# SCIENCE
# PERFORMANCE DESCRIPTORS

## GRADES 6 - 12

# RESPONDING TO THIS DOCUMENT

We welcome your response to this document.

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# INTRODUCTION

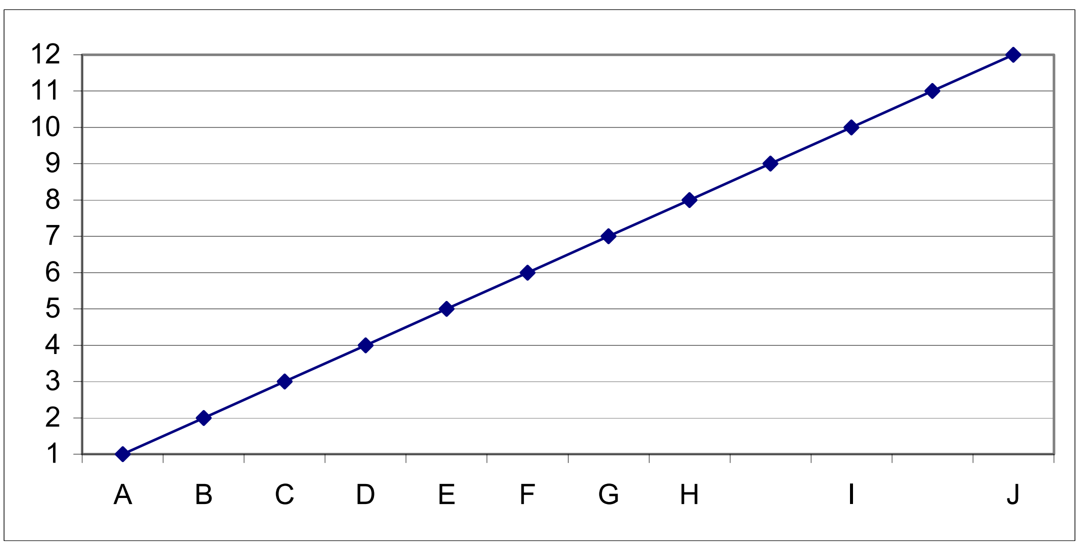
## Design for Performance Standards

The Illinois Learning Standards are content standards that describe *"what"* students should know and be able to do in grades K – 12. Each content standard includes five benchmarks that describe what students should know and be able to do at early elementary, late elementary, middle/junior high, early high school, and late high school.

The challenge for the 2000-2001 school year was to produce performance standards that would indicate *"how well"* students should perform to meet the standards. To address this challenge, a number of perspectives needed to be considered. For example, the National Governors Association[1] raised two pertinent questions policymakers should consider for the design of performance standards:

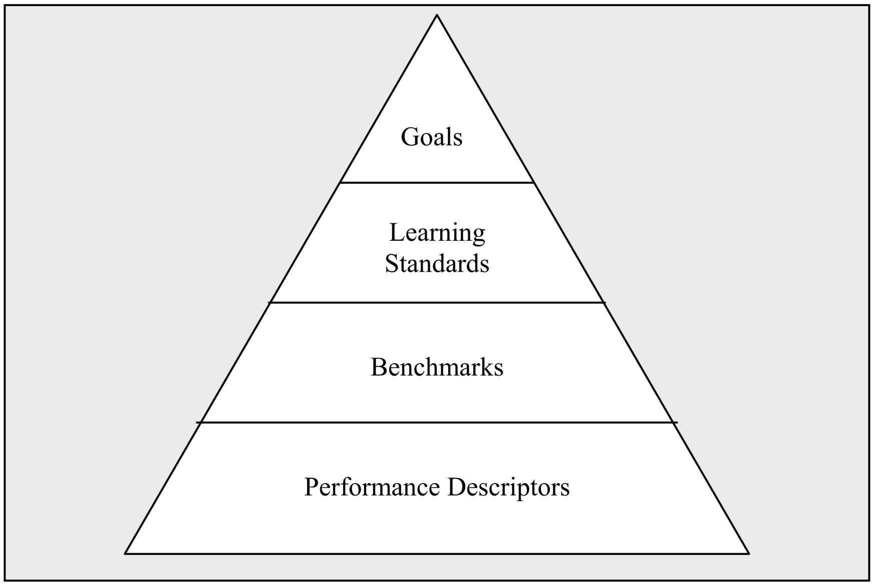
- Do the performance standards indicate the levels of performance students should attain, descriptions of performance at each level, and rules that enable educators to determine whether students have reached a given level?
- Do the performance standards include a range of work . . . to show that students can meet the standards in a variety of ways?

The performance standards describe how well students perform at various points on an educational development continuum. This continuum shows how students can demonstrate mastery of progressively more difficult content and cognitive skills over ten incremental stages of development. Performance within each stage can be assessed by the extent to which students are meeting the standards (i.e., starting, approaching, meeting, exceeding). Performance standards include four essential elements: performance descriptors, performance levels, assessment tasks, and performance examples.




[1] Ouellette, M. (2000). "Maintaining progress through systemic education reform: Performance standards," Washington, DC: National Governors Association.

The performance standards are classroom resources for voluntary use at the local level. They are not intended to replace the Illinois Learning Standards. Instead, they supplement them by providing sufficient detail and examples to enable teachers to establish appropriate grade-level performance expectations for students. The performance descriptors are a direct outgrowth of the state goals for learning. Whereas the benchmarks filled in detail on each of the standards at five grade-level clusters, the performance descriptors provide additional detail at each grade level.




**Definitions**

***performance standards****:* the knowledge and skills that students are to perform at various stages of educational development (*performance descriptors*) and the performance expectations (*performance levels and assessment tasks)* for student work *(performance exemplars)* at each of the stages.

***performance descriptors****:* statements of how students can demonstrate the knowledge and skills they acquired.[2]

***performance levels****:* descriptions of how well students have achieved the standards; that is, the range, frequency, facility, depth, creativity, and/or quality of the knowledge and skills they acquired. Students can demonstrate levels of achieving performance standards along six dimensions:

| PERFORMANCE LEVEL = | **RANGE +** | **FREQUENCY +** | **FACILITY +** | **DEPTH +** | **CREATIVITY +** | **QUALITY** |
|---|---|---|---|---|---|---|
| Exceeding | extensively | consistently | automatically | profoundly | inventively | excellently |
| Meeting | fully | usually | quickly | deeply | imaginatively | well |
| Approaching | partially | occasionally | haltingly | cursorily | commonly | marginally |
| Starting | narrowly | rarely | slowly | superficially | imitatively | poorly |

[2] New Standards. Performance Standards. (1997) Washington, DC: The National Center on Education and the Economy.

***assessment tasks:*** descriptions of what students can do to demonstrate they have met the standards and a means for evaluating the levels of their performance.

***performance examples:*** student work samples resulting from the classroom-based performance assessment tasks that illustrate performance levels.

### Template For Expanded Performance Descriptors

| BENCHMARKS ⇒ | early elementary | | | late elementary | | middle/ junior high | | | early high | late high |
|---|---|---|---|---|---|---|---|---|---|---|
| STAGES ⇒<br>PERFORMANCE LEVELS ⇓ | A | B | C | D | E | F | G | H | I | J |
| Exceeding | | | | | | | | | | |
| Meeting | | | | | | | | | | |
| Approaching | | | | | | | | | | |
| Starting | | | | | | | | | | |

### Vision for Science Performance

A major goal of Illinois science education is to develop science literate, life-long learners. Schools create learning communities where each student has multiple opportunities to gain content knowledge and apply that knowledge in a relevant manner to the local, regional and global communities. To help achieve this outcome, performance standards, which indicate how well students are expected to perform specific tasks, provide educators with logical extensions to the Illinois Goals and Learning Standards. Students who meet these performance standards will apply an extensive knowledge base of science content and scientific processes to occupations and everyday life.

Upon completion of their education, students will complete complex investigations and solve problems creatively. They will ask questions, gather evidence, seek and obtain in-depth answers, review, understand and compare findings, and communicate research to others. Students will use a variety of technologies as effective tools to facilitate their research. They will develop a variety of tools using a technological design process. Students will participate in a variety of individual activities and collaborate with other students in group activities. They will relate the scientific fields by applying knowledge gained in one field to another.

Students will understand the impact of science concepts, processes, and connections in their lives as individuals, community members, and citizens. Students will realize the constancy of the nature of science in order to question and answer their future challenges. Upon completion of their education, students will have experienced the excitement of doing science and the joy of learning.

### Vision for Incrementally Improving Science Performance

Educating today's science student is an extremely complex and exciting adventure. For the sake of convenience, schools frequently place students in graduated levels called grades. However, within each classroom, students vary by age, physical development, intellectual capacity, background experience, socio-economic level, interests, performance, motivation, and learning styles.

The purpose of Science Performance Descriptors is to furnish educators with a logical and measurable continuum of performance and developmental indicators. Education will benefit by the development of descriptors that provide information about what every student needs to learn to meet Illinois Science Learning Standards and by describing how students perform while doing so. These performance descriptors provide information regarding physiological and intellectual development of students as they progress through their K-12 education. State Science Learning Standards describe what students need to know and how they will apply that knowledge in ten stages of intellectual development. Within each class and grade level, students will be functioning at a variety of stages.

There are three equally important science goals. The following statements provide a vision of science performance for students who meet the standards. The performance descriptions provide a synopsis of expectations while the expansion presents a more detailed explanation. The concepts from Goal 12 provide the context for the processes of science of Goal 11 and the connections to and from science described in Goal 13.

## Intended Use and Interpretation

The primary function of these descriptors is to provide educators with necessary tools to continue the quest of improving the quality of science education throughout Illinois. They have been written, reviewed, and analyzed by teachers and experts in the field of science education. They are intended to be used as a descriptive tool by teachers, administrators, parents, and students, and have not been created to represent a state-mandated curriculum. They can be powerful tools in determining how to best meet the needs of students from the time they enter elementary school to their graduation from high school as they become life-long learners. The purpose of this section is to explain what these descriptors are and how they can be used to facilitate the learning of science.

**Exactly what are Science Expanded Performance Descriptors?** Before they can be described it will be helpful to explain what already exists. There are three goals for science that are general statements of what students need to know to be successful in this learning area. These goals are followed by ten science learning standards that are specific statements of knowledge or skills needed for science. They represent what students learn as a result of their schooling. Then, there are thirty-one to thirty-seven learning benchmarks which are clustered throughout early elementary, late elementary, middle/junior high school, early high school, and late high school years. These benchmarks are indicators of student achievement and form a basis for measuring that achievement over time. The science expanded performance descriptors represent the developmental stages of student learning and show a progression through which students develop knowledge and the application of that knowledge in science education.

Each learning standard has ten expanded performance descriptors (Stages A, B, C, D, E, F, G, H, I, and J) that furnish educators with a logical and measurable continuum of performance and developmental indicators. They provide information about what every student needs to learn to meet Illinois Science Learning Standards and by describing how students perform while doing so. These performance descriptors provide information regarding physiological and intellectual development of students as they progress through their K-12 education.

These stages are not intended to represent any one specific grade level since teachers will have students at multiple levels in any given classroom. The stages represent the developmental progression of student learning. For clarity, several stages correspond to specific levels for ISAT purposes and represent the "meets" standards and benchmarks at that level. Level C corresponds to the "meets" level for 3rd grade, level E for the 5th grade, level H to 8th grade, level I to early high school, and level J to late high school.

