Minnesota Comprehensive Assessment-Series IV (MCA-IV)

Guide to Science MCA-IV Released Items

Grade 8

Purpose of the Guide to Released Items

The purpose of this guide is to give Minnesota education professionals examples of phenomenon-based, multidimensional items aligned to the 2019 Minnesota Science Standards. These items can be used for professional development to prepare for the Science MCA-IV, which will be administered beginning in spring 2025. Until that time, students will be assessed using the Science MCA-III. Resources for students to prepare for testing can be found on the Minnesota AssessmentsStudent Tutorials page.

This group of items is an example of one phenomenon with its associated items. There are some unique features specific to the MCA-IV:

- Phenomenon-based item sets. The context for each phenomenon is focused around observable events occurring in the universe that can be explained or predicted with scientific reasoning (Achieve, Next Generation Science Storylines, and STEM Teaching Tools).
- Multi-dimensional items. Each item assesses the Practice and Core Idea of the benchmark. Most items also assess the Cross-cutting Concept of the benchmark.
- Tabs. The information explaining the phenomenon may be contained in multiple tabs, which are all simultaneously available for each item.
- Constructed Response. In order to better assess student learning of several of the practices, MDE is investigating the use of short-answer constructed response items. An example is contained in this set of items.

The data included in this document are actual student responses from the 2021 field test results. Items in this guide are not interactive. Visit G08 Science MCA-IV Released Items to see this Grade 8 phenomenon and associated items as they appeared in the testing platform.

For more information, see Minnesota Comprehensive Assessment-Series IV (MCA-IV) Draft Test Specifications for Science.

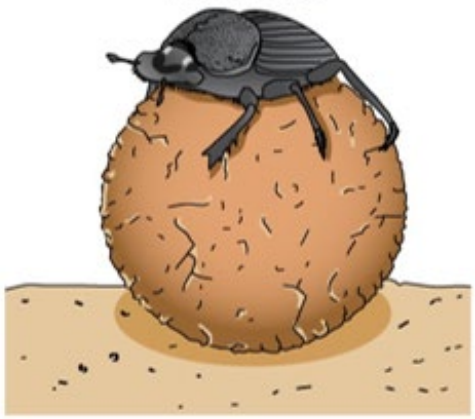
Phenomenon Title: Dung Beetle Starlight Orientation

Tab A

Tab A | Tab B | Tab C

Dung beetles are known for rolling dung (the solid waste of animals) into balls and then moving the balls into underground storage. The dung balls serve as a source of food for adult beetles and their larvae. Each ball is rolled by a male, who covers the ball with a chemical to attract a female beetle for mating. Once a female has been attracted, the male rolls the ball away from the pile of dung as quickly as possible to prevent the ball and female beetle from being stolen by another male beetle. Rolling the ball away from the dung pile in a straight line allows the beetle to move the ball and female beetle as quickly as possible to underground storage. The nocturnal dung beetle, *Scarabaeus satyrus*, is the only dung beetle species that uses light patterns from the stars to move dung balls. Figure 1 shows *Scarabaeus satyrus* on a dung ball.

Figure 1. *Scarabaeus satyrus* Dung Beetle



Tab B

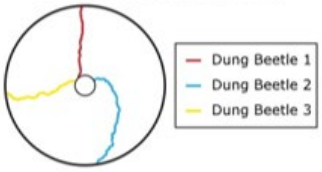
Tab A | Tab B | Tab C

To test that the *S. satyrus* dung beetle uses star patterns to roll dung balls, scientists attached cardboard hats to the heads of some of these beetles to block starlight from reaching their eyes. The scientists tracked the rolling paths of the beetles before and after attaching the hats to their heads. Figure 2 shows one of the dung beetles with the cardboard hat attached.

Figure 2. Dung Beetle with Cardboard Hat

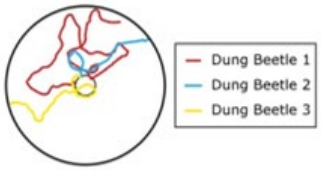
To gather data on the rolling paths of dung beetles without cardboard hats, scientists placed beetles in the center of a circular area. The beetles were allowed to roll dung balls, and the scientists observed that the beetles rolled the dung balls away from the center of the circular area toward underground storage. Figure 3 shows the rolling paths of dung beetles without cardboard hats.

Figure 3. Rolling Paths of Dung Beetles without Cardboard Hats



To gather data on the rolling paths of dung beetles with cardboard hats, scientists placed beetles in the center of a circular area. The beetles were allowed to roll dung balls, and the scientists observed that the beetles rolled the dung balls away from the center of the circular area toward underground storage. Figure 4 shows the rolling paths of dung beetles with cardboard hats attached.

