Physics 1010 Homework 4 (23+ points)

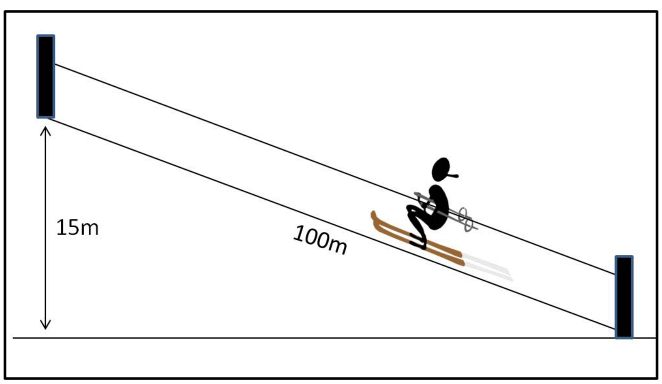
Due Monday night October 1 at midnight

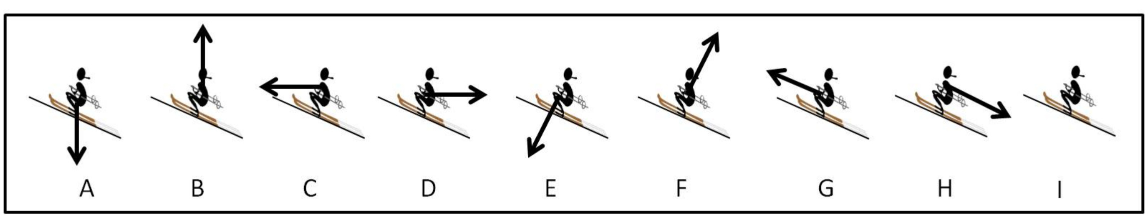
Question 0: (2 pts): HOMEWORK/ EXAM CORRECTION ESSAY: Each week you should review both your answers and the answer key for the previous week's homework. Each week to correct a problem from the prior week. Select one problem either from HW 3 or from the exam for which you had the wrong answer. In the 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?

Questions 1- 17 are about a kids/beginner slope at a ski resort. Assume that the tow bar pulls each skier a distance of 100m along the snow and in the process raises the skier by a vertical distance of 15m. The tow rope pulls each skier along at a constant velocity. A child skier has a mass of 30kg and an adult skier has a mass of 60kg. Assume for now that ski conditions are perfect and the snow is frictionless.

Use $g = 9.8 m/s^2$ throughout this HW.

Show your work/reasoning in all long answer questions.





1. (0.5pt) Which picture best represents the net force on the skier when using the tow rope?

2. (0.5pt) Which picture above best represents the direction of the force of gravity on the skier when using the tow rope?
3. (0.5pt) Which picture above best represents the direction of the force applied by the tow rope to the skier?
4. (0.5pt) Which picture above best represents the direction of the support (normal) force of the slope on the skier when using the tow rope?
5. (0.5pt) Which picture above best represents the direction of the vector sum of gravity + support force from slope when using the tow rope?

6. (0.5pt) Imagine that there are 2 options for getting to the top of the ski run: the tow rope described above; and an elevator, that takes you vertically upwards at a constant velocity for 15 m from the ground to the top of the run. From the pictures above what is the direction of the force that the elevator must exert on each skier?

7. (0.5pt) What is the magnitude of the force that the elevator must exert on each child skier?

   a. 0
   b. 588N
   c. 30 kg
   d. 294 N
   e. 9.8 m/s^2

8. (0.5pt) How much work does the elevator do lifting one child skier to the top of the run?

   a. 588 N
   b. 4410J
   c. 29400J
   d. 9.8 J
   e. Can’t be determined from information given

9. (0.5pt) The elevator does work on the skier. It is converting energy from one form to another. What form does the energy end up in when the skier reaches the top of the run?

   a. Heat
   b. GPE - gravitational potential energy
   c. KE - kinetic energy
   d. Chemical energy
   e. Elastic potential energy

10. (0.5pt) If you ignore friction, how much work did the elevator do to lift the child, compared to the work that the tow rope did to pull the child to the top?

