PHY 340
Assignment # 5

5-1. What is a blackbody? How do real bodies differ from a blackbody?

5-2. An ideal gas at a given state expands to a fixed final volume first at constant pressure and then at constant temperature. For which case is the work done greater?

5-3. Carbon dioxide contained in a piston-cylinder device is compressed from 0.3 to 0.1 m^3. During the process, the pressure and volume are related by $P = aV^{-2}$, where a = 8 kPa.m^6. Calculate the work done on the carbon dioxide during this process.
Answer: 53.3 kJ

5-4. Under what conditions is the relation $Q - W_{other} = H_2 - H_1$ valid for a closed system?

5-5. A closed system undergoes a cycle consisting of three processes. During the first process, which is adiabatic, 50 kJ of work is done on the system. During the second process, 200 kJ of heat is transferred to the system while no work interaction takes place. And during the third process, the system does 90 kJ of work as it returns to its initial state.
(a) Determine the heat transfer during the last process.
(b) Determine the net work done during this cycle.

5-6. Is the relation $\Delta H = m\, C_{P,av}\, \Delta T$ restricted to constant-pressure processes only, or can it be used for any kind of process of an ideal gas? (*av* stands for average)

5-7. A rigid tank contains 10 kg of air at 200 kPa and 27°C. The air is now heated until its pressure doubles. Determine *(a)* the volume of the tank and *(b)* the amount of heat transfer.
Answers: (a) 4.305 m3, *(b)* 2199 kJ

5-8. A 4 m x 5 m x 6 m room is to be heated by a baseboard resistance heater. It is desired that the resistance heater be able to raise the air temperature in the room from 7 to 23°C within 15 min. Assuming no heat losses from the room and an atmospheric pressure of 100 kPa, determine the required power of the resistance heater. Assume constant specific heats at room temperature.
Answer: 1.91 kW

5-9. An insulated rigid tank is divided into two equal parts by a partition. Initially, one part contains 3 kg of an ideal gas at 800 kPa and 50°C, and the other part is evacuated. The partition is now removed, and the gas expands into the entire tank. Determine the final temperature and pressure in the tank.

5-10. A mass of 15 kg of air in a piston-cylinder device is heated from 25 to 77°C by passing current through a resistance heater inside the cylinder. The pressure inside the cylinder is held constant at 300 kPa during the process, and a heat loss of 60 kJ occurs. Determine the electric energy supplied, in kWh.
Answer: 0.235 kWh

5-11. A piston-cylinder device contains 5 kg of argon at 400 kPa and 30°C. During a quasi-equilibrium, isothermal expansion process, 15 kJ of boundary work is done by the system, and 3 kJ of paddle-wheel work is done on the system. Determine the heat transfer for this process.
Answer: 12 kJ

5-12. A piston-cylinder device, with a set of stops on the top, initially contains 3 kg of air at 200 kPa and 27^{o}C. Heat is now transferred to the air, and the piston rises until it hits the stops, at which point the volume is twice the initial volume. More heat is transferred until the pressure inside the cylinder also doubles. Determine the work done and the amount of heat transfer for this process. Also show the process on a *P*-*V* diagram.

5-13. A piston-cylinder device contains helium gas initially at 150 kPa, 20°C, and 0.5 m^3. The helium is now compressed in a polytropic process (PV^n = constant) to 400 kPa and 140°C. Determine the heat transfer for this process.
Answer: -11.2 kJ