Strand 1 – Thinking and Practice – SCIENTIFIC METHOD

Essential Question: How do we find out about everything in the universe?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
				Two textbooks are listed under resources often. They are denoted as follows: **CP** for Conceptual Physics by Paul Hewitt ISBN 0-13-166301-1 and **P** for Physics by Serway and Faughn CP is the resource for the Physics Course and P is the resource for the Advanced Physics Course. In the Advanced Physics Course, many of the labs are extensions of the Physics Lab.

Strand I THINKING & PRACTICE Process of Investigation **SCIENTIFIC METHOD** **Standard I:** Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically. **Benchmark I:** Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results	1. Describe the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions. 2. Design and conduct scientific investigations that include: • testable hypotheses • controls and variables • methods to collect, analyze, and interpret data • results that address hypotheses being investigated • predictions based on results • re-evaluation of hypotheses and additional experimentation as necessary • error analysis. 3. Use appropriate technologies to collect, analyze, and communicate scientific data (e.g., computers, calculators, balances, microscopes). 4. Convey results of investigations using scientific concepts, methodologies, and expressions, including: • scientific language and symbols • diagrams, charts, and other data displays • mathematical expressions and processes (e.g., mean, median, slope, proportionality) • clear, logical, and concise communication • reasoned arguments. 5. Understand how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom).	1.In a lab report, student will use standard lab format. 2. Student will design their own investigation including hypothesis, data collection, analysis and communication. 3. Student will be able to use the Vernier probes and generate graphs manually and using computer software or calculators. 4. In a lab report, student will use standard lab format. 5. Student will be able to explain atomic structure.		1. Teacher generated labs/investigations Ex: Rescue Rangers Lab Around and Around Lab Rayleigh/Taylor Instability Lab 2. Teacher directed labs. Ex: Parachute Drop Lab Catapult Project 3. Vernier lab manual/Teacher generated labs. Ex: Coefficient of Restitution Energy of a Tossed Ball Graph Matching Momentum Conservation 4. Teacher generated labs. Same list of labs as in #1 5.**CP**- Ch 17. **P** – Ch 21

Strand 1 - Thinking and Practice – SCIENTIFIC THINKING

Essential Question: How do we find out about things and agree on an answer?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
Strand 1 THINKING & PRACTICE Process of Investigation **SCIENTIFIC THINKING** **Standard I:** Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically. **Benchmark II:** Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.	1. Understand how scientific processes produce valid, reliable results, including: • consistency of explanations with data and observations • openness to peer review • full disclosure and examination of assumptions • testability of hypotheses • repeatability of experiments and reproducibility of results. 2. Use scientific reasoning and valid logic to recognize: • faulty logic • cause and effect • the difference between observation & unsubstantiated inferences and conclusions • potential bias. 3. Understand how new data and observations can result in new scientific knowledge. 4. Critically analyze an accepted explanation by reviewing current scientific knowledge. 5. Examine investigations of current interest in science (e.g., superconductivity, molecular machines, age of the universe). 6. Examine the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time-consuming experiments such as medical clinical trials), and investigations of phenomena that can be repeated easily and frequently.	1. On a lab, students will compare their results to other groups and defend their methods. 2. In lab analysis, student will use objective, scientific methods. 3. Student will the change from geocentric to heliocentric view of the Solar System. 4. Student will explain the relationship between force and acceleration and how this differed from previous ideas. 5. Student will explain current ideas in gravity. Ex: black holes 6. Student will explain certain scientific theories in terms of modeling.		1. Teacher generated labs. Ex: Catapult Project Magnetic Field of a Slinky Bombing Run 2. All labs. 3. Orbit of Mars lab or similar 4. **CP** Ch 4,5,6 **P** Ch 4 Hold the Force Lab or similar 5. Video- “Black Holes”. Student project and/or guest speakers 6. **CP** Ch 39 **P** Ch 7 Star Logo Models, Optics Simulations on the Web, Think Quest, and/or Radioactive dice lab.

