

Form 1025SV



The **ACT**[®]

2025 | 2026

In response to your request for ACT My Answer Key materials, this booklet contains the scored test questions, scoring keys, and conversion tables used in determining your ACT scores. Non-scored questions have been removed and the multiple-choice response options (A, B, C, D and F, G, H, J) for a question are the same as on test day.

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ENGLISH TEST

35 Minutes—50 Questions

DIRECTIONS: In the passages that follow, certain words and phrases are underlined and numbered. In the right-hand column, you will find alternatives for the underlined part. You are to choose the best answer to each question. If you think the original version is best, choose “**No Change**.”

You will also find questions about a section of the passage, or about the passage as a whole. These questions do not refer to an underlined portion of the passage, but rather are identified by a number or numbers in a box.

For each question, choose the alternative you consider best and fill in the corresponding oval on your answer document. Read each passage through once before you begin to answer the questions that accompany it. For many of the questions, you must read several sentences beyond the question to determine the answer. Be sure that you have read far enough ahead each time you choose an alternative.

PASSAGE I

Seeing Streams in a New Light

[1]

As cities grew, in the nineteenth, and twentieth¹ centuries, thousands of urban streams were diverted underground into large metal or concrete pipes called culverts. Culverting controlled the paths of urban waterways and created space for new construction, but its unintended consequences—increased flooding, habitat loss, maintenance costs—far outweigh its benefits today. To alleviate these issues, communities should invest in² “daylighting” long-buried waterways by uncovering and then restoring them to more natural conditions. [A]

1. Which choice makes the sentence most grammatically acceptable?

- A. No Change
- B. grew in the nineteenth
- C. grew in the nineteenth,
- D. grew, in the nineteenth

2. Which choice most effectively maintains the essay’s tone?

- F. No Change
- G. To curtail the predicaments referenced above, communities may want to contemplate investing
- H. But there’s a conceivable fix if communities would only just invest their monetary assets
- J. One surefire way to remedy the culverting mess is for communities to invest



[2]

Daylighting projects remove impermeable barriers (such as concrete) between waterways and the soil. Thus, daylighting reduces flooding by allowing more rainwater to be absorbed where it falls. 3 Furthermore, the rocky

bottoms and plant life of daylighted streams, which slow the water's flow, giving rain more time to be absorbed.

Culverts and storm sewers, by contrast, accelerate water velocity, which leads to flash floods, downstream flooding, and greater erosion.

[3]

Although it's initially expensive, daylighting ultimately saves much more money than it costs. [B] Daylighting a mile of the Bee Branch Creek watershed cost Dubuque, Iowa, \$100 million; however, researchers estimate that the project will prevent \$582 million in flood damages over the coming decades. [C] And daylighting saves cities money in other ways, too: open creeks are much cheaper to maintain than culverts are, and daylighting projects have lessened flooding in cities across the United States.

3. If the writer were to delete the preceding sentence, the essay would primarily lose information that:

- A. articulates one advantage of removing barriers between waterways and the soil.
- B. provides data on the effects of removing barriers between waterways and the soil.
- C. describes the process through which soil absorbs rainwater where it falls.
- D. explains the impact of rainwater on daylighting projects.

4. Which choice makes the sentence most grammatically acceptable?

- F. **No Change**
- G. streams, these
- H. streams that
- J. streams

5. Given that all the choices are accurate, which one provides the most relevant support for the primary claim in this sentence?

- A. **No Change**
- B. keeping stormwater out of sewer systems reduces water treatment costs.
- C. natural streambeds actually help clean the water that flows over them.
- D. accessible waterways provide habitats for fish and other wildlife.

[4]

Because culverting was historically used to construct buildings over waterways, early attempts at culverting required innovative construction techniques. Therefore, city officials need to plan daylighting projects in careful collaboration with residents and business

owners whom may be effected. Thoughtfully

planned daylighting embellishes the quality of life for the community as a whole—creating green spaces, reintroducing wildlife, and providing public recreational amenities. [D] Nearby homes increase in value, and businesses report higher profits. Citizens far and wide should oppose future culverting initiatives.

6. At this point in the essay, the writer wants to introduce a counterclaim that an opponent of daylighting might reasonably assert. Which choice most effectively accomplishes that goal?

F. No Change

G. certain daylighting projects tear down abandoned malls and warehouses before adding bridges.

H. many citizens have lived and worked above their cities' streams.

J. a downside of daylighting is the loss of some usable structures.

7. Which choice makes the sentence most grammatically acceptable?

A. No Change

B. whom may be affected.

C. who may be effected.

D. who may be affected.

8. Which choice is clearest and most precise in context?

F. No Change

G. refurbishes

H. enriches

J. fortifies

9. Which choice provides the most effective conclusion for the paragraph and essay?

A. No Change

B. In the last twenty years, cities worldwide have contemplated daylighting various streams.

C. Daylighting offers more than a view of a waterway; it brings life back to the city center.

D. Daylighting is doable when people work together, but it isn't easy.

Question 10 asks about the preceding passage as a whole.

10. The writer is considering adding the following assertion to the essay:

(If it had happened sooner, the project might have saved \$70 million more in flood damage that occurred between 1999 and 2011.)

If the writer were to add the sentence, it would most logically be placed at:

F. Point A in Paragraph 1.

G. Point B in Paragraph 3.

H. Point C in Paragraph 3.

J. Point D in Paragraph 4.

PASSAGE II

Long Distance

“I can’t believe people gather to throw cell phones for fun,” I scoffed, stretching my stiffened muscles. After a long drive from her place in Helsinki, my cousin Anneli and I had finally arrived at our destination—a running track in Savonlinna, Finland. A huge banner near the entrance read, “Welcome to the Mobile Phone Throwing World Championships!”

“Give it a chance,” Anneli replied, grinning at me. “It’s become something of a national sport.”

I’ve definitely felt the urge, during a few annoyingly irritating calls with my sister, to want to hurl my phone across the room. But, according to Anneli, this competition

wasn’t inspired by annoying siblings; it was ascertained as an engaging reminder for Finns to dispose of their mobile phones responsibly. As such, after the competition, all the phones gathered for the event are recycled at appropriate facilities. Beforehand, though, contestants dig through the tubs of outdated models, searching for the phone with the greatest flight potential.

As we entered the venue, athletes and spectators of all ages milled around us. I found the lively, agitated atmosphere (with no trace of the fierce rivalry I often saw at competitive events) to be a pleasant surprise. Some attendees showed off themed or zany costumes, but most people wore casual, everyday clothes. However, the only telltale signs of who was competing were the paper bib numbers pinned to the athletes’ shirts.

11. Which choice is least redundant in context?

- A. No Change
- B. aggravating calls with my sister that make me long to throw my phone,
- C. some frustrating calls with my sister on the phone,
- D. certain exasperating calls with my sister,

12. Which choice is clearest and most precise in context?

- F. No Change
- G. speculated
- H. conceived
- J. supposed

13. Which choice most effectively maintains the essay’s tone?

- A. No Change
- B. in pursuit of the phone with which an elongated lob could most likely be achieved.
- C. seeking the phone with a structural configuration most suited to being flung afar.
- D. keeping their eyes peeled for the phone that might take to the skies with gusto.

14. Which choice creates the clearest contrast between the atmosphere at this event and the fierce rivalry the narrator expected to see?

- F. No Change
- G. dignified, focused
- H. festive, cordial
- J. tense, wary

15. Which transition word or phrase is most logical in context?

- A. No Change
- B. Eventually,
- C. Besides,
- D. In fact,

[1] The crowd cheered as a woman rode a unicycle in a circle for a full forty-five seconds before lofting her phone to the sky. [2] The contestant after that drew whistles and whoops when, from a handstand position, he “threw” his phone—with his teeth. [3] We stopped

to watch the Freestyle event, which is judged more on

the creativity of the throws than on their distance. 18

Everyone—even competitors in the Original category, who were genuinely trying for the farthest throw—seemed to be having fun. Spectators didn’t talk on their phones; they talked to each other. Following

their lead, I turned my own phone off. 20

16. If the writer were to delete the underlined portion, the essay would primarily lose a specific detail that:
- F. helps clarify that the woman on the unicycle was the most impressive contestant.
 - G. helps illustrate why the woman’s performance was particularly noteworthy.
 - H. defines the minimum required length of the performances in this event.
 - J. reveals why the woman chose to ride a unicycle before throwing her phone.
17. Which choice makes the sentence most grammatically acceptable?
- A. **No Change**
 - B. at least as much
 - C. primarily
 - D. **Delete** the underlined portion.
18. Which sequence of sentences makes this paragraph most logical?
- F. **No Change**
 - G. 1, 3, 2
 - H. 3, 1, 2
 - J. 3, 2, 1
19. Which choice makes the sentence most grammatically acceptable?
- A. **No Change**
 - B. phones, instead, they talked
 - C. phones, they were talking
 - D. phones instead talking
20. Which of the following sentences, if added here, would most effectively suggest that at this moment the narrator intends to connect with others in person rather than engaging with the phone?
- F. After all, I had taken enough pictures and video to remember this experience in the years to come.
 - G. Then I linked arms with Anneli and stepped further into the crowd.
 - H. At that moment, I started hoping that I could come again next year.
 - J. I could still feel it in my pocket, but I ignored it—mostly.

PASSAGE III

Threading Connections

As a child growing up in the village of Bermeja, Cuba, artist Alexi Torres worked the land with his father, friends, and neighbors. For Torres, farming was a revelation through which he first noticed that his village, the land, and time were interconnected. He and his people planted and harvested the crops during consecutive waning moons, just as their ancestors had in centuries past. Interconnectedness eventually became the central theme of Torres’s art²¹ in 2016, with his *Sun Light* series, he paid homage to the people and place that first inspired him. Torres created sixteen oil portraits of friends and family from Bermeja, starting and completing each portrait in the same²² lunar phase in which the village’s residents farm.²²

To visually represent interconnectedness, Torres painted the portraits—in his signature²³, “woven” style. The portraits appear as though they’re made from

strands of hemp or jute that have been assembled to²⁴ form lifelike faces. To achieve this effect, Torres

worked from photographs to draw²⁵ realistic renderings of his subjects directly onto giant canvases in his

21. Which choice makes the sentence most grammatically acceptable?
 - A. No Change
 - B. art, and
 - C. art and
 - D. art,
22. If the writer were to delete the underlined portion (adjusting the punctuation as needed), the paragraph would primarily lose:
 - F. a detail illustrating how Torres’s approach to creating the *Sun Light* series was influenced by his personal and cultural history.
 - G. an example clarifying how Torres depicted various types of moonlight in the paintings in his *Sun Light* series.
 - H. a suggestion that Torres often finds inspiration for his art from a connection with friends and family.
 - J. a description of Torres’s upbringing and the cultural traditions that most influenced his artistry.
23. Which choice makes the sentence most grammatically acceptable?
 - A. No Change
 - B. portraits, in his signature,
 - C. portraits in his signature
 - D. portraits, in his signature
24. Which choice provides the most specific description of the appearance of the “strands” composing the faces in Torres’s portraits?
 - F. No Change
 - G. combined in such a way that they
 - H. precisely interlaced to
 - J. artistically used to
25. Which choice makes the sentence most grammatically acceptable?
 - A. No Change
 - B. photographs, which would draw
 - C. photographs, who drew
 - D. photographs that drew

studio in Atlanta, Georgia. For instance, he
²⁶
 applied thousands of thin, fiber-like dabs of

paint, mostly—whites, grays, and blacks—to give
²⁷
 the multilayered portraits the appearance of being
 rough and woven.

Torres chose a unique set of textures for each of
 the sixteen portraits in the series. In *Sun Light—Mario*,
 an older man’s skin possesses a checkered texture, so the
²⁸
 salt-and-pepper hairs of his handlebar mustache appear
 sharp and wiry. In *Sun Light—Yaneisy*, a young woman’s
 skin has a subtle, flower-patterned texture, and her hair,
 soft and silky, is tied on the top of her head in a bun. To
 Torres, each brushstroke or “thread” in the work is an
 integral part of the whole, final creation—a reflection of
 his overarching philosophy that everything (and everyone)
 is interconnected. He likens his artistic process to how
 his family has, for generations, cultivated and harvested
 crops: “With my works, it is as if I am planting an idea
²⁹
and working with universal laws in their realization.”
²⁹

26. Which transition word or phrase is most logical in context?
F. No Change
G. Consequently,
H. Again,
J. Then,
27. Which choice makes the sentence most grammatically acceptable?
A. No Change
B. paint—mostly whites, grays, and blacks—
C. paint, (mostly whites, grays, and blacks),
D. paint—mostly whites, grays, and blacks,
28. Which choice is clearest and most precise in context?
F. No Change
G. since
H. and
J. for
29. Given that all the choices are actual quotations from Torres, which one would most effectively conclude the sentence and the essay?
A. No Change
B. “Even if it looks like a lot of effort to create my paintings, they are effortless because it is total joy to make them.”
C. “Most of the Cuban population is made up of farmers who plant and harvest their crops on the waning moon.”
D. “I started to paint objects and people made out of natural elements, like feathers and basket weaving.”



