

CONCEPTUAL PHYSICS

Course Number: 441 (Elective- 11,12)

Purpose: This course is designed to acquaint the student with the basic concepts of Physics without the usual emphasis on mathematics.

Prerequisites: Intermediate Algebra or Algebra II and Chemistry.

Course Objective: This course will include laboratory experimentation and is suggested for those students who will not be science majors but would like an understanding of physical principles.

Students will apply the fundamentals of physics to their daily experiences, as well as investigate their importance in our technological society.

Students will be presented with the opportunity to develop their ability to generalize their everyday experiences to fundamental principles, laws and theories of physics.

Students are expected in a laboratory environment to establish relationships between observable data and relate their observations to fundamental principles of science.

Students will practice the ability to recognize that which is pertinent to their everyday life, and exclude the irrelevant.

Students will extend their personal experiences with current everyday topics as an opportunity to interrelate their experiences and thus unify the material.

Students will use classroom or library computer resources to research current topics in science and present a written or oral explanation of their research.

The student's expected outcome is the interpretation and application of principles as opposed to the rote memorization and assisted recall of scientific facts.

Content Objectives:

Introduction ...This Unit is designed to introduce the student to the primary objectives of the course. The teacher and student will discuss classroom procedures, homework assignments with deadlines, and course grading requirements. Students will become familiar with laboratory safety procedures from a formal handout and understand the reasons for each safety procedure. The principles of investigation using the scientific method will be introduced and each student will be expected to use the scientific method in modified form for all investigative work.

Unit - Mechanics....This unit introduces the student to the study of kinematics. The student will examine speed, velocity, acceleration, uniform circular motion, momentum

and impulse. Discussion and examples will provide the student with the opportunity to relate these concepts to everyday occurrences. The student explores the applications of Newton's Three Laws as the basic explanation of motion in the world around us. The student will examine various forces in terms of mass, density, and motion. Calculation of center of gravity will be used to predict the path of the force generated motion of bodies under various everyday conditions. The students understanding of forces will be used to investigate the special cases of rotary motion, including gravitational interactions and centripetal force.

Unit - Properties of MatterThis unit begins with the atom as the basic building block of matter and examines the three common states of matter on Earth. The student uses the concept of density to transition between the three states of matter and examines area, volume, pressure, Archimedes Principle, and Pascal's Principle. The student will examine the local atmosphere as a vehicle to understand Boyle's Law and Bernoulli's Principle.

Unit - Sound and Light This unit introduces the student to waves by examining the cyclic, mechanical motion of vibrations and the pendulum. Sound waves, harmonics and resonance lead the discussion of uses of waves in everyday life. Earthquakes and tsunami discussion conclude the basic investigation of wave mechanics with the wave equation. This unit extends the discussion of waves to the visible spectrum and examines the field of optics. The student examines the phenomena of refraction and reflection of electromagnetic energy in the visible range, discusses images formed in mirrors and examines the formation of colors in the form of light and pigments. The unit culminates with the study of the lens as used in both camera and human applications.

Unit - Electricity and MagnetismThis unit is intended to introduce the student to the principles and laws of electricity. The student will discuss simple circuits, examine the relationship between voltage, current and resistance and apply Ohm's Law. Expanding on the discussion of ionic solutions, the student will discuss electrolysis as a vehicle of chemical change. Discussion of motors, generators and transmission of electricity will culminate in a discussion of a typical electrical distribution system in a home.

Unit - Atomic and Nuclear PhysicsThis unit introduces the student to the Quantum Theory of Physics by discussing the models of the atom and light in the form of photons. The student will examine the lines seen in atomic spectra. The student will compare nuclear forces to electrical forces and examine the three types of rays emitted by radioactive nuclei. Discussion of different types and uses of radioactive isotopes, and naturally occurring background radiation will be related to the student's environment. Examination of the role of Nuclear Fission and Fusion as past, current and future sources of energy will be discussed.