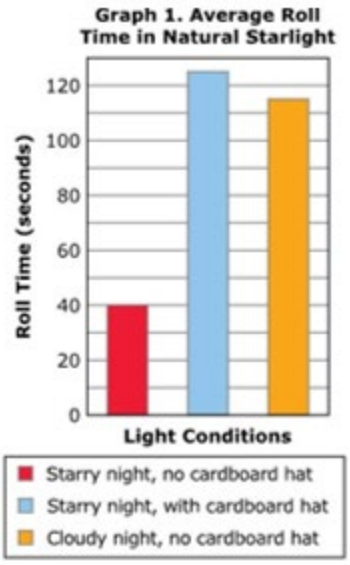
Figure 4. Rolling Paths of Dung Beetles with Cardboard Hats



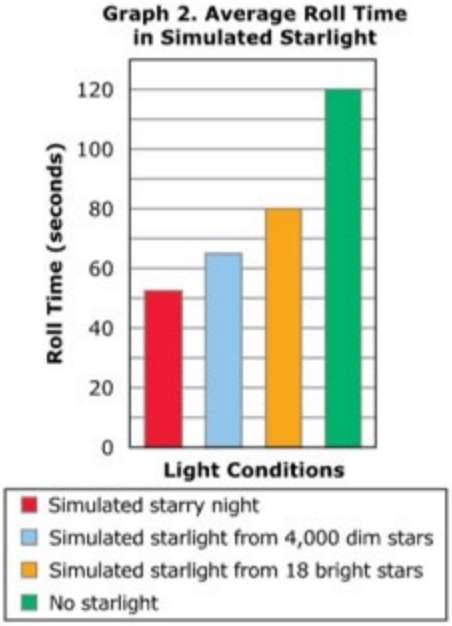
Tab C

Tab A | Tab B | Tab C

The scientists also tested how long it takes the *S. satyrus* beetle to roll a dung ball on a path with natural starlight and with simulated starlight. Graph 1 shows the average time a beetle took to roll its dung ball along an outdoor path using natural starlight.



Graph 2 shows the average time a beetle took to roll its dung ball along an indoor path using simulated starlight.

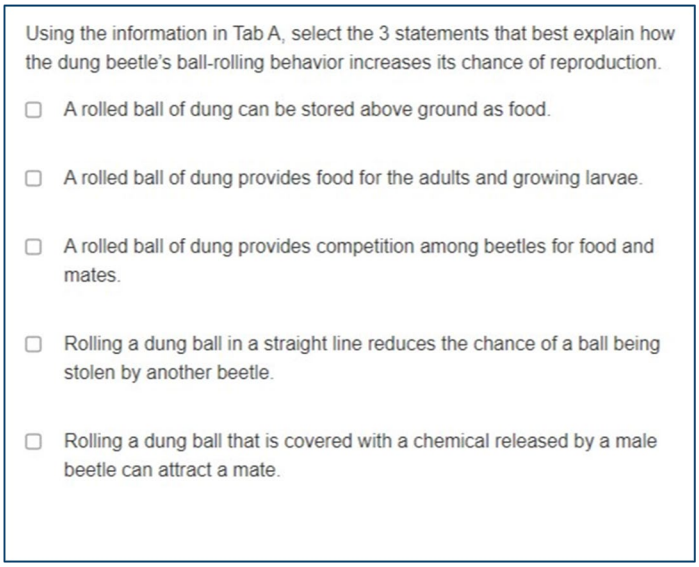


Item 1

Item 1 Information

Item Characteristic	Description
Item Number	1
Associated Tab	Tab A
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.1.2 Support or refute an explanation by arguing from evidence and scientific reasoning for how animal behavior and plant structures affect the probability of successful reproduction.** (P: 7, CC: 2, CI: LS1) Examples of behaviors that affect the probability of animal reproduction may include nest building to protect young, herding of animals to protect young from predators, and vocalization and/or colorful plumage to attract mates for breeding. Examples of animal behaviors that affect probability of plant reproduction may include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures may include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	2 Cause and effect
Core Idea	LS1 From molecules to organisms: Structures and processes
Points	1

Illustration Reference for Item 1



Item 1 Scoring Information

Score	Description	Percentage of Student Responses
1	A. A rolled ball of dung can be stored, but that alone does not increase the chances of reproduction. B. **Correct.** A rolled ball of dung provides energy to mate and food energy for growing larvae. C. A rolled ball of dung can trigger competition among beetles, but does not increase their chances of reproduction. D. **Correct.** Rolling a ball in a straight line reduces the chance it can be stolen, can attract a mate, and can ensure food energy for mating and growing larvae. E. **Correct.** Rolling a ball of dung covered with a chemical by a male beetle can attract a mate.	27%
0	The response is incorrect or irrelevant.	73%