Question 30 asks about the preceding passage as a whole.

30. Suppose the writer's primary purpose had been to discuss paintings that represent a key theme in an artist's work. Would this essay accomplish that purpose?
- F. Yes, because it explains Torres's philosophy that childhood relationships have the most profound influence on an artist's paintings.
 - G. Yes, because it explores how Torres's *Sun Light* series exemplifies his philosophy about interconnectedness.
 - H. No, because although it discusses major ideas that Torres has explored throughout his artistic career, it doesn't focus on particular artworks.
 - J. No, because although it describes Torres's *Sun Light* portraits in detail, it fails to discuss thematic elements in the series.

PASSAGE IV

Our Place in the World

In the dusk of a late summer evening, I walked quietly with a small gathering of people toward a shelter at the edge of a field in northern Indiana.

Although I had never met more of the people who
31

walked with me, a few of them I did know quite well.
32

We were Miami Indians, and we had waited years to

make this journey across Miami land into a ceremonial

longhouse made of saplings and earth. 33

31. Which choice makes the sentence most grammatically acceptable?
- A. No Change
 - B. more of the people whom
 - C. most of the people who
 - D. most of the people whom
32. The writer wants to balance the statement made in the earlier part of this sentence with a related detail that suggests the unity of the people. Given that all of the choices are true, which one best accomplishes this goal?
- F. No Change
 - G. we each had our own personal reasons for being there.
 - H. I hoped I could get to know some of them.
 - J. I felt a kinship with them.
33. The writer is considering revising the preceding sentence by deleting the phrase "into a ceremonial longhouse made of saplings and earth" (placing a period after the word *land*). If the writer did this, the paragraph would primarily lose:
- A. information comparing the narrator's own journey to similar ones made by members of other tribes.
 - B. details describing the destination of the people the narrator is traveling with.
 - C. details that establish the time and place of the events in the essay.
 - D. interesting but irrelevant information about the Miami.

GO ON TO THE NEXT PAGE.

For years I had seen other Miami's pictures—
³⁴
 many of them the ancestors of the people who walked
 along with me to the longhouse that summer evening.

My mother and grandmother helped preserve tribal
³⁵
 history by collecting books and newspaper clippings.
³⁵
 Books describing the history and culture of the Miami
 people lined the bookshelves, and framed photos of Miami
 lined the walls of these rooms. While I was growing up I
 often found my mother and grandmother each sitting
 quietly in her own room, reading old letters or listening
 to the music of Native American drums.

That room contained everything I knew about being a
³⁶

Miami, and unlike the larger Plains tribes, the Miami had
³⁷
 retained no reservation lands. Once a year, the tribe held a

powwow that was always well attended. This social
³⁸
 gathering was the only tribal event that my grandmother or
 mother had ever participated in. For generations, the tribe
 had owned no land on which a longhouse could be built
 and Miami religious ceremonies conducted. Because of
³⁹
 this, I had never attended a Miami religious ceremony,

never danced in front of a crowd of Miami. Still, I had
⁴⁰
 never known any other Miami children outside of my own
 family.

34. Which choice makes the sentence most grammatically acceptable?
F. No Change
G. pictures in which other Miami were present—
H. pictures of other Miami—
J. other Miami whose pictures had been taken—
35. Given that all of the choices are true, which one would most effectively lead the reader from the first sentence of this paragraph to the description that follows in the next two sentences?
A. No Change
B. Some of those pictures had been reprinted in books my mother and grandmother collected.
C. My grandmother and mother proudly displayed those pictures in their houses.
D. Like many Miami, my grandmother and mother had each dedicated a room in her own house to the tribe.
36. Which choice makes the sentence most grammatically acceptable?
F. No Change
G. Her rooms
H. Those rooms
J. This room
37. Which choice makes the sentence most grammatically acceptable?
A. No Change
B. Miami unlike
C. Miami, unlike
D. Miami. Unlike
38. Given that all of the choices are true, which one provides information most relevant to the main focus of this paragraph?
F. No Change
G. notable for its exquisite dancing.
H. on borrowed land.
J. that lasted several days.
39. Which choice makes the sentence most grammatically acceptable?
A. No Change
B. Miami ceremonies were conducted there.
C. there were Miami ceremonies conducted there.
D. the conducting of Miami ceremonies.
40. Which transition word or phrase is most logical in context?
F. No Change
G. Meanwhile,
H. In fact,
J. On the other hand,

PASSAGE V

(Re)Defining Music

Dip hop—a growing subgenre of hip hop grounded in Deaf culture and aesthetics—challenge stereotypes⁴¹ and help⁴¹ to reshape mainstream notions of what music is. Fundamental to the style are a heavy emphasis on bass beats and lyrics rapped in sign language such as ASL (American Sign Language). Audiences feel the rhythmic vibrations, see the lyrics in motion, and engage sonic imagination.

Though rooted in hip hop, dip hop is not simply rap songs translated into ASL but musical expression⁴² from a Deaf perspective; artists craft original songs and develop individual styles. Some collaborate with

DJs, deaf or hearing, some induct⁴³ visual elements like sound-activated lights, and some use specialized equipment to enhance sound vibrations. There are

artists who only sign their raps, and those who⁴⁴ incorporate both oral and sign languages to make their music accessible to hearing audiences.

But many have yet to encounter dip hop.⁴⁵ In 2020, dip hop artist Sean Forbes’s “Little Victories” reached number one in hip hop on iTunes; in 2021, Wawa’s “LOUD” was a Top 20 dance track; and in 2022, both artists performed in the Super Bowl Halftime Show, bringing dip hop to the masses.

41. Which choice makes the sentence most grammatically acceptable?

- A. No Change
- B. are challenging stereotypes and have helped
- C. challenge stereotypes and are helping
- D. challenges stereotypes and is helping

42. Which choice makes the sentence most grammatically acceptable?

- F. No Change
- G. hip hop, dip hop is not simply, rap songs translated into ASL, but musical expression
- H. hip hop—dip hop is not simply rap songs, translated into ASL but musical expression,
- J. hip hop, dip hop is not simply rap songs translated into ASL but—musical expression

43. Which choice is clearest and most precise in context?

- A. No Change
- B. congregate
- C. compound
- D. integrate

44. Which choice makes the sentence most grammatically acceptable?

- F. No Change
- G. whom only sign their raps, and those whom
- H. which only sign their raps, and them that
- J. who only sign their raps, and them which

45. Which choice most effectively leads the reader from the preceding paragraph to the information that follows in this paragraph?

- A. No Change
- B. And this is just one of many styles of rap that have developed over time.
- C. And dip hop is resonating.
- D. But each artist is unique.

PASSAGE V

Southside Blooms

In Chicago’s Englewood neighborhood, every employee at Southside Blooms, a flower fulfillment center, have embraced the motto painted on the wall: “Flowers that ⁴⁶empower.” The employees—all neighborhood residents and most of whom are

under the age of thirty ⁴⁷arrange peonies, hyacinths, and tulips into bouquets that are delivered throughout the area.

Quilen and Hannah Blackwell opened Southside Blooms in 2020 to increase opportunity in their community. Besides flower arranging, the employees at Southside Blooms can learn how to employ sustainable agricultural techniques. For two years, “farm team” member Dionta White ⁴⁸has planted and cultivated flowers on five vacant city lots, all of which are powered by solar panels and irrigated by rainwater. For White, it’s been revelatory, he’s learning ⁴⁹about eco-friendly methods that he didn’t know existed.

And White isn’t an outlier. In four years, over thirty Southside Blooms employees have earned stipends that ⁵⁰study urban agriculture. Hoping to encourage more Englewood residents to earn such opportunities, Quilen Blackwell says, “It’s a nice little village that we’re building here, and everybody has something to contribute.”

46. Which choice makes the sentence most grammatically acceptable?
- F. **No Change**
 G. are embracing
 H. embraces
 J. embrace
47. Which choice makes the sentence most grammatically acceptable?
- A. **No Change**
 B. thirty—
 C. thirty,
 D. thirty:
48. Which choice makes the sentence most grammatically acceptable?
- F. **No Change**
 G. member, Dionta White,
 H. member, Dionta White
 J. member Dionta White,
49. Which choice makes the sentence most grammatically acceptable?
- A. **No Change**
 B. revelatory, he has learned
 C. revelatory; he’s learning
 D. revelatory; to learn
50. Which choice makes the sentence most grammatically acceptable?
- F. **No Change**
 G. employees who have earned stipends to
 H. employees, having earned stipends, to
 J. employees have earned stipends to



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MATHEMATICS TEST

50 Minutes—45 Questions

DIRECTIONS: Solve each problem, choose the correct answer, and then fill in the corresponding oval on your answer document.

Do not linger over problems that take too much time. Solve as many as you can; then return to the others in the time you have left for this test.

You are permitted to use a calculator on this test. You may use your calculator for any problems you choose,

but some of the problems may best be done without using a calculator.

Note: Unless otherwise stated, all of the following should be assumed.

1. Illustrative figures are **not** necessarily drawn to scale.
2. Geometric figures lie in a plane.
3. The word “line” indicates a straight line.
4. The word “average” indicates arithmetic mean.

1. What is the solution of the equation $\sqrt{x} - 9 = 8$?

A. 1
B. 25
C. 34
D. 289

2. $\left(\frac{1}{64}\right)^{-\frac{1}{2}} = ?$

F. $-\frac{1}{8}$
G. $-\frac{1}{128}$
H. 8
J. 128

3. For which of the following fractions does the decimal expansion require 1 repeating nonzero digit?

A. $\frac{1}{4}$
B. $\frac{3}{5}$
C. $\frac{5}{8}$
D. $\frac{2}{3}$

4. When a fair coin is flipped a large number of times, the number of heads should be approximately equal to the number of tails. Assume that the fairness of a particular coin is being investigated. Which of the following results provides the **strongest** evidence that the coin is **not** fair?

F. 2 out of 3 flips were heads.
G. 3 out of 4 flips were heads.
H. 4 out of 5 flips were heads.
J. 5 out of 6 flips were heads.

DO YOUR FIGURING HERE.



DO YOUR FIGURING HERE.

5. Ana plans to save \$200 for a summer skate park pass. She already has \$45 and plans to save \$15 per week. At this rate of savings, what is the minimum number of weeks after which Ana will have enough money for the skate park pass?
- A. 10
B. 11
C. 13
D. 14
6. Similar triangles **must** have the same:
- F. angle measures.
G. area.
H. perimeter.
J. side lengths.
7. At the U-Can-Rent-It Company, the initial payment on a dining room set is \$200. Then, the rent for the first 2 weeks is \$30 each week. For every week after that, the rent is \$10 each week. What would be the total cost of renting this dining room set for 52 weeks?
- A. \$560
B. \$720
C. \$760
D. \$960
8. Which of the following expressions is equivalent to $(3x - 9)^2$?
- F. $6x - 18$
G. $6x^2 + 81$
H. $9x^2 - 54x + 81$
J. $9x^2 - 27x + 18$
9. Next year, there will be 3,432 high school students in a certain district. Each of these students will attend either East High School or West High School but **not** both. Because of the facilities, the ratio of the number of East High School students to the number of West High School students must be 11 to 13. How many of these students will attend East High School?
- A. 143
B. 1,573
C. 2,904
D. 4,056



DO YOUR FIGURING HERE.

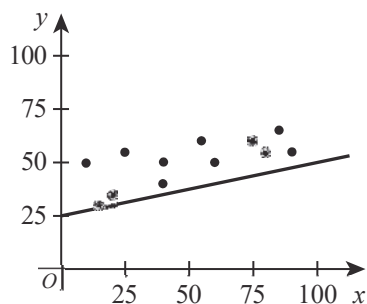
10. A worker earns a standard hourly wage of \$20.10 per hour for the first 40 hours he works in 1 week. For each hour over 40 hours he works in 1 week, he earns $1\frac{1}{2}$ times his standard hourly wage. Which of the following gives the amount, in dollars, this worker earns for working 54 hours in 1 week?

- F. $54(20.10 + \frac{1}{2}(20.10))$
 G. $54(20.10 + (1\frac{1}{2})(20.10))$
 H. $40(20.10) + 14(\frac{1}{2})(20.10)$
 J. $40(20.10) + 14(1\frac{1}{2})(20.10)$

11. For the complex variable z , one of the following is a solution of $z^2 = -9$. Which one?

- A. -3
 B. 3
 C. $3i$
 D. $9i$

12. A student modeled a set of paired data with the equation $y = 0.25x + 25$. The student's model and a scatterplot of the paired data are graphed in the standard (x,y) coordinate plane. Among the following possible changes to the student's equation, which one will most improve the fit to the paired data?



- F. Increase the slope by 0.75
 G. Decrease the slope by 0.25
 H. Increase the y -intercept by 12.5
 J. Decrease the y -intercept by 12.5



DO YOUR FIGURING HERE.

