Spring 2001

DELAWARE

STUDENT TESTING PROGRAM

ITEM SAMPLER

AN ANALYSIS OF HIGH SCHOOL DSTP SCIENCE ITEMS

Delaware Department of Education

Document Control No. 95-01010406

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The purpose of this handout is to help Delaware teachers prepare their students for the science portion of the Delaware Student Testing Program (DSTP). Included in the handout are high school level science items that were either field tested in classrooms throughout Delaware or were part of the Spring 2000 "live test." Items included in this handout will not be part of the 2001 DSTP.

Each student taking the test received both a total science score and a set of four sub-scores, broken out in the areas of Inquiry, Life, Earth, and Physical Science. Although multiple forms of the assessment were administered across the State, the maximum number of points that could be earned was 68. The Targeted Item Distribution for DSTP Science Test included below shows the number of assessment items for each reporting category and the total number of points that could be earned per category.

Targeted Item Distribution for DSTP Science Test

K-3

Reporting Category	Multiple Choice	Short Answer	Percentage of Entire Test	MC Total Points	SA Total Points
Inquiry	10	6	30	10	12
Life Science	10	6	30	10	12
Earth Science	6	3	20	6	6
Physical Science	6	3	20	6	6
Totals	32	18	100	32	36
Total Point per Test = 68					

4-5

Reporting Category	Multiple Choice	Short Answer	Percentage of Entire Test	MC Total Points	SA Total Points
Inquiry	8	5	25	8	10
Life Science	8	5	25	8	10
Earth Science	8	4	25	8	8
Physical Science	8	4	25	8	8
Totals	32	18	100	32	36
Total Point per Test = 68					

6-8

Reporting Category	Multiple Choice	Short Answer	Percentage of Entire Test	MC Total Points	SA Total Points
Inquiry	5	3	15	5	6
Life Science	10	6	30	10	12
Earth Science	8	4	25	8	8
Physical Science	9	5	30	9	10
Totals	32	18	100	32	36
Total Point per Test = 68					

11th

Reporting Category	Multiple Choice	Short Answer	Percentage of Entire Test	MC Total Points	SA Total Points
Inquiry	5	3	15	5	6
Life Science	10	6	30	10	12
Earth Science	8	4	25	8	8
Physical Science	9	5	30	9	10
Totals	32	18	100	32	36
Total Point per Test = 68					

STATEWIDE PATTERNS AND TRENDS

SCIENCE AS INQUIRY

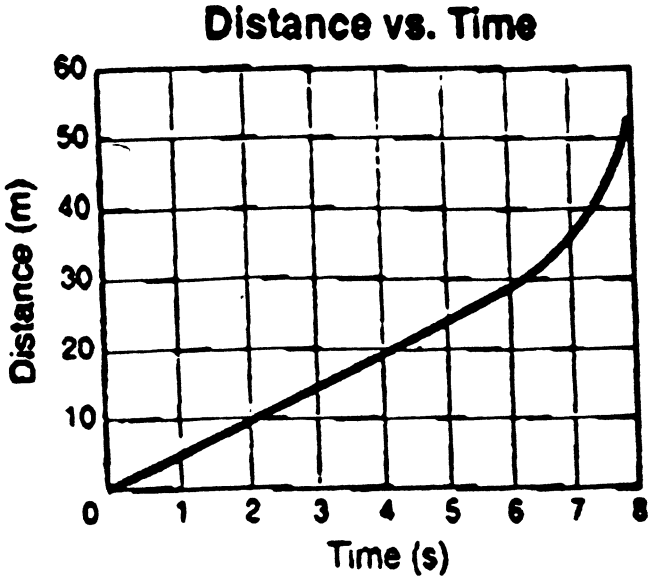
Within this reporting category the DSTP assesses student capabilities related to:

- Designing scientific investigations
- Identifying controls and variables
- Describing the relationship between variables
- Selecting the appropriate instrument to obtain data
- Measuring accurately
- Determining appropriate sampling techniques and procedures
- Collecting data
- Constructing data tables and graphs
- Analyzing and interpreting data tables and graphs
- Constructing and drawing inferences from charts, tables and graphs that summarize data from actual situations (NCTM)
- Developing descriptions, explanations, predictions, and models based on evidence.

Analyses of DSTP results show that constructing graphs, and in particular line graphs, are especially problematic for Delaware students. A large percentage of students appear to be confused about which axis the dependent variable should be placed (Y axis) and about which axis the independent should be placed (X axis). Often they forget to include the unit of measurement that needs to accompany each variable (e.g. millimeters, seconds, weeks, etc.) and have difficulty determining an acceptable scale for the axes. Many students neglect or ignore the inclusion of a title or their title fails to relate the independent and dependent variables being investigated.

