ARISE

PHYSICS

ARISE Freshman Physics - Introductory Comments

The following pages are intended to provide a reference to science interrelationships of physics to chemistry and biology, demonstrations, activities and laboratories, science- related stories, worksheets, websites and videos. This reference book is not a textbook, but is intended to be used along with established textbooks as a supplement to help see interrelationships in science and a pedagogy that flows in an understandable manner and provide activities and worksheets that get to the point of subject matter at an introductory and mainly conceptual approach. Existing labs by textbook authors often approach topics from a qualitative approach, so combining my introductory presentations with existing author material should provide plenty of options for the discretion of the teacher. The topics chosen and the order of presentation were obtained from the use of about one dozen highly regarded physics textbook programs from my 38 years of teaching.

This resource book is primarily intended for beginning physics teachers. However, it is my wish that all physics teachers can use some of the material, especially in the Good Stories section, which is probably new to even the experienced physics teacher. Also, current websites can be helpful to everyone. The demonstrations, activities, laboratories and links are purposely few in numbers, but attempt to address most of the chosen topics in a fun and understandable manner. Also, many of the activities and worksheets approach the listed topics from the introductory level to obtain a conceptual understanding.

The two textbooks and laboratory books that are referenced throughout this resource were written with freshman in mind and somewhat follow the chosen topics in this resource book, but not topic by topic. One textbook referenced is a proven freshman program by Paul H. Hewitt, called *Conceptual Physics*. The second is a 2005 textbook called *Physics: A First Course*, by Tom Hsu. Hewitt's book follows traditional approaches to topics as does Hsu's book and both are at the proper reading level. Both have links to physics, chemistry and biology throughout. Hsu's text and laboratory books use the inquiry approach in all chapters to initially present topics using experiments to formulate beginning ideas for the student. Then, using clever guided questioning, Dr. Hsu challenges the student to formulate fundamental ideas as the teacher assists in the learning process. Then, to check for mastery at the end of the topic, a concluding laboratory tests the student's ability to apply what should have been learned in studying the chapter. This concluding lab might be considered as a lab practical. Hewitt's laboratory manual has many experiments and appropriate worksheets to assist in the learning process. His experiments are well thought out and are at the correct difficulty level. In this resource, I will refer to many of Hewitt and Hsu's experiments as well as show several that I have written. I will refer to Hewitt's text as (*Conceptual Physics*) and Hsu's text as (CPO physics).

I need to comment on my beginning choice of topics, which is the vector. As mentioned above, I have used many textbooks in 38 years and only one senior physics text started with vectors. In the years that I used that sequence, I felt the student really got to understand and appreciate vectors earlier and develop throughout high school, as students would relate to me when their math class began the study of vectors. If vectors are introduced to freshman from a conceptual

approach, the students CAN understand, from the start, that vectors are throughout the physical world. Graphical drawings at the freshman level should be used to work with vectors and not the Pythagorean theorem or right angle trigonometry. In my mind, to teach displacement, velocity, acceleration and force and THEN introduce vectors doesn't seem to follow the proper pedagogy. Having taught freshman, they can understand vectors, or at least most of them.

Throughout each topic section, the source, materials, building on, leading to, links to physics, chemistry and biology, good stories, activities and laboratories, worksheets, demonstrations, websites and videos are chosen to be appropriate for freshman although can be used by older physics programs.

In the material section for each topic I have used (a) for listing Hewitt's labs, (b) for Hsu's labs, (c) for my introductory labs, (d) for my worksheets, (e) for my demonstrations (many borrowed/modified from other physics teachers), (f) for Joe Liaw's tested websites with accompanying worksheets and activities and videos that are accessible and most free, and finally, interesting "Good Stories" mainly written by Jim Szeszol that either fit into each of the 19 topics or are just "Good Science Stories" that need to be told.

Enjoy your students and, hopefully, much or at least some of this reference book is helpful to you!

