

Scientific Minds Want to Know: Addressing the High Impact Indicators of the GED® Science Test

Tools for the Classroom



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TOOLS FOR THE CLASSROOM

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Science High Impact Indicators

Indicator	What to look for in student work: Students' work shows they have . . .
SP.2.b: Identify and refine hypotheses for scientific investigations.	<ul style="list-style-type: none"> • identified a hypothesis for a given scientific investigation. • differentiated between an appropriate hypothesis and a poorly conceived hypothesis. • used a hypothesis to support or challenge a given conclusion. • identified a hypothesis for a given data set. • refined a hypothesis to more appropriately suit a scientific experiment.
SP.2.e: Identify and interpret independent and dependent variables in scientific investigations.	<ul style="list-style-type: none"> • identified the independent variable in a given investigation. • identified the dependent variable in a given investigation. • fully explained the relationship between the independent and dependent variables in a given experiment.
SP.4.a: Evaluate whether a conclusion or theory is supported or challenged by particular data or evidence.	<ul style="list-style-type: none"> • identified and explained why the evidence supports the proposed claim or solution. • identified and explained which piece of data supports or contradicts the given hypothesis. • identified multiple reasons a piece of evidence supports a theory or hypothesis and compare those reasons to each other. • identified which scientific model would be weakened or strengthen by particular evidence. • fully explained why given evidence supports a scientific theory. • fully explained why given evidence challenges a scientific theory.
SP.6.a: Express scientific information or findings visually.	<ul style="list-style-type: none"> • translated information presented verbally or numerically into a visual format • integrated information presented verbally and numerically into a visual format • identified relationships among graphs or diagrams • identified visual representations of scientific processes explained in a given text • completed diagrams to demonstrate understanding of relationships among variables, scientific concepts, or processes
SP.7: Apply formulas from scientific theories.	<ul style="list-style-type: none"> • solved for a variable within a scientific equation • balanced an equation. • identified what changes will result if a variable within a scientific equation increases or decreases. • identified relationships between variables in a scientific formula. • interpreted symbolic representations of information and scientific data.

Science Themes

		Science Content Topics		
		Life Science (40%)	Physical Science (40%)	Earth & Space Science (20%)
Focusing Themes	Human Health and Living Systems	<ul style="list-style-type: none"> • Human body and health • Organization of life • Molecular basis for heredity • Evolution 	<ul style="list-style-type: none"> • Chemical properties and reactions related to human systems 	<ul style="list-style-type: none"> • Interactions between Earth's systems and living things
	Energy and Related Systems	<ul style="list-style-type: none"> • Relationships between life functions and energy intake • Energy flows in ecologic networks (ecosystems) 	<ul style="list-style-type: none"> • Conservation, transformation, and flow of energy • Work, motion, and forces 	<ul style="list-style-type: none"> • Earth and its system components • Structure and organization of the cosmos

Science Lesson Planning Strategies – The 5 Es

The 5E Instructional Model provides a format for lessons that builds on what students already know. The 5Es sequence the learning experience so that the learners construct their understanding of a concept across time. Each phase of the learning sequence can be described using five words that begin with "E": *engage, explore, explain, extend, and evaluate*.

Engage

Begin each unit or topic with a lesson or activity that engages students with an activity or question as they are introduced to the concept. Students should make connections to prior knowledge and what is to be studied. During this phase, teachers ask questions of students and engage them in the guided inquiry lessons. They use strategies such as KWL or ABC Brainstorm that make connections between the past and present learning experience.

Explore

Have students carry out hands-on activities in which they explore the concept or skill. This phase allows students to acquire a common set of experiences that they can use to help each other make sense of the new concept or skill. Teachers should set up the investigation and guide students in inquiry, asking probing questions to clarify understanding.

Explain

After students have explored the concept or skill, the teacher provides the concepts and terms used by the students to develop explanations for the phenomenon they have experienced. The significant aspect of this phase is that explanation follows experience. Teachers should ask probing questions that encourage students to look for additional information.

