El Paso Collaborative for Academic Excellence
K-16 Science Frameworks

Background

In 1998, the El Paso Collaborative Board identified as its top priorities: 1) continuing to focus on mathematics and 2) the alignment of the mathematics curriculum. A review of local data on mathematics achievement showed larger numbers of students enrolled in and completing college preparatory mathematics course in high school. It also revealed a continuous increase in student achievement on TAAS. This high student achievement however, did not reflect student readiness for college mathematics courses. Gaps also existed in high school science preparation for entering college freshmen. Further review of data revealed that large numbers of high school students were placing and enrolling in remedial courses as well as large numbers of students not succeeding in the freshman science courses at El Paso Community College and the University of Texas at El Paso. While many factors contribute to these large numbers, one known factor is that there was little alignment between what high school teachers expect students to know and be able to do, and the expectations of college and university faculty.

To deal with some of these issues, the Mathematics and Science Partnership, MSP, proposed and was funded to continue supporting alignment of mathematics curriculum, assessment, and instruction and to initiate alignment of science K-16. Included in MSP's goals and objectives is to provide students with challenging courses and curriculum in high school mathematics and science courses that prepare them to enroll in and successfully complete college level mathematics and science courses.

Working Group

Starting in Fall 2003, MSP convened a working group of classroom teachers to write curriculum frameworks for Chemistry, Physics, Biology and K-8 Science for teachers to use as curriculum guides no matter what instructional materials they were using for the course. The Working Group included: K-12 classroom teachers from both urban and rural independent school districts; mathematics and science staff developers, specialists in science from both rural and urban school districts; science faculty from El Paso Community College; and faculty representing the Colleges of Education and Science from the University of Texas at El Paso. A complete list of the participants in the K-16 Science Working Group is attached.

To prepare for writing curriculum frameworks for K-8 and high school science courses, the Group engaged in dialogue and discussion focused on science teaching and learning. Using whole and small group formatted discussions, the K-16 Science Working Group:

- analyzed and discussed student performance in science using data collected from state mandated assessments and performance in college freshman courses;
- examined textbooks, course requirements, outline format, state and national placement tools used to assess student readiness for college;
- reviewed the Texas Essential Knowledge and Skills (TEKS), National Science Education Standards, and Atlas of Science Project 2061;
- discussed how concepts were connected and developed in grade levels and how they led to concepts incorporating higher cognitive demands in science;
- identified alternate methods of assessing student learning that provide for standards-based assessment;
- discussed models of teaching science; and
- reviewed and discussed science education literature.

Meeting bimonthly during the 2003 – 2006 academic years and for several days each summer, the Group wrote curriculum frameworks for Chemistry, Physics, K-8 Science, and Biology. Content for the course was placed in text outline form as well as matrix form to map knowledge and skills to cognitive demands as well as to state (TEKS) and national science standards.

K-16 Leaders Group

A leaders group of district leaders and central office personnel from both urban and rural independent school districts and the Education Service Center for Region 19, the provost of the University, science and education deans and mathematics and science department chairs from both the Community College and University, and lead principals and teachers from school districts, was also convened. As an advisory group they discussed and engaged in focused dialogue around issues in mathematics and science education and provided guidance and feedback in the development of the K-16 Mathematics and Science frameworks.

Needs

What we need now is assistance from high school principals and teachers to review, revise, and make practical use of the framework during the academic year. The biology curriculum framework should be reviewed by *every* biology teacher, and, if possible, by all high school science teachers to help prioritize aligning K-16 science curriculum, instruction, and assessment. In order to continue this work, we need participation from every science department in every high school in both urban and rural independent school districts and by secondary biology faculty and chairs.

K-16 SCIENCE ALIGNMENT WORKING GROUP

Maria Luisa Arroyo	SISD	El Dorado HS	2004 – present
Socorro Arteaga, Ph. D.	EPCC	Chemistry	2003 – present
Karen Blaine	Region 19	MSP Staff Dev	2004 – 2005
Sally Blake, Ph. D.	UTEP	Science Education	2003 – 2006
Amy Canales	SISD	Science Specialist ES	2003 – present
Evangelina Cantu	SISD	Science Specialist HS	2004 – present
Deborah Caskey	EPCC	Geology	2004 – present
William Cornell, Ph. D.	UTEP	Geology	2005 – present
Karen Davis	Region 19	MSP Staff Dev	2003 – 2004
Olga Deslongchamps	YISD	Parkland HS	2003 – present
Sylvia Esparza	SISD	Socorro HS	2003 – 2005
Maritza Fernandez	YISD	Hacienda Heights ES	2004 – 2005
Sandy Garza	SISD	Science Specialist ES	2003 – 2004
Jeannie Geske	EPISD	Bond ES	2003 – present
Kristin Gosselink, Ph. D.	UTEP	Biology	2005 – present
Eric Hagedorn, Ed. D.	UTEP	Physics	2003 – 2005
Kastro M. Hamed, Ph. D	UTEP	Physics	2003 – 04, 06 – present
Terry Jimarez	UTEP	College of Science	2003 – 2004
Kathy Kraften	EPISD	MSP Staff Dev	2003 – present
Richard Langford, Ph. D.	UTEP	Geology	2005 – present
Carl Lieb, Ph. D.	UTEP	Biology	2004 – present
Mary Liggett	SISD	Socorro MS	2003 – 2005
Jorge Lopez, Ph. D.	UTEP	Physics	2004
Victor Macias	SISD	El Dorado HS	2003 – Aug. 2004
Jose Maldonado	EPCC	Biology	2003 – present
Michael Martin	SISD	Bill Sybert K-8	2006
Nancy Marcus, Ph. D.	UTEP	Mathematics	2003
Emil Michal	EPCC	Physics	2003 – present
Diana Noriega	YISD	Cadwallader ES	2003 – present
Gloria Ontiveros	YISD	Ranchland Hills MS	2003 – present
Myriam Sanchez	SISD	Sambrano ES	2003 – 2005
Luis Saez, Ph. D.	UTEP	Physics	2004
Cynthia Stone	SISD	Science Specialist ES	2003 – 2004
Virginia Tovar	EPISD	Jefferson HS	2003 – 2004
Enrique Villalobos	SISD	MSP Staff Dev	2003 – 2005
Diane Walker	YISD	MSP Staff Dev	2003 – present

Curriculum Framework for High School Biology

A K-16 group of classroom science and biology teachers, faculty, curriculum specialists, and department chairs met over the course of a year and developed a curriculum framework for high school Biology, an important step in developing explicit and comprehensive goals for teachers in El Paso area schools. The framework is a product of collective work of K-16 classroom teachers and faculty from K-12 schools, El Paso Community College, and the University of Texas at El Paso. It is meant to assist science teachers in ensuring that current high school courses are aligned with first year college science courses entering college freshmen will take. Biology is the most recent course in the science alignment process. In previous years, the group developed frameworks for Chemistry, Physics and K-8 Science. The expectation is that as teachers use the framework to provide challenging courses and curriculum in science, the number of students who successfully enroll in and complete college level science courses will increase. Students will benefit because of the collective effort of K-16 teachers who will embrace the next state in this process: implementation with the goal of providing practical revision. With participation from every high school biology teacher, the framework will become the standard in science coursework for every student in El Paso.