Even when students were asked to interpret a graph requiring some content knowledge they were unable to discuss the relationship between variables. For example, when asked to interpret the graph (see next page), which was included on the Spring 2000 DSTP only 12.5% of the students earned a full 2 points. Most students received only partial credit by simply stating the data points. In this case they may have reported that at "six (6) seconds **it** had gone 30 meters." Providing a description of the graph will not suffice for full credit, students must be able to explain how the variables are related.

Consider a distance versus time graph showing the motion of a cyclist taking a pleasure ride on a highway.



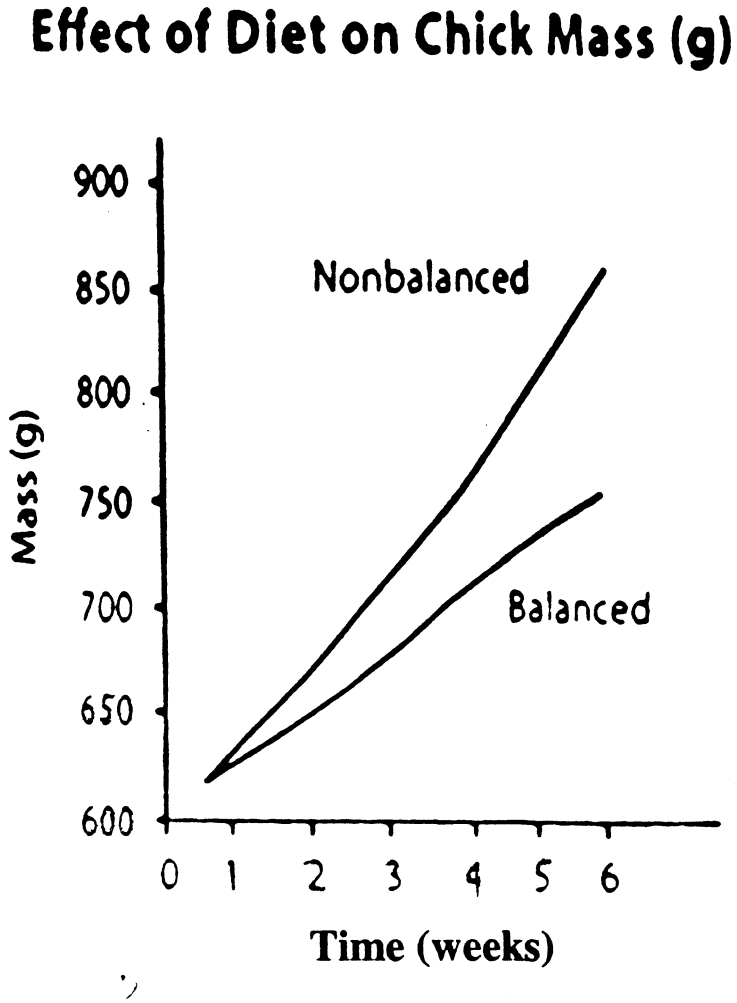
Describe how the motion from 1 to 6 seconds differs from the motion from 6 to 8 seconds. Explain how this change could have occurred.

Science Standard #3.22. Displacement, velocity, acceleration, and time are used to describe the motion or changes in the motion of an object.

Scoring Tool:

2 points:	Student explains that the cyclist is traveling at a constant speed from 1 to 6 seconds and is speeding up (or accelerating) from 6 to 8 seconds. The cyclist has changed his pedaling speed or is moving downhill from 6 to 8 seconds.
1 point:	Student describes the graph without any explanation.
0 points:	Incorrect response.

Some graphing items on the DSTP also require students to compare two graphs or to interpret or present more than one variable or subject on the same graph. The graph below is an example of one that students might be asked to interpret on the DSTP.



Results from the DSTP suggest that students need more opportunities to evaluate and interpret graphs involving repeated measurement over time, multiple subjects and multiple variables.

PHYSICAL SCIENCE – CONSERVATION OF ENERGY

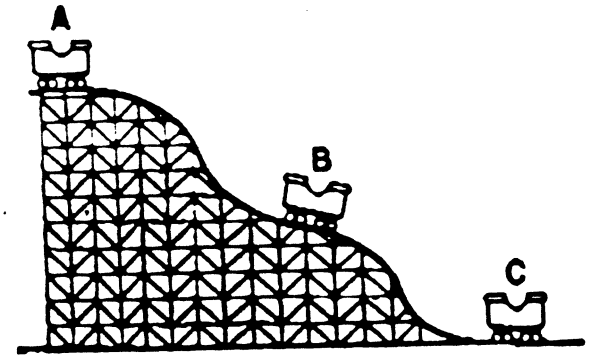
Data from DSTP questions involving potential, kinetic, and conservation of energy suggest that students do not understand energy and, as shown in the result in the item below, cannot trace the transformation of energy as an object moves along a surface.

