

Name (printed) _____

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Lab Section Number _____

Exam IV Chaps. 12-15 in Cutnell and Johnson

Multiple Choice questions. Circle the correct answer. No work needs to be shown.

(5 pts) 1. A circular hole is drilled in a steel plate. When the steel plate is heated so its temperature rises, the diameter of the hole

- a) increases
b) decreases
c) remains the same

(5 pts) 2. A monatomic ideal gas undergoes an adiabatic expansion ($Q = 0$) in which the volume of the gas increases. In this process the temperature of the gas

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

(5 pts) 3. A monatomic ideal gas undergoes an isothermal process in which the volume increases. In this process the internal energy of the gas

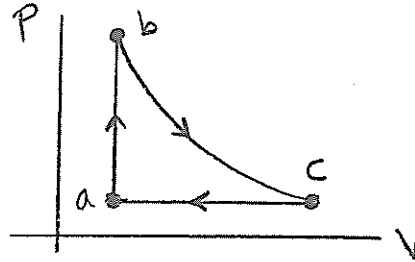
- c) stays the same
a) increases
b) decreases

(5 pts) 4. A monatomic ideal gas undergoes a reversible isothermal process in which the volume increases. In this process the entropy of the gas

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

(5 pts) 5. A monatomic gas goes through the cycle $a \rightarrow b \rightarrow c \rightarrow a$ that is shown in the sketch. For the complete cycle there is

- a
- (a) a net heat flow into the gas
 - (b) a net heat flow out of the gas
 - (c) the net heat flow is zero



(5 pts) 6. In a constant pressure process the temperature of 2 moles of monatomic ideal gas increases from 100 K to 300 K. During this process the work done by the gas is

- d
- (a) -8314 J
 - (b) -4988 J
 - (c) -3326 J
 - (d) 3326 J
 - (e) 4988 J
 - (f) 8314 J

(5 pts) 7. A mixture of the monatomic gases helium and argon ^{is} at a uniform temperature T . Both gasses may be treated as ideal gasses. The mass of an argon atom is greater than the mass of a helium atom. Which statement is correct:

- a
- (a) the average kinetic energy of the helium atoms is the same as the average kinetic energy of the argon atoms
 - (b) the average kinetic energy of the helium atoms is greater than the average kinetic energy of the argon atoms
 - (c) the average kinetic energy of the helium atoms is less than the average kinetic energy of the argon atoms

(5 pts) 8. A heat engine has thermal efficiency 40%. In each cycle it rejects 120 J of heat energy to the low temperature reservoir. How much work does it perform each cycle?

- b
- (a) 48 J
 - (b) 80 J
 - (c) 120 J
 - (d) 300 J
 - (e) 320 J
 - (f) none of the above

(5 pts) 9. A Carnot heat engine operates between a high temperature reservoir at 400 K and a low temperature at 100 K. In each cycle the engine absorbs 120 J of heat energy from the high temperature reservoir. How much work does the engine perform each cycle?

- (a) 30 J
- b (b) 90 J
- (c) 120 J
- (d) 150 J
- (e) 480 J
- (f) none of the above

(5 pts) 10. Initially the translational rms speed of an atom of a monatomic ideal gas is 420 m/s. The number of atoms is kept fixed, the pressure is doubled $P_f = 2P_i$ and the volume is doubled $V_f = 2V_i$. What is the final rms speed of the atoms?

