Alternate Midterm Examination Physics 100

March 14, 2013

Name/Student #:

Instructions: Formulas at the back (you can rip that sheet off). Questions are on both sides. Calculator permitted. Put your name and student number at the top of the question sheet and complete all questions on the question sheet. Point values are shown with the questions. Complete the questions in any order. Total exam is worth 50 points.

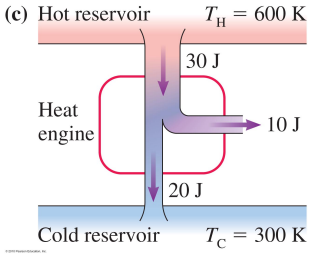

Figure 1: Figure for question 1

1. (a) For the heat engine in Fig. 1 calculate the entropy change of the system ($\Delta S_{\text{system}} = \Delta S_H + \Delta S_C$). (3)

   (b) Calculate the efficiency. (2)

   (c) Calculate the Carnot efficiency. (2)

   (d) Does your answer for entropy change make sense? Include in your comment any possible difference between the answers for parts (b) and (c). (3)

2. $n = 0.010$ mol ($N = 6.02 \times 10^{21}$) of an ideal gas undergoes the process $1 \rightarrow 2$ show in Fig. 2.

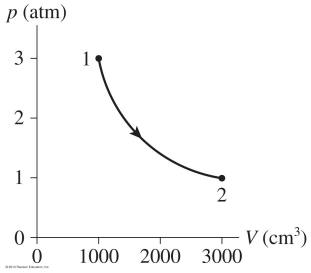

Figure 2: Figure for question 2

(a) What are the temperatures T_1 and T_2? (You may say that $p_1 = 3.0 \times 10^5$ Pa, $p_2 = 1.0 \times 10^5$ Pa, $V_1 = 1.0 \times 10^{-3}$ m^3, $V_2 = 3.0 \times 10^{-3}$ m^3.) (4)

(b) What type of process is this? (2)

(c) The gas undergoes constant-volume heating from point 2 until the pressure is restored to the value it had at point 1. What is the final temperature of the gas? (3)

3. (a) The wave speed on a string is 150 m/s when the tension is 75.0 N. What tension will give a speed of 180 m/s? (5)

(b) What is the frequency of blue light that has a wavelength of 450 nm (4.5×10^{-7} m)? (2)

(c) What is the frequency of red light that has a wavelength of 650 nm (6.5×10^{-7} m)? (2)

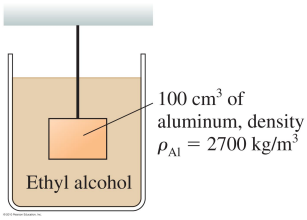

Figure 3: Figure for question 4a

4. (a) What is the tension in the string in Fig. 3? $\rho_{\text{ethyl alcohol}} = 790$ kg/m^3. Your answer should be in Newtons. 100 cm^3 $= 1.0 \times 10^{-4}$ m^3. (4)

(b) A hurricane wind blows across a 6.00 $\times$ 15.0 m flat roof at a speed of 130 km/hr (36.1 m/s). Use $\rho_{\text{air}} = 1.20$ kg/m^3.

i. Is the air pressure above the roof higher or lower than the pressure inside the house? (don't need to explain) (2)

ii. What is the pressure difference? (May assume $y_1 = y_2$ in Bernoulli's equation.) (3)

iii. How much force is exerted on the roof? (Use a pressure difference of 950 Pa for a dummy answer if you wish.) (3)

5. As we've seen, astronauts measure their mass by measuring the period of oscillation T when sitting in a chair connect to a spring with a spring constant $k = 606$ N/m. The empty chair has a period of 0.901 s. What is the mass of an astronaut who oscillates with a period of 2.09 s when sitting in the chair? (10)