CHAPTER 12

1. A system is acted on by its surroundings in such a way that it receives 50 J of heat while simultaneously doing 20 J of work. What is its net change in internal energy?

   a. 70 J
   b. 30 J
   c. zero
   d. –30 J

2. The volume of an ideal gas changes from 0.40 to 0.55 m^3 although its pressure remains constant at 50 000 Pa. What work is done on the system by its environment?

   a. –7 500 J
   b. –200 000 J
   c. 7 500 J
   d. 200 000 J

3. In an isothermal process for an ideal gas system (where the internal energy doesn't change), which of the following choices best corresponds to the value of the work done on the system?

   a. its heat intake
   b. twice its heat intake
   c. the negative of its heat intake
   d. twice the negative of its heat intake

4. A heat engine exhausts 3 000 J of heat while performing 1 500 J of useful work. What is the efficiency of the engine?

   a. 15%
   b. 33%
   c. 50%
   d. 60%

5. A heat engine operating between a pair of hot and cold reservoirs with respective temperatures of 500 K and 200 K will have what maximum efficiency?

   a. 60%
   b. 50%
   c. 40%
   d. 30%

6. Which of the following choices best corresponds to what is required by the second law of thermodynamics for any process taking place in an isolated system?

   a. entropy decreases
   b. entropy remains constant
   c. entropy increases
   d. entropy equals work done on the system

7. Which of the following choices is an appropriate unit for measuring entropy changes?

   a. J·K
   b. N·K
   c. J/s
   d. J/K

8. An electrical power plant manages to send 88% of the heat produced in the burning of fossil fuel into the water-to-steam conversion. Of the heat carried by the steam, 40% is converted to the mechanical energy of the spinning turbine. Which of the following choices best describes the overall efficiency of the heat-to-work conversion in the plant (as a percentage)?

   a. greater than 88%
   b. 64%
   c. less than 40%
   d. 40%

9. If one could observe the individual atoms making up a piece of matter and note that during a process of change their motion somehow became more orderly, then one may assume which of the following in regard to the system?

   a. increases in entropy
   b. decreases in entropy
   c. gains in thermal energy
   d. positive work done on

10. A 1.0-kg chunk of ice at 0°C melts, absorbing 80 000 cal of heat in the process. Which of the following best describes what happens to this system?

    a. increased entropy
    b. lost entropy
    c. entropy maintained constant
    d. work converted to energy

11. According to the first law of thermodynamics, the sum of the heat gained by a system and the work done on that same system is equivalent to which of the following?

    a. entropy change
    b. internal energy change
    c. temperature change
    d. specific heat

12. If an ideal gas does positive work on its surroundings, we may assume, with regard to the gas:

    a. temperature increases
    b. volume increases
    c. pressure increases
    d. internal energy decreases

13. In an isovolumetric process by an ideal gas, the system's heat gain is equivalent to a change in:

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

14. According to the first law of thermodynamics, for any process that may occur within an isolated system, which of the following choices applies?

    a. entropy remains constant
    b. entropy increases
    c. entropy decreases
    d. None of the above choices apply.

15. According to the second law of thermodynamics, which of the following applies to the heat received from a high temperature reservoir by a heat engine operating in a complete cycle?

    a. must be completely converted to work
    b. equals the entropy increase
    c. converted completely into internal energy
    d. cannot be completely converted to work

16. The maximum theoretical thermodynamic efficiency of a heat engine operating between hot and cold reservoirs is a function of which of the following?

    a. hot reservoir temperature only
    b. cold reservoir temperature only
    c. both hot and cold reservoir temperatures
    d. None of the above choices are valid.

17. During an isobaric process which one of the following does not change?

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

18. A 2.0-mol ideal gas system is maintained at a constant volume of 4.0 L; if 100 J of heat is added, what is the work done on the system?

    a. zero
    b. 5.0 J
    c. –6.7 J
    d. 20 J

19. A closed 2.0-L container holds 3.0 mol of an ideal gas. If 200 J of heat is added, what is the change in internal energy of the system?

    a. zero
    b. 100 J
    c. 150 J
    d. 200 J

20. An adiabatic free expansion refers to the fact that:

    a. No heat is transferred between a system and its surroundings.
    b. The pressure remains constant.
    c. The temperature remains constant.
    d. The volume remains constant.

