

**ChE 201 – Spring 2002 – Exam #1**  
**Pink Sheets Only – No Notes, No Textbook**  
**For  $C_p$  use only the A and B terms from Table B.2**  
**Put all work and solutions in the blue book**

1. (10 pts) Define the following terms:
  - a. adiabatic
  - b. isothermal
  - c. closed system
  
2. (15 pts for the sketch) Natural gas is burned with 20 % excess air in a boiler to produce steam (90 % gas, 10 % liquid) at 5 bar absolute pressure from liquid water at 100 °C and 5 bar absolute pressure. The natural gas consists of 90 mole % methane and 10 mole % ethane. The natural gas and air are mixed prior to entering the boiler. Natural gas enters the process at 15 psia and 30 °C, and passes through a compressor before being mixed with the air. The natural gas leaves the compressor at 22 psia and 50 °C with a velocity of 10 m/s, and is then mixed with the air. Air enters the process at 20 °C and 15 psia, and passes through a compressor and a preheater before being mixed with the natural gas. Air leaves the compressor at 22 psia and 35 °C with a velocity of 10 m/s. Air leaves the preheater at 200 °C and 22 psia. The combustion of natural gas in the boiler is complete. The stack gases leave the boiler at 800 °C and 15 psia, and are used to heat the air in the preheater before being vented to the atmosphere. The stack gases leave the preheater at 678 °C.
  - a. (20 pts) Calculate the amount of heat that must be transferred in the preheater per 100 moles natural gas fed to the process.
  - b. (15 pts) Calculate the minimum amount of work required by the natural gas compressor per 100 moles natural gas fed to the process.
  - c. (15 pts) Show / explain how to calculate the temperature of the air / gas mixture fed to the boiler per 100 moles natural gas fed to the process.
  - d. (15 pts) Calculate the minimum energy that must be supplied by the boiler per kg steam produced.
  
3. Draw a hypothetical process path to calculate the specific enthalpy of n-pentane at 1 atm and 50 °C relative to n-pentane at 25 °C and 2 atm. Show how you would calculate the change in specific enthalpy involved at each step.