I. INTRODUCTION

Satisfactory completion of this course earns the student four semester hours credit in physics, chemistry, certain fields of engineering and other majors which require a calculus-based physics. The student should have taken or be currently enrolled in calculus.

The student will be introduced to the basic principles of electricity and magnetism as well as the principles of electromagnetic waves and the properties of light. Topics in twentieth century advances in physics, namely, Relativity, Atomic and Quantum nature of matter, will be surveyed. Mastery of this course material should give the student a working knowledge of electric and magnetic phenomena, nature of light and optical instruments, and modern theory of atomic and nuclear physics.

II. OVERALL OR GENERAL OBJECTIVES OF THE COURSE

Upon successful completion of this course, University Physics II, the student will be able to:

A. Explain the origin of electric and magnetic forces.

B. Explain and use the concept of electric fields.

C. Explain electrical circuits.

D. Carry out calculations involving electrical circuits.

E. Explain electromagnetism.

F. Describe the structure and functioning of various electrical and electromagnetic devices.

G. Discuss the nature of electromagnetic radiation.

H. Discuss the nature and properties of light.
I. Carry out calculations involving lenses, plane mirrors, and spherical mirrors.

J. Describe the structure and use of various optical devices.

K. Understand the concept of special theory of relativity.

L. Describe the nature of atoms, molecules, and nucleus.

III. INSTRUCTIONAL MATERIALS

A. The instructional materials identified for this course are viewable through www.ctcd.edu/books


D. Required: A Scientific Calculator.

C. Optional: Halliday Students Solutions Manual

D. Optional: Halliday Learningware CD-ROM

E. Optional: Halliday, Study Guide.

IV. COURSE REQUIREMENTS

A. Normally a grade of "C" or better must be earned for transfer to other colleges or universities.

B. A student begins to earn his final grade in the course with the first class meeting. This grade will be determined by exam scores, class participation, initiative and attendance.

C. Preparation for the final exam also begins with the first class meeting. The final exam will be comprehensive.

D. The student should spend a minimum of two hours of study for each class period. This time should not only be devoted to the completion of class assignments, but also to the review of past material, correction of errors on past assignments, etc.

E. The student is expected to take adequate lecture notes and to review them as soon as
possible after they are taken. Do not attempt to write every word, use key phrases and a logical method or organization.

F. The student should bring his textbook and all necessary materials to each class meeting.

G. Disability Support Services provide services to students who have appropriate documentation of a disability. Students requiring accommodations for class are responsible for contacting the Office of Disability Support Services (DSS) located on the central campus. This service is available to all students, regardless of location. Explore the website at www.ctcd.edu/disability-support for further information. Reasonable accommodations will be given in accordance with the federal and state laws through the DSS office.

H. The collegiate expectation is that students will conduct themselves with civility at all times in classrooms. Minimal civility includes:

1. Being in class on time;
2. Staying in class for the entire class period;
3. Leaving early occurs only after informing the teacher, prior to class, of an unavoidable conflict requiring your early departure (if possible, position yourself close to the door for a minimum disruption to the class);
4. Avoiding such uncivil conduct as talking, sleeping, reading papers/magazines, or working on some other class homework assignment; and
5. Using socially acceptable language in classroom discussions.

Additionally, your instructor requires you to take personal responsibility for your actions.

V. EXAMINATIONS

There will be four unit exams given at the times announced. Lowest exam score will be dropped. Missed exams will not be made up under any circumstances. There will also be a comprehensive final exam. The final exam cannot be missed.

VI. SEMESTER GRADE COMPUTATIONS

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
<th>Score Range</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour exams</td>
<td>60%</td>
<td>90 - 100</td>
<td>A</td>
</tr>
<tr>
<td>Final exam</td>
<td>10%</td>
<td>80 - 89</td>
<td>B</td>
</tr>
<tr>
<td>Homework</td>
<td>10%</td>
<td>70 - 79</td>
<td>C</td>
</tr>
<tr>
<td>Laboratory</td>
<td>20%</td>
<td>60 - 69</td>
<td>D</td>
</tr>
</tbody>
</table>
VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM COURSE INSTRUCTOR

A. Withdrawal from course: It is the student's responsibility to officially drop a class if circumstances prevent attendance. Any student who desires to, or must, officially withdraw from a course after the first scheduled class meeting must file an Application for Withdrawal or an Application for Refund. The withdrawal form must be signed by the student.

