University of Salford MANCHESTER

BSc Physics

Level 5 Induction Session

15th September 2023

11 September 2023	*Welcome/Induction*		0	
18 September 2023	**Trimester 1**	1	1	
25 September 2023	**Trimester 1**	2	2	✓
2 October 2023	**Trimester 1**	3	3	✓
9 October 2023	**Trimester 1**	4	4	✓
16 October 2023	**Trimester 1**	5	5	✓
23 October 2023	**Trimester 1**	6	6	✓
30 October 2023	**Trimester 1**	7	7	✓
6 November 2023	**Trimester 1**	8	8	✓
13 November 2023	**Trimester 1**	9	9	✓
20 November 2023	**Trimester 1**	10	10	✓
27 November 2023	**Trimester 1**	11	11	✓
4 December 2023	**Trimester 1**	12	12	✓
11 December 2023	**Trimester 1**	13	13	✓
18 December 2023	*Christmas Vacation*		14	
25 December 2023	*Christmas Vacation*		15	
1 January 2024	*Christmas Vacation*		16	
8 January 2024	*Welcome/Induction*		17	✓
15 January 2024	**Trimester 2**	1	18	✓
22 January 2024	**Trimester 2**	2	19	✓
29 January 2024	**Trimester 2**	3	20	✓
5 February 2024	**Trimester 2**	4	21	✓
12 February 2024	**Trimester 2**	5	22	✓
19 February 2024	**Trimester 2**	6	23	✓
26 February 2024	**Trimester 2**	7	24	✓
4 March 2024	**Trimester 2**	8	25	✓
11 March 2024	**Trimester 2**	9	26	✓
18 March 2024	**Trimester 2**	10	27	✓
25 March 2024	*Easter Vacation*		28	*(Bank Holiday Friday)*
1 April 2024	*Easter Vacation*		29	*(Bank Holiday Monday)*
8 April 2024	*Easter Vacation*		30	
15 April 2024	**Trimester 2**	11	31	✓
22 April 2024	**Trimester 2**	12	32	✓
29 April 2024	**Trimester 2**	13	33	✓

Modules

T1	**Electro-magnetism** John Proctor	**Quantum Physics** Ian Morrison	**Thermal Physics** Dan Bull	**Waves and Optics** James Christian Tiehan Shen	**Physics Laboratory 2** Heather Yates (Experimental) Dan Bull (Computational)	**Option Modules** Acoustics Languages
T2					**Option Module** Group Project	

Trimester 1 Timetable

	9	10	11	12	13	14	15	16	17
Mon									
Tue	**Electromagnetism** Peel G10				**Quantum Physics** Maxwell 819				
Wed									
Thu	**Waves and Optics** Maxwell 819				**Thermal Physics** Maxwell 819				
Fri		**Physics Lab: Exp GROUP A** SEE Building SB3.07				**Physics Lab: Computing GROUP A** Maxwell 200			
		Physics Lab: Computing GROUP B Maxwell 200				**Physics Lab: Exp GROUP B** SEE Building SB3.07			

Assessment Deadlines

TRIMESTER 1 ASSIGNMENT DEADLINES		
Quantum Physics	50%	Wednesday 6th December
Thermal Physics	50%	Friday 8th December
Physics Laboratory 2 (Experimental)	50%	Monday 11th December
Electromagnetism MCQ Test	30%	Tuesday 12th December
Physics Laboratory 2 (Computing)	50%	Wednesday 13th December
Waves and Optics WAVES ONLY	50%	Friday 15th December

