Physics II

Chapter 15 Practice

Fall 2016

IMPORTANT: Except for multiple-choice questions, you will receive no credit if you show only an answer, even if the answer is correct. Always show in the space on your answer sheet some sketches, words, or equations which clearly justify your answer. Show the equations you use and the values substituted into them whenever equations are necessary. If you go from a formula directly to an answer without showing the values used, you will lose points. Points will also be deducted for missing or erroneous units.

Each individual answer is weighted roughly evenly throughout the exam.

Name ____

EQUATIONS:

$$\Delta E = Q - W \qquad PV = NkT \qquad PV = nRT$$

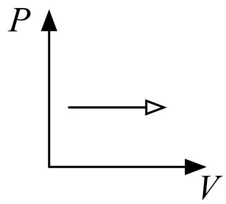
$$E_{total} = \frac{3}{2}NkT \qquad k = 1.38 \times 10^{-23}\ \mathrm{J/K} \qquad R = 8.31\ \mathrm{J/(K{\cdot}mole)}$$

$$N_A = 6.02 \times 10^{23} \qquad e = \frac{W_{out}}{Q_H} \qquad e_{Carnot} = 1 - \frac{T_c}{T_h}$$

$$\Delta S = \frac{Q}{T} \qquad W = P\Delta V$$

1. When a sample of gas undergoes an isothermal process, there is no change in its

   (a) temperature.
   (b) pressure.
   (c) volume.
   (d) heat.



2. The process shown on the PV diagram is an

   (a) isobaric expansion.
   (b) isometric expansion.
   (c) adiabatic expansion.
   (d) isothermal expansion.

3. When a goes undergoes an isochoric process, there is no change in its

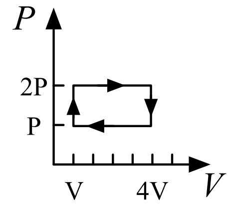
   (a) pressure.
   (b) temperature.
   (c) volume.
   (d) internal energy.

4. During an isothermal process, 5.0 J of heat is removed from an ideal gas. What is the change in its internal energy?

   (a) 2.5 J
   (b) zero
   (c) 5.0 J
   (d) 10 J

5. A certain amount of a monatomic gas is maintained at constant volume as it is cooled by 50 K. This feat is accomplished by removing 400 J of energy from the gas. How much work is done by the gas?

   (a) -400 J
   (b) 400 J
   (c) zero
   (d) none of the above



6. A gas is taken through the cycle illustrated here. How much work is done during one cycle by an engine operating on this cycle?

   (a) 4PV
   (b) PV
   (c) 3PV
   (d) 2PV

7. If the theoretical efficiency of a Carnot engine is to be 100%, the heat sink must be

   (a) at 0° C
   (b) at 100° K
   (c) infinitely hot.
   (d) at 0 K

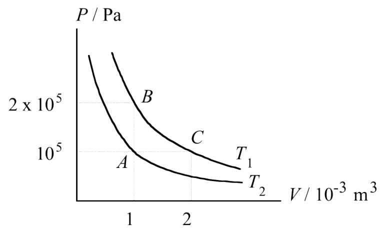
8. A heat engine runs between reservoirs at temperatures of 300°C and 30°C. What is its maximum theoretical efficiency?

   (a) 10%
   (b) 47%
   (c) 53%
   (d) 90%
   (e) 100%

9. If two different systems are put in thermal contact so that heat can flow from one to the other, then heat will flow until the systems have the same

   (a) energy.
   (b) heat capacity.
   (c) entropy.
   (d) temperature.

10.



The figure above shows two curves for a given mass of gas at temperature T_1 and T_2. If the symbols P, V and T stand for the pressure, volume and absolute temperature of the gas, which of the following statements is FALSE?

(a) Temperature T_1 is twice the temperature T_2.

(b) $\dfrac{PV}{T}$ is constant for all the points on the two curves.

(c) When the gas expands from state B to state C as represented by the curve BC, no energy is transferred from the surroundings to the gas.

(d) No work is done by the gas when it changes from state A to state B along the line AB.

(e) To take the gas from state A to state C, 100 J of energy is needed.

11. An ideal gas confined in a box initially has pressure P. If the absolute temperature of the gas is doubled and the volume of the box is quadrupled, the pressure is

(a) $\frac{1}{8}P$

(b) $\frac{1}{4}P$

(c) $\frac{1}{2}P$

(d) P

(e) $2P$

12. As an ideal gas is compressed at constant temperature,

(a) heat flows into the gas.

(b) the internal energy of the gas does not change.

(c) the work done on the gas is zero.

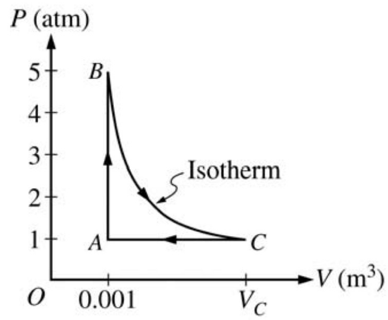
(d) both choices (a) and (b)

(e) both choices (a) and (c)

1. How does the kinetic theory of gases explain the fact that a gas cools as it expands into the atmosphere, but a gas does not cool as it expands into the the vacuum of space?