BIOLOGY COURSE OUTLINE

I. COURSE DESCRIPTION

Biology is the study of living things. The course will provide a foundation for understanding living systems and how they function. You will study major life processes at several levels from molecules to ecosystems and how they are interrelated. In addition, the integration of biology to other sciences and its use in making informed decisions about everyday life will be covered. Major concepts you will study include evolution, genetics, classification of organisms, energy transfer, cellular structure, and the function of maintaining homeostasis. Field and laboratory investigations will be an integral part of your biology experience. This course will prepare you for a freshman college course in biology.

II. PREREQUISITE KNOWLEDGE

Students entering high school biology should have a middle school level of understanding of**:**

A. Basic academic skills, reading, writing, mathematics, following directions, and problem solving
B. The scientific method
C. Evolution, Mendelian genetics, cell structure and processes/photosynthesis
D. Tools of science (measuring, etc.)
E. Principles of classification

III. CONTENT

Upon completion of high school biology, students should understand and be able to use:

A. The scientific method including knowing how to ask testable questions
B. Energy production/utilization and waste elimination
C. Organization of living systems/ecosystems
D. Principles of classification/taxonomy
E. Interaction between chemical, cellular, and organism systems
F. Integration of biology, chemistry, and physics in nature
G. Scientific observations and know the difference between casual observations versus observations from scientific inquiry

H. Biology concepts and ideas to:
   1. Apply concepts across systems (reproduction, respiration, homeostasis)
   2. Apply biological principles to everyday experiences
   3. Understand the environment enough to become part of the solution and not part of the problem on our planet.

IV. ASSESSMENT

A. It is suggested that a variety of methods be used to assess student learning. This includes assessments that are formative and summative and include elements that show student growth over time. A variety of activities can be used to identify preconceptions. The teacher should try to incorporate assessments that show student work as well as student explanations of their work. These assessments may include methods such as:
   1. Performance-based assessments including laboratory investigations
   2. Open book (including homework)
   3. Technology-based presentations
   4. Interviews
   5. Observations
   6. Projects
   7. Portfolios
   8. Projects with rubrics (individual and group)
   9. Multiple choice
   10. Open response
   11. Comprehensive, multi-step problems
   12. Final comprehensive exam

B. Recommended Course Grade – Each district has guidelines for course grades and, whenever possible, it is recommended that the final course grade for students be determined by a combination of the following:
   1. 25% from formative assessments (daily tools such as warm-ups, quizzes, teacher observations and interviews, group work)
   2. 35% from closed book assessments (constructed response, multiple choice, quantitative comparisons, SAT problems, multi-step problems)
   3. 25% from open book assessments (homework, projects, presentations, portfolios)
   4. 15% from a Final Comprehensive Exam

V. TIMELINE

A brief overview of everyday applications of biology principles may be given during the first week of the semester. It is recommended that the rest of the time be allotted to cover course content and that any further review be embedded in the following units as needed. If a district or school does not have an agreed upon timeline, teachers should convene to agree on a recommended sequence and distribution of time allotted to cover the following units appropriately.

A. Biochemistry (c9A - C)
B. Cellular structure (c5A, c4A-C)
C. Energy (c9B, c9D, c4B, c12A)
D. Genetics (c6A – F)
E. Evolution (c7A – B, c12C)
F. Classification of organisms (c8A – C, c10C)
G. Ecosystems (c9D, c11D, c12A – E, c13A – B)

H. Homeostatic Systems (c4D, c5B – C, c10A – C, c11A – D)

VI. INFORMATION/RESOURCES REQUIRED FOR STUDENTS

A. Course description
B. Teacher information (conference period, office hours)
C. Work, projects, homework, exams, grading policy for each
D. Rubrics for projects/presentations/portfolios
E. Resources – tutoring, lab, Internet websites specific to the course, computer programs, teacher conference period, other outside support available
F. Weekly calendar
G. Textbook, calculator
H. Lab materials

VII. MATRIX MAPPING TOPICS TO COGNITIVE DEMANDS

A. Attached is a matrix that maps knowledge and skills to cognitive demands.
The work on cognitive demands has been guided by work of Andrew Porter, Norman Webb, and John Smithson. The cognitive demands identified by Porter, Webb, and Smithson were used as models and modified by the K-16 Science working group to fit their work in high school science courses. These identify thinking levels that incorporate five (5) levels of cognitive demands. They are listed on the matrix from higher order to lower order as you read from left to right. The matrix also maps content to state standards and, for some courses, frameworks also map textbooks and materials used in major independent school districts. The K-16 Science Working Group produced the matrix to provide guidance for teachers in planning instruction and designing assessment for the course.

B. Cognitive Demands for Science
Cognitive demands assist teachers in distinguishing what students are expected to know and be able to do with science content, and what level of thinking students must be engaged in while learning content. This mapping of topics to cognitive demands describes content knowledge that will not merely be stored, but also understood, represented, organized, connected, and structured in ways that facilitate retrieval and application of knowledge. By mapping knowledge and content to cognitive demands, teachers engage students in using, representing and connecting pieces of content knowledge in coherent ways that will determine whether students understand knowledge deeply and can use it to solve new problems. They are:

1. **Analyze Information** – classify and compare data, analyze data, recognize patterns, reason inductively or deductively, draw conclusions, identify faulty arguments or misrepresentations of data, spatial reasoning

2. **Apply Concepts/Make Connections** – apply and adapt science information to real-world situations, apply science ideas outside the context of science, build or revise theory, plan and design experiments, synthesize content and ideas from several sources, use and integrate science concepts

3. **Understand Concepts** – explain concepts, observe and explain teacher/student demonstrations, explain procedures and methods of science inquiry, organize and

display data in tables or charts, present science information, construct or use models to represent science ideas

4. **Perform Procedures/Conduct Investigations** – make observations, collect and record data, use appropriate tools make measurements, do computations, organize and display data in tables or charts, execute procedures, generate questions, make predictions, conduct experiments, test effects of different variables, select and use appropriate tools.

5. **Memorize Facts, Definitions, Formulas** – recite basic science facts, recall science terms and definitions, recall scientific formulas

C. Matrix Format and Its Use as A Teaching and Learning Tool
   1. Strands and topics in matrices overlap and may be integrated
   2. Cognitive demands overlap and are neither linear nor sequential.
   3. TEKS are categorized in 4 strands
      a. Nature of science (TEKS c1 – c3) embedded in all strands
      b. Properties, Patterns, and Models (TEKS c4, c5, c13)
      c. Constancy and change (TEKS c6 – c8)
      d. Systems (TEKS c9 – c12)
   4. Items in the matrix appearing in regular fonts are actual TEKS and are placed within a suggested cognitive demand.
   5. Italicized items support teaching and learning at a higher level of cognitive demand to reach conceptual understanding of a topic or concept and are meant to support the learning of TEKS with understanding. Paraphrased TEKS are also italicized where they address different cognitive demands or reference TEKS under multiple cognitive demands.

