Thermodynamics - 1

a) If a well-insulated tank of fluid is stirred by a rotating paddle wheel, the energy of the fluid increases. When the stirrer is stopped, will the energy of the fluid decrease and cause the stirrer to rotate in the opposite direction, as dictated by the first law of thermodynamics? **(10 points)**

b) Define a polytropic thermodynamic process indicating whether it applies to both reversible and irreversible processes. **(5 points)**

When applied to an ideal gas if and only if the ratio of energy transfer as heat to energy transfer as work at each slow step of the process is kept. **(5 points)**

TRUE or FALSE

c) One m^3 of a gas (can be considered to behave like an ideal gas) at 100kpa and 100^oC is polytropically compressed to a volume of 0.25 m^3 and a pressure of 600kpa. Given that R= 0.287kJ.kg, γ (gamma) =1.4, determine

i. Mass of the gas (m) **(10 points)**
ii. The value of index 'n' for compression **(10 points)**
iii. Change in the internal energy of the gas. **(10 points)**
iv. Show that the work done, $W = (mRT_2 - mRT_1)/(1-n)$. Calculate its value.

Explain the physical meaning of the sign associated with the value of W. **(10 points)**

v. Show that the heat transferred by the gas during the compression, Q is given by

$$Q = (W).(\gamma-n)/(\gamma-1)$$

Calculate the value of Q using this relationship and explain the physical meaning of the sign associated with it. **(15 points)**

Also, determine Q by using the first law of thermodynamics and the numerical values calculated in (iii) and (iv) above. Explain any difference between the two calculations of Q, if any. **(5 points)**

vi. Show that the specific heat for a polytropic process (C_n) can be calculated from the given values of R, γ, and n using the following expression

$$C_n = R/(-1+\gamma) + R/(1-n)$$ **(10 points)**

Calculate the value of C_n and explain its physical meeting. **(10 points)**

To verify the correctness of your expression for C_n , calculate Q using C_n and check if it matches with the calculated values of Q in (v) and (vi).