21. A 4-mol ideal gas system undergoes an adiabatic process where it expands and does 20 J of work on its environment. What is its change in internal energy?

    a. –20 J
    b. –5 J
    c. zero
    d. +20 J

22. A 4-mol ideal gas system undergoes an adiabatic process where it expands and does 20 J of work on its environment. How much heat is received by the system?

    a. –20 J
    b. zero
    c. +5 J
    d. +20 J

23. A 5-mol ideal gas system undergoes an adiabatic free expansion (a rapid expansion into a vacuum), going from an initial volume of 10 L to a final volume of 20 L. How much work is done on the system during this adiabatic free expansion?

    a. –50 J
    b. –10 J
    c. zero
    d. +50 J

24. A heat engine receives 6 000 J of heat from its combustion process and loses 4 000 J through the exhaust and friction. What is its efficiency?

    a. 33%
    b. 40%
    c. 67%
    d. 73%

25. If a heat engine has an efficiency of 30% and its power output is 600 W, what is the rate of heat input from the combustion phase?

    a. 1 800 W
    b. 2 400 W
    c. 2 000 W
    d. 3 000 W

26. A turbine takes in 1000-K steam and exhausts the steam at a temperature of 500 K. What is the maximum theoretical efficiency of this system?

    a. 24%
    b. 33%
    c. 50%
    d. 67%

27. A 2.00-kg block of ice is at STP while it melts completely to water. What is its change in entropy? (For ice, $L_f = 3.34 \times 10^5$ J/kg)

    a. zero
    b. 584 J/K
    c. 1 220 J/K
    d. 2 450 J/K

28. One kilogram of water at 1.00 atm (boiling point = 100°C) is heated until all the water vaporizes. What is its change in entropy? (For water, $L_v = 2.26 \times 10^6$ J/kg)

    a. 12 100 J/K
    b. 6 060 J/K
    c. 3 030 J/K
    d. 1 220 J/K

29. What is the change in entropy (ΔS) when one mole of silver (108 g) is completely melted at 961°C? (The heat of fusion of silver is 8.82×10^4 J/kg.)

    a. 5.53 J/K
    b. 7.72 J/K
    c. 9.91 J/K
    d. 12.10 J/K

30. An avalanche of ice and snow of mass 1 800 kg slides a vertical distance of 160 m down a mountainside. If the temperature of the ice, snow, mountain and surrounding air are all at 0°C, what is the change in entropy of the universe?

    a. 31 000 J/K
    b. 10 000 J/K
    c. 3 200 J/K
    d. 1 100 J/K

31. An electrical generating plant operates at a boiler temperature of 220°C and exhausts the unused heat into a nearby river at 18°C. What is the maximum theoretical efficiency of the plant? (0°C = 273 K)

    a. 61%
    b. 32%
    c. 21%
    d. 41%

32. An electrical generating plant operates at a boiler temperature of 220°C and exhausts the unused heat into a nearby river at 19°C. If the generating plant has a power output of 800 megawatts (MW) and if the actual efficiency is 3/4 the theoretical efficiency, how much heat per second must be delivered to the boiler? (0°C = 273 K)

    a. 5 200 MW
    b. 1 810 MW
    c. 3 620 MW
    d. 2 620 MW

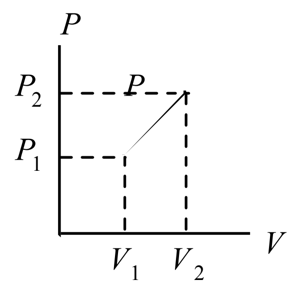
33. During each cycle of operation a refrigerator absorbs 55 cal from the freezer compartment and expels 85 cal to the room. If one cycle occurs every 10 s, how many minutes will it take to freeze 500 g of water, initially at 0°C? (L_v = 80 cal/g)

    a. 800 min
    b. 4 400 min
    c. 120 min
    d. 60 min

34. Which of the following increases the internal energy of a solid metal rod?

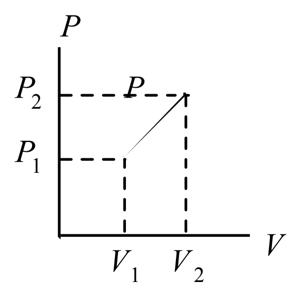
    a. raising it to a greater height
    b. throwing it through the air
    c. having the rod conduct heat
    d. having the rod absorb heat

