D86 Science Program
October 2021

What is Rigor?
The Role of Earth & Space Science in the NGSS
Accountability for our State Learning Standards
Physics, Chemistry, and Biology in D86
D86 Science Program

What is Rigor?

What is “rigor”?

Different people define rigor in different ways

challenges students' thinking in new and interesting ways	Volume of Content	Difficulty or amount of Homework	Requiring critical thinking (Science skills and practices)
More chapters! More reading!	Breadth over Depth	Depth over breadth	High fail rate
will prepare them to succeed in college or the world of work	*focused, coherent, and appropriately challenging*	determined not just by what is taught, but how it is taught and how it is assessed	engenders critical-thinking skills as well as content knowledge
Expand access to high quality vertically aligned courses	Students read at least one book every two to three weeks - ideally more	Low number of students earning As	**Really hard homework and test questions**

Rigor at Risk: Reaffirming Quality in the High School Core Curriculum, ACT

High school teachers and college faculty also disagree about the depth and breadth of essential state standards needed to prepare students for college... high school teachers rated a much larger number of topics and skills as being "important" or "very important" for college success than did college instructors.

And where high school teachers give equal emphasis to numerous content topics and skills, ***college instructors believe that a more thorough study of fewer but essential content and skills is a better foundation for postsecondary success.***

Why We Are Changing AP Biology and Other AP Science Courses?

To Emphasize scientific inquiry and reasoning

To Respond to changes recommended by the National Research Council and the National Science Foundation

To Reduce the emphasis on broad content coverage and focus on depth of understanding

To Support teachers in their efforts to foster students' deep understanding of science

CollegeBoard inspiring minds

The Development of an Index of Academic Rigor for College Readiness (College Board)

By Jeffrey N. Wyatt, Andrew Wiley, Wayne J. Camara, and Nina Proestler

"Only 28% of college instructors believe that public high schools adequately prepare students for the challenges of college (Achieve, 2005). Similarly, Conley (2007) argued that high school often does not adequately prepare students with the skills required of college level courses, which are generally faster paced and require students to engage in more high level tasks. The requisite skills can include ***drawing inferences, interpreting results, analyzing conflicting sources of information, supporting arguments with evidence, and thinking deeply about material.****"*

Emphasis on Science Practices

The science practices enable students to establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena

SCIENCE PRACTICES

- 1.0 The student can use representations and models to communicate scientific phenomena and solve scientific problems
- 2.0 The student can use mathematics appropriately
- 3.0 The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course
- 4.0 Student can plan and implement data collection strategies in relation to a particular scientific question
- 5.0 The student can perform data analysis and evaluation of evidence
- 6.0 The student can work with scientific explanations and theories
- 7.0 The student can connect and relate knowledge across various scales, concepts, and representations in and across domains

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Illinois Adopts Science Learning Standards

Science Learning Standards

Illinois' current science standards became effective in February 2014 and are based on the Next Generation Science Standards (NGSS). Forty-one experts, including three Illinois educators, wrote the NGSS. State-level committees in 26 states reviewed the learning benchmarks. These groups confirmed that the design and development of the NGSS were guided by the best available evidence to ensure that students who meet these standards are prepared for postsecondary education and careers in the 21st century. The NGSS can be viewed at 23 Illinois Administrative Code 1 Appendix D .

NGSS

"How does this affect what a classroom looks like?"