Application for Withdrawal will be accepted at any time prior to Friday of the 12th week of classes during the 16 week fall and spring semesters. The deadline for sessions of other lengths is as follows.

- 11 week session: Friday of the 8th week
- 8 week session: Friday of the 6th week
- 5 week session: Friday of the 4th week

The equivalent date (75% of the semester) will be used for sessions of other lengths. The specific last day to withdraw is published each semester in the Schedule Bulletin.

Students who officially withdraw will be awarded the grade of "W", provided the student's attendance and academic performance are satisfactory at the time of official withdrawal. Students must file a withdrawal application with the college before they may be considered for withdrawal.

A student may not withdraw from a class for which the instructor has previously issued the student a grade of "F" or "FN" for nonattendance.

B. An Administrative Withdrawal: An administrative withdrawal may be initiated when the student fails to meet College attendance requirements. The instructor will assign the appropriate grade on the Administrative Withdrawal Form for submission to the registrar.

C. An Incomplete Grade: The College catalog states, "An incomplete grade may be given in those cases where the student has completed the majority of the course work but, because of personal illness, death in the immediate family, or military orders, the student is unable to complete the requirements for a course..." Prior approval from the instructor is required before the grade of "I" is recorded. A student who merely fails to show for the final examination will receive a zero for the final and an "F" for the course.
VIII. COURSE OUTLINE

A. **Unit One**: Electric Charge and Electric Field

1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:
   
   a. Discuss the history of electromagnetism.
   b. Describe the types of electrical charge.
   c. Explain static electricity.
   d. Describe the ways of producing static charge.
   e. Discuss the structure of the atom.
   f. Discuss the conduction of electricity.
   g. State Coulomb's law and carry out calculations involving this law.
   h. Describe what is meant by the concept of electric field.
   i. Carry out calculations involving electric fields.
   j. Explain the concept of lines of force.
   k. Discuss electric fields in conductors.
   l. Carry out calculations involving the motion of electric charges.
   m. Explain what is meant by electric dipoles and carry out calculations involving such dipoles.
   n. Use and define the following terms:
      - Electron, Proton, Neutron, Ion, Nucleus, Conductor, Insulator, Semiconductor, Electrostatics, Test charge, Dipole moment, Electric dipole

2. **Learning Activities**:
   
   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapters 21 and 22 in text
3. **Unit Outline:**

   a. Static electricity
   b. Electric charge in the atom
   c. Insulators and conductors
   d. Induced charge: the electroscope
   e. Coulomb's Law
   f. Electric field
   g. Calculation of electric field
   h. Lines of force
   i. Electric fields and conductors
   j. Motion of a charged particle in an electric field
   k. Electric dipoles

B. **Unit Two: Gauss' Law**

1. **Unit Objectives:** Upon successful completion of this unit, the student will be able to:

   a. Explain the concept of electric flux.
   b. Carry out calculations involving electric flux.
   c. State and explain Gauss' law.
   d. Carry out calculations involving Gauss' law
   e. Apply Gauss' law to particular situations and carry out calculations involving these situations.
   f. Define and use the following terms:
      Flux, Closed surface, Gaussian Surface, Surface Charged density, Line Charged density.