Students do not appear to understand that energy is conserved (whenever energy is reduced in one place, it is increased somewhere else by exactly the same amount) and can also be transformed from one form to another. Students have misconceptions about energy for a variety of reasons, including confusing everyday usage of words such as *work* and *energy*. The entire concept of energy can be very abstract and conceptually difficult for students. Misconceptions are perpetrated in phrases such as "energy is used", or "energy is lost" neither of which conveys conservation of energy. A more accurate description would be to refer to the transformation of energy.

In many cases, the idealized treatment of energy in books ignores friction and transformation of kinetic energy into heat energy. (See also Stepans *Targeting Students' Science Misconceptions.)*

One of the questions from the DSTP asks students the following:

A roller coaster car freely descends down the last hill of the ride. The brakes are applied at position C to stop the car. Review the data table showing the amount and types of energy that the car has at positions A, B, and C.



Use the data to explain how much energy was transformed into heat (thermal energy) during the braking process.

Position	Kinetic Energy	Potential Energy	Heat (Thermal) Energy
A	10,000 J	7,500 J	0 J
B	15,000 J	2,500 J	0 J
C	2,500 J	0 J	?

Scoring Tool

2 points:	Explains that at position C, 15,000 J of energy was transformed into heat AND the total energy of the system is 17,500 J or shows some understanding of the Law of Conservation of Energy.
1 point:	Partially correct, e.g., explains that at position C, 15,000 J of energy was transferred into heat OR the total energy of the system is 17,500 J or cites the Law of Conservation of Momentum or its definition ("The total energy in a system is constant" or "Energy cannot be created or destroyed.")
0 points:	Incorrect, inappropriate, incomplete response.

Less than 15% of students received full or partial credit on this problem, although over 55% of students attempted an answer.

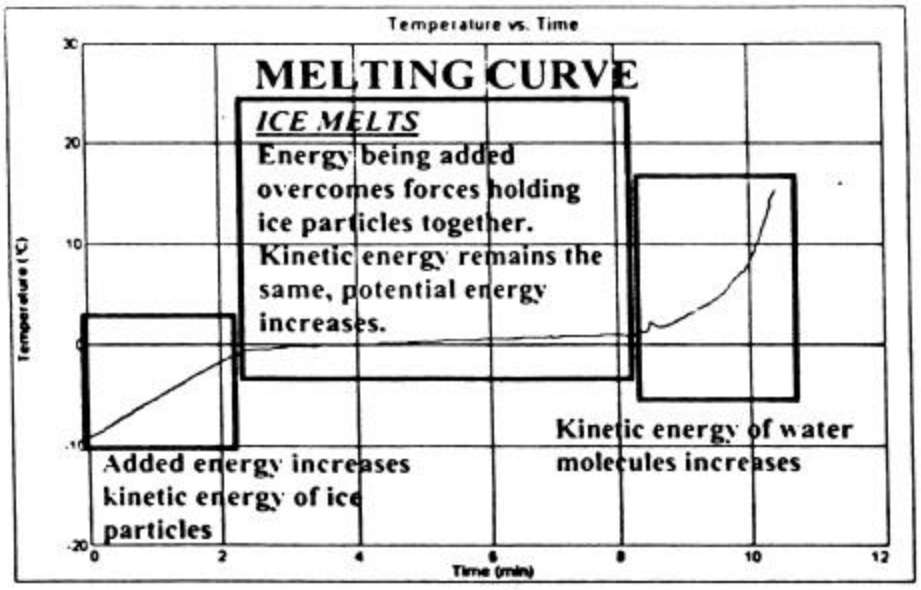
CHEMISTRY

Students are expected to understand the basic patterns and trends of the periodic table. For example, given a periodic table students should be able to discern metals and non-metals by their placement on the periodic table as well as relative reactivity of elements (e.g., noble gases vs. halogens).

When given a simple chemical equation, students should be able to calculate coefficients and subscripts and explain how the equation demonstrates the law of conservation of matter.