Classroom activities in High School will look less like this:	And more like this:
Physical Sciences	**Physical Sciences**
Students learn the periodic table by rote memorization.	Students use the periodic table as a tool to explain and predict the properties of elements.
Students learn that substances combine or react to make new substances.	Students characterize chemical reactions and use that knowledge to explain various biological and geophysical phenomena.
Students calculate energy transfer.	Students design, build, and refine devices to optimize the conversion of energy.
Life Sciences	**Life Sciences**
Students learn the stages of mitosis.	Students create scientific arguments for how mitosis can produce complex organisms with different kinds of body parts.
Students learn about trophic levels in ecosystems.	Students construct explanations for the role of energy in the cycling of matter in organisms and ecosystems.
Students create Punnett squares to learn about Mendelian genetics.	Students use statistics and probability concepts in written essays explaining how traits are expressed in a population.
Earth & Space Sciences	**Earth & Space Sciences**
Students learn about the composition of asteroids and meteors.	Students use evidence from meteorites and other planetary surfaces to form hypotheses about the early history of Earth.
Students learn about different Earth systems, including water systems and weather systems.	Students analyze geoscience data to determine the feedback effects between Earth systems.
Students study different types of natural hazards, such as hurricanes and tornadoes.	Students conduct research to gather data on how different types of natural hazards have influenced human activity.

Key ideas related to the NGSS and its development

NGSS is designed to...

- Promote **in-depth understanding** of a focused set of core concepts and interdisciplinary ideas.
- Reflect the **interconnected** nature of science as it's practiced and experienced in the real world.
- Build science concepts and practices **coherently** K–12.
- Focus on **deeper understanding** of **content** as well as **application** of content.
- Align with "College Board Standards for College Success," which defines the content and skills needed to be **college- and career-ready**, including to transition into AP courses

Source 1, Source 2, Source 3

The Role of Earth & Space Science in the NGSS

Content Area Domains of the NGSS

HIGH SCHOOL

PHYSICAL SCIENCE	LIFE SCIENCE	EARTH AND SPACE SCIENCES
HS.Structure and Properties of Matter	HS.Structure and Function	HS.Space Systems
HS.Chemical Reactions	HS.Matter and Energy in Organisms and Ecosystems	HS.History of Earth
HS.Forces and Interactions	HS.Interdependent Relationships in Ecosystems	HS.Earth's Systems
HS.Energy	HS.Inheritance and Variation of Traits	HS.Weather and Climate
HS.Waves and Electromagnetic Radiation	HS.Natural Selection and Evolution	HS.Human Sustainability

https://www.nextgenscience.org/overview-topics

Earth and Space Science Comes of Age in the NGSS

Michael E. Wysession *Professor of Earth and Planetary Sciences,* **NORTHWESTERN UNIVERSITY**

Look at the news over the course of a year and you'll see Earth and space science dominates: hurricanes, tornadoes, earthquakes, tsunamis, volcanoes, climate change… droughts, floods, coal resources, gas prices, mineral resources, water supplies, oil spills…

Earth and space science directly impacts the lives of humans... The course of civilization has been intimately shaped by climate change, natural catastrophes, and the availability of natural resources...

The fact that no civilization in human history has lasted very long poses a reminder to us that those who do not learn from the past are doomed to repeat it... It's not only timely that the NGSS will provide students with a much deeper understanding of Earth and space science. Our very survival may depend upon it.

Source of edit

ESS standards in D86 Physics, Chemistry, and Biology

The NGSS Earth and Space Science standards integrated into core courses were chosen based upon their relationship to Physics, Chemistry and Biology standards.

Earth and Space Science typically requires an understanding of concepts found in these core courses, so the ESS standards were matched to the appropriate course units based on their ability to add to the contextual experience for our students.

Examples of NGSS ESS within Core Courses

NGSS	Performance Expectation	Physics	Chem	Biology
ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of ***nuclear fusion*** in the sun's core to release energy as radiation.			
ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of ***light spectra, motion of distant galaxies***, and the ***composition of matter*** in the universe.			
ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, ***produce elements***.			
ESS1-4	Use mathematical or computational representations to predict the ***motion of orbiting objects*** in the solar system.			
ESS2-7	Construct an argument based on evidence about the simultaneous ***coevolution*** of Earth's systems and ***life on Earth***.			
ESS3-3	Create a computational simulation to illustrate relationships among natural resources, *the sustainability of* ***human populations****, and* ***biodiversity***.			