However, teachers should not confine themselves to one specific stage for their grade level. The teacher must look at a series of three stages to find the progression of understanding and application students should experience. The other stages are not meant to correspond to the missing grades. The following chart indicates the stage clusters teachers should look at when determining the developmental needs of their students.

| | | | | |
|---|---|---|---|---|
| Grade 1 (A-B) | Grade 2 (A-B-C) | Grade 3 (B-C-D) | Grade 4 (C-D-E) | Grade 5 (D-E-F) |
| Grade 6 (E-F-G) | Grade 7 (F-G-H) | Grade 8 (G-H-I) | Grade 9-10 (H-I-J) | Grade 11-12 (I-J) |

**What are these stages?** As students progress from stage to stage, the level of difficulty increases. Remember that science descriptors indicate what students need to know and how to apply that knowledge. For example, in Standard 12C, students who meet this standard know and apply the concepts that explain the properties of matter and energy and how they interact.

**How can these Expanded Performance Descriptors be used as a curriculum development tool?** These stages of development can help a school district devise a science curriculum that will meet state standards and subsequently improve performance of ISAT science tests. It is not the responsibility of any one grade level to cover all standards or curricula. Science curriculum development teams can study the performance descriptors and make the necessary local decisions to determine what material should be covered at each grade level and how it will be taught.

The descriptors do provide a framework for making these decisions. They are descriptive and not prescriptive. The science goals, standards, benchmarks, and performance descriptors provide the minimum amount of information which students need to know and how to apply that knowledge in a developmentally appropriate manner, but the local school districts determine how and when this material should be covered. Using the stages of development provided in this document, school district curriculum teams can develop a science curriculum that will meet state standards.

**Who really wrote these descriptors and where did the ideas come from?** A team of experts in science education wrote these expanded performance descriptors. They included teachers, curriculum writers, consultants, professors, and governmental science center directors. Each writer was or currently is an active educator, and all are currently involved in the promotion and improvement of science education. The descriptors were reviewed on two different occasions by teams of teachers from throughout the State of Illinois. All segments from early elementary to late high school were represented.

The descriptors are well grounded in solid science educational research. The two major sources of reference are *Benchmarks for Science Literacy: Project 2061* by American

Association for the Advancement of Science and the *National Science Education Standards* by the National Academy of Sciences.

**Final comments.** Educational reform and improvement in science is an ongoing process. The major players in this movement have been, are, and will continue to be teachers. The descriptors are not the result of any one individual sitting in an office, isolated from the teaching profession. Rather, they emerged from some of the finest minds in science education and teaching. They were written by teachers, reviewed by teachers, for teachers, to be used by teachers, to improve the quality of science education for the students of Illinois.

# Science Performance Descriptors

**11A** Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

| Stage E | Stage F | Stage G |
|---|---|---|
| • **Construct an inquiry hypothesis that can be investigated**,<br>o researching pertinent context, or<br>o proposing the logical sequence of steps, or<br>o securing the appropriate materials and equipment, or<br>o determining data-collection strategies and format for approved investigation.<br>(Link to 5A, 12A-F, 13A.)<br>• **Conduct scientific inquiry investigation,**<br>o observing safety precautions and following procedural steps accurately over multiple trials.<br>(Link to 12A-F,13A.)<br>• **Collect qualitative and quantitative data from investigation,**<br>o using available technologies, or<br>o determining the necessary required precision, or<br>o validating data for accuracy.<br>(Link to 7A-C, 12A-F, 13A.)<br>• **Organize and display data,**<br>o determining most appropriate visualization strategies for collected data, or<br>o using graphs (i.e., double bar, double line, stem and leaf plots) and technologies.<br>(Link to 8B, 9C, 12A-F, 13A.)<br>• **Analyze data to produce reasonable explanations,**<br>o comparing and summarizing data from multiple trials,<br>o interpreting trends, or<br>o evaluating conflicting data, or<br>o determining sources of error.<br>(Link to 7A-C, 9C, 10, 12A-F.)<br>• **Communicate analysis and conclusions from investigation,**<br>o interpreting graphs and charts, or<br>o preparing oral, and/or written conclusions for peer review, or<br>o generating additional questions that can be tested.<br>(Link to 5A-C, 10A-B, 12A-F, 13A.) | • **Formulate hypotheses,**<br>o generating if-then, cause-effect statements and predictions, or<br>o choosing and explaining selection of the controlled variables.<br>(Link to 5A, 7A-C, 9, 10, 12A-F, 23C.)<br>• **Design and conduct scientific investigation**,<br>o incorporating appropriate safety precautions, available technology and equipment, or<br>o researching historic and current foundations for similar studies, or<br>o replicating all processes in multiple trials.<br>(Link to 5, 12A-F, 13A-B.)<br>• **Collect and organize data accurately,**<br>o using consistent measuring and recording techniques with necessary precision, or<br>o using appropriate metric units, or<br>o documenting data accurately from collecting instruments, or<br>o graphing data appropriately.<br>(Link to 7A, 8B-C, 10A-B, 12A-F.)<br>• **Interpret and represent results of analysis to produce findings**,<br>o differentiating observations that support or refute a hypothesis, or<br>o identifying the unexpected data within the data set, or<br>o proposing explanations for discrepancies in the data set.<br>(Link to 12A-F, 13A.)<br>• **Report the process and results of an investigation**,<br>o using available technologies for presentations, or<br>o distinguishing observations that support the original hypothesis, or<br>o analyzing a logical proof or explanation of findings, or<br>o generating additional questions which address procedures, similarities, discrepancies or conclusions for further investigations.<br>(Link to 5A-C, 12A-F, 13A.) | • **Formulate contextual hypotheses,**<br>o generating an if-then, cause- effect premise, or<br>o differentiating qualitative and quantitative data and their applicability, or<br>o using conceptual/mathematical/ physical models, or<br>o previewing existing research as primary reading sources.<br>(Link to 5, 7, 8, 9, 10, 12A-F.)<br>• **Design inquiry investigation which addresses proposed hypothesis,**<br>o Determining choice of variables, or<br>o preparing data-collecting format, or<br>o incorporating all procedural and safety precautions, materials and equipment handling directions.<br>(Link to 7, 10, 12A-F, 13A.)<br>• **Conduct inquiry investigation**<br>o choosing applicable metric units of measurement with estimated scale and range of results for student-generated data tables, or<br>o using direct, indirect, or remote technologies for observing and measuring, or<br>o conducting sufficient multiple trials, or<br>o recording all necessary data and observations objectively.<br>(Link to 7B, 10A, 12A-F, 13A.)<br>• **Interpret and represent analysis of results to produce findings,**<br>o observing trends within data sets, or<br>o evaluating data sets to explore explanations of outliers or sources of error, or<br>o analyzing observations and data which may support or refute inquiry hypothesis,<br>(Link to 7, 10B, 12A-F.)<br>• **Report and display the process and findings of inquiry investigation,**<br>o presenting oral or written final report for peer review, or<br>o generating further questions for alternative investigations or procedural refinements, or<br>o evaluating other investigations for consolidation/refinement of procedures or data explanation.<br>(Link to 5, 10, 12A-F.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**11A** Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

| Stage H | Stage I | Stage J |
|---|---|---|
| • **Formulate issue-specific hypothesis,**<br>○ generating inquiry questions for an issue investigational premise, or<br>○ differentiating qualitative and quantitative data and their applicability, or<br>○ using conceptual/mathematical/ physical models, or<br>○ previewing associated research.<br>(Link to 5, 7, 8, 9, 10, 12A-F.)<br>• **Design scientific issue investigation which addresses proposed hypothesis(es),**<br>○ proposing applicable survey instruments, or<br>○ selecting associated research, analysis, and communication components.<br>(Link to 6C, 7, 10A-B, 12A-F, 13A.)<br>• **Conduct issue investigation,**<br>○ using technologies for data collection and assimilation, or<br>○ following established formats for random sampling, or<br>○ following all procedural and safety precautions, materials and equipment handling directions.<br>(Link to 7, 10A-B, 12A-F, 13A.)<br>• **Interpret and represent analysis of results,**<br>○ evaluating data sets to explore explanations of unexpected responses and data concurrence, or<br>○ evaluating survey validity and reliability, or<br>○ analyzing research and data for supporting or refuting the hypothesis.<br>(Link to 7, 10A-B, 12A-F.)<br>• **Report, display and defend the process and findings of issue investigation,**<br>○ presenting oral or written final report for action response options for peer review, or<br>○ generating further questions or issues for consideration, or<br>○ evaluating other resolutions or responses for action for applicable correlations, consolidation or explanations.<br>(Link to 5, 10, 12A-F.) | • **Formulate independent content-specific hypothesis,**<br>○ referencing pertinent reliable prior research, or<br>○ proposing options for appropriate questions, procedural steps, and necessary resources.<br>(Link to 5, 7, 8, 9, 10, 12A-F.)<br>• **Design an inquiry investigation which addresses proposed hypothesis,**<br>○ determining variables and control groups, or<br>○ incorporating all procedural and safety precautions, materials and equipment handling directions and data-collection formatting preparations, or<br>○ securing approval for all procedures, equipment use and safety concerns.<br>(Link to 5, 7, 8, 9, 10, 12A-F.)<br>• **Conduct inquiry investigation,**<br>○ using technologies for observing and measuring directly, indirectly, or remotely, or<br>○ completing multiple, statistically-valid trials, or<br>○ accurately and precisely recording all data.<br>(Link to 8B-C, 10A, 12A-F, 13A.)<br>• **Interpret and represent analysis of results to produce findings that support or refute inquiry hypothesis,**<br>○ evaluating data sets to explore explanations of outliers or sources of error and trends, or<br>○ applying statistical methods to compare mode, mean, percent error and frequency functions.<br>(Link to 7, 10A-B, 12A-F, 13A.)<br>• **Present and defend process and findings in open forum,**<br>○ generating further questions, or<br>○ explaining impact of possible sources of error, or<br>○ reflecting on and evaluating peer critiques and comparable inquiry investigations for consolidation or refinement of procedures.<br>(Link to 5, 10, 12A-F.) | • **Formulate issue- hypothesis,**<br>○ reviewing literature as primary reading sources, or<br>○ differentiating between subjective/objective data and their usefulness to the issue, or<br>○ examining applicable existent surveys, impact studies, or models.<br>(Link to 5, 10, 12A-F.)<br>• **Design an issue investigation,**<br>○ proposing applicable survey and interview instruments and methodologies, or<br>○ selecting appropriate simulations, or<br>○ projecting possible viewpoints, variables, applicable data sets and formats for consideration.<br>(Link to 5, 10, 12A-F.)<br>• **Conduct issue investigation (following all procedural and safety precautions),**<br>○ using appropriate technologies, or<br>○ interviewing associated entities or experts, or<br>○ testing applicable simulation models, or<br>○ completing all data collection requirements.<br>(Link to 7, 10A-B, 12A-F, 13A)<br>• **Interpret and analyze results to produce findings and issue resolution options,**<br>○ evaluating data sets and trends to explore unexpected responses and data distractors, or<br>○ evaluating validity and reliability, or<br>○ substantiating basis of inferences, deductions, and perceptions.<br>(Link to 7, 10A-B, 12A-F)<br>• **Report, display and defend the process and findings of issue investigation,**<br>○ critiquing findings by self and peer review, or<br>○ generating further questions or issues for consideration, or<br>○ evaluating comparable issue resolutions or responses for action, or<br>○ generalizing public opinion responses.<br>(Link to 5, 10, 12A-F.) |

Grade 6 (E-F-G)  Grade 7 (F-G-H)  Grade 8 (G-H-I)  Grade 9-10 (H-I-J)  Grade 11-12 (I-J)