Item 2

Item 2 Information

Item Characteristic	Description
Item Number	2
Associated Tab	Tab B
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.** (P: 7, CC: 7, CI: LS2) Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations and on evaluating empirical evidence supporting arguments about changes and/or impacts to ecosystems. Examples of physical components may include human-built structures like urban developments, or dams.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	7 Stability and change
Core Idea	LS2 Ecosystems: Interactions, energy, and dynamics
Points	1

Illustration Reference for Item 2

Based on the data in Figure 3 (Tab B) and Figure 4 (Tab B), which statement correctly infers what happened to beetles that were wearing cardboard hats?

A. The beetles could more easily move in a straight line.
B. The beetles' ability to see the light of stars increased.
C. The beetles could more easily find underground storage.
D. The beetles' risk of having their dung ball stolen increased.

Item 2 Scoring Information

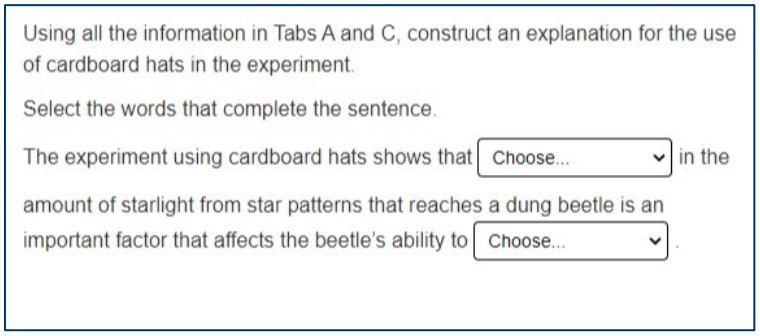
Score	Description	Percentage of Student Responses
0	A. Beetles wearing hats were not able to move in a straight line compared to beetles without cardboard hats.	9.8%
0	B. Beetles wearing hats would most likely have a reduction in all visible light.	10.7%
0	C. Beetles wearing hats would most likely have a reduction in all visible light and would have an increased risk in not being able to find underground storage.	13.9%
1	D. **Correct.** Less visible light correlates to a less straight path that would mean beetles wearing hats were at a greater risk of having their dung ball stolen or not being able to bury their dung ball underground as food storage.	65.6%

Item 3

Item 3 Information

Item Characteristic	Description
Item Number	3
Associated Tab	Tab C
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.** (P: 7, CC: 7, CI: LS2) Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations and on evaluating empirical evidence supporting arguments about changes and/or impacts to ecosystems. Examples of physical components may include human-built structures like urban developments, or dams.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	7 Stability and change
Core Idea	LS2 Ecosystems: Interactions, energy, and dynamics
Points	1

Illustration Reference for Item 3



Response Number	First Answer Option	Second Answer Option
Response 1	a decrease	an increase
Response 2	feed larvae	steal a ball

Item 3 Scoring Information

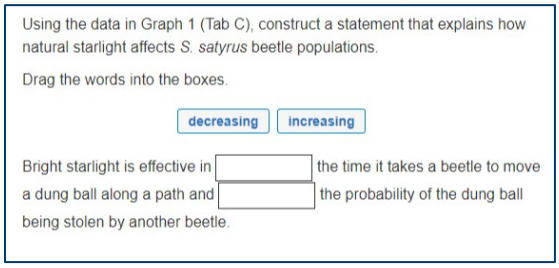
Score	Description	Percentage of Student Responses
1	The experiment using cardboard hats shows that **a decrease** in the amount of starlight from star patterns that reaches a dung beetle is an important factor that affects the beetle's ability to **feed larvae**.	39%
0	The response is incorrect or irrelevant.	61%

Item 4

Item 4 Information

Item Characteristic	Description
Item Number	4
Associated Tab	Tab C
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.** (P: 7, CC: 7, CI: LS2) Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations and on evaluating empirical evidence supporting arguments about changes and/or impacts to ecosystems. Examples of physical components may include human-built structures like urban developments, or dams.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	7 Stability and change
Core Idea	LS2 Ecosystems: Interactions, energy, and dynamics
Points	1

Illustration Reference for Item 4



Item 4 Scoring Information

Score	Description	Percentage of Student Responses
1	The student selects the following words to complete the sentence: Bright starlight is effective in **decreasing** the time it takes a beetle to move a dung ball along a path and **decreasing** the probability of the dung ball being stolen by another beetle.	37%
0	The response is incorrect or irrelevant.	63%