Examples of NGSS ESS within Core Courses

NGSS	Performance Expectation	Physics	Chem	Biology
ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of ***nuclear fusion*** in the sun's core to release energy as radiation.		X	
ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of ***light spectra, motion of distant galaxies***, and the ***composition of matter*** in the universe.	X	X	
ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, ***produce elements***.		X	
ESS1-4	Use mathematical or computational representations to predict the ***motion of orbiting objects*** in the solar system.	X		
ESS2-7	Construct an argument based on evidence about the simultaneous ***coevolution*** of Earth's systems and ***life on Earth***.			X
ESS3-3	Create a computational simulation to illustrate relationships among natural resources, *the sustainability of* ***human populations****, and* ***biodiversity***.			X

Overview of ESS standards in Physics, Chemistry and Biology

NGSS PE	Performance Expectation	PITU & PITU H	COES & COES H	BOTLE
HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release		X	
HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. HS-ESS1-2	X	X	
HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements. HS-ESS1-3		X	
HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. HS-ESS1-4	X		
HS-ESS1-5	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. HS-ESS1-5	X*		X
HS-ESS1-6	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. HS-ESS1-6			X
HS-ESS2-1	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. HS-ESS2-1	X*		
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-2		X	
HS-ESS2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. HS-ESS2-3	X		
HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-ESS2-4	X	X	X
HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS2-5			X
HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. HS-ESS2-6			X
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. HS-ESS2-7			X
HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and chang			X
HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-2		X	
HS-ESS3-3	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of huma			X
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-4			X
HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-ESS3-5	X	X	X
HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. HS-ESS3-6			X

Accountability for our State Learning Standards

State Testing Implications to Consider: Illinois School Report Card

The Illinois Science Assessment (ISA) has been a part of the publicly reported Illinois School Report Card for over a decade. Before 2021, the ISA was given in 11th grade or biology classes and was not designed to assess NGSS.

The newly designed and administered Illinois Science assessment measures the NGSS based Illinois State Science Standards.

The new format of the test includes equal-parts items that measure a student's understanding of Life (Biology), Physical (Chem and Physics) and Earth/Space Science Standards. One third of the test is devoted to each of these content areas.

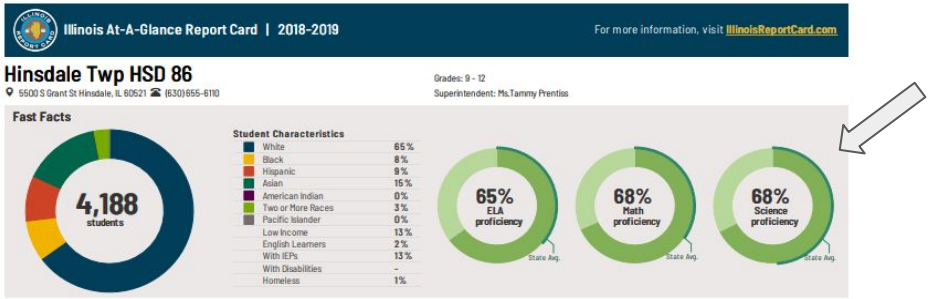


Table 1. Test Blueprint by Domain - Targeted Number of Dichotomous* (DCTMS) and Non-Dichotomous** (N-DCTMS) Items per Test

Reporting groups		Grade 5: DCTMS	Grade 5: N-DCTMS	Grade 8: DCTMS	Grade 8: N-DCTMS	HS: DCTMS	HS: N-DCTMS
Engineering Technology and Application of Science	Physical Science	13-16	3-6	13-16	3-6	15-21	3-6
	Life Science	13-16	3-6	13-16	3-6	15-21	3-6
	Earth and Space Science	13-16	3-6	13-16	3-6	15-21	3-6
Total Items in Test		**40-45**	**12-15**	**40-45**	**12-15**	**50-60**	**12-15**

ISBE | ISA 2.0 Blueprint

ENSURING THAT EVERY STUDENT IS PREPARED TO SUCCEED.