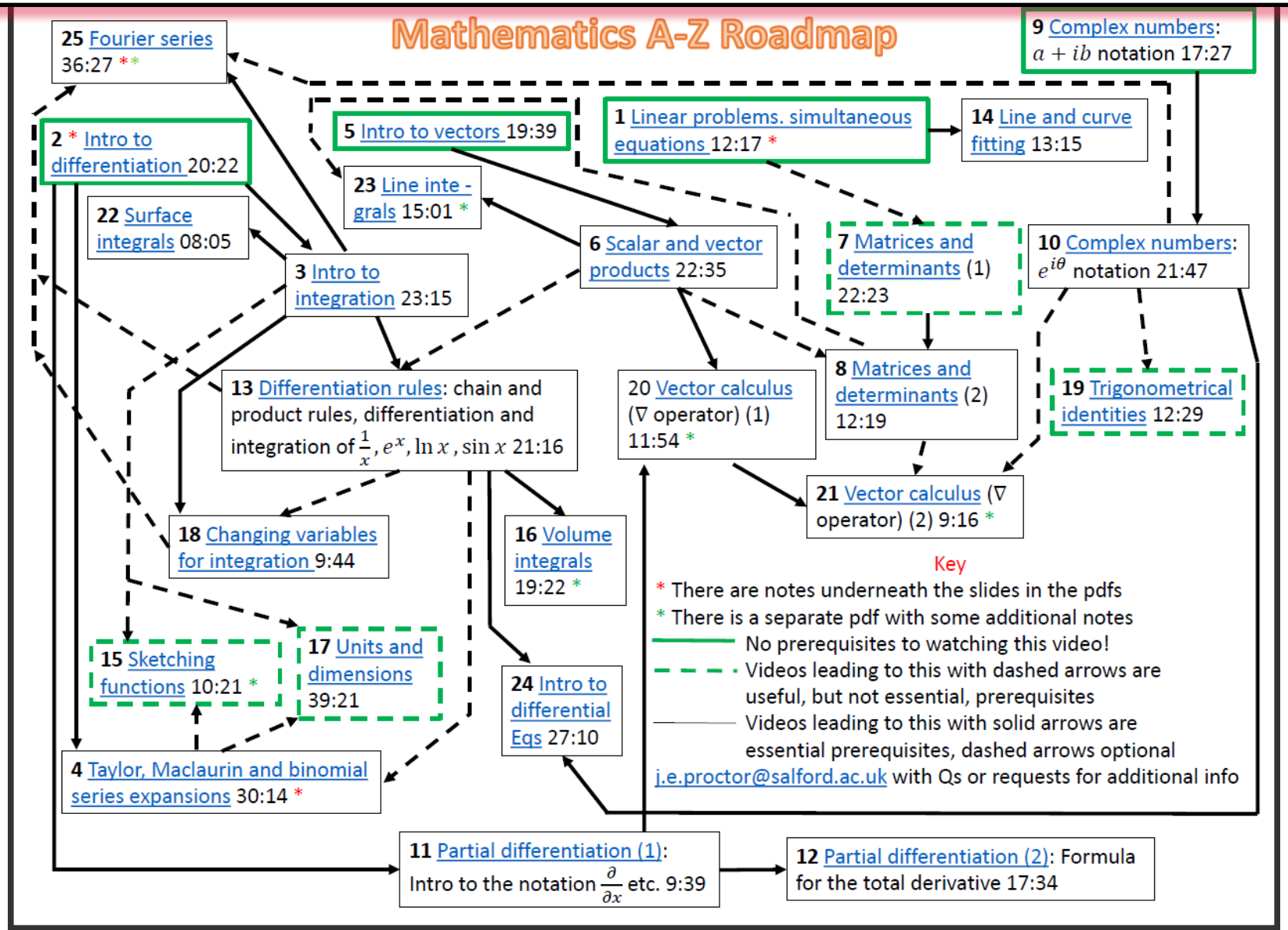
TRIMESTER 2 ASSIGNMENT DEADLINES		
Group Project (CAD and Interfacing Exercises)	30%	Friday 1st March
Group Project (Report and Presentation)	70%	Friday 26th April
Electromagnetism (Exam)	70%	Friday 26th April **[PROVISIONAL]**
Quantum Physics (Exam)	50%	Monday 29th April **[PROVISIONAL]**
Thermal Physics (Exam)	50%	Wednesday 1st May **[PROVISIONAL]**
Waves and Optics (Exam) OPTICS ONLY	50%	Friday 3rd May **[PROVISIONAL]**

