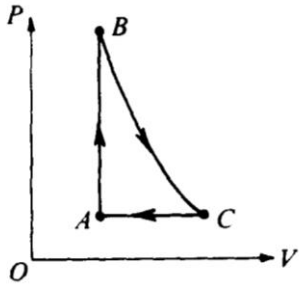
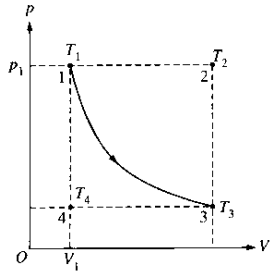
AP Physics Multiple Choice Practice – Thermodynamics

7. An ideal gas in a closed container initially has volume V, pressure P. and Kelvin temperature T. If the temperature is changed to 3T, which of the following pairs of pressure and volume values is possible?
(A) 3P and V (B) P and V (C) P and V/3 (D) P/3 and V (E) 3P and 3V

11. Which of the following is always a characteristic of an adiabatic process?
(A) The temperature does not change ($\Delta T = 0$). (B) The pressure does not change ($\Delta P = 0$).
(C) The internal energy does not change ($\Delta U = 0$). (D) No heat flows into or out of the system ($Q = 0$)
(E) No work is done on or by the system ($W = 0$)



14. Gas in a chamber passes through the cycle ABCA as shown in the diagram above. In the process AB, 12 joules of heat is added to the gas. In the process BC, no heat is exchanged with the gas. For the complete cycle ABCA, the work done by the gas is 8 joules. How much heat is added to or removed from the gas during process CA?
(A) 20 J is removed. (B) 4 J is removed. (C) 4 J is added. (D) 20 J is added.
(E) No heat is added to or removed from the gas.



20. An ideal gas is initially in a state that corresponds to point 1 on the graph above, where it has pressure p_1, volume V_1, and temperature T_1. The gas undergoes an isothermal process represented by the curve shown, which takes it to a final state 3 at temperature T_3. If T_2 and T_4 are the temperatures the gas would have at points 2 and 4, respectively, which of the following relationships is true?

(A) $T_1 < T_3$ (B) $T_1 < T_2$ (C) $T_1 < T_4$ (D) $T_1 = T_2$ (E) $T_1 = T_4$

22. Which of the following statements is NOT a correct assumption of the classical model of an ideal gas?
(A) The molecules are in random motion.
(B) The volume of the molecules is negligible compared with the volume occupied by the gas.
(C) The molecules obey Newton's laws of motion.
(D) The collisions between molecules are inelastic.
(E) The only appreciable forces on the molecules are those that occur during collisions.

23. A sample of an ideal gas is in a tank of constant volume. The sample absorbs heat energy so that its temperature changes from 300 K to 600 K. If v_1 is the average speed of the gas molecules before the absorption of heat and v_2 is their average speed after the absorption of heat, what is the ratio v_2/v_1?
(A) 1/2 (B) 1 (C) $\sqrt{2}$ (D) 2 (E) 4

27. Which of the following will occur if the average speed of the gas molecules in a closed rigid container is increased?
(A) The density of the gas will decrease. (B) The density of the gas will increase.
(C) The pressure of the gas will increase. (D) The pressure of the gas will decrease.
(E) The temperature of the gas will decrease.

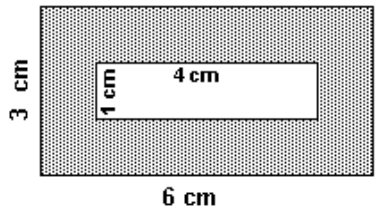
29. A gas with a fixed number of molecules does 32 J of work on its surroundings, and 16 J of heat are transferred from the gas to the surroundings. What happens to the internal energy of the gas?
(A) It decreases by 48 J. (B) It decreases by 16 J. (C) It remains the same. (D) It increases by 16 J.
(E) It increases by 48 J.

30. Which of the following could *NOT* be used to indicate a temperature change? A change in:
(A) color of a metal rod. (B) length of a liquid column. (C) pressure of a gas at constant volume.
(D) electrical resistance. (E) mass of one mole of gas at constant pressure.

31. A mass *m* of helium gas is in a container of constant volume *V*. It is initially at pressure *p* and absolute (Kelvin) temperature *T*. Additional helium is added, bringing the total mass of helium gas to *3m*. After this addition, the temperature is found to be *2T*. What is the gas pressure?
(A) 2/3 *p* (B) 3/2 *p* (C) 2 *p* (D) 3 *p* (E) 6 *p*

36. When an ideal gas is isothermally compressed:
(A) thermal energy flows from the gas to the surroundings.
(B) the temperature of the gas decreases.
(C) no thermal energy enters or leaves the gas.
(D) the temperature of the gas increases.
(E) thermal energy flows from the surroundings to the gas.

40. A heat engine takes in 200 J of thermal energy and performs 50 J of work in each cycle. What is its efficiency?
(A) 50 % (B) 40 % (C) 25 % (D) 20 % (E) 12 %



43. A rectangular piece of metal 3 cm high by 6 cm wide has a hole cut in its center 1cm high by 4 cm wide as shown in the diagram at right. As the metal is warmed from 0°C to 100°C, what will happen to the dimensions of the hole?
(A) both height and width will increase
(B) both height and width will decrease
(C) both height and width will remain unchanged
(D) height will decrease while width will increase
(E) height will increase while width will decrease

44. A gas is enclosed in a cylindrical piston. When the gas is heated from 0ºC to 100ºC, the piston is allowed to move to maintain a constant pressure. According to the Kinetic-Molecular Theory of Matter
(A) the mass of the gas will increase
(B) the number of molecules of gas must increase
(C) the size of the individual molecules has increased
(D) the average speed of the molecules has increased
(E) the molecules continue to strike the sides of the container with the same energy

46. A thermally insulating container has a membrane separating the container into two equal parts. In one part is a vacuum. In the other part is an ideal gas of temperature T and internal energy U. The membrane is punctured and the gas rushes into the region which was a vacuum. After the system has returned to equilibrium, which of the following is NOT true for the gas?
(A) The temperature of the gas is unchanged.
(B) No work is done by the gas on the surroundings.
(C) There is no heat exchanged by the gas with the surroundings.
(D) There is no entropy change of the system.
(E) The internal energy of the gas is unchanged.