D. Vocabulary

Key terms are **bolded** in the TEKS within the curriculum framework matrix. These terms represent essential concepts in biology that require a deep understanding beyond memorization. During instruction, it is important that both teachers and students use these and other appropriate terms within the conceptual framework of the course. In this way, students learn to incorporate relevant terms, express their thinking and knowledge using scientific language, and use terms in context.

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

	Cognitive Demands				
Knowledge and skills	**Analyze Information**	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Scientific Processes The student: c1 For at least 40% of instructional time, , conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. c2 Uses scientific methods during field and laboratory investigations c3 Uses critical thinking and scientific problem solving to make informed decisions	c2D organize, analyze, evaluate, make inferences, and predict trends from data c2E communicate valid conclusions c3A *Analyze scientific explanations, including hypotheses and theories, add to their strengths and weaknesses using scientific evidence and information*	c2A *Plan investigative procedures* c3B Make responsible choices in selecting everyday products and services using scientific information c3C Evaluate the impact of research on scientific thought, society, and the environment c3D Describe the connection between chemistry and future careers	c1B make wise choices in the use and conservation of resources and the disposal or recycling of materials *c2C Manipulate chemical quantities using scientific conventions and mathematical procedures such as dimensional analysis, scientific notation, and significant figures* c3A *Review and critique scientific explanations, including hypotheses and theories, add to their strengths and weaknesses using scientific evidence and information*	c1A Demonstrate safe practices during field and laboratory investigations c1B Make wise choices in the use and conservation of resources and the disposal or recycling of materials. c2A *Implement investigative procedures including asking questions, formulating testable hypothesizes, and selecting equipment and technology* c2B Collect data and make measurements with precision c2C *Express chemical quantities using scientific conventions and mathematical procedures such as dimensional analysis, scientific notation, and significant figures* c3E Research the history of chemistry and contributions of scientists	c3D *List careers in chemistry* c3E Describe the history of chemistry and contributions of scientists
Timeline	**Textbook and Materials**			**National Science Standards**	
				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Nature of Science The student: c1 for at least 40% of the time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. c2. uses scientific methods during field and laboratory investigations. c3. uses critical thinking and scientific problem solving to make informed decisions.	c2, c3	c2, c3	c1, c2, c3	c1, c2, c3	
	c1B. Make wise choices in the use and conservation of resources and the disposal or recycling of materials *c2C. Organize, analyze, and evaluate trends from data* *c3A. Analyze and review scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information* c3B. Evaluate promotional claims that relate to biological issues such as product labeling and advertisements c3E. Evaluate models according to their adequacy in representing biological objects or events	c2C. Make inference and predict trends from data *c2A. Plan investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology* *c3A. Critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information* c3C. Evaluate the impact of research on scientific thought, society and the environment c3D. Describe the connection between biology and future careers	c1A. Demonstrate safe practices during field and laboratory investigations c2D. Communicate valid conclusions	c2A. Implement investigative procedures including asking questions and selecting equipment and technology c2B. Collect data and take measurements c3F. Research and describe the history of biology and contributions of scientists	

Textbook and Materials	National Science Education Standards
	9-12 Life Science: The Cell 9-12 Science and Personal & Social Perspectives: Personal and Community Health 9-12 Unifying Concepts & Processes: Systems Form & Function Evolution and Equilibrium 9-12 Science as Inquiry

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Properties, Patterns, and Models c4. The student knows that **cells** are the basic structures of all living things and have specialized parts that perform specific functions and that **viruses** are different from **cells** and have different properties and functions	c2, c3	c2, c3	c1, c2, c3	c1, c2, c3	
		c4C. Compare the structures and functions of **viruses** to **cells** and describe the role of viruses in causing diseases such as acquired immune deficiency syndrome, common colds, smallpox, influenza, and warts c4D. Identify and describe the role of **bacteria** in maintaining health such as in digestion and in causing diseases such as in streptococcus infections and diphtheria	*c4B. Identify cellular processes including **homeostasis**, **permeability**, energy production, transportation of molecules, disposal of wastes, function of cellular parts, and synthesis of new molecules*	*c4B. Investigate cellular processes including **homeostasis**, **permeability**, energy production, transportation of molecules, disposal of wastes, function of cellular parts, and synthesis of new molecules*	c4A. Identify the parts of **prokaryotic** and **eukaryotic** cells

Textbook and Materials	National Science Education Standards
	9-12 Life Science: The Cell 9-12 Science and Personal & Social Perspectives: Personal and Community Health 9-12 Unifying Concepts & Processes: Systems Form & Function Evolution and Equilibrium 9-12 Science as Inquiry: Ability Necessary to do Scientific Inquiry

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Properties, Patterns, and Models c5. The student knows how an **organism** grows and how specialized **cells, tissues**, and **organs** develop.	c2, c3	c2, c3	c1, c2, c3	c1, c2, c3	
		c5B. Identify **cell differentiation** in the development of **organisms** c5C. Sequence the levels of organization in **multicellular organisms** to relate the parts to each other and to the whole		c5A. Compare **cells** from different parts of plants and animals including **roots, stems, leaves, epithelia, muscles**	Xylem Phloem

Textbook and Materials	National Science Education Standards
	9-12 Life Sciences: The Cell 9-12 Science as Inquiry 9-12 Unifying Concepts & Processes/Form and Function

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Constancy and Change c6. The student knows the structure and functions of **nucleic acids** in the mechanisms of **genetics**.	c2, c3	c2, c3	c1, c2, c3	c1, c2, c3	
	c6E. Compare the processes of **mitosis** and **meiosis** and their significance to sexual and asexual reproduction c6F. *Analyze **karyotypes***	C6C. *Illustrate how changes in **DNA** cause **mutations** and evaluate the significance of these changes*	c6A. *Illustrate how the information for specifying the **traits** of an organism is carried in the **deoxyribonucleic acid, DNA*** c6B. Explain **replication, transcription,** and **translation** using models of **DNA** and **ribonucleic acid (RNA**) c6C. *Identify how changes in **DNA** cause **mutations** and evaluate the significance of these changes*	c6D. Compare **genetic variations** observed in plants and animals c6F. *Identify **karyotypes***	c6A. *Describe components of **deoxyribonucleic acid, DNA*** Chromosome Protein

Textbook and Materials	National Science Education Standards
	9-12 Life Science: Molecular Basis of Heredity, Biological Evolution 9-12 Science As Inquiry: Ability Necessary to do Scientific Inquiry, Understandings About Scientific Inquiry 9-12 Unifying Concepts and Processes: Evolution and Equilibrium; Form and Function; Evidence, Models and Explanation

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Constancy and Change c7. The student knows the **theory of biological evolution.**	c2, c3	c2, c3	c1, c2, c3	c1, c2, c3	
	c7B. Illustrate the results of **natural selection** in **speciation, diversity, phylogeny, adaptation, behavior, and extinction**			c7A. Identify evidence of change in **species** using **fossils, DNA sequences**, anatomical similarities, physiological similarities, and **embryology**	Anatomy Physiology

