

Teacher's Guide For

Core Physics: Modern Physics

For grade 7 - College

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MATERIALS IN THE PROGRAM

Teacher's Guide -This Teacher's Guide has been prepared to aid the teacher in utilizing materials contained within this program. In addition to this introductory material, the guide contains the following:

- Suggested Instructional Notes
- Student Learning Goals
- Test Questions on Blackline Masters A for duplication and handout to students.

INSTRUCTIONAL NOTES

It is suggested that you preview the program and read the related Student Goals and Teacher Points. By doing so, you will become familiar with the materials and be better prepared to adapt the program to the needs of your class. You will probably find it best to follow the programs in the order in which they are presented in this Teacher's Guide, but this is not necessary. It is also suggested that the program presentation take place before the entire class and under your direction. As you review the instructional program outlined in the Teacher's Guide, you may find it necessary to make some changes, deletions, or additions to fit the specific needs of your students. After viewing the programs you may wish to copy the Test Questions on Blackline Master 1A, and distribute to your class to measure their comprehension of the events.

INTRODUCTION AND SUMMARY OF PROGRAM

Core Physics: Modern Physics is a unique approach to presenting in a logical way modern physics' core principles relating to the nature and property of matter. In the long history of physics, a series of discoveries and laws have laid the foundation for how the universe works. This program, *Modern Physics* covers the modern era, which brought us new paradigms of how the universe works and our place in it. Presented in an effective format designed to promote successful student learning, the core principles, discoveries and laws of this period are laid out in chronological order, each naturally building on the former. *Core Physics: Modern Physics* examines the key points in the development of modern physics beginning with the discovery of the electron in 1897 and following through the principle of quantum mechanics, the development of chaos theory, Einstein's breakthrough theory of Relativity, the discovery of wave particle duality and Heisenberg's uncertainty principle, the first nuclear chain reaction in 1942 and ending with the discovery of quarks 26 years later.

Below is a list of the program and its segments. Using this program, teachers can create a lesson plan to cover the specific concepts, themes and the historical figures mentioned.

Core Physics: Modern Physics

1897 - First Subatomic Particle Found: The Electron

1900 - Principle of Quantum Physics

1903 - Chaos Theory

1905 - Einstein's Theories of Special and General Relativity

1925 - Wave-particle Duality and The Uncertainty Principle
1942 - First Self-sustaining Chain Reaction
1964 - Quarks

LINKS TO CURRICULUM STANDARDS

The design for this program includes the following curriculum correlations: National Science Educations Standards, Content Standard B - Properties and changes of properties in matter, motions and forces, transfer of energy: Content Standard D – Structure of the Earth system, Earth’s history, Earth in the solar system and the McRel K-12 Science Standards and Benchmarks, Level III (Grades 6-8) and Level IV (Grades 9-12); California State Content Standards for Physics (Grades 9-12): Motion and Forces, Conservation of Energy and Momentum, Heat and Thermodynamics and Waves. There are also many correlations to the standards of Astronomy, Chemistry and Geology. The content of this program presents the foundational discoveries and principles of Modern physics in an historical order.

SUMMARY OF PROGRAM

Core Physics: Modern Physics

This program on Core Physics presents the key concepts in the development of modern physics.

Chapter one covers the discovery by scientists that atom was actually made up of parts: electrons, neutrons and protons, and mostly empty space.

Chapter two shows how Max Planck proposed that light was made up of discrete units called quanta or photons, opening the door to quantum mechanics and relativity.

Chapter three examines how Chaos theory, with its butterfly effect, challenged Newton’s assumption of a mechanistic world, stating that the world was inherently unpredictable and showing how small changes in initial conditions produced dramatic differences over time.

Einstein’s Theory of Special Relativity, showing that time and space were relative to the observer not absolute, and his Theory of General relativity, showing how gravity could be explained as the bending of space, are outlined in chapter four.

Chapter five discusses how light is both a wave and a particle, and it introduces the Heisenberg Uncertainty Principle.

The first sustained nuclear reaction and how it led to the Manhattan Project’s development of a nuclear bomb is shown in chapter six.

Chapter seven follows the discovery of new subatomic particles, such as quarks.

1897 - First Subatomic Particle Found: The Electron

Student Goals - In this Modern Physics chapter the students will learn:

- That atoms have parts
- How the electron was discovered
- The discovery of the solar system model of the atom
- How the positively charged nucleus of the atom was discovered

1900 - Principle of Quantum Physics

Student Goals - In this Modern Physics chapter the students will learn:

- That classical physics is made up of objects governed by Newton's Laws of motion and Maxwell's fields
- What a field is in physics
- How quantum physics began when Max Planck postulated the light was made up of quanta, small particles called photons
- What a quanta is

1903 - Chaos Theory

Student Goals - In this Modern Physics chapter the students will learn:

- What chaos theory is
- What the butterfly effect is
- How Newton's clockwork universe may not be correct
- What fractals are
- How inherently random and chaotic systems can produce predictable results
- What self-similar is

1905 - Einstein's Theories of Special and General Relativity

Student Goals - In this Modern Physics chapter the students will learn:

- The two experiences that lead Einstein to Special relativity
- That the speed of light is constant while space and time are relative
- That there is no one set of events that occur at the same time for everyone
- That Special relativity gave us $E = MC^2$ and the atomic bomb
- What General relativity is

1925 - Wave-particle Duality and The Uncertainty Principle

Student Goals - In this Modern Physics chapter the students will learn:

- Who the founding fathers of quantum mechanics were
- The quantum structure of the atom
- The uncertainty principle
- How light is both a wave and a particle
- That quantum mechanics gave us a new definition of what reality means

1942 - First Self-sustaining Chain Reaction

Student Goals - In this Modern Physics chapter the students will learn:

- How nuclear fission works
- That nuclear fission produced the first atomic bomb

1964 - Quarks

Student Goals - In this Modern Physics chapter the students will learn:

- How subatomic particles are discovered
- What a quark is

Answers to Blackline Master 1A Quiz

1-c; 2-b; 3-a; 4-a & b; 5-a; 6-b; 7-b; 8-c; 9-a; 10-a & c; 11-b & c; 12-b; 13-a; 14-a; 15-a; 16-a, b & c; 17-b; 18-b; 19-a & c; 20-b; 21-b; 22-b; 23-b