Conceptual Physics - 441 Syllabus

Text Reference: Conceptual Physics (Second Edition), Hewitt, Paul G.,
Addison Wesley 1992

Lesson Objectives: Upon completion of the lesson, the student will be able to:

Chapter 1 Mechanics

- Explain why physics is the most basic of the sciences
- Outline the steps of the scientific method
- Distinguish between a hypothesis and a law or principle
- Describe when a hypothesis or law must be changed
- Explain why the refinement of theories is a strength
- Distinguish between science and technology

Chapter 2 Motion

- Define speed and give examples of the units for speed
- Distinguish between instantaneous speed and average speed
- Distinguish between speed and velocity
- Define acceleration and give examples of appropriate units
- Describe the motion of an object in free-fall from rest
- Describe the motion of an object thrown straight up
- Determine the speed and position of a falling object
- Describe how air resistance affects falling objects

Chapter 3 Inertia

- Describe Galileo's contribution to the science of motion
- Describe inertia
- State Newton's first law of motion
- Distinguish among mass, volume and weight
- Distinguish between the kilogram and the Newton as units
- Explain how objects not connected to the earth can keep up with the moving earth

Chapter 4 Force & Acceleration

- Define net force
- State the relation between acceleration and net force
- State the relation between acceleration and mass
- Distinguish between the concepts of direct and inverse proportionality
- State Newton's second law of motion
- Describe the effect of friction on the motion of an object
- Distinguish between force and pressure
- Describe the effect of air friction on a falling object

Chapter 5 Action & Reaction

- State Newton's third law of motion
- Given an action force, define the reaction force
- Explain why the acceleration caused by the action and reaction forces are often different
- Explain why the action and reaction forces do not cancel

Chapter 6 Vectors

- Distinguish between vector and scalar quantities
- Draw vector diagrams of forces or velocities
- Use the parallelogram method to combine vector quantities
- Resolve a given vector into perpendicular components
- For an object on a slope, find the components of weight parallel and perpendicular to the slope
- Explain why the horizontal velocity of a projectile is constant if air friction is absent
- Describe the vertical and horizontal velocity components of a projectile in the absence of air friction

Chapter 7 Momentum

- Define momentum, impulse and describe their relationship
- Give examples showing that both size of force and length of time the force is applied affect the change in momentum
- State the law of conservation of momentum
- Distinguish between elastic and inelastic collisions
- Give an example of momentum conservation involving vectors

Chapter 8 Energy

- Determine the work done from the force used and the distance
- Determine the power given the work done and the time used
- Define energy in terms of work
- Distinguish between potential energy and kinetic energy
- Compute kinetic energy given speed and mass
- State and apply the law of conservation of energy

Chapter 13 Gravitational Interactions

- Distinguish between linear and rotational speed
- Give examples of centripetal force
- Describe the motion of a revolving body if centripetal force ceases
- Describe how linear speed and radius affect centripetal force
- Apply Newton's laws to explain why the water in a spin-dry washer is forced of the holes of the basket

Chapter 14 Satellite Motion

- Define and compute torque
- Find the torque needed to balance an object
- Describe what factors rotational inertia depend on
- Explain how a gymnast changes spin rate by changing rotational inertia
- Define angular momentum and explain when it is conserved

Chapter 10 Center of Gravity

- Explain how the moon falls toward the earth like an apple
- Explain why the moon does not fall into the earth
- State Newton's law of universal gravitation
- Explain the significance of the inverse-square law
- Explain the connection between gravity and the expanding universe

Chapter 11 Rotational Mechanics

- Distinguish between g and G and explain each
- Describe a gravitational field
- Explain why a person in earth orbit feels weightless even though gravity is pulling on him/her continuously
- Explain how the sun and moon cause ocean tides
- Describe a black hole and how it is formed

Chapter 12 Universal Gravitation

- Explain how the pull of gravity on an orbiting object must provide the centripetal force to keep it turning
- Explain why the pull of gravity does not cause an object in circular orbit to speed up or slow down
- Describe what is meant by escape speed

Chapter 15 Special Relativity - Time & Space

- Give examples of relative and non-relative motion
- State and explain Einstein's first two postulates of special relativity
- Give an example of time dilation
- Explain how a space traveler can cover a distance of 200 light years in one human lifetime

Chapter 16 Special Relativity - Length, Energy, & Momentum

- Describe the conditions under which lengths contract
- Explain why it is impossible to accelerate matter to the speed of light
- Describe the meaning of mass-energy equivalence and how the conservation of mass and energy are not violated
- Explain why we don't notice a weight gain as we accelerate in our automobiles or aircraft
- Explain how the correspondence principle is a good test of any new theory

