1. Please describe the internal energy (or energy change) from microscopic point of view. (10%)

2. (a) What is the mass of a substance weighted $64\,lb_f$ on the surface of moon? (3%)

   (b) Please discuss the number of properties required to determine the state of a closed system of a mixture of alcohol and water. (3%)

   (c) Please describe the physical meanings of "ideal gas" and its thermodynamic characteristics. (4%)

3. Considering a human body as a powerplant, please identify the relative variables for energy and entropy analyses of a man riding a bicycle. (14%)

4. A 1 m^3 insulated rigid tank contains 1.1 kg of air at 100 kPa. Now paddle-wheel work is done the system until the pressure in the tank rises to 120 kPa. Please a) determine the minimum work done with which this process could be accomplished. Take $T_o = 298^oK$. Assume that c_p, c_v and gas constant R of air is constant and is equal to 1.005, 0.718 and 0.287 kJ/kgK respectively. (16%)

5. An insulated rigid tank is divided into two equal parts by partition. Initially, one part contains 3 kg of air gas at 300 kPa and 75°C, and the other side is evacuated. The partition is now removed, and the gas fills the entire tank. Assuming the surroundings to be at 25°C, determine the exergy destroyed during this process if the same c_p, c_v and R of air property in the previous problem are used. (17%)

(背面仍有題目,請繼續作答)

6. (15%)The state principle of thermodynamics states that the number of independent properties for a thermodynamic system is one plus the number of relevant work interaction. Therefore, for a simple system a total of two independent properties are needed to fix the state. Tthe specific internal energy and enthalpy can be expressed as a function of $u(T,v)$ and $h(T, p)$. On the other hand, the ideal gas model constitutes by the following specifications:

$$pv = RT$$
$$u = u(T)$$
$$h = h(T) = u(T) + RT$$

where the universal gas constant $R = \lim_{p \to 0} \frac{pv}{T}$. Please show that for any gas whose equation of state is given exactly by $pv=RT$, the specific internal energy depends on temperature only.

In deriving the relations you may need the following equations:

$$ds = (\frac{\partial s}{\partial T})_v dT + (\frac{\partial s}{\partial v})_T dv = (\frac{\partial s}{\partial T})_v + (\frac{\partial p}{\partial T})_v dv$$
$$du = c_v dt + (\frac{\partial u}{\partial v})_T dv = (\frac{\partial u}{\partial T})_v dT + (\frac{\partial u}{\partial v})_T dv = Tds - pdv$$

7. (18%)(a)Please derive the thermal efficiency for a cold air-standard gas turbine (Brayton) cycle in terms of the compressor pressure ratio or the turbine inlet temperature (T_4), also please state clearly all the assumptions you made in the derivation. (b) In reality there is a limit of about 1700K imposed by metallurgical consideration on the maximum allowed temperature at the turbine inlet. Please argue that under the constraint of the fixed turbine inlet temperature and the minimum weight requirement of an aircraft engine, the design option of the engine is to choose a compressor pressure ratio to yield the most work per unit of mass rather than to choose the compressor pressure ratio to generate the greatest thermal efficiency. Please derive the compressor pressure ratio that yields the most work per unit of mass of inlet air. (c) Please sketch the T-S diagram showing the Bayton cycle with fixed turbine inlet temperature producing higher thermal efficiency and the one yielding larger work output per unit of mass.