MECH 225 Engineering Science 2

Tutorial Sheet - Application of Non-Flow Energy Equation

1. 0.05 kg of CO_2, relative molecular mass 44 kg/kmol, occupying a volume of 0.03m^3 at 102.5kPa is compressed reversibly until the pressure is 615kPa. Calculate the final temperature and the work transfer for the air:
   a) when the process is according to the law $pV^{1.4} = C$;
   b) when the process is isothermal.

Assume CO_2 to be a perfect gas, take R_0 = 8.314 kJ/kmol K.

(270°C; 5.145kJ; 52.6°C; 5.51kJ)

2. A quantity of gas occupying 0.14m^3 at a pressure of 1.4 MPa and temperature of 300°C is expanded adiabatically to 280kPa. If, for this gas, C_v = 0.74 kJ/kgK and Cp = 1.04 kJ/kgK, determine:
   a) the mass of the gas;
   b) the temperature of the gas after expansion;
   c) the work done during the expansion.

(1.14kg; 87°C; 180kJ)

3. A quantity of CO_2, initially occupying 0.10m^3 at pressure 101.3kPa and temperature 27°C is compressed according to the law $PV^n = C$, until it occupies 0.02m^3 at pressure 620kPa. Determine:
   a) the value of 'n';
   b) the change of internal energy;
   c) the heat transfer

For CO_2, C_v = 0.737 kJ/kgK. R = 0.189 kJ/kgK.

(n = 1.125; 8.69kJ; 9.47kJ (rejected))

4. The bore of a gas engine is 350mm, the stroke is 405mm and the clearance volume 6.2 x 10^{-3} m^3. When the piston is at inner dead centre, the gas pressure is 1.92MPa, and the temperature is 1100°C. The gas then expands according to the law $PV^{1.35}$ = constant as the piston moves to outer dead centre. Determine the work transfer during the expansion, the average force on the piston during the stroke, and the heat flow which occurs during the expansion, stating its direction. Take C_v = 710 J/kgK and R = 290 J/kgK.

(17.06kJ; 42.1kN; 2.46kJ (supplied).)

5. A certain gas occupies 4m^3 at 110 kPa and 20°C. It is compressed adiabatically in a closed system to a pressure of 690kPa. Determine:
   a) the final temperature
   b) the final volume
   c) the change in internal energy of the gas.

The density of the gas is 1.39kg/m^3 at 101.3kPa and 0°C, and the specific heat capacity at constant volume is 0.732 kJ/kgK.

(477.9 K, 1.04 m^3, 760.6 kJ)