1 Remote teaching exam instructions

Write your answers in any form that can be quickly turned into a pdf. For example (i) handwritten on blank sheets of paper, (ii) written on a tablet device. I do not recommend LaTeX or word processors because I want you to draw figures and manipulate algebra.

During the exam, you are allowed to look at textbooks, the class website, your own notes, old homework questions and use google to find fundamental constants and other useful values. You are not allowed to look at tutoring websites such as Chegg. I suggest that you prepare an information sheet so that you can work quickly and complete the exam within the time limit.

You must work alone and construct all solutions from scratch (never copy word-for-word from another source).

The course instructor will be available to answer clarifying questions during the exam. You can ask the instructor any question you wish. They may or may not answer. One goal of this course is that you become comfortable picking a reasonable value for a quantity. Therefore, the questions won't tell you every quantity. If you get stuck because you cannot pick a reasonable value, please ask. The instructor will tell you the quantity, and make a small reduction in the points available for that question.

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 if you are doing arithmetic by hand.

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, 1.2×10^6). 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.

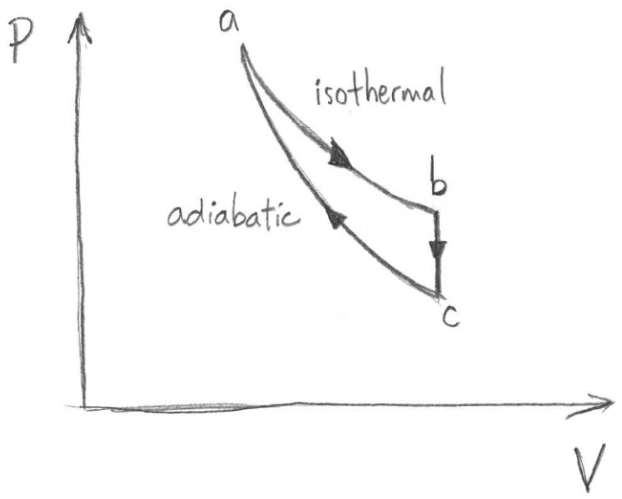
(a) Draw an energy flow diagram showing heat going from the nuclear furnace into the heat engine. Show all the energy leaving the heat engine.

(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 4.2 J/(g K).

5 Practice Midterm Problem 4: Gas Cycle

Consider an ideal gas that undergoes the following cycle:



where the isothermal step occurs at constant temperature, and the adiabatic step has no energy transfer by heating.

(a) Determine the sign of ΔU, Q and W for each step of the cycle. Fill in the chart below with $+$, $-$ or 0. Use the standard sign conventions for heat and work, which is that $Q > 0$ means energy was added to the system by heating, and $W > 0$ means energy was added to the system by working.

	ΔU	Q	W
$a \to b$			
$b \to c$			
$c \to d$			

(b) At what point in the cycle is the temperature of the gas lowest?

(c) Is the gas working as a heat engine or a heat pump? Explain how you know.