

## Measuring Success: Assessing Student Learning

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T. Johnson, Erie 1 BOCES, WNYRIC  
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## Assessment Purposes

- Teachers
  - Measure knowledge
  - Measure gain in knowledge
  - Sorting (Grading)
- Students/Parents
  - Measure preparation (predict success)
- School District/State Education Department
  - Degree requirements (benchmarks)
- Others...

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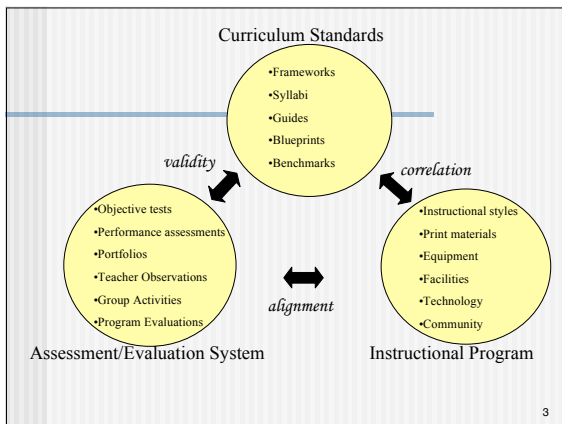
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## NJ Core Curriculum Content Standards for Science

- 5.1 Scientific Processes (*Habits of Mind, Inquiry, Safety*)
- 5.2 Science and Society (*Cultural, Historical Perspectives*)
- 5.3 Mathematical Applications (*Operations, Geometry, Measurement, Patterns, Algebra, Data Analysis and Probability*)
- 5.4 Nature and Process of Technology (*Science & Technology, Nature, Design*)
- 5.5 Life Science (*Matter, Energy, and Organization, Diversity, Evolution, Reproduction and Heredity*)
- 5.6 Physical Science – Chemistry (*Structure and Properties of Matter, Chemical Reactions*)
- 5.7 Physical Science – Physics (*Motion & Forces, Energy Transformation*)
- 5.8 Earth Science (*Properties and Materials, Atmosphere and Weather, Processes, Study*)
- 5.9 Astronomy and Space Science (*E-M-Sun System; Solar System; Stars; Galaxies and Universe*)
- 5.10 Environmental Studies (*Natural Systems and Interactions, Human Interactions and Impact*)

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## Assessment Formats

- Statewide Assessments
  - Multiple Choice
  - Short Constructed Response
  - Open-Ended
- Classroom Measures (*NJ Science Curriculum Framework*)
  - Matching pre- and post-module assessments
  - Embedded assessments
  - Prediction activities
  - Final assessments (hands-on, pencil-and-paper, notebooks) [*Summative*]
  - Informal assessments [*Formative*]
  - Documentation and record keeping

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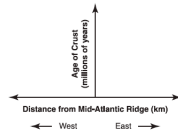
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## Sample Item - Earth Science

**Earth Science Cluster/Structure and Dynamics of Geophysical Systems**  
 Directory of Science Test Specifications: 5.9, p. 12, A, 4, D  
 The *Theory of Plate Tectonics* can be used to explain earthquakes, volcanoes, mid-ocean ridges, and deep sea trenches.



A set of axes for mapping the relationship between the age of oceanic crust and the distance from the Mid-Atlantic Ridge is shown above.

- In your answer folder, draw a graph showing the expected trends between distance and age.
- Use the theory of plate tectonics to explain your answer.

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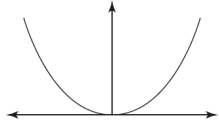
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## Sample Item - Earth Science

Sample Response:

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- According to the theory of plate tectonics, new crust is formed at mid-ocean ridges. This pushes older crust from the ridge. As the plates move apart from each other, magma from beneath Earth's surface rises up, fills in the gaps, and hardens into crust. New crust is continually being formed in this manner. Thus, the greater the distance from the mid-ocean ridge, the older the crust.

Note: The graph could be either two straight lines bent upward or two curved lines bent upward.

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## Sample Item - Student Response

**SCIENCE  
OPEN-ENDED RESPONSE**

Use this page for question 32 only.

32.

This graph is only accurate until other tectonic plates are reached.

At the Mid-Atlantic Ridge, magma from the Earth's mantle rises and cools to form crust. The new crust pushes the old,

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## Sample Item - Student Response

Use this page for question 32 only.

32.

Farther away = older

The Mid-Atlantic ridge is formed by two plates moving apart. This movement creates a long crack in the Earth's surface through which magma emerges. The magma hardens to create the "crust." As the plates continue to move away from each other, more magma emerges from the crack and pushes the older layer of crust down away from the split. Thus, the more new magma emerges the farther the old crust is pushed away from the ridge.

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## “Capturing” Student Thinking

- Exam summaries provided by...
- Error analysis of classroom exams
- Use of specific items as journal questions, exit or entrance slips, or homework assignments (Answer and explain...)...