ARISE Physics Supplemental Resource

- 21 Traditional Physics Topics Addressed

- Connections or Links between Physics, Chemistry and Biology

- Introductory Approach to Topics of:
  1. Laboratories
  2. Worksheets
  3. Demonstrations

- Websites and Videos

- Good Stories

Curriculum Topics and Sequence

The topics which have been chosen for the proposed first year physics ARISE high school sequence are those which I believe will best prepare the young minds of freshman for chemistry for the following year. This means that some topics found in a "conventional" high school physics course have to be excluded and some topics presented will have to be optional due to time consideration. The topics not presented, it is hoped, will be taken up in the elective physics course as upper classman and perhaps at college.

Physics is the basic science that provides the foundation for a broad array of applications such as chemistry, biology, earth science, applied science, band and art, and all physical applications.

I believe that the topics listed below will provide a suitable introduction to a basic principle science, physics, and prepare the student with skills and background to study chemistry. Some topics are necessary for preparing students for chemistry and should not be omitted. Thus, the high priority topics for a 36-week school year should be Topics 1-11, 15, 16, 17 and 18. Extra or optional topics are 12, 13, and 14. This is roughly 7.5 topics/semester, which can be accomplished. Therefore, this is about 2.5 weeks/topic if one uses about one week of lab/activities and 1.5 weeks for worksheets, presentation and discussions and two days for small quizzes and tests. The students will have the tools to be well prepared to do well in chemistry and have a better appreciation and understanding of the physical world that they enjoy.

Main Subject:	Topics:
1. Vectors	Displacement Velocity Force
2. Graphical Analysis and Analytical Techniques	Measurement Significant Figures and Scientific Notation Graphing Graphing Calculator
3. Kinematics	Displacement Velocity Acceleration 1- and 2-Dimensional Motion
4. Dynamics	Force Newton's 1st Law Newton's 2nd Law Newton's 3rd Law Friction

5. Work and Energy	Work Kinetic Energy and Work-Energy Theorem Potential Energy Conservation of Mechanical Energy Power Special Role of Energy in Science
6. Momentum and Collisions	Momentum and Impulse Conservation of Momentum Collisions in 1 Dimension Collisions in 2 Dimensions
7. Circular Motion	Linear Speed, Tangential Speed and Rotational Speed Centripetal Force and Centrifugal Force Centripetal Acceleration
8. Gravitation	Gravitational Force Fields Acceleration of Gravity (g) Universal Law of Gravitation Satellite Circular Motion Escape Velocity
9. Electric Forces	Electric Charge Electric Field Force between Charges Electroscopes Conduction and Induction
10. Electric Potential	Electric Potential Energy Potential Difference Equipotential Battery
11. Current and Resistance	Electric Current Resistance and Ohm's Law Electric Energy and Power
12. Direct-Current Circuits	Sources of EMF Circuits with Resistors in Series Circuits with Resistors in Parallel
13. Magnetism	Magnetic Field Mapping Earth Magnetic Field Magnetic Field Created by an Electric Current
14. Electromagnetic Waves	Oscillating Electric and Magnetic Fields

	Spectra
15. Vibrations and Waves	Periodic Motion Hooke's Law and Elasticity Simple Harmonic Motion Wave Interaction: Reflection and Transmission Interference as the Indicator of Waves Phenomena Wave Resonance in a String Transverse and Longitudinal Waves
16. Geometric Optics	The Concept of Light The Velocity of Light
17. Relativity	Postulates of Relativity Speed of Light as Limiting Speed Simultaneity Moving Clocks Run Too Slowly Relativistic Length Contraction Relativistic Mass-Energy Relationship
18. Photons	Planck's Discovery: Blackbody Radiation Einstein's Use of Planck's Constant: Photoelectric Effect Compton Effect
19. Quantum Mechanics	de Broglie Wavelength Wave Mechanics versus Classical Mechanics Resonance in de Broglie Waves The Uncertainty Principle
20. The Atom	Atomic Structure Electron Energy Levels A Glimpse at Chemistry Nucleus Fission and Fusion
21. The Universe	Origin and Evolution The Scale of Distance and Time Big Bang Hypothesis Stars, Galaxies, Quasars, Black Holes Evolution and Destiny Dark Matter and Dark Energy