13. A certain committee is composed of 11 juniors and 79 seniors. Two different members of the committee will be randomly selected, each for a different leadership role. Given that the 1st member selected is a junior, what is the probability that the 2nd member selected will be a senior?

- A. $\frac{10}{79}$
 B. $\frac{10}{89}$
 C. $\frac{79}{89}$
 D. $\frac{79}{90}$

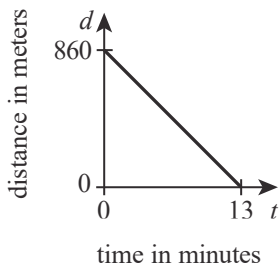
14. This table lists the engine size, x liters, and the weight, w kilograms, of each of 5 vehicles. A linear model for the data in the table is $\hat{w} = 375x + 370$. The actual weight of the vehicle with the smallest engine size differs from the linear model's predicted weight of this vehicle by how many kilograms?

Engine size (L)	Weight (kg)
2.0	1,041
4.3	2,021
3.4	1,670
2.8	1,547
4.0	1,754

- F. 79
 G. 296
 H. 370
 J. 671

15. Let d be a function of t . The given graph of the function models the distance, d meters, left to hike on a trail t minutes since beginning the hike. It took a total of 13 minutes to hike the 860-meter trail. One of the following intervals is the domain of the function. Which one?

- A. $[0, 13]$
 B. $[0, 66\frac{2}{13}]$
 C. $[0, 436\frac{1}{2}]$
 D. $[0, 860]$

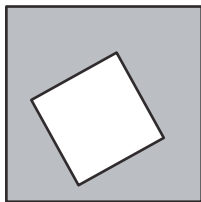




DO YOUR FIGURING HERE.

16. The figure below shows a small square inside a larger square. The smaller square has sides 2 inches long, and the area of the shaded region is 12 square inches. What is the length, in inches, of one of the sides of the larger square?

- F. 4
G. 8
H. 10
J. $\sqrt{12}$



17. Which of the following numbers is equal to $\frac{10i+2}{2i}$?

(Note: $i^2 = -1$)

- A. $5 - i$
B. 6
C. $9i$
D. $11i$

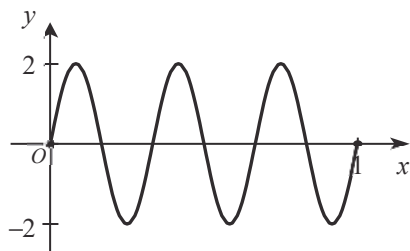
18. What is the value of x in the solution to the given system of linear equations?

$$8x + y = 6$$

$$9x - 6y = 11$$

- F. $\frac{25}{39}$
G. $\frac{47}{57}$
H. $\frac{57}{47}$
J. $\frac{39}{25}$

19. The function $y = 2 \sin(6\pi x)$ is graphed in the standard (x, y) coordinate plane for x radians in the interval $0 \leq x \leq 1$. What are the period and amplitude of the function?



- A. Period: $\frac{1}{3}$
Amplitude: 2
B. Period: $\frac{1}{3}$
Amplitude: 4
C. Period: 3
Amplitude: 2
D. Period: 3
Amplitude: 4



DO YOUR FIGURING HERE.

20. Let c , h , and q be distinct nonzero real numbers, and let x be a variable. Which of the following gives the solution to $c(x - h) = q$?

F. $\frac{q}{c} - h$

G. $\frac{q}{c} + h$

H. $\frac{q}{c} + \frac{h}{c}$

J. $\frac{q}{h} + \frac{c}{h}$

21. Given $\triangle RST$ with $RS = 18$ cm, $ST = 12$ cm, and $RT = 27$ cm, which of the following statements is true about the angles of this triangle?

- A. The measure of $\angle R$ is the least.
 B. The measure of $\angle S$ is the least.
 C. The measure of $\angle R$ is the greatest.
 D. The measure of $\angle T$ is the greatest.

22. Given $f(x) = 2x - 5$, what is the inverse, $f^{-1}(x)$?

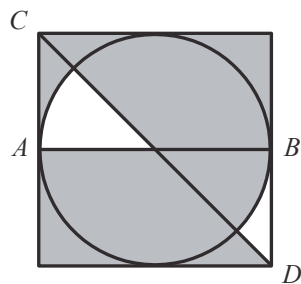
F. $\frac{x-5}{2}$

G. $\frac{x+5}{2}$

H. $\frac{x+2}{5}$

J. $\frac{1}{2}x + 5$

23. In the figure shown, a square is circumscribed about a circle with an 8-inch radius. Diameter $\overline{AB}$ is parallel to 2 sides of the square, and $\overline{CD}$ is a diagonal of the square. Some regions, bounded by the square, the circle, $\overline{AB}$, and $\overline{CD}$, are shaded. Which of the following is closest to the total area, in square inches, of the shaded regions?



- A. 64
 B. 176
 C. 224
 D. 256



DO YOUR FIGURING HERE.

24. In the standard (x,y) coordinate plane, a certain dilation maps the point $(0,0)$ to itself and maps the point $(4,-16)$ to the point $(1,-4)$. This dilation maps the point $(12,-24)$ to the point:

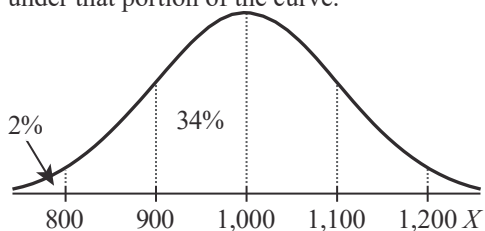
F. $(3,-6)$
 G. $(9,-36)$
 H. $(15,-36)$
 J. $(16,-20)$

25. A cleaning company sends out advertisements to potential customers. The table lists the probability of an advertisement leading to a certain amount of revenue. To the nearest cent, what is the expected value of the revenue generated from an advertisement sent to a potential customer?

Revenue	Probability
\$400	0.02
\$100	0.02
\$60	0.04
\$0	0.92

A. \$12.40
 B. \$13.32
 C. \$35.00
 D. \$80.00

26. A normal distribution for random variable X is given. Each percentage shown is the percentage of the area under that portion of the curve.



One of the following values is the value of $P(1,100 < X < 1,200)$ to the nearest 1%. Which one?

F. 14%
 G. 17%
 H. 18%
 J. 30%

27. Consider the repeating decimal $0.\overline{7412}$ in expanded form. What is the 323rd digit to the right of the decimal point?

A. 1
 B. 2
 C. 4
 D. 7



DO YOUR FIGURING HERE.

28. Jabari is walking along a straight sidewalk when he sees a tree directly ahead of him. He estimates that the angle of elevation from his feet to the top of the tree is 25° . As he continues walking, he finds that he was about 45 feet from the base of the tree when he estimated the angle of elevation. Based on Jabari's estimates, which of the following expressions represents the height, in feet, of the tree?

F. $45 \sin 25^\circ$
 G. $45 \cos 25^\circ$
 H. $45 \tan 25^\circ$
 J. $45 \cot 25^\circ$

29. A small hole was torn in the bottom corner of an unopened 1.5-pound bag of granulated sugar. By the time the hole was plugged, the leaked sugar had formed a pile in the shape of a cone with a radius of 3 inches and a height of 2 inches. Given that granulated sugar weighs 0.025 pounds per cubic inch, which of the following values is closest to the amount of sugar, in pounds, that was left in the bag after the leak was fixed?

(Note: The volume of a cone with radius r and height h is given by $V = \frac{\pi}{3}r^2h$.)

A. 0.086
 B. 1.029
 C. 1.350
 D. 1.475

30. Right after graduating from college, Consuelo was offered a job. The job pays a starting salary of \$40,000 per year. Consuelo computed what her salary would be each year for 10 years if she earned a 5% raise each year. Which of the following best describes the sequence formed by these salaries?

F. Arithmetic with a common difference of 5
 G. Arithmetic with a common difference of 40,000
 H. Geometric with a common ratio of 1.05
 J. Geometric with a common ratio of 5

31. The expression $(x + by)^n$ will be expanded and like terms will be combined. The resulting terms will be arranged in descending powers of x . After these steps are done, the 2nd term will be $8x^3y$. What will be the total number of terms?

A. 5
 B. 8
 C. 11
 D. 12



DO YOUR FIGURING HERE.

32. The concentration of a certain medication decreases each hour such that at $t = 0$ hours, the concentration is approximately equal to 850 mg/L; at $t = 6$ hours, the concentration is approximately equal to 151 mg/L; and at $t = 12$ hours, the concentration is approximately equal to 27 mg/L. One of the following identifies the best type of functional model for the data representing this 12-hour interval and gives a valid reason why that model is best. Which one?

- F. Linear, because over equal time intervals, the concentration decreases by equal factors.
- G. Linear, because over equal time intervals, the concentration decreases by equal differences.
- H. Exponential, because over equal time intervals, the concentration decreases by equal factors.
- J. Exponential, because over equal time intervals, the concentration decreases by equal differences.

33. Given that n is a rational number, which of the following statements about the number $\frac{-4\sqrt{14}-n}{2}$ must be true?

- A. $\frac{-4\sqrt{14}-n}{2}$ is positive.
- B. $\frac{-4\sqrt{14}-n}{2}$ is negative.
- C. $\frac{-4\sqrt{14}-n}{2}$ is an irrational number.
- D. $\frac{-4\sqrt{14}-n}{2}$ is a rational number.

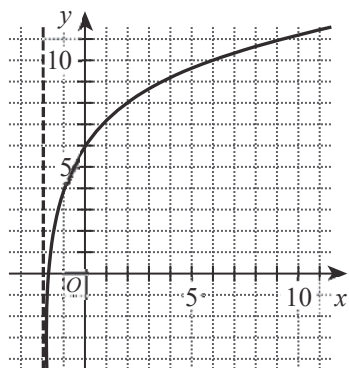
34. The graph of $\frac{x^2}{9} - \frac{y^2}{49} = 1$ in the standard (x, y) coordinate plane has an x -intercept at which of the following points?

- F. $(0, 0)$
- G. $(3, 0)$
- H. $(7, 0)$
- J. $(9, 0)$



DO YOUR FIGURING HERE.

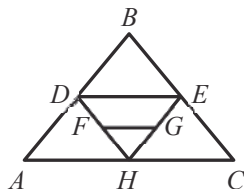
35. One of the following is the equation of this graph in the standard (x,y) coordinate plane. Which one?



- A. $y = 4(4)^{x-4} - 2$
 B. $y = 4(4)^{x+2} + 4$
 C. $y = 4 \log_4(x-4) - 2$
 D. $y = 4 \log_4(x+2) + 4$
36. Event W consists of 14 simple events. Event X consists of 11 simple events, none of which are in event W . Event Y is the intersection of events W and X , and event Z is the union of events W and X . Which of the following statements is true?

(Note: Given that event E consists of n simple events, $|E| = n$.)

- F. $|X| < |W| < |Y| < |Z|$
 G. $|X| < |W| < |Z| < |Y|$
 H. $|Y| < |X| < |W| < |Z|$
 J. $|Y| < |Z| < |X| < |W|$
37. An isosceles triangle, $\triangle ABC$, with $\overline{AB} \cong \overline{CB}$ is shown. Points D , E , and H are the midpoints of $\overline{AB}$, $\overline{CB}$, and $\overline{AC}$, respectively. Points F and G are the midpoints of $\overline{DH}$ and $\overline{EH}$, respectively. What is the ratio of the area of $\triangle ABC$ to the area of $\triangle FGH$?

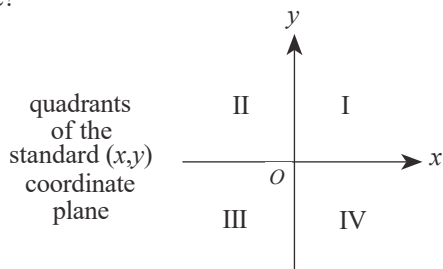


- A. 4:1
 B. 8:1
 C. 16:1
 D. 64:1



DO YOUR FIGURING HERE.

38. The quadrants of the standard (x,y) coordinate plane are labeled in the figure below. For each value of θ , let $x = \cos \theta$ and $y = \sin \theta$. Whenever $(\cos \theta)(\sin \theta) < 0$ is true, in which quadrants do the points (x,y) on the unit circle lie?



- F. I and III only
 G. II and III only
 H. II and IV only
 J. I, II, III, and IV
39. Two perpendicular lines in the standard (x,y) coordinate plane each have nonzero slopes. What is the product of their slopes?
- A. -2
 B. -1
 C. 1
 D. 2
40. For integers m and n such that $-3 \leq m \leq 4$ and $-10 \leq n \leq 9$, what is the greatest possible value of $|m - n|$?
- F. 5
 G. 7
 H. 12
 J. 14
41. A factor of $2.5x^2 - 30x + c$ is $x + 4$. What is the value of c ?
- A. -160
 B. -26
 C. 80
 D. 110



DO YOUR FIGURING HERE.

