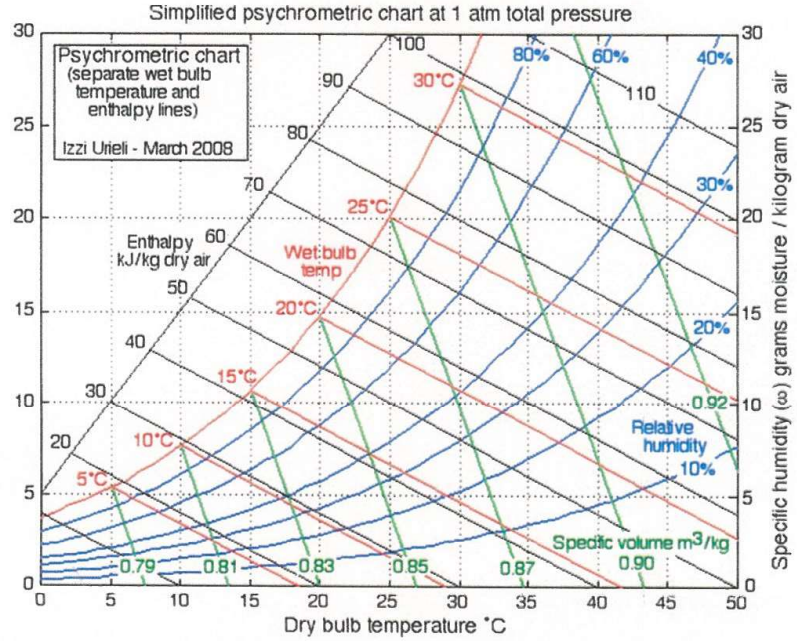
1. For a micro-environment of dry-bulb temperature= 25°C, and relative humidity= 60%. Please determine:
(a) (5%) The specific humidity of the air in the space
(b) (5%) The maximum temperature of the surface to dehumidify the air in the space
(c) (5%) When the direct evaporative cooling is applied in the space, how many degrees of the maximum temperature drop can be achieved?




2. (a) (5%) Suppose you want to operate an ideal refrigerator with a cold temperature of −10.0°C, and you would like it to have a coefficient of performance of 7.00. What is the hot reservoir temperature for such a refrigerator?

(b) (5%) What is the best coefficient of performance for a heat pump that has a hot reservoir temperature of 50.0°C and a cold reservoir temperature of −20.0°C? (5%) How much heat transfer occurs into the warm environment if $3.60 \times 10^7$ J of work is put into it?

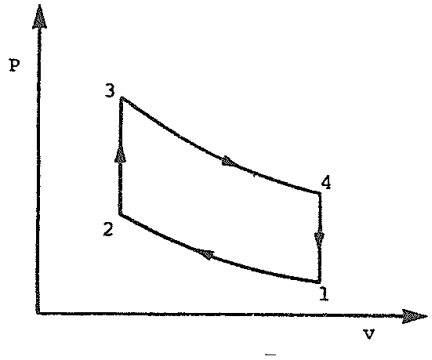
3. Please derive (a) (8%) the Joule-Thomson coefficient and (b) (7%) the inversion temperature for a gas whose equation of state is $(P-\frac{a}{v^2})(v-b)=RT$.

4. 4 kg of nitrogen is contained in an insulated rigid tank at 1 MPa and 30°C. A valve is now opened, and nitrogen is allowed to escape until the pressure reach 500 kPa. Please determine:
(a) (8%) The final temperature.
(b) (7%) The amount of mass that escapes the tank.
For nitrogen, $T_{cr}$=126.2 K, $P_{cr}$=3.39 MPa. Please state clearly all of your assumptions.

5. (10%) The ambient temperature in an outdoor ice-skating rink is at -5°C. How much force should one exert to skate smoothly at this temperature if the width and length of the skate blade are 1 mm and 30 cm ? Assume that enthalpy of fusion for water is 333.55 J/g. The density of water and ice at this temperature are assumed 1000 kg/m$^3$ and 917.5 kg/m$^3$. Please state clearly all of your assumptions.

見背面

6. *P-v* diagram of an ideal air standard Otto cycle is shown here in which the salient points are 1, 2, 3, and 4, and the upper and lower limits of absolute temperatures are $T_3$ and $T_1$, and the constant-volume specific heat is $C_v$. Please state clearly all of your assumptions.




(a) (10%) Derive the net work per cycle in terms of $C_v$, temperature, and compression ratio $R_c$.

(b) (8%) What is the compression ratio value to achieve the maximum work per mass of air?

(c) (7%) Express the intermediate temperature $T_2$ and $T_4$ in (b) in terms of $T_1$ and $T_3$.

(d) (5%) What is the maximum theoretical efficiency of this engine if the fuel-air mixture is initially at 25 °C and the mixture is compressed by a factor of 7.8?

試題隨卷繳回