Topic Index for ARISE Supplemental Laboratories and Activities

		Laboratory/Activity (* = Not done)
Topic 1:	Vectors	
	(a) Displacement	1. Pre-Vector Discussion 2. Walking Vectors
	(b) Velocity	None - Given in Topic 3
	(c) Force	Force Vectors
Topic 2:	Measurement and Graphical Analysis	1. Significant Figures 2. Three-Part Graphing Activity 3. Significant Digits
Topic 3:	Kinematics	1. Walking Vectors (same as Topic 1 (a) 2 2. Walk a Number Line 3. Velocity and Acceleration (four parts)
Topic 4:	Dynamics	1. Constant Force Produces Constant Acceleration 2. Constant Mass, Vary Force, Measure "a" 3. Constant Force, Vary Mass, Measure "a" 4. Friction
Topic 5:	Work and Energy	1. Car Up and Down Ramp 2. GPE and KE*
Topic 6:	Momentum and Collisions	1. Linear Momentum on an Air Track 2. Collisions in 2 Dimensions* 3. Computer Collisions*
Topic 7:	Circular Motion	Conceptual Circular Motion
Topic 8:	Gravitation	Measure "g"
Topic 9:	Electric Forces	Conceptual Coulombs Law
Topic 10:	Electric Potential	Electric Potential*
Topic 11:	Current and Resistance	Ohm's Law, Electrical Energy and Power*

Topic 12: Direct Current Circuits	Series and Parallel Circuits (a) Light bulbs (b) Resistors
Topic 13: Magnetism	Right-Hand Rule and Charges in Motion
Topic 14: Electromagnetic Waves	EM Wave Properties
Topic 15: Vibrations and Waves	None*
Topic 16: Geometric Optics	Water Waves and Light
Topic 17: Relativity	None*
Topic 18: Photons	None*
Topic 19: Quantum Mechanics	None*
Topic 20: The Atom	Hydrogen's Lowest Energy Level*
Topic 21: The Universe	View Jupiter's Moons

Topic Index for ARISE Supplemental Worksheets

		Worksheets (* = Not done)
Topic 1:	Vectors	
	(a) Displacement	Vector Practice Worksheet
	(b) Velocity	Velocity Worksheet
	(c) Force	Force Vectors
Topic 2:	Measurement and Graphical Analysis	1. Scientific Notation 2. Significant Figures 3. Metric Prefixes 4. Graphical Analysis
Topic 3:	Kinematics	Displacement, Velocity and Acceleration
Topic 4:	Dynamics	Newton's Law Questions and Problems
Topic 5:	Work and Energy	1. Work and Energy 2. GPE and KE*
Topic 6:	Momentum and Collisions	Momentum Worksheet/Activities
Topic 7:	Circular Motion	Circular Motion
Topic 8:	Gravitation	Gravitational Field
Topic 9:	Electric Forces	Electric Field
Topic 10:	Electric Potential	Electric Potential*
Topic 11:	Current and Resistance	Ohm's Law*
Topic 12:	Direct Current Circuits	Circuits*
Topic 13:	Magnetism	Magnets*
Topic 14:	Electromagnetic Waves	EM Waves*
Topic 15:	Vibrations and Waves	Vibration and Waves*
Topic 16:	Geometric Optics	Water Waves and Light*

Topic 17: Relativity	None*
Topic 18: Photons	Energy Levels in a Fake Atom*
Topic 19: Quantum Mechanics	None*
Topic 20: The Atom	The Atom
Topic 21: The Universe	None*

Topic Index for ARISE Supplemental Demonstrations

		Demonstrations (* = Not done)
Topic 1:	Vectors	
	(a) Displacement	1. Step Displacement Vector Demonstration 2. Vector Miscellaneous (a, b, c)
	(b) Velocity	1. Velocity Demonstration 2. Ball on Incline
	(c) Force	Vector Components
Topic 2:	Measurement and Graphical Analysis	Graphing (plus some rule for graphing) using Hooke's Law (a, b, c)
Topic 3:	Kinematics	2-Dimensional Motion
Topic 4:	Dynamics	1. Newton's 1st Law (a) Toilet Paper Pull (b) Cart and Figure with/without seatbelt (c) Coin into Cup 2. Newton's 2nd Law (a) Change Mass of Cart being Pulled by Same Cart (b) Change Force on Same Cart 3. Newton's 3rd Law (a) Skateboard, Student and Wall
Topic 5:	Work and Energy	1. Bend Wire 2. Lead Shot in Cardboard Tube 3. Pulley and Lever 4. Jumping Disk 5. Energy Transfer #1 6. Energy Transfer #2
Topic 6:	Momentum and Collisions	1. Jump from a Chair 2. Happy and Sad Balls
Topic 7:	Circular Motion	Tangential Velocity in Circular Motion

