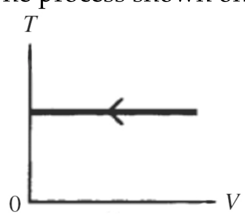
1) When a gas expands adiabatically,
   A) it does no work.
   B) work is done on the gas.
   C) the temperature of the gas remains constant.
   D) the internal (thermal) energy of the gas increases.
   E) the internal (thermal) energy of the gas decreases.

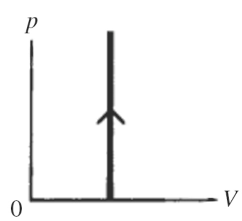
2) An ideal gas is compressed isobarically to one–third of its initial volume. The resulting pressure will be
   A) nine times the initial value.
   B) three times as large as the initial value.
   C) more than three times as large as the initial value.
   D) equal to the initial value.
   E) impossible to predict on the basis of this data.

3) The process shown on the TV graph in the figure is an



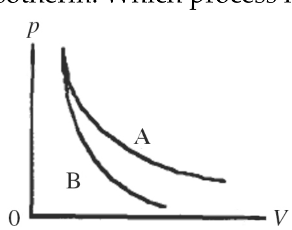
A) isothermal compression.
B) adiabatic compression.
C) isobaric compression.
D) isochoric compression.

4) The process shown on the pV diagram in the figure is



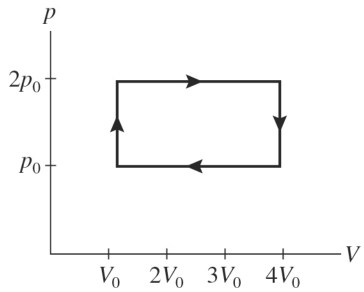
A) adiabatic. B) isochoric. C) isothermal. D) isobaric.

5) Two processes are shown on the pV diagram in the figure. One of them is an adiabat and the other one is an isotherm. Which process is the isotherm?



A) process A
B) process B
C) The processes shown are neither isotherms nor adiabats.
D) It is not possible to tell without knowing if the gas is monatomic or diatomic.

6) A gas is taken through the cycle shown in the pV diagram in the figure. During one cycle, how much work is done by the gas?

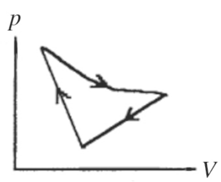


A) $4\ p_0V_0$ B) $2\ p_0V_0$ C) $3\ p_0V_0$ D) p_0V_0

7) A certain gas is compressed adiabatically. The amount of work done on the gas is 800 J. What is the change in the internal (thermal) energy of the gas?

A) 400 J
B) 800 J
C) 0 J
D) –800 J
E) More information is needed to answer this question.

8) A cyclic process is carried out on an ideal gas such that it returns to its initial state at the end of a cycle, as shown in the pV diagram in the figure. If the process is carried out in a clockwise sense around the enclosed area, as shown on the figure, then the magnitude of the enclosed area represents



A) the heat added to the gas.
B) the work done on the gas.
C) the work done by the gas.
D) the heat that flows out of the gas.

9) Which one of the following is a *true* statement?

A) It is not possible to convert work entirely into heat.
B) The second law of thermodynamics is a consequence of the first law of thermodynamics.
C) It is possible for heat to flow spontaneously from a hot body to a cold one or from a cold one to a hot one, depending on whether or not the process is reversible or irreversible.
D) It is impossible to transfer heat from a cooler to a hotter body.
E) All of these statements are false.

10) If the efficiency of a Carnot engine were to be 100%, the heat sink would have to be

A) at absolute zero. B) at 100°C. C) infinitely hot. D) at 0°C.

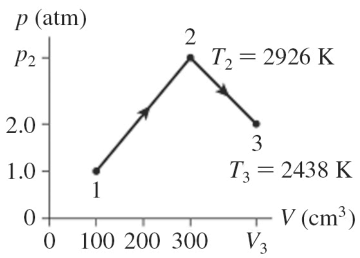
11) An important feature of the Carnot cycle is that

A) its efficiency depends only on the absolute temperature of the hot reservoir used.
B) it is an example of an irreversible process that can be analyzed exactly without approximations.
C) its efficiency can be 100%.
D) its efficiency is determined by the temperatures of the hot and cold reservoirs between which it works and by the properties of the working substance used, and on nothing else.
E) no engine can be more efficient than a Carnot engine operating between the same two temperatures.

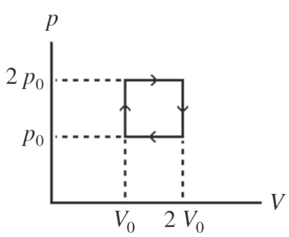
12) An ideal gas undergoes an isothermal expansion. During this process, its entropy

A) remains unchanged.
B) decreases.
C) increases.
D) cannot be predicted from the data given.