- Grades 5, 8, and 11
- Three test sections per grade – 96 items overall
- General science assessment
  - Life, physical, earth, and engineering technology (imbedded in LS, PS, ESS)
  - Content balanced across sections
    - Content -- 1/3, 1/3, 1/3 between LS, PS, ESS
    - Sections have content in different order
    - SEPs – science and engineering practices are tracked

State Testing Implications: Illinois School Designation

Starting in the Spring of 2020, all juniors in Illinois started taking the NGSS based ISA.

In the same way that the Math and the EBRW (ELA) sections of the SAT provide a measurement for every school, so will the ISA.

Starting in 2022, the ISA officially becomes a component that determines a school's Overall Designation: Exemplary, Commendable, Targeted, Comprehensive.

Category	HS Application
ELA Proficiency (7.5%)	Determined by SAT ERBW
Math Proficiency (7.5%)	Determined by SAT Math
Science Proficiency (5%)	Determined by ISA
ELPtP (5%)	ELL Student Progress measured by ACCESS test
Chronic Absenteeism (10%)	# of students missing more than 10% of school year
Climate Survey (6.67%)	Student participation in the 5 Essential Survey
9th Grade on Track (8.33%)	Freshman Academic Success
Graduation Rate (50%)	% of students who graduate in 4 years

Illinois At-A-Glance Report Card | 2018-2019

For more information, visit IllinoisReportCard.com

Hinsdale Twp HSD 86

Schools in District

School Name	Grades	Summative Designation	School Name	Grades	Summative Designation
Hinsdale Central High School	9 - 12	Exemplary	Hinsdale South High School	9 - 12	Commendable

Physics, Chemistry, and Biology in D86

PHYSICS & PHYSICS HONORS	CHEMISTRY & CHEMISTRY HONORS	BIOLOGY *(DRAFT)*
Science Practices	Big Bang and Nuclear Chemistry	Habitability
Constant Velocity	Atomic Structure	Populations
Forces*/Acceleration and Gravity*	The Periodic Table	Ecosystems
Forces & Motion (1-D) and (2-D)**	Chemical Bonding	Photosynthesis
Circular Motion**	Chemical Quantities	Cellular Respiration
Momentum	Chemical Reactions	Evolution
Waves	Stoichiometry and Copper Unlimited Project	History of Life
Application of Waves: Big Bang	Thermochemistry	DNA
Application: Earth's Interior and Plate Tectonics*	Gases	Cell Growth & Division
Energy	Weather and Climate	RNA & Protein Synthesis
Circuits + Electromagnetic Energy Production**	Climate Change	Biotechnology
Orbital Motion	Reaction Rates and Equilibrium	Genetics
Application of Orbital Motion: Seasons & Climate	Acid-Base Equilibria	Population Evolution
	Ocean Acidification	Humans and Global Change
**Honors only **Regular only*	Organic Chemistry	