# Science Performance Descriptors

**11B** Students who meet the standard know and apply the concepts, principles, and processes of technological design.

| Stage E | Stage F | Stage G |
|---|---|---|
| • **Identify an innovative technological design from ordinary surroundings or circumstances,**<br>o brainstorming common design questions (e.g., how to squeeze toothpaste better, how to fly a better paper airplane), or<br>o researching background information, or<br>o suggesting the appropriate materials, equipment and data-collection strategies and success factors for approved investigation.<br>(Link to 12A-F.)<br>• **Construct selected technological innovation,**<br>o sketching design, or<br>o proposing the logical sequence of steps for construction, or<br>o collecting appropriate materials, supplies, and safety equipment, or<br>o completing assembly of innovation.<br>(Link to 7A-C, 12A-F, 13A.)<br>• **Test prototype,**<br>o conducting multiple trials, or<br>o collecting reliable and precise data, or<br>o recording observations.<br>(Link to 7, 10, 12A-F, 13A-B.)<br>• **Analyze data,**<br>o comparing and summarizing data, or<br>o interpreting trends,<br>o evaluating conflicting data, or<br>o determining sources of error.<br>(Link to 7, 10, 12A-F, 13A-B.)<br>• **Communicate design findings,**<br>o selecting graphs and charts that effectively report the data,<br>o preparing oral and written investigation conclusions, or<br>o generating alternative design modifications which can be tested from original investigated question.<br>(Link to 5A-C, 10A-B, 12A-F.) | • **Formulate proposals for technological designs which model or test scientific principles,**<br>o generating investigation ideas to apply curricular science principles (e.g., how to test phase changes of substances or acceleration in free fall, or effect of ice/glaciers on rocks), or<br>o brainstorming pertinent variables, or<br>o researching historic designs, or<br>o conducting peer review and choice for design and criteria selection.<br>(Link to 12A-F, 16.)<br>• **Plan and construct technological design,**<br>o incorporating the safety and procedural guidelines into the construction plan, or<br>o maximizing resource capabilities.<br>(Link to 12A-F, 13A-B.)<br>• **Collect and record data accurately,**<br>o using consistent metric measuring and recording techniques with necessary precision, or<br>o documenting data from collecting instruments accurately in selected format.<br>(Link to 7, 10A-B, 12A-F, 13A-B.)<br>• **Interpret and represent results of analysis to produce findings,**<br>o comparing data sets for supporting or refuting scientific principle, or<br>o evaluating multiple criteria for overall design success, or<br>o proposing explanations for sources of error in the data set for process or product design flaws.<br>(Link to 7, 10B, 12A-F, 13A-B.)<br>• **Communicate the results of design investigation,**<br>o presenting an oral and/or written report, or<br>o explaining the test of the scientific principle, or<br>o using available technologies, or<br>o relating anecdotal and quantitative observations, or<br>o generating additional design modifications which can be tested later.<br>(Link to 5A-C, 12A-F, 13A-B.) | • **Identify an important historic innovation or model of a technological design,**<br>o examining inventions or entrepreneurial events driven by science or engineering principles, or<br>o searching pertinent historical foundation, or<br>o determining the success criteria, design constraints, and testing logistics that were encountered.<br>(Link to 12A-F, 14E, 15C-D, 16A-C, 16E, 17C-D.)<br>• **Construct selected technological innovation model,**<br>o sketching a progression of design stages and prototypes, or<br>o proposing the logical sequence of steps in design construction, or<br>o identifying original and comparable simulation materials for construction, or<br>o predicting proportional scale for actual parameters and materials, or<br>o completing assembly of innovation model.<br>(Link to 7A-C, 12A-F, 13A.)<br>• **Test prototype,**<br>o predicting proportional scale for actual parameters and materials, or<br>o conducting multiple trials according to success criteria, scale, and design constraints, or<br>o recording reliable and precise data and anecdotal observations.<br>(Link to 7, 8, 9, 10A-B, 12A-F, 13B.)<br>• **Analyze data to evaluate design,**<br>o comparing and summarizing data from multiple model trials, or<br>o correlating historic conditions and data to model testing.<br>(Link to 7, 10B, 12A-F, 13A.)<br>• **Communicate design evaluation report,**<br>o presenting oral and written report on historical significance of selected technological design and tested model, its original constraints and conditions, or<br>o generating possible alternative designs which could have been considered historically.<br>(Link to 5A-C, 10A-B, 12A-F, 13A.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**11B** Students who meet the standard know and apply the concepts, principles, and processes of technological design.

| Stage H | Stage I | Stage J |
|---|---|---|
| • **Formulate proposals for design investigation,**<br>○ generating strategies to test or model a scientific concept, or<br>○ suggesting appropriate supplies, materials, resources, and equipment to test concepts.<br>(Link to 12A-F, 13A.)<br>• **Create and conduct technological design testing objectively,**<br>○ sketching schematic of design or predictions, or<br>○ incorporating the appropriate safety, available technology and equipment capabilities into construction and testing of design.<br>(Link to 12A-F, 13A.)<br>• **Collect and record data accurately,**<br>○ using consistent metric measuring and recording techniques with necessary precision, or<br>○ recording data accurately in appropriate format, or<br>○ graphing data appropriately according to the tested variables.<br>(Link to 7B, 10A, 12A-F, 13A.)<br>• **Represent results of analysis to produce findings,**<br>○ comparing data sets according to the design criteria, or<br>○ evaluating multiple prototype solutions to the overall design success criteria, or<br>○ proposing explanations for sources of error in the data set with regards to product design flaws, or model limitations.<br>(Link to 7, 10B, 12A-F, 13A.)<br>• **Report the process and results of a design investigation,**<br>○ selecting graphs and charts that effectively report the design data, or<br>○ making oral and/or written presentations, or<br>○ proposing logical explanations of success or errors, or<br>○ generating additional design modifications which can be tested later.<br>(Link to 5A-C, 10A-B, 12A-F, 13A.) | • **Identify an historic engineering feat, innovation or model,**<br>○ researching historic dilemmas which necessitated new scientific or engineering solutions, or<br>○ brainstorming the kinds of barriers or circumstances that existed, or<br>○ identifying the simulation materials and procedural sequence which can simulate historic conditions, or<br>○ determining success criteria, design constraints, and testing logistics encountered.<br>(Link to 5, 12A-F, 13A, 16.)<br>• **Construct innovation model,**<br>○ sketching progressive schematics of the design, or<br>○ collecting appropriate materials, supplies, and safety equipment, or<br>○ completing assembly of innovation or model.<br>(Link to 7A-C, 12A-F, 13A.)<br>• **Test prototype,**<br>○ conducting multiple trials according to success criteria, scale, and design constraints, or<br>○ collecting reliable and precise data.<br>(Link to 7, 10B, 12A-F.)<br>• **Analyze data to evaluate designs,**<br>○ comparing and summarizing data from multiple trials, or<br>○ evaluating conflicting data for validity and precision, or<br>○ correlating historic conditions and observations to model testing, or<br>○ determining sources of error.<br>(Link to 7, 10B, 12A-F, 13A-B, 16.)<br>• **Communicate design evaluation report**,<br>○ selecting graphs and charts that most effectively report the design data, or<br>○ preparing oral and written investigation conclusions for peer review, or<br>○ relating historic setting and impact to scientific or engineering solution and eventual progression of designs, or<br>○ generating alternative design modifications which can be or could have been tested.<br>(Link to 5A-C, 10A-B, 12A-F.) | • **Formulate proposals for innovative technological design,**<br>○ generating ideas for innovations and variables, or<br>○ identifying design constraints due to access to tools, materials, and time, or<br>○ researching applicable scientific principles or concepts.<br>(Link to 12A-F, 13A-B.)<br>• **Design and conduct technological innovation testing,**<br>○ developing the sequence of the design with visualizations, or<br>○ incorporating the appropriate safety, available technology and equipment capabilities into construction of design, or<br>○ repeating procedural steps for multiple trials.<br>(Link to 10A, 12A-F, 13A.)<br>• **Collect and record data accurately,**<br>○ using consistent metric measuring and recording techniques and media with necessary precision, or<br>○ documenting data from instruments accurately in selected format, or<br>○ graphing data appropriately to show relation to variables in design solution proposal.<br>(Link to 7B, 10A, 12A-F.)<br>• **Interpret and represent results of analysis to produce findings,**<br>○ comparing data sets to design criteria for suitability, acceptability, benefits, or<br>○ proposing explanations for sources of error in the data set for process or product design flaws.<br>(Link to 7, 10B, 12A-F, 13A.)<br>• **Report the process and results of a design investigation,**<br>○ explaining application to appropriate scientific principle or concept, or<br>○ communicating anecdotal and quantitative observations, or<br>○ analyzing a logical explanation of success or errors, or<br>○ generating additional design modifications which can be tested later.<br>(Link to 5A-C, 12A-F, 13A-B.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**12A** Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

| Stage E | Stage F | Stage G |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to explore the patterns of change and stability at the micro- and macroscopic levels of organisms (including humans),**<br>○ comparing the stages of simple life cycles and energy requirements, or<br>○ identifying structures and their functions in cells, tissues, organs, systems and organisms (including humans).<br>(Link to 11A-B, 12B, 23B-C.)<br>• **to distinguish the similarities and differences of offspring in organisms (including humans),**<br>○ comparing specific characteristics of offspring with their parents, or<br>○ predicting possible genetic combinations from selected parental characteristics.<br>(Link to 10C, 11A-B, 12B.)<br>• **to examine the nature of inheritance in structural and functional features of organisms (including humans),**<br>○ describing genetic and environmental influences on the features of organisms, or<br>○ distinguishing between inherited and acquired characteristics, or<br>○ explaining how cells respond to genetic and environmental influences.<br>(Link to 11A-B, 12B, 22C.)<br>• **to examine the nature of learned behavior or responses in all organisms (including humans),**<br>○ distinguishing characteristics as learned or inherited, or<br>○ conducting simple surveys relating to learned behaviors of classmates, and/or family members.<br>(Link to 10B-C, 11A-B, 12B, 22B, 24B-C.) | **Apply scientific inquiries or technological designs**<br>• **to examine the cellular unit,**<br>○ recognizing how cells function independently to keep the organism alive at the single cell level and dependently at specialized levels, or<br>○ comparing the metabolic and reproductive processes, structures and functions of single and multi-cellular organisms.<br>(Link to 11A-B, 22A-F, 23A-C.)<br>• **to examine the patterns of change and stability over time,**<br>○ investigating the development of organisms and their environmental adaptations over broad time periods, or<br>○ comparing the physical characteristics of two to three generations of familial characteristics.<br>(Link to 11A-B, 12B, 23A-C.)<br>• **to explore the basic roles of genes and chromosomes in transmitting traits over generations,**<br>○ describing how physical traits are transmitted through sexual or asexual reproductive processes, or<br>○ charting 'pedigree' probabilities for transmissions, or<br>○ identifying examples of selective breeding for particular traits, or<br>○ analyzing how familiar human diseases are related to genetic mutations.<br>(Link to 11A-B.)<br>• **to examine stimulus-response reactions in organisms,**<br>○ comparing growth responses in plants, or<br>○ comparing simple locomotive or metabolic responses in simple or complex life forms.<br>(Link to 11A-B.) | **Apply scientific inquiries or technological designs**<br>• **to examine the cellular-to-organism interrelationships,**<br>○ comparing the increasingly complex structure and function of cells, tissues, organs and organ systems, or<br>○ demonstrating the processes for biological classification, or<br>○ analyzing normal and abnormal growth and health in organisms (with a focus on humans), or<br>○ describing how physiological systems carry out vital functions (e.g., respiration, digestion, reproduction, photosynthesis, excretion, and temperature regulation).<br>(Link to 11A-B, 12B, 22A, 23A-C.)<br>• **to examine macro- and micro-evolution in organisms,**<br>○ comparing and assessing changes in the features or forms of organisms over broad time periods to their adaptive functions and competitive advantages, or<br>○ describing how natural selection accounts for diversity of species over many generations.<br>(Link to 11A-B, 12B.)<br>• **to explore the science of genetics,**<br>○ tracing the history of genetics, or<br>○ correlating the principles of genetics to mitotic cell division and simple mathematical probabilities, or<br>○ researching applied genetics in plant and animal breeding, or<br>○ associating genetic factors for inheritance in humans, including genetic disorders.<br>(Link to 10C, 11A-B, 12B.)<br>• **to examine the cellular coordination of responses,**<br>○ describing how the nervous system communicates between cells within the whole organism, or<br>○ tracing stimulus-response paths in various nervous systems, or<br>○ analyzing the effect of substances (e.g., oxygen, food, blood, hormones, drugs) circulating through the body.<br>(Link to 11A-B, 23A.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**12A** Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