Electromagnetism

Learning outcomes

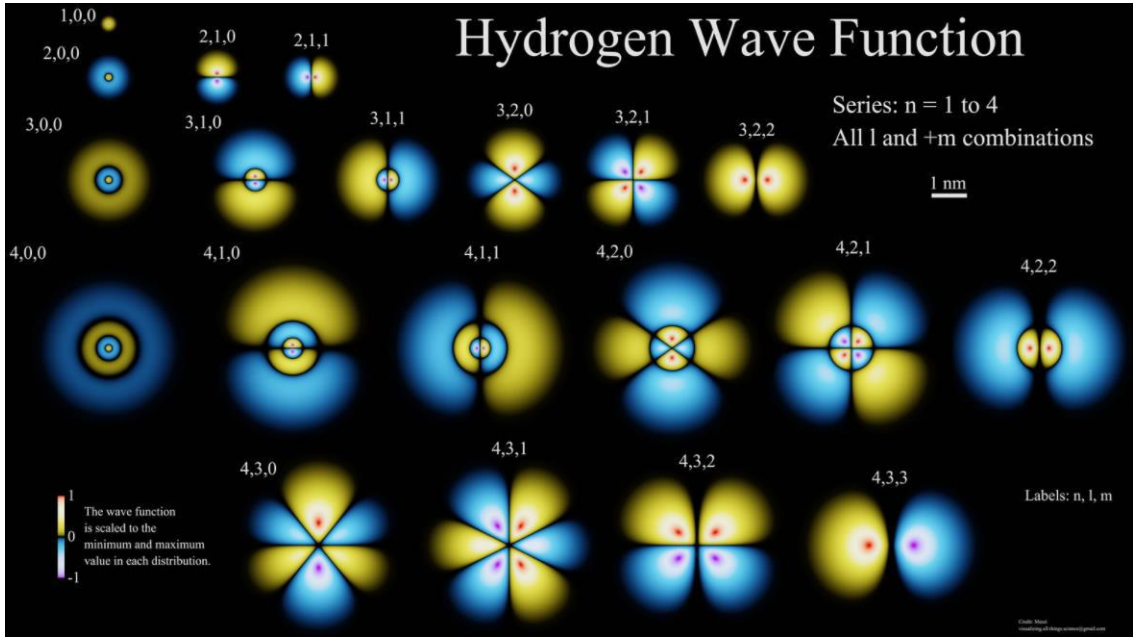
- The basic laws of electric interaction (Coulomb's law -> Gauss's law etc.)
- The basic laws of magnetic interactions, leading to understanding of electromagnetic self-induction and mutual induction.
- The construction of Maxwell's equations. Their solution for the electric fields from monopoles and dipoles, magnetic fields from dipoles and the propagation of electromagnetic waves in vacuum.
- Common examples of static electric and magnetic fields.
- Reflection and refraction of electromagnetic waves, and propagation down transmission lines / waveguides.
- Generation of electromagnetic waves from antenna, synchrotron effect.

Electromagnetism (but relevant to all modules)



Quantum Physics

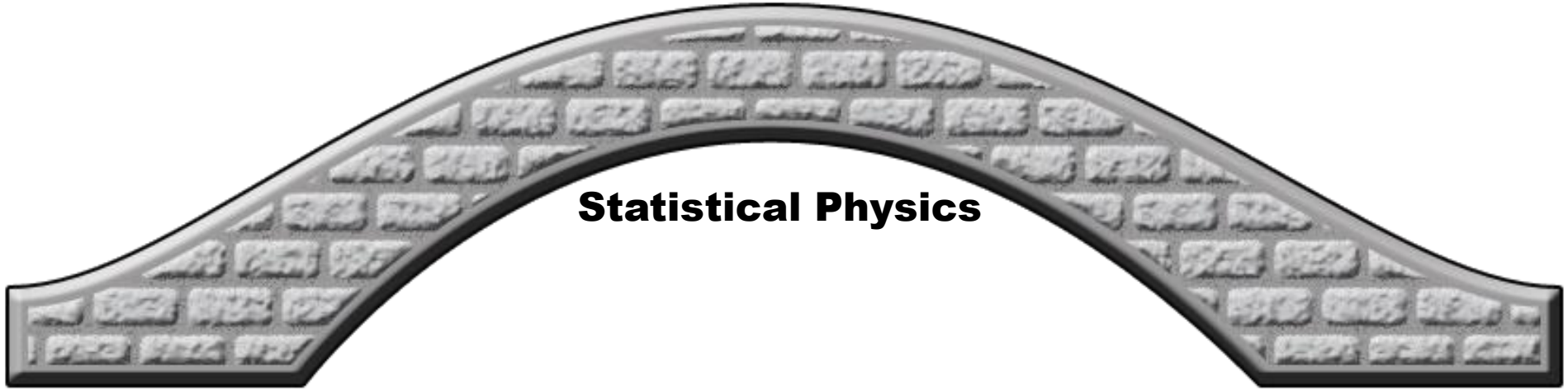
- Breakdown of classical physics
- De Broglie waves
- Wavepackets
- The uncertainty principle
- Schrodinger's wave equation
- The time independent Schrodinger equation
- 1-D examples
- Quantum Tunnelling
- 3-D quantum mechanics – the Hydrogen Atom
- The formal rules of quantum mechanics
- Angular Momentum and Intrinsic Spin
- Approximation Methods
- Time Dependence
- Many Particle Systems