Strand 1 – Thinking and Practice – MATH SKILLS

Essential Question: What skills and tools do we need to find out about our universe?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
Strand 1 THINKING & PRACTICE Process of Investigation **MATH SKILLS** **Standard I:** Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically. **Benchmark III:** Use mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.	1. Create multiple displays of data to analyze and explain the relationships in scientific investigations. 2. Use mathematical models to describe, explain, and predict natural phenomena. 3. Use technologies to quantify relationships in scientific hypotheses (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling). 4. Identify and apply measurement techniques and consider possible effects of measurement errors. 5. Use mathematics to express and establish scientific relationships (e.g., scientific notation, vectors, dimensional analysis).	1. Student will do lab reports with data tables, graphs and equations as appropriate. 2. Student will be able to write the equation of the line given their scientific graph. 3. Student will be able to generate graphs manually and using computer software or calculators. 4. Student will use proper measurement tools and the correct number of significant figures for the equipment used and/or error analysis. 5. Students will be able to solve vector problems.		1. All labs. 2. **CP** Ch 2 **P** Ch2 Analyze motion graphs. 3. **CP** Ch 8, 25 **P** Ch5, 11 Teacher generated labs. Ex: It's All Uphill 1&2 Period of a Pendulum 4. **CP** Ch 1 **P** Ch1 All lab activities. 5. **CP** Ch 3 **P** Ch 3 (+ Text problems).

Strand II Content of Science – PHYSICAL SCIENCE – Properties of Matter

Essential Question: How does the universe work?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
Strand II: Content of Science **PHYSICAL SCIENCE Properties of Matter** **Standard I):** Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy. **Benchmark II**: Understand the transformation and transmission of energy and how energy and matter interact	**Energy Transformation and Transfer** 1. Identify different forms of energy, including kinetic, gravitational (potential), chemical, thermal, nuclear, and electromagnetic. 2. Explain how thermal energy (heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature. 3. Understand that energy can change from one form to another (e.g., changes in kinetic and potential energy in a gravitational field, heats of reaction, hydroelectric dams) and know that energy is conserved in these changes. 4. Understand how heat can be transferred by conduction, convection, and radiation, and how heat conduction differs in conductors and insulators. 5. Explain how heat flows in terms of the transfer of vibrational motion of atoms and molecules from hotter to colder regions.	1. The student will be able to identify potential and kinetic energy in a lab setting. 2. The student will be able to explain the role of friction. 3. The student will be able to solve problems that involve energy transformation and conservation. 4. The student will be able to explain the lack of heat transfer in a calorimeter cup. 5. Student will identify insulators and conductors of heat.		1. **CP** Ch 8 **P** Ch 5 Incline plane lab or similar. 2. **CP** Ch 4,5 **P** Ch 4 Friction lab or similar 3. **CP** Ch 8 **P** Ch 5 (+ Text problems) teacher generated labs Ex:Hot Wheels Lab Orbit of Mars Lab 4. **CP** Ch 21,22 **P** Ch 9 Calorimeter cup or equivalent demo. Specific or Latent Heat Lab 5. **CP** Ch 21,22. **P** Ch 9 Explorations on conductors and insulators

	6. Understand that the ability of energy to do something useful (work) tends to decrease (and never increases) as energy is converted from one form to another. **Interactions of Energy & Matter** 7. Understand that electromagnetic waves carry energy that can be transferred when they interact with matter. 8. Describe the characteristics of electromagnetic waves (e.g., visible light, radio, microwave, X-ray, ultraviolet, gamma) and other waves (e.g., sound, seismic waves, water waves), including: • origin and potential hazards of various forms of electromagnetic radiation • energy of electromagnetic waves carried in discrete energy packets (photons) whose energy is inversely proportional to wavelength. 9. Know that each kind of atom or molecule can gain or lose energy only in discrete amounts. 10. Explain how wavelengths of electromagnetic radiation can be used to identify atoms, molecules, and the composition of stars. 11. Understand the concept of equilibrium (i.e., thermal, mechanical, and chemical).	6. Students will explain why if energy is conserved that there is an energy crisis. 7. Students will explain an apparatus like a solar cooker or radio works. 8. Student will compare similarities and differences of sound and light. 9. Student will diagram atomic energy levels. 10. Student will be able to contrast continuous and discrete spectra. 11. Students will be able to recognize systems where the net force equals zero.		6. **CP** Ch 8 **P** Ch 5 Class discussion of energy conservation. Lab or Demos on Simple Machines It's All Uphill 7. **CP** Ch 27 **P** Ch 13 Film: _____ Solar Gain lab or similar. 8. **CP** Ch 26,27 **P** Ch 12, 13 Ripple While You Work Lab, Speed of Sound Lab, Slinky lab or similar. 9. **CP** Ch 17,27 **P** Ch 13,17 Bohr model 10. **CP** Ch 28 **P** Ch 13 Atomic Spectra Lab or similar 11. **CP** Ch 3 **P** Ch 3 Free Body Diagrams Adding Forces Lab