| Stage H | Stage I | Stage J |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to explain the chemical nature of biological processes,**<br>o describing photosynthesis in terms of basic requirements and products, or<br>o correlating respiration, or<br>o diagramming the nitrogen, water, oxygen, and carbon cycles with reference to ecosystem-to-molecular levels.<br>(Link to 11A-B.)<br>• **to correlate the basis of cellular and organism reproductive processes,**<br>o correlating possible genetic combinations to the type of reproductive process, or<br>o diagramming and comparing mitotic and meiotic cell division, or<br>o distinguishing asexual and sexual (egg, sperm and zygote formation) reproduction with examples.<br>(Link to 11A-B.)<br>• **to compare evolutionary trends between kingdoms and phyla,**<br>o exploring natural and applied hybridization, or<br>o explaining the increasing sophistication of body systems correlating embryological, structural, and functional development, or<br>o exploring the impact of environmental factors on these trends.<br>(Link to 11A-B.)<br>• **to explore social and environmental responses of organisms,**<br>o describing learned and inherited behaviors and responses across kingdoms and between/among phyla, or<br>o explaining cyclic behaviors and responses in various species, or<br>o examining social behaviors of insects and vertebrates.<br>(Link to 11A-B.) | **Apply scientific inquiries or technological designs**<br>• **to explain metabolic processes within cells and between organisms and their environment,**<br>o explaining gas exchange, food processing, transport, excretion, locomotion, body regulation, and nervous control, or<br>o investigating enzyme actions in various reactions, or<br>o describing the applications of the polar nature of water and the pH index in biochemical reactions.<br>(Link to 11A-B.)<br>• **to analyze the cellular organelles and functions,**<br>o using different microscopic techniques, or<br>o explaining functional processes chemically and structurally (e.g., osmotic, active and facilitated transport, enzyme action and protein/lipid/carbohydrate metabolism).<br>(Link to 11A-B.)<br>• **to explain the molecular nature of the genetic code,**<br>o explaining the function, chemical reactions, and schematic diagrams of the molecular components of DNA, RNA and simple proteins, or<br>o exploring the processes of recombinant DNA research, or<br>o describing the role of chromosomes in the normal and aberrant display of hereditary traits, mutations and disease.<br>(Link to 11A-B.)<br>• **to compare taxonomic criteria among organisms,**<br>o examining unicellular, colonial, and multi-cellular organisms for common and differing characteristics.<br>(Link to 11A-B.)<br>• **to explain tests of evolutionary evidence,**<br>o analyzing acceptance of geologic and fossil records,<br>o researching comparative anatomy, embryology, biochemistry and cytology studies of analogous and homologous structures.<br>(Link to 11A-B, 12B, 12E, 13A-B.) | **Apply scientific inquiries or technological designs**<br>• **to explain biochemical reactions,**<br>o diagramming metabolic, hormonal, regulatory, feedback or transport molecular models in and between organ systems, or<br>o explaining homeostasis, or<br>o tracing the balance of cellular ATP.<br>(Link to 11A-B.)<br>• **to explain new biological technologies,**<br>o projecting possible implications of current research (e.g., Human Genome Project, immune system responses).<br>(Link to 11A-B.)<br>• **to synthesize the principles of genetic studies,**<br>o examining phenotypic and genotypic displays,<br>o modeling predictable dominance outcomes and probabilities, or<br>o making connections to early and current research in agriculture, forensics, medicine, etc.<br>(Link to 11A-B.)<br>• **to examine explanations of evolution,**<br>o researching how genetic similarities are conserved between species, genera, families, etc., or<br>o analyzing the testing process for acceptance by the scientific community, or<br>o referencing geographic, geologic, or anthropologic evidence for the sequencing of the genus, Homo, or<br>o introducing the mitochondrial and nuclear DNA basis of genetic kinship of the species.<br>(Link to 11A-B, 12C, 12E, 13A-B.)<br>• **to explain disease from the organelle-to-population levels,**<br>o explaining body defenses to infectious disease in various organisms, or<br>o researching historic and on-going efforts to prevent, cure or treat diseases.<br>(Link to 11A-B, 22, 23.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**12B** Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

| Stage E | Stage F | Stage G |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to categorize organisms (including humans) by their energy relationships in their environments,**<br>○ classifying organisms by their position in a food web, or<br>○ grouping organisms according to their adaptive internal and/or external features, or<br>○ contrasting food webs within and among different biomes, or<br>○ identifying the biotic and abiotic factors associated with specific habitats, or<br>○ making simple inferences to the closed systems of other planets.<br>(Link to 11A-B, 12A, 12C, 13B, 22A.)<br>• **to explain competitive, adaptive and survival potential of species in different local or global ecosystems,**<br>○ identifying survival characteristics of organisms, or<br>○ explaining abiotic or biotic factors which threaten health or survival of populations or species (including humans), or<br>○ identifying theories explaining mass extinctions.<br>(Link to 11A-B, 12A, 13A-B, 16E, 17C-D.) | **Apply scientific inquiries or technological designs**<br>• **to study the impact of multiple factors that affect organisms in a habitat,**<br>○ describing how behaviors are influenced by internal and external factors, or<br>○ sketching the interrelationships among/between the land, water and air components to life in the system, or<br>○ predicting the consequences of the disruption of a food pyramid, or<br>○ identifying the interrelationships and variables that affect population sizes and behaviors, or<br>○ identifying different niches and relationships found among organisms in an Illinois habitat.<br>(Link to 11A-B, 12A, 13B, 16E, 17C-D.)<br>• **to apply the competitive, adaptive and survival potential of organisms,**<br>○ describing how fossils are used to determine patterns of evolution, or<br>○ observing how plant and animal characteristics help organisms survive in their environments, or<br>○ analyzing how environmental factors threaten or enhance the survival potential of populations.<br>(Link to 11A-B, 12A, 13B, 16E, 17C-D, 22A.) | **Apply scientific inquiries or technological design**<br>• **to examine the energy requirements of ecosystems,**<br>○ tracing the roles and population ratios of producers, consumers, and decomposers in food chains and webs, or<br>○ identifying the biomass relationship with the transfer of energy from the sun to final consumers.<br>(Link to 11A-B, 12C.)<br>• **to relate the chemical cycles in ecosystems,**<br>○ modeling the water, carbon, and nitrogen cycles with local references, or<br>○ researching groundwater resources and potential sources of contamination with local examples.<br>(Link to 11A-B, 12D, 16, 17.)<br>• **to explore the interactions between an ecosystem's organisms,**<br>○ examining types of interactive relationships (e.g., mutualism, predation, parasitism) with specific examples, or<br>○ explaining interrelationship of adaptations and ecosystem survival.<br>(Link to 11A-B.)<br>• **to introduce population dynamics in ecosystems,**<br>○ exploring models of population growth rates, or<br>○ determining factors that limit population growth, or<br>○ researching specific instances of population explosions over time.<br>(Link to 6B-C, 8A, 8D, 7, 10, 11A-B, 13A.)<br>• **to model global biomes,**<br>○ identifying the general climate, soil, and inhabitant of the six major land-based biomes, or<br>○ mapping the global biomes, or<br>○ comparing the graphical meteorological data (temperature, precipitation) of biomes/ecosystems.<br>(Link to 7, 10, 11A-B, 13A-B, 16, 17.) |

# Science Performance Descriptors

**12B** Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

| Stage H | Stage I | Stage J |
|---|---|---|
| **Apply scientific inquiries or technological design**<br>• **to explore the implications of change and stability in ecosystems,**<br>○ identifying evolutionary adaptations brought on by environmental changes, or<br>○ analyzing factors that influence the size and stability of populations (e.g., temperature, climate, soil conditions, predation, habitat), or<br>○ contrasting energy use by organisms.<br>(Link to 7, 10, 11A-B, 12C, 13A-B, 16, 17.)<br>• **to examine species' demise or success within ecosystems,**<br>○ identifying problems for species conservation and extinction, or<br>○ projecting population changes when habitats are altered or destroyed (deforestation, desertification, wetlands destruction, introduction of exotic species),or<br>○ researching economic and scientific value implications for changes to genetic diversity.<br>(Link to 11A-B, 16, 17.)<br>• **to study biogeography,**<br>○ researching global biomes, or<br>○ locating hemispheric, continental, and regional examples of each biome, or<br>○ graphing associated mathematical comparison factors.<br>(Link to 10, 11A-B, 16, 17.)<br>• **to analyze Illinois-specific ecosystems and biomes,**<br>○ modeling topographic features, population data, plant diversity and distribution from historic records, or<br>○ collecting scientific seasonal/annual local ecosystem data for direct connection to change and stability factors, or<br>○ projecting scenarios of changes to local ecosystem for near- and long-term future contingencies.<br>(Link to 7, 10, 11A-B, 13A, 16, 17.) | **Apply scientific inquiries or technological design**<br>• **to explain population growth, density factors in ecosystem change and stability and biodiversity:**<br>○ researching population model studies to determine limiting factors and mathematical patterns of population growth in real-world situations, or<br>○ investigating biotic and abiotic factors of ecosystems, or<br>○ identifying the roles and relationships of organisms in their community in terms of impact on populations and the ecosystem.<br>(Link to 7, 8C, 10, 11A-B, 13A.)<br>• **to explain the environment-energy interactions,**<br>○ comparing the biomass involved in energy transfer by organisms at different tropic levels, or<br>○ relating biome productivity to carbon-fixing and energy storage by producers, or<br>○ correlating major chemical cycles (nitrogen, carbon dioxide, water) to other chemical cycles in nature (e.g., phosphorus, sulfur, strontium), or<br>○ relating the laws of thermodynamics to environmental-energy transfer efficiency.<br>(Link to 11A-B, 12C-E, 13B, 16, 17.)<br>• **to research global biomes,**<br>○ identifying the latitude, altitude, soil, temperature and precipitation ranges, and inhabitants of the six major land-based biomes, or<br>○ comparing the salinity, light penetration, nutrients, and inhabitants of aquatic biomes, identifying feeding relationships within biomes, or<br>○ comparing climatographs of biomes or carbon-fixing/storage productivity estimations.<br>(Link to 11A-B, 12C-E, 13B, 16, 17.) | **Apply scientific inquiries or technological design**<br>• **to research the sustainability of water resources,**<br>○ sketching and quantifying the hydrologic cycle locally and globally, or<br>○ describing the role of oceans on climatic systems, or<br>○ describing the impact of invasive organisms, alterations of chemical and microbial concentrations (pollutants, salinity), global and site average temperatures, or<br>○ simulating water supply recharge/deficit/surplus and groundwater infiltration, or<br>○ modeling effects of point source and non-point source pollution, or<br>○ explaining water and sewage treatment.<br>(Link to 11A-B, 12C-E, 13B, 16, 17.)<br>• **to research the sustainability of land resources,**<br>○ studying the role of biotic and abiotic soil components in decomposition and nutrient cycling, or<br>○ collecting data on soil composition, porosity, permeability, fertility etc., or<br>○ quantifying the impact of topsoil and mineral preservation, erosion, and reclamation.<br>(Link to 11A-B, 12C-E, 13B, 16, 17.)<br>• **to research the sustainability of air resources,**<br>○ modeling the atmospheric layers with their currents and temperature inversions, or<br>○ explaining the percentage chemical compositions and conversions at varying levels as associated with the greenhouse effect and ozone depletion or acid-rain concentrations.<br>(Link to 11A-B, 12C-E, 13B, 16, 17.)<br>• **to research the sustainability of energy sources,**<br>○ comparing alternative natural sources of energy to fossil energy sources in terms of risks, costs, benefits, supplies, efficiencies, storage, and renewability, or<br>○ analyzing impacts of conservation measures and recycling on energy consumption.<br>(Link to 11A-B, 12C-E, 13B, 16, 17.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**12C** Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

