

Physics 3410 Homework #9

5 problems

Due by April 6

▷ 1.

If I take air ($f = 5$) at room temperature ($T_i = 300\text{ K}$) and compress it adiabatically to a tenth of its initial value, what is its temperature T_f after the compression?

▷ 2.

Consider an engine which operates between room temperature $T_c = 300\text{ K}$ and some hot reservoir T_h . What is the minimum value of T_h so that the engine can have an efficiency of 50%?

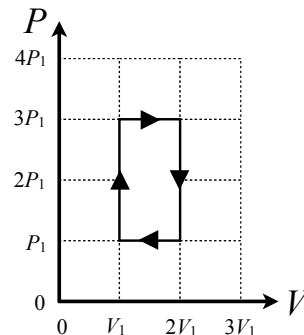
▷ 3.

Suppose a power plant produces 1 GW of electricity at 40% efficiency, taking in steam at a temperature of 500° C . The waste heat is expelled into the environment at 20° C . At what rate (in watts) is heat expelled into the environment?

▷ 4.

The figure shows a heat engine which involves constant-pressure and constant-volume processes, where the pressure goes between some value P_1 and $3P_1$, and the volume goes between some value V_1 to $2V_1$. The engine uses air, which has $f = 5$.

- (a) Calculate the internal energy U at each of the four corners.
- (b) Calculate the work flow during each of the four processes.
- (c) Calculate the heat flow during each of the four processes.
- (d) Calculate the efficiency η of this engine.



▷ 5.

Suppose that heat leaks into a typical kitchen refrigerator (without freezer) at an average rate of 400 W. What is the minimum amount of power it needs to draw from the wall? (Refrigerators generally keep food at 40° F .)