Textbook and Materials	National Science Education Standards
	9-12 Life Science: The Cell 9-12 Science and Personal & Social Perspectives: Personal and Community Health 9-12 Unifying Concepts & Processes: Systems Form & Function Evolution and Equilibrium 9-12 Science as Inquiry: Ability Necessary to do Scientific Inquiry

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Constancy and Change c8. The student knows applications of **taxonomy** and can identify its limitations.	c2, c3	c2, c3	c1, c2, c3	c1, c2, c3	
	c8B. *Analyze relationships among* ***organisms***	*Explore reasons for constructing the groups*	c8B. *Develop a model of a hierarchical classification system based on similarities and differences using* ***taxonomic nomenclature***	c8A. Collect and classify organisms at several **taxonomic levels** such as **species**, **phylum**, and **kingdom** using **dichotomous keys** c8C. Identify characteristics of **kingdoms** including **monerans, protists, fungi, plants,** and **animals**	Hierarchy

Textbook and Materials	**National Science Education Standards**
	9-12 Life Science: Biological Evolution 9-12 Unifying Concepts and Processes 9-12 Science as Inquiry

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Systems c9. The student knows **metabolic processes** and **energy transfers** that occur in living **organisms**.	c2, c3	c2, c3	c1, c3, c3	c1, c2, c3	
	c9C. *Analyze* and identify the effects of **enzymes** on food molecules c9D. Analyze the **flow of matter and energy** through different **trophic levels** and between organisms and the physical environment	c9B. Compare the **energy flow** in **photosynthesis** to the **energy flow** in cellular respiration	c9A. Compare the structures and functions of different types of **biomolecules** such as **carbohydrates, lipids, proteins,** and **nucleic acids** c9B. *Explain and* compare the energy flow in **photosynthesis** to the **energy flow** in **cellular respiration**	c9C. Investigate and identify the effects of **enzymes** on food molecules	Polarity

Textbook and Materials	National Science Education Standards
	9-12 Life Sciences: Matter Energy, Organizational in Living Systems 9-12 Unifying Concepts and Processes 9-12 Science as Inquiry

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Systems c10. The student knows that, at all levels of nature, **living systems** are found within other living systems, each with its own boundary and limits. (*i.e. Understanding biological levels of organization)*	c2, c3	c2, c3	c1, c3, c3	c1, c2, c3	
	c10B. Compare the interrelationships of **organ systems** to each other and to the body as a whole c10C. Analyze and identify characteristics of **plant systems**, *plant structure, plant function*, and subsystems	c10B. Compare the interrelationships of **organ systems** to each other and to the body as a whole	c10A. Explain the functions of systems in organisms including **circulatory, digestive, nervous, endocrine, reproductive, integumentary, skeletal, respiratory, muscular, excretory,** and **immune**		

Textbook and Materials	National Science Education Standards
	9-12 Life Science: Interdependence of Organisms; Matter, Energy, & Organization in Living Systems 9-12 Unifying Concepts and Processes 9-12 Science as Inquiry

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Constancy and Change c11. The student knows that **organisms** maintain **homeostasis.**	c2, c3	c2, c3	c1, c3, c3	c1, c2, c3	
		c11C. Analyze the importance of **nutrition**, environmental conditions, and physical exercise on health c11D. Summarize the role of **microorganisms** in maintaining and disrupting **equilibrium** including diseases in plants and animals and decay in an **ecosystem**	c11A. Identify and describe the relationships between internal **feedback mechanisms** in the maintenance of **homeostasis**	cllB. Investigate and identify how organisms, including humans, respond to external stimuli	Negative feedback Positive feedback Stimulus

Textbook and Materials	National Science Education Standards
	9-12 Life Science: The Cell, Behavior of Organisms, Behavior of organisms, Interdependence of Organisms 9-12 Unifying Concepts and Processes: Change, Constancy, & Measurement; Evolution and Equilibrium

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Systems c12. The student knows that interdependence and interactions occur within an **ecosystem**.	c2, c3	c2, c3	c1, c3, c3	c1, c2, c3	
	c12A. Analyze the **flow of energy** through various cycles including the carbon, oxygen, nitrogen, and water cycles c12C. Compare *and contrast* variations, tolerances, and adaptations of plants and animals in different **biomes**	c12B Interpret interactions among **organisms** exhibiting **predation, parasitism, commensalism, and mutualism** c12E. Investigate and explain the interactions in an **ecosystem** including food chains, food webs, and food pyramids	c12D. Identify and illustrate that long term survival of species is dependent on a resource base that may be limited c12E. Investigate and explain the interactions in an **ecosystem** including food chains, food webs, and food pyramids		

Textbook and Materials	National Science Education Standards
	9-12 Life Science: Interdependence of Organisms; Matter, Energy, and Organization in Living Systems 9-12 Science in Personal and Social Perspective: Natural Resources 9-12 Unifying Concepts and Processes: Change, Constancy, and Measurement 9-12 Science as Inquiry

Biology Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures**	**Memorize**
Properties, Patterns, and Models c13. The student knows the significance of plants in the environment. *(i.e. structure and function of plants)*	c2, c3	c2, c3	c1, c3, c3	c1, c2, c3	
	c13A. Evaluate the significance of structural and physiological **adaptations** of plants to their environment		c13B. Survey and identify methods of reproduction, growth and **development** of various types of plants		

Textbook and Materials	National Science Education Standards
	9-12 Life Science: Behavior of Organisms, The Cell 9-12 Unifying Concepts & Processes: Behavior of Organisms, The Cell

Curriculum Framework for High School Chemistry

A K-16 group of classroom science and biology teachers, faculty, curriculum specialists, and department chairs met over the course of a year and developed a curriculum framework for high school Chemistry, an important step in developing explicit and comprehensive goals for teachers in El Paso area schools. The framework is a product of collective work of K-16 classroom teachers and faculty from K-12 schools, El Paso Community College, and the University of Texas at El Paso. It is meant to assist science teachers in ensuring that current high school courses are aligned with first year college science courses entering college freshmen will take. The group has also developed frameworks for K-8 Science, Biology and Physics. The expectation is that as teachers use the framework to provide challenging courses and curriculum in science, the number of students who successfully enroll in and complete college level science courses will increase. Students will benefit because of the collective effort of K-16 teachers who will embrace the next state in this process: implementation with the goal of providing practical revision. With participation from every high school physics teacher, the framework will become the standard in science coursework for every student in El Paso.

CHEMISTRY

I. COURSE DESCRIPTION

Chemistry is the study of properties of matter and energy and their physical and chemical changes. Students will learn and experience the natural world through an understanding of the periodic table and use of the scientific method to conduct field and laboratory investigations. Along with learning and understanding how chemistry is an integral part of their lives, students will engage in critical thinking to solve problems and make informed decisions about the world around them.