2. **Learning Activities:**

   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 23 in text

3. **Unit Outline:**

   a. A new look at Coulomb's Law
   b. Electric flux
   c. Gauss' Law
   d. Applications of Gauss' Law
C. **Unit Three**: Electrical Potential

1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:
   a. Discuss the concepts of electric potential and potential difference.
   b. Distinguish between electric potential energy and electric potential.
   c. Carry out calculations involving electric potential and potential difference.
   d. Discuss the concepts of equipotential lines and equipotential surfaces.
   e. Discuss the electric potential field of a single charge.
   f. Carry out calculations involving work energy and potential.
   g. Relate the concept of potential difference to the work done on a test charge.
   h. Calculate the electric potential due to point charges.
   i. Explain what electric dipoles are.
   j. Carry out calculations of potential due to extended charge distribution.
   k. Determine electric fields from potential difference.
   l. Explain and carry out calculations involving electrostatic potential energy.
   m. Define and use the following terms: Electric potential, Potential difference, Equipotential, Potential energy, Voltage, Electron volt.

2. **Learning Activities**:
   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 24 in text

3. **Unit Outline**:
   a. Electric potential and potential difference
   b. Relation between electric potential and electric field
   c. Equipotential surfaces
   d. The electron-volt
   e. Electric potential due to single point charges
   f. Potential of an electric dipole
   g. Potential due to any charge distribution
D. **Unit Four:** Capacitance

1. **Unit Objectives:** Upon successful completion of this unit, the student will be able to:

   a. Describe the construction and function of capacitors.
   b. Carry out calculations involving capacitance.
   c. Discuss the use of capacitors in series and parallel.
   d. Carry out calculations involving capacitors wired in series and parallel.
   e. Discuss the storage of electric energy by capacitors.
   f. Carry out calculations involving energy storage in capacitors.
   g. Discuss the use of dielectrics in capacitors.
   h. Carry out calculations involving dielectrics in capacitors.
   i. Apply Gauss's Law to capacitors with dielectrics.
   j. Define and use the following terms: Capacitor, Capacitance, Energy density, Dielectric, Dielectric constant.

2. **Learning Activities:**

   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 25 in text

3. **Unit Outline:**

   a. Capacitors
   b. Determination of capacitance
   c. Capacitors in parallel and series
   d. Electric energy storage
   e. Dielectrics
   f. Dielectrics: an atomic view
   g. Gauss' Law in Dielectrics

E. **Unit Five:** Electric Current and Resistance

1. **Unit Objectives:** Upon successful completion of this unit, the student will be able to:
a. Discuss the history and explain the basic structure of an electric battery.
b. Interpret and draw electric circuit diagrams.
c. Carry out calculations involving electric charge and current.
d. Explain Ohm's Law.
e. Carry out calculations involving Ohm's Law.
f. Explain the concepts of resistivity, conductivity, and superconductivity.
g. Carry out calculations involving resistivity and temperature dependence of resistivity.
h. Discuss electric current, current density, and drift velocity.
i. Carry out calculations involving electric current, current density, and drift velocity.
j. Discuss the transformation of electric power.
k. Carry out calculations involving electric power.
l. Compare alternating and direct current.
m. Carry out calculations involving alternating current.
n. Use and define the following terms:
   Electric cell, Electrode, Anode, Cathode, Electromotive force (EMF),
   Electric current, Resistance, Resistivity, Conductivity, Electrolyte,
   Terminal, Circuit, Resistor, Conductor.

2. Learning Activities:
   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 26 in text

3. Unit Outline:
   a. The electric battery
   b. Electrical current
   c. Ohm's Law: resistance and resistors
   d. Resistivity and superconductivity
   e. Microscopic view of current
   f. Electric power

F. **Unit Six**: DC Circuits and Instruments
   1. **Unit Objectives**: Upon successful completion of this unit, the student will be
able to:

a. Compare current, voltage, and resistance of resistors in series and parallel circuits.
b. Carry out calculations involving resistors in series and parallel circuits.
c. Distinguish between the EMF of a seat of electromotive force and the terminal voltage of the seat.
d. Carry out calculations involving EMF and terminal voltage.
e. State and use Kirchhoff's rules.
f. Analyze simple circuits.
g. Carry out calculations of EMFs in series and parallel.
h. Discuss current and voltage variations of circuits involving capacitors and resistors.
i. Carry out calculations involving capacitors and resistors in the same circuits.
j. Describe the modifications necessary to change a galvanometer to an ammeter or voltmeter.
k. Explain the use of voltmeters and ammeters.
l. Carry out calculations involving capacitors, ammeters, and voltmeters.
m. Discuss the construction and use of the potentiometer.
n. Carry out calculations involving the potentiometer.
o. Explain the use of the Wheatstone bridge.
p. Carry out calculations involving Wheatstone bridges.
q. Discuss the use of transducers and thermocouple.

