1. Determine the enthalpy of reaction at the standard-state pressure of 1.0 atm and 2000 K for the water-gas reaction

$$H_2O + CO \rightleftharpoons H_2 + CO_2$$

(20 %)

Table LOGARITHMS TO THE BASE E OF THE EQUILIBRIUM CONSTANTS, K_p

Temp. K	$H_2 \rightleftharpoons 2H$	$O_2 \rightleftharpoons 2O$	$N_2 \rightleftharpoons 2N$	$H_2O \rightleftharpoons H_2 + \frac{1}{2}O_2$	$H_2O \rightleftharpoons \frac{1}{2}H_2 + OH$	$CO_2 \rightleftharpoons CO + \frac{1}{2}O_2$	$\frac{1}{2}N_2 + \frac{1}{2}O_2 \rightleftharpoons NO$
298	−164.005	−186.975	−367.480	−92.208	−106.208	−109.762	−35.052
500	−92.827	−105.630	−213.372	−52.691	−60.281	−57.616	−20.295
1000	−39.803	−45.150	−99.127	−23.163	−26.034	−23.529	−9.388
1200	−30.874	−35.005	−80.011	−18.182	−20.283	−17.871	−7.569
1400	−24.463	−27.742	−66.329	−14.609	−16.099	−13.842	−6.270
1600	−19.637	−22.285	−56.055	−11.921	−13.066	−10.830	−5.294
1800	−15.866	−18.030	−48.051	−9.826	−10.657	−8.497	−4.536
2000	−12.840	−14.622	−41.645	−8.145	−8.728	−6.635	−3.931
2200	−10.353	−11.827	−36.391	−6.768	−7.148	−5.120	−3.433
2400	−8.276	−9.497	−32.011	−5.619	−5.832	−3.860	−3.019
2600	−6.517	−7.521	−28.304	−4.648	−4.719	−2.801	−2.671
2800	−5.002	−5.826	−25.117	−3.812	−3.763	−1.894	−2.372
3000	−3.685	−4.357	−22.359	−3.086	−2.937	−1.111	−2.114
3200	−2.534	−3.072	−19.937	−2.451	−2.212	−0.429	−1.888
3400	−1.516	−1.935	−17.800	−1.891	−1.576	0.169	−1.690
3600	−0.609	−0.926	−15.898	−1.392	−1.088	0.701	−1.513
3800	0.202	−0.019	−14.199	−0.945	−0.501	1.176	−1.356
4000	0.934	0.796	−12.660	−0.542	−0.044	1.599	−1.216
4500	2.486	2.513	−9.414	0.312	0.920	2.490	−0.921
5000	3.725	3.895	−6.807	0.996	1.689	3.197	−0.686
5500	4.743	5.023	−4.666	1.560	2.318	3.771	−0.497
6000	5.590	5.963	−2.865	2.032	2.843	4.245	−0.341

2. At the triple state of water the pressure and temperature are 6.12 mbar and 0.010°C . The enthalpy of melting is 333.4 kJ/kg, and the specific volumes of the liquid and solid phases are 1.0002 and 1.0911 cm^3/g, respectively. A person skates on ice at 30°F on blades with a contact area of 0.32 cm^2. What must the weight and the mass, in N and kg, respectively, of a person be to just melt the ice beneath the blades. (10 %)

3. A nozzle is required to produce a stream of air at 200 m/s at a condition of 20°C, 100 kPa. It is estimated that the nozzle has an efficiency of 92 % . What nozzle inlet pressure and temperature are required?
(The gas constant of air R is 0.287 kJ/kgk) (20 %)

4. An ideal gas proceeds a reversible adiabatic process. If it has constant specific heats, it will follow the process equation of pv^k = const ;where p, v and k are the pressure , specifit volume and specific heat ratio, respectively. Please verify this equation. If the specific heats are not constant but function of temperature , what's appropriate process equation can you present? Why ? (20 %)

5. (a) For equal maximum pressure and work done, which cycle will be more efficient ? the Diesel or Otto cycle ?
(b) For the same temperature limits and equal amounts of heat added , which cycly will be more efficient ? the Diesel or Otto cycle ?
The above two cycles should have a common state corresponding to the start of compression . Please explain your results by pressure-volume and temperature-entropy diagram. (20 %)

6. (a) How is the Joule-Thomson experiment useful in determining thermodynamic properties ? (4 %)
(b) What is the inequality of Clausius and how is it related to entropy? (6%)