Chapter 32 Electrostatics

- Describe electrical forces between objects
- Explain how an object can attain an electric charge
- State Coulomb's law and explain its use
- Compare electrical and gravitational forces between charged objects
- Distinguish between a conductor and an insulator
- Describe charging by friction, contact, induction and by polarization

Chapter 33 Electric Field & Potential

- Define electrical field strength and explain how it can be measured
- Describe how to shield an object from all electric fields
- Describe the electric potential energy of a charged object in an electric field
- Define electric potential and explain how it differs from electric potential energy

Chapter 34 Electric Current

- Describe the conditions for the flow of electric charge
- Explain how current flows in a conductor
- Give examples of voltage (potential difference) sources
- State Ohm's law and explain how current behaves as voltage changes
- Compare electron flow rates with electric signal speeds in a wire
- Compute electric power given voltage and current data

Chapter 35 Electric Circuits

- Distinguish between series and parallel circuits
- State that the current in a series circuit is the same everywhere
- Predict what happens to the current in a series circuit when an additional resistor is added
- Describe what will happen when a branch of a parallel circuit is broken
- Relate the total current in a parallel circuit to the current in each branch
- Describe what will happen in a parallel circuit when a resistor is added in parallel
- Analyze a simple circuit diagram and describe the currents and voltages in it
- Describe the currents and voltages in a combined series-parallel circuit
- Describe overload in household circuits and how to prevent it

Chapter 36 Magnetism

- Compare and contrast magnetic poles and electric charges
- Relate motion of electrons within an atom to the ability of a substance to become magnetic
- Describe what happens to domains in the presence of an external magnetic field and relate this to temporary magnetism
- Explain why magnets are spoiled by heating or mechanical shock
- Describe the magnetic field around a current-carrying wire and explain how the field can be made stronger
- State under what conditions a force is exerted on a charged particle in a magnetic field

Chapter 37 Electromagnetic Induction

- Describe how a voltage can be induced in a wire
- Relate the voltage induced in a coil to the number of loops in the coil and the rate of change of the magnetic field
- Describe a generator and how it works

- Compare and contrast the workings of a motor and a generator
- Describe a transformer and how it works
- Explain why transformers are used for the transmission of large amounts of power over long distances
- Relate the direction and strength of the electric field induced by a changing magnetic field, and vice versa
- Explain why electromagnetic waves must travel at the speed they do

Chapter 25 Vibrations & Waves

- Identify the crests, troughs, amplitude and wavelength
- Describe the relationship between period and frequency
- Describe what travels when a wave passes through a medium
- Describe what determines the speed of a wave
- Distinguish between a longitudinal and transverse wave
- Distinguish between constructive and destructive interference
- Describe a standing wave and explain how it occurs
- Describe the Doppler effect and how it changes the pitch
- Describe the conditions for a sonic boom to be heard

Chapter 26 Sound

- Relate the pitch of a sound to frequency
- Compare the transmission of sound through air with transmission through solids and liquids
- Describe the factors that affect the speed of sound
- Describe conditions of resonance
- Describe conditions for beats

Chapter 27 Light

- Describe the dual nature of light
- Relate light waves to radio waves, microwaves and X-rays
- Explain what happens to light when it enters a substance and how the frequency of the light affects what happens
- Cite evidence that light waves are transverse
- Explain how Polaroid glasses eliminate glare from horizontal surfaces of water and sand

Chapter 28 Color

- Explain why white and black are not colored in the sense that red and green are colors
- Explain how a color TV screen can display all the colors using only red, green and blue dots
- Define complimentary colors and give examples
- Distinguish between coloring by addition and by subtraction
- Explain why the sky is blue at noon and red/orange at sunset
- Explain why each element has a unique line spectrum

Chapter 29 Reflection & Refraction

- Predict the path of reflected light given the angle of incidence
- Explain why the image formed by a mirror is virtual
- Give examples of refraction of light and its effect
- Explain how a prism splits white light into many colors
- Describe the conditions for a rainbow
- Describe the process of total internal reflection

Chapter 30 Lenses

- Distinguish between converging and diverging lenses
- Distinguish between real and virtual images formed by a lens
- Construct a ray diagram that shows the position of the image formed by a converging or diverging lens
- Cite examples of optical devices which use lenses
- Compare how the human eye and a camera focus light
- Explain the causes of common eye focusing disorders

