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1. Explain the following terms:
   (a) work
   (b) heat
   (c) the compressibility factor, Z
   (d) the critical state
   (e) stagnation enthalpy
   (f) the Joule-Thomson coefficient. (18%)
2. Air expands adiabatically through a nozzle from a pressure of 5 atm and a temperature of 2000 K to a final pressure of 1 atm. The enthalpy of air decreases by 120 kJ/kg during the expansion. If the entering velocity of air is 10 m/s, compute the exit velocity. (15%)
3. Answer the following true or false. If false, explain why (答錯倒扣一半分數, 請勿猜寫!!) (8%)
   (i) When a net amount of energy is added by heat transfer to a closed system undergoing an internally reversible process, a net amount of work is also done.
   (ii) A process that violates the second law of thermodynamics violates the first law of thermodynamics.
   (iii) A reversible heat pump and a reversible refrigerator operating between the same two reservoirs have the same COP.
   (iv) A gas contained within a piston-cylinder assembly expands adiabatically. The gas is subsequently compressed back to its initial state. The gas undergoes a reversible process.
4. Please answer the following questions: (8%)
   (v) An ideal gas undergoes a process between two specified temperatures, first at constant volume and then at constant pressure. For which case will the ideal gas experience a larger entropy change? For which case will the ideal gas experience more work output?
   (vi) Does a heat pump that has a higher COP necessarily have a higher second-law efficiency than one with a lower COP? Explain.
5. Consider two bodies of identical mass m and specific heat C. The first body is initially at an absolute temperature T_1 while the second one is at a lower absolute temperature T_2. If these two bodies are brought into contact, please determine (i) the final temperature T_{f1}, If heat is transferred from the first body to the heat engine, which rejectes the waste heat to the second body. The process continues until the final temperature of the two bodies T_{f2} are equal. Show that (ii) $T_{f2} = \sqrt{T_1 T_2}$ when the heat engine produces the maximum possible work, and

（背面仍有題目,請繼續作答）

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that (iii) $T_{f1} > T_{f2}$, and that (iv) the maximum theoretical amount of work that can be developed is $W_{max} = mC[T_1 + T_2 - 2(T_1T_2)^{1/2}]$. (18%)

6. If one wants to evaluate the enthalpy changes of a real gas by the following equation:

$$h_2 - h_1 = \int_{T_1}^{T_2} C_p dT + \int_{P_1}^{P_2} \left[v - T\left(\frac{\partial v}{\partial T}\right)_P \right] dP$$

Please describe in a T-s diagram that how you would find the enthalpy changes. (16%)

7. Please describe and give a brief reason how you could modify a Brayton cycle so as to increase the net power output, at the same time to increase or at least not to decrease the efficiency of the cycle. It is noted that due to the material limitations the P_{out} from the compressor and T_{out} from the combustor can not be raised any further and have to be kept at fixed values. (17%)