

# 1

## Reading Test

60 MINUTES, 47 QUESTIONS

Turn to Section 1 of your answer sheet to answer the questions in this section.

### DIRECTIONS

Each passage or pair of passages below is followed by a number of questions. After reading each passage or pair, choose the best answer to each question based on what is stated or implied in the passage or passages and in any accompanying graphics (such as a table or graph).

#### Questions 1-9 are based on the following passage.

This passage is adapted from Ruth Ozeki, *A Tale for the Time Being*. ©2013 by Ruth Ozeki Lounsbury. This passage is set in British Columbia. Ruth has discovered a bag containing a book on a beach.

"In search of lost time," Ruth said, translating the tarnished gilt title, embossed on the book's red cloth spine. "I've never read it."

Line "I haven't, either," said Oliver. "I don't think I'll  
5 be trying it in French, though."

"Mm," she said, agreeing, but then she opened the cover, anyway, curious to see if she could understand just the first few lines. She was expecting to see an age-stained folio, printed in an antique font, so she  
10 was entirely unprepared for the adolescent purple handwriting that sprawled across the page. It felt like a desecration, and it shocked her so much she almost dropped the book.

Print is predictable and impersonal, conveying  
15 information in a mechanical transaction with the reader's eye.

Handwriting, by contrast, resists the eye, reveals its meaning slowly, and is as intimate as skin.

Ruth stared at the page. The purple words were  
20 mostly in English, with some Japanese characters scattered here and there, but her eye wasn't really taking in their meaning as much as a *felt* sense, murky and emotional, of the writer's presence. The fingers that had gripped the purple gel ink pen must  
25 have belonged to a girl, a teenager. Her handwriting, these loopy purple marks impressed onto the page,

retained her moods and anxieties, and the moment Ruth laid eyes on the page, she knew without a doubt that the girl's fingertips were moist and soft, and that  
30 she had bitten her nails down to the quick.

Ruth looked more closely at the letters. They were round and a little bit sloppy (as she now imagined the girl must be, too), but they stood more or less upright and marched gamely across the page at a  
35 good clip, not in a hurry, but not dawdling, either. Sometimes at the end of a line, they crowded each other a little, like people jostling to get onto an elevator or into a subway car, just as the doors were closing. Ruth's curiosity was piqued. It was clearly a  
40 diary of some kind. She examined the cover again. Should she read it? Deliberately now, she turned to the first page, feeling vaguely prurient, like an eavesdropper. Novelists spend a lot of time poking their noses into other people's business. Ruth was not  
45 unfamiliar with this feeling.

*Hi!, she read. My name is Nao, and I am a time being. Do you know what a time being is? . . .*

"Flotsam," Oliver said. He was examining the barnacles that had grown onto the surface of the  
50 outer plastic bag. "I can't believe it."

Ruth glanced up from the page. "Of course it's flotsam," she said. "Or jetsam." The book felt warm in her hands, and she wanted to continue reading but heard herself asking, instead, "What's the difference,  
55 anyway?"

"Flotsam is accidental, stuff found floating at sea. Jetsam's been jettisoned. It's a matter of intent. So you're right, maybe this is jetsam." He laid the bag back down onto the table. "I think it's starting."

60 "What's starting?"

"Drifters," he said. "Escaping the orbit of the Pacific Gyre . . ."

His eyes were sparkling and she could tell he was excited. She rested the book in her lap. "What's a  
65 gyre?"

"There are eleven great planetary gyres," he said.

"Two of them flow directly toward us from Japan and diverge just off the British Columbia coastline.

The smaller one, the Aleut Gyre, goes north toward  
70 the Aleutian Islands. The larger one goes south. It's sometimes called the Turtle Gyre, because the sea turtles ride it when they migrate from Japan to Baja."

He held up his hands to describe a big circle.

"Imagine the Pacific," Oliver said. "The Turtle Gyre  
75 goes clockwise, and the Aleut Gyre goes counterclockwise." His hands moved in the great arcs and spirals of the ocean's flow.

Which choice best supports the conclusion that Ruth first believes the diary is very old?

- A) Lines 8-11 ("She was . . . page")
- B) Lines 14-16 ("Print . . . eye")
- C) Lines 39-40 ("It was . . . kind")
- D) Lines 48-50 ("He was . . . bag")

As used in line 14, "conveying" most nearly means

- A) bearing.
- B) communicating.
- C) projecting.
- D) conducting.

The narrator distinguishes between print and handwriting (lines 14-18) primarily to illustrate

- A) how writers reveal specific mannerisms through text.
- B) how readers interact with different types of text.
- C) why readers find it difficult to decipher handwritten text.
- D) why readers classify printed text as more durable than handwritten text.

As used in line 26, "impressed" most nearly means

- A) designed.
- B) emphasized.
- C) forced.
- D) inscribed.