Recommended Texts

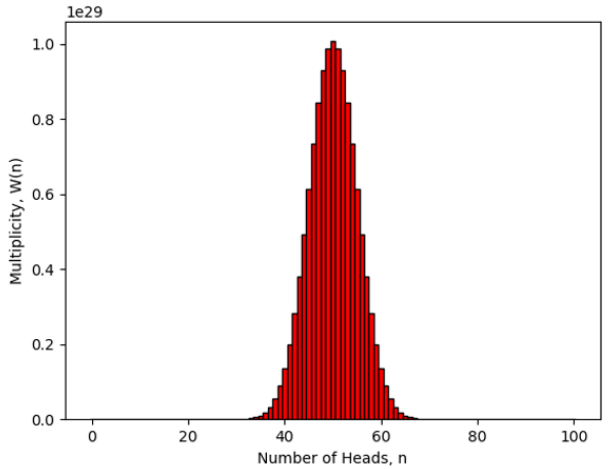
- Quantum Mechanics – A.I.M. Rae (4th Edition)
- Quantum Mechanics of Atoms, Molecules and Solids – Eisberg and Resnick
- Introduction to Quantum Mechanics – Griffiths and Schroeter
- Hyperphysics : http://hyperphysics.phy-astr.gsu.edu/

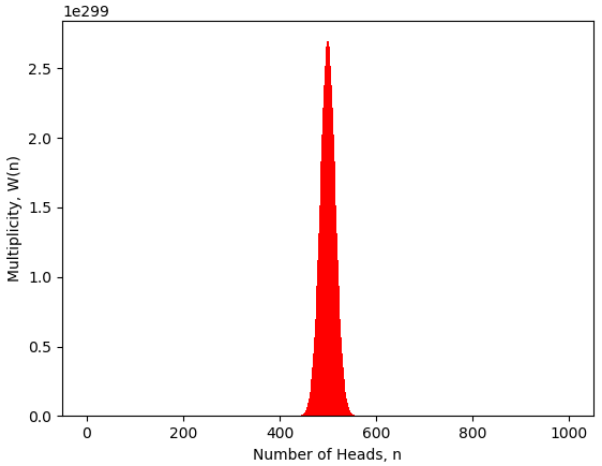
Thermal Physics



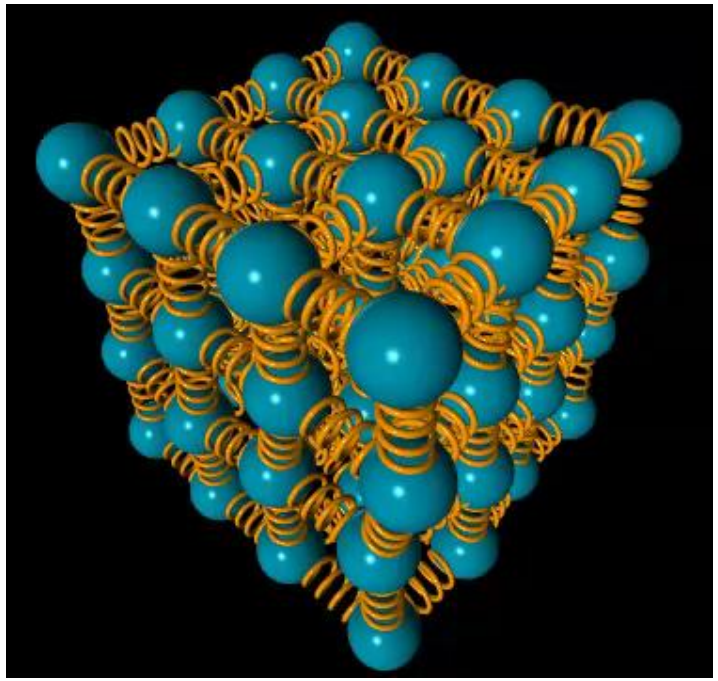
Microscopic World

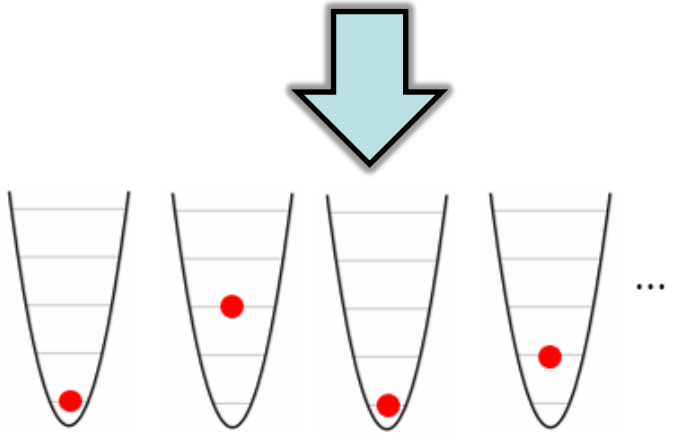
Thermodynamics

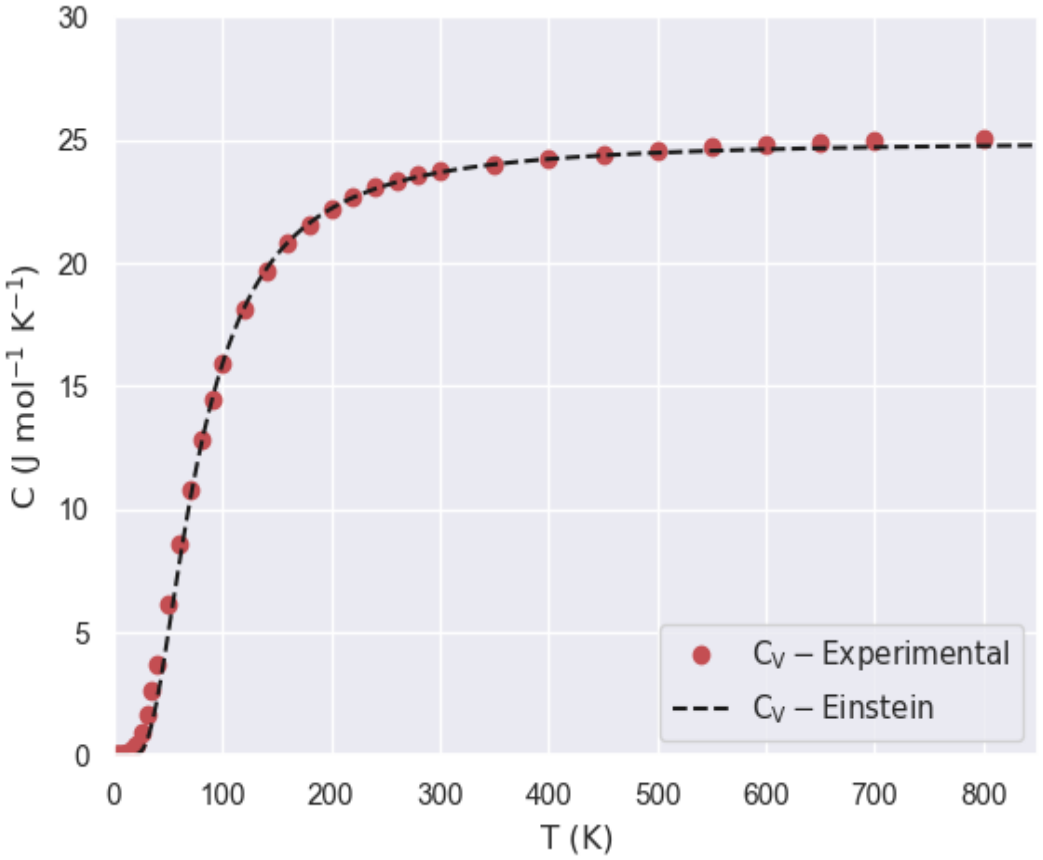




