

University of California, San Diego
GRE Prep – Spring 2022
Practice Thermodynamics Problems
May 16, 2022

1. A gas is initially at temperature T_0 and pressure P_0 . If the gas undergoes an isothermal expansion to twice its initial volume, what are the final temperature and pressure of the gas?

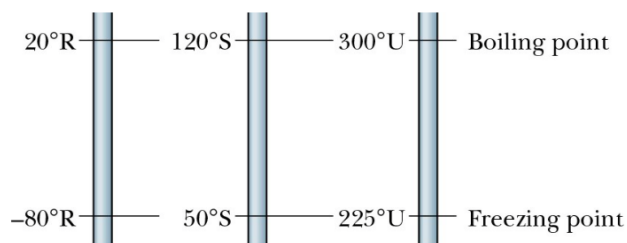
- A) Temperature T_0 and pressure P_0 .
 - B) Temperature $2T_0$ and pressure P_0 .
 - C) Temperature T_0 and pressure $(1/2)P_0$. ✓
 - D) Temperature $(1/2)T_0$ and pressure $(1/2)P_0$.
 - E) Temperature T_0 and pressure $2P_0$.
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2. You have a balloon at room temperature containing air (nitrogen gas N_2 and oxygen gas O_2). An oxygen molecule has more mass than a nitrogen molecule. Which of the following statements is true of the nitrogen and oxygen molecules?

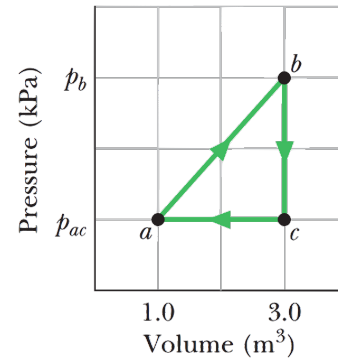
- A) The oxygen molecules are moving faster than the nitrogen molecules, and both are rotating.
 - B) The oxygen molecules are moving slower than the nitrogen molecules, and both are rotating. ✓
 - C) The oxygen molecules are moving the same speed as the nitrogen molecules, and both are rotating.
 - D) The oxygen molecules are moving the same speed as the nitrogen molecules, but neither are rotating.
 - E) The oxygen molecules are moving slower than the nitrogen molecules, but neither are rotating.
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3. The figure below shows where the freezing and boiling points of carbon dioxide are on three different temperature scales. A temperature of 450°U equals which of the following?

- A) 140°R
- B) 190°R
- C) 220°S
- D) 190°S
- E) 220°R ✓



4. A sample of an ideal gas is taken through the cyclic process $abca$ shown in the figure below ($abca$). The pressures satisfy $p_b = 3p_{ac}$. Which of the following is TRUE concerning this cycle?

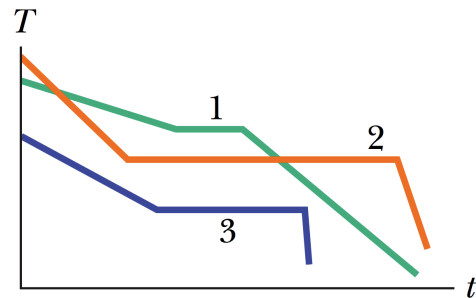


- A) Positive work is done by the gas during ca .
- B) The internal energy change of the gas is positive for bc .
- C) The temperature of the gas increases from c to a .
- D) The entropy of the gas is highest at state b . ✓
- E) The heats extracted from the gas during bc and ca are equal.

5. Three identical gas-cylinder systems expand from the same initial state to final states that have the same volume. One system expands isothermally, one adiabatically, and one isobarically. The _____ process has the most heat added to the gas and the _____ process has the least heat added.

- A) Isothermal, Isobaric.
- B) Isothermal, Adiabatic.
- C) Adiabatic, Isothermal.
- D) Adiabatic, Isobaric.
- E) Isobaric, Adiabatic. ✓

6. Three different materials of identical mass are placed one at a time in a special freezer that can extract energy from a material at a certain constant rate. During the cooling process, each material begins in the liquid state and ends in the solid state; The figure below shows the temperature T versus time t . Rank materials 1, 2, and 3 according to specific heat in the liquid state, greatest first.



- A) 1, 2, 3
- B) 3, 2, 1
- C) 2, 3, 1
- D) 3, 1, 2
- E) 1, 3, 2 ✓

7. In an effort to reduce the amount of heat escaping your house in the winter, you insulate the thick walls of your house. The walls, previously filled with air (thermal conductivity $0.026 \text{ W}/(\text{m} \cdot \text{K})$), are filled with glass wool / “fiberglass” (thermal conductivity $0.048 \text{ W}/(\text{m} \cdot \text{K})$). In doing so, you _____ the heat transfer via convection and _____ heat transfer via conduction.

- A) Increase, Increase
 - B) Decrease, Decrease
 - C) Increase, Decrease
 - D) Decrease, Increase ✓
 - E) No change in either (insulation is for radiation only).
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8. Two containers are at the same temperature. The first contains gas with pressure p_1 , molecular mass m_1 , and rms speed v_{rms} . The second contains gas with pressure $3p_1$, molecular mass m_2 , and average speed $2v_{\text{rms}}$. What is the mass ratio m_2/m_1 ?

