

# Midterm Examination Physics 100

March 11, 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.

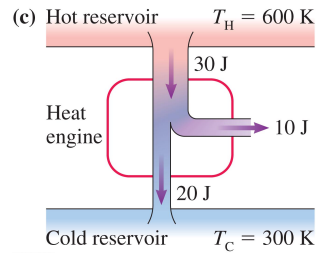


Figure 1: Figure for question 1

- (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.  $n = 0.030$  mol ( $N = 1.81 \times 10^{22}$ ) of an ideal monatomic gas undergoes an adiabatic compression that raises its temperature from  $10^\circ\text{C}$  (283 K) to  $50^\circ\text{C}$  (323 K). How much work is done on the gas to compress it? (8)

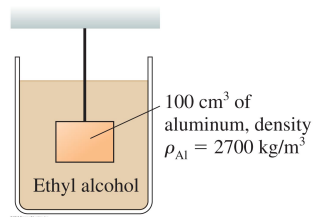


Figure 2: Figure for question 3a

3. (a) What is the tension in the string in Fig. 2?  $\rho_{\text{ethyl alcohol}} = 790 \text{ kg/m}^3$ . Your answer should be in Newtons.  $100 \text{ cm}^3 = 1.0 \times 10^{-4} \text{ m}^3$ . (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  $\rho_{\text{air}} = 1.20 \text{ kg/m}^3$ .
- Is the air pressure above the roof higher or lower than the pressure inside the house? (don't need to explain) (2)
  - What is the pressure difference? (May assume  $y_1 = y_2$  in Bernoulli's equation.) (3)
  - How much force is exerted on the roof? (Use a pressure difference of 950 Pa for a dummy answer if you wish.) (3)

4. 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  $k = 606 \text{ N/m}$ . The empty chair has a period of  $0.901 \text{ s}$ . What is the mass of an astronaut who oscillates with a period of  $2.09 \text{ s}$  when sitting in the chair? (10)

5. A wave on a string is described by

$$y(x, t) = (3.0 \text{ cm}) \cos \left[ 2\pi \left( \frac{x}{2.4 \text{ m}} + \frac{t}{0.20 \text{ s}} \right) \right] \quad (1)$$

- (a) In what direction is the wave travelling? (2)

- (b) What are the wave speed, frequency, and wavelength? (4)

- (c) At  $t = 0.50 \text{ s}$ , what is the displacement of the string at  $x = 0.20 \text{ m}$ ? (Remember to take the cosine in radians mode.) (4)