Thermal Physics

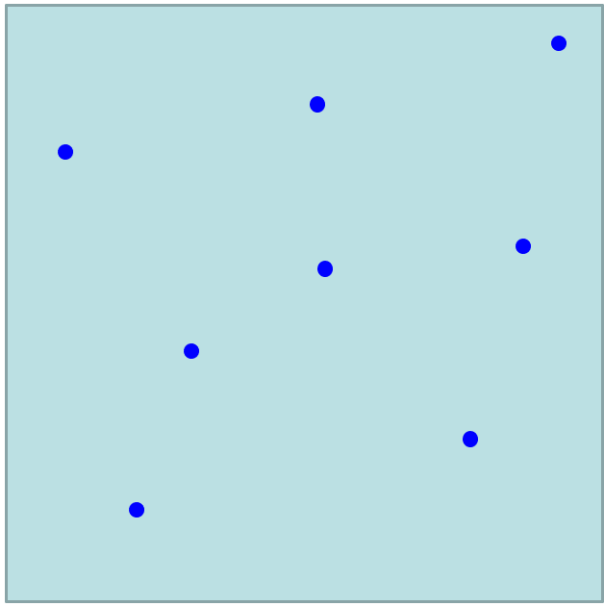


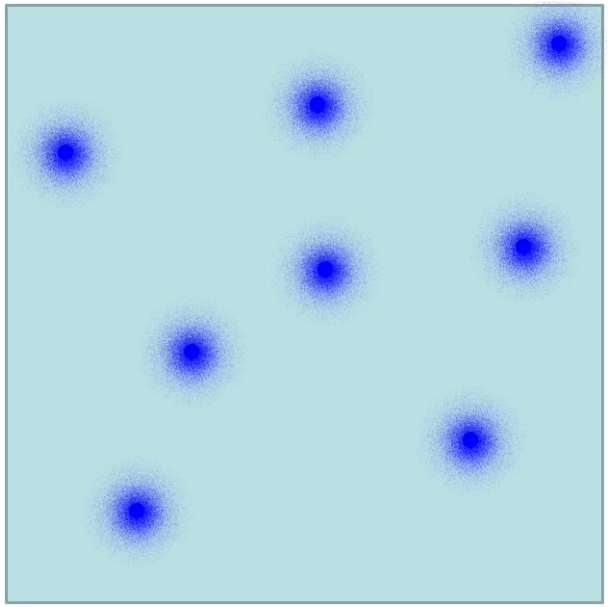


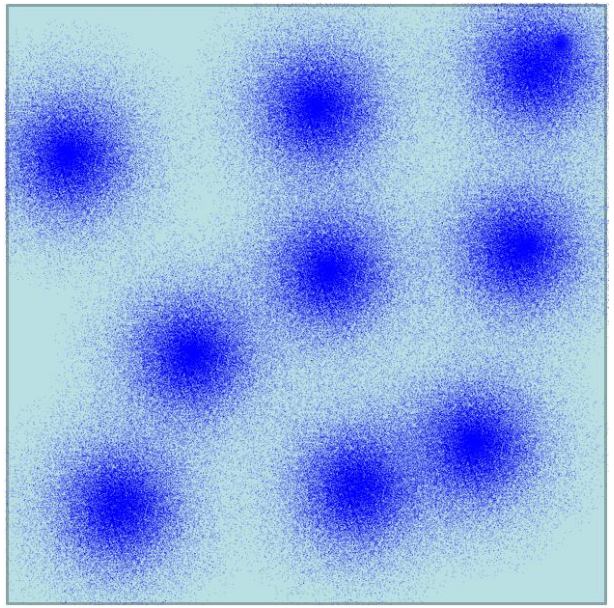


Thermal Physics

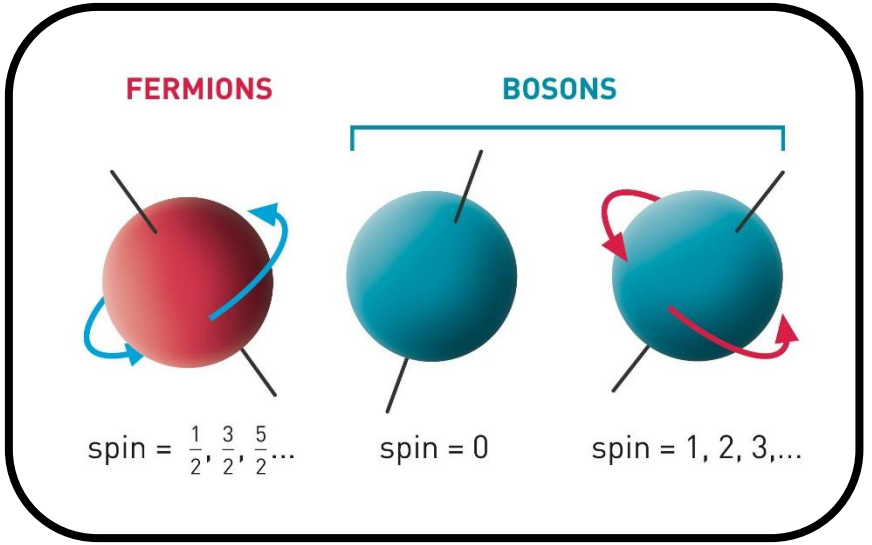
Classical and Quantum Statistics: Distinguishability