47. A fan blows the air and gives it kinetic energy. An hour after the fan has been turned off, what has happened to the kinetic energy of the air?
(A) it disappears (B) it turns into sound energy (C) it turns into potential energy
(D) it turns into electrical energy (E) it turns into thermal energy

48. According to the kinetic theory of gases, when the absolute temperature of an ideal gas doubles, the average kinetic energy of the molecules of the gas
(A) quadruples (B) doubles (C) stays the same (D) is cut in half (E) is quartered

51. Two completely identical samples of the same ideal gas are in equal volume containers with the same pressure and temperature in containers labeled A and B. The gas in container A performs non-zero work W on the surroundings during an isobaric (constant pressure) process before the pressure is reduced isochorically (constant volume) to ½ its initial amount. The gas in container B has its pressure reduced isochorically (constant volume) to ½ its initial value and then the gas performs non-zero work W on the surroundings during an isobaric (constant pressure) process. After the processes are performed on the gases in containers A and B, which is at the higher temperature?

(A) The gas in container A
(B) The gas in container B
(C) The gases have equal temperature
(D) The value of the work W is necessary to answer this question.
(E) The value of the work W is necessary, along with both the initial pressure and volume, in order to answer the question.

55. A new monatomic ideal gas is discovered and named "Wellsium". A pure 4-mole sample is sitting in a container at equilibrium in a 20.0ºC environment. According to the kinetic theory of gases, what is the average kinetic energy per molecule for this gas?
(A) 4.14×10^{-22} J (B) 3652 J (C) 6.07×10^{-21} J (D) 2.02×10^{-21}J
(E) The molar mass of the gas is needed to answer this question.

60. Which is not true of an isochoric process on an enclosed ideal gas in which the pressure decreases?
(A) The work done is zero. (B) The internal energy of the gas decreases. (C) The heat is zero.
(D) The rms speed of the gas molecules decreases. (E) The gas temperature decreases.

63. A mole of a monatomic ideal gas has pressure P , volume V , and temperature T . Which of the following processes would result in the greatest amount of energy added to the gas from heat?
(A) A process doubling the temperature at constant pressure.
(B) An adiabatic free expansion doubling the volume.
(C) A process doubling the pressure at constant volume.
(D) An adiabatic expansion doubling the volume.
(E) A process doubling the volume at constant temperature.

65. A scientist claims to be investigating "The transfer of energy that results from the bulk motion of a fluid." Which of the following terms best describes the energy transfer method that this scientist is studying?
(A) radiation (B) convection (C) conduction (D) latent heat (E) specific heat

72. A sample of an ideal monatomic gas is confined in a rigid 0.008 m^3 container. If 40 joules of heat energy were added to the sample, how much would the pressure increase?
(A) 5 Pa (B) 320 Pa (C) 1,600 Pa (D) 3,333 Pa (E) 5000 Pa

73. Hydrogen gas (H_2) and oxygen gas (O_2) are in thermal equilibrium. How does the average speed of the hydrogen molecules compare to the average speed of oxygen molecules?
(A) equal (B) 4 times greater (C) 8 times greater (D) 16 times greater (E) 32 times greater

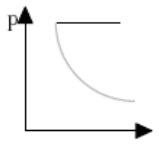
79. An ideal heat engine takes in heat energy at a high temperature and exhausts energy at a lower temperature. If the amount of energy exhausted at the low temperature is 3 times the amount of work done by the heat engine, what is its efficiency?
(A) 0.25 (B) 0.33 (C) 0.67 (D) 0.9 (E) 1.33

81. One end of a metal rod of length L and cross-sectional area A is held at a constant temperature T_1. The other end is held at a constant T_2. Which of the statements about the amount of heat transferred through the rod per unit time are true?

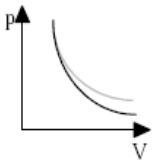
I. The rate of heat transfer is proportional to $1/(T_1 - T_2)$.
II. The rate of heat transfer is proportional to A
III. The rate of heat transfer is proportional to L.

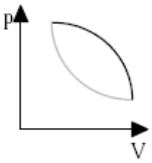
(A) II only (B) III only (C) I and II only (D) I and III only (E) II and III only

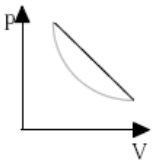
82. On all of the pV diagrams shown below the lighter curve represents isothermal process, a process for which the temperature remains constant. Which dark curve best represents an adiabatic process, a process for which no heat enters or leaves the system?

(A) 

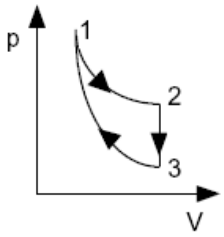
(B) 

(C) 

(D) 

(E) 

83. Three processes compose a thermodynamic cycle shown in the accompanying pV diagram of an ideal gas.



Process 1→2 takes place at constant temperature (300 K). During this process 60 J of heat enters the system.
Process 2→3 takes place at constant volume. During this process 40 J of heat leaves the system.
Process 3→1 is adiabatic. T_3 is 275 K.

What is the change in internal energy of the system during process 3→1?

(A) –40 J (B) –20 J (C) 0 J (D) +20 J (E) +40 J