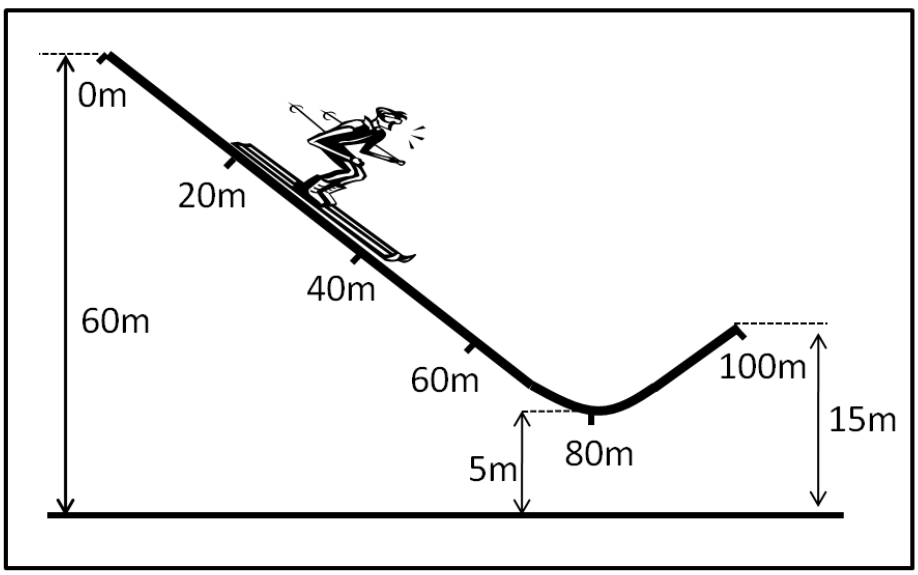
Physics 1010 Homework 5 (23+ points)
Due Monday night 10/8 at Midnight

1.) (2 pts): HOMEWORK CORRECTION ESSAY: Each week you should review both your answers and the answer key for the previous week's homework. Occasionally you will get to correct an essay from a prior week. 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 had no incorrect answers, which problem(s) did you find most useful to your understanding and why?

Note: use $g = 9.8 m/s^2$ throughout this HW

The Ski Jump: For questions 2-15, consider a skier heading down the ski jump shown below. The distances along the ramp are shown. He starts from rest at a height of 60m above the ground, is 5m above the ground at the lowest point and leaves the ramp at a vertical height of 15m. Assume air resistance is zero. Assume that friction is zero for questions 2-12.



NOTE: remember that we only care about *differences* in height for potential energy, not *absolute* height.

2.) (0.5 pt) The ski jumper has maximum KE at the start of the run (T/F)

3.) (0.5 pt) The ski jumper has minimum GPE at the takeoff point (T/F)

4.) (0.5 pt) 'GPE + KE = constant' is true for the skier's motion along the ramp (T/F)

5.) (0.5 pt) What form of energy is maximized at the 80m mark:
KE, GPE, Thermal, none

6.) (0.5 pt) How does the net force acting on the skier at the 20m mark compare with the net force on the skier at the 40m mark:
smaller, bigger, same

7.) (0.5 pt) If we halve the height of the downhill part of the ramp, the speed of the skier at the 80m mark will be:
the same, half, one quarter, one eighth, some other number

8.) (0.5pt) The KE of the skier decreases between 80 and 100m (T/F)

9.) (0.5 pt) Imagine (for this question only) that we changed the shape of the run by adding a large smooth bump around the 20m mark. When the skier hits the take off point after traveling down this new ramp, he will be traveling slower than when he took off from the original bump-less ramp (T/F).

10.) (1 pt) Assuming that the force of friction is negligible, what is the KE of a 100kg skier at the 80m mark? What is her velocity? Show your working. [Hint: is there any work being done? Another hint: how much did the height change?]

11.) (1 pt) How does her takeoff speed (at the 100m mark) compare with her speed at the 80m mark?

a. the same
b. about 10% less
c. about half
d. about a quarter
e. zero

12.) (1pt) Does the takeoff speed of the skier depend on her mass? Explain.

13.) (0.5pt) Realistically, the run isn't frictionless. There will be a small amount of friction between the skis and the snow. So now we will consider the size and effect of this frictional force. How will this impact the maximum speed at take off:

a) takeoff speed will be the same
b) takeoff speed will increase
c) takeoff speed will decrease
d) it depends – can't be determined

14.) (0.5pt) Now that we have included friction in the problem, will this takeoff velocity depend on the mass of the skier?

a. Yes
b. No
c. Can't be determined

15.) (1 pt) Why? (if you're having problems with this, either use the math or the energy skate park phet from the next two problems).

16.) (2 pts) Build two different ramps in the energy skate park simulator that have the same starting and ending point heights – make these ends the highest points of the two tracks:
http://phet.colorado.edu/en/simulation/energy-skate-park

a) Describe the tracks you built
b) Turn friction off… what are the parameters that matter for describing the GPE? KE? does the length of the track matter?

17.) (1 pt) Now turn the friction on…

a) Does the length of the track matter now?
b) Does the mass of the skater matter?