| Stage E | Stage F | Stage G |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to explore energy,**<br>  ○ demonstrating how mirrors, prisms, diffraction gratings and filters direct light patterns, or<br>  ○ diagramming how electricity can be produced from different sources of energy, or<br>  ○ explaining how electrical energy can be converted to light, heat, sound, and magnetic energy, or<br>  ○ analyzing common examples of potential, and kinetic energy, or<br>  ○ comparing insulation, conduction, convection, and radiation of heat.<br>  (Link to 11A-B, 12D, 13A-B.)<br>• **to distinguish the properties of matter,**<br>  ○ separating components of mixtures by solubility, magnetic properties, and densities, or<br>  ○ analyzing compound samples by quantitative methods, or<br>  ○ graphing the temperature variations associated with phase changes of simple substances, or<br>  ○ categorizing the properties of common elements into a graphic format.<br>  (Link to 10C, 11A-B, 12D, 12E, 13A-B.) | **Apply scientific inquiries or technological designs**<br>• **to demonstrate the interactions of energy forms,**<br>  ○ explaining how interactions of matter and energy affect the changes of state, or<br>  ○ tracing electrical current in simple direct and alternating circuits, or<br>  ○ diagramming how sound, heat and light energy forms are detected by humans and other organisms.<br>  (Link to 11A-B, 12A, D, 13A-B.)<br>• **to explore the basic structure of matter**<br>  ○ illustrating the structure of elements and simple compounds, or<br>  ○ measuring the masses of chemical reactants and products to show that the sum equals the parts, or<br>  ○ investigating the compressibility and expansion of gases at colder and hotter temperatures, or<br>  ○ analyzing the electrical nature of charges, attraction, and repulsion.<br>  (Link to 11A-B, 12D, 13A-B.) | **Apply scientific inquiries or technological designs**<br>• **to compare heat, light, and sound energies,**<br>  ○ distinguishing heat and temperature, their measurements, and the relationship to mass, or<br>  ○ recording temperatures of simple substances collected during melting/freezing or boiling/condensing to trace phase changes, or<br>  ○ identifying ways of production and travel for heat, light, and sound in various media, or<br>  ○ relating sound reflection, loudness, frequency, and pitch in common examples.<br>  (Link to 11A-B, 12D.)<br>• **to explore the nature of energy conversions and conservation,**<br>  ○ describing energy and its different forms with common examples, or<br>  ○ categorizing energy into kinetic and potential states, or<br>  ○ explaining energy conversion and conservation possibilities, or<br>  ○ introducing the connections to concepts of force, momentum, power, and motion.<br>  (Link to 11A-B, 12D.)<br>• **to explore the basic structure of matter,**<br>  ○ measuring mass and volumes of common solids (regular and irregular) and liquids to introduce density ratios, or<br>  ○ comparing ratios of different masses and different volumes of the same kinds of samples, or<br>  ○ relating how historic models of elemental matter from ancient Greeks to medieval alchemists evolved to current representations and explanations, or<br>  ○ classifying comparable properties of representative elements or similar compounds (mixtures, acids, bases, salts, metals, non-metals), or<br>  ○ constructing simple chemical structure models to explain chemical combinations, states, and properties.<br>  (Link to 6C, 7B, 10, 11A-B.) |

Grade 6 (E-F-G)     Grade 7 (F-G-H)     Grade 8 (G-H-I)     Grade 9-10 (H-I-J)     Grade 11-12 (I-J)

# Science Performance Descriptors

**12C** Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

| Stage H | Stage I | Stage J |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to examine patterns of interactions of energy with matter,**<br>○ describing and measuring how the interactions effect changes of state or properties, or<br>○ using quantitative data from investigations and simple chemical formulas and equations to support the concept of conservation of mass, or<br>○ comparing positions, movements, and relationships of atoms in different states, or<br>○ predicting chemical reactivity from information in the Periodic Table.<br>(Link to 7, 8, 11A-B.)<br>• **to explore electric and magnetic energy fields,**<br>○ describing natural forces of static electricity and kinds of conductors and insulators, or<br>○ sketching the magnetic lines of force and basic polar attraction and repulsion, or<br>○ creating electric, magnetic, and electromagnetic fields with simple explanations.<br>(Link to 11A-B, 12D.)<br>• **to examine the chemical and physical characteristics of matter,**<br>○ constructing and discussing models and charts that explain these properties, or<br>○ investigating the relationships among atoms, molecules, elements, and compounds, or<br>○ classifying objects and mixtures based on these properties, or<br>○ explaining the organization of elements in the Periodic Table, or<br>○ investigating the properties of gases at varying temperatures and pressures.<br>(Link to 11A-B.)<br>• **to examine the conservation of matter and energy,**<br>○ quantifying conservation of mass, or<br>○ diagramming conservation of energy in common examples, or<br>○ relating the concepts of force, momentum, power, motion, and work to the concepts of mass, distance, and velocity and their applicable constants, laws, and equations.<br>(Link to 8C, 11A-B, 12D.) | **Apply scientific inquiries or technological designs**<br>• **to investigate the energies of the electromagnetic spectrum,**<br>○ describing the nature/ characteristics/types/speed/ interactions of waves, or<br>○ contrasting the spectral bands of energy, their detection and applications, or<br>○ modeling rays, reflection, refraction, diffraction and polarization of waves.<br>(Link to 11A-B, 12G, 13A-B.)<br>• **to investigate heat and sound energy mechanics,**<br>○ contrasting the production and conversions of heat and sound from the atomic to industrial levels, or<br>○ diagramming and modeling the processes or systems associated with large- and small-scale production, transmission and uses of heat and sound (e.g., heat engines, cooling systems, musical instruments).<br>(Link to 10, 11A-B.)<br>• **to investigate the atomic and nuclear structure of matter,**<br>○ examining historical atomic theories and quantum theory, or<br>○ modeling nuclear and electron configurations and their reactions, or<br>○ predicting bonding and molecular structure.<br>(Link to 11A-B, 13B.)<br>• **to explain how physical and chemical structures of matter affect its properties,**<br>○ relating bonding types and shapes of molecules to organic and inorganic compounds, or<br>○ examining the colligative properties of solutes on the properties of solutions/mixtures.<br>(Link to 11A-B.)<br>• **to investigate kinetic theory and laws of thermodynamics,**<br>○ describing the ideal gases, or<br>○ analyzing the gas laws, or<br>○ explaining entropy/ enthalpy, exothermic/endothermic reactions, and/or Hess's law.<br>(Link to 11A-B.) | **Apply scientific inquiries or technological designs**<br>• **to explain chemical bonding and reactions**<br>○ balancing chemical reactions using formulas and equations to quantify reaction masses, volumes and ratios, or<br>○ examining factors that affect capacity to react or rates (concentrations, pH, catalysts, molarity, temperature, etc.), or<br>○ referencing the bonding potential and strengths within and between atoms and molecules.<br>(Link to 7A, 8C, 11A-B.)<br>• **to explain atomic and sub-atomic structures and energy**,<br>○ describing the composition of the nucleus and its transformations in nuclear reactions and predicting energy released and absorbed, or<br>○ explaining atomic structures to masses, volumes, charges, and isotopic connections, or<br>○ explaining schematic designs for devices to detect, analyze, produce such structures or processes.<br>(Link to 7A, 11A-B.)<br>• **to explain wave theory,**<br>○ explaining the wave and particle nature of light, or<br>○ constructing tests for reflection, refraction, image formation by mirrors and lenses, diffraction, and polarization, or<br>○ describing common examples of optical devices, or<br>○ addressing light in the context of the human eye (and other light-sensitive animals).<br>(Link 11A-B, 12B, 13A.) |

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# Science Performance Descriptors

**12D** Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

| Stage E | Stage F | Stage G |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to explore constant, variable and periodic motion,**<br>○ tracing and measuring motion of vehicles (e.g., cars, bicycles, skates) in terms of position, direction, acceleration, and speed in straight line, circular, and inclined paths, or<br>○ introducing the concepts of harmonic and oscillating motion in everyday examples, or<br>○ applying the concepts of natural frequency.<br>(Link to 7A, 8A-B, 8D, 9A, 11A-B, 12C, 13A-B.)<br>• **to analyze actions and reactions,**<br>○ examining initial and final forces, or<br>○ manipulating simple, direct, and inverse proportions to forces, or<br>○ explaining thrust, weight, lift, and drag in flight, or<br>○ analyzing gears and gear ratios to do work, or<br>○ demonstrating Newton's Laws of Motion in terms of space flight.<br>(Link 7A, 8A-B, 8D, 9A, 11A-B, 12C, 13A-B.) | **Apply scientific inquiries or technological designs**<br>• **to examine gravitational forces,**<br>○ correlating how an object's mass and distances affect weight in Earth and planetary examples, or<br>○ identifying the effects of the Sun's gravitational force in the solar system, or<br>○ predicting direct and inverse proportional trends from data of gravitational attraction.<br>(Link to 7A, 8A-B, 8D, 9A, 11A-B, 12C, 12F, 13A-B.)<br>• **to incorporate the impact of force on motion,**<br>○ associating Newton's three laws of motion to mass, distance, and acceleration, or<br>○ making metric mathematical calculations of average speed, velocity, and acceleration, or<br>○ comparing resistance and friction factors in electrical, magnetic, fluid, and physical systems.<br>(Link to 7A, 8A-B, 8D, 9A, 11A-B, 12C, 13A-B.) | **Apply scientific inquiries or technological designs**<br>• **to explore frames of reference for measuring motion,**<br>○ visualizing the possible reference frames in multiple motion examples, or<br>○ comparing scope of motion (straight line, projectile, inclined, free fall, circular) of various objects.<br>(Link to 7, 8, 9, 10, 11A-B)<br>• **to measure motion,**<br>○ explaining the dimensions of speed/time with directional units, or<br>○ comparing speed, average speed, velocity, acceleration, and momentum with common examples, or<br>○ using simple machines to demonstrate the principles of mechanics, or<br>○ analyzing components of motion graphically.<br>(Link to 7A-B, 8, 9, 10, 11A-B.)<br>• **to measure force,**<br>○ explaining the dimensions of force graphically, or<br>○ comparing common examples of balanced or unbalanced forces in everyday use, or<br>○ examining frictional forces in common examples.<br>(Link to 7A-B, 8, 9, 10A, 11A-B.)<br>• **to explore laws and theories associated with motion,**<br>○ comparing common situations to each of Newton's three laws of motion, or<br>○ using the appropriate units, or<br>○ introducing applications to Newton's Law of Universal Gravitation, or<br>○ incorporating the variant of air resistance.<br>(Link to 7, 8, 9, 10, 11A-B, 12F.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**12D** Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

