# 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 ±20%. For example, $\pi$ 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. You can ask the instructor any question you wish. They may or may not answer.

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.

If a question asks for a quantitative answer, do not expect partial credit for a conceptual answer.

Very big or very small numbers must be expressed in scientific notation (for example, $1.2 \times 10^6$). 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 Practice Midterm Problem 1

What is the time-averaged translational kinetic energy of a single gas atom in room-temperature gas? Write your answer in units of joules. *You had a homework problem about fusion that gave you an equation for this.*

# 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 Practice Midterm Problem: Nuclear Power in Oregon

Imagine a future, 20 years from now, in which Oregon builds a 1-gigawatt nuclear power plant beside the Columbia River because Facebook wants more electricity for its data centers! The nuclear furnace produces 3 GJ/s, which is sent to a heat engine that produces 1 GJ/s of electrical energy.

(a) Draw an energy flow diagram showing heat going from the nuclear furnace into the heat engine. Show all the energy leaving the heat engine.

(b) The waste heat is dumped into the Columbia River (flow rate 7500 $m^3/s$). Estimate the increase in water temperature after the thermal energy is completely mixed into the river. Give your answer in Kelvin, °C or °F.

Notes: The flow rate of the Columbia River is about 7500 $m^3/s$. The specific heat capacity of water is 4200 J/(kg.K).