Multiple choice questions. Circle the correct answer. No work needs to be shown; no partial credit given.

(6 pts) 1. An organ pipe is open at one end and closed at the other end. If the wavelength of the first overtone standing wave is 1.60 m, what is the length of the pipe?

(a) 1.60 m  
(b) 1.20 m  
(c) 0.80 m  
(d) 0.40 m  
(a) 3.20 m  
(f) none of the above answers

(6 pts) 2. A stationary whistle emits sound waves with frequency 600 Hz. The speed of sound in air is 340 m/s. If you are moving away from the whistle at a speed of 40.0 m/s, what frequency do you hear?

(a) 537 Hz  
(b) 529 Hz  
(c) 680 Hz  
(d) 671 Hz  
(e) none of the above answers

(6 pts) 3. In an adiabatic process of an ideal gas, the gas is compressed to one-third of its original volume. In this process, the temperature of the gas

(a) decreases  
(b) increases  
(c) stays the same

(6 pts) 4. In one cycle a Carnot heat engine absorbs 800 J of heat and performs 600 J of work. If the temperature of the high temperature reservoir is 560 K, what is the temperature of the low temperature reservoir?

(a) 140 K  
(b) 240 K  
(c) 320 K  
(d) 420 K  
(e) none of the above answers

(6 pts) 5. Two speakers $A$ and $B$ emit sound waves that have the same wavelength and that are in phase. Point $P$ is 9.0 m from speaker $A$ and 5.0 m from speaker $B$. What is the longest wavelength of the sound emitted by the speakers for which the interference at $P$ will be destructive?

(a) 8.0 m  
(b) 4.0 m  
(c) 28.0 m  
(d) 14.0 m  
(e) none of the above answers
6. How much heat must be added to 0.00200 kg of ice at \( T = -60.0^\circ\text{C} \) to produce 0.0020 kg of liquid water at 30.0°C? (Note: For ice, \( c = 2010 \text{ J/(kg} \cdot \text{K)} \) and for liquid water \( c = 4190 \text{ J/(kg} \cdot \text{K)} \). For water, \( L_f = 3.34 \times 10^5 \text{ J/kg} \) and \( L_v = 2.256 \times 10^6 \text{ J/kg} \). Round your answer to three significant figures.)

(a) 5000 J
(b) 1420 J
(c) 1160 J
(d) 1030 J
(e) 909 J
(f) 493 J
(g) none of the above answers

7. In a reversible isothermal process for 3.00 moles of a monatomic ideal gas, the volume increases from 0.0200 m\(^3\) to 0.0600 m\(^3\) while the temperature is kept constant at 97.0°C. In this process the entropy change for the gas is

(a) 24.9 J/K
(b) 27.4 J/K
(c) 34.6 J/K
(d) 40.1 J/K
(e) none of the above answers

8. The temperature of 5.00 moles of a monatomic ideal gas is increased from 27.0°C to 257.0°C while the pressure is kept constant at 3.00 \( \times 10^4 \) Pa. For the gas, \( C_v = 3R/2 \) and \( C_p = 5R/2 \). What is the work \( W \) done by the gas?

(a) zero
(b) 9560 J
(c) 7480 J
(d) 5400 J
(e) none of the above answers

9. A monatomic ideal gas has \( C_p = 5R/2 \). In a constant pressure process at \( p = 2.00 \times 10^5 \) Pa, the volume of 0.500 moles of the gas is increased from 3.00 \( \times 10^{-3} \) m\(^3\) to 9.00 \( \times 10^{-3} \) m\(^3\). For this process, the change in the internal energy of the gas is

(a) 1200 J
(b) 1500 J
(c) 1800 J
(d) 2000 J
(e) 2500 J
(f) 3000 J
(g) none of the above answers
(7 pts) 10. In each cycle a heat engine rejects 300 J of heat to the low temperature reservoir and performs 1200 J of work. What is the thermal efficiency of the engine?

(a) 80.0%  
(b) 75.0%  
(c) 70.0%  
(d) 62.5%  
(e) 33.3%  
(f) none of the above answers

On the following problems show all your work. Partial credit will be given, if earned. Write your answers in the blanks provided. All answers must include the correct plus or minus sign and the correct units.

(16 pts) 11. A hollow plastic sphere is held below the surface of a freshwater lake by a cord anchored to the bottom of the lake. The sphere has a volume of 0.460 m$^3$ and the tension in the cord is 900 N. The density of the water in the lake is 1000 kg/m$^3$.

a) Calculate the buoyant force exerted by the water on the sphere.  
   Ans. 4508 N

b) What is the density of the sphere?  
   Ans. 800 kg/m$^3$
12. In the process shown in the figure, 8.00 moles of a monatomic ideal gas follows the path shown in the figure from state 1 to state 2. State 1 has pressure \( p_1 = 5.00 \times 10^4 \text{ Pa} \) and volume \( V_1 = 2.00 \times 10^{-3} \text{ m}^3 \). State 2 has pressure \( p_2 = 7.00 \times 10^4 \text{ Pa} \) and volume \( V_2 = 5.00 \times 10^{-3} \text{ m}^3 \). The gas has \( C_v = 3R/2 \) and \( C_p = 5R/2 \).

a) In this process, what is \( \Delta U \), the change in the internal energy of the gas? Ans. \( 375 \text{ J} \)

b) What is the heat flow \( Q \) for this process? Ans. \( 555 \text{ J} \)

c) In the process, does heat flow into the gas or out of the gas? Ans. \( \text{into} \)