Revision lecture

- Important things to know
  - Exam
  - Past papers
  - Office hours
  - Course content

- Key concepts in the course

Exam

- Friday the 15th of June at 10am
- Joint with thermodynamics
- Lasts 2 hours

THERMODYNAMICS & STATISTICAL PHYSICS

For 2nd-Year Physics Students

Friday, 11th June 2010: 10:00 to 12:00

Answer ALL parts of Section A, ONE question from Section B and ONE question from Section C.
Marks shown on this paper are indicative of those the Examiners anticipate assigning.

General Instructions

Complete the front cover of each of the 4 answer books provided.

If an electronic calculator is used, write its serial number at the top of the front cover of each answer book.

USE ONE ANSWER BOOK FOR EACH QUESTION.

Enter the number of each question attempted in the box on the front cover of its corresponding answer book.

Hand in 4 answer books even if they have not all been used.

You are reminded that Examiners attach great importance to legibility, accuracy and clarity of expression.

SECTION A

1. (i) State the third Law of Thermodynamics. [2 marks]

(ii) A Carnot cycle is run as a heat pump operating between a hot and a cold reservoir.

(a) State briefly what is a Carnot cycle. [2 marks]

(b) Is heat taken from the cold reservoir during a cycle of operation? [1 mark]

(c) Which of the two reservoirs experience the largest heat exchange (i.e., magnitude of heating or cooling) with the working substance during each cycle of operation? Do not forget to explain briefly your answer. [2 marks]

(iii) Write down Clausius' inequality, identifying all the variables in it. [2 marks]

(iv) A paramagnetic material is initially at temperature T_o and possesses a net magnetic moment $\mathcal{M}_o$. It is then demagnetized fully through a reversible and adiabatic process. Express the final temperature T_1 as a function of T_o and $\mathcal{M}_o$, and discuss physically why you find a larger (or smaller) final temperature.

[3 marks]

Information needed: Entropy of a paramagnetic solid $S = C_{\mathcal{M}} \ln T - \frac{\mu_o}{2C_C}\mathcal{M}^2$ in which $C_{\mathcal{M}}, \mu_o$ and C_C are constants.

[Total 12 marks]

2. (i) Write down the expression for the entropy of an isolated system, identifying the symbols that appear in it and explaining their meaning. [4 marks]

(ii) Consider a system of 3 spin-1 particles in a magnetic field. The single particle states are labelled by $r \in \{-1, 0, 1\}$ and have energies

$$\epsilon_r = \mu B r,$$

where μ is the magnetic moment and B is the magnetic field strength. List the possible microstates with zero total energy, $E = 0$, if the particles are

(a) distinguishable,

(b) indistinguishable,

giving a brief explanation why. [4 marks]

[Total 8 marks]

Section C

- Two questions (5 and 6)
- Both cover statistical physics
- You must do one of them

Four answer books

- Section A Q1 (thermodynamics short questions)
- Section A Q2 (stat. phys. short questions)
- Section B, Q3 or Q4 (thermodynamics)
- Section C, Q5 or Q6 (statistical physics)

Past papers

Year	Q 2	Q 5	Q 6
2011	All	All	All
2010	All	All	Parts i and ii, have a stab at the rest
2009	All	All	All
2008	All	All apart from ii (d)	All
2007	All	All	All

Office hours

- Huxley 6M71 (floor 6M)
- I have tried to schedule these to be convenient for your exams, etc.

- Thursday 31st May, 4pm
- Friday 8th June, 12pm
- Monday 11th June, 12pm
- Wednesday 13th June, 12pm
- Thursday 14th June, 10am

- Look at Blackboard for the definitive schedule!

Course materials

What it's called	When you got it	What it covers
Handout 1	10 Jan	Aims and objectives
Classwork 1	16 Jan	Counting and the statistical weight
Problem sheet 1	16 Jan	Lagrange multipliers; paramagnetic solids as an example thermodynamic system
APS4 section B	20 Jan	Statistical physics of a 2 level system
Problem sheet 2	23 Jan	Harmonic oscillators; internal energy for large N
Classwork 2	27 Jan	A statistical view of work and heat
Classwork 3	3 Feb	The diatomic classical gas
Problem sheet 3	3 Feb	The grand canonical ensemble; chemical reactions
Problem sheet 4	7 Feb	Quantum effects
APS5 section B	10 Feb	A 2D degenerate electron gas
Handout 2	7 Feb	Course summary
Handout 3	25 May	Some important equations

Help!

- Look at a textbook
  - Guenault is a good place to start
- Come to an office hour
- Talk to your friends
- Go through past papers
  - They’re not as hard as all that

GOOD LUCK!