Item 5

Item 5 Information

Item Characteristic	Description
Item Number	5
Associated Tab	Tab C
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.** (P: 7, CC: 7, CI: LS2) Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations and on evaluating empirical evidence supporting arguments about changes and/or impacts to ecosystems. Examples of physical components may include human-built structures like urban developments, or dams.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	7 Stability and change
Core Idea	LS2 Ecosystems: Interactions, energy, and dynamics
Points	1

Illustration Reference for Item 5

Based on the data in Graph 2 (Tab C), what can the scientists conclude?

A. A dung beetle cannot survive without starlight.
B. As the number of stars increase, the time it takes a dung beetle to roll a ball along a path increases.
C. As the brightness of starlight increases, the time it takes a dung beetle to roll a ball along a path increases.
D. As the number of stars increase, the time it takes a dung beetle to roll a ball along a path decreases.

Item 5 Scoring Information

Score	Description	Percentage of Student Responses
0	A. Dung beetles are less efficient in no starlight, but can survive without starlight	13.0%
0	B. As the number of stars increases, the time it takes a dung beetle to roll a ball along a path does not also increase.	15.7%
0	C. As the brightness of starlight increases, the time it takes a dung beetle to roll a ball along a path does not also increase.	22.8%
1	D. **Correct.** Using a simulated night sky, a dung beetle could roll a dung ball along a path in under 60 seconds.	48.5%

Item 6

Item 6 Information

Item Characteristic	Description
Item Number	6
Associated Tab	Tab C
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.** (P: 7, CC: 7, CI: LS2) Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations and on evaluating empirical evidence supporting arguments about changes and/or impacts to ecosystems. Examples of physical components may include human-built structures like urban developments, or dams.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	7 Stability and change
Core Idea	LS2 Ecosystems: Interactions, energy, and dynamics
Points	1

Illustration Reference for Item 6

Review the data in Graph 1 (Tab C) and Graph 2 (Tab C).

Which statement is the best inference from the information provided in both graphs?

A. In the absence of starlight, some dung beetle larvae are less likely to survive.
B. The number of stars visible in the night sky has no effect on dung beetle ball rolling.
C. A natural starry night and a simulated starry night have the same effect on dung beetle ball rolling.
D. The dung beetle can roll a ball more quickly in a simulated indoor environment that in a natural outdoor environment.

Item 6 Scoring Information

Score	Description	Percent of Student Responses
1	A. **Correct.** The absence of starlight makes the dung beetle more susceptible to competition and reduced food for its larvae.	44.2%
0	B. The number of visible stars does make a difference in dung beetle ball rolling.	13.7%
0	C. A natural and simulated starry night sky have different effects on dung beetle ball rolling.	24.1%
0	D. The dung beetle does not roll a dung ball better indoors as compared to outdoors in a natural environment.	18.0%

Item 7

Item 7 Information

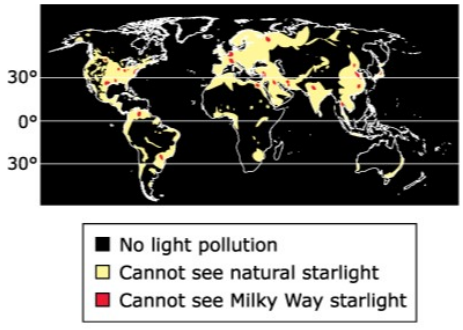
Item Characteristic	Description
Item Number	7
Associated Tab	Tab C
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.** (P: 7, CC: 7, CI: LS2) Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations and on evaluating empirical evidence supporting arguments about changes and/or impacts to ecosystems. Examples of physical components may include human-built structures like urban developments, or dams.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	7 Stability and change
Core Idea	LS2 Ecosystems: Interactions, energy, and dynamics
Points	1

Illustration Reference for Item 7

Light pollution is caused by streetlights and lights used by cars and businesses. Light pollution can increase night sky brightness by at least 8%, making it difficult to see natural starlight.

The map below shows areas affected by increased light pollution.

Impact of Light Pollution



Using the map, compare light pollution at 30°N and 30°S to infer how light pollution would most likely affect *S. satyrus* beetle populations.

Drag the words into the boxes.

less | greater | decrease | increase

The amount of light pollution at 30°N is [ ] than it is at 30°S, which means that populations of the *S. satyrus* beetle would most likely [ ] at 30°N because light pollution can [ ] a beetle's ability to roll a dung ball in a straight path.