Topics include: characteristics of matter and energy and their transformations during physical and chemical changes, atomic structure, periodic table of elements, behavior of gases, bonding, nuclear fusion and nuclear fission, oxidation-reduction and other chemical reactions, chemical equations, acids and bases, solutes, and properties of solutions. The course will prepare students to enroll and be successful in a college freshman chemistry course.

II. PREQUISITE KNOWLEDGE

Students entering high school chemistry should know and be able to apply:

A. laboratory techniques and safety
B. four basic operations with real numbers
C. algebra I and concurrent enrollment of second year math course
D. scientific method and scientific process skills, TEKS b1-4
E. reading comprehension at 10^{th} grade level
F. writing that clearly expresses thinking
G. understanding of the structures and properties of matter
H. calculator skills
I. metric system
J. conversion factors and scientific notation

K. knowledge of what a system is and how it functions
L. scientific theories and explanations

III. CONTENT

After taking high school chemistry, students should know, understand, and be able to apply:

A. roles, interactions, characteristics, and transformations of matter and energy in chemical reactions
B. law of conservation
C. atoms and their behavior in bonding and in reactions
D. periodic table of elements
E. behavior of gases
F. chemical formulas and equations
G. chemical reactions-nuclear, oxidation-reduction, and other reactions
H. laboratories and the real world
I. properties and behavior of acids and bases and their ecological interactions
J. solutes and properties of solutions
K. science literacy
L. connections between chemistry and daily life
M. applications of chemistry to solve problems and make inform decisions, e.g., wise ecological choices in disposing, recycling, conserving matter
N. writing accurate and precise laboratory reports
O. integration of chemistry to other sciences

IV. TIMELINE

A brief overview of everyday applications of chemistry principles may be given during the first week of the semester. It is recommended that the rest of the time be allotted to cover course content and that any further review be embedded in the content units as needed. If a district or school does not have an agreed upon timeline, teachers should convene to agree on a recommended sequence and distribution of time allotted to cover the following units appropriately.

VI. INFORMATION/RESOURCES REQUIRED FOR STUDENTS

A. Course description
B. Teacher information (conference period, office hours)
C. Work, projects, homework, exams, grading policy for each
D. Rubrics for projects/presentations/portfolios
E. Resources – tutoring, lab, Internet websites specific to the course, computer programs, teacher conference period, other outside support available
F. Weekly calendar
G. Textbook, calculator
H. Lab materials

VII. MATRIX MAPPING PHYSICS TO COGNITIVE DEMANDS

A. Attached is a matrix that maps knowledge and skills to cognitive demands.
The work on cognitive demands has been guided by work of Andrew Porter, Norman Webb, and John Smithson. The cognitive demands identified by Porter, Webb, and Smithson were used as models and modified by the K-16 Science working group to fit their work in high school science courses. These identify thinking levels that incorporate five (5) levels of cognitive demands. They are listed on the matrix from higher order to lower order as you read from left to right. The matrix also maps content to state standards and, for some courses, frameworks also map textbooks and materials used in major independent school districts. The K-16 Science Working Group produced the matrix to provide guidance for teachers in planning instruction and designing assessment for the course.

B. Cognitive Demands for Science
Cognitive demands assist teachers in distinguishing what students are expected to know and be able to do with science content, and what level of thinking students must be engaged in while learning content. This mapping of topics to cognitive demands describes content knowledge that will not merely be stored, but also understood, represented, organized, connected, and structured in ways that facilitate retrieval and application of knowledge. By mapping knowledge and content to cognitive demands, teachers engage students in using, representing and connecting pieces of content knowledge in coherent ways that will determine whether students understand knowledge deeply and can use it to solve new problems. They are:

1. **Analyze Information** – classify and compare data, analyze data, recognize patterns, reason inductively or deductively, draw conclusions, identify faulty arguments or misrepresentations of data, spatial reasoning

2. **Apply Concepts/Make Connections** – apply and adapt science information to real-world situations, apply science ideas outside the context of science, build or revise theory, plan and design experiments, synthesize content and ideas from several sources, use and integrate science concepts

3. **Understand Concepts** – explain concepts, observe and explain teacher/student demonstrations, explain procedures and methods of science inquiry, organize and display data in tables or charts, present science information, construct or use models to represent science ideas

6. **Perform Procedures/Conduct Investigations** – make observations, collect and record data, use appropriate tools make measurements, do computations, organize and display data in tables or charts, execute procedures, generate questions, make predictions, conduct experiments, test effects of different variables, select and use appropriate tools.

7. **Memorize Facts, Definitions, Formulas** – recite basic science facts, recall science terms and definitions, recall scientific formulas

C. Matrix Format and Its Use as a Teaching and Learning Tool
   1. Strands and topics in matrices overlap and may be integrated
   2. Cognitive demands overlap and are neither linear nor sequential.
   3. All TEKS are included
   4. Items in the matrix appearing in regular fonts are actual TEKS and are placed within a suggested cognitive demand.
   5. Italicized items support teaching and learning at a higher level of cognitive demand to reach conceptual understanding of a topic or concept and are meant to support the learning of TEKS with understanding. Paraphrased TEKS are also italicized where they address different cognitive demands or reference TEKS under multiple cognitive demands.

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

	Cognitive Demands				
Knowledge and skills	**Analyze Information**	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Scientific Processes The student: c1 For at least 40% of instructional time, , conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. c2 Uses scientific methods during field and laboratory investigations c3 Uses critical thinking and scientific problem solving to make informed decisions	c2D organize, analyze, evaluate, make inferences, and predict trends from data c2E communicate valid conclusions c3A *Analyze scientific explanations, including hypotheses and theories, add to their strengths and weaknesses using scientific evidence and information*	c2A *Plan investigative procedures* c3B Make responsible choices in selecting everyday products and services using scientific information c3C Evaluate the impact of research on scientific thought, society, and the environment c3D Describe the connection between chemistry and future careers	c1B make wise choices in the use and conservation of resources and the disposal or recycling of materials *c2C Manipulate chemical quantities using scientific conventions and mathematical procedures such as dimensional analysis, scientific notation, and significant figures* c3A *Review and critique scientific explanations, including hypotheses and theories, add to their strengths and weaknesses using scientific evidence and information*	c1A Demonstrate safe practices during field and laboratory investigations c1B Make wise choices in the use and conservation of resources and the disposal or recycling of materials. c2A *Implement investigative procedures including asking questions, formulating testable hypothesizes, and selecting equipment and technology* c2B Collect data and make measurements with precision c2C *Express chemical quantities using scientific conventions and mathematical procedures such as dimensional analysis, scientific notation, and significant figures* c3E Research the history of chemistry and contributions of scientists	c3D *List careers in chemistry* c3E Describe the history of chemistry and contributions of scientists
Timeline	**Textbook and Materials**			**National Science Standards**	
				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Scientific Processes	c2, c3	c2, c3	c1, c2, c3	c1, c2	
c4 Science Concepts: The student knows the characteristics of matter. Interactions of Energy and Matter c5 Science Concepts: The student knows that energy transformations occur during physical or chemical changes in matter.	c4B Analyze examples of solids, liquids & gases to determine their compressibility, structure, motion of particles, shape and volume c4D *Make inferences about the physical and chemical characteristics of an element using the periodical table* c5A *Determine the nature of the changes in matter*	c4A Differentiate between physical and chemical properties of matter c4D *Make inferences about the physical and chemical characteristics of an element using the periodical table* c5A *Determine the nature of the changes in matter*	c5 design & present an experiment that shows conceptual understanding of energy transformation	c4C Investigate properties of mixtures and pure substances c5A *Observe and examine the forms of energy involved in changes in matter* c5B *Measure energy transformation and exchanges involved in chemical reactions* c5C Measure the effects of the gain or loss of heat energy on the properties of solids, liquids and gases	c4D *Describe the physical and chemical characteristics of an element using the periodic table* c4C *Identify properties of mixtures and pure substances* c5A *Identify changes in matter* c5B *Identify energy transformation and exchanges involved in chemical reactions*
Timeline	**Textbook and Materials**			**National Science Standards**	
				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
	c2, c3	c2, c3	c2, c3	c1, c2	
c6 Science Concepts: The student knows that atomic structure is determined by nuclear composition, allowable electron cloud, and subatomic particles.	c6B Analyze stable and unstable isotopes	c6A *Describe the existence of subatomic particles* c6B Determine the relationship between the isotopes stability and its application c6C Summarize the historical development of the periodic table	c6B Determine the relationship between the isotopes stability and its application c6C Summarize the historical development of the periodic table to understand the concept of periodicity	c6B Determine the relationship between the isotopes stability and its application *Design atomic models*	c6A Describe the properties of subatomic particles *Vocabulary:* *isotopes* *electron cloud* **Glossary for teacher understanding:* *Investigate* *Identify* *Evaluate* *Describe* *Determine the Relationship*

