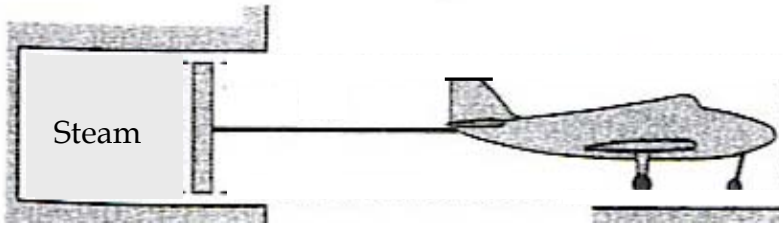
Unified Engineering **MIT ID# (last four digits):**
Thermo Quiz 1 **Fall 2007**

A light airplane catapult uses high-pressure steam to launch aircraft with the system shown schematically below. Initially the cylinder volume is 3 m^3, and finally it is 10 m^3. The piston and linkage can be assumed massless. The launch velocity is 60 m/s, and the mass of the aircraft is 3000 kg. The process occurs such that there is not much time for energy transfer as heat between the steam and the cylinder walls, and adiabatic conditions can be assumed. Also, friction and the interaction of the aircraft with the surrounding air can be neglected.



a) Make a sketch of the situation on your exam paper, consider appropriate system boundaries, and state all assumptions.

b) Consider the aircraft as the system. What modes of energy transfer are at play? Write the first law of thermodynamics for this system.

c) What is the change in total energy of the aircraft during the launch? What is the change in internal energy of the aircraft during the launch?

d) The system being the aircraft, is work done on the system or by the system? Determine the work.

e) What is the change in internal energy of the steam for this process?

f) Show that the change in total energy of the entire system (steam, piston, linkage and aircraft) is equal to zero. An explanation together with equations relating back to parts b) through e) are expected.

.

(Extra page for solutions)