Problem 3

A scientific expedition stayed on an uninhabited island. The members of the expedition had had some sources of energy, but after some time these sources exhausted. Then they decided to construct an alternative energy source. Unfortunately, the island was very quiet: there were no winds, clouds uniformly covered the sky, the air pressure was constant and the temperatures of air and water in the sea were the same during day and night. Fortunately, they found a source of chemically neutral gas outgoing very slowly from a cavity. The pressure and temperature of the gas are exactly the same as the pressure and temperature of the atmosphere.

The expedition had, however, certain membranes in its equipment. One of them was ideally transparent for gas and ideally non-transparent for air. Another one had an opposite property: it was ideally transparent for air and ideally non-transparent for gas. The members of the expedition had materials and tools that allowed them to make different mechanical devices such as cylinders with pistons, valves etc. They decided to construct an engine by using the gas from the cavity.

Show that there is no theoretical limit on the power of an ideal engine that uses the gas and the membranes considered above.