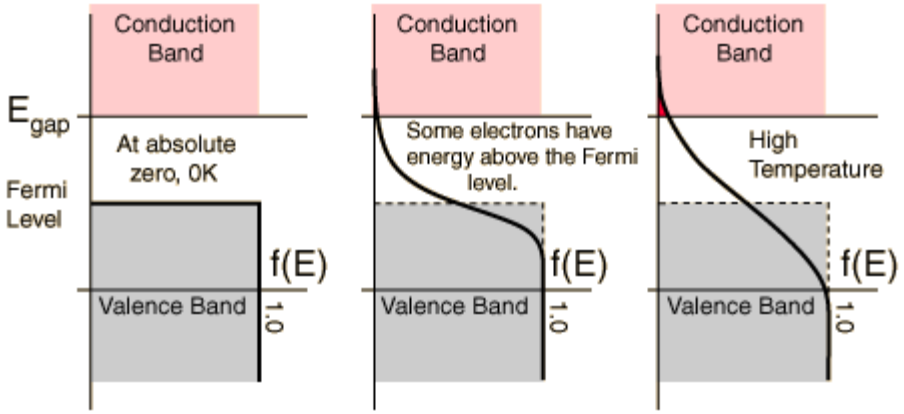




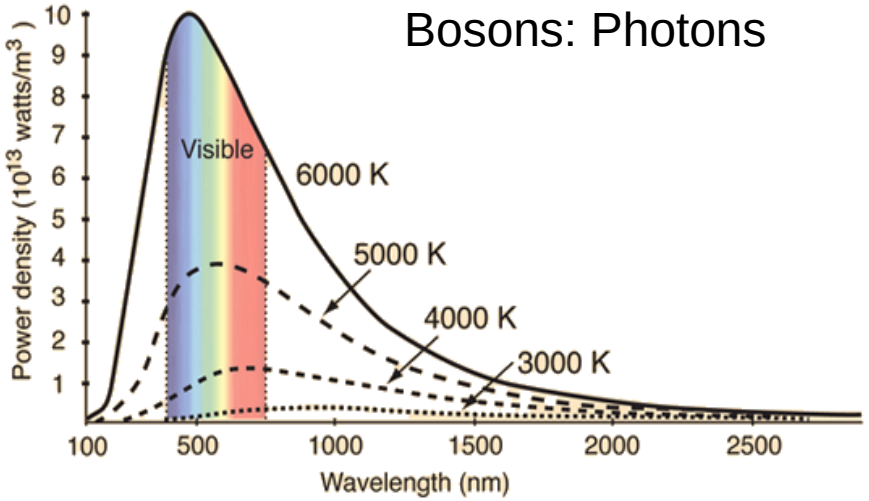
Thermal Physics



Fermions: Electrons



Bosons: Photons



Waves and Optics (Waves)

Aims & objectives

- The WAVES half of the module provides an introduction to vibrations and waves in classical physics.
- Builds on elementary phenomena covered in Level 4 by establishing a more rigorous mathematical footing for understanding physics.
- Everything in WAVES is a precursor to the *Quantum Mechanics* module
  (e.g., operators, eigenvalue problems, Fourier decompositions)

Pre-requisites

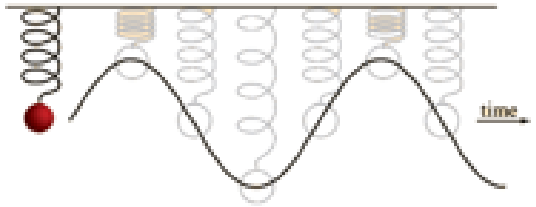
- Pre-requisites from prior mathematics are:
  (i) ordinary and partial differentiation,
  (ii) complex numbers,
  (iii) ordinary differential equations (ODEs)
  (linear, 2nd-order, homogeneous & inhomogeneous, constant coeffs.),
  (iv) elementary matrices,
  (v) Fourier series.