2. **Learning Activities:**

a. Classroom lecture and discussion
b. Homework assignments
c. Laboratory experiments
d. Chapter 27 in text

3. **Unit Outline:**

a. Resistors in series and parallel
b. EMF and terminal voltage
c. Kirchhoff's rules
d. EMFs in series and parallel
e. Circuits containing resistors and capacitors
f. Ammeters and voltmeters
g. Use of voltmeters and ammeters
G. **Unit Seven**: Magnetism

1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:
   
   a. Discuss the concepts of magnetism and magnetic fields.
   b. Explain the origin of magnetic field.
   c. Discuss the effect of a magnetic field on an electrical charge moving through space.
   d. Carry out calculations involving the motion of an electric charge in a magnetic field.
   e. Explain the magnetic force exerted on a current in a wire.
   f. Carry out calculations involving magnetic force on electric currents.
   g. Be able to determine the direction of a magnetic force acting on a current-carrying wire.
   h. Describe the discovery and the properties of the electron.
   i. Discuss thermionic emission and the cathode ray tube.
   j. Discuss the functioning and use of the cyclotron and synchrotron.
   k. Explain the construction and use of galvanometers, electric motors, and loudspeakers.
   l. Discuss the earth's magnetic field.
   m. Carry out calculations involving torque on a current loop.
   n. Define and use the following terms:
      North pole, Cathode ray, Commutator, South pole, Armature, Ferromagnetic, Brushes

2. **Learning Activities**:
   
   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 28 in text

3. **Unit Outline**:
   
   a. Magnets and magnetic fields
   b. Electric currents produce magnetism
   c. Magnetic force on a current
   d. Moving electric charge in magnetic field
H. **Unit Eight**: Sources of Magnetic Fields

1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:

   a. Describe the magnetic field surrounding a straight wire.
   b. Carry out calculations involving magnetic fields of straight wires.
   c. Use Ampere's law to calculate the field surrounding a current-carrying wire of any shape.
   d. Describe the magnetic field created by a current in a solenoid and a toroid.
   e. Carry out calculations involving magnetic fields of current-carrying solenoids and toroids.
   f. Discuss the magnetic force between two parallel wires.
   g. Carry out calculations involving magnetic force between parallel wires.
   h. State the operational definition of an ampere and a coulomb.
   i. Use the Biot-Savart Law to calculate the magnetic field near an electric conductor.
   j. Define and use the following terms: Ampere's, Current length element, Magnetic dipole, Right-Hand Rule, Rail Gun, Coil, Solenoid, Toroid.

2. **Learning Activities**:

   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 29 in text

3. **Unit Outline**:

   a. Magnetic field of a straight wire
   b. Ampere's Law
   c. Magnetic field of solenoid and a toroid
   d. Force between two parallel wires
   e. Biot-Savart law
f. Ferromagnetism

g. Hysteresis

h. Paramagnetism and diamagnetism

I. **Unit Nine**: Electromagnetic Induction and Magnetism of Matters

1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:

   a. Explain induced EMF.
   b. Use Faraday's Law of induction and Lenz's Law to calculate induced EMF.
   c. Carry out calculations concerning induced EMF in a moving conductor.
   d. Discuss the relationship between changing magnetic flux and electric fields.
   e. Carry out calculations involving the induction of electric fields by changing magnetic flux.
   f. Discuss mutual inductance.
   g. Discuss self-inductance.
   h. Carry out calculations involving self-inductance.
   i. Explain the storage of energy in a magnetic field.
   j. Discuss ferromagnetism.
   k. Explain hysteresis.
l. Discuss paramagnetism and diamagnetism.

