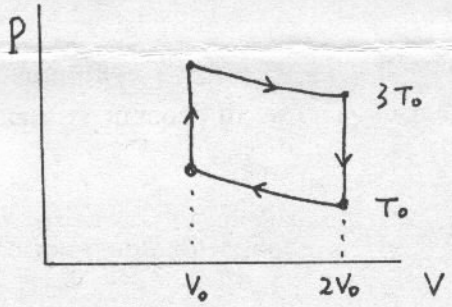
(10%)1. A rocket moving in free space has a speed of 4.0×10^3 m/s relative to Earth. Its engines are turned on, and exhaust is ejected in a direction opposite the rocket's motion at speed of 5.0×10^3 m/s relative to the rocket. (a)What is the speed of the rocket relative to Earth once its mass is reduced to 1/4 of its mass before ignition? (b) What is the thrust on the rocket if it burns fuel at the rate of 50 kg/s?

(10%)2. Find the moment of inertia of a thin rod of mass M and length L about an axis at one end and perpendicular to the rod.

(10%)3. The Figure shown below represents n mol of ideal monatomic gas being taken through a cycle that consists two isothermal processes at temperature 3To and To and two constant volume processes. For the cycle, determine, in terms of n, R, and To, (a) the net heat transferred to the gas and (b) the efficiency of an engine operating in this cycle.



(10%)4. If two adjacent natural frequencies of an organ pipe are determined to be 0.55 kHz and 0.65 kHz, calculate the fundamental frequency and length of this pipe. (Use v = 340 m/s.)

(10%)5. A large storage tank is filled to a height h_o. The tank is punctured at a height h from the bottom of the tank.(a) Prove that the speed at which the water comes out is $(2g(h_o-h))^{1/2}$ if the flow is steady and frictionless. (b) How far from the tank will the stream land?

(10%)6. Please describe the four Maxwell equations in electromagnetism.

(10%)7. A wire coincides with the x axis, and carries a current I = 2.0 A in the +x direction. A nonuniform magnetic field points in the y direction, given by $\mathbf{B} = B_o(x/x_o)^2\mathbf{j}$, where $B_o = 0.22$ T, $x_o = 1.0$ m, and x is the x coordinate. Find the force on the section of wire between x = 1.0 m and x = 3.5 m.

(10%)8. Find (a) the speed and (b) the momentum of a proton whose kinetic energy is 500 MeV.

(10%)9. Please describe Compton effect.

(10%)10. A 10-g mass is attached to an ideal spring of spring constant k = 150 N/m, and set oscillating with amplitude 12 cm. To what quantum number does this oscillation correspond?