    a. Elevator did more work
    b. Elevator did less work
    c. Elevator did the same work

11. (1pt) What is the magnitude of the force exerted by the tow rope on the child (show working)? [Hint: use the result from #8 and #10, and the definition of work]

12. (0.5pt) If you ignore friction, how did the size of the force that the elevator applied to lift the child compare to the force that the tow rope applied to pull the child to the top?
    a. Elevator exerted a larger force
    b. Elevator exerted a smaller force
    c. Elevator exerted the same force

13. (0.5pt) Where did the energy described in Question #9 most likely come from?

    a. Heat
    b. GPE – gravitational potential energy
    c. KE – kinetic energy
    d. Electrical energy
    e. Elastic potential energy

14. (0.5pt) Now the child skis down the slope and does a snowplow / wedge and comes to a stop. Where did the energy from Question #9 go?

    a. Heat
    b. GPE – gravitational potential energy
    c. KE – kinetic energy
    d. Chemical energy
    e. Disappeared

15. (1pt) For this question only: consider a ski run that has slope length of 200m and a height of 20m. How much work is done by a tow dragging a child to the top of this run?
    a. 294N
    b. 5880J
    c. 58800J
    d. 4410J
    e. 20m

16. (2pt) The engine running the tow rope of Question #1 (the original ski slope, **not** the one in Question #15) has a maximum output power of 700W.
    When running at maximum power, how many children can it deliver to the top of the run in one hour? [Hint: Note how much energy it takes for one child from Q8, and the relation between energy and power]

17. (0.5pt) How many adults (60kg) can the tow rope deliver to the top of the run in one hour?
    a. Same as number of children
    b. Half as many adults as children
    c. Twice as many adults as children
    d. Quarter the number of adults as children
    e. None of these

18. (1pt) You decide to string lights up on the lift. You have 20 light bulbs that each are rated at 200 Watts, for a total of 4000 W of light. Each hour these are on, how many Joules of energy are used:
    a. 240 Joules
    b. 400 Joules
    c. 4000 Joules
    d. 240,000 Joules
    e. 14,400,000 Joules

19. (1pt) Let's say you had to produce that much energy on a stationary bicycle. How long would you have to ride?
    Assume 150 Watts steady state on a bike (in good shape).

20. (1pt) Given the estimate from class that you are only about 20% efficient (that is, you produce 600Watts of heat for 150 Watts of output), how much energy are you producing in heat?

21. (1pt) Accounting for both the energy produced to drive the lightbulbs (#18) and the heat you generated (#20), how many calories do you need to eat to produce this energy?
    [Note: (1 Cal = 4184 J)]
    (bonus: how many snickers is that?)

22. Home experiment: (4pts)
    Do home experiments either of your own design, or ideas from lecture or things here. The goal of the experiment is to verify or challenge some idea that we have learned in class about energy: either energy conservation, or that gravitational potential energy = m g h .

    For example, you could imagine rolling some object down a ramp (e.g. a coke can rolling down a book tilted at an angle) and rolling across the floor (better if carpeted). Measure the change in heights and measure the distance that these roll. Do these trend in the right direction as predicted by gravitational potential energy and then kinetic energy?

    Or, you could try some sort of dropping experiment where you demonstrate gravitational potential energy changes with mass or height. Try to come up with a clever energy measuring device (you can measure splatter radius of your object if it smashes… like grapes on the floor), or crush an empty soda can dropping different weight objects.

    Be sure to explain the experiment, what physics principles you are using, what variables you are changing and what the measured outcome is.

23. Energy Log: (2pts)
    Pick some activity you are involved in (playing tennis, stamp collecting, traveling to the moon, coming to physics class, etc…). Trace *all* (or as many of) the types of energy that are used [that you know of… consider chemical (e.g. from food or gas), gravitational potential, kinetic (energy of motion), thermal (friction and heating)]. List where energy comes from to start the process, and how it changes throughout the system.

    Be as detailed as possible, and make sure to pick something that has at least three different steps of energy transfer… (e.g. "me pushing a book (chemical -> kinetic) to the top of a hill (gravitational potential)" is both too terse [I want to know why each draws from the form of energy] and it needs more steps after or before).