See John's videos!

Waves and Optics (Waves)

Starts with a simple harmonic motion (including damping and external forcing), such as a mass on a spring. Starts with Hooke's law, the SHO equation, and initial-value problems:

$$\frac{d^2x}{dt^2} + \omega_0^2 x = 0.$$



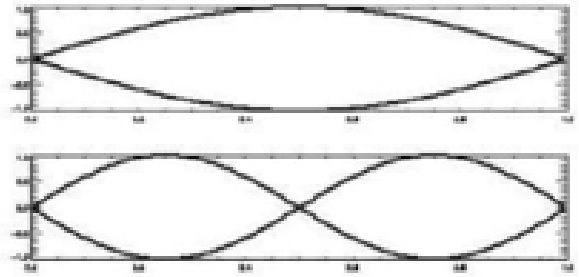
Then on to coupled oscillators and the concept of normal modes (need matrices)... a fundamental idea that underpins QM, too!

$$\frac{d^2x_1}{dt^2} + 2\omega_0^2 x_1 - \omega_0^2 x_2 = 0, \quad \frac{d^2x_2}{dt^2} - \omega_0^2 x_1 + 2\omega_0^2 x_2 = 0.$$

Part 2: Waves

Unpicking the classical wave equation (a PDE),

$$\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} - \frac{\partial^2\phi}{\partial x^2} = 0,$$



and its properties / basic solutions. Then using Fourier decomposition to solve boundary-value problems (e.g., standing waves on a string... also crucial for QM!).

Finally, will look at sound waves in a gas (need some thermodynamics...)

Waves and Optics (Optics)

- Diffraction, interference and coherence.
- Fourier Transforms and convolutions,
- Fourier Optics. Fraunhoffer and Fresnel diffraction
- Single and double slits, gratings, multiple apertures
- Interferometers and applications

Physics Laboratory 2

- The module is split 50:50 into an experimental and a computational component
- Assessment is via ‘journals’ where you will submit work during the semester, and receive an overall mark
- There is as experimental journal and a computational journal

Experimental Laboratory - Mark Breakdown

Weekly experiments with data and analysis logged in Journal (50%)

Choice of one of these for –

Oral presentation and interview (20%)

Technical report (30%)

- All sections of this assessment are part of an accumulative mark for this component.
- No one section is pass/fail as the overall assessment mark determines this.
- A PMC can only be submitted for failure of overall assessment, not its parts.

Physics Laboratory 2: Computational

There is an Introductory Session and

10 Topics with Journal Exercises

1. Data Manipulation and Plotting
2. Visualising 2D Data Sets
3. Numerical Integration
4. Systems of Linear Equations and Matrices
5. Solving Non-linear Equations
6. Fourier Transforms
7. 1st Order Ordinary Differential Equations
8. 2nd Ordinary Differential Equations
9. Partial Differential Equations – Boundary Value Problems
10. Partial Differential Equations – Initial Value Problems

- We will start from scratch
- Each topic has a set of notes and examples, and a set of practice exercises (with example code provided)
- There will also be two 'Journal Exercises' for which code and a supporting report should be submitted to the computational journal. **CODE MUST BE DEMONSTRATED IN PERSON BEFORE SUBMISSION**
- Please go to the blackboard site to see the material for an Introduction to Python Programming

Physics Laboratory 2

Experimental Lab	Computing Lab
10:00 – 13:00	10:00 – 13:00
Group A	**Group B**
14:00 – **17:00**	14:00 – 17:00
Group B	**Group A**

NOTE: Both labs run for 3 hours.

Groups for Physics Laboratory 2

Group A			Group B	
George	Boustany		Morgan	McDonald
Robert	Couchman		Matthew	Meadowcroft
Joshua	Daniels		Alexander	Omekara
Declan	Davison		Ellie	Rea
David	Dsouza		Emmanouil	Savva
Zaher	Faruk		Harry	Walker
Daniel	Feist		Kyle	Watson
James	Hammond		Emily	Welsh
Blake	Holmes		Natalie	Yau
Matthew	Makin		Bradie	Zimmer Collins