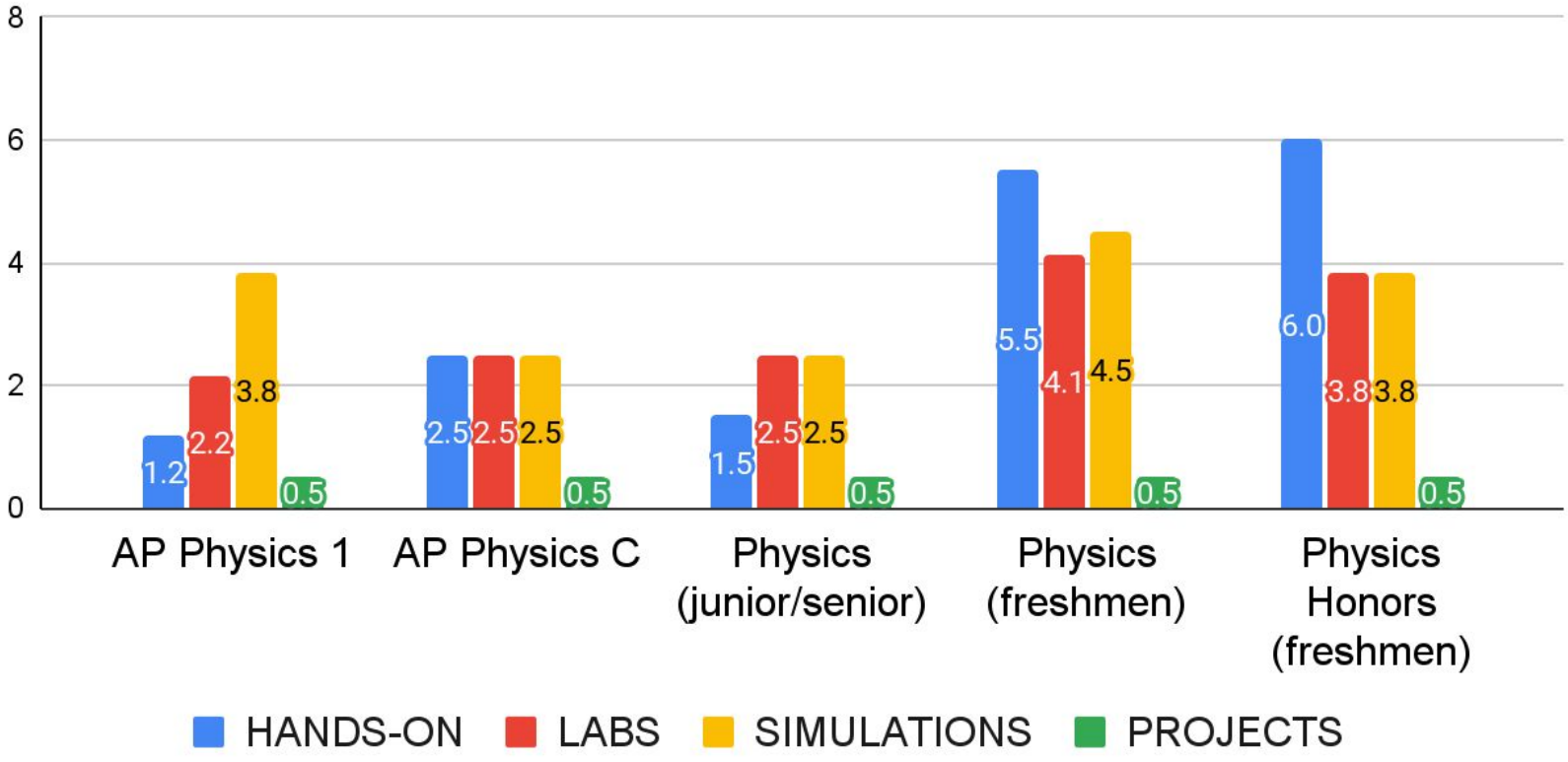
Emphasis on in-depth understanding

Physics (Junior)	Physics (Freshman)	Physics Honors (Freshman)
6.2 Understand impulse.	**I can create and utilize models to problem-solve situations involving the linear collision of an isolated object.** ● I can analyze an *F-t* graph of a collision to determine information such as average/maximum force, and time of impact. ● I can apply the impulse equation: $F_{t=} mv_f - mv_i$, to solve for F, t, m, v_f , v_i ● I can use the impulse equation to qualitatively justify and make claims about the relationship between the net force acting on an object and time duration of that net force.	**I can create and utilize models to problem-solve situations involving the linear collision of an isolated object.** ● I can analyze a *v-t, &/or F-t* graph of a collision to determine information such as impulse, velocity before/after a collision, average/maximum impact force, and time of impact. This includes understanding that area under an F-t graph can be used to calculate impulse delivered to an object. ● I can apply the impulse equation: $F_{t=} mv - mv_o$, to solve for F, t, m, v , v_o ● I can use the impulse equation to qualitatively justify and make claims about the relationship between the net force acting on an object and time duration of that net force.