The phrase in parentheses in lines 32-33 primarily serves to suggest Ruth is

- A) deciding whether to read Nao's diary.
- B) adapting to Nao's shifting moods.
- C) criticizing Nao's messy handwriting.
- D) forming an idea of Nao's characteristics.

6

Which choice best describes how Ruth approaches the idea of reading the diary?

- A) She feels entitled to study Nao's writing but is worried about translating it.
- B) She fails to contemplate whether Nao's diary should be viewed only by its owner.
- C) Her hesitation to read the diary is overcome by a desire to pry into Nao's affairs.
- D) Her consideration for Nao's privacy is based on her own experience as a novelist.

7

It can reasonably be inferred that Nao would react to her diary being read with

- A) embarrassment, because she reflects on personal matters.
- B) approval, because she addresses an imagined reader in her writing.
- C) alarm, because she describes her moods and anxieties.
- D) surprise, because she is unaware that readers are inquisitive.

8

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 27-30 ("and the . . . quick")
- B) Lines 31-32 ("Ruth . . . sloppy")
- C) Lines 43-44 ("Novelists . . . business")
- D) Lines 46-47 ("Hi! . . . is")

9

In the passage, Oliver indicates that the two Pacific gyres

- A) rotate in opposite directions.
- B) are named for their points of origin.
- C) are used by turtles to migrate to Baja.
- D) end near the British Columbia coastline.

**Questions 10-19 are based on the following passage and supplementary material.**

This passage is adapted from Daniel H. Pink, *To Sell Is Human: The Surprising Truth about Moving Others*. ©2012 by Daniel H. Pink.

The notion that extraverts—people who are very outgoing and talkative—are the finest salespeople is so obvious that we’ve overlooked one teensy flaw.

Line There’s almost no evidence that it’s actually true.

5 When social scientists have investigated the relationship between extraversion and sales success, they’ve found the link, at best, flimsy. For instance, while supervisors often give extraverts high ratings, several researchers have found that extraversion has  
10 “no statistically significant relationship . . . with sales performance” and that “extraversion is not related to sales volume.” One of the most comprehensive investigations—a set of three meta-analyses of thirty-five separate studies involving  
15 3,806 salespeople—found that the correlation between extraversion and sales was essentially nonexistent. (Positive correlations are measured on a scale that goes from 0 to 1, with higher numbers—say, 0.62—indicating close correlations and 0 no  
20 correlation at all. Across the thirty-five studies, the correlation between extraversion and sales performance was a minuscule 0.07.)

Does this mean that introverts—those soft-spoken souls more at home in a study carrel than at a  
25 party—are better at moving others? Not at all. In fact, the evidence, which is emerging in new research, reveals something far more intriguing.

Adam Grant is a management professor at the University of Pennsylvania’s Wharton School and  
30 one of America’s top young social psychologists. Some of his previous research had examined extraversion and he’d become curious that a trait so widely associated with sales didn’t have much connection to success in that realm. So he decided to  
35 find out why.

Grant collected data from a software company that operates call centers to sell its products. He began by asking more than three hundred sales representatives to complete several personality  
40 assessments, including one that social scientists use to measure where people fall on the introversion-extraversion spectrum. This particular assessment lists statements such as “I am the life of the party” and “I am quiet around strangers” and asks

45 participants to rate themselves on a 1-to-7 scale, with their answers resulting in a numerical measure of extraversion. Then Grant tracked the sales representatives’ revenues over the next three months.

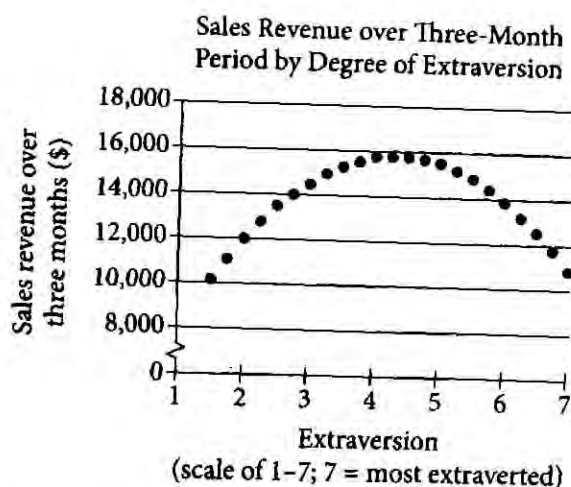
Perhaps not surprisingly, introverted sales reps  
50 didn’t perform as well as extraverted ones, earning an average of \$120 per hour in revenue compared with \$125 per hour for their more outgoing colleagues. But neither did nearly as well as a third group: the ambiverts.

