

Physics 201/211 Graded Assignment

FREE ENERGY!

This is a take-home assignment. You may use any resource (book, notes, calculator, computer, library, etc.) you wish when working on this assignment--it is "open-everything".

You may also work on the assignment with your class mates. I encourage you to work with others; working with others is one of the best ways to learn. However, there are some things you should keep in mind:

1) The final work that you turn in is to be your own unique work. You may work with others all you want in figuring out how to solve the problems, in doing the math, etc., but when you write up your final draft you must be working alone. Turning in copies, or near-copies, of each other's work is not acceptable.

2) You must list all the people you worked with on your paper. List these people under your name as "collaborators". **If you worked alone, write "I worked alone" under your name.** If it is obvious that you have worked with someone, but do not state that you did, you will be considered to be cheating.

3) Take-home assignments are graded under a mildly competitive grading scheme. In short, you will receive more credit if you are one of a few people who attacked a problem in a **unique and creative** way than you will if everyone in the class attacked the problem the exact same way you did. The result of this is that **it is to your advantage to work with people who pull their weight and help you as much as you help them, but it is to your disadvantage to dole out information to someone who gives nothing back in return.**

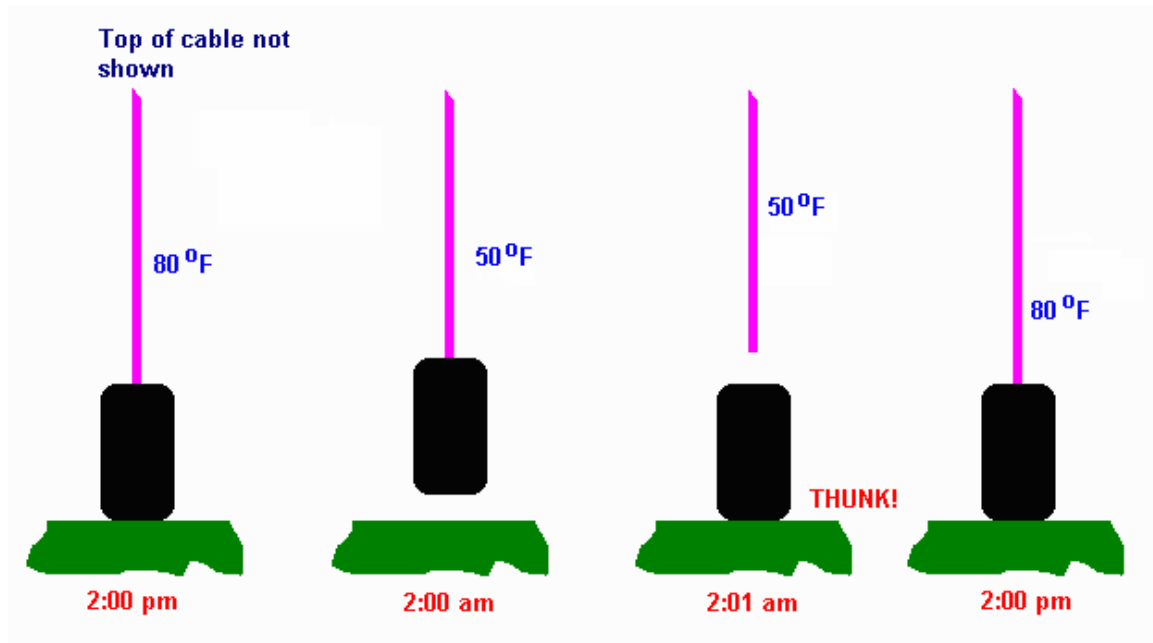
If you want to maximize partial credit for wrong answers, work neatly (rewriting a final draft is recommended), use pencil (or a computer), show details in your work, and circle all final answers.

A Heat Engine with few moving parts can be constructed to extract energy from the simple cycle of day and night.

An aluminum cable 25 meters long and 25 cm in diameter hangs from a fixed point. During the day, when it is 80°F outside, the cable is just long enough that it can be attached, by means of a ratchet to a 55 ton mass that rests on the ground. At night, when the temperature drops to 50°F, the cable contracts, lifting the mass off the ground. The mass is then released from the cable and work is done. When it warms back up to 80°F the next day the cable will once again expand to the point where it can be attached to the mass, and the cycle repeats. This is a HEAT ENGINE because it extracts heat energy from the atmosphere

and converts it into work by way of a recurring cycle that repeats itself every 24 hours.

The cycle of the engine is as shown:



I -- Do the Following:

- Determine how much the cable contracts in length between 2 pm and 2 am.
- Determine how much the cable contracts in length between 2:00 am and 2:01 am.
- Determine the work (in J) released when the mass falls at 2:01 am.
- Supposing you used this work generated by the engine to run a 4-watt Christmas tree bulb, how long could the bulb be made to light using the energy/work generated?
- Determine the heat input per cycle in J.
- Determine the actual efficiency of the Engine.
- Create a *rough sketch* of the P-V plot for one cycle of the engine. HINT – P in this case will be the stress in the cable. V will be the cable's volume.
- Determine the Carnot Efficiency of the Engine.

II -- Do the Following:

Re-work part I for a cable made of steel rather than aluminum. Everything else is the same.

III -- Do the Following:

Re-work part I if this heat engine were a desert, where the daytime temperature is 80°F and the nighttime temperature is 25°F . Discuss whether the greater temperature difference results in an increase in efficiency.

IV -- Do the Following:

Discuss what you have learned from this assignment.