42. A company designed a questionnaire to be completed by its employees. The questionnaire has 5 questions with the answer choices of only “yes” or “no.” Given that every question must be answered and an employee can only choose 1 answer to each question, in how many ways can an employee answer all 5 questions on the questionnaire?

F. 7
G. 25
H. 32
J. 64

43. Consider quantities a , b , and m . Given that 40% of m is equal to a and that $b = \frac{7a}{10}$, which of the following expressions gives 112% of m in terms of b ?

A. $4b$
B. $12b$
C. $40b$
D. $84b$

44. The sum of the first 15 positive integers is 120. Which of the following values is the sum of the first 75 positive integers?

F. 600
G. 1,140
H. 2,775
J. 2,850

45. What are the equations of all the asymptotes in the standard (x,y) coordinate plane for the function $y = f(x) = \frac{3x^2}{x^2-9}$?

A. $x = -3$ and $y = 3$
B. $x = 3$ and $y = 0$
C. $x = -3$, $x = 3$, and $y = 0$
D. $x = -3$, $x = 3$, and $y = 3$

END OF TEST 2

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.

DO NOT RETURN TO THE PREVIOUS TEST.

READING TEST

40 Minutes—36 Questions

DIRECTIONS: There are several passages in this test. Each passage is accompanied by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

Passage I

INFORMATIONAL: This passage is from the essay "Producing and Collecting Portraits of Artists" by Anna Reynolds and Lucy Peter.

One practical consideration with painted self-portraits, which is easy to forget today, was the availability of mirrors. Flat glass mirrors were invented in Venice in around 1500. Before this date, mirrors were 5 small and convex, and therefore a potential deterrent to artists. However, attributing the development of self-portraiture purely to the development of mirrors is an oversimplification. While flat mirrors were available from c.1500, they were also prohibitively expensive: it 10 was not until the 1700s, when the French started producing mirrors of the same size and quality as the Venetians, that the market opened up and mirrors became more affordable. This is not to say that practical advancements in the production of mirrors had no 15 impact on the development of self-portraiture. The ability to see yourself more clearly and more frequently, around the turn of the sixteenth century, must have had a considerable social impact, encouraging greater physical self-awareness and helping to fuel the vanity of the 20 Renaissance self-portraitist.

Before the invention of flat glass in the late fifteenth century, mirrors were either made of polished stone, metal or convex glass. The latter were created from balls of blown glass filled with molten metal (typically lead, mercury or silver); and once cool, sections 25 of the ball were cut to form individual pieces. The first-known representation of a self-portrait being painted with the use of a mirror is in Giovanni Boccaccio's *Concerning Famous Women* (Bibliothèque nationale de France, c.1404): the Ancient Roman artist Iaia of Cyzicus (also known as Marcia) is shown working from a small convex glass mirror held in her hand. From the fifteenth century convex mirrors also frequently 30 appeared in a range of narrative paintings to demonstrate the skill of the artist. Even after the invention of flat mirrors, many artists continued to allude to convex mirrors in their work; indeed, it was to become an attribute of the artist, often shown hanging in the workshop of St Luke, the patron saint of artists.

40 In the early sixteenth century Parmigianino painted one of the most iconic images in the history of self-portraiture, *Self-Portrait in a Convex Mirror*. The painting itself was created on a specially prepared

convex panel of wood designed to imitate the curve of 45 the convex glass. The foreground is dominated by the artist's right hand, exaggerated by the curve of the mirror, while a gold C-shaped curve on the far right probably indicates the frame of the actual mirror from which the artist was working.

50 The first flat glass mirrors were produced in Venice in the late fifteenth century thanks to two major technical developments: the discovery of a new type of glass known as 'cristallo', so clear it was compared to rock crystal, and an improved silvering technique 55 achieved through the combination of mercury and tin. By the early sixteenth century flat glass mirrors were available to artists across Europe, although they remained expensive. *A Man in Armour* after Girolamo Savoldo (c.1480–1548) shows the sitter, possibly the 60 artist himself, reflected in two flat glass mirrors. In Dutch paintings of the seventeenth century such mirrors often feature as part of a domestic interior, as in Vermeer's *Lady at the Virginals with a Gentleman*, which shows a half-length mirror on the wall above the 65 instrument.

Full-length mirrors did not come into use until c.1700, which may account for the limited number of full-length self-portraits prior to this date. It was not until the nineteenth century, with the discovery of a 70 cheaper technique for silvering glass, that mirrors of a standard thickness and quality were finally available to the mass market.

When working on a flat table or drawing board the artist could sit in front of the mirror, producing an 75 accordingly frontal pose. Use of an easel, however, meant repositioning the mirror so that it could be seen: Jean Alphonse Roehn (1799–1864), for example, shows a mirror propped on a chair to the artist's left, at right angles to her easel. In this painting the window beyond 80 the mirror has been partially covered so that the light falls onto the artist from the upper left; her painting hand is furthest from the mirror, neither casting a shadow on her canvas nor blocking her view of her body. This practical set-up resulted in the most common 85 and enduring pose in self-portraiture: the artist, in three-quarter length view, turns (usually) over the right shoulder fixing the viewer with a steady outward gaze.

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1. The main purpose of the passage is to:
 - A. provide an overview of famous self-portraits created using flat glass mirrors.
 - B. explore trends in the art world that led to the development of self-portraiture.
 - C. describe the relationship and significance of mirrors to the development of self-portraits.
 - D. explain the history of and manufacturing methods involved in the development of mirrors.
2. The main point of the first paragraph (lines 1–20) is that:
 - F. while mirrors were not wholly responsible for the development of self-portraiture, they likely played an important role.
 - G. mirrors enabled people to see themselves, which likely had a great social impact.
 - H. flat glass mirrors were invented in Venice around the year 1500.
 - J. before flat mirrors were invented, convex mirrors were the norm and not particularly helpful to most self-portraitists.
3. Based on the passage, one similarity shared by *A Man in Armour* and *Lady at the Virginals with a Gentleman* is:
 - A. the featuring of a convex mirror in the paintings.
 - B. the inclusion of flat glass mirrors in the paintings.
 - C. a focus on domestic interiors.
 - D. the biographical backgrounds of the artists.
4. In the context of the passage, the author uses the phrase “fuel the vanity” (line 19) mainly to:
 - F. question Renaissance artists’ commitment to the genre of the self-portrait.
 - G. suggest one reason why the availability of mirrors might have resulted in more self-portraits.
 - H. dispute the idea that mirrors were a significant cause of vanity during the Renaissance.
 - J. explain why the availability of mirrors affected some artists more than others.
5. Which of the following statements most effectively captures the process by which convex mirrors were produced?
 - A. A ball of molten metal was formed, covered with glass, allowed to cool, and then cut into individual pieces.
 - B. A ball of molten metal was formed, allowed to cool, cut into individual pieces, and then covered with glass.
 - C. A ball of blown glass was formed, cut into individual pieces, filled with molten metal, and then allowed to cool.
 - D. A ball of blown glass was formed, filled with molten metal, allowed to cool, and then cut into individual pieces.
6. Based on the passage, which of the following statements best summarizes the role of convex mirrors after flat mirrors came into use for artists?
 - F. Although flat mirrors had obvious advantages for self-portraitists, many artists refused to use them, opting instead to use the older, more traditional convex mirrors.
 - G. Although the convex mirror became a less popular tool for artists after flat mirrors became available, it nonetheless remained a well-known symbol of the artist.
 - H. Some artists who began using flat mirrors chose to return to using convex mirrors for particular types of works, especially narrative paintings.
 - J. Once convex mirrors were used less often than flat mirrors for self-portraits, the convex mirror became a symbol of outdated, unfashionable artistic practices.
7. According to the passage, one development that allowed for the invention of flat mirrors was a new kind of glass that was particularly:
 - A. hard.
 - B. sturdy.
 - C. lightweight.
 - D. clear.
8. According to the passage, mirrors became widely available in the nineteenth century primarily because of:
 - F. the discovery of a new type of glass.
 - G. the development of mercury and tin as silvering agents.
 - H. a more economical silvering technique.
 - J. consumers finally expressing a need for mirrors.
9. As it is used in line 87, the word *fixing* most nearly means:
 - A. focusing on.
 - B. adhering to.
 - C. stabilizing.
 - D. correcting.

Passage II

LITERARY NARRATIVE: Passage A is adapted from the short story “All the Flowers in the Air” by Aarti Monteiro (©2021 by Kweli Journal, Inc.). Passage B is adapted from the novel *Central Places* by Delia Cai (©2023 by Delia Cai).

Passage A by Aarti Monteiro

With one more day in Bombay, Rani decided to visit her old neighborhood. She followed the route to the train station Siya had laid out and bought a ticket. She snaked her way through the crowded platform and
5 stopped at a group of women. The long train staggered into view and the crowd pushed to the edge of the platform. Rani felt her heart pulse, anxious about being left behind. Before the train stopped completely, the women hoisted themselves up and pushed Rani along with
10 them.

The train didn’t have doors so she gripped the sticky railing as tightly as she could. Warm air blew through the car as it crept forward. She watched the homes and trees as they passed. She’d always found
15 comfort in the anonymity of cities, how no one noticed you nor cared whether or not you belonged. In this way Bombay reminded her of New York—it wouldn’t welcome you but it didn’t mind that you were there.

Rani had barely seen the Lower Parel sign before
20 the current of people pushed her off. She stepped into a narrow vegetable market beneath the tracks. She knew she looked like a tourist but snapped photos anyway: a pile of drying chilies, plump green peppers, flowers strung together. The sellers called after her but she
25 couldn’t understand what they said and kept walking.

She glanced at her phone to see the directions to the building. She walked up a hill, each curve a current moving her closer to her home until she finally stopped at her old street corner. A high-rise stood in place of the
30 small building where they’d lived. Scaffolding blew in the hot wind and the gate was covered in dust. Rani could feel something tangle inside her like weeds. She used to play foursquare in the parking lot with the neighborhood kids, walk to the small corner shop with
35 her brother—in matching blue and white school uniforms—to buy candy. She waited, as if the building would turn back into the home she remembered if she was just there long enough. She took a photograph of the grey scaffolding against the bright sky. A passerby
40 looked at where her camera pointed and mumbled something Rani couldn’t understand.

She quickly moved the camera back into her bag, the sun beating down on her. When she was a child, she belonged to the city in a way she never had to think
45 about. The disappointment of returning home is the burden of anyone who leaves.

Passage B by Delia Cai

The narrator has just arrived with her fiancé, Ben, to visit her parents, and they’ve stopped at a grocery store on the way home.

Inside the H Mart, the instant confrontation with ninety thousand square feet of food laid out under a battery of flashing screens and fluorescent bulbs and
50 plastic holly makes me want to stop and massage my temples a little. Ben snaps a few pictures. My dad observes Ben with a bemused expression. “He’s very good,” my dad remarks to me, as if he can tell just by the way that Ben glides through the produce aisle, even
55 though I am sure that Ben is the first photographer, and journalist, and photojournalist, that my dad has ever met in his entire life. I take the shopping cart from my dad and follow him around as he gradually loses interest in watching Ben and then revs into grocery mode,
60 picking out crates of Asian pears and fat persimmons and twelve whole cartons of the soft tofu on sale for ninety-nine cents each. Ben takes a few pictures of a bin overflowing with bok choy before putting his camera away, which I’m relieved about.

65 “It’s a lot,” I apologize as my dad bobs ahead of us in the produce aisles. I think about what else I should preemptively say that I’m sorry for, amid the strangeness of trailing after my dad in this random Chicago suburb H Mart, but Ben squeezes my hand and tells me
70 to stop.

“You’re *so* stressed out.” He chuckles, and ordinarily this would be all it takes to make me roll my eyes and nod along, but I’m watching my dad closely so we don’t lose him in the soy sauce aisle. “Breathe,” Ben
75 reminds me. “Everything is going great, okay?”

He takes the cart from me and gestures for me to climb onto the end. I want to humor him, so I do, and he steers the cart past rows of Spam and cellophane noodles, his eyes softening with satisfaction as I try to
80 tell him to slow down but start laughing instead. Maybe this *was* a good idea, bringing my chronically starry-eyed fiancé home. If anyone could handle this trip, it was going to be Ben, Mr. Up for Whatever, and as long as I had him with me, that made me the soon-to-be
85 Mrs. Up for Whatever. And that meant I was truly coming back to this place as a different person than the one who left. How stupid it was to worry about Ben on this trip when being slightly out of place, I realize, has always been his natural element.