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## Concepts

- Difficulty – Percentage or proportion that are successful on an item
- Discrimination – How well does an item differentiate between students who understand the subject and those who do not?
- Validity – Does an item measure student understanding of the intended concept?

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## Concepts (Continued)

- Reliability – can the results be replicated?
  - Inter-rater
  - Test/Re-test
  - Internal Consistency
- Criterion referenced tests
- Latency

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## Types of Analysis

- Traditional
  - Difficulty
  - Discrimination
  - Response pattern
- Rasch Analysis
  - Item difficulty equated to student ability
  - Standard setting benchmark's essential

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## Types of Analysis (Continued)

- Cognitive Level - Bloom's taxonomy
  - Knowing
  - Using
  - Integrating
- Alignment
  - Curriculum and Assessment
  - Andrew Porter
- Item format



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## Types of Analysis (Continued)

### Teacher Review (Biology Mentor Network)

- Difficulties analyzed in the context of:
  - Student issues
  - Testing issues
  - Instructional issues
- Use of formative techniques to support conjectures

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## Student Difficulty?

- Content Knowledge?
- Literacy/Reading Comprehension?
- Question interpretation Skills?
- Misconception?
  - From previous instruction?
  - From culture contexts?
  - Insufficient reinforcement?
- Effort?

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## Test Difficulty?

- Difficulty (Facility) Level?
- Discrimination?
- Placement on exam?
- Visual distraction by nearby (graphic) items?
- Style of Question?
- Flawed item?

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## Instructional Difficulty?

- You didn't teach the associated core major understandings.
- You didn't reinforce the core understandings enough.
- You taught the core content wrong

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## Test Data – Discussion and Analysis

- Collecting Data
  - Urban, suburban and rural school participation
  - Sample sizes range between 2008 (Physics) to 9232 (LE)
  - Western New York State (Buffalo area)
  - Statewide assessment data
    - commencement level exams at the conclusion of a 1 year course
    - June 2006 Exams, rating guides and documentation are available at <http://www.nysed.gov>
- Analysis
  - Difficulty
  - Response Pattern

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## Interpreting Data

Item	Difficulty	1	2	3	4	NR	Item	Difficulty	0	1	2
27-MC	0.95	61	19	22	<b>1903</b>	3	64-CR	0.92	152	1854	0
23-MC	0.90	43	67	93	<b>1802</b>	3	53-CR	0.90	208	1798	0
46-MC	0.89	43	<b>1793</b>	96	72	4	61-CR	0.87	144	249	1613
18-MC	0.88	96	<b>1764</b>	78	63	7	59-CR	0.86	274	1732	0
16-MC	0.86	62	132	<b>1733</b>	75	6	65-CR	0.86	154	250	1602
37-MC	0.84	<b>1692</b>	192	68	52	4	60-CR	0.85	157	300	1549
43-MC	0.84	222	54	43	<b>1686</b>	3					

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## Life Sciences

10 The illustration below shows an insect resting on some green leaves.



The size, shape, and green color of this insect are adaptations that would most likely help the insect to

- (1) compete successfully with all birds
- (2) make its own food
- (3) hide from predators
- (4) avoid toxic waste materials

Item	Difficulty	1	2	3	4	NR
10	0.98	29	91	<b>9085</b>	25	2

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## Life Sciences

14 Steps in a reproductive process used to produce a sheep with certain traits are listed below.

**Step 1** — The nucleus was removed from an unfertilized egg taken from sheep A.

**Step 2** — The nucleus of a body cell taken from sheep B was then inserted into this unfertilized egg from sheep A.

**Step 3** — The resulting cell was then implanted into the uterus of sheep C.

**Step 4** — Sheep C gave birth to sheep D.

Which sheep would be most genetically similar to sheep D?

- (1) sheep A, only
- (2) sheep B, only
- (3) both sheep A and B
- (4) both sheep A and C

Item	Difficulty	1	2	3	4	NR
14	0.27	1001	2504	4545	1179	3

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## Environmental Studies

45 Plot the data for dissolved oxygen on the grid. Surround each point with a small circle and connect the points. [1]

Example: 

Item	Difficulty	0	1
45	0.94	594	8635

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## Life Sciences

Read each question to questions 56 and 58 on the statement and diagram below and use your knowledge of biology.

Women are advised to avoid consuming alcoholic beverages during pregnancy.



56 Identify the structure labeled A and explain how the functioning of structure A is essential for the normal development of the fetus. [1]

Structure A \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Item	Difficulty	0	1	2
58	0.28	1131	3204	4894

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## Astronomy and Space Science

Read your answer to question 39 through 41 on the August below. Which has the largest area during the summer of Earth and the Moon.