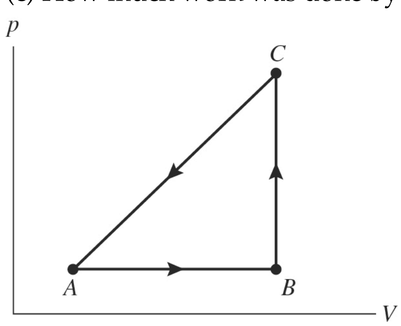
13) The figure shows a pV diagram for 0.0061 mol of ideal gas that undergoes the process $1 \rightarrow 2 \rightarrow 3$. What is the pressure p_2? ($R = 8.31$ J/mol • K)



14) The figure shows a pV diagram for an ideal gas that is carried around a cyclic process. How much work is done in one cycle if $p_0 = 4.00$ atm and $V_0 = 3.00$ L? (1.00 atm = 101 kPa)



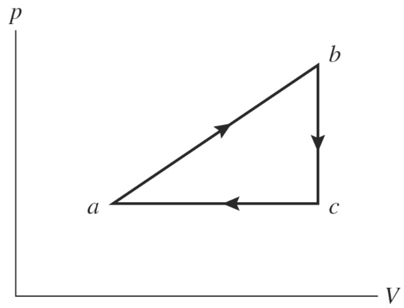
15) The figure shows a pV diagram for a gas going through a cycle from A to B to C and back to A. From point A to point B, the gas absorbs 50 J of heat and finds its internal (thermal) energy has increased by 20 J. Going from B to C, the internal (thermal) energy decreases by 5.0 J.
(a) How much work was done by the gas from A to B?
(b) How much heat was absorbed by the gas from B to C?
(c) How much work was done by the gas going from B to C?



16) An ideal gas undergoes an adiabatic process while doing 25 J of work. What is the change in the internal (thermal) energy of the gas?

17) The gas in a perfectly insulated but flexible container does work at a rate of 13 W. At what rate is the internal (thermal) energy of the gas changing?

18) An ideal gas undergoes the process $a \rightarrow b \rightarrow c \rightarrow a$ shown in the pV diagram. In the figure, $P_a = P_c = 240$ kPa, $V_b = V_c = 40$ L, $V_a = 15$ L, and $P_b = 400$ kPa. How much heat is gained by the gas in this $a \rightarrow b \rightarrow c \rightarrow a$ process?



19) A heat engine has an efficiency of 35.0% and receives 150 J of heat per cycle.
(a) How much work does it do in each cycle?
(b) How much heat does it "waste" in each cycle?

20) A heat engine has an efficiency of 31.4% and receives 8.72 kJ of heat per cycle.
(a) How much work does it perform in each cycle?
(b) How much heat does it exhaust in each cycle?

21) An ideal Carnot engine is operated between a hot and a cold reservoir. The temperature difference between the two reservoirs is 284°C. If the efficiency of this ideal engine is 24.0%, find the temperature of the cold reservoir in degrees Celsius.

22) A heat engine having the maximum possible efficiency has an efficiency of 25% when operating between two heat reservoirs. If the temperature of the cold reservoir is 300 K, what is the temperature of the hot reservoir?

23) A coal-fired plant generates 600 MW of electric power. The plant uses 4.8×10^6 kg of coal each day, and the heat of combustion of coal is 3.3×10^7 J/kg. The steam that drives the turbines is at a temperature of 300°C, and the exhaust water is at 37°C.
(a) What is the overall efficiency of the plant for generating electric power?
(b) How much thermal energy is exhausted each day?
(c) Using the same heat reservoirs, what is the maximum possible efficiency for a heat engine?

24) An ideal Carnot engine operates between a warm reservoir at 233 K and a colder reservoir. During each cycle, this engine extracts 15.0 J of heat from the warm reservoir and does 4.0 J of work. What is the temperature of the colder reservoir?

25) A Carnot engine operates between two reservoirs with unknown temperatures. If the Carnot engine operates at 67% efficiency, what is the ratio of the absolute temperatures of the reservoirs, T_c/T_h?

26) During each cycle of operation, a refrigerator absorbs 230 J of heat from the freezer and expels 356 J of heat to the room. How much work input is required in each cycle?

27) An ideal reversible heat pump is taking heat from the outside air at –10.0°C and discharging it into the house at 18.0°C. What is the coefficient of performance of this heat pump?

28) An ideal Carnot engine is operated as a heat pump to heat a room in the winter. The heat pump delivers heat to the room at the rate of 47 kJ per second and maintains the room at a temperature of 293 K when the outside temperature is 237 K. The power requirement to run the heat pump under these operating conditions is closest to

29) What is the change in entropy when 15.0 g of water at 100°C are turned into steam at 100°C? The latent heat of vaporization of water is 22.6×10^5 J/kg.

30) A 0.42-kg quantity of ethanol, in the liquid state at its melting point of −114.4°C, is frozen at atmospheric pressure. The heat of fusion of ethanol is 1.04×10^5 J/kg, and its molecular mass is 46.1 g/mol. What is the change in the entropy of the ethanol as it freezes?

31) What is the entropy change of 450 g of water when it changes from (a) liquid to steam at its usual boiling point and (b) ice to liquid at its usual melting point? For water, $L_F = 0.334$ MJ/kg, $L_V = 2.26$ MJ/kg.

Answer Key
Testname: HW_CH15_THERMODYNAMICS

1) E
2) D
3) A
4) B
5) A
6) C
7) B
8) C
9) E
10) A
11) E
12) C
13) 4.9 atm
14) 1210 J
15) (a) 30 J (b) –5.0 (i.e. released 5.0 J) (c) 0 J
16) –25 J
17) –13 W
18) 2000 J
19) (a) 52.5 J (b) 97.5 J
20) (a) 2.74 Kj (b) 5.98 kJ
21) 626°C
22) 400 K
23) (a) 33% (b) 1.1×10^{14} J (c) 46%
24) 171 K
25) 0.33
26) 126 J
27) 10.4
28) 9000 W.
29) 90.8 J/K
30) –280 J/K
31) (a) 2.73 kJ/K (b) 549 J/K