18.) (0.5 pt) What principle is Bernoulli's Equation based on?

a. Conservation of energy for each small volume of water
b. Conservation of force for each small volume of water
c. Newton's second law applied to each small volume of water
d. Conservation of momentum for each small volume of water
e. Conservation of heat for each small volume of water

19.) (0.5pt) Water is flowing steadily through a horizontal pipe. One section of the pipe has half the diameter of the rest of the pipe, and the water speeds up to get through this section. Since the water has accelerated, we also know that the water pressure must be higher in the narrow section (T/F)

20.) (0.5pt) According to Bernoulli's equation, water can only accelerate when it is going downhill (losing GPE) (T/F)

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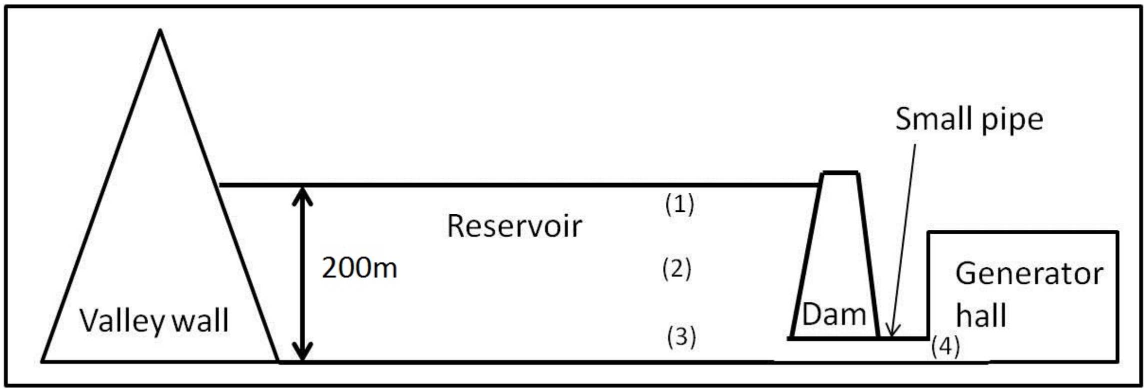
Hydroelectric Power.
Questions 21 – 30 help you understand the basics of generating electricity using water behind dams.
Assume that the reservoir is 200m deep, held back by the dam wall as shown in the picture below (not drawn to scale). A small horizontal pipe at the base of the dam transfers water to the generator hall, where it gushes out at high speed and is used to turn the turbines that generate electricity.



Bernoulli's equation says that an incompressible fluid like water can contain several different types of energy. In Questions 22 – 25, give the main type(s) of energy associated with the water at each point in the hydroelectric system.

21.) (1 pt) Why can I ignore air pressure in this system?

22.) (0.5pt) Main type(s) of energy at bottom of reservoir (position 3):
a. PPE
b. KE
c. GPE
d. Part GPE, Part PPE
e. Part KE, Part PPE

23.) (0.5pt) Main type(s) of energy halfway between surface and bottom of reservoir (position 2):
a. PPE
b. KE
c. GPE
d. Part GPE, Part PPE
e. Part KE, Part PPE

24.) (0.5pt) Main type(s) of energy at surface of reservoir (position 1):
a. PPE
b. KE
c. GPE
d. Part GPE, part PPE
e. Part KE, Part PPE

25.) (0.5pt) Main type(s) of energy at exit of pipe in turbine hall (position 4):

a. PPE
b. KE
c. GPE
d. Part GPE, Part PPE
e. Part KE, Part PPE

26.) (1 pt) What is the speed of the water coming out of the pipe in the generator hall? Note: Use (rho) to represent fluid density in your working, since greek symbols are not readily available in the D2L textboxes.

The National Center for Atmospheric Research has a laboratory located on the Table Mesa in south Boulder. This lab is located high above most of Boulder. Water to the lab is supplied from a big green water tank, which is located on a ridge 300 m west of the lab. The bottom of the tank is 60 m higher than the lab. (You can see it if you hike up there.)

27.) (0.5 pt) Why does NCAR get its water supply from a tank rather than the water mains pipe like the rest of us in Boulder?

a. Outside range of city water mains – it is getting water supply from a spring that feeds the tank
b. Tank ensures a steady and decently high water pressure in a building that sits way higher than the rest of town
c. Historical reasons – if NCAR were built today it would get its supply straight from the water mains in town
d. Tank minimizes the water pressure at NCAR preventing pipes from bursting
e. None of the above

28.) (3 pts) Home experiment:
As we noted in class, air is also a fluid (though much less dense than water). As a result we can apply Bernoulli's equation to study air flow. Try the following experiment and describe what your result is, and why this happens in terms of Bernoulli's principles. Note to consider the pressure (force per unit area) on each side of the soda cans.

Take two empty soda cans and put them on a smooth level surface (like a counter) about 1/2 to 1 inch apart. Predict what will happen if you blow in between the two cans. Run the experiment. Describe why this happens in terms of the physics principles in class (Bernoulli, force, etc.)

29.) (Bonus question!) Create another home experiment!
Describe your setup, run the experiment, and explain what you found (using physics principles such as Bernoulli, force, etc.).