Comparing Physics Objectives with an NGSS Emphasis

Physics (Junior)	Physics (Freshman)
4.1 Identify different types of forces 4.2 Demonstrate knowledge about friction 4.3 Draw/choose/interpret a free body diagram 4.4 Write a force equation from a given free body diagram 4.5 - 4.7 Understand and apply Newton's 1st/2nd/3rd Law	**I can draw force diagrams (free-body diagrams).** ● I can identify which forces are acting on an object. **I can use Newton's Laws to make and justify claims about the forces acting on an object.** ● I can apply Newton's 1st/2nd/3rd law to justify and make claims . . . ● Using a force diagram, I can write a mathematical expression for . . . **I am able to make predictions by algebraically solving force equations.** **I can design, construct, and carry-out an experiment on an object moving at a constant acceleration using appropriate science practices.** ● I can design, construct, and carry-out an experiment to measure and/or verify on or more of Newton's Laws (e.g. force of friction, inertia, etc.).

In a typical 10-day unit, how many...



Inside the Classroom: 9th Grade Physics

Link

D86 Science Program

D86 Science Program -- Implemented Fall 2020

9th Grade	Physics or Physics Honors
10th Grade	Chemistry or Chemistry Honors
11th Grade	Biology or AP Biology
12th Grade	AP Biology, AP Chemistry, AP Environmental Science, AP Physics C-M, AP Physics C, Anatomy & Physiology, Earth Science Capstone

Physics, Chemistry and Biology have Earth Science standards integrated where appropriate. “Physics in the Universe”, “Chemistry of Earth Systems” and “Biology of the Living Earth” were names used to distinguish from the prior courses that did not include ESS standards.

D86 BOE direction -- Summer 2021

9th Grade	Physics or Physics Honors or AP Physics 1	Biology or Biology Honors
10th Grade	Chemistry or Chemistry Honors	
11th Grade	Biology or Honors Biology or AP Biology	Earth Science or AP Physics 1*
12th Grade	AP, Elective and Capstone Courses	

Physics, Chemistry and Biology have Earth Science standards integrated where appropriate.
*Could offer Physics Honors or Physics as well for 11th grade

D86 Science Program Team

Updated and Reconvened
2021-2022

Marv Breig	Central	AP Physics
David Bonner	South	Physics Honors, AP Physics
Randy Brogan	South	Physics, Interventionist
Dylan Canavan	Central	Earth Sci, Physics, Phys Honors
Julie Gaubatz	South	Science DC, Biology, AP Bio
Robb Gotlund	South	Biology, AP Biology
Julie May	Central	Science DC, Chem, AP Chem
Tracy McDonald	South	Chemistry, Anat & Phys
JR Paige	Central	Biology, Biology Honors
Paul Woods	Central	AP Chem, Chem H, Physics H

Combining BOE direction with Program Team's work

9th Grade	Physics 9 or Physics Honors 9	Biology 9 or Biology Honors 9
10th Grade	Chemistry 10 or Chemistry Honors 10	Chemistry 10 or Chemistry Honors 10
11th Grade	Biology 11 or AP Biology	Physics 11 or AP Physics 1
12th Grade **(or concurrent 11th grade)**	AP Biology, AP Chemistry, AP Environmental Science, AP Physics C-M, AP Physics C, Anatomy & Physiology, Earth Science Capstone	

Provides a P-C-B or B-C-P sequence with freshman and junior-level courses single grade only. Physics, Chemistry and Biology have Earth Science standards integrated where appropriate.

Considerations of the refined program

- Provides experiences with all four core sciences in the first three years.
- Places students in science courses with their age-similar peers.
- Allows choice for freshmen.

- Increases parent/student confusion in choosing high school pathway.
- Decreases vertical alignment in the second year of the program.
- Increases the number of courses offered from 14 to 18, likely requiring an additional 1-2 FTE at South to run sufficient sections with lower enrollments.