PHYSICS EXAMINATION PROBLEMS
SOLUTIONS AND HINTS FOR STUDENT SELF-STUDY

Module Code	PHY2201
Name of module	Statistical Physics
Date of examination	Jan 2003

1. i) a) 8855,

   b) broadens the energy levels (not covered in 2004 syllabus).

   ii) $dp_i/dt = \sum_j \nu_{ij}\left(p_j - p_i\right)$ (NB this topic does not appear in the 2004) syllabus

2. i) $$p_r = \frac{\exp\left(-\varepsilon_r/k_B T\right)}{\sum_r \exp\left(-\varepsilon_r/k_B T\right)}$$

   $$\overline{\Omega} = \sum_r \Omega_r p_r = \frac{\sum_r \Omega_r \exp\left(-\varepsilon_r/k_B T\right)}{\sum_r \exp\left(-\varepsilon_r/k_B T\right)}$$

   NB do not confuse the use of Ω in this question with its more usual use i.e. to represent the number of microstates compatible with a given macrostate.

   ii) a) they are equal (principle of equal probability for all accessible microstates)

   b) macrostate B is more probable than A (higher entropy) as Ω (number of microstates compatible with that macrostate) is higher for B.

   iii) thermal: max of entropy, as defined by Clausius's formula.

   Statistical: max. of Ω ie. rvolution towards the most probable energy sharing configuration.

3. i) Use Clausius's defn of entropy change and relation between S,U,V and T given by FTR. Require that $dS_{total} > 0$ as change is irreversible. Hence show that $d'Q_A < 0$ if $T_A > T_B$. NB $d'Q$ means the inexact differential "d-bar Q".

   ii) Kelvin statement, from notes. Entropy cannot fall, easy to show it would if Kelvin statement violated.

   iii) Use fact that dS_{total} = zero if the process is perfectly reversible, which in turn implies greatest poss. efficiency.

4. a) Carnot cycle – see notes

   b) ditto.

   c) adiabatic: dS=zero. Isotherma $dS=\Delta Q/T$

   d) Implied by 1st law and fact that U is a fn of state.

   e) see notes. $\eta = 1 - T_2/T_1$ ($T_2 < T_1$)

5. i) see notes

   ii) not covered in 2004 syllabus.