Thermodynamics Problem Set

1. 100 ^{o}C converted to both the Fahrenheit scale and the kelvin scale is which of the following?

   a. 238 ^{o}F, 373.15 K
   b. 88 ^{o}F, 273.15 K
   c. 238 ^{o}F, 273.15 K
   d. 212 ^{o}F, 373.15 K

2. The amount of heat necessary to raise a body one degree of temperature (K or ^{o}C) is called:

   a. one calorie
   b. the specific heat capacity
   c. the heat capacity
   d. the molar heat capacity

3. A guitarist tunes the steel strings of her electric guitar in the cool air-conditioned environment of the hotel room. The neck and body of the guitar is wood. The coefficient of linear expansion for steel is 1.1×10^{-5} $(^{o}C)^{-1}$ and that for wood is 4.0×10^{-6} $(^{o}C)^{-1}$. When she begins to play that eveninig under the hot stage lighting:

   a. Her guitar will sound slightly flat.
   b. Her guitar will sound slightly sharp.
   c. Her guitar will be in tune.
   d. impossible to determine from given information.

4. When a mercury thermometer at room temperature is placed over a flame,

   a. The column of mercury first dips slightly then begins to rise
   b. The column of mercury rises quickly at first, then slows down.
   c. The column of mercury rises at a steady pace from the beginning on.
   d. none of the above.

5. Which of the following volumes is closest to that occupied by one mole of an ideal gas at room temperature?

   a. 22.4 liters
   b. 24.4 liters
   c. 18.9 liters
   d. 1 liter

6. What is the minimum energy required to transform a 100 g piece of ice at -50 ^{o}C into steam?

   a. 77.0 kcal
   b. 15.0 kcal
   c. 74.5 kcal
   d. 77.5 kcal

7. As compared to the day (17 ^{o}C) what is the percentage increase in the rate of heat loss at night (7 ^{o}C) from a house maintained at 27 ^{o}C?

a. 100%
b. 50%
c. 97%
d. impossible to determine from the given information

8. If the temperature on the surface of the sun were doubled, the intensity of heat on the side of the planet Mercury facing the sun would be approximately:

a. 2 times greater
b. 4 times greater
c. 8 times greater
d. 16 times greater

9. During an adiabatic free expansion of a gas:

I. The temperature remains constant.
II. The entropy of the gas increases.
III. The internal energy of the gas remains constant

a. I
b. I and III
c. II and III
d. I, II, and III

10. Using the key below, which of the following sequences represents the Carnot cycle?

AA. adiabatic expansion
BB. adiabatic compression
CC. isothermal expansion
DD. isothermal compression

a. DD, AA, CC, BB
b. CC, AA, DD, BB
c. BB, DD, AA, CC
d. more than one of the above

11. Which of the following statements is not true?

a. The Carnot cycle is reversible.
b. The entropy of the universe has increased after a complete Carnot cycle.
c. The Carnot cycle is not 100% efficient.
d. all of the above are true.

12. What is the maximum efficiency of an engine operating between 177 ^{o}C and 27 ^{o}C?

a. 33%
b. 85%
c. 50%

The following passage pertains to the questions on this page (13-17).

A car is traveling down a road in Spring. Although the temperature is above freezing, there are still snow drifts beside the road. The car loses control and plows into one of the snow drifts, completely submerging its tires. Before the wreck, the car's four tires contained a total of 30.3 L of air (assume the average molecular weight to be 16 g mol^{-1}, specific heat = 0.25 cal g^{-1} $^oC^{-1}$) at 8 X 10^6 Pa and 30 ^oC.

13. What is the mass of the air in the tires?

    a. 1.6 X 10^4 g
    b. 1.0 X 10^7 g
    c. 1.6 X 10^8 g
    d. 1.6 X 10^3 g

14. Which of the following most closely approximates the behavior of the tires after they are submerged in the snow?

    a. isothermal compression
    b. adiabatic compression
    c. isobaric compression
    d. more than one of the above

15. Which of the following statements is true?

    I. As heat flows from a tire into the snow, the entropy of the tire increases.
    II. As heat flows from a tire into the snow, the entropy of the snow increases.
    III. The magnitude of the entropy change in the snow is greater than the magnitude of entropy change in the tire.

    a. I
    b. I and III
    c. II and III
    d. I, II, and III

16. Assuming that the air in the tires (1600 g) behaves like an ideal gas, and assuming constant pressure, approximately how much snow is melted by heat flow from the air in the tires alone?

    a. 15 g
    b. 25 g
    c. 45 g
    d. impossible to determine from given information

17. The entire process of heat flowing from the tires into the snow bank could be reversed if:

    a. if a machine such as a heat pump were constructed to extract heat from the snow bank and transmit it into the tires at the rate of heat loss from the tires
    b. the heat flow occured at a slow enough rate
    c. the second law of thermodynamics precludes the reversibility of the process
    d. if we divide the heat flow rate per unit area by the temperature gradient

18. If an air-conditioner that runs at 25% efficiency under certain internal and external temperature conditions were turned around in the window to act as a heat pump. What would its COP equal?

    a. 2.5
    b. 4.0
    c. .50
    d. Such a device would violate the second law of thermodynamics.

19. If the fire below a pot of boiling water on a gas stove were doubled, so that heat flow into the water were also doubled:

    a. The rate of entropy change associated with the heat flow into the boiling water would be sixteen times greater.
    b. The rate of entropy change associated with the heat flow into the boiling water would be doubled.
    c. The rate of entropy change associated with the heat flow into the boiling water would remain the same.
    d. The water would get hotter.