| Stage H | Stage I | Stage J |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to examine multiple dimensions of motion,**<br>○ tracing and measuring motion in terms of position, direction, acceleration, and speed in straight line, circular, and inclined paths, or<br>○ testing the harmonic and oscillating motion in everyday examples, or<br>○ applying natural frequency to common examples and scientific studies.<br>(Link to 7, 8, 9, 10, 11A-B, 13A.)<br>• **to investigate gravitational forces:**<br>○ explaining the comparisons of weight and mass with variations of 'g' forces and different locations, or<br>○ calculating descent and free fall trajectories of objects in various settings.<br>(Link to 6B, 7A, 8, 9, 10, 11A-B, 13A.)<br>• **to explore the applications of scientific work,**<br>○ constructing variations of simple and compound machines to measure work, power, and force with varying frictional factors, or<br>○ calculating work efficiency of common and complex machines, or<br>○ converting forces of nature (such as weather: tornadoes, wind) into Newtonian factors.<br>(Link 7, 10, 11A-B, 13A-B.) | **Apply scientific inquiries or technological designs**<br>• **to investigate motion relationships in natural and forced settings,**<br>○ calculating the kinematics of rectilinear, free fall, projectile, rotational, and circular motion in commonly experienced problem settings, or<br>○ explaining torque and center of mass in relation to the conditions of equilibrium, or<br>○ explaining the Doppler effect, or<br>○ calculating forces in elastic and inelastic collisions.<br>(Link to 7, 8, 9, 10, 11A-B, 13B.)<br>• **to investigate motion and pressure common examples in nature,**<br>○ defining the factors of pressure and its equilibrium, or<br>○ identifying how particles in a fluid can exert pressure as related to altitude and depth, or<br>○ explaining buoyancy and hydraulics in terms of comparative densities, or<br>○ addressing Bernoulli's principles to flight, or<br>○ relating pressure and gravity to common engineering settings.<br>(Link to 7, 8, 9, 10, 11A-B, 13B.)<br>• **to explore atomic and nuclear physical systems,**<br>○ describing historic, current, and proposed research to explain purposes and impact of discoveries, or<br>○ explaining radioactivity in terms of atomic decay, nuclear reactions, and emissions.<br>(Link to 11A-B, 13B.)<br>• **to explain harmonic motion,**<br>○ describing the scope of vibrational motion, or<br>○ calculating harmonic periods variations, or<br>○ constructing variations to linear and angular simple harmonic motion and elastic constants, or<br>○ exploring historic studies which established applicable constants, laws and theories.<br>(Link to 7, 8, 9, 10, 11A-B.)<br>• **to investigate electricity and magnetism,**<br>○ comparing, flow, units, and charges in magnetic and electric fields and circuits, or<br>○ measuring electromagnetic conversions and induction, or<br>○ examining applicable historic discoveries, explanations and laws, or<br>○ explaining static electricity, or<br>○ explaining the schematic designs and flow models for electromagnetic devices.<br>(Link to 7, 8, 9, 10, 11A-B.) | **Apply scientific inquiries or technological designs**<br>• **to explore the nature of forces,**<br>○ comparing gravitational, electromagnetic, nuclear strong and weak interactive forces, or<br>○ describing the impact of these forces at all levels.<br>(Link to 11A-B, 13B.)<br>• **to explore the basics of general and special relativity,**<br>○ identifying the basic tenets of Galilean transformations, Newtonian relativity, Einstein's postulates, Hawking's theorems, etc., or<br>○ describing real-world applications to these postulates.<br>(Link to 11A-B, 13B.)<br>• **to explore gravitation in terms of space physics,**<br>○ applying gravitational potential energy and satellites, or<br>○ describing the applications of rocket propulsion.<br>(Link to 11A-B, 13B)<br>• **to explore thermodynamics,**<br>○ explaining the kinetic theory of gases, the ideal gas laws, or<br>○ calculating temperature and pressure variations of gases, specific heat values, and heat capacities of solids and liquids and mechanical equivalents of heat, or<br>○ calculating thermal expansion and transfer capabilities of different substances, or<br>○ explaining entropy in common terms and examples.<br>(Link to 10, 11A-B.) |

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# Science Performance Descriptors

**12E** Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

| Stage E | Stage F | Stage G |
|---|---|---|
| **Apply scientific inquiries or technological designs**<br>• **to analyze global topographic features**<br>  o modeling the effect of glaciation on a surface with applications to Illinois topography, or<br>  o using satellite pictures, various topographic and thematic maps to indicate demographic, economic and weather patterns, and/or their interrelationships to each other.<br>  (Link 9A, 11A-B, 13A-B, 17A.)<br>• **to analyze weather and climatic conditions,**<br>  o comparing historic and current precipitation, barometric, and temperature records, and trends, or<br>  o projecting future trends based on past and correct records, or<br>  o making inferences about cloud formations and weather conditions.<br>  (Link to 10A-B, 11A-B, 13A-B, 15D, 17A.)<br>• **to examine long-term global, national and local renewable and nonrenewable resource supplies,**<br>  o explaining how historic economic choices have affected resource supplies, or<br>  o focusing on comparative historic and projected water supplies and demands such as those for the local community, Illinois, the nation, and/or the world.<br>  (Link to 10A-B, 11A-B, 13A-B, 15A, 16A-B, 16D, 17A-B, 22C.) | **Apply scientific inquiries or technological designs**<br>• **to examine the large-scale dynamic forces, events and processes that affect Earth's land and populations,**<br>  o demonstrating tectonic movements related to earthquakes, tsunamies and volcanoes, or<br>  o researching past, current and projected Earth system phenomena that affect populations.<br>  (Link to 10A-B, 11A-B, 13A-B, 16A, 16E, 17A-B, 17D.)<br>• **to examine the large-scale dynamic forces, events and processes that affect Earth's water/atmospheric systems and populations,**<br>  o researching hurricane paths, global temperature trends, ocean temperatures and their effects on populations, or<br>  o researching past, current and projected Earth system phenomena that affect populations, or<br>  o exploring the concepts associated with the 'greenhouse effect' on Earth.<br>  (Link to 10A-B, 11A-B, 13A-B, 16A, 16E, 17A-B, 17D.)<br>• **to relate various pollution and resource relationships,**<br>  o examining community and national policies for regulating recycling, pollution, and production of resources, or<br>  o evaluating biodegradability of natural and synthetic materials according to composition and risk/benefits.<br>  (Link to 10A-B, 11A-B, 13A-B, 16C, 22C.) | **Apply scientific inquiries and technological designs**<br>• **to investigate large-scale dynamic forces that change geologic features,**<br>  o diagramming single global features over time as affected by continental drift, or<br>  o identifying properties and origins of rocks and minerals, or<br>  o explaining impact of weathering, erosion, and deposition.<br>  (Link to 11A-B, 17.)<br>• **to investigate large-scale meteorological forces.**<br>  o distinguishing weather from climate, or<br>  o examining global weather data over broad periods of time, or<br>  o explaining how atmospheric circulation is driven by solar heating.<br>  (Link to 11A-B, 17.)<br>• **to investigate large-scale oceanographic forces,**<br>  o mapping ocean motions and life zones,<br>  o identifying the quantitative proportions of ocean and fresh water.<br>  (Link to 11A-B, 17.) |

Grade 6 (E-F-G)  Grade 7 (F-G-H)  Grade 8 (G-H-I)  Grade 9-10 (H-I-J)  Grade 11-12 (I-J)

# Science Performance Descriptors

**12E** Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

| Stage H | Stage I | Stage J |
|---|---|---|
| **Apply scientific inquiries and technological designs**<br>• **to investigate the explanations of the geologic features and structures,**<br>○ diagramming the established geologic eras, periods, and epochs, or<br>○ describing the geological events that led to the formation of the Great Lakes and Illinois, or<br>○ relating physical and chemical properties of minerals.<br>(Link to 11A-B, 17.)<br>• **to examine meteorological phenomena,**<br>○ describing large-scale and local weather systems, or<br>○ interpreting weather maps, or<br>○ describing the composition, properties, range of temperatures, and/or pressures in various layers of the atmosphere.<br>○ describing relationships between the sun and the earth's climate, seasons and weather.<br>(Link to 11A-B, 17.)<br>• **to examine Earth's resources quantitatively,**<br>○ demonstrating biodegradation of various substances, or<br>○ explaining specific examples of mining, or<br>○ comparing renewability or availability of earth resources, including freshwater reserves.<br>(Link to 11A-B, 16, 17.) | **Apply scientific inquiries and technological designs**<br>• **to examine Earth's atmosphere and its changes,**<br>○ observing local weather factors over time, or<br>○ comparing current and past climate, or<br>○ analyzing weather conditions in terms of Earth's inclination and solar fluctuations.<br>(Link to 11A-B, 17.)<br>• **to examine Earth's hydrosphere and its changes,**<br>○ documenting impact of large-scale weather systems from short- and long-term weather reports, or<br>○ predicting climatic conditions for geographic settings.<br>(Link to 11A-B, 17.)<br>• **to examine Earth's lithosphere and its changes,**<br>○ using earth rock cycle remnants, soil formation, and tectonic movements, and fossil records, or<br>○ constructing models of tectonic plates and their impact on large-scale structures, or<br>○ constructing local topographic maps.<br>(Link to 11A-B, 17.)<br>• **to examine earth's interior and its changes,**<br>○ explaining the distribution and causes of natural events such as earthquakes and volcanoes, or<br>○ explaining the indirect methods to determine the Earth's inner structure and its effects on the surface features.<br>(Link to 11A-B, 17.)<br>• **to examine the changing perspective of the Earth in space,**<br>○ documenting the changes in public perception of the Earth since the space program began, or<br>○ researching the technologies which have broadened the information known about the earth and its resources.<br>(Link to 11A-B.) | **Apply scientific inquiries and technological designs**<br>• **to analyze meteorological research,**<br>○ defining and quantifying factors which affect local and global weather and climate, or<br>○ relating earth-to-solar interrelationships, or<br>○ applying local or global topographic features to weather and climate.<br>(Link to 11A-B, 17.)<br>• **to analyze geological research,**<br>○ modeling the formation of volcanoes, earthquakes, ocean floor spreading, and tectonic plates with quantitative data, or<br>○ explaining technologies which determine relative and absolute age, or<br>○ documenting effect of natural and human-influenced erosion and deposition that have changed the Earth's surface.<br>(Link to 11A-B, 17.)<br>• **to analyze oceanographic research,**<br>○ describing current ocean research, or<br>○ projecting potential resources from mining the oceans,<br>○ proposing ocean levels from varied data associated with global warming, or<br>○ Quantifying Earth's water budget.<br>(Link to 11A-B, 17.)<br>• **to synthesize the earth sciences,**<br>○ describing the flow of energy in different earth subsystems and their physical and chemical effects on atmosphere, land, and water, or<br>○ explaining theories of the origin and evolution of Earth's oceans, atmosphere and land masses.<br>(Link to 11A-B, 17.) |

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# Science Performance Descriptors