- (a) 420 m/s
- (b) 594 m/s
- c (c) 840 m/s
- (d) 1680 m/s
- (e) none of the above

(5 pts) 11. A metal sphere at a temperature of 127°C radiates heat at a rate of 40 J/s. If the temperature of the sphere is increased to 227°C, the sphere radiates heat at a rate of

- (a) 50 J/s.
- (b) 71 J/s
- c (c) 98 J/s
- (d) 408 J/s
- (e) none of the above

(5 pts) 12. The temperature of a monatomic ideal gas is increased from 100 K to 400 K. If this is done at constant pressure, 500 J of heat flows into the gas. If the temperature increase occurs instead at constant volume, the amount of heat that flows into the gas is

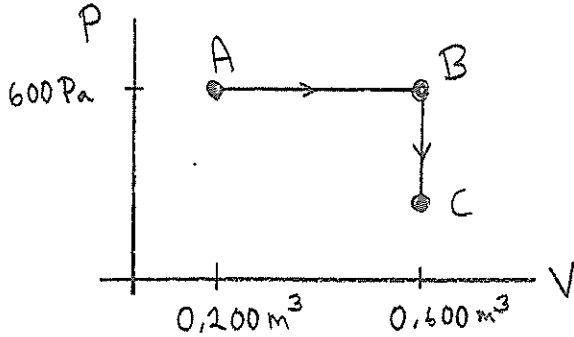
- a (a) less than 500 J
- (b) greater than 500 J
- (c) 500 J

On the following three problems show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

(15 pts) 13. A 6.00 kg piece of solid copper metal at an initial temperature T is placed with 2.00 kg of ice that is initially at -20°C . The ice is in an insulated container of negligible mass and no heat is exchanged with the surroundings. After thermal equilibrium is reached, there is 1.20 kg of ice and 0.80 kg of liquid water. What was the initial temperature of the piece of copper? (For copper, $c = 387 \text{ J}/(\text{kg}\cdot\text{C}^\circ)$. For ice, $c = 2000 \text{ J}/(\text{kg}\cdot\text{C}^\circ)$. For water $c = 4186 \text{ J}/(\text{kg}\cdot\text{C}^\circ)$, $L_f = 3.35 \times 10^5 \text{ J}/\text{kg}$ and $L_v = 2.26 \times 10^6 \text{ J}/\text{kg}$.)

Ans. 150 °C

(15 pts) 14. The pressure and volume of an ideal monatomic ideal gas changes from state A to B to C , along the path shown in the sketch. States A and B have pressure 600 Pa . States B and C have volume 0.600 m^3 and state A has volume 0.200 m^3 . The temperature of state A is the same as the temperature of state C .



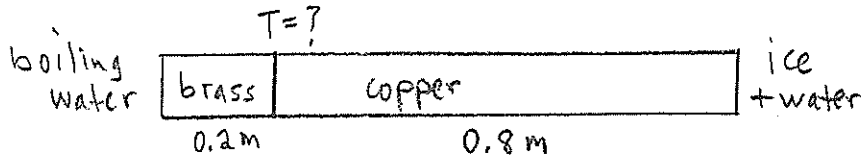
a) What is the total heat flow Q for the process?

Ans. 240 J

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

Ans. into

(15 pts) 15. Two rods, one made of brass and the other made of copper, are joined end to end. The length of the brass section is 0.20 m and the length of the copper section is 0.80 m. Each segment has cross sectional area 0.0050 m^2 . The free end of the brass segment is in boiling water and the free end of the copper segment is in an ice and water mixture, both under 1 atm pressure. The loss of heat through the sides of the rod may be ignored. The thermal conductivity of brass is $k = 110 \text{ J}/(\text{s}\cdot\text{m}\cdot\text{C}^\circ)$ and the thermal conductivity of copper is $k = 390 \text{ J}/(\text{s}\cdot\text{m}\cdot\text{C}^\circ)$.



a) What is the temperature T of the point where the brass and copper segments are joined?

Ans. 53.0°C

b) What mass of ice is melted in 5 minutes by the heat conducted by the composite rod? (For water $c = 4186 \text{ J}/(\text{kg}\cdot\text{C}^\circ)$, $L_f = 3.35 \times 10^5 \text{ J}/\text{kg}$ and $L_v = 2.26 \times 10^6 \text{ J}/\text{kg}$.)

Ans. 0.116 kg