10. It can reasonably be inferred that the author of Passage A uses the metaphors “current of people” (line 20) and “each curve a current” (line 27) primarily to:
- F. suggest that Rani is to some degree being compelled onward by external forces.
 - G. emphasize the number of people in the crowds traveling alongside Rani.
 - H. indicate that Rani is trying to remind herself to stay present and aware in the moment.
 - J. underscore that the thought of returning home is deeply exciting to Rani.
11. As it is used in Passage A, the phrase “laid out” (line 3) most nearly means:
- A. outlined.
 - B. invented.
 - C. projected.
 - D. interpreted.
12. In Passage B, compared to the narrator, the narrator’s father is characterized as being more focused on:
- F. chatting about the narrator’s family.
 - G. selecting various grocery items to buy.
 - H. observing Ben’s interactions with store patrons.
 - J. helping Ben learn how to pick out the best produce.
13. In Passage B, the narrator’s thoughts in response to her father’s remark about Ben’s photography most nearly suggest that the narrator is:
- A. skeptical that her father has any true understanding of photojournalism.
 - B. overjoyed that her father already seems to value Ben’s professional skills.
 - C. proud of being the one to introduce her father to the world of photojournalism.
 - D. bewildered that her father doesn’t ask Ben any questions about photography.
14. As it is used in Passage B, the phrase “chronically starry-eyed” (lines 81–82) most nearly means that Ben:
- F. can often dazzle people with his charm.
 - G. is regularly found daydreaming instead of working.
 - H. has a consistently optimistic outlook on life.
 - J. is frequently perceived by others as aloof and shy.
15. The passages are structurally similar in that both mainly:
- A. relate events that take place within a single day.
 - B. recount characters’ feelings and thoughts about moments from their past.
 - C. describe a particular event and its long-term effects.
 - D. alternate between relating characters’ memories of the past and events occurring in the present.
16. Which of the following statements best captures a difference in the way the passages explore the themes of home and belonging?
- F. Passage A focuses on how Rani regrets leaving home; Passage B discusses the narrator’s newfound desire to return home.
 - G. Passage A considers how the place that was once home for Rani has changed; Passage B discusses how the narrator realizes that she herself is different.
 - H. Passage A examines the lasting impact on Rani of leaving home as a child; Passage B considers the impact that returning home has on the narrator’s relationship with her parents.
 - J. Passage A focuses on how Rani feels that the people she once knew are different; Passage B examines how the narrator’s hometown has changed.
17. It can most reasonably be inferred from the passages that compared to the narrator of Passage B, Rani in Passage A would be more likely to describe her experience of visiting her former home as:
- A. amusing.
 - B. pleasant.
 - C. stimulating.
 - D. disappointing.
18. Which of the following statements best describes how the tone of the last paragraph of Passage A (lines 42–46) compares to the tone of the last paragraph of Passage B (lines 76–89)?
- F. The tones are similar in that both reflect the contentment the characters feel with their circumstances.
 - G. The tones are similar in that both reflect the hesitancy and indecision the characters feel about what to do next.
 - H. The tones are different in that Passage A ends with a tone of wistfulness, whereas Passage B ends on a hopeful note.
 - J. The tones are different in that Passage A ends with a tone of acceptance, whereas Passage B ends on a defiant note.

Passage III

INFORMATIONAL: This passage is adapted from the essay "Spaced Out: The *Star Trek* Literary Phenomenon: Where No TV Series Has Gone Before" by Michael M. Epstein, which appeared in *Television Quarterly* (©1996 by The National Academy of Television Arts and Sciences).

On September 8, 1966, when NBC premiered its new futuristic series, *Star Trek*, few were watching. Conceived by television writer Gene Roddenberry as part American Western, part science fiction, and part
5 contemporary morality play, *Star Trek* languished for two and a half years before being canceled as a ratings flop in January 1969.

Two years later, *Star Trek* somehow had captured the imagination and viewer loyalty of millions of
10 Americans who "discovered" the show anew in syndicated reruns. *Star Trek*'s meteoric rise to popularity was unprecedented for a television program. By January 1972, the show was airing in over one hundred local markets in America and seventy more around the
15 world.

Perhaps more than other television series, *Star Trek* benefited greatly from being the right show at the right time. In middle-class America, social and political change in the late 1960s made it increasingly
20 difficult for people to unite in common purpose. Civil rights struggles, the Vietnam War, and the rise of a culturally empowered youth movement, among other things, divided many Americans by race, gender, age, and politics.

Although television news programs helped focus the country on the rifts that had begun to percolate on campuses, in city streets, and around dining room tables, as a rule entertainment programming avoided conflict and controversy. Escapist comedy about sub-
25 urban witches, genies, and rural townspeople was standard fare. Network drama emphasized law, order, and conformity, whether on the police beat, in a courtroom, or out on the great Western frontier.
30

Star Trek was different. Created in the optimistic
35 afterglow of John F. Kennedy's inauguration of the space race, *Star Trek*'s exploration of the "final frontier" was a theme that resonated with millions of idealistic and awestruck Americans who looked at the Apollo moon landings as a crowning, positive achievement for humankind. Still, as Gene Roddenberry often
40 claimed, *Star Trek* was less about the future than the present.

Indeed, it was precisely because of its futuristic storyline that *Star Trek* was able to address many of the
45 contemporary social problems that other programs shunned. *Star Trek*'s visionary episodes on race relations, nuclear deterrence, multiculturalism, and ecology (among others) were not threatening to those who saw it as fantastic science fiction. For those who saw the
50 program as a window into current controversy, *Star Trek* offered insight and added perspective to continued

American cultural and political change in the 1970s. Either way, the show's wide appeal in syndication was such that, by 1977, *Star Trek* had become the most-
55 watched off-network series drama of all time.

In nearly thirty years, Gene Roddenberry's fantasy space concept has spawned four prime-time series, continued syndication, a cartoon, eight major motion pictures, countless toys, games, and computer software.
60 Nearly overlooked, however, is the unparalleled impact *Star Trek* has had on an industry that has only recently become television friendly: publishing. Since the early 1970s, when the first novels hit bookshelves, the world of *Star Trek* has exploded in print like no other phe-
65 nomenon in American popular culture. *Star Trek* fan volumes, cast memoirs, and novels continue to appear—and in record numbers.

Of all the "classic" and contemporary shows available to a critic, none illustrates the scope of America's
70 cultural evolution as eloquently as the saga of *Star Trek* and its next-generation spin-offs. In a culture that has undergone dramatic and far-reaching change in the last thirty years, *Star Trek* sweetens the often bitter alienation of contemporary change with the type of familiarity and constancy that only a show with a thirty-year
75 history can offer.

Star Trek offers viewers the paradox of a program that combines provocative insight into changing cultural values with the reassuring comfort that the
80 "known" universe of Starfleet, Klingons, and phasers can nonetheless survive intact, and even grow.

Because of its active fandom, *Star Trek* has become a television phenomenon like no other in American culture. And just as the original *Star Trek* has
85 found new expression in series such as *The Next Generation*, *Deep Space Nine*, and *Voyager*, I suspect fans will find new ways to indulge or express their private affection for *Star Trek* by reading—and writing—books in greater numbers. As America goes boldly into
90 the next millennium, so will *Star Trek* in print, on television, and in formats yet to come.

19. The main purpose of the passage can best be described as an effort to:

- A. explain how and why *Star Trek* has endured.
- B. illustrate what American society was like at the time the original *Star Trek* series was created.
- C. discuss how *Star Trek*'s storyline has changed over its thirty-year history.
- D. describe the different forms that *Star Trek* has taken, such as television series, films, and novels.

20. The author's attitude toward the subject of the passage can best be characterized as:
- F. amused tolerance.
 - G. detached interest.
 - H. warm appreciation.
 - J. mild skepticism.
21. It can be reasonably inferred that the author believes *Star Trek* first became a success in:
- A. 1966.
 - B. 1969.
 - C. 1971.
 - D. 1977.
22. According to the fourth paragraph (lines 25–33), compared to television news programs of the time period, entertainment programming is described as:
- F. more willing to examine the rifts developing in American society.
 - G. more willing to portray violent conflict and controversy.
 - H. less willing to promote the principles of conformity and order.
 - J. less willing to present a realistic picture of contemporary life.
23. As described in the passage, the effect *Star Trek* has had on the publishing industry can best be summarized by which of the following statements?
- A. *Star Trek*'s impact can be safely overlooked because the publishing industry remains unfriendly to television.
 - B. *Star Trek* made an impact with its first novels, but that impact has lessened over time.
 - C. *Star Trek*'s tremendous impact has been primarily limited to novels.
 - D. *Star Trek* has had a deep impact with its extensive and popular range of books.
24. When the author states that *Star Trek* was "the right show at the right time" (lines 17–18), he most likely means that the series benefited from:
- F. the unsettled social and political conditions.
 - G. the general popularity of syndicated reruns.
 - H. an increasing appetite for escapist entertainment.
 - J. the increasingly empowered middle class.
25. The passage indicates that *Star Trek* creator Gene Roddenberry's primary purpose in creating the series was to:
- A. show how different life would be in the future.
 - B. promote the space program and the exploration of space.
 - C. offer a lighthearted alternative to serious entertainment.
 - D. comment on problems facing people in the present.
26. According to the author, the primary benefit of the original *Star Trek*'s futuristic storyline was that it allowed the series' writers to:
- F. offer perspectives and insights that were unthreatening.
 - G. invent fantastic and entertaining science fiction worlds.
 - H. easily develop related spin-offs, such as films and new series.
 - J. avoid controversial topics, such as nuclear deterrence and multiculturalism.
27. The "paradox" mentioned in line 77 most directly refers to what the author sees as the conflicting ideas of:
- A. cultural values and entertainment.
 - B. familiarity and change.
 - C. comfort and the *Star Trek* universe.
 - D. survival and being provocative.

Passage IV

INFORMATIONAL: This passage is from the article “Life Springs” by Martin J. Van Kranendonk, David Deamer, and Tara Djokic (©2017 by Scientific American).

The researchers, who are also the authors of the passage, are hiking back to their truck after spending the day at the Dresser Formation.

Heading up the side of the creek embankment, Djokic suddenly stumbles back downhill. Has she lost her balance? To stop her from falling, Van Kranendonk reaches out to stop her and pushes her back uphill, which prompts a screech, something unintelligible, and finally a sputtered cry: “Sp- ... p- ... p- ... pppider!” Djokic has not stumbled at all. She is in flight mode, in fear for her life as she tries to swat away the thick spider web enveloping her. Spiders have a deservedly bad reputation in Australia. In the dark, it is not a good idea to assume that you have found the odd benign species.

The reason we are feeling our way around the Pilbara at night is because we had spent the day enthralled by a new discovery Djokic had made in 3.48-billion-year-old sedimentary rocks called the Dresser Formation. Some of the rocks are wrinkled orange and white layers, called geyserite, which were created by a volcanic geyser on Earth’s surface. They revealed bubbles formed when gas was trapped in a sticky film, most likely produced by a thin layer of bacterialike microorganisms. The surface rocks and indications of biofilms support a new idea about one of the oldest mysteries on the planet: how and where life got started. The evidence pointed to volcanic hot springs and pools, on land, about 3.5 billion years ago.

This is a far different picture of life’s origins from the one scientists have been sketching since 1977. That was the year the research submarine *Alvin* discovered hydrothermal vents at the bottom of the Pacific Ocean pumping out minerals containing iron and sulfur and gases such as methane and hydrogen sulfide, surrounded by primitive bacteria and large worms. It was a thriving ecosystem. Biologists have since theorized that such vents, protected from the cataclysms wracking Earth’s surface about four billion years ago, could have provided the energy, nutrients and a safe haven for life to begin. But the theory has problems. The big one is that the ocean has a lot of water, and in it the needed molecules might spread out too quickly to interact and form cell membranes and primitive metabolisms.

Now we and others believe land pools that repeatedly dry out and then get wet again could be much better places. The pools have heat to catalyze reactions, dry spells in which complex molecules called polymers can be formed from simpler units, wet spells that float these polymers around, and further drying periods that maroon them in tiny cavities where they can interact and even become concentrated in compartments of fatty acids—the prototypes of cell membranes.

What Djokic found was strong geologic evidence that the Dresser, now a dry, hot and barren outback environment, had once been like the steaming pools and erupting geysers of Yellowstone National Park in the U.S., an active geothermal field. And everywhere in the Dresser there are fossilized signs of life intimately associated with the old hot spring system. Although the Dresser was not the actual site where the most primitive life began half a billion years earlier, it was showing us that hydrothermal environments on land were present very early in Earth’s history. Charles Darwin had suggested, back in 1871, that microbial life originated in “some warm little pond.” A number of scientists from different fields now think that the author of *On the Origin of Species* had intuitively hit on something important. And the implications of these ideas stretch beyond our own planet: in our search for alien life elsewhere in the solar system, a land-based theory about origins would guide us to different places and planets than would an ocean-based theory.

Ten years before Djokic’s run-in with the spider web, another of us (Deamer) had shown that volcanic pools could foster the assembly of compartments made of membranes, essential boundaries of all cellular life.

28. The primary purpose of the passage is to:
- F. relate the story of how researchers studying the Dresser Formation found indications of biofilms in geyserite.
 - G. explain how evidence from the Dresser Formation supports a new idea about where life on Earth began.
 - H. discuss the strengths and weaknesses of theories about where life on Earth began.
 - J. provide a chronology of the prevailing beliefs about when and where life on Earth began.
29. Which of the following events mentioned in the passage occurred **last** chronologically?
- A. Van Kranendonk reached out to push Djokic back uphill.
 - B. Djokic discovered indications of biofilms in the Dresser Formation.
 - C. Djokic encountered the spiderweb.
 - D. The researchers began hiking through the Pilbara at night.