2. **Learning Activities**:

   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapters 30 in text

3. **Unit Outline**:

   a. Induced EMF
   b. Faraday's Law of Induction: Lenz's Law
   c. EMF induced in a moving conductor
   d. A changing magnetic flux produces an electric field
   e. Inductors and Inductance
   f. Self-Induction
   g. RL Circuits
   h. Energy in a Magnetic Field
i. The Magnetic Materials
j. Diamagnetism, Paramagnetism, Ferromagnetism
k. The Magnetism of Earth

J. **Unit Ten**: Electromagnetic Oscillations and Alternating Current

1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:
   
   a. Briefly discuss voltage and current variations in AC circuits.
   b. Describe the effect of having only a resistance in an AC circuit.
   c. Describe the effect of having only a capacitor in an AC circuit.
   d. Describe the effect of having only an inductor in an AC circuit.
   e. Discuss RLC circuits.
   f. Carry out calculations involving RLC circuits.
   g. Explain resonance in AC circuits.
   h. Carry out calculations involving resonance in AC circuits.
   i. Discuss the structure and functioning of an electric generator.
   j. Carry out calculations involving electric generators.
   k. Explain counter EMF and torque.
   l. Explain eddy currents.
   m. Carry out calculations involving counter EMFs and torques.
   n. Describe the structure and use of transformers.
   o. Carry out calculations involving transformers.

2. **Learning Activities**:
   
   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapters 31 in text

3. **Unit Outline**:
   
   a. Introduction: AC circuits
   b. AC circuits containing only resistance
   c. AC circuits containing only capacitance
   d. AC circuits containing only inductance
   e. RLC AC circuits
   f. Resonance in AC circuits
   g. The electric generator
   h. Transformers
K. **Unit Eleven:** Maxwell's Equations and Electromagnetic Waves

1. **Unit Objectives:** Upon successful completion of this unit, the student will be able to:

   a. Describe, in general terms, Maxwell's argument to explain the production of a magnetic field by a changing electric field.
   b. Carry out calculations involving the production of a magnetic field by a changing electric field.
   c. Write Maxwell's equations and state them in words.
   d. Discuss the production of electromagnetic waves.
   e. Describe the nature of light.
   f. Discuss the electromagnetic spectrum.
   g. Discuss energy in EM waves.
   h. Carry out calculations involving energy in electromagnetic waves.
   i. Describe the polarization of EM Waves
   j. Describe Reflection and Refraction of EM Waves
   k. Discuss Total Internal Reflection

2. **Learning Activities:**

   a. Classroom lecture and discussion
   b. Homework assignments
   c. Laboratory experiments
   d. Chapters 32 and 33 in text

3. **Unit Outline:**

   a. Changing electric fields produce magnetic fields
   b. Maxwell's Equations
   c. Production of electromagnetic waves
   d. Electromagnetic waves and their speed, from Maxwell's equations
   e. The Poynting Vector
   f. Radiation Pressure
   g. Polarization
   h. Reflection and Refraction
   i. Total Internal Reflection
L. **Unit Twelve:** Geometrical Optics

1. **Unit Objectives:** Upon successful completion of this unit, the student will be able to:
   
   a. Describe image formations in plane mirrors
   b. Understand image formation by spherical mirrors
   c. Carry out calculations involving reflection by plane or spherical mirrors
   d. Use ray tracing to determine the size and location of images
   e. Explain concave & convex mirrors and sign conventions
   f. Discuss refraction at a spherical surface.
   g. Discuss refraction by thin lenses.
   h. Carry out calculations involving refraction by thin lenses.
   i. Discuss lens aberrations.
   j. Carry out calculations involving lens aberrations.
   k. Discuss the construction of a Camera.
   l. Discuss the use and functioning of a magnifying glass.
   m. Carry out calculations involving magnifying glasses.
   n. Describe the structure of a compound microscope and how it functions.
   o. Carry out calculations involving compound microscopes.
   p. Describe the structure of a telescope and how it functions.
   q. Carry out calculations involving telescopes.
   r. Use and define the following terms:
      Real image, Virtual image, Lateral magnification, Mirror equation, Radius of curvature, Focal point, Focal length, Concave, Convex, Ray diagrams, Spherical aberration, Magnification.