Strand II Content of Science – PHYSICAL SCIENCE Forces of Matter

Essential Question: How and why do the things in the universe move?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
Strand II: Content of Science **PHYSICAL SCIENCE Forces of Matter** **Standard I):** Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy. **Benchmark III:** Understand the motion of objects and waves, and the forces that cause them	**Forces** 1. Know that there are four fundamental forces in nature: gravitation, electromagnetism, weak nuclear force, and strong nuclear force. 2. Know that every object exerts gravitational force on every other object, and how this force depends on the masses of the objects and the distance between them. 3. Know that materials containing equal amounts of positive and negative charges are electrically neutral, but that a small excess or deficit of negative charges produces significant electrical forces. 4. Understand the relationship between force and pressure, and how the pressure of a volume of gas depends on the temperature and the amount of gas. 5. Explain how electric currents cause magnetism and how changing magnetic fields produce electricity (e.g., electric motors, generators).	1. Student will be able to list the four fundamental forces. 2. Student will recognize that the force that makes the moon go around the earth is the same that makes the apple fall. 3. Student can explain and demonstrate the charging of a pith ball or balloon. 4. Student will explain why they can sit on a bed of nails and not get hurt. 5. Student will write up the motor/generator lab.		1. **CP** Ch 12 p.173 **P** Ch 22 pp.811-12 Class discussion 2. **CP** Ch 12 (section 2) **P** Ch 7 (section 2) and Isaac Newton 3. **CP** Ch 32,33 **P** Ch 16, 17 Static Cling Lab or similar Van de Graaff demonstrations 4.**CP** Ch 4 **P** Ch 8 (section 1,2) Bed of nails demo Film: Math Under Pressure 5. **CP** Ch 37 **P** Ch 20 Motor/generator lab or similar.

	6. Represent the magnitude and direction of forces by vector diagrams. 7. Know that when one object exerts a force on a second object, the second object exerts a force of equal magnitude and in the opposite direction on the first object (i.e., Newton's Third Law). **Motion** 8. Apply Newton's Laws to describe and analyze the behavior of moving objects, including: • displacement, velocity, and acceleration of a moving object • Newton's Second Law, *F = ma* (e.g., momentum and its conservation, the motion of an object falling under gravity, the independence of a falling object's motion on mass) • circular motion and centripetal force. 9. Describe relative motion using frames of reference.	6. Student will draw a vector diagram. 7. Student will be able to explain the windshield and the bug. 8. Student will be able to solve Newton's Second Law Problems. 9. Student can explain that all motion is relative and solve problems using momentum conservation.		6. **C**P Ch 2, 4 **P** Ch 3, 4 Vector Treasure Hunt or similar 7. **C**P Ch 6 **P** Ch 4 Magnet/Clip demo or similar 8. **C**P Ch 5,9 **P** Ch 4, 7 (+Text problems) 9. **C**P Ch 2, 7 **P** Ch 2,6 (+ Text problems) Speed Buggy demos or similar Optional: **C**P Ch 15,16 **P** Appendix J pp. 915-921 with class discussion and class presentations.

	10. Describe wave propagation using amplitude, wavelength, frequency, and speed. 11. Explain how the interactions of waves can result in interference, reflection, and refraction. 12. Describe how waves are used for practical purposes (e.g., seismic data, acoustic effects, Doppler effect).	10. Student will be able to diagram a wave and solve problems using velocity equals frequency * wavelength. 11. Student will explain wave interactions in the ripple tank. 12. Student will give examples of how waves are used in everyday life for example Doppler Effect.		. 10. **C**P Ch 25. **P** Ch 11 Wave Properties Lab (slinkys) or similar 11. **C**P Ch 25 **P** Ch 11 Ripple While you Work lab or similar. 12. **C**P Ch 26 **P** Ch 12 Sound labs