Item	Difficulty	1	2	3	4	NR
39	0.89	141	351	406	7761	13

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## Environmental Studies

44 The photograph below shows a sign near the Esopus Creek in Kingston, New York.



The main purpose of the word "watershed" on this sign is to communicate that the Esopus Creek

- (1) is a tributary of the Hudson River
- (2) is a flood basin where it flows into the Hudson River
- (3) forms a delta in the Hudson River
- (4) contains ancient fish fossils

Item	Difficulty	1	2	3	4	NR
44	0.34	2933	2043	1596	25	2

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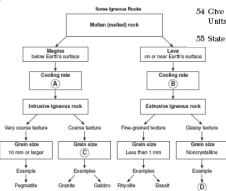
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## Earth Science

Read your answer to question 54 through 55 on the flowchart below and on your knowledge of Earth science. The flowchart shows the formation of igneous rocks. The circled letters A, B, C, and D indicate parts of the flowchart that have been labeled.



54 Give the numerical grits-size range that should be placed in the flowchart at **C**. Units must be included in your answer. [1]

55 State one igneous rock that could be placed in the flowchart at **D**. [1]

Item	Difficulty	0	1
54	0.91	796	7863

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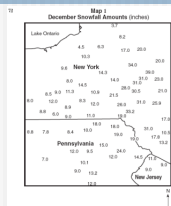
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## Earth Science



72 On map 1 in your answer booklet, draw the 30.0-inch snowfall isoline. Assume that the decimal point for each snowfall depth marks the exact location where the snowfall was measured. [4]

Item Difficulty 0 1  
72 0.34 5745 2914

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## Chemistry

- 14 Two substances, A and Z, are to be identified. Substance A can *not* be broken down by a chemical change. Substance Z can be broken down by a chemical change. What can be concluded about these substances?
- (1) Both substances are elements.
  - (2) Both substances are compounds.
  - (3) Substance A is an element and substance Z is a compound.
  - (4) Substance A is a compound and substance Z is an element.

Item Difficulty 1 2 3 4 NR  
14 0.95 36 26 **4680** 200 2

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## Chemistry

- 19 Which balanced equation represents an endothermic reaction?
- (1)  $C(s) + O_2(g) \rightarrow CO_2(g)$
  - (2)  $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$
  - (3)  $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
  - (4)  $N_2(g) + O_2(g) \rightarrow 2NO(g)$

Item Difficulty 1 2 3 4 NR  
19 0.35 1295 1593 25 **1724** 13

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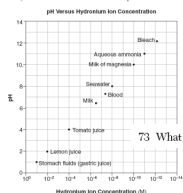
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## Chemistry

Item 73 refers to questions 73 through 75 on the graph below. The graph shows the relationship between pH value and hydronium ion concentration for various aqueous solutions and substances.



73 What is the hydronium ion concentration of tomato juice? [1]

Item	Difficulty	0	1
73	0.93	370	4565

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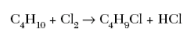
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## Chemistry

Given the balanced equation for an organic reaction between butane and chlorine that takes place at 300.°C and 101.3 kilopascals:



61 Identify the type of organic reaction shown. [1]

Item	Difficulty	0	1
61	0.32	3379	1557

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## Physics

27 Electromagnetic radiation having a wavelength of  $1.3 \times 10^{-7}$  meter would be classified as

- (1) infrared                      (3) blue  
 (2) orange                        (4) ultraviolet

Item	Difficulty	1	2	3	4	NR
27	0.95	61	19	22	1903	3

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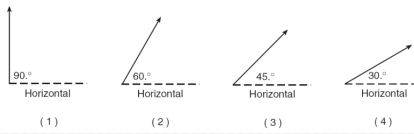
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## Physics

44 A volleyball hit into the air has an initial speed of 10. meters per second. Which vector best represents the angle above the horizontal that the ball should be hit to remain in the air for the greatest amount of time?



Item	Difficulty	1	2	3	4	NR
44	0.32	649	151	902	302	4

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## Physics

Base your answers to questions 64 through 66 on the information below.

A car on a straight road starts from rest and accelerates at  $1.0 \text{ meter per second}^2$  for 10. seconds. Then the car continues to travel at constant speed for an additional 20. seconds.

64 Determine the speed of the car at the end of the first 10. seconds. [1]

Item	Difficulty	0	1	2
64	0.92	152	1854	0

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## Physics

58 If a proton were to combine with an antiproton, they would annihilate each other and become energy. Calculate the amount of energy that would be released by this annihilation. [Show all work, including the equation and substitution with units.] [2]

Item	Difficulty	0	1	2
58	0.37	995	524	487

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## In Conclusion

- Summary of findings
  - Easier
    - Plotting points
    - Major concepts
    - Typical item formats
  - More Difficult
    - Conceptually challenging items
    - “Inscription”
    - Calculations, showing work...
  - Next steps: *considerations within our classrooms...*

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## Resources from this presentation...

<http://physicsed.buffalostate.edu/pubs/NJSTA/Fall06>

Email: [zawickjl@buffalostate.edu](mailto:zawickjl@buffalostate.edu)  
Office Phone (716) 878-3800

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## In Conclusion

- Summary of findings
- Future directions
- Next steps...

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