**12F** Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

| Stage E | Stage F | Stage G |
|---|---|---|
| • **Apply scientific inquiries or technological designs to introduce concepts that explain planetary, interplanetary and stellar characteristics and cycles,**<br>○ generalizing the composition and features of the inner and outer planets, asteroids, comets, and different star types, or<br>○ applying orbital concepts for seasonal positions of constellations, or<br>○ applying apparent motions in the sky to use the sky as a clock, compass, or calendar, or<br>○ explaining how the planets change their position in the sky relative to the stars over time using varying astronomic images.<br>(Link to 11A-B, 13A-B.)<br>• **Apply scientific inquiries or technological designs to introduce the concepts of gravitation in the solar system and beyond,**<br>○ identifying the general applications of gravitational forces on Earth and in near and far space examples, or<br>○ explaining continuous free fall in space flight, or<br>○ applying solar system cycles to trajectories in space flight and research.<br>(Link to 11A-B, 13A-B.) | • **Apply scientific inquiries or technological designs to analyze the solar system and planetary characteristics,**<br>○ comparing gravitational, atmospheric, compositional, and energy factors necessary for planetary habitation, or<br>○ describing evidence for presence of water beyond Earth, or<br>○ predicting factors and materials necessary for interplanetary travel and study.<br>(Link to 11A-B, 13A-B.)<br>• **Apply scientific inquiries or technological designs to examine the features of the universe,**<br>○ introducing the calculations associated with the scale of the universe in terms of the speed of light, or<br>○ describing the star groupings according to masses, color, apparent color, distances and brightness, or<br>○ identifying these characteristics about our star and its layers, or<br>○ comparing the capabilities of different kinds of telescopes and imaging technologies.<br>(Link to 6A-B, 10A-B, 11A-B, 13A-B.) | • **Apply scientific inquiries or technological designs to explore the earth in space with its moon,**<br>○ plotting how the relative motions and positions of the sun, earth, and moon influence eclipses, moon phases, and tides, comparing the composition and surface features of the earth and moon, or<br>○ using imaging, magnifications and displays to model the moon's surface features, or<br>○ calculating earth and moon rise and set over time.<br>(Link to 11A-B.)<br>• **Apply scientific designs to explore the solar system,**<br>○ comparing the major features of the solar system including the nine planets, their moons, orbital shapes, surface and atmospheric conditions, orientation and periods of rotation and revolution, or<br>○ charting orbital factors of comets, asteroids, meteors, etc., or<br>○ explaining imaging displays of different kinds of solar system objects.<br>(Link to 11A-B.)<br>• **Apply scientific inquiries or technological designs to study the galaxies,**<br>○ describing the relationship of galactic components (e.g., age, composition, properties), or<br>○ explaining imaging displays of views of galactic objects.<br>(Link to 11A-B.)<br>• **Apply scientific inquiries or technological designs to study space exploration,**<br>○ creating a timeline which denotes the important events associated with the global space programs, or<br>○ identifying the kinds of technologies which are currently used for studying the solar system and universe, or<br>○ reporting on applicable historic studies which have provided discoveries, tools or explanations associated with space exploration.<br>(Link to 11A-B, 13A-B.) |

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# Science Performance Descriptors

**12F** Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

| Stage H | Stage I | Stage J |
|---|---|---|
| • **Apply scientific inquiries or technological design to compare the view of Earth as a planet,**<br>○ studying prehistoric and historic views of the universe, or<br>○ explaining the absorption, reflection and transfer of the Sun's energy over land, water surfaces and features.<br>(Link to 11A-B, 16.)<br>• **Apply scientific inquiries or technological designs to compare the view from Earth to the solar system,**<br>○ relating gravitational force between planetary bodies in the solar system, or<br>○ introducing theories of origin of the solar system components, or<br>○ explaining photographic or historic records and mathematical calculations of comets and their orbits.<br>(Link to 11A-B.)<br>• **Apply scientific inquiries or technological designs to compare the view from Earth to the galaxies,**<br>○ calculating exponential scale of distances within and beyond the Milky Way galaxy, or<br>○ explaining the possible distortions of these views from Earth's surface, or<br>○ classifying galaxies, etc. by size, composition, distances, established shapes, etc.<br>(Link to 6, 7, 8, 9, 10, 11A-B.)<br>• **Apply scientific inquiries or technological designs to compare the history of astronomy through the ages,**<br>○ modeling major constellations, or<br>○ explaining the roles that constellations played in the multi-cultural development of navigation and agriculture, or<br>○ explaining theories, past and present, for the origin and evolution of the universe, or<br>○ comparing astrological beliefs to astronomical laws and theories.<br>(Link to 11A-B, 16.) | • **Apply scientific inquiries or technological designs to examine Earth's place in the solar system,**<br>○ calculating distances between planetary bodies, orbital paths, trajectories and collision potential with asteroids, etc., or<br>○ explaining lunar and solar eclipses, or<br>○ graphing meteor impact craters to geologic time periods and mass extinctions.<br>(Link to 6B, 7, 8, 9D, 10A-C, 11A-B, 13A-B.)<br>• **Apply scientific inquiries or technological designs to examine the Sun's place in the solar system,**<br>○ explaining the energy of the sun in relation to the full electromagnetic spectrum, or<br>○ correlating sunspot activity and cycles to earth events and phenomena, or<br>○ describing the solar atmosphere, inner layers, nuclear reactions, and temperatures.<br>(Link to 11A-B, 12C, 13A-B.)<br>• **Apply scientific inquiries or technological designs to examine the solar system's place in the universe,**<br>○ analyzing the life cycles of stars of different masses, or<br>○ explaining the flow of energy within stars to the formation of the chemical elements, or<br>○ relating nebulae, dust clouds, stars, pulsars, black holes, etc.<br>(Link to 6, 7, 8, 9, 10, 11A-B.)<br>• **Apply scientific inquiries or technological designs to examine the similarities found throughout the universe,**<br>○ comparing bright line spectra of different elements in different stars, or<br>○ using proportional relationships of reference stars to estimate magnitude of unknown stars, or<br>○ demonstrating models of the expanding universe concepts.<br>(Link to 6, 8, 9, 10, 11A-B, 13A-B.) | • **Apply scientific inquiries or technological designs to investigate historical studies of the universe**,<br>○ comparing schematics, optics, development and capabilities of telescopes and spectroscopes, or<br>○ examining data collections of Copernicus, Brahe, Kepler, Newton, Galileo, etc. as the basis for their discoveries or theories and current research.<br>(Link to 11A-B, 13B, 16.)<br>• **Apply scientific inquiries or technological designs to investigate current and proposed research studies of the universe,**<br>○ comparing schematics, optics, development and capabilities of spectrophotometric technologies, or<br>○ explaining the Doppler effect in terms of red and blue shifts, or<br>○ reporting on the newest discoveries from the Hubble Space Telescope, ground-based or satellite counterparts, etc.<br>○ exploring the mathematical calculations and evidence associated with the Big Bang Theory, or<br>(Link to 11A-B, 13B.)<br>• **Apply scientific inquiries or technological designs to investigate the energetic reactions of stars,**<br>○ explaining the fusion process and its associated nuclear and mathematical calculations, or<br>○ predicting the gravitational collapse of stars of different masses, or<br>○ evaluating the supporting evidence for the size, age and expansion of the universe, or<br>(Link to 6B, 10, 11A-B, 13B.)<br>• **Apply scientific inquiries or technological designs to explore exobiological possibilities,**<br>○ comparing different elemental life forms on earth, or<br>○ researching evidence associated with existence of past life on solar system bodies.<br>(Link to 11A-B, 13A-B.) |

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# Science Performance Descriptors

## 13A

Students who meet the standard know and apply accepted practices of science.

| Stage E | Stage F | Stage G |
|---|---|---|
| • **Apply appropriate principles of safety,**<br>○ wearing appropriate safety gear during inquiry or design investigations, or<br>○ demonstrating how to use a fire extinguisher, or<br>○ identifying safety procedures for preparation, process and conclusion of science investigations to minimize safety hazards, or<br>○ recognizing potential poisonous plants or substances in classroom, outdoor or home settings, or<br>○ role-playing safe reactions to safety crisis situations.<br>(Link to 11A-B, 12A-F, 22A.)<br>• **Apply scientific habits of mind,**<br>○ explaining why similar investigations should, but may not, produce similar results, or<br>○ identifying circumstances which distort how variables interact, or<br>○ labeling accurate observations fully and carefully, or<br>○ generating questions and strategies to test science concepts using critical and creative thinking.<br>(Link to 11A-B, 12A-F, 13B.) | • **Apply appropriate principles of safety,**<br>○ outlining safety precautions, clean-up and disposal procedures, as well as specimen care and handling for inquiry or design investigations, or<br>○ role-playing responses for individual or group reactions in threatening weather, hazardous chemical contamination, or other unsafe situations, or<br>○ conducting safety tests or surveys about potential safety hazards in the classroom, school building, or home.<br>(Link to 10F, 11A-B, 12A-F, 22A.)<br>• **Apply scientific habits of mind,**<br>○ generating questions and strategies to test science concepts using critical and creative thinking, or<br>○ researching historic examples of valid and faulty hypothesis generation and investigations, or<br>○ contrasting the scientific methods of observational and experimental investigations, or<br>○ proposing how and why more than one possible conclusion should be considered and can be drawn from scientific investigations.<br>(Link to 11A-B, 12A-F, 13B.)<br>• **Analyze cases of scientific studies,**<br>○ studying historic examples of valid inquiry investigations associated with the life, environmental, physical, earth and space sciences,<br>○ contrasting faulty studies with deviations from established scientific methods,<br>○ contrasting the scientific methods between observational, remote and experimental investigations, or<br>○ suggesting how societal influences have affected scientific inquiry positively and negatively.<br>(Link to 11A-B, 12A-F, 13B.) | • **Apply appropriate principles of safety,**<br>○ identifying potentially hazardous chemical combinations in the home or classroom, or<br>○ suggesting responses and reactions in home and classroom settings in case of threatening chemical scenarios, or<br>○ following all necessary safety precautions, cleaning and disposal procedures for scientific investigations, or<br>○ demonstrating safe transport, precise use, and appropriate storage for scientific equipment, or<br>○ providing safe and ethical care for all classroom organism collections.<br>(Link to 11A-B, 12A-F.)<br>• **Apply scientific habits of mind,**<br>○ generating questions and strategies to test science concepts using critical and creative thinking, or<br>○ identifying instances of how scientific reasoning, insight, skill, creativity, intellectual honesty, tolerance of ambiguity, skepticism, persistence, and openness to new ideas have been integral to scientific discoveries and technological improvements, or<br>○ comparing scientist's work and habits of mind to work in other careers.<br>(Link to 11A-B, 12A-F, 13B, 16.)<br>• **Analyze cases of scientific studies,**<br>○ studying historic examples of valid investigations from curricular life, environmental, physical, earth, and space sciences, or<br>○ finding examples of faulty or biased scientific reasoning which distorted scientific understanding, or<br>○ citing experimental and observational strategies in direct, indirect, and remote investigations.<br>(Link to 11B, 12A-F, 16.) |

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# Science Performance Descriptors

**13A** Students who meet the standard know and apply accepted practices of science.

| Stage H | Stage I | Stage J |
|---|---|---|
| • **Apply appropriate principles of safety within and beyond the science classroom,**<br>○ communicating and following clear instructions, or<br>○ mapping classrooms for safe egress and distances/times to access safety treatment features, or<br>○ demonstrating safety practices and emergency procedures pertaining to laboratory and field work, or<br>○ explaining the basis of safety practices and procedures.<br>(Link to 11A-B, 12A-F)<br>• **Apply scientific habits of mind to curricular investigations in life, environmental, physical, earth, and space sciences,**<br>○ evaluating evidence, or<br>○ inferring statements based on data, or<br>○ questioning sources of information, or<br>○ explaining necessity of manipulating only one variable at a time, or<br>○ retrieving mathematical data accurately for scientific analysis.<br>(Link to 10B, 11A-B, 12A-F.)<br>• **Analyze scientific studies referenced in curricular investigations in life, environmental, physical, earth, and space sciences,**<br>○ reviewing experimental procedures or explanations for possible faulty reasoning or unproven statements (e.g., power line magnetic fields, abiogenesis models), or<br>○ distinguishing relationships of scientific theories, models, hypotheses, experiments, and methodologies, or<br>○ distinguishing fact from opinion and science from pseudoscience.<br>(Link to 11A-B, 12A-F.) | • **Apply appropriate principles of safety,**<br>○ following established procedures to maintain both personal & environmental safety when handling & disposing of chemicals, or<br>○ estimating risks/benefits to alternative procedures, or<br>○ mapping classroom laboratory facilities for safe egress & distances/times to access safety treatment features, or<br>○ manipulating, reading and troubleshooting scientific equipment safely, or<br>○ communicating school science storage and disposal policies for classroom investigations, or<br>○ demonstrating safety practices and emergency procedures pertaining to laboratory and field work, or<br>○ researching community disposal procedures (e.g., mercury thermometers or lead batteries), or<br>○ participating in household waste and hazardous waste pickup programs in Illinois.<br>(Link to 11A-B, 12A-F, 13B.)<br>• **Apply scientific habits of mind to curricular investigations in life, environmental, physical, earth, and space sciences,**<br>○ identifying instances of how scientific reasoning, insight, creativity, skill, intellectual honesty, tolerance of ambiguity, skepticism, persistence, openness to new ideas, and sheer luck have been integral to discoveries, or<br>○ identifying specific studies which demonstrate how scientific conclusions are open to modification as new data are collected, or<br>○ researching classroom and real-world standards for peer review.<br>(Link to 10B, 11A-B, 12A-F, 13B.) | • **Apply appropriate principles of safety in pure and applied research studies,**<br>○ examining animal care precautions for adherence to safety standards, or<br>○ referencing applicable chemical storage, handling, and disposal procedure regulations, or<br>○ researching procedures and policies to eliminate or reduce risk in potentially hazardous activities, or<br>○ citing federal or state agency requirements for employees for safety regulations in science research settings.<br>(Link to 11A-B, 12A-F, 13B.)<br>• **Apply scientific habits of mind to current pure and applied research studies in life, environmental, physical, earth, and space sciences,**<br>○ interviewing scientists about how they address validity of scientific claims and theories and/or their understanding of scientific habits of mind (including sheer luck) and how they have been integral to their own research, or<br>○ recognizing limitations of investigation methods, sample sets, technologies, or procedures, or<br>○ questioning sources of information and representation of data, or<br>○ recognizing selective or distorted use of data, discrepancies and poor argument, or<br>○ distinguishing opinion from supported theory, or<br>○ tracing citations from research studies for validity and reliability, or<br>○ reporting on peer review and juried panel review in research approval and scientific community acceptance.<br>(Link to 11A-B, 12A-F, 13B.) |

