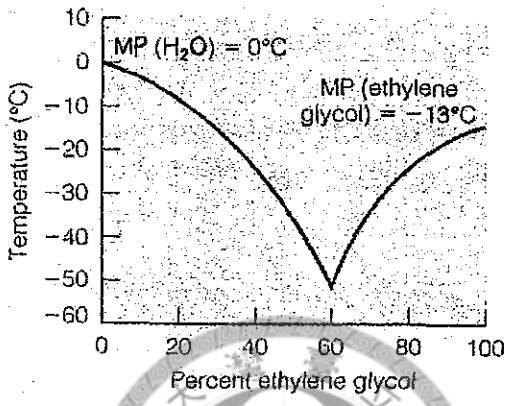
1. The following figure shows a phase diagram of H_2O and ethylene glycol. Explain why this mixture, in an approximately 50：50 mixture, is used as a coolant and antifreeze in automobile engines.(15%)



2. The second law of thermodynamics states that entropy increases for spontaneous processes and that an increase in entropy is associated with transitions from ordered to disordered states. Living organisms, even the simplest bacteria growing in cultures, appear to violate the second law, because they grow and proliferate spontaneously. They convert simple chemical substances into the highly organized structure of their descendants. Write a critical evaluation of the proposition that living organisms contract the second law. Be sure to state your conclusion clearly and to present detailed arguments to support it.(15%)

3. Show that for an ideal gas, $\left[C_p-\left(\frac{\partial U}{\partial T}\right)_p-\left(\frac{\partial H}{\partial P}\right)_S\left(\frac{\partial P}{\partial T}\right)_V\right]=0$。(15%)

4. State whether or not the Clausius-Clapeyon equation strictly applicable to the following phase transitions.(15%)
   (a) Sublimation of ice in your freezer.
   (b) Condensation of steam into water.
   (c) Conversion of diatomic oxygen $O_{2(g)}$, to triatomic ozone $O_{3(g)}$.
   (d) Formation of diamond under pressure from graphite.
   (e) Evaporation of mercury liquid, $Hg_{(l)}$ from a broken thermometer.

5. A particle having mass m is described as having the (unnormalized) wavefunction Ψ=k, where k is some constant when confined to an interval in

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one dimension, that interval having length a (that is, the interval of interest is x=0 to a). What is the probability that the particle will exist in the first third of the internal, that is, from x=0 to (1/3)a ? What is the probability that the particle will be in the box from x=(2/3)a to a. (20%)

6. under certain conditions the decomposition of nitrogen dioxide according to the equation $2NO_2 \rightarrow 2NO + O_2$ follows the rate equation

$$\text{Rate} = k[NO_2]^2$$

The following values of k as a function of temperature have been reported

T, K	592	603.2	627	651.5	656
k, L mol^{-1} s^{-1}	0.522	0.755	1.700	4.020	5.030

Deduce the values of the parameters in the Arrehenius equation $k = Ae^{-E_a/(RT)}$ (20%)