Strand II Content of Science – EARTH AND SPACE SCIENCE Universe/Solar System

Essential Question: Where did the universe come from and where is it going?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
Strand II: Content of Science **EARTH & SPACE SCIENCE Universe/Solar System** **Standard III (Earth and Space Science):** Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.	1. Understand the scale and contents of the universe, including: • range of structures from atoms through astronomical objects to the universe • objects in the universe such as planets, stars, galaxies, and nebulae. 2. Predict changes in the positions and appearances of objects in the sky (e.g., moon, sun) based on knowledge of current positions and patterns of movements (e.g., lunar cycles, seasons). 3. Understand how knowledge about the universe comes from evidence collected from advanced technology (e.g., telescopes, satellites, images, computer models). 4. Describe the key observations that led to the acceptance of the Big Bang theory and that the age of the universe is over 10 billion years.	1. Student will convert exponential notation to standard notation for atoms and galaxies. 2. Student will explain the lunar phases. 3. Student will explain the diagram of the refracting telescope. 4. Students need to be able to list evidence to support the Big Bang theory for example the red shift and cosmic background radiation.		1. Earth as a Walnut or similar lab. 2. Lunar journal and lunar phases lab or similar. 3. **CP** Ch 29,30 **P** Ch 14 Image This Lab or similar. 4. **CP** Ch 25,27,28 **P** Ch 11, 12, 13. Appendix J pp 912-13 Class discussion Doppler shift lab/demo

Benchmark I: Examine the scientific theories of the origin, structure, contents, and evolution of the solar system and the universe, and their interconnections.	5. Explain how objects in the universe emit different electromagnetic radiation and how this information is used. 6. Describe how stars are powered by nuclear fusion, how luminosity and temperature indicate their age, and how stellar processes create heavier and stable elements that are found throughout the universe. 7. Examine the role that New Mexico research facilities play in current space exploration (e.g., Very Large Array, Goddard Space Center).	5. Student will compare emission spectra of elements. 6. Student will distinguish between the atomic structure of various elements. 7. Student will describe how various regions of the electromagnetic spectrum are used to find out about the universe.		5. **CP** Ch 28 **P** Ch 13, 21 6. **CP** Ch 17 **P** Ch 21 Class discussion and/or HR lab or similar 7. **CP** Ch 27 **P** Ch 13, 21, Appendix J Any or all of- Class discussions, guest speakers, Bradbury Science Museum, the World wide web

Strand II Content of Science – EARTH & SPACE SCIENCE Earth

Essential Question: Why, of all places in the universe, is the Earth the best place to live?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
Strand II: Content of Science **EARTH & SPACE SCIENCE Earth** **Standard III (Earth and Space Science):** Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems. **Benchmark II:** Examine the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.	**Characteristics and Evolution of Earth** 2. Recognize that radiometric data indicate that Earth is at least 4 billion years old and that Earth has changed during that period. 5. Explain plate tectonic theory and understand the evidence that supports it. **Energy in Earth's System** 6. Know that Earth's systems are driven by internal (i.e., radioactive decay and gravitational energy) and external (i.e., the sun) sources of energy. 7. Describe convection as the mechanism for moving heat energy from deep within Earth to the surface and discuss how this process results in plate tectonics, including: • geological manifestations (e.g., earthquakes, volcanoes, mountain building) that occur at plate boundaries • impact of plate motions on societies and the environment (e.g., earthquakes, volcanoes).	2. N/A covered in Chemistry and Biology, but not covered in Physics. 5. Student will calculate rates of motion of the movement in tectonic plates. 6. Student will discuss sources of energy for the Earth. 7. Students will explain demos on Ch 22 (**CP**)		2. N/A 5. **CP** Ch2 **P** Ch 2 Film and teacher generated problems. 6. **CP** Ch 8 **P** Ch 5 Class discussion 7. **CP** Ch 22 **P** Ch 9 Demos on Ch 22. Ex: Lava lamp, multi-metal wheel

Strand III Science & Society – DISCOVER / INVENT Scientific Influence

Essential Question: How do we minimize the human footprint on the universe?

Category	Physics	End Learning Mastery	Assessment(s)	Resources
Strand III: Science and Society **Discover / Invent Scientific Influence** **Standard I:** Understand how scientific discoveries, inventions, practices, and knowledge influence, and are influenced by, individuals and societies. **Benchmark I:** Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies	**Science and Technology** 1, Know how science enables technology but also constrains it, and recognize the difference between real technology and science fiction (e.g., rockets vs. antigravity machines; nuclear reactors vs. perpetual-motion machines; medical X-rays vs. Star-Trek tricorders). 2. Understand how advances in technology enable further advances in science (e.g., microscopes and cellular structure; telescopes and understanding of the universe). 3. Evaluate the influences of technology on society (e.g., communications, petroleum, transportation, nuclear energy, computers, medicine, genetic engineering) including both desired and undesired effects, and including some historical examples (e.g., the wheel, the plow, the printing press, the lightning rod).	1. Student will write a critique analyzing the science in a Sci-Fi episode of Star Trek for example. **2. Student will explain how lenses enabled one to see clearly if one is near or far sighted.** **3. Student will discuss current policies in nuclear power for example.**		1. Star Trek episode or similar. 2. **CP** Ch 30 **P** Ch 14 Lens lab or similar 3. **CP** Ch 8 **P** Ch 5, 22 Class discussion. 4. **CP** Ch 7,8