30. Based on lines 13–26 and 71–74, what can reasonably be inferred about the relationship between Djokic’s and Deamer’s discoveries?
- F. Djokic found geologic evidence to support what Deamer had shown was possible.
 - G. Deamer found the same geologic evidence in the Dresser a decade earlier than Djokic did.
 - H. Deamer’s research later proved that Djokic had found evidence of early life on Earth.
 - J. Djokic’s discovery undermined Deamer’s research from ten years earlier.
31. Which of the following details from the passage most directly challenges the claim that life originated in the ocean?
- A. Primitive bacteria weren’t found on ocean-based hydrothermal vents until 1977.
 - B. In vast amounts of water, molecules may spread out too quickly to interact.
 - C. Cataclysms wracked the Earth about four billion years ago.
 - D. Hydrothermal vents emit gases such as hydrogen sulfide.
32. Which of the following statements best summarizes the passage’s description of polymers in land pools?
- F. Polymers form during a heated dry spell, and then they float around and interact with each other during wet spells.
 - G. Polymers form and interact in the pools during wet spells, then float around and become fatty acids during dry spells.
 - H. Polymers form during a dry spell, float around during a wet spell, and interact with each other when the pools dry out again.
 - J. Polymers repeatedly dry out and get wet again, which allows them to interact with each other.
33. As it is used in line 11, the word *odd* most nearly means:
- A. unorthodox.
 - B. eccentric.
 - C. miscellaneous.
 - D. unlikely.
34. In the passage, what evidence mentioned by the authors best supports the claim “it was a thriving ecosystem” (lines 33–34)?
- F. Biologists’ theories about hydrothermal vents after the 1977 *Alvin* discovery
 - G. The minerals, gases, and organisms that the *Alvin* detected around hydrothermal vents
 - H. The similarities between the ecosystems of hydrothermal vents and volcanic pools
 - J. How primitive bacteria use iron and sulfur to form cell membranes
35. The passage authors include the details about Yellowstone National Park primarily to:
- A. provide an example of where fossilized signs of life have been found.
 - B. acknowledge where life on Earth likely began.
 - C. portray what the Dresser once looked like.
 - D. emphasize how similar the Dresser’s current climate is to Yellowstone’s.
36. According to the passage, establishing a land-based theory for life’s origins will likely influence future research pertaining to:
- F. prototypes of cell membranes.
 - G. sedimentary rocks in the Pilbara.
 - H. how hydrothermal vents function.
 - J. the search for alien life.

END OF TEST 3

**STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.
DO NOT RETURN TO A PREVIOUS TEST.**

**SCIENCE TEST***40 Minutes—40 Questions*

DIRECTIONS: There are several passages in this test. Each passage is followed by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

You are **not** permitted to use a calculator on this test.

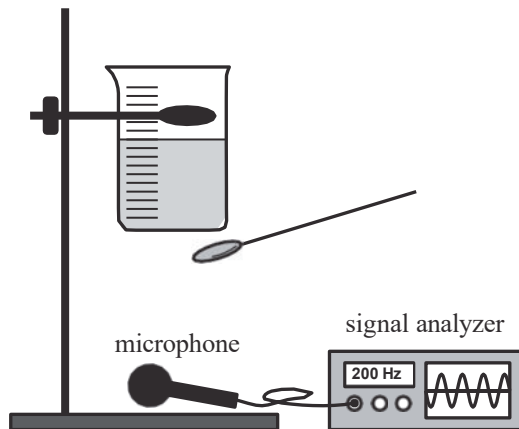
Passage 1

When the base of a beaker is tapped, sound waves are produced. A scientist performed 2 experiments to study the frequency of the sound waves produced in a beaker containing a solution of water and salt.

Experiment 1

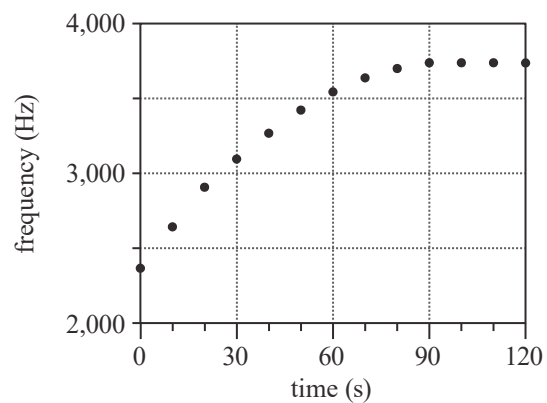
A scientist clamped a 1,000 mL beaker to a stand and placed a microphone attached to a signal analyzer near the base of the stand. Then, the scientist poured water at a temperature of 85°C into the beaker until the height of the water was 10 cm. Next, the scientist added 10 g of salt and stirred the solution with a lab spoon until the salt completely dissolved before beginning to tap the base of the beaker. See Figure 1.

Figure 1



The scientist tapped the base of the beaker for 2 minutes at a constant rate. Immediately following the first tap (at 0 s), and every 10 s thereafter, the frequency, in hertz (Hz), displayed by the signal analyzer was recorded. The results are shown in Figure 2.

Figure 2

*Experiment 2*

The scientist repeated the procedures of Experiment 1 three times except that the scientist varied the height of the water. Table 1 shows, for each height, the frequency recorded at each of 4 times.

Table 1				
Height of water (cm)	Frequency (Hz) at time:			
	0 s	30 s	60 s	90 s
12	1,978	2,580	2,918	3,131
14	1,692	2,209	2,503	2,680
16	1,480	1,938	2,188	2,344



1. The speed of sound is directly proportional to the frequency of the sound wave. Based on the results of Experiment 1, how did the speed of sound vary, if at all, between 0 s and 120 s? The speed of sound:
 - A. increased and then decreased.
 - B. increased and then remained constant.
 - C. decreased and then remained constant.
 - D. did not vary.
2. The musical note A6 has a frequency of 1,760 Hz. How many of the frequencies listed in Table 1 are higher than the note A6?
 - F. 5
 - G. 6
 - H. 10
 - J. 12
3. Based on the results of Experiments 1 and 2, if the procedures of Experiment 1 had been repeated and the frequency of the sound wave at 60 s had been 2,300 Hz, the height of water in the beaker would most likely have been:
 - A. less than 10 cm.
 - B. between 12 cm and 14 cm.
 - C. between 14 cm and 16 cm.
 - D. greater than 16 cm.
4. In Experiment 1, during which of the following time intervals was the average rate of change in frequency least?
 - F. From 0 s to 10 s
 - G. From 20 s to 30 s
 - H. From 40 s to 50 s
 - J. From 60 s to 70 s
5. In which of the experiments, if either, did the scientist vary the rate of tapping the base of the beaker?
 - A. Experiment 1 only
 - B. Experiment 2 only
 - C. Both Experiment 1 and Experiment 2
 - D. Neither Experiment 1 nor Experiment 2
6. Based on the procedures of Experiment 1 and Experiment 2, what was the height of the water when the water had the least concentration of salt?
 - F. 10 cm
 - G. 12 cm
 - H. 14 cm
 - J. 16 cm



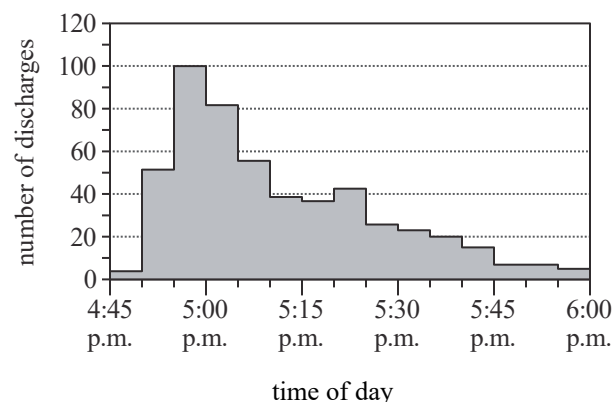
Passage II

Lightning is an electrical discharge during which 2 oppositely charged regions, each either in the atmosphere or on the ground, temporarily equalize themselves, causing an instantaneous release of energy. Over 1 summer, observations of lightning discharges were collected during 10 thunderstorms (Storms 1–10). See Table 1.

Storm	Storm duration (min)	Total number of discharges	Maximum flash rate (discharges/min)
1	35	16	1
2	130	673	11
3	130	71	1
4	40	30	2
5	85	49	1
6	75	515	20
7	130	673	10
8	111	355	9
9	84	335	8
10	265	1,212	16

Figure 1 shows the distribution of discharges (number of discharges per 5 min) over the duration of Storm 6.

Figure 1



During Storm 6, the negative charge (in coulombs, C) on the ground prior to each of 70 lightning discharges was measured. Figure 2 shows, for each 5 C range, the number of discharges associated with a charge in that range.

Figure 2

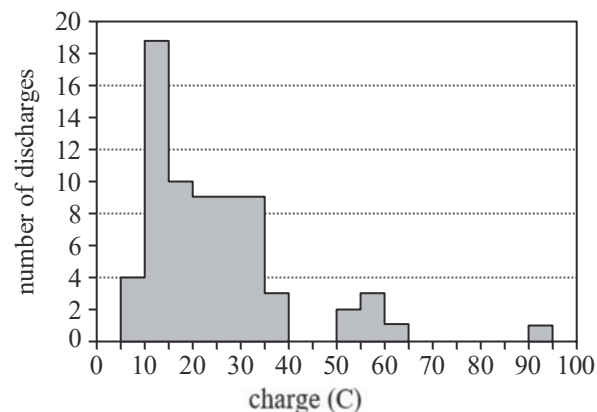


Table and figures adapted from the article "Electrostatic Field Changes Produced by Florida Lightning" by Elizabeth A. Jacobson and E. Philip Krider. (©1976 by American Meteorological Society).

7. Based on Figure 1, the greatest number of lightning discharges occurred during which time period, and approximately how many lightning discharges were observed during that time period?
 - A. Time period: 4:55 p.m. to 5:00 p.m.
Number of discharges: 85
 - B. Time period: 4:55 p.m. to 5:00 p.m.
Number of discharges: 100
 - C. Time period: 5:00 p.m. to 5:05 p.m.
Number of discharges: 85
 - D. Time period: 5:00 p.m. to 5:05 p.m.
Number of discharges: 100
8. Which of the following lists Storm 2, Storm 4, Storm 6, and Storm 8 in order from the storm with the highest maximum flash rate to the storm with the lowest maximum flash rate?
 - F. Storm 4, Storm 2, Storm 8, Storm 6
 - G. Storm 4, Storm 8, Storm 2, Storm 6
 - H. Storm 6, Storm 2, Storm 8, Storm 4
 - J. Storm 6, Storm 8, Storm 2, Storm 4



9. For Storm 7, what was the approximate average number of discharges per minute (average flash rate), and what was the approximate difference between the maximum flash rate and the average flash rate?
- A. Average flash rate: 3
Difference: 5
 - B. Average flash rate: 3
Difference: 15
 - C. Average flash rate: 5
Difference: 5
 - D. Average flash rate: 5
Difference: 15
10. Based on Figure 2, exactly 9 lightning discharges were detected for which range(s) of charge?
- F. 15–20 C only
 - G. 15–20 C and 25–30 C only
 - H. 20–25 C and 30–35 C only
 - J. 20–25 C, 25–30 C, and 30–35 C only
11. Based on Figure 1, what was the approximate average flash rate per minute for the 5 min time period starting at 5:25 p.m.?
- A. 5 discharges/min
 - B. 9 discharges/min
 - C. 11 discharges/min
 - D. 16 discharges/min
12. Based on Table 1 and the description of Figure 2, how many lightning discharges from Storm 6 are **not** represented in Figure 2?
- F. 70
 - G. 75
 - H. 445
 - J. 515

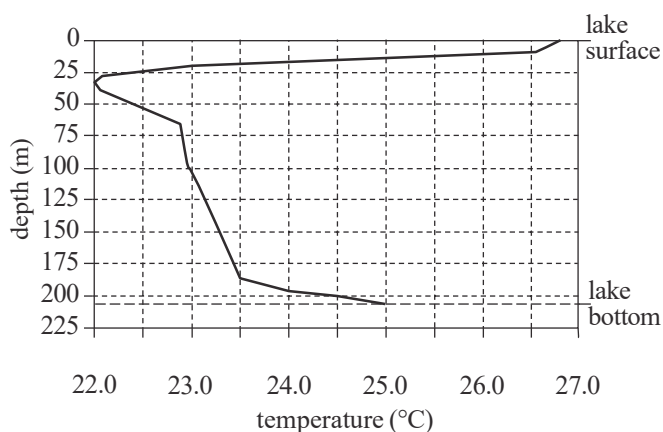
Passage III

Lake Nyos, a volcanic lake 210 m deep, has a unique water chemistry that is related to the presence of *magma* (molten rock) beneath the lake bottom, and to the magma-heated groundwater that enters the lake from below. Scientists performed 3 studies on Lake Nyos.