Elaborate (extend)

Students expand their learning, practice skills and behavior, and make connections or applications to related concepts and in the world around them. Teachers provide learning opportunities for students to apply their knowledge and to gain a deeper understanding. Activities can include reading articles and books, writing, designing other experiments, and exploring related topics on the Internet. Provide opportunities for students to apply what they have learned to new situations. It is important for students to discuss and compare their ideas with each other during this phase.

Evaluate

The final phase provides an opportunity for students to review and reflect on their own learning and new understandings and skills. This is the phase where students provide evidence for changes to their understandings, beliefs, and skills. Teachers should assess students understanding through both formative and summative activities.

An Overview of the 5 Es

An Overview of the 5Es		
Phase	Purpose	Role of Teacher
Engage	Create interest and stimulate curiosity. Set learning within a meaningful context. Raise questions for inquiry. Reveal students' ideas and beliefs, compare students' ideas.	Activity or multi-modal text used to set context and establish topicality and relevance. Motivating/discrepant experience to create interest and raise questions. Open questions, individual student writing, drawing, acting out understandings, and discussion to reveal students' existing ideas and beliefs so that teachers are aware of current conceptions and can plan to extend and challenge as appropriate – a form of diagnostic assessment.
Explore	Provide experience of the phenomenon or concept. Explore and inquire into students' questions and test their ideas. Investigate and solve problems.	Open investigations to experience the phenomenon, collect evidence through observation and measurement, test ideas and try to answer questions. Investigation of text-based materials (e.g. newspaper articles, web-based articles) with consideration given to aspects of critical literacy, including making judgments about the reliability of the sources or the scientific claims made in the texts.
Explain	Introduce conceptual tools that can be used to interpret the evidence and construct explanations of the phenomenon. Construct multi-modal explanations and justify claims in terms of the evidence gathered. Compare explanations generated by different students/groups.	Student reading or teacher explanation to access concepts and terms that will be useful in interpreting evidence and explaining the phenomenon. Small group discussion to generate explanations, compare ideas and relate evidence to explanations. Individual writing, drawing and mapping to clarify ideas and explanations. Formative assessment to provide feedback to teacher and students about development of investigation skills and conceptual understandings. Small group writing/design to generate a communication product (e.g. poster, oral report, formal written report or PowerPoint presentation, cartoon strip, drama presentation, letter) with attention to form of argumentation, genre form/function and audience, and with integration of different modes for representing science ideas and findings.
Elaborate (extend)	Use and apply concepts and explanations in new contexts to test their	Further investigations, exercises, problems or design tasks to provide an opportunity to apply, clarify, extend and consolidate new

	<p>general applicability. Reconstruct and extend explanations and understandings using and integrating different modes, such as written language, diagrammatic and graphic modes, and mathematics.</p>	<p>conceptual understandings and skills. Further reading, individual and group writing may be used to introduce additional concepts and clarify meanings through writing. A communication product may be produced to re-represent ideas using and integrating diverse representational modes and genres consolidating and extending science understandings and literacy practices.</p>
Evaluate	<p>Provide an opportunity for students to review and reflect on their own learning and new understandings and skills.</p> <p>Provide evidence for changes to students' understandings, beliefs and skills.</p>	<p>Discussion of open questions or writing and diagrammatic responses to open questions – may use same/similar questions to those used in Engage phase to generate additional evidence of the extent to which the learning outcomes have been achieved.</p> <p>Reflections on changes to explanations generated in Engage and Evaluation phases to help students be more metacognitively aware of their learning.</p>

Planning with the 5 Es

Topic: _____

Engage (introduce with excitement)	
Explore (meaning of the concept)	
Explain (how the concept applies, an investigation)	
Elaborate (on the meaning or application of concept)	
Evaluate (student's level of understanding)	

Scientific Inquiry – Which Falls Fastest?

