Midterm Examination Physics 100

Feb. 17, 2014

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. Include the correct units. Total exam is worth 50 points.

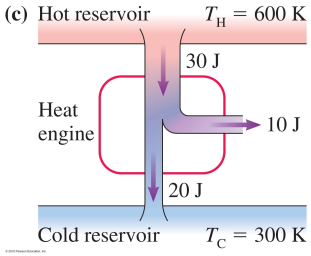

Figure 1: Figure for question 1

1. (a) Does the heat engine in Fig. 1 obey the first law of thermodynamics? Explain. (2)

   (b) One way of stating the 2nd law of thermodynamics is that the efficiency of a heat engine cannot exceed the maximum or Carnot efficiency. Calculate the efficiency and the Carnot efficiency of the heat engine in 1 to show that it satisfies this form of the 2nd law of thermodynamics. (4)

   (c) The other way of stating the 2nd Law involves entropy change. Calculate the entropy change of the system ($\Delta S_{\text{system}} = \Delta S_H + \Delta S_C$). How does this answer satisfy the 2nd Law? (4)

2. A gas with an initial temperature of 900°C= 1173 K undergoes the process shown in Fig. 2. Once you have converted units $p_i = 3.04 \times 10^5$ Pa, $p_f = 3.04 \times 10^5$ Pa, $V_i = 3.0 \times 10^{-4}$ m^3, $V_f = 1.0 \times 10^{-4}$ m^3.

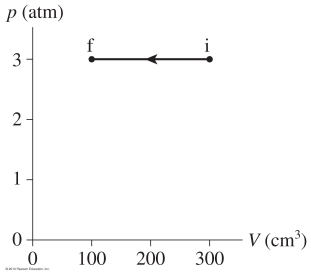

Figure 2: Figure for question 2

(a) What type of process is this? (1)

(b) What is the final temperature in Kelvin? (3)

(c) How many moles of gas are there? (The gas constant is on the formula sheet.) (4 points)

3. Air flows through the tube shown in Fig. 3. $\rho_{\text{air}} = 1.20$ kg/m^3 and $\rho_{\text{Hg}} = 13600$ kg/m^3.

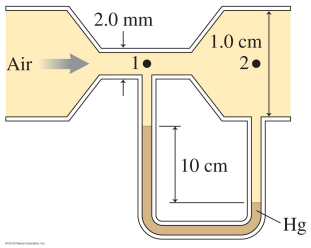

Figure 3: Figure for question 3

(a) Give the pressure difference between region 1 and region 2 based on the mercury manometer. (3)

(b) $v_1 = 25v_2$. Why? (2)

(c) Use the pressure difference from part 3a to calculate v_1. (dummy answer $p_2 - p_1 = 14000$ Pa) using Bernoulli's equation. You may assume that $y_1 = y_2 = 0$ and you may also ignore the v_2^2 term in Bernoulli's equation if you like (reason: it is much smaller than the other terms). (3)

4. A 0.507 kg mass oscillates with an amplitude of 0.10 m on a spring whose spring constant in 20.0 N/m. Determine A. the period (3 points), B. the maximum speed (3 points), C. the total energy (3 points). Use a dummy answer of $\omega = 6.0$ s^{-1} for partial credit.

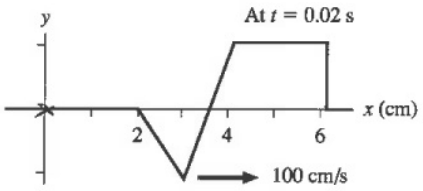

Figure 4: Figure for question 5.

5. A snapshot of a wave pulse on a string is shown in Fig. 4. Draw a history graph at $x = 0$ cm over a time range of -0.06 s to 0.02 s. Show the steps for how at least one feature is mapped from the snapshot graph to the history graph. (8 points)

6. Figure 5 shows a standing wave oscillating at 100 Hz on a string. What is the mode number? What is the wavelength? What is the wave speed? (7)

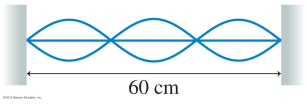

Figure 5: Figure for question 6.