PHY1020

BASIC CONCEPTS IN PHYSICS I

A basic course for non-physicists assuming no prior knowledge of physics (although basic science and mathematics is required) that covers the principal ideas across the breadth of Physics, without going into the mathematical detail and worked examples that are usually associated with the subject. The first unit of this two-semester course covers Mechanics and Heat.

Why Physics?

What is Science?

The nature of physical laws.

Mechanics

The problem of motion Kinematics in 1-D : position, velocity and acceleration Kinematics in 2-D: projectiles, circular motion Dynamics: Newton's Laws of motion, momentum Forces: gravitation and planetary orbits Energy: kinetic and potential, conservation Frames of reference - the classical view Ideas from special relativity (time dilation, etc.)

Heat and Thermodynamics

Temperature: thermometry Specific heat capacity; latent heat; first law Entropy; second law; heat engines

Recommended Texts:

- Harris Benson, *University Physics* (1995)
- Keller F J et al, *Physics*
- Richard Feynman, The Feynman Lectures in Physics, Vol. I

Further Reading:

- Jacob Bronowski, *The Ascent of Man*
- Kenneth Clark, Civilisation
- Galileo and Einstein (lecture course) <u>http://www.phys.virginia.edu/classes/109N/home.html</u>

WHAT IS SCIENCE?

SCIENCE IS A COLLECTION OF KNOWLEDGE

ABOUT THE NATURAL WORLD

WHAT IS PHYSICS ?

"The study of the natural world"

Motion

ALL CHANGE INVOLVES MOTION

- Change in energy states (transport of energy)

- chemical transformation (motion of atoms, electrons, etc.)

 biological change (evolution, growth...) (transformations in living beings)

ALL SCIENCE CAN BE STUDIED IN TERMS OF PHYSICS

Science at different SCALES

Only the simplest systems can be studied at such a basic level. Different scientific disciplines are all about systems on DIFFERENT SCALES.

Physics: Smallest and largest scales (quantum and atomic level; size of the known universe)

Chemistry, biology, other sciences: Everything in between (large number of molecules – chemistry; large number of chemical processes – biology...)









Prize Awarder for the Nobel Prize in Physics

Nomination and Selection of Physics Laureates

Nobel Medal for Physics

Articles in Physics

Video Nobel Lectures

Nobel Prize in Chemistry

Nobel Prize in Medicine

Nobel Prize in Literature

Nobel Peace Prize

Prize in Economic Sciences

Nobel Laureates Have Their Say

Nobel Prize Award Ceremonies

Nomination and Selection of Nobel Laureates



The Nobel Prize in Physics 1901

Wilhelm Conrad Röntgen

The Nobel Prize in Physics 1901

Wilhelm Conrad Röntgen

The Nobel Prize in Physics 1901 was awarded to Wilhelm Conrad Röntgen "in recognition of the extraordinary services he has rendered by the discovery of the remarkable rays subsequently named after him".

Photos: Copyright © The Nobel Foundation

The Nobel Prize in Physics 2011 Saul Perlmutter, Brian P. Schmidt, Adam G. Riess

The Nobel Prize in Physics 2011 Saul Perimutter Brian P. Schmidt Adam G. Riess

Video Nobel Lectures

- Nobel Prize in Chemistry
- Nobel Prize in Medicine

Nobel Prize in Literature

Nobel Peace Prize

Prize in Economic Sciences

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Lawrence Berkeley National

Saul Perlmutter

Laboratory



National University

Brian P. Schmidt

The Nobel Prize in Physics 2011 was divided, one half awarded to Saul Perlmutter, the other half jointly to Brian P. Schmidt and Adam G. Riess "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae".

Photo: Homewood Photography

Adam G. Riess

Post your greetings to the 2011 Nobel Laureates in Physics

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A. PICCARD E. HENRIOT P. EHRENFEST Ed. HERZEN TH. DE DONDER E. SCHRÖDINGER E. VERSCHAFFELT W. PAULI W. HEISENBERG R.H. FOWLER L. BRILLOUIN P. DEBYE M. KNUDSEN W.L. BRAGG H.A. KRAMERS P.A.M. DIRAC A.H. COMPTON L. de BROGLIE M. BORN N. BOHR I. LANGMUIR M. PLANCK Mme CURIE H.A. LORENTZ A. EINSTEIN P. LANGEVIN CH.E. GUYE C.T.R. WILSON O.W. RICHARDSON Absents : Sir W.H. BRAGG, H. DESLANDRES et E. VAN AUBEL

Do not ask me of what I cannot measure.



- Galileo Galilei (1564 - 1642)



Admit no more causes of natural things such as are both true and sufficient to explain their appearances

The same natural effects must be assigned to the same causes

Qualities of bodies are to be esteemed as universal

Propositions deduced from observation of phenomena should be viewed as accurate until other phenomena contradict them.

- Isaac Newton (1642 - 1727)

THE TOOLS OF PHYSICS

REDUCTION to component parts (break the system down into simpler systems)

ABSTRACTION/APPROXIMATION: use ideal components (study the ideal case first)

UNIFICATION: one rule has many applications (so our predictions are valid FOR ALL SUCH SYSTEMS)

METHOD: examine facts and formulate rules

EXPERIMENTS

GATHER INFORMATION ABOUT THE WORLD AROUND US

THEORIES

CLASSIFY THE FACTS AND PROVIDE RULES THAT NATURE APPEARS TO FOLLOW



SCIENTIFIC FACTS

- MUST BE SPECIFIC

- MUST BE IRREFUTABLE

SCIENTIFIC THEORIES

- MUST BE GENERAL

- MUST EXPLAIN ALL KNOWN RESULTS

- MUST MAKE DETAILED PREDICTIONS (which are FALSIFIABLE)

- CAN NEVER BE PROVED, ONLY DISPROVED

ARE THESE SCIENTIFIC FACTS?

- Objects dropped near the surface of the Earth fall with an acceleration of 9.8 ms⁻²
- There is a cosmic microwave background radiation corresponding to a black-body temperature of 3K.
- The speed of light in a vacuum, measured in any inertial frame of reference, is 2.998 x 10⁸ ms⁻¹
- The Universe evolved to its present state from a "big bang" about 14 billion years ago

ARE THESE SCIENTIFIC THEORIES?

- The gravitational force between two masses is proportional to the product of the masses and inversely proportional to the square of the distance between them.
- The Universe was created in its present state, in seven days about 3000 years ago, by an allpowerful Creator.
- The velocity of one object relative to another is equal to the difference in their velocities as measured by a third observer.
- The Earth revolves around the Sun with a period of one year
- The world will end on 21st December, 2012



Physics in action: from the medieval gonne to a modern assault rifle











BR Tuote Ky Reflex Rifle Suppressor Cross-section La filosofia è scritta in questo grandissimo libro che continuamente ci sta aperto innanzi a gli occhi (io dico l'universo), ma non si può intendere se prima non s'impara a intender la lingua e conoscer i caratteri, ne' quali è scritto. Egli è scritto in lingua matematica, e i caratteri son triangoli, cerchi, ed altre figure geometriche, senza i quali mezzi è impossibile a intenderne umanamente parola; senza questi è un aggirarsi vanamente per un oscuro laberinto.

- Galileo Galilei

Science is written in this great book that is open in front of our eyes (I refer to the Universe), but one cannot understand it unless one first learns the language and understands the characters it is written in. The language of this book is mathematics, and the characters are triangles, circles and other geometric figures, without which it is impossible to understand a single word: without these one will vainly wander in an obscure labyrinth.