2. Describe how an air conditioner works. Include a sketch that shows the compressor, the throttling (expansion) valve, the condenser, and the evaporator. Also discuss what goes on with the "working fluid."

3. Calculate the total change in entropy of the universe that occurs when 0.2 kg of ice at 0°C melts in a 30° tub of ethanol.



4. A 0.03 mol sample of helium is taken through the cycle shown in the diagram above. The temperature of state A is 400 K.

   (a) For each process in this cycle, indicate in the table below whether the quantities W, Q, and ΔU are positive (+), negative (−), or zero (0). W is the work done on the helium sample.

Process	W	Q	ΔU
$A \to B$	0	+	+
$B \to C$	+	+	0
$C \to A$	−	−	−

   (b) Explain your response for the signs of the quantities for process $A \to B$. and for the others!

   (c) Calculate V_C . Use Ideal Gas Law

5. In a certain process, 3200 J of energy is added to an ideal gas by heating. During the same process, 2100 J of work is done on the gas.

   (a) Determine the change in the internal energy of the gas that results from this process. Use First Law of Thermo

   (b) Indicate whether each of the following properties of the gas increases, decreases, or remains the same during the process.

      i. Volume
      Increases / Decreases / Stays the same
      Justify your answer.

      ii. Temperature
      Increases / Decreases / Stays the same
      Justify your answer.

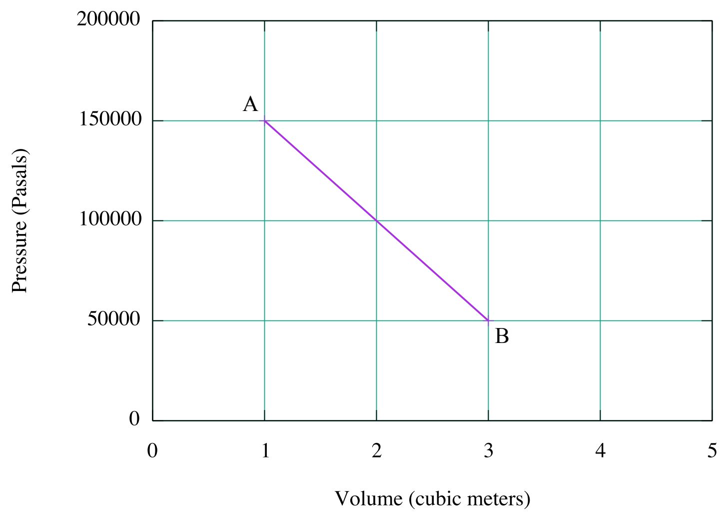
      iii. Pressure
      Increases / Decreases / Stays the same
      Justify your answer.

   Suppose that in a different process 1800 joules of work is done on the ideal gas at a constant temperature.

(c) Determine the change in internal energy of the gas during the process. Zero

(d) Which of the following correctly describes the energy transfer by heating, if any, between the gas and its surroundings?
There is a heat transfer out of the gas. / There is a heat transfer into the gas. / There is no net heat transfer.
Justify your answer.

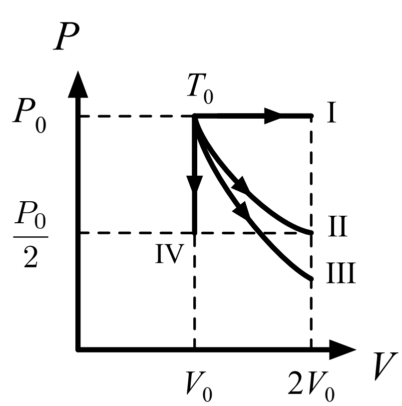
6. One-tenth of a mole of an ideal monatomic gas undergoes a process described by the straight-line path AB shown in the P-V diagram below.



(a) Show that the temperature of the gas is the same at points A and B.Use Ideal Gas Law

(b) How much heat is added to the gas during the process described by A→B?Use First Law of Thermo; $\Delta E = 0$ for isothermic process

(c) What is the highest temperature of the gas during the process described by A→B? [This is not on the test, but you should be able to figure it out. There's only one possible point!]



7. Four separate samples of an ideal gas are each initially at a pressure P_0, and volume V_0, and a temperature T_0 as shown on the P-V graph above. These samples are taken in separate processes from this initial state to their respective final state I, II, III, and IV. These processes are represented on the P-V graph.

(a) One of the processes is isothermal. Identify which one, and justify your choice.II

(b) One of the processes is adiabatic. Identify which one, and justify your choice. III

(c) In which process or processes does heat flow from the gas to its surroundings? IV

(d) In which process or processes does the gas do work on its surroundings? Justify your choice. I, II, III

(e) In which process or processes does the root-mean-square speed of the gas particles increase? Justify your choice. I