35. What is the work done on the gas as it expands from pressure P_1 and volume V_1 to pressure P_2 and volume V_2 along the indicated straight line?



    a. $(P_1 + P_2)(V_1 - V_2)/2$
    b. $(P_1 + P_2)\ (V_1 - V_2)$
    c. $(P_1 + P_2)\ (V_1 - V_2)/2$
    d. $(P_1 - P_2)\ (V_1 + V_2)$

36. As the ideal gas expands from pressure P_1 and volume V_1 to pressure P_2 and volume V_2 along the indicated straight line, it is possible that:



    a. the temperature stays constant.
    b. the internal energy decreases.
    c. the gas is changing state.
    d. all of the above are impossible for this particular graph.

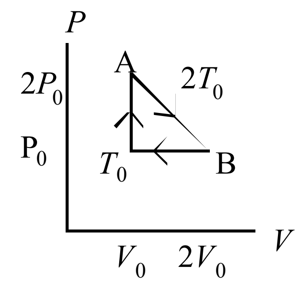
37. Heat is applied to an ice-water mixture to melt some of the ice. In this process:

    a. work is done by the ice-water mixture.
    b. the temperature increases.
    c. the internal energy increases.
    d. all of the above are correct.

38. In which system is heat usually transferred from the cooler part to the warmer part?

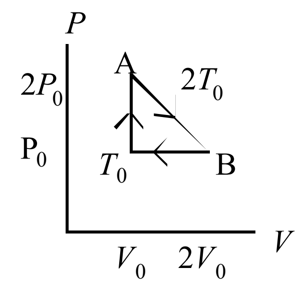
    a. a stove as it heats up water
    b. a refrigerator that is running
    c. an electric fan that is running
    d. none of the above, because it is impossible to transfer heat in this manner

39. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy increases by $3P_0V_0/2$ going from point T_0 to point A. How much heat entered the gas from point T_0 to point A?



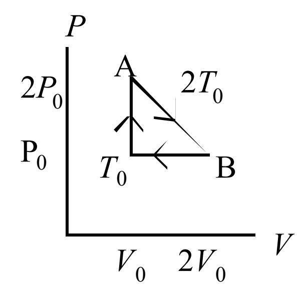
a. 0
b. $P_0V_0/2$
c. 3 $P_0V_0/2$
d. 5 $P_0V_0/2$

40. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy decreases by $3P_0V_0/2$ going from point B to point T_0. How much heat left the gas from point B to point T_0?



a. 0
b. $P_0V_0/2$
c. $3P_0V_0/2$
d. $5P_0V_0/2$

41. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy decreases by $3P_0V_0/2$ going from point B to point T_0. In going around this cycle once, which quantity equals zero?



a. the net change in internal energy of the gas
b. the net work done by the gas
c. the net heat added to the gas
d. All three are zero.

42. When gasoline is burned, it gives off 46 000 J/g of heat energy. If an automobile uses 13.0 kg of gasoline per hour with an efficiency of 21%, what is the average horsepower output of the engine? (1 hp = 746 W)

a. 47 hp
b. 110 hp
c. 67 hp
d. 34 hp

43. A bottle containing an ideal gas has a volume of 2.0 m^3 and a pressure of 1.0×10^5 Pa at a temperature of 300 K. The bottle is placed against a metal block that is maintained at 900 K and the gas expands as the pressure remains constant until the temperature of the gas reaches 900 K. The change in internal energy of the gas is $+6.0 \times 10^5$ J. How much heat did the gas absorb?