- A) $1/4$ ✓
 - B) $1/3$
 - C) 2
 - D) 3
 - E) 4
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9. Does the internal energy of an ideal gas increase, decrease, or stay the same during: (i) a decrease in pressure at constant volume, (ii) an adiabatic expansion, and (iii) an increase in pressure at constant temperature?

- A) (i) stay the same ; (ii) increase ; (iii) increase
 - B) (i) decrease ; (ii) decrease ; (iii) stay the same ✓
 - C) (i) decrease ; (ii) decrease ; (iii) increase
 - D) (i) increase ; (ii) decrease ; (iii) decrease
 - E) (i) decrease ; (ii) stay the same ; (iii) stay the same
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10. A diatomic gas has rotational degrees of freedom excited, but no vibrational modes excited. How much energy in the form of heat is required to raise the temperature of 1 mol of the gas by 100 Kelvin when heating the gas at constant pressure?

- A) 1.2 kJ
 - B) 2.1 kJ
 - C) 2.9 kJ ✓
 - D) 3.7 kJ
 - E) Impossible to tell (requires the molar mass).
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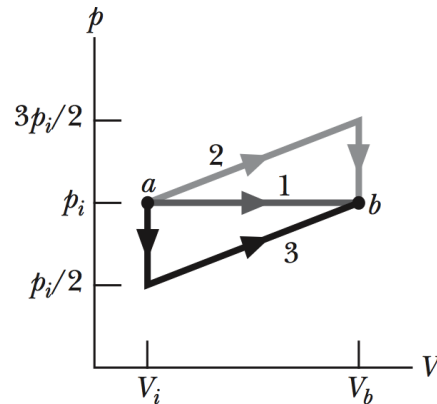
11. Which of the following is NOT true regarding irreversible processes?

- A) These processes lead to an increase in entropy of the universe.
- B) The path of an irreversible process cannot be traced on a PV diagram.
- C) Melting an ice cube in a cup of room temperature water is an example of this kind of process.
- D) Macroscopic quantities like temperature and pressure are not defined for the initial and final states of a system undergoing an irreversible process. ✓
- E) Any heat transfer through a positive, finite temperature difference is an example of an irreversible process.

12. A gas initially at temperature T_0 and pressure P_0 undergoes an adiabatic compression to half of its initial volume. What happens to the temperature and pressure of the gas?

- A) The pressure increases to a value $P_f > 2P_0$ and the temperature increases. ✓
 B) The pressure increases to a value $P_f < 2P_0$ and the temperature increases.
 C) The pressure decreases and the temperature increases.
 D) The pressure increases to a value $P_f < 2P_0$ and the temperature decreases.
 E) The pressure decreases and the temperature decreases.

13. Shown below are three processes: 1, 2, and 3. All three processes have the same starting point, a , and the same final point, b . $V_b = 5V_i$, and the heat added to the gas in process 1 is $10p_iV_i$. What is the change in internal energy the gas undergoes in process 3?



- A) $2 p_i V_i$
 B) $4 p_i V_i$
 C) $6 p_i V_i$ ✓
 D) $8 p_i V_i$
 E) $10 p_i V_i$

14. A gas expands and the average internal energy of the gas increases. Which of the following is not necessarily true?

- A) Heat is added to the gas.
- B) The gas does work on its surroundings.
- C) The entropy of the gas increases.
- D) The temperature of the gas increases.
- E) All of the above are necessarily true. ✓

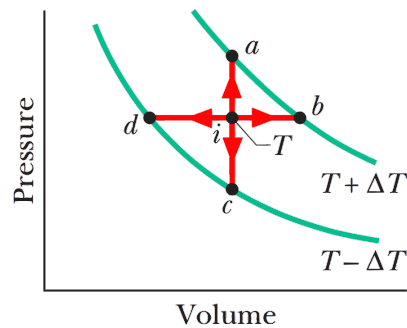
15. Three identical gas-cylinder systems expand from the same initial state to final states that have the same volume. One system expands isothermally, one adiabatically, and one isobarically. The _____ process does the most work and the _____ process does the least work.

- A) Isothermal, Isobaric.
- B) Isothermal, Adiabatic.
- C) Adiabatic, Isothermal.
- D) Adiabatic, Isobaric.
- E) Isobaric, Adiabatic. ✓

16. Suppose I throw a copper block at 80°C into water at 10°C , and the two come to equilibrium. The entropy of the block has _____, the entropy of the water has _____, and the overall entropy _____.

- A) Increased, Decreased, Remained Constant.
- B) Increased, Decreased, Increased.
- C) Decreased, Increased, Increased. ✓
- D) Increased, Increased, Increased.
- E) Decreased, Increased, Remained Constant.

17. Point i in the figure below represents the initial state of an ideal gas at temperature T . Taking algebraic signs into account, rank the entropy changes that the gas undergoes as it moves, successively and reversibly, from point i to points a , b , c , and d , greatest first.



- A) a, b, d, c
- B) c, d, b, a
- C) b, a, c, d ✓
- D) d, c, a, b
- E) b, a, d, c

End of Multiple Choice Questions