Chapter 31 Diffraction & Interference

- Explain why water waves have curved wave fronts after passing thru a narrow opening
- Describe the conditions for visible bright and dark fringes of light caused by interference

- Explain cause of dark and bright bands seen when monochromatic light is reflected from a thin film
- Explain the variety of colors seen in soap bubbles and oil slicks
- Compare laser light with ordinary lamp light
- Distinguish between a photograph and a hologram

Chapter 38 The Atom and the Quantum

- Give examples of models for the atom and for light
- Explain why the energy of light can be considered to be a multiple of small units of energy
- Explain why the photoelectric effect is evidence for the particle nature of light
- Cite evidence for the wave nature of electrons
- Describe deBroglie's model of matter waves in the atom, and use it to explain the lines seen in atomic spectra
- Explain why the diameters of heavier elements are not much larger than the diameters of lighter elements

Chapter 39 The Atomic Nucleus and Radioactivity

- Distinguish between the two kinds of nucleons in the nucleus, and compare the numbers of each found in the nuclei of different elements
- Compare the strong force to the electrical force
- Distinguish among the three types of rays given off by radioactive nuclei, and compare their penetrating power
- Interpret the symbols used to label isotopes of an element
- Predict, given the symbol for a radioactive isotope and particle it gives off, the product of the decay
- Give examples of different types of uses for radioactive isotopes
- List the major sources of natural background radiation
- Explain why additional exposure to radiation is harmful

Chapter 40 Nuclear Fission and Fusion

- Describe the role of neutrons in causing and sustaining nuclear fission
- Explain how nuclear fission can be controlled in a reactor
- Distinguish between a breeder reactor and a uranium-based fission reactor
- Describe current problems associated with the use of fission as a source of power
- Distinguish between nuclear fission and nuclear fusion
- Describe the advantages of fusion over fission as a source of power
- Describe the current problems associated with using fusion as a source of power

Lesson Planning Guide

Semester 1 Hours - 69

Semester 2 Hours - 70

Ch	Subject	Class	Lab	Quiz	Test
1	About Science	2	1	0	0
	UNIT I - MECHANICS				
2	Motion	7	1	0.5	0
3	Inertia	2	1	0	1
4	Force & Acceleration	9	1	.5	0
5	Action & Reaction	3	1	0	1
6	Vectors	5	1	.5	0
7	Momentum	6	1	0.5	0
8	Energy	4	1	0	1
9	Circular Motion	5	1	0.5	0
10	Center of Gravity	0	1	0.5	0
11	Rotational Mechanics	5	1	0.5	0
12	Universal Gravitation	4	1	0	1
13	Gravitational Interactions	4	1	0.5	0
14	Satellite Motion	1	1	0	1
15	Special Relativity - Space & Time	0	0	0	0
16	Spec Rel - Length, Energy, Momentum	0	0	0	0
	Unit I Totals	55			
	Unit II PROPERTIES OF MATTER				
17	Atomic Nature of Matter	2	0	.5	0
18	Solids	1	0	0	0
19	Liquids	2	0	0	0
20	Gases	0	0	0	1
	Unit II Totals	5			
	Unit IV Sound & Light				
25	Vibrations & Waves	7	1	.5	0
26	Sound	4	1	.5	0
27	Light	5	1	.5	0
28	Color	5	1	.5	0
29	Reflection & Refraction	5	1	.5	0
30	Lenses	5	1	.5	0

31	Diffraction & Interference	5	1	0	1
	Unit IV Totals	36			
	Unit V ELECTRICITY & MAGNETISM				
32	Electrostatics	4	1	0	0
33	Electric Fields & Potential	5	1	0.5	0
34	Electric Current	5	1	.5	0
35	Electric Circuits	5	1	0	1
36	Magnetism	5	1	.5	0
37	Electromagnetic Induction	4	1	0	1
	Unit V Totals	28			
	Unit VI Atomic & Nuclear Physics				
38	Atom & the Quantum	2	1	0	0
39	Atomic Nucleus & Radioactivity	3	1	0	0
40	Nuclear Fission & Fusion	2	1	0	1
	Unit VI Totals	7			
	Course Totals	136			