Part I. Short answer and multiple choice questions. NOTE: On multiple choice questions, you are to circle the answer *or answers* which are correct. Some questions may have *no* correct answer, while for some questions, all the responses may be correct!
[Hint: For several of these you should draw a P-V diagram for the process and apply the first law.]

1. (3) During an isothermal expansion of an ideal gas,
   a. The internal energy of the gas increases.
   b. The work done by the gas is positive.
   c. Heat is added to the gas.

2. (3) When heat is added to a gas during an isometric (isochoric) process,
   a. The work done by the gas is negative.
   b. The pressure of the gas increases.
   c. The internal energy of the gas remains constant.

3. (3) When a gas is compressed at constant pressure (an isobaric process),
   a. The work done by the gas is positive.
   b. Heat is removed from the gas.
   c. The internal energy of the gas decreases.

4. (3) When a gas expands adiabatically,
   a. The temperature of the gas decreases.
   b. The change in internal energy of the gas is zero.
   c. No work is done by the gas.

5. (3) According to the first law of thermodynamics,
   a. If heat is added to the system, the internal energy of the system *must* increase.
   b. If heat is added to the system, the system *must* do work on the surroundings.
   c. If no heat is added to the system, the system can do no work on the surroundings.

6. (5) In a cyclic process involving an ideal gas,
   a) the net change in the internal energy of the gas is zero.
   b) no heat is added to the system.
   c) the net work done by the gas is always positive.
   d) the temperature of the gas always stays the same.
   e) the net heat added to the gas must equal to the net work done by the gas.

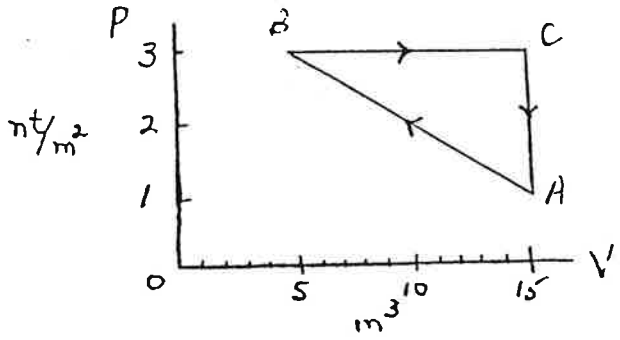
7. (5) In your own words, state the second law of thermodynamics.

PHYSICS 201

1. A 50 kg block of ice at 0°C slides down a frictionless incline from a height of one meter and then slides across a level floor. The coefficient of kinetic friction between the ice and the level floor is 0.20.
   a. How far will the block of ice slide before coming to rest?
   b. Assuming that 50% of the heat produced by friction goes into melting the ice, how much of the ice is melted? The heat of fusion of water 80 cal/gram.

2. A solar engineer designs a cyclic heat engine which uses the suns rays to heat a gas to 102°C, and a cold mountain stream to cool the gas back down to 2°C.
   a. What is the maximum theoretical efficiency of this engine?
   b. Assuming that the heat engine is reversible, if 100 cal of heat is absorbed from the high temperature reservoir in one cycle, how much work is done per cycle?
   c. If the engineer now uses the energy produced by this solar engine to work a refrigerator that has a coefficient of performance of 2.75, how many grams of water (originally at 0°C) can be changed into ice at 0°C per cycle? The heat of fusion of water is 80 cal/gram.

3. Gas within a chamber passes through the processes shown in the p-V diagram below. Calculate the net heat added to the system during one complete cycle.



TRUE OR FALSE:

_____ 4. It is possible to completely convert mechanical energy into heat energy.
_____ 5. It is not possible to completely convert an amount of heat energy into mechanical energy.
_____ 6. In a cyclic process $\Delta Q = 0$.
_____ 7. In a cyclic process $\Delta E = 0$, where E is the internal energy.
_____ 8. In a adiabatic process $\Delta Q = 0$.
_____ 9. The internal energy of a monatomic ideal gas is always a constant.
_____ 10. No heat engine operating between two heat reservoirs can be more efficient than a reversible heat engine (i.e. a Carnot heat engine) operating between the same two heat reservoirs.

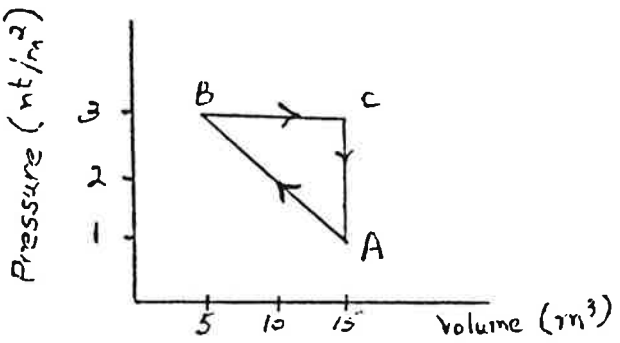
MULTIPLE CHOICE:

1. A reversible engine operates between two heat reservoirs with temperature of 400K and 300K. The efficiency of the engine is:
   (a) 25%; (b) 33%; (c) 300%; (d) not defined; (e) none of these

12. The heat engine mentioned in question 11 is reversed so that it works like a refrigerator. The coefficient of performance of the refrigerator is given by:
(a) 25; (b) 33; (c) 3.00; (d) not defined; (e) none of these.

13. A heat engine whose efficienty is 40% performs work at a rate of 10kWatt (10 kJ/sec). What is the amount of exhaust heat coming from the engine per second?
(a) 4kJ; (b) 25kJ; (c) 15kJ; (d) none of these

14. The following questions deal with the P-V diagram shown. (20 pts.)



Circle the correct answer or answers.

A. This system is performing like:

(a) refrigerator (b) an engine

Explain:

B. The net work done by the system in the cyclic process is:
(a) + 10 J; (b) - 10 J; (c) + 20 J; (d) - 20 J; (e) + 30 J; (f) zero
(g) none of these.

C. The net heat added to the system in one complete cycle is:
(a) + 10 J; (b) - 10 J; (c) + 20 J; (d) - 20 J; (e) + 30 J; (f) zero;
(g) impossible to determine

D. The net change in internal energy of the system in the cyclic process is:
(a) + 10 J; (b) - 10 J; (c) + 20 J; (d) - 20 J; (e) + 30 J; (f) zero;
(g) impossible to determine

E. The work done in going from C to A is:
(a) + 10 J; (b) - 10 J; (c) + 20 J; (d) - 20 J; (e) + 30 J; (f) zero;
(g) none of these.

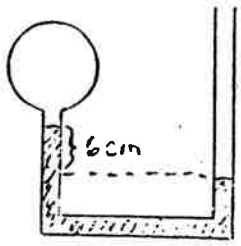
15. Briefly explain, describe, or define the following terms. If you includ an equation, explain what it means and define the symbols it contains.

    a. First Law of Thermodynamics

    b. Bouyant force

    c. State the second law of thermodynamics in two different ways.

16. If the atmospheric pressure is 760 mm of mercury what is the pressure inside the bulb if the liquid in the glass tube is also mercury?

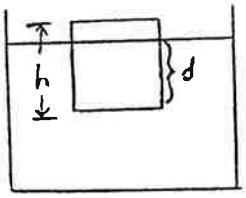


17. A solid block of wood 10 cm on a side (i.e., a cube) floats in water such that 1 cm of the block is above the water (i.e., d = 9 cm).

    a. Determine the specific gravity of the wood

$$\frac{\rho_{wood}}{\rho_{water}}$$

$h = 10\,cm$



    b. This same block is placed in a different liquid and d = 8 cm. What is the specific gravity of this liquid?