Timeline	**Textbook and Materials**	**National Science Standards**
		9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Scientific Processes	c1	c2 ,c3	c1	c1, c2	
c7 Science Concepts: The student knows the variables that influence the behavior of gases. c8 Science Concepts: The student knows how atoms form bonds to acquire a stable arrangement of electrons.	c7B *Determine if data obtained from investigations with gases within a closed system are consistent with Universal Gas Law* c8B Compare the physical and chemical properties of ionic and covalent compounds	c7A Describe interrelationships among temperature, particle number, pressure, and volume of gases contained within a closed system c8C Compare the arrangement of atoms in molecules, ionic crystals, polymers, and compounds c8D Describe the influence of intermolecular forces on the physical and chemical properties of covalent compounds	*Make a model of a closed system* *Make conjectures about closed system* c8D Explain how intermolecular forces influence the physical and chemical properties of covalent compounds	c7B *Illustrate the data obtained from conducting investigations with gases in a closed system* *Conduct investigation in a closed system* c8B *Investigate the physical and chemical properties of ionic covalent compounds*	Vocabulary Particle number Pressure Gas Universal Gas Law Atom Covalent compound Ionic compound Bonding c8A Identify characteristics of atoms involved in chemical bonding
Timeline	**Textbook and Materials**			**National Science Standards**	
				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
		c2, c3		c1, c2	
c9 Science Concepts: The student knows the processes, effects, and significance of nuclear fission and nuclear fusion. c10 Science Concepts: The student knows common oxidation-reactions.	c9A Compare fission and fusion reactions in terms of the masses of the reactants and products and the amount of energy released in the nuclear reactions c10B *Document the effects of a corrosion process*	c9D Evaluate environmental issues associated with the storage, containment, and disposal of nuclear wastes c10B *Discuss the importance of electroplating metals*	c9C Evaluate the commercial use of nuclear energy and medical uses of radioisotopes Discuss the commercial use of nuclear energy and medical uses of radioisotopes c10A Evaluate oxidation-reduction processes c10B *Evaluate the importance of electroplating metals*	c9A *Compare fission and fusion reactions in terms of the masses of the reactants and products and the amount of energy released in the nuclear reactions* (*computer simulations)* C9A *Balance /complete nuclear reaction equation* C9B Investigate radioactive elements to determine half-life c10B *Demonstrate the effects of a corrosion process*	Fission Fusion Nuclear particles Nuclear forces Electrostatic forces Isotopes Types of radiation Recognize formulae *e.g.* N_n^Z c10A Identify oxidation-reduction processes
Timeline	**Textbook and Materials**			**National Science Standards**	
				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
	c2, c3	c2, c3	c2, c3	c1, c2	
c11 Science Concepts: The student knows that balanced chemical equations are used to interpret and describe the interactions of matter.	c11B *Analyze how to balance chemical reactions by changing coefficients*	*c11B Describe interactions of matter such as chemical and nuclear reactions using symbols, formulas, and equations*	c11C *Explain balanced chemical and nuclear equations using number of atoms, masses and charge* c11 *Demonstrate how chemical equations explain chemical reactions*	c11B Demonstrate the use of symbols, formulas, and equations in describing interactions of matter such as chemical and nuclear reactions c11C *Balance chemical and nuclear equations using number of atoms, masses and charge*	c11A Identify common elements and compounds using scientific nomenclature
Timeline	**Textbook and Materials**			**National Science Standards**	
Five 90-minute classes				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
	c2, c3	c2, c3	c2, c3	c1, c2	
c12 Science Concepts: The student knows the factors that influence the solubility of solutes in a solvent. c13 The student knows relationships among the concentration, electrical conductivity, and colligative properties of a solution.	c12C Analyze the significance of water as a solvent in living organisms and in the environment c13A Compare unsaturated, saturated and supersaturated solutions c13C Compare the rates of reaction of a solid reactant in solutions of varying concentration	c12B Apply general rules for solubility through investigations with aqueous solutions c13B Interpret relationships among ionic and covalent compounds, electrical conductivity, and colligative properties of water	c12A Explain effects of temperature and the nature of solid solutes on the solubility of solids c12B Develop general rules for solubility through investigations with aqueous solutions c12C Evaluate the significance of water as a solvent in living organisms and in the environment c13B Detect and explain relationships among ionic and covalent compounds, electrical conductivity, and colligative properties of water	c12A Demonstrate effects of temperature and the nature of solid solutes on the solubility of solids c13C Measure rates of reaction of a solid reactant in solutions of varying concentration	Solid Solute Solution Aqueous solution Solvent Ionic compounds Covalent compounds Solution Concentration Electrical conductivity Colligative properties c13c Identify unsaturated saturated and supersaturated solutions
Timeline	**Textbook and Materials**			**National Science Standards**	
				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Chemistry Curriculum Framework Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
	c2, c3	c2, c3	c2, c3	c1, c2	
c14 The student knows the properties and behavior of acids and bases. c15 Science Concepts: The student knows factors involved in chemical reactions.	c14D Analyze effects of acids and bases on an ecological system c15A *Analyze the energy exchange that occurs as a consequence a chemical reactions* *Make a conjecture about the energy exchange that occurs as a consequence of chemical reactions*	c14D Describe effects of acids and bases on an ecological system c14A *Classify products as acids or bases of common household products using a variety of indicators* c15B Relate the rate of a chemical reaction to temperature, concentration, surface area and presence of a catalyst	*Explain relationship between electrons, conduction of electricity, and ionization* *c14A Explain ionization and its application to pH* c15A *Evaluate the energy exchange that occurs as a consequence of a chemical reaction*	*c14A Measure pH of products using a variety of indicators* c14B Demonstrate the electrical conductivity of acids and bases c15A *Verify the law of conservation of energy*	Acid Base pH scale Electron Conduction Ionization c14C Identify the characteristics of a neutralization reaction c15A *State the law of conservation of energy*
Timeline	**Textbook and Materials**			**National Science Standards**	
				9-12 A Science as Inquiry 9-12 B Physical Science 9-12 F Science n Personal and Social Perspectives 9-12 G History and Nature of Science	

