Concise list of video lecture content

Lecture 1 Jan 22

Syllabus

Lecture 2 Jan 24

Letter to Self instructions

Space, Copernican world model, Video Inertial Systems

Lecture 3 Jan 26

Newtonian Mechanics, E&M, and Absolute Space

Waves, Interference

Lecture 4 Jan 29

No sound lecture, sound file on webpage

Michelson-Morley Experiment, conceptual

Lecture 5 Jan 31

Michelson-Morley, analysis (see book excerpt on course webpage)

Michelson-Morley, lecture video, first Henry-Albert video

Lecture 6 Feb 2

Review Henry-Albert video

Second Henry-Albert video, clocks and time dilation

Third Henry-Albert video, length contraction, Lorentz Transformation

Example length contraction (see separate file on webpage for full solution)

Lecture 7 Feb 5

Time dilation and length contraction

Radioactive particles example

Video mountain top & time dilation

Video spacetime diagram with length contraction and time dilation

Lecture 8 Feb 7

Example ‘same physics in all frames’: pole and garage problem

Relativistic Kinematics

Video spacetime diagram velocity addition, derive velocity addition formulas

Lecture 9 Feb 9

Comparison Lorentz and velocity transformation formulas

Two space ship problem, velocity addition

Lecture 10 Feb 12

Repeat space ship velocity addition problem to address student questions

Doppler Effect and Relativistic Doppler Effect

Short Doppler effect example

Lecture 11 Feb 14

Derive one Doppler Effect formula

(At first only partial view, later camera opens up to show it all)

Momentum Conservation video, Space Billiard, mass depends on v

Lecture 12 Feb 16

Relativistic Dynamics, Einstein’s Box (see book excerpt on webpage)

Derive E = m c2 formula

Example, inelastic collision of two masses

Lecture 13 Feb 19

Silent lecture (audio file in preparation)

Video E= mc^2 derivation, second way to do it

Repeat collision problem to address student questions

Lecture 14 Feb 21

Momentum-energy Transformation (analog to Lorentz transformation), derivation

4-vectors (four-dimensional vectors)

Relativistic forces

Lecture 15 Feb 23

General relativity overview

Lecture 16 Feb 26

Wrapping up Relativity: The GPS system

Atomic Physics: Do Atoms Exist?

Lecture 17 Feb 28

Do atoms exist? Continued

Caloric Theory vs. Kinetic Theory – existence of atoms

Periodic table and subatomic particle insights; isotopes

Helmholtz Coil – Thomson e/m experiment, conceptual

Lecture 18 Mar 2

Thomson e/m landmark experiment, magnetic forces overview, derivation

Calculating field of Helmholtz coils

Millikan landmark experiment, derivation

Lecture 19 Mar 5

Photoelectric Effect landmark experiment

Blackbody Radiation landmark experiment

Primer atomic energy diagrams

Lecture 20 Mar 7

Blackbody Radiation, three distribution functions

Statistical interpretation, Maxwell Boltzmann speed distribution

Standing waves and normal modes

Lecture 21 Mar 9

The Compton Effect landmark experiment, derivation

Interlude: energy scales in [eV]

x-ray spectra

>spring break<

Lecture 22 Mar 19

Silent lecture

Bohr model (old quantum mechanics)

x-ray diffraction, Compton effect review

Lecture 23 Mar 21

Silent lecture

Franck-Hertz landmark experiment

Bohr model waves

Lecture 24 Mar 23

Waves and beats

Interference, diffraction, and double slit experiments – with light, with particles

Angular momentum quantization, de Broglie wave picture of particles

Example de Broglie wave of a moving electron

Lecture 25 Mar 26

Sound crackly

De Broglie particle waves, making localized beats

Uncertainty relation, classical

Lecture 26 Mar 28

Silent lecture

Wave packets & group velocity

Teaser modern quantum mechanics: discovery of elements, Bohr’s classification

Bohr model of the hydrogen atom, Balmer formula of spectroscopic lines, atomic energy levels,

Again

Lecture 27 Mar 30

Generalization of Balmer formula

Calculational justification of Bohr model, derivation Balmer formula, quantization

Extension to hydrogen-like (ionized) atoms

Uncertainty relation quantum mechanics

Lecture 28 Apr 2

Uncertainty relation

Schroedinger equation: classical DEQ reminder, boundary conditions, stationary solutions

Lecture 29 Apr 4

Schroedinger Hydrogen Atom: preparation 1 – Particle in a box

Interlude Bonus Lecture 1 - 5/18 10am

Crackly Sound

More quantum wells: Free particle, not-inf. deep box, stepping potential

Lecture 30 Apr 6

Expectation values in quantum mechanics

Hydrogen Atom: preparation 2 – a two-dimensional case with polar coordinates

Spherical coordinates intro, separation of variables in 2-d, solving the Phi-equation trick

Lecture 31 Apr 9

2-dim case S-eqn Hydrogen atom: preparation 3 – solving the 2-d case in Phi, boundary conditions

What angular momentum has to do with it

Lecture 32 Apr 11

Taking it to 3-dim

Solving the radial eqn, s and p orbital examples

Lecture 33 Apr 13

Silent Lecture

Interpreting radial functions for different orbitals, shells

Angular momentum quantum number

Magnetic moment, magnetic quantum number

Lecture 34 Apr 16

Zeeman Effect

Spin quantum number, Stern-Gerlach experiment, Periodic Table

Lecture 35 Apr 18

Evidence for nuclei: Rutherford gold-foil experiment

Lecture 36 Apr 20

Nuclear Physics

Rutherford formula

Mass formula nucleus, short hand language nuclear physics

Lecture 37 Apr 23

Facts about nuclei, binding energy formula

Lecture 38 Apr 25

Nuclear force

Three competing nuclear models: no happy end

Lecture 39 Apr 27

Radioactivity:  processes

Lecture 40 Apr 30

Radioactive decay law

Toward StatMech: Thermodynamics primer

Boltzmann distribution vs QM fermions vs QM bosons

Interlude Bonus Lecture 2 - 5/18 11am

Crackly Sound

Finish StatMech problem

Blackbody Theory

Lecture 41 May 2

Teaser particle physics – four fundamental forces

Interlude Bonus Lecture 3 - 5/18 12pm

Crackly Sound

Electron bands

Intro Solid State Physics: Metals (Insulators) and Semiconductors

Superconductors, Superconducting Magnets