	4. Understand the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment). 6. Analyze the impact of digital technologies on the availability, creation, and dissemination of information. **Science and Society** 9. Describe how scientific knowledge helps decision makers with local, national, and global challenges (e.g., Waste Isolation Pilot Project [WIPP], mining, drought, population growth, alternative energy, climate change). 10. Describe major historical changes in scientific perspectives (e.g., atomic theory, germs, cosmology, relativity, plate tectonics, evolution) and the experimental observations that triggered them. 11. Know that societal factors can promote or constrain scientific discovery (e.g., government funding, laws and regulations about human cloning and genetically modified organisms, gender and ethnic bias, AIDS research, alternative-energy research).	4. Students will explain how rockets work in terms of momentum and energy. 6. Student will discuss how semi-conductor technology has revolutionized communication and information technologies. 9. Student will have to argue both sides of an issue like Nuclear Power or Global Warming. 10. Student will describe major advances in our understanding of the atom. 11. Students will do role-playing or discussion/dialog on nuclear energy and how to handle nuclear waste.		4. **CP** Ch 7,8 **P** Ch 5, 6 Balloon Rocket Lab or similar 6. **CP** Ch 32, p. 509 **P** Ch 16 p. 561 Ch 18 p. 646 Appendix J pp 926-7 Class discussion and interview of ancient teachers. 9. **CP** Ch 8, 22 **P** Ch 5,9 World Wide Web, current publications. 10. **CP** Ch 17 **P** Ch 21, 22, Appendix J Ex: Rutherford's experiment and its' relevance 11. **CP** Ch 8 **P** Ch 5, 22 Lynne Ovaska's notes on Socratic Seminar and/or touchstones. 13. LANL website and/

	13. Describe how environmental, economic, and political interests impact resource management and use in New Mexico. 14. Describe New Mexico's role in nuclear science (e.g., Manhattan Project, WIPP, national laboratories). **Science and Individuals** 15. Identify how science has produced knowledge that is relevant to individual health and material prosperity. 16. Understand that reasonable people may disagree about some issues that are of interest to both science and religion (e.g., the origin of life on Earth, the cause of the Big Bang, the future of Earth). 17. Identify important questions that science cannot answer (e.g., questions that are beyond today's science, decisions that science can only help to make, questions that are inherently outside of the realm of science).	13. Student will discuss role of LANL in the nation. 14. Student will teach (possibly by designing a handout) some section from CP Ch 39,40 and will include some discussion of how WIPP fits into the lesson. 15. Student will demonstrate a knowledge of how a house is wired. 16. Student will be able to discuss the domains of science, art and religion. 17. Student will do Concept Development Worksheet 1.1 from the CP curriculum.		13. LANL website and/ or guest speakers, Bradbury Science Museum, Frontiers in Science Talks, PEAK 14. **CP** Ch 39, 40 **P** Ch 21, 22 Bradbury Science and PEAK. 15.**CP** Ch 35 **P** Ch 18 Ohm's Law, Parallel & Series Circuit, &Power Lab. Circuit diagrams. 16. **CP** Section 1.7 **P** Appendix J p 912-13 class discussion 17. **CP** Ch 1 **P** Ch 1 **CP** concept development workbook 18. Film : "Einstein's

	18. Understand that scientists have characteristics in common with other individuals (e.g., employment and career needs, curiosity, desire to perform public service, greed, preconceptions and biases, temptation to be unethical, core values including honesty and openness). 19. Know that science plays a role in many different kinds of careers and activities (e.g., public service, volunteers, public office holders, researchers, teachers, doctors, nurses, technicians, farmers, ranchers).	18. Student will profile in what ways they themselves are a scientist. 19. Student will discuss a career they are interested in and discuss how science knowledge is a part of this career.		18. Film : "Einstein's Big Idea" or similar and/or a paragraph in a lab that they designed where they analyze themselves during the design phase. 19. **CP** Ch 1 **P Ch 1** Science Survey.