Curriculum Framework for High School Physics

A K-16 group of classroom science and physics teachers, faculty, curriculum specialists, and department chairs met over the course of a year and developed a curriculum framework for high school Physics, an important step in developing explicit and comprehensive goals for teachers in El Paso area schools. The framework is a product of collective work of K-16 classroom teachers and faculty from K-12 schools, El Paso Community College, and the University of Texas at El Paso. It is meant to assist science teachers in ensuring that current high school courses are aligned with first year college science courses entering college freshmen will take. Physics is the most current course in the science alignment process. In previous years, the group developed frameworks for Chemistry and on K-8 Science Frameworks. The expectation is that as teachers use the framework to provide challenging courses and curriculum in science, the number of students who successfully enroll and complete college level science courses will increase. Students will benefit because of collective effort of teachers K-16 who will embrace the next stage in this process: implementation with the goal of providing practical revision. With participation from every high school physics teacher, the framework will become the standard in science coursework for every student in El Paso.

PHYSICS COURSE OUTLINE

I. COURSE DESCRIPTION

Physics is the study of natural phenomena in the world around us. It forms the basis of all science. The study of physics engages students in scientific inquiry to explain and help them understand forces of nature and interactions of matter, space, and time. Physics attempts to explain stars, galaxies, planetary motions, electricity, energy, and why an apple falls. Physics takes students on an adventure with scientists like Einstein and Newton in learning how and why the world operates through relationships between matter and energy. The course assists students in using physics to ponder questions like: Why are we here? Where do we come from? Where are we going? Physics prepares students pursuing careers in engineering, medicine, teaching, technology, and other sciences. Beyond that, students come to understand the magic of physics as they participate in learning it.

II. PREREQUISITE KNOWLEDGE

Students entering physics must know about and be able to apply:

A. Phenomena: optics, sound, motion, electricity, and magnetism
B. Science Process Skills: demonstrate observational skills, perform experiments, formulate questions, inquire, make predictions given data,
C. Mathematics and algebraic skills: solve equations, read graphs, take measurements
D. Critical reading and writing skills
E. Imagination
F. Transfer of knowledge from concrete to abstract and from abstract to concrete

III. CONTENT

In Physics, students will focus on knowing and learning to apply:

A. All listed in II above, but at a higher cognitive and mathematical level
B. Physics in their world
C. Critical thinking and scientific problem solving
D. Physics to make decisions
E. Connections between science disciplines
F. Concepts of energy and matter
G. Principles of physics
H. How change occurs

IV. ASSESSMENT

A. It is suggested that a variety of methods should be used to assess student learning. This includes assessments that show student work as well as student explanations of their work. These assessments might include both traditional and alternative methods such as:
   1. Performance-based tasks
   2. Open book (including homework)
   3. Technology-based presentations
   4. Interviews
   5. Observations
   6. Projects
   7. Portfolios
   8. Projects with rubrics (individual and group)
   9. Multiple choice
   10. Open response
   11. Comprehensive, multi-step problems
   12. Final comprehensive exam

B. Recommended Course Grade – Each district has guidelines for course grades and, whenever possible, it is recommended that the final course grade for students be determined by a combination of the following:
   1. 25 % from formative assessments (daily tools such as warm-ups, quizzes, teacher observations and interviews, group work)
   2. 35% from closed book assessments (constructed response, multiple choice, quantitative comparisons, SAT problems, multi-step problems)
   3. 25% from open book assessments (homework, projects, presentations, portfolios)
   4. 15% from a Final Comprehensive Exam

V. TIMELINE

A brief overview of everyday applications of physics principles may be given during the first week of the semester. It is recommended that the rest of the time should be allotted to cover the course and that any further review be embedded in the following units as needed. Some districts have their own timeline embedded in their scope and sequence

work. If a district or school does not have an agreed upon timeline, teachers should convene to agree on a recommended distribution of time allotted to cover the following units appropriately.

A. Principles of Motion _____%
B. Conservation of Energy and Momentum _____%
C. Forces in Nature _____%
D. Principles of Thermodynamics _____%
E. Waves and Quantum Physics _____%

VI. INFORMATION/RESOURCES FOR STUDENTS

A. Course description
B. Teacher information (conference period, office hours)
C. Work, projects, homework, exams, etc., to be produced by the students including grading policy for each
D. Rubrics for projects/presentations/portfolios
E. Resources – tutoring, lab, Internet web sites specific to the course, computer programs, teacher conference period, other outside support available
F. Weekly calendar
G. Materials: It is recommended that a textbook and graphing calculator package be issued to each student.

H. CBL – Calculator Based Lab; CBR – Calculator Based Range, LapPro

VII. MATRIX MAPPING TOPICS TO COGNITIVE DEMANDS

A. Attached is a matrix that matches cognitive demands to topics in Physics. The work on cognitive demands has been guided by work of Andrew Porter, Norman Webb, and John Smithson. The cognitive demands identified by Porter, Webb, and Smithson were used as models and modified by the working group to fit our work in high school science courses. These identify thinking levels that incorporate five (5) levels of cognitive demands. They are listed on the matrix from higher order to lower order as you read from left to right. Frameworks also map topics to state and national standards and for some courses, frameworks also map textbook and materials used in major independent school districts.