Study 1

A temperature probe was lowered into the lake in several locations. The probe continuously recorded the water temperature from the surface to the bottom at each location. Figure 1 shows the averaged results.

Figure 1

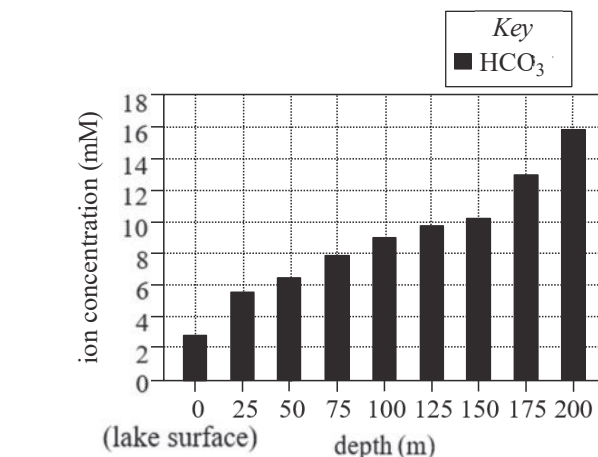
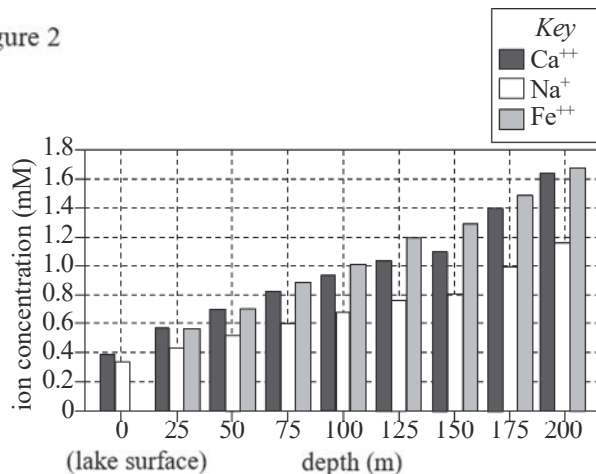


Study 2

Water samples were taken every 25 m between the surface and 200 m depth using stainless steel sampling bottles. Each bottle was first sealed and pressurized to prevent water from entering, then lowered to the depth where a sample was to be collected. The bottle was then depressurized, allowing water to enter. After each bottle was resealed, it was brought to the surface and the water sample was analyzed.

The concentrations of calcium, sodium, bicarbonate, and iron ions (Ca^{++} , Na^+ , HCO_3^- , and Fe^{++}) were measured in the lake water samples. The scientists noted that the concentrations of these ions in the samples from 75 m to 200 m were much higher than expected for the lake water. Figure 2 shows the results of the analyses. Concentrations are millimolar (mM).

Figure 2



Study 3

The water samples from depths of 75 m to 200 m taken in Study 2 were also analyzed for the concentrations of dissolved gases. Table 1 shows the results of those analyses.

Depth (m)	Dissolved gas concentrations ($\mu\text{mol/kg}$)			
	O_2	N_2	CH_4	CO_2
75	2.7	217	249	72,600
100	5.6	175	294	88,500
125	13.9	200	425	132,000
150	24.1	271	481	158,000
175	2.3	101	492	203,000
200	6.7	137	635	259,000

Figure 1 and Table 1 adapted from William Evans et al., "Gas Buildup in Lake Nyos, Cameroon: The Recharge Process and its Consequences." ©1993 by Pergamon Press Ltd.

Figure 2 adapted from George Kling, Michele Tuttle, and William Evans, "The Evolution of Thermal Structure and Water Chemistry in Lake Nyos." ©1989 by Elsevier Science Publishers.



13. Which of the following statements best describes how the design of Study 2 differs from the design of Study 3? Study 2 measured the concentrations of:
- A. ions in the lake water, whereas Study 3 measured the concentrations of dissolved gases in the lake water.
 - B. ions in the lake water, whereas Study 3 measured the temperature of the lake water.
 - C. dissolved gases in the lake water, whereas Study 3 measured the concentrations of ions in the lake water.
 - D. dissolved gases in the lake water, whereas Study 3 measured the temperature of the lake water.
14. A scientist hypothesized that the concentration of N_2 gas increases with increasing depth in Lake Nyos. Is this hypothesis supported by the results of Study 3?
- F. Yes; the concentration of N_2 steadily increases as the depth increases.
 - G. Yes; the concentration of N_2 remains constant through all depths.
 - H. No; the concentration of N_2 steadily decreases as the depth increases.
 - J. No; the concentration of N_2 does not show a consistent increase or decrease with depth.
15. According to the results of Study 2, how does the concentration of HCO_3^- in the lake water samples compare to the concentrations of the other measured ions? The concentration of HCO_3^- at any given depth is:
- A. the same as the concentrations of the other measured ions at any given depth.
 - B. lower than the concentrations of the other measured ions at any given depth.
 - C. sometimes lower and sometimes higher than the concentrations of the other measured ions at any given depth.
 - D. higher than the concentrations of the other measured ions at any given depth.
16. In Study 3, the unit of measure for the dissolved gases is $\mu\text{mol/kg}$. The “kg” refers to a kilogram of which of the following?
- F. Pure oxygen
 - G. Lake water
 - H. Air
 - J. Lake sediment
17. According to Study 2, the average concentration of Ca^{++} at 185 m depth in Lake Nyos would most likely be between:
- A. 1.2 mM and 1.4 mM.
 - B. 1.4 mM and 1.6 mM.
 - C. 1.6 mM and 1.8 mM.
 - D. 1.0 mM and 1.2 mM.
18. According to the information provided, to find out why the ion concentrations in the deeper lake water were much higher than was expected for the lake water, it would be most helpful for the scientists in Study 2 to do analyses of several samples of which of the following?
- F. The surface water of Lake Nyos
 - G. The air above Lake Nyos
 - H. The groundwater below Lake Nyos
 - J. The surface water from another freshwater lake



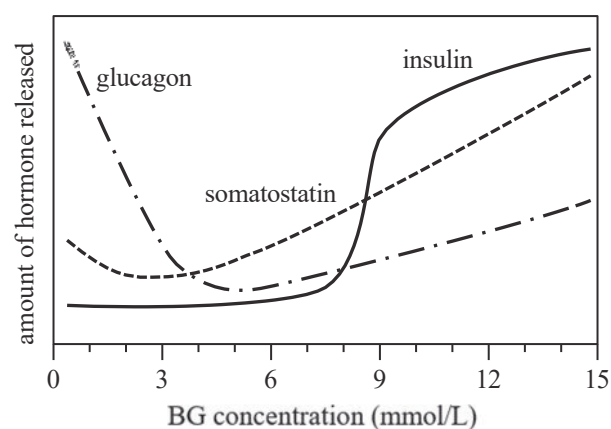
Passage III

Introduction

The pancreas is an organ in mammals that contains clusters of endocrine cells. Each cluster contains 3 cell types—alpha (α), beta (β), and delta (δ). Each cluster also releases 3 hormones (chemical messengers)—insulin, glucagon, and somatostatin. These 3 hormones are involved in the regulation of blood glucose (BG) concentration.

Figure 1 shows the relationship between the amount of each hormone released and the BG concentration in millimoles per liter (mmol/L).

Figure 1



Four students discussed the release of each hormone, the BG set point (concentration range over which BG is at homeostasis), and the role of somatostatin.

Student 1

In the pancreas, α -cells release insulin, β -cells release glucagon, and δ -cells release somatostatin. The BG set point is 1–3 mmol/L. BG concentrations greater than 8 mmol/L are not recommended. The greatest amounts of insulin and glucagon are released at BG concentrations greater than the set point. Somatostatin inhibits the release of insulin and glucagon.

Student 2

In the pancreas, α -cells release glucagon, β -cells release insulin, and δ -cells release somatostatin. The BG set point is 4–6 mmol/L. BG concentrations less than 3 mmol/L and greater than 11 mmol/L are not recommended. The greatest amount of insulin is released at a BG concentration greater than the set point. The greatest amount of glucagon is released at a BG concentration less than the set point. Somatostatin inhibits the release of insulin and glucagon.

Student 3

Student 2 is correct except the BG set point is 7–9 mmol/L, and somatostatin promotes the release of insulin but does not affect the release of glucagon.

Student 4

In the pancreas, α -cells release glucagon and somatostatin, β -cells release insulin, and δ -cells release no hormone. The BG set point is 7–9 mmol/L. BG concentrations greater than 7 mmol/L are not recommended. The greatest amount of insulin is released at a BG concentration greater than the set point. The greatest amount of glucagon is released at a BG concentration less than the set point. Somatostatin inhibits the release of insulin only.

Figure adapted from the article "The Difference δ -Cells Make in Glucose Control" by Mark O. Huising et al. (©2018 by Int. Union Physiol. Sci./Am. Physiol. Soc).

19. Based on the Introduction, which of the following statements best describes the pancreas? The pancreas is:
- a cell, the smallest functional unit of a living organism.
 - a cell, a group of tissues that perform a specific function.
 - an organ, the smallest functional unit of a living organism.
 - an organ, a group of tissues that perform a specific function.



20. Based on the explanation given by Student 3, if the release of somatostatin increased, would the release of insulin most likely increase or decrease, and would the release of glucagon most likely decrease or stay approximately the same?
- F. Insulin: increase
Glucagon: decrease
 - G. Insulin: increase
Glucagon: stay approximately the same
 - H. Insulin: decrease
Glucagon: decrease
 - J. Insulin: decrease
Glucagon: stay approximately the same
21. Which of Students 1, 2, and 3 would agree that a BG concentration of 2 mmol/L is not recommended?
- A. Student 2 only
 - B. Students 1 and 3 only
 - C. Students 2 and 3 only
 - D. Students 1, 2, and 3
22. All 4 student explanations are consistent with which of the following statements about somatostatin? Somatostatin is:
- F. An endocrine cell that can regulate hormone release.
 - G. An endocrine cell that cannot regulate hormone release.
 - H. A chemical messenger that can regulate hormone release.
 - J. A chemical messenger that cannot regulate hormone release.
23. In Figure 1, consider the BG concentration that results in the greatest amount of glucagon released. Are these data consistent with Student 1's explanation?
- A. Yes; Student 1 indicated that the greatest amount of glucagon is released when BG concentrations are within the set point.
 - B. Yes; Student 1 indicated that the greatest amount of glucagon is released when BG concentrations are greater than the set point.
 - C. No; Student 1 indicated that the greatest amount of glucagon is released when BG concentrations are within the set point.
 - D. No; Student 1 indicated that the greatest amount of glucagon is released when BG concentrations are greater than the set point.
24. Is the explanation given by Student 4 consistent with the definition of the BG set point in the Introduction?
- F. No; Student 4 indicated that the BG set point was **not** recommended, but based on the Introduction, the BG set point results in optimal body functioning.
 - G. No; Student 4 indicated that the BG set point was recommended, but based on the Introduction, the BG set point results in poor body functioning.
 - H. Yes; Student 4 indicated that the BG set point was **not** recommended, and based on the Introduction, the BG set point results in poor body functioning.
 - J. Yes; Student 4 indicated that the BG set point was recommended, and based on the Introduction, the BG set point results in optimal body functioning.

Passage IV

Phenol is a toxic material often found in wastewater. Phenol reacts with hydrogen peroxide (H_2O_2) to give nontoxic products. Scientists performed 3 studies to examine the removal of phenol from wastewater with H_2O_2 .

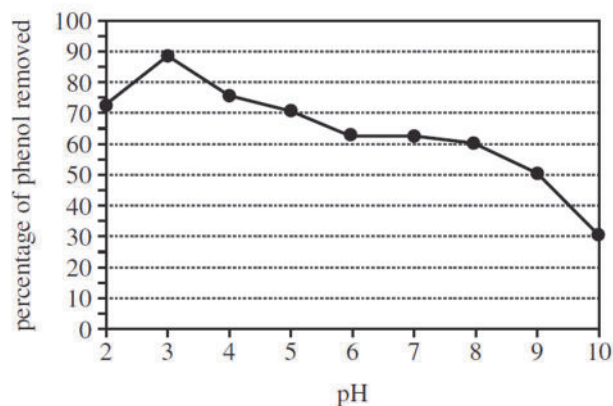
An aqueous phenol solution with a concentration of 10.0 mg of phenol per liter of solution was prepared for use in the studies. The pH of the solution was measured and found to be 6.6. In each trial of the studies, Steps 1–6 were performed.

1. A 200.0 mL volume of the phenol solution was placed in a clean flask.
2. The pH of the solution was adjusted to some particular value by addition of either concentrated sodium hydroxide (NaOH , a base) or concentrated hydrochloric acid (HCl).
3. A certain volume of 30% aqueous H_2O_2 was added to the flask.
4. The reaction was allowed to proceed for a specific amount of time at 25°C .
5. The concentration of phenol remaining was determined.
6. The percentage of phenol removed was calculated.