Effects of Air Resistance	
Paper Type	Time
Flat paper	
Loosely crumpled paper	
Tightly crumpled paper	
Your paper design	

Scientific Inquiry – Which Falls Fastest?

Which shape of paper falls fastest: An unfolded sheet of paper, a loosely crumpled piece of paper, or a tightly crumpled piece of paper? Or can you create a different shape with paper that falls even faster?

Make Your Plan:

What is your independent (manipulated variable)?	
What is your dependent (responding) variable	
What is your question?	
What is your hypothesis?	If, then . . .
What are the constants? (name at least 3)	

Data:

Identify your dependent and independent variables for each trial.

- Independent variables are the variables that are changed in a given model or equation. One can also think of them as the 'input' which is then modified by the model to change the 'output' or dependent variable.
- Dependent variables are considered to be functions of the independent variables, changing only as the independent variable changes.

Dependent Variable _____

Independent Variables _____

Effects of Air Resistance	
Paper Type	Time
Flat paper	
Loosely crumpled paper	
Tightly crumpled paper	
Your paper design	

Conclusion:

Based on the data from my experiment, I reject or accept the hypothesis that

(Restate your hypothesis WORD FOR WORD)

The evidence to support this is that

Sample Questions for Guiding Scientific Thinking

Question Type	Sample Question Starters
Recalling	Who, what, when, where, how ____?
Comparing	How is _____ similar to/different from _____?
Identifying Attributes and Components	What are the characteristics/parts of _____?
Classifying	How might we organize _____ into categories?
Ordering	Arrange _____ into sequence according to _____.
Identifying Relationships and Patterns	Develop an outline/diagram/web of _____.
Representing	In what other ways might we show/illustrate _____?
Identifying Main Ideas	What is the key concept/issue in _____? Retell the main idea of _____ in your own words.
Identifying Errors	What is wrong with _____?
Inferring	What might we infer from _____? What conclusions might be drawn from _____?
Predicting	What might happen if _____?
Elaborating	What ideas/details can you add to _____? Give an example of _____. Summarizing Can you summarize _____?
Establishing Criteria	What criteria would you use to judge/evaluate _____?
Verifying	What evidence supports _____? How might we prove/confirm _____?

Science Excerpt, Prompt, and Samples

A farmer purchased 30 acres of farmland. The farmer calculated that the average topsoil thickness on the farmland is about 20 centimeters.

The farmer wants to maintain the thickness of the soil on this farmland by reducing erosion. The farmer plans to test the effectiveness of two different farming methods for reducing soil erosion.

Method 1: No-till (planting crops without plowing the soil)

Method 2: Winter cover crop (growing plants during the winter that are plowed into the soil in spring)

The farmer hypothesizes that using either method will reduce erosion compared to using traditional farming methods (plowing and no cover crop).

Design a controlled experiment that the farmer can use to test this hypothesis. Include descriptions of data collection and how the farmer will determine whether his hypothesis is correct.

Type your response in the box. This task may require approximately 10 minutes to complete.

Sample Anchor Papers for Science Short Answer

Sample Paper 1

The farmer would have to set up 3 experiments. The first would be a years worth of traditional farming methods (plowing and no cover crop) on a 5 x 5 acres of land. He would have to measure the top soil in every month throughout the year and record it in a data table. For the second experiment the farmer would have to farm a plot of land 5 x 5 acres of land with winter cover crop and measure the soil every month and record it in a lab table. At the end of the year the farmer would have to compare the 2 methods against the traditional method and determine if he is correct.

Sample Paper 2

The farmer could separate the land into two sections (15 acres each), and use one method on each section over a two season period. Over the two season period he would record how much soil was left after using each method, comparing the results to each other and the traditional farming method.

Sample Paper 3

To test his hypothesis the farmer should divide his land into three equal parts one for the first method, one for the second method and one for the control group. In the first part he divided he should test method one and keep a record of the process and the results. In the second part he divided he should test the second method and keep a record of the process and the results. In the third part that he divided he should have the control group where he would use the traditional method keep a record of the process and the results, then compare the records he has collected identify the different results, make an analysis and decide which method is the best way to prevent soil erosion.

