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

(6 pts) 1. An organ pipe is 6.00 m long. The pipe is closed at one end and open at the other end. What is the wavelength of the first overtone standing wave for the pipe?

(a) 2.00 m  
(b) 4.00 m  
(c) 8.00 m  
(d) 3.00 m  
(e) 6.00 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 toward 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. The temperature of 5.00 moles of a monatomic ideal gas is decreased from 207.0°C to 27.0°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) 9560 J  
(f) 7480 J  
(g) 5400 J  
(h) none of the above answers

(6 pts) 4. Two speakers $A$ and $B$ emit sound waves that are in phase. The wavelength of the waves emitted by each speaker is 0.50 m. Point $P$ is 3.50 m from speaker $A$ and 4.50 m from speaker $B$. Is the interference detected at point $P$ constructive or destructive?

(a) destructive  
(b) constructive
(6 pts) 5. How much heat must be added to 0.00200 kg of ice at $T = -60.0^\circ$C to produce 0.0020 kg of liquid water at 30.0°C? (Note: For ice, $c = 2010$ J/(kg·K) and for liquid water $c = 4190$ J/(kg·K). For water, $L_i = 3.34 \times 10^5$ J/kg and $L_v = 2.256 \times 10^6$ 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

(6 pts) 6. A monatomic ideal gas undergoes an adiabatic expansion ($Q = 0$) in which the volume of the gas doubles. During this process the temperature of the gas

(a) increases
(b) doesn't change
(c) decreases

(6 pts) 7. In an isothermal process for 3.00 moles of a monatomic ideal gas, the volume increases from $V_1 = 0.020$ m$^3$ to $V_2 = 0.050$ m$^3$ while the temperature is kept constant at 27.0°C. In this process the change in the internal energy of the gas is

(a) positive
(b) zero
(c) negative

(6 pts) 8. In a reversible isothermal process for 3.00 moles of a monatomic ideal gas, the volume decreases from $V_1 = 0.090$ m$^3$ to $V_1 = 0.060$ m$^3$ while the temperature is kept constant at 27.0°C. In this process the entropy change for the gas is

(a) negative
(b) positive
(c) zero

(6 pts) 9. You add equal amounts of heat to two identical cylinders containing equal amounts of the same ideal gas. Cylinder A is allowed to expand while cylinder B is not. How do the temperature changes of the two cylinders compare?

(a) Cylinder A will experience a greater temperature change.
(b) Cylinder B will experience a greater temperature change.
(c) The two cylinders will experience the same temperature change.
(6 pts) 10. A Carnot heat engine has a high-temperature reservoir that has temperature \( T_h = 1200 \, \text{K} \). During one cycle, the engine rejects 400 J of heat energy to the low-temperature reservoir and performs 600 J of work. What is the temperature \( T_c \) of the low-temperature reservoir?

(a) 400 K
(b) 480 K
(c) 600 K
(d) 300 K
(e) 200 K
(f) none of the above answers

(6 pts) 11. A refrigerator consumes 400 J of mechanical energy in one cycle. In one cycle the refrigerator expels 500 J of heat energy into the high-temperature reservoir. In one cycle the amount of that energy the refrigerator absorbs from the low-temperature reservoir is

(a) 500 J
(b) 200 J
(c) 100 J
(d) 1300 J
(e) 1000 J
(f) 900 J
(g) 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) 2. When a rock is suspended in air from the end of a light string, the tension in the string is 49.0 N. The density of the rock is \( 4.2 \times 10^3 \, \text{kg/m}^3 \). When the rock is totally immersed in a liquid, the tension in the string is 37.0 N. What is the density of the liquid?

Ans. 1029 kg/m^3
Six moles of a monatomic ideal gas undergo the process shown in the figure. State 1 has pressure \( p_1 = 4.00 \times 10^4 \text{ Pa} \) and volume \( V_1 = 2.00 \times 10^{-3} \text{ m}^3 \). State 2 has pressure \( p_2 = 3.00 \times 10^4 \text{ Pa} \) and volume \( V_2 = 6.00 \times 10^{-3} \text{ m}^3 \). 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. \( 1504 \text{ J} \)

(b) What is the heat flow \( Q \) for this process?

Ans. \( 2904 \text{ J} \)

c) Does heat flow into the gas or out of the gas?

Ans. into