2. **Learning Activities:**
   
   a. Classroom lectures and discussions
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 34 in the text

3. **Unit Outline:**
   
   a. Plane Mirrors
   b. Images formed by spherical mirrors
   c. Ray diagrams for mirrors
   d. Refraction at a spherical surface
   e. Thin lenses
f. Ray diagrams for thin lenses

g. Combinations of thin lenses

h. Spherical aberrations

i. Chromatic aberrations

j. The magnifying glass

l. Compound microscopes

m. Telescopes

M. Unit Thirteen: The Wave Optics

1. Unit Objectives: Upon successful completion of this unit, the student will be able to:

a. Explain interference of light.
b. Discuss the conditions for interference
c. Describe the Young double-slit interference.
d. Discuss coherence of light.
e. Discuss interference produced by thin films.
f. Discuss diffraction of light and carry out calculations involving Diffraction.
g. Use and define the following terms: Constructive and destructive interference, Thin films, Newton's ring, Diffraction.

2. Learning Activities:

a. Classroom lectures and discussions
b. Homework assignments
c. Laboratory experiments
d. Chapters 35, 36 in the text

3. Unit Outline:

a. Waves versus particles: conditions for interference
b. Young's double slit experiment
c. Change of phase due to reflection
d. Coherence
e. Interference by thin films
f. Diffraction by a single slit
g. Intensity in single-slit diffraction pattern
h. Diffraction in the double-slit experiment

N. Unit Fourteen: Relativity
1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:

   a. Understand relative motion and reference frame.
   b. Remember the postulates of special theory of relativity.
   c. Explain four-dimensional space-time.
   d. Describe time dilation and length contraction.
   e. Understand Relativistic energy.
   f. Use and define the following terms: Frame of Reference, Postulates of Relativity, Simultaneity, Time Dilation, The Twin-Paradox, Length contraction.

2. **Learning Activities**:

   a. Classroom lectures and discussions
   b. Homework assignments
   c. Laboratory experiments
   d. Chapter 37 in the text

3. **Unit Outline**:

   a. Galilean-Newtonian relativity
   b. The Michelson-Morley experiment
   c. Postulates of the special theory of relativity
   d. Simultaneity
   e. Time dilation and the Twin Paradox
   f. Length contraction
   g. Four dimensional space-time
   h. Mass increase
   i. The ultimate speed
   j. Mass and energy
   k. Relativistic addition of velocities
   l. Galilean and Lorentz Transformation
   m. The impact of special relativity

**Unit Fifteen**: Modern Physics

1. **Unit Objectives**: Upon successful completion of this unit, the student will be able to:

   a. Discuss Waves and Particles nature of light.
   b. Understand the quantum structure of the atom.
   c. State and use the uncertainty principle.
d. Discuss "bonding" in molecules.
e. Understand fusion and fission.
f. Discuss radioactivity.
g. Understand the origin of the Universe.
h. Name the fundamental particles
i. Use and define the following terms:
   Photon, X-rays, Pair production, Wave function, Atomic spectra,
   Electron Clouds, Buckyballs, Lasers, Holography, Compact Disc,
   Isotopes, Binding Energy, Radioactivity, Fermion, Boson, Hadron,
   Lepton, Particle, Antiparticle, Quarks and Baryons.

2. Learning Activities:
   a. Classroom lectures and discussions
   b. Homework assignments
   c. Laboratory experiments
   d. Chapters 38-44 in the text

3. Unit Outline:
   a. Discovery of atomic nucleus
   b. Bohr model
   c. Atomic spectra
   d. De Broglie's hypothesis
   e. Heisenberg's uncertainty principle
   f. Molecular bondings
   g. Structure of nucleus
   h. Radioactivity
   i. Half-life
   j. Nuclear fission
   k. Nuclear reactors, the "The Atom Bomb"
   l. Fusion
   m. Fundamental particles
   n. Fundamental Forces of Nature
   o. The Big Bang