Topic 8: Gravitation	Up and Down “g”
Topic 9: Electric Forces	1. Electrostatics 2. Conduction and Induction 3. Electric Field
Topic 10: Electric Potential	Potential Difference and Equipotential
Topic 11: Current and Resistance	Burning a Wire using a Power Transformer*
Topic 12: Direct Current Circuits	3-Way Light Switch*
Topic 13: Magnetism	Magnets*
Topic 14: Electromagnetic Waves	EM Waves*
Topic 15: Vibrations and Waves	Vibration and Waves*
Topic 16: Geometric Optics	Water Waves and Light*
Topic 17: Relativity	None*
Topic 18: Photons	Energy Levels in a Fake Atom*
Topic 19: Quantum Mechanics	None*
Topic 20: The Atom	The Atom
Topic 21: The Universe	None*

Topic Index for ARISE Supplemental Good Stories

		Good Stories (* = Not done)
Topic 1:	Vectors	
	(a) Displacement	Direction
	(b) Velocity	None*
	(c) Force	1. The Wrath of Newton 2. Newton's Two Birthdays
Topic 2:	Measurement and Graphical Analysis	1. Richard Owens – The Worst Lab Partner in the World 2. Standard Units 3. Transit of Venus 4. Tycho Brahe (1546-1601)
Topic 3:	Kinematics	1. Why a Seven-Day Week? 2. Nicolas Copernicus 3. The Fastest Airplane in the World 4. Johannes Kepler – A Life of Tragedy 5. Aristotle and Galileo on Early Mechanics*
Topic 4:	Dynamics	1. The Wrath of Newton (repeat) 2. Newton's Two Birthdays (repeat)
Topic 5:	Work and Energy	1. The Household Match 2. Joule – Jewel - Jowl
Topic 6:	Momentum and Collisions	None*
Topic 7:	Circular Motion	Circular Motion and the "Funky Chicken"
Topic 8:	Gravitation	1. Johannes Kepler – The Father of Sci-Fi 2. Johannes Kepler – Amazing Accomplishments 3. Tycho's Knows 4. Tycho's Pet Moose
Topic 9:	Electric Forces	1. Charles Coulomb 2. Charles Augustin Coulomb – Civil Engineer 3. Millikan's Oil Drop Experiment

	4. John Bardeen
Topic 10: Electric Potential	1. Alessandro Giuseppe Antonio Anastasio Volta (1745-1827) 2. Michael Faraday – The Fading of a Genius 3. Michael Faraday – The Early Years
Topic 11: Current and Resistance	1. Andre-Marie Ampere (1775-1836) 2. Joseph Priestley – Extremist
Topic 12: Direct Current Circuits	None*
Topic 13: Magnetism	1. Magnetism – The Early Years 2. Hans Christian Oersted (1777-1851) 3. William Gilbert (1544-1603) – The Father of Magnetism
Topic 14: Electromagnetic Waves	James Clerk Maxwell – Maker of Waves
Topic 15: Vibrations and Waves	Hooke's Spring
Topic 16: Geometric Optics	Thomas Young – The Last Person Who Knew Almost Everything
Topic 17: Relativity	1. Einstein* 2. Albert Michelson (1852-1931) – A Lot of Nothing 3. Albert Michelson in Popular Culture
Topic 18: Photons	Max Planck and a Lucky Guess
Topic 19: Quantum Mechanics	Three Men Who Created Quantum Mechanics: Werner Heisenberg, Erwin Schrödinger, Paul Dirac
Topic 20: The Atom	1. Marie Curie (1867-1934) and the Little Curies 2. Fermi's Paradox – "Where is Every-Body?"
Topic 21: The Universe	Carl Sagan*