1 In-person examination instructions

Write your answers in the space underneath each question. Put your name on every page. You are welcome to use extra paper. Extra paper will be provided (put your name on every page). If writing in pencil, make sure it is dark enough to be scanned.

You may use a single-sided note card of size 8.5" x 11" (letter paper). Use this note card to write down any information you want to access during the exam.

You may use a calculator. Alternatively, full credit will be given if you do arithmetic by hand and make a reasonable effort to get a final answer within $\pm 20\%$. For example, π can be rounded to 3, and g can be rounded to 10 m/s^2.

One goal of this course is that you become comfortable choosing a reasonable value for a quantity. Therefore, the questions won't tell you every quantity. If you get stuck because you cannot choose a reasonable value, please ask. The instructor will tell you the quantity, and make a small reduction in the points available for that question.

The course instructor will also be available to answer clarifying questions during the exam.

State any assumptions you make to solve the problem. Show the mathematics that you use to solve the problem. Show units when working with the numerical values of physical quantities. Because time is limited, you are not required/expected to write very many words explaining your reasoning. However, using words to explain your reasoning can allow the grader to distinguish small mistakes from big ones.

Very big or very small numbers must be expressed in scientific notation (for example, 1.2×10^6). You will lose points if you use decimal notation to express numbers that are greater than 10^6 or less than 10^{-3}. You will also lose points if you use E-notation (for example, do not write 1.2E6).

2 Gravity Battery

A gravity energy storage tower is a technology designed to store energy generated by other means as gravitational potential energy. An electric motor (powered by wind turbines, hydropower, etc) lifts a series of elevators containing heavy materials, thereby storing the energy in gravitational potential energy. To retrieve the energy, the elevators are lowered (in a controlled way).

(a) How high would an elevator need to be to to freefall (from rest) for 1.0 seconds?

(b) What is the maximum average power generated by a 1.0×10^3 kg elevator dropping from that height?

(c) According to the Oregon government, the power needs of an average Oregonian is 7.3 kJ/s. The efficiency of these gravity energy storage towers can be as high as 75%. How many Oregonian's power needs could be supported by one such tower during the fall?

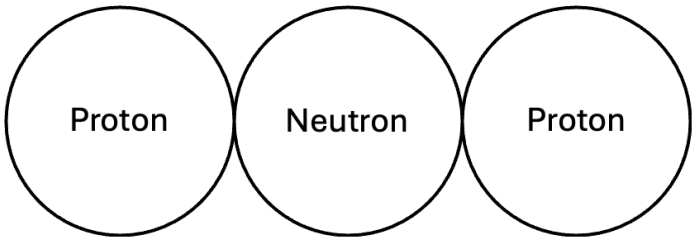
3 Practice Midterm Problem 2: Windfarm

Make a coarse-grained estimate of the electrical energy produced by the Bigelow Canyon Wind Farm in Oregon when the wind speed is 7 m/s. Give your answer in joules/second. Incorporate the following assumptions in your calculation:

- Radius of a windmills 40 m
- Number of windmills 200

4 Binding energy of a linear nucleus

A Helium-3 nucleus is composed of 2 protons and 1 neutron. In our coarse-grained model for atomic nuclei, we assumed that the nucleons were arranged as close as possible, which would be a triangle for Helium-3. What if we modeled the nucleus in a line like this instead? (+)(0)(+)



What is the binding energy of the arrangement shown in this model?