B. Cognitive Demands for Science
Cognitive demands assist teachers in distinguishing what a student is expected to know and be able to do with science content, and what level of thinking students must be engaged in while learning content. This mapping of topics to cognitive demands describes content knowledge that will not merely be stored, but also understood, represented, organized, connected, and structured in ways that facilitate retrieval and application of knowledge. With cognitive demands, teachers know how to get student to use, represent and connect pieces of content knowledge in coherent ways that will determine whether students understand knowledge deeply and can use it to solve new problems. They are:

1. **Analyze Information –** classify and compare data; analyze data, recognize patterns; reason inductively or deductively; draw conclusions; identify faulty arguments or misrepresentations of data; spatial reasoning

2. **Apply Concepts/Make Connections –** apply and adapt science information to real-world situations; apply science ideas outside the context of science; build or revise theory, plan and design experiments; synthesize content and ideas from several sources; use and integrate science concepts

3. **Understand Concepts** – explain concepts, observe and explain teacher/student demonstrations; explain procedures and methods of science and inquiry; organize and display data in tables or charts; present science information; construct or use models to represent science ideas

4. **Perform Procedures/Conduct Investigations –** make observations; collect and record data; use appropriate tools; make measurements, do computations; organize and display data in tables or charts; execute procedures; generate questions, make predictions; conduct experiments; test effects of different variables; select, use appropriate tools

5. **Memorize Facts, Definitions, Formulas –** recite basic science facts; recall science terms and definitions; recall scientific formula

C. Matrix Format and Its Use as A Teaching and Learning Tool
   1. Strands and topics in matrices overlap and may be integrated
   2. Cognitive demands overlap and are neither linear nor sequential.
   3. TEKS are categorized in four strands:
      a. Nature of Science (TEKS c1 – c3);
      b. Constancy and Change (TEKS c4);
      c. Properties, Patterns, and Models (TEKS c9); and
      d. Systems (TEKS c5 – c7, c9)
   4. Items in the matrix appearing in regular fonts are actual TEKS and are placed within a suggested cognitive demand.
   5. Italicized items support teaching and learning at a higher level of cognitive demand, lead to conceptual understanding of a topic or concept, and are meant to support learning of TEKS with understanding. Paraphrase TEKS are also italicized where they address different cognitive demands or reference TEKS and are placed under multiple cognitive demands.

Physics Framework Matrix Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Nature of Science **The student:** c1 for at least 40% of the time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. c2 uses scientific methods during field and laboratory investigations. c3 uses critical thinking and scientific problem solving to make informed decisions	c1B Make wise choices in the use and conservation of resources and the disposal or recycling of materials c2C *Organize, analyze and evaluate trends from data* *c3A Analyze and review scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information*	c2C *Make inference and predict trends from data* *c2E Identify relationships between variables* *c2A Plan experimental procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology* *c3A Critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information* c3C Evaluate the impact of research on scientific thought, society and the environment	c1A Demonstrate safe practices during field and laboratory investigations c2D Communicate valid conclusions c3D Describe the connection between physics and future careers *c3B Express laws symbolically to solve physical problems*	*c2A Implement experimental procedures including asking questions and selecting equipment and technology* c2B Make quantitative observations and measurements with precision *c2E Graph data to observe relationships between variables* c2F Read the scale on scientific instruments with precision *c3B Employ mathematical procedures including vector addition and right-triangle geometry to solve physical problems* c3E Research and describe the history of physics and contributions of scientists	Vocabulary: Meniscus Calibrate instruments Precision Accuracy Vector Right triangle
Timeline	**Textbooks and Materials**		**National Science Standards**		
			9 -12A Science as Inquiry 9 - 12B Physical Science 9 - 12E Science and Technology 9 -12F Science in Personal and Social Perspectives 9 -12G History and Nature of Science		

Physics Framework Matrix Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Constancy and Change c4 The student knows the laws governing motion.	c1, c2, c3	c1, c2, c3	c1, c2, c3	c1, c2, c3	c1, c2, c3
	c4B Analyze examples of uniform and accelerated motion including linear, projectile, and circular c4D *Interpret a free body diagram for force analysis*	c4A Generate and interpret graphs describing motion including the use of real-time technology c4C Demonstrate the effects of forces on the motion of objects *c4D Develop a free body diagram for force analysis* *c4E Describe motion relative to different frames of reference*	*c4E Identify motion relative to different frames of reference*		Vocabulary: motion force uniform motion accelerated motion linear projectile circular free body diagram relativity frame of reference
Timeline	**Textbooks and Materials**			**National Science Standards**	
				9 - 12A Science as Inquiry 9 - 12B Physical Science 9 – 12E Science and Technology	

Physics Framework Matrix Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Properties, Patterns, and Models c8 The student knows the characteristics and behavior of waves.	c1, c2, c3	c1, c2, c3	c1, c2, c3	c1, c2, c3	
	c8C Interpret the role of wave characteristics and behaviors found in medicinal and industrial applications	c8B Identify the characteristics and behaviors of sound and electromagnetic waves	*c8A Describe wave characteristics such as velocity, frequency, and amplitude, and behaviors such as reflection, refraction, and interference*	c8A *Examine and describe a variety of waves propagated in various types of media*	Vocabulary: waves velocity frequency amplitude reflection refraction interference electromagnetic constructive destructive propagated
Timeline	**Textbooks and Materials**			**National Science Standards**	
				9 - 12A Science as Inquiry 9 - 12B Physical Science	

Physics Framework Matrix Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Systems c5 The student knows that changes occur within a physical system and recognizes that energy and momentum are conserved. c6 The student knows forces in nature.	c1, c2, c3	c1, c2, c3	c1, c2, c3	c1, c2, c3	
	c5A Interpret evidence for the work-energy theorem *c6C Analyze the influences of charge and distance on electric forces* *c6E Analyze electric circuits*	*c5C Make connections between mechanical energy and momentum in a physical system such as billiards, cars, and trains* *c6E Design electric circuits* c6F Identify examples of electrical and magnetic forces in everyday life	*c5B Describe examples of kinetic and potential energy and their transformations* c5D Demonstrate the conservation of energy and momentum c6A Identify the influence of mass and distance on gravitational forces	*c5B Observe examples of kinetic and potential energy and their transformations* c5C Calculate the mechanical energy and momentum in a physical system such as billiards, cars, and trains c6B Research and describe the historical development of the concepts of gravitational, electrical, and magnetic force c6D Demonstrate the relationship between electricity and magnetism	Vocabulary: Work Kinetic energy Potential energy Mechanical Energy Momentum Conservation of energy Conservation of momentum Electric circuits Electric forces Gravitational forces *c6C Identify the influences of charge and distance on electric forces*
Timeline	**Textbooks and Materials**			**National Science Standards**	
				9 -12A Science as Inquiry 9 -12B Physical Science	

Physics Framework Matrix Mapping Knowledge and Skills to Cognitive Demands

Knowledge and Skills	Cognitive Demands				
	Analyze Information	**Apply Concepts/ Make Connections**	**Understand Concepts**	**Perform Procedures/ Conduct Investigations**	**Memorize**
Systems c7 The student knows the laws of thermodynamics. c9 The student knows simple examples of quantum physics.	c1, c2, c3 *c7A Analyze everyday examples of the laws of thermodynamics* c7B Evaluate different methods of heat energy transfer that result in an increasing amount of disorder	c1, c2, c3 *c7A Explain everyday examples that illustrate the laws of thermodynamics*	c1, c2, c3 *c7A Recognize everyday examples that illustrate the laws of thermodynamics* c9B Explain the line spectra from different gas-discharge tubes c9A Describe the photoelectric effect	c1, c2, c3 *c7B Demonstrate different methods of heat energy transfer that result in an increasing amount of disorder*	c1, c2, c3 Laws of Thermodynamics Formulas Types of heat energy transfer Photoelectric Spectra Quantum physics
Timeline	**Textbooks and Materials**			**National Science Standards**	
				9-12A Science as Inquiry 9-12B Physical Science	