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