Item 7 Scoring Information

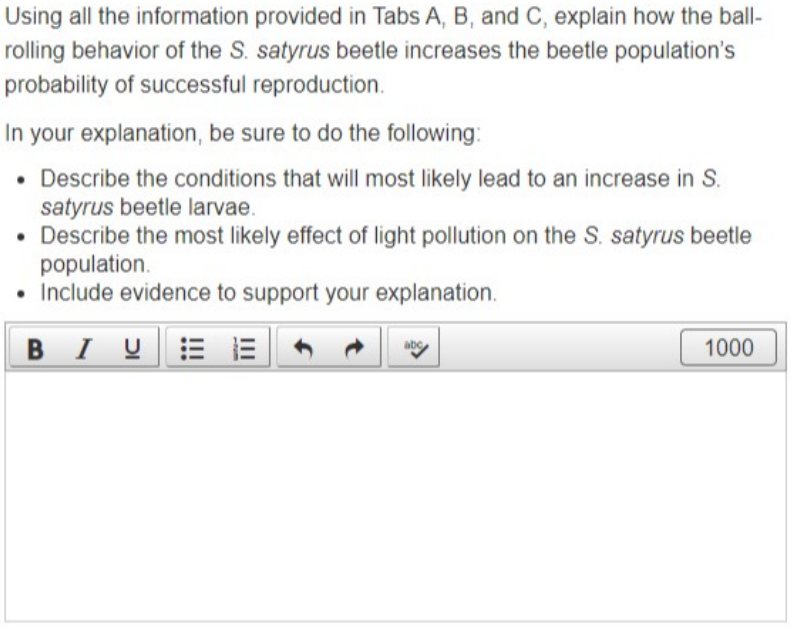
Score	Description	Percentage of Student Responses
1	The student selects the following words to complete the sentence: The amount of light pollution at 30°N is **greater** than it is at 30°S, which means that populations of the *S* satyrus beetle would most likely **decrease** at 30°N because light pollution can **decrease** a beetle's ability to roll a dung ball in a straight path	44%
0	The response is incorrect or irrelevant.	56%

Item 8

Item 8 Information

Item Characteristic	Description
Item Number	8
Associated Tab	Tab A, Tab B, Tab C
Phenomenon	Dung Beetle Starlight Orientation
Benchmark	**7L.4.1.1.2 Support or refute an explanation by arguing from evidence and scientific reasoning for how animal behavior and plant structures affect the probability of successful reproduction.** (P: 7, CC: 2, CI: LS1) Examples of behaviors that affect the probability of animal reproduction may include nest building to protect young, herding of animals to protect young from predators, and vocalization and/or colorful plumage to attract mates for breeding. Examples of animal behaviors that affect probability of plant reproduction may include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures may include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	2 Cause and effect
Core Idea	LS1 From molecules to organisms: Structures and processes
Points	3

Illustration Reference for Item 8



Item 8 Scoring Information

Score	Description	Percentage of Student Responses
3	The response demonstrates a complete understanding of the question. The response thoroughly: explores phenomena/problems; utilizes evidence; develops explanations/solutions; and/or communicates information. • The response is fully cohesive and developed. • The response is solidly based on core ideas. • The response clearly and definitively connects ideas/concepts to the question. • The response is solidly based on evidence.	3.0%
2	The response demonstrates a partial understanding of the question. The response somewhat: explores phenomena/problems; utilizes evidence; develops explanations/solutions; and/or communicates information. • The response is somewhat cohesive and developed. • The response is based on core ideas. • The response connects ideas/concepts to the question.	14.9%
1	The response demonstrates a minimal understanding of the question. The response minimally: explores phenomena/problems; utilizes evidence; develops explanations/solutions; and/or communicates information. • The response lacks cohesion and development. • The response may be based on core ideas. • The response lacks connections between ideas/concepts and the question.	34.6%
0	The response demonstrates no understanding of the question. • The response may contain correct information, but overall the response lacks enough correct information that is connected to the question.	50.2%

3-point Actual Student Response from 2021

The conditions most likely to lead to Scarabaeus satyrus reproduction is a clear, starry night. This is due to their reliance on starlight to position themselves. If the night is cloudy, the beatle will struggle to roll the dung in a steaight line, increasing the chance of competition. The problem of light will likely have negative effects on Scarabaeus satyrus. This is because of their dependence on starlight for navigation and light pollution may confuse the beatles, thinking the lights are stars. This confusion can have serious effects, Scarabaeus satyrus will likely have a decrease in its population due to difficulties in rolling the dung underground which results in reproduction decreasing.