    a. 0
    b. 4.0×10^5 J
    c. 6.0×10^5 J
    d. 10×10^5 J

44. A bottle containing an ideal gas has a volume of 2.0 m^3 and a pressure of 1.0×10^5 Pa at a temperature of 300 K. The bottle is placed against a metal block that is maintained at 900 K and the gas expands as the pressure remains constant until the temperature of the gas reaches 900 K. The change in internal energy of the gas is 6.0×10^5 J. Find the change in entropy of the block associated with the heat transfer to the gas.

    a. 0
    b. +670 J/K
    c. −440 J/K
    d. −1 100 J/K

45. Suppose a power plant uses a Carnot engine to generate electricity, using the atmosphere at 300 K as the low-temperature reservoir. Suppose the power plant produces 1×10^6 J of electricity with the hot reservoir at 500 K during Day One and then produces 1×10^6 J of electricity with the hot reservoir at 600 K during Day Two. The thermal pollution was:

    a. greatest on Day One
    b. greatest on Day Two
    c. the same on both days
    d. zero on both days

46. The efficiency of a Carnot engine operating between 100°C and 0°C is most nearly:

    a. 7%
    b. 15%
    c. 27%
    d. 51%

47. The surface of the Sun is at approximately 5 700 K and the temperature of the Earth's surface is about 290 K. What total entropy change occurs when 1 000 J of heat energy is transferred from the Sun to the Earth?

    a. 2.89 J/K
    b. 3.27 J/K
    c. 3.62 J/K
    d. 3.97 J/K

48. An 800-MW electric power plant has an efficiency of 30%. It loses its waste heat in large cooling towers. Approximately how much waste heat (in MJ) is discharged to the atmosphere per second?

a. 1 200 MJ
b. 1 900 MJ
c. 800 MJ
d. 560 MJ

49. A gasoline engine with an efficiency of 30.0% operates between a high temperature T_1 and a low temperature T_2 = 320 K. If this engine operates with Carnot efficiency, what is the high-side temperature T_1?

a. 1 070 K
b. 868 K
c. 614 K
d. 457 K

50. Entropy is a measure of the ___________ of a system.

a. disorder
b. temperature
c. heat
d. internal energy

51. On a P-V diagram, an ______________ process is represented by a horizontal line.

a. isobaric
b. isothermal
c. isovolumetric
d. adiabatic

52. A thermodynamic process that happens very quickly tends to be

a. isobaric.
b. isothermal.
c. isovolumetric.
d. adiabatic.

53. The Carnot cycle consists of a combination of _____________ and ___________ processes.

a. isobaric, isovolumetric
b. isovolumetric, adiabatic
c. isobaric, isothermal
d. adiabatic, isothermal

54. Of the following heat engines, which has the highest efficiency?

    a. Hero's engine
    b. a Carnot engine
    c. a car's gasoline engine
    d. a truck's diesel engine

55. A Carnot engine runs between a hot reservoir at T_h and a cold reservoir at T_c. If one of the temperatures is either increased or decreased by 3.5 K, which of the following changes would increase the efficiency by the greatest amount?

    a. increasing T_h
    b. increasing T_c
    c. decreasing T_c
    d. cannot be determined from information given

56. On a P-V diagram, if a process involves a closed curve, the area inside the curve represents

    a. internal energy.
    b. heat.
    c. work.
    d. zero.

CHAPTER 12 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
1.	B	1	29.	B	2
2.	A	2	30.	B	2
3.	C	1	31.	D	2
4.	B	1	32.	D	2
5.	A	1	33.	C	3
6.	C	1	34.	D	1
7.	D	1	35.	A	2
8.	C	1	36.	D	3
9.	B	1	37.	C	2
10.	A	1	38.	B	1
11.	B	1	39.	C	3
12.	B	2	40.	D	3
13.	D	2	41.	A	3
14.	D	1	42.	A	2
15.	D	1	43.	D	2
16.	C	1	44.	D	3
17.	D	1	45.	A	3
18.	A	2	46.	C	2
19.	D	1	47.	B	3
20.	A	1	48.	B	2
21.	A	1	49.	D	2
22.	B	1	50.	A	1
23.	C	2	51.	A	2
24.	A	1	52.	D	2
25.	C	1	53.	D	2
26.	C	1	54.	B	1
27.	D	1	55.	C	3
28.	B	1	56.	C	2