Study 1

Each of Trials 1–9 was conducted at a different pH, with 1.0 mL of H_2O_2 added to the phenol solution and the reaction allowed to proceed for 5.0 hr. See Figure 1.

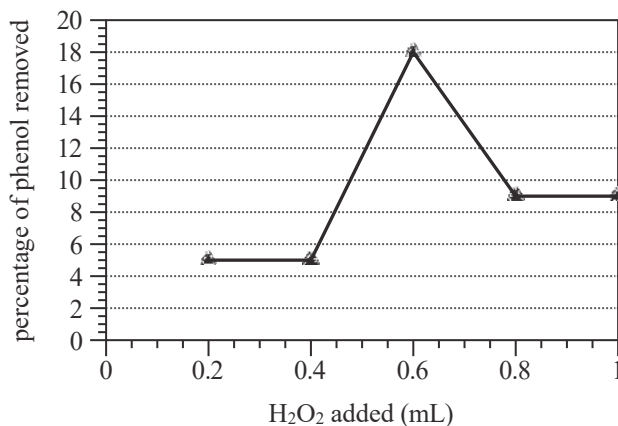
Figure 1



Study 2

Each of Trials 10–14 was conducted at $\text{pH} = 7.0$, with a different volume of H_2O_2 added to the phenol solution and the reaction allowed to proceed for 1.0 hr. See Figure 2.

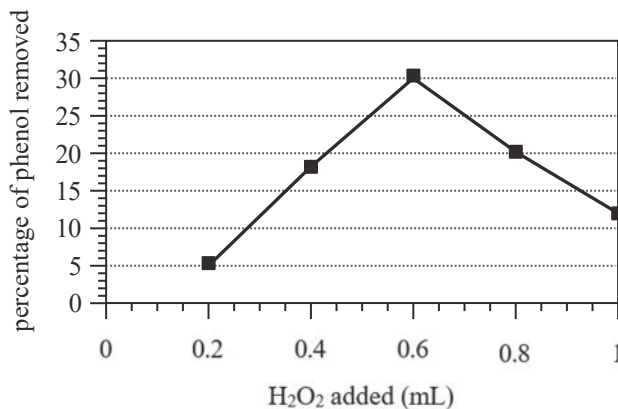
Figure 2



Study 3

Each of Trials 15–19 was conducted at $\text{pH} = 7.0$, with a different volume of H_2O_2 added to the phenol solution and the reaction allowed to proceed for 2.0 hr. See Figure 3.

Figure 3



Figures adapted from the article "Study of Degradation of Phenol in Waste Water Sample via Advanced Oxidation Technology" by J. Wu et al. (©2015 by the authors through Atlantis Press).

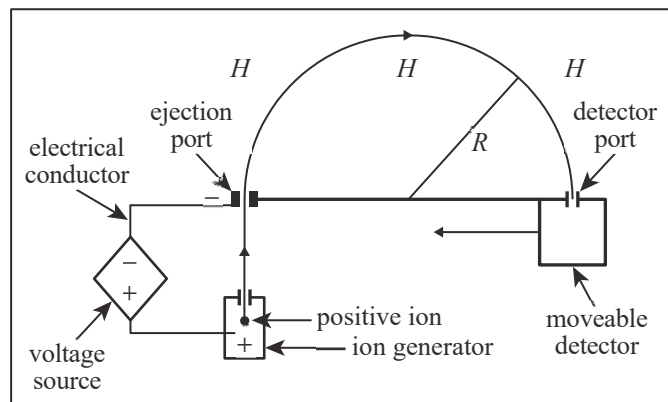


25. Suppose that in Study 3 a trial had been run in which 0.9 mL of H_2O_2 had been added. The percentage of phenol removed would most likely have been:
- A. less than 5%.
 - B. between 5% and 12%.
 - C. between 12% and 20%.
 - D. greater than 20%.
26. The lowest percentage of phenol removed in Study 1 was approximately how many times as great as the lowest percentage of phenol removed in Study 3?
- F. $\frac{1}{6}$
 - G. $\frac{1}{4}$
 - H. 4
 - J. 6
27. Less than 10% of the phenol was removed in a total of how many trials from Study 2?
- A. 1 trial
 - B. 2 trials
 - C. 3 trials
 - D. 4 trials
28. Which of the following was an independent variable in Study 2?
- F. pH
 - G. H_2O_2 added
 - H. Phenol concentration
 - J. Temperature
29. Suppose it were found that a typical sample of wastewater had a phenol concentration of 30 mg/L and a pH of 9. Assume that the percentage of phenol removed from a wastewater sample would be the same as for the phenol samples used in the studies. Based on the results of Study 1, after treatment with H_2O_2 under the same conditions as those used in the study, the concentration of phenol in the wastewater would most likely be closest to:
- A. 10 mg/L.
 - B. 15 mg/L.
 - C. 25 mg/L.
 - D. 30 mg/L.
30. Consider the trial in Study 1 in which the percentage of phenol removed was closest to 60.0%. In Step 2 of that trial, is it more likely that NaOH or HCl was added to the phenol solution?
- F. NaOH; the solution tested in that trial was more basic than the starting phenol solution.
 - G. NaOH; the solution tested in that trial was more acidic than the starting phenol solution.
 - H. HCl; the solution tested in that trial was more basic than the starting phenol solution.
 - J. HCl; the solution tested in that trial was more acidic than the starting phenol solution.

Passage V

A mass spectrometer (MS) is a device for measuring the ratio of an ion's electric charge, Q , to the ion's mass, M . Students participated in the design of an MS (see Diagram).

Diagram



An ion generator produced a single ion at a time of either isotopically pure lithium-7 (Li^+), beryllium-9 (Be^{2+}), or boron-11 (B^{3+}). A variable voltage source accelerated the ion to a maximum speed, V , and directed the ion through the ejection port into a magnetic field of variable intensity, H . Once inside the magnetic field, the ion followed a semicircular orbit at speed V to the input port of a detector. The radius, R , of the orbit was half the distance between the ejection port and the detector port; R had to have a minimum value of 0.0150 m and a maximum value of 0.0250 m. Students were asked to determine the H required for each ion's orbit to have the minimum or maximum R value.

(Note: the ratio Q/M is equal to 1.375×10^7 coulombs per kilogram (C/kg) for Li^+ , 2.14×10^7 C/kg for Be^{2+} , and 2.629×10^7 C/kg for B^{3+} .)

Study 1

For each ion, V was 1.00×10^3 meters/sec (m/s), and H (in tesla, T) was varied such that R was 0.0150 m. (See Table 1.)

Table 1		
Trial	Ion	H ($\times 10^{-3}$ T)
1	Li^+	4.85
2	Be^{2+}	3.12
3	B^{3+}	2.54

Study 2

The procedure from Study 1 was repeated, except H was varied such that R was 0.0250 m. (See Table 2.)

Table 2		
Trial	Ion	H ($\times 10^{-3}$ T)
4	Li^+	2.91
5	Be^{2+}	1.87
6	B^{3+}	1.52

Study 3

The procedure from Study 1 was repeated, except that V was 1.00×10^4 m/s. (See Table 3.)

Table 3		
Trial	Ion	H ($\times 10^{-3}$ T)
7	Li^+	48.5
8	Be^{2+}	31.2
9	B^{3+}	25.4

Study 4

The procedure from Study 2 was repeated, except that V was 1.00×10^4 m/s. (See Table 4.)

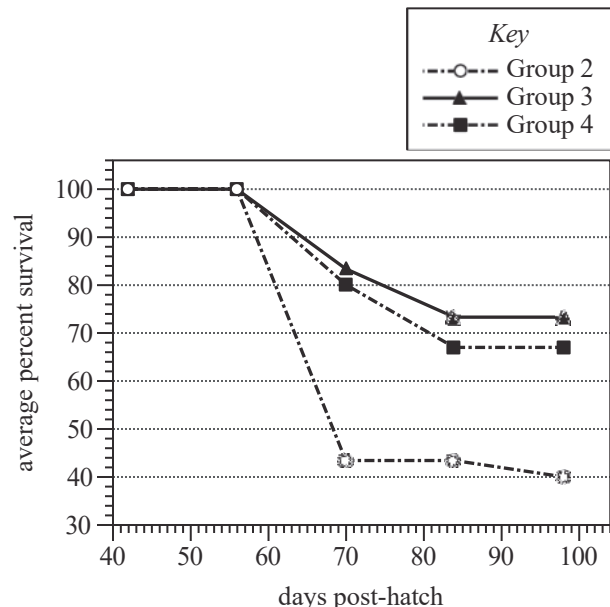
Table 4		
Trial	Ion	H ($\times 10^{-3}$ T)
10	Li^+	29.1
11	Be^{2+}	18.7
12	B^{3+}	15.2



31. The value of H was greatest in which of the following trials?
- A. Trial 1
 - B. Trial 4
 - C. Trial 7
 - D. Trial 10
32. A difference between Study 1 and Study 3 is best described by which of the following statements?
- F. The V tested in Study 1 was greater than that tested in Study 3.
 - G. The V tested in Study 1 was less than that tested in Study 3.
 - H. The R tested in Study 1 was greater than that tested in Study 3.
 - J. The R tested in Study 1 was less than that tested in Study 3.
33. In Study 2, what was the value of V for Li^+ ?
- A. $1.00 \times 10^3 \text{ m/s}$
 - B. $2.00 \times 10^3 \text{ m/s}$
 - C. $1.00 \times 10^4 \text{ m/s}$
 - D. $2.00 \times 10^4 \text{ m/s}$
34. One millitesla (mT) equals 10^{-3} tesla (T). In Trial 8, what was H in mT?
- F. $31.2 \times 10^{-3} \text{ mT}$
 - G. 31.2 mT
 - H. $31.2 \times 10^3 \text{ mT}$
 - J. $48.0 \times 10^3 \text{ mT}$
35. The mass of an Li^+ ion is $1.1 \times 10^{-26} \text{ kg}$ and the mass of a sodium ion, Na^+ , is $3.8 \times 10^{-26} \text{ kg}$. Suppose the Li^+ were traveling at the maximum speed tested in Study 1 and the Na^+ were traveling at the maximum speed tested in Study 2. Compared to the kinetic energy of the Na^+ , the kinetic energy of the Li^+ ion would be:
- A. greater.
 - B. the same.
 - C. less.
 - D. sometimes greater and sometimes less.

#

Figure 3



Figures 2 and 3 adapted from the article "Culturing the Oceanic Seahorse, *Hippocampus kuda*" by S.D. Job et al. (©2002 by Elsevier Science B.V.).

36. Seahorses carry their fertilized eggs in a brood pouch while the embryos fully develop. Based on Figure 1, which of male or female seahorses carry the fertilized eggs?
- F. Males; females deposit the sperm into the male's brood pouch where the male deposits its eggs.
 - G. Males; females deposit the eggs into the male's brood pouch where the eggs are fertilized by the male's sperm.
 - H. Females; males deposit the sperm into the female's brood pouch where the female deposits its eggs.
 - J. Females; males deposit the eggs into the female's brood pouch where the eggs are fertilized by the

37. Which of Group 3 and Group 4, if either, experienced no mortality prior to 56 days post-hatch?
- A. Group 3 only
 - B. Group 4 only
 - C. Both Group 3 and Group 4
 - D. Neither Group 3 nor Group 4
38. Wet mass was measured during which of the grow-out stage and the nursery stage, if either?
- F. Grow-out stage only
 - G. Nursery stage only
 - H. Both the grow-out stage and the nursery stage
 - J. Neither the grow-out stage nor the nursery stage
39. Consider the statement "By 98 days post-hatch, seahorses fed a diet of both blended fish and *Acetes* sp. had a greater average percent survival than did seahorses fed blended fish only." Is this statement consistent with the data shown in Figure 3?
- A. No; Group 2 seahorses had an average percent survival just over 30 percentage points less than that of Group 4.
 - B. No; Group 2 seahorses had an average percent survival just under 30 percentage points less than that of Group 4.
 - C. Yes; Group 2 seahorses had an average percent survival just over 30 percentage points less than that of Group 4.
 - D. Yes; Group 2 seahorses had an average percent survival just under 30 percentage points less than that of Group 4.
40. Based on the data available in Figure 2, was the overall rate of change in average SL greater over the course of the nursery stage or over the course of the grow-out stage?
- F. Nursery stage; the overall rate of change during the nursery stage was greater than 1.0 mm/day, whereas the overall rate of change during the
 - G. Nursery stage; the overall rate of change during the nursery stage was greater than 0.5 mm/day, whereas the overall rate of change during the grow-out stage was less than 0.5 mm/day.
 - H. Grow-out stage; the overall rate of change during the grow-out stage was greater than 1.0 mm/day, whereas the overall rate of change during the nursery stage was less than 1.0 mm/day.
 - J. Grow-out stage; the overall rate of change during the grow-out stage was greater than 0.5 mm/day, whereas the overall rate of change during the nursery stage was less than 0.5 mm/day.

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.