> The formula for copper nitrate is Cu $(NO_3)_2$. For every copper atom in this compound, how many oxygen atoms are there?
>
> (F) 3
>
> (G) 2
>
> (H) 5
>
> (J) 6

Students need ample opportunities to think about a particulate model and how that relates to the molecular activity. They seem to have significant difficulty relating energy changes and the consequent molecular movement and resultant phase change. More specifically, when students are asked to interpret a melting or freezing graph, students can not account for the change of phase in terms of kinetic and potential energy.



LIFE SCIENCE

In the Life Science section of the DSTP students are required to figure out the possible gene pairs that come from two parents. Often this type of genetics word problem will require students to explain how dominant and recessive genes affect the way traits are inherited. On of the released items from the spring 2000 DSTP illustrates a genetics question students are asked and what is required to earn complete credit.

In cats, the gene for short hair (A) is dominant over the gene for long hair (a). A short-haired cat is mated to a long-haired cat, and four kittens are produced, two short-haired and two long-haired. Explain how the two parents could produce these offsprings.

Scoring Tool:

Response must indicate in words and/or in a correctly constructed Punnett square the appropriate genotypes of both parents and the predicted offspring. For example:

2 points: One parent must be heterozygous and therefore, has a 50% chance of giving the short-haired gene and a 50% chance of giving the long-haired gene. The other parent can only give the long-haired gene. Therefore, 50% of the offspring will be long-haired and 50% short haired. Note: The words "heterozygous" and "homozygous" are not required to receive full credit.

OR

	a	a
A	Aa	Aa
a	aa	aa

OR

Parents: aa x Aa Offspring: 50% Aa 50% aa

1 point: Partially correct response, but some flaws may be included. For example, the student may explain the parent with the dominant gene is carrying the recessive allele, but the combinations inside the Punnett square does not reflect separation of the alleles.

0 points: Incorrect, inappropriate or incomplete response.

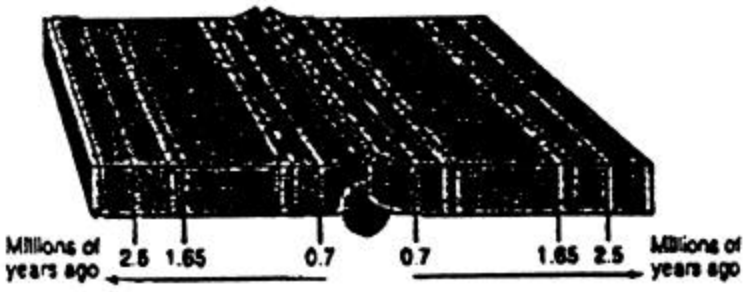
After analyzing DSTP results from across the State, it appears that many students are struggling with some of the same genetic concepts. For instance, when expected to construct Punnett squares, students fail to separate the gene pair (alleles) of the parents. This error tends to indicate that students are confused as to how meiosis affects the distribution of chromosomes and subsequently genes. Once the students make this kind of mistake it is impossible for them to determine all the gene pairs for a given characteristic that could come from a set of parents. Furthermore, when students end up with gene combinations (inside the squares) that contain more genetic information than the parents it does not seem to cue them into the fact that they have done something wrong in setting up the Punnett square.

Students also experience difficulty with genetic problems when they are given phenotypic patterns of inheritance and asked to derive information about the genotype of an organism (as is the case in the released problem). Again, if students attempt to construct a Punnett square to answer the question they must first be able to determine the genotype for each of the parent organisms and then separate the alleles across the top and down the side of the square. After completing the simple monohybrid crosses they should then be able to apply their understanding of genetics to explain the relationships between the phenotypes and genotypes of the parents and offsprings.

EARTH SCIENCE

A portion of the DSTP requires students to demonstrate their understanding of the theory of plate tectonics. A comprehensive understanding of most scientific theories requires the assimilation of knowledge across earth, physical and life sciences.

When asked multiple-choice questions, students appear to have some basic knowledge of plate tectonics. However, when asked to construct a response, using specific evidence to explain and support the theory, students have significant difficulty as indicated by the results on the following released item. Only 2.1% of Delaware students received full credit, 22.2% received partial credit while 49.9% received no credit even though they attempted a response.



Why is the spreading of rocks at the mid-ocean ridge evidence of plate tectonics?

Scoring Tool:

2 points:	Some understanding of plate tectonics (continents are splitting apart or moving together because Earth's crust is made up of moving plates.) Mid-ocean ridge occurs where plates of Earth's surface pull apart. Magma from the interior rises and forms ridge, and spreads out from the ridge. Therefore, same age bands on either side of upwelling occur.
1 point:	Correct understanding of theory of plate tectonics (above) but does not include details of the phenomena of matched bands moving away from spreading zone.
0 points:	Inappropriate or no response.