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# Science Performance Descriptors

**13B** Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

| Stage E | Stage F | Stage G |
|---|---|---|
| • **Apply scientific technologies,**<br>○ collecting, storing, retrieving, and communicating data in classroom research and investigations, or<br>○ researching the progression of technological advances in pure and applied scientific investigations and innovations.<br>(Link to 8, 10, 11A-B, 12A-F, 13A.)<br>• **Investigate the interactions of technology in science and societal situations,**<br>○ displaying graphically the improvements and their impact in local and global agriculture, transportation, health, sanitation, engineering, and manufacturing settings over time, or<br>○ explaining different perceptions about discoveries, innovations, and trends in places, events, and regions.<br>(Link to 8, 10, 11A-B, 12A-F, 13A, 15, 16, 17.)<br>• **Investigate the interactions of societal decisions in science and technology innovations and discoveries,**<br>○ exploring the family, local, national, or global impact of them, or<br>○ examining conceptual, mathematical, and policy implications of energy conservation programs for classrooms, schools, homes, and communities, or<br>○ describing the changes in tools, careers, resource use, and productivity over the centuries.<br>(Link to 12A-F, 13A, 15, 16, 17.) | • **Apply scientific technologies,**<br>○ incorporating technology and probe ware into classroom research, investigations, and contextual studies, or<br>○ projecting possible technological advances in the near and long-term future.<br>(Link to 11A-B, 12A-F, 13A.)<br>• **Research the interactions of technology in science and societal situations,**<br>○ explaining ways that ecosystems have been changed as results of technological innovations, or<br>○ inferring technological impact in published medical, economic, and population statistics (e.g., birth/death rates, disease transmission), or<br>○ explaining how changes in transportation, communication, production, and other technologies affect the location of economic activities.<br>(Link to 11A-B, 12A-F, 13A.)<br>• **Analyze the societal interactions resulting from scientific discoveries and technological innovations,**<br>○ researching the scientific milestones that have revolutionized thinking over time, or<br>○ grouping technological innovations to historic time periods and changes in communities and countries, or<br>○ comparing public perceptions about the costs and impact of pure science research and applied science solutions.<br>(Link to 11A-B, 12A-F, 13A.) | • **Explore scientific technologies in life, environmental, physical, earth, and space sciences,**<br>○ identifying advances in the past century, or<br>○ describing technologies used by scientists to forecast, explain, or test major events in each of the sciences, or<br>○ diagramming processes and products from applicable technologies.<br>(Link to 11A-B, 12A-F, 16, 22B.)<br>• **Explore the interactions of science and technology in multicultural, societal, and economic settings,**<br>○ analyzing how the introduction of a new technology has affected human activities worldwide, or<br>○ associating personal biographic information about science leaders from around the world.<br>(Link to 11A-B, 12A-F, 16, 22B.)<br>• **Explore historic, multicultural societal influences on scientific discoveries and technological innovations,**<br>○ comparing the knowledge, skills, and methods of early and modern scientists in the sciences, or<br>○ finding examples of rejection of scientific or technological advances by cultures based on belief systems.<br>(Link to 11A-B, 12A-F, 16, 18B, 22B.)<br>• **Explore scientific concepts in career and technical knowledge and skills in everyday settings,**<br>○ interviewing adults to identify specific applications of scientific concepts or technological innovations, or<br>○ researching job market trends for anticipated changes in the next ten-year period based on projected technology interventions, resource depletion or access, or economic interactions, or<br>○ demonstrating relationships between improving technology, all science fields, and educational/training requirements for such careers.<br>(Link to 11A-B, 12A-F, 16, 17, 22B.) |

Grade 6 (E-F-G) Grade 7 (F-G-H) Grade 8 (G-H-I) Grade 9-10 (H-I-J) Grade 11-12 (I-J)

# Science Performance Descriptors

**13B** Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

| Stage H | Stage I | Stage J |
|---|---|---|
| • **Explore interaction of resource acquisition, technological development, and ecosystem impact**,<br>○ documenting actual local, regional, national, or global examples, or<br>○ proposing alternative solutions to interaction impact, or<br>○ estimating costs of such interactions.<br>(Link to 10, 11A-B, 12A-F, 16, 17, 22B.)<br>• **Explore natural resource conservation and management programs,**<br>○ calculating home/school electric or water usage, etc., to propose plans for increased efficiency, or<br>○ evaluating their effect on natural resources and the local economy, or<br>○ researching the past, current, and future local landfill plans, or<br>○ examining state wildlife programs for controlled breeding or population maintenance.<br>(Link to 6B-C, 11A-B, 12A-F, 16, 17, 22B.)<br>• **Explore policies which affect local science or technology issues,**<br>○ researching applicable issue of local concern (e.g., subdivision development, groundwater contamination), or<br>○ developing classroom criteria to measure effectiveness of policies, or<br>○ developing survey instruments to assess depths of informed opinions on issues, or<br>○ collecting pertinent data from expert local sources, or<br>○ analyzing data and policy correlation.<br>(Link to 10A, 11A-B, 12A-F, 16, 17, 22B.) | • **Analyze the pure and applied research nature of science,**<br>○ evaluating public perceptions of value of scientific research, or<br>○ assessing short- and long-term risks/benefits of specific pure research which directly led, or may lead, to direct applications.<br>(Link to 11A-B, 12A-F, 16, 17, 22B.)<br>• **Analyze career and occupational decisions that are affected by a knowledge of science,**<br>○ associating scientific concepts considered in career-specific decisions (e.g., use of pesticides by farmers, choosing ink for printing), or<br>○ explaining chemical/physical interactions in occupational settings (e.g., insect abatement programs, waste water treatment).<br>(Link to 11A-B, 12A-F, 16, 17, 22B.)<br>• **Analyze how resource management and technologies accommodate population trends,**<br>○ explaining factors needed to sustain and enhance the quality of Earth's water, or<br>○ quantifying benefits, costs, limitations and consequences involved in using scientific technologies or resources, or<br>○ assessing global consequences of ecosystem modifications (Link to 11A-B, 12A-F, 16, 17, 22B.)<br>• **Analyze claims used in advertising and marketing strategies for scientific validity,**<br>○ collecting statements of purported scientific studies to evaluate mathematical validity, or<br>○ researching scientific foundations use (or manipulation) in marketing and advertising strategies for target populations.<br>(Link to 10B, 11A-B, 12A-F, 16, 17, 18, 22B.) | • **Analyze challenges created by international cooperation and competition in scientific knowledge and technological advances,**<br>○ explaining multinational corporations' challenges or impact for resource acquisition, or<br>○ researching the cooperative efforts and dilemmas associated with global partnerships<br>(Link to 10B, 11A-B, 12A-F, 16, 17, 18, 22B.)<br>• **Analyze scientific breakthroughs in terms of societal and technological effects,**<br>○ citing how beliefs and attitudes influence advances, or<br>○ examining global distribution of energy, natural or fiscal resources, or<br>○ evaluating how scientific advances from different cultures are received.<br>(Link to 10B, 11A-B, 12A-F, 16, 17, 18, 22B.)<br>• **Analyze environmental impact studies,**<br>○ describing the design and procedures, or<br>○ synthesizing the findings and justifying the recommendations, or<br>○ comparing methods for minimizing pollution or procedures for monitoring environmental quality.<br>(Link to 11A-B, 12A-F, 16, 17, 18, 22B.)<br>• **Analyze local, state, national, global scientific policies in terms of costs, benefits, and effects,**<br>○ identifying policies which have affected local needs, costs, or products, or<br>○ assessing national or global costs of policies from American or non-American perspectives, or<br>○ evaluating data used in media explanations of resource, technology, or policy impact.<br>(Link to 10B, 11A-B, 12A-F, 16, 17, 18, 22B.)<br>• **Analyze how scientific and technological progress have affected job markets and everyday life,**<br>○ investigating projected trends over 2-3 decades, or<br>○ assessing costs for technological progress on personal, governmental, economic and ecosystem impact in the sciences.<br>(Link to 10B, 11A-B, 12A-F, 16, 17, 18, 22B.) |

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# RELATIONSHIP OF PERFORMANCE DESCRIPTORS TO NATIONAL AND STATE STANDARDS

The Illinois Science Performance Descriptors were compared to: The state science standards of Arizona, California, Delaware, Indiana, Massachusetts, North Carolina, New Jersey, Rhode Island, and Texas; The National Science Education Benchmarks; and the American Association for the Advancement of Science Benchmarks.

## Comparison of Illinois Science Performance Descriptors to Nine Other States

The academic rigor of the Illinois performance descriptors is commensurate with the rigor of those states receiving an "A" score from the Fordham report. There exists a distinction between academic rigor and detail specificity of performance standards. That is, those states having substantially more detailed performance descriptors (e.g., NJ, RI, and TX) were not any more or less academically rigorous than our Illinois performance descriptors. Primary variability was observed in the level of detail and content specificity rather than in the levels of academic rigor of specific performance indicators. The overall conclusion is that the Illinois performance descriptors are comparable in a very favorable way to those descriptors of the states receiving "A" scores from the Fordham report and the AFT reviews.

## Illinois State Science Standards as Compared to National Science Education Benchmarks and AAAS Benchmarks

State standards at the elementary level seem to be more comprehensive and detailed in their description of concepts and content. For example, state Standard 12F (early elementary) is quite a bit more detailed than NSES Content Standard D. This holds true for several of the state standards at the early and late elementary levels. State Goal 13B is more comprehensive and does not have a true match to a NSES Standard, however the concept of the goal is matched. At the middle school level all three of the standards align well with each other. Again, it can be said that the Illinois State Standards are more detailed, and the National and AAAS standards are more general. With regards to the Early High School and Late High School standards, they are very comparable to the NSES and AAAS standards with a few exceptions. State standard 12 does not seem to be as detailed as the National standards. (All goals are met with regards to their specific concepts.)

It would appear that the Illinois State performance descriptors align with the National Science Education Standards, and in fact, these parallel each other rather well. The Illinois State Standards on the other hand, seem to be more rigorous, and even include more definitive content than the AAAS Benchmarks. There does not seem to be any omission of basic skills or educational content areas in the Illinois Standards.

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