Science Resources from the World Wide Web

ABC Science. News, video clips, games, and lots of activities for the science classroom from the American Broadcasting Company.

<http://www.abc.net.au/science/>

Annenberg: The Habitable Planet. The Habitable Planet is a multimedia course for learners interested in studying environmental science.

<http://www.learner.org/channel/courses/envsci/index.html>

Annenberg Science in Focus: Force and Motion. Explore science concepts in force and motion. Learn more about gravity, friction, air resistance, magnetism, and tension through activities, discussions, and demonstrations.

<http://www.learner.org/channel/workshops/force/>

BBC Science. From space to the human body to, this interactive site allows learners to discover many different facets of science. <http://www.bbc.co.uk/sn/>

Cells Alive. This site can be used by teachers and students. Lots of great interactivity and resources on the basics of cells. <http://www.cellsalive.com/toc.htm>

Discovery Channel. The website has lots more information than even the channel. Lots of interactivity with excellent videos, interactivity, and high-level games. <http://www.discovery.com/>

Exploratorium Online. The Exploratorium was one of the first science museums to build an Internet site. See over 15,000 articles and displays including interactivity regarding science. <http://www.exploratorium.edu/>

Franklin Institute. Excellent collection of online resources and activities designed to create curiosity and promote science in everyday life.

<http://www.fi.edu/explore.html>

How Stuff Works. Ever wondered why a cd works? How about the ten myths about the brain? An interesting science site filled with real-world information. <http://www.howstuffworks.com/>

Interactive Websites for Teaching Science. Just click on one of the topics and explore the myriad of resources on the World Wide Web.
<http://interactivesites.weebly.com/science.html>

Live Science. Articles from the headlines in all of the various areas of science. Great non-fiction materials. <http://www.livescience.com/>

National Science Teachers Association. Don't forget the professional organization for science teachers. This site has lots of ideas, lessons, and scientific updates. <http://www.nsta.org/>

NEWSELA. This website is an innovative way to build reading comprehension with nonfiction through daily news articles. <https://newsela.com/>

Newton's Apple. NEWTON'S APPLE is a production of Twin Cities Public Television from a grant from the 3M Foundation. The site is filled with free videos for use in many different areas. <http://www.newtonapple.tv/>

Nye Labs.com This is indeed "Bill Nye, the science guy" with lots of activities and applications for science. <http://www.billinye.com>

PBS: Science & Nature. Highlights and background information on every Science-based PBS program on the air; check out the Science for the Classroom link. <http://www.pbs.org/science/>

Steve Spangler. This site has lots of free experiments and videos for use in the classroom. <http://www.stevespanglerscience.com/lab>

Teachers Try Science. This site provides free and engaging **lessons**, along with **teaching strategies and resources**. <http://www.tryscience.org/>

TED-Ed. Provides numerous videos that have been developed by instructors. You can build a lesson around any TED-Ed Original, TED Talk or YouTube video. <http://ed.ted.com/lessons>

The Physics. An online, free to use physics website developed primarily for beginning physics students and their teachers. <http://www.physicsclassroom.com/>

The Why Files. University of Wisconsin, Board of Regents. Real world articles to support all areas of science. Click on the "Why Files in Education." <http://whyfiles.org/teach/>

Understanding Science. The Understanding Science website is a fun, free resource. It provides "an inside look at the general principles, methods, and motivations that underlie all of science." <http://undsci.berkeley.edu/>

Weather Classroom. The Weather Classroom presents all kinds of online interactive resources for students and teachers; worth investigating. <http://www.weatherclassroom.com/index.php>

Don't Forget!

- **Florida IPDAE** – <http://floridaipdae.org/>
- **GED Testing Service[®]** – www.GEDtestingservice.com

