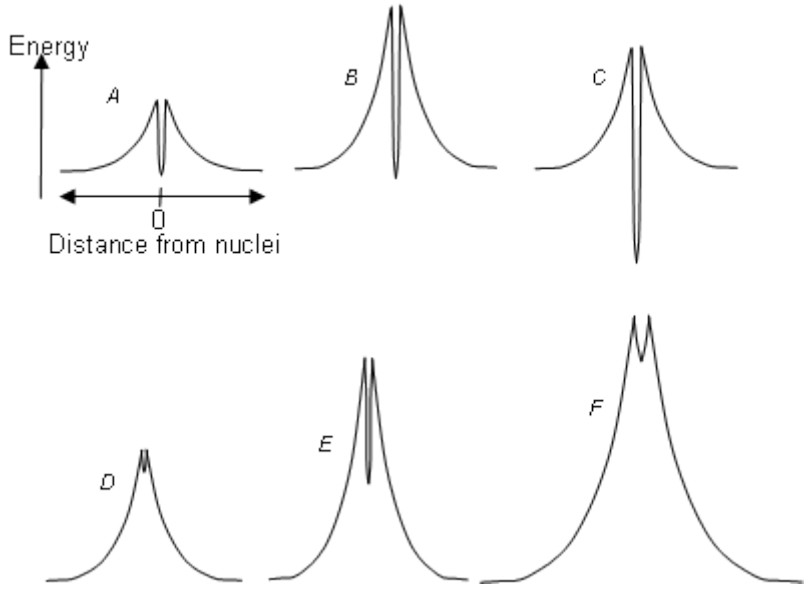
7.) [**3pts**] Come up with a neato (nifty or cool) experiment to do with the water tower simulation, and describe it and how it demonstrates some principle about energy conservation / bernoulli's equation. Be sure to state the physical scenario, hypothesis, the nature of the experiment, what variable(s) you are change (and which stay fixed), and the evidence to confirm or refute the hypothesis.

8.) [0.5pt] In the fusion of a deuterium nucleus (one proton, one neutron) with a tritium nucleus (one proton, two neutrons), the deuterium nucleus must have enough initial kinetic energy to overcome the repulsion force due to the electrostatic interaction as the two nuclei get close together.

As the deuterium nucleus approaches the tritium nucleus, but before it collides with it, the energy of the deuterium atom is converted from one form to another. What happens?

a) electromagnetic energy is converted to electrostatic potential energy
b) electrostatic potential energy is converted to kinetic energy
c) kinetic energy is converted to electrostatic potential energy
d) gravitational potential energy is converted to electrostatic potential energy
e) kinetic energy is converted to thermal energy
f) electrostatic potential energy is converted to nuclear energy

Questions 9-19: As we have discussed in class, potential energy curves are a useful tool for making sense of nuclear processes such as alpha-decay, fission, and fusion. The potential energy curve for each different type of nucleus is different and depends on the number of protons and neutrons. Below are plots of the potential energy as a function of the distance from the center of the nuclei for several atoms:



9.) [1.5pts] Describe why the potential energy curve for a nucleus has this type of shape. If you'd like you can discuss this in the context of the energy of a proton that starts out traveling towards the nucleus at a fast clip, and thinking about what forces the proton is feeling as it approaches, and how this is affecting its speed and its potential energy. Remember the graph is representing the potential energy only.

Questions 10-19: Examine the curves above and decide on the following:

10.) [0.5pt] Which of these nuclei has the largest number of protons?
A B C D E F

11.) [0.5pt] Which of these nuclei has the smallest number of protons?
A B C D E F

12.) [0.5pt] For which of these nuclei does it take the most energy to add another proton?
A B C D E F

13.) [0.5pt] Which nucleus would release the most amount of energy if fissioned?
A B C D E F

14.) [0.5pt] Which nucleus would likely undergo alpha-decay the soonest?
A B C D E F

15.) [0.5pt] Which of these nuclei is the most stable?
A B C D E F

16.) [0.5pt] Which atom would release the most energy if undergoing fusion with a deuterium atom?
A B C D E F

17.) [1pt] Explain the physics principles and reasoning behind your answer to Question 10.

18.) [1pt] Explain the physics principles and reasoning behind your answer to Question 13.

19.) [1pt] Explain the physics principles and reasoning behind your answer to Question 14.

20.) [0.5pt] True / False – An alpha particle is a type of photon.

21.) [0.5pt] True / False – During a radioactive decay event, the radioactive atom vanishes as a high-energy particle is created.

22.) [0.5pt] True / False – Gamma rays are very high energy photons.

Questions 23-26: Imagine that you are in the very first stages of trying to figure out how to build a nuclear power reactor or a nuclear weapon using fission. The first step you would consider is what kind of nucleus could live for a reasonable length of time so that you could keep it around,

but would also be able to decay by some process that would give off lots of energy.

23.) [1pt] Explain why you could be pretty sure that any suitable isotope would have both a lot of protons and a lot of neutrons. (Be sure this is consistent with your answers to Questions 9-19.)

24.) [0.5pt] In induced fission, a neutron is used to induce fission. Why is a neutron used to induce fission instead of a proton?

25.) [1pt] For this question, play around with the chain reaction panel of the nuclear reaction simulation (http://phet.colorado.edu/en/simulation/nuclear-fission).

Why is the number of free neutrons emitted by U235 important in creating a chain reaction?

26.) [1pt] Why are gamma rays emitted by the daughter nuclei?

Bonus questions 27-28: In the first plutonium bomb a 6.1 kg sphere of plutonium was used and the explosion produced the energy equivalent of 22 kilotons of TNT = 8.8 x 10^13 J. As the textbook says, 17% of the plutonium atoms underwent fission.

27.) [1pt bonus] As a reality check: say you had 1000 light bulbs, each 100 Watts. For how many seconds could you power them given the energy produced from this bomb? And how many years is that?

28.) [1pt bonus] Bonus question: come up with some other comparison of how much energy this is and how long it would last... e.g. this is like 50,000,000 hamsters on a treadmill for 6 days ... and justify your answer.