55 Ambi-whats?

These are people who are neither overly extraverted nor wildly introverted. Go back to that 1-to-7 introversion-extraversion scale. Ambiverts sit roughly in the center. They’re not 1s or 2s, but  
60 they’re not 6s or 7s. In Grant’s study, these Goldilocks personalities—not too hot, not too cold—earned an average of nearly \$155 per hour, easily besting their counterparts. In fact, the salespeople who had the highest average  
65 revenue—\$208 per hour—had extraversion scores between 4.0 and 4.5, smack at the midpoint.

“These findings call into question the longstanding belief that the most productive salespeople are extraverted,” Grant writes.  
70 According to a large study of European and American customers, the “most destructive” behavior of salespeople wasn’t being ill-informed. It was an excess of assertiveness and zeal that led to contacting customers too frequently. Extraverts, in  
75 other words, often stumble over themselves. They can talk too much and listen too little, which dulls their understanding of others’ perspectives. They can fail to strike the proper balance between asserting and holding back, which can be read as  
80 pushy and drive people away.





Adapted from Adam M. Grant, "Rethinking the Extraverted Sales Ideal: The Ambivert Advantage." ©2013 by Adam M. Grant.

The primary purpose of the passage is to

- A) propose a theory that accounts for a recent trend in a profession.
- B) present several hypotheses about the existence of a new personality type.
- C) describe research that undermines a popular belief about a profession.
- D) summarize findings that challenge a controversial study about a personality type.

As used in line 2, "finest" most nearly means

- A) purest.
- B) subtlest.
- C) ablest.
- D) fanciest.

The parenthetical statements in lines 17-22 ("Positive . . . minuscule 0.07") mainly serve to

- A) provide quantitative information to emphasize a finding presented earlier.
- B) clarify why experts found a small positive correlation between sales performance and personality type.
- C) distinguish between the scale used for the three meta-analyses discussed earlier and the scale used in Grant's study discussed later.
- D) explain how researchers compiled the data to calculate statistical values reported in the study.

As used in line 25, "moving" most nearly means

- A) persuading.
- B) advancing.
- C) transporting.
- D) vacating.

The perspective adopted by the author in line 55 is best characterized as that of a

- A) researcher who questions the validity of a finding.
- B) general reader who is presented with an unfamiliar term.
- C) social historian who investigates the origin of a technical term.
- D) scientist who formulates a hypothesis about a phenomenon.

15

Which choice best supports Grant's claim in lines 67-69 ("These . . . writes")?

- A) Lines 49-52 ("Perhaps . . . colleagues")
- B) Lines 57-59 ("Go back . . . center")
- C) Lines 59-60 ("They're . . . or 7s")
- D) Lines 60-63 ("In Grant's . . . counterparts")

16

Based on the passage, which choice best describes the relationship between Grant's study and the study of European and American customers presented in the last paragraph?

- A) The study of customers offers a more detailed analysis of the scale used in Grant's study.
- B) The study of customers shows research on personality types excluded by Grant's study.
- C) The study of customers challenges the method used to assess extraversion in Grant's study.
- D) The study of customers helps to account for the findings in Grant's study.

17

According to the graph, the amount of revenue generated by a salesperson with an extraversion rating of 7 was within which interval?

- A) \$8,000-\$10,000
- B) \$10,000-\$12,000
- C) \$12,000-\$14,000
- D) \$14,000-\$16,000

18

The passage best supports which statement about salespeople such as those who generated average revenue of approximately \$15,000 or more over three months, as shown in the graph?

- A) Many social scientists mistakenly regard such salespeople as less persuasive than those who are ambiverts.
- B) Many customers mistakenly regard such salespeople as less knowledgeable than those who are more introverted.
- C) Many supervisors mistakenly regard such salespeople as less effective than those who are very outgoing.
- D) Many salespeople mistakenly regard such colleagues as less diligent than those who are more extraverted.

19

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 5-7 ("When . . . flimsy")
- B) Lines 7-12 ("For instance . . . volume")
- C) Lines 23-25 ("Does . . . all")
- D) Lines 70-72 ("According . . . ill-informed")

**Questions 20-29 are based on the following passage.**

This passage is adapted from Dennis Normile, "Close Look at Young Star Finds a Chemical Surprise." ©2014 by American Association for the Advancement of Science.

The basics of star formation are easy. Find an unusually dense region within a molecular cloud filled with dust and gas in interstellar space and let gravity do the rest. The gas and dust will eventually coalesce into a doughnut-shaped envelope that encircles an inner rotating disk. As material accumulates over hundreds of thousands of years, the central region collapses into a star while the disk solidifies into planets.

Astronomers have understood this overall scenario for decades, but the details are fuzzy because telescopes haven't been good enough to check theorists' computer models. That changed in 2011 with the partial completion of the Atacama Large Millimeter/submillimeter Array (ALMA). The telescope, a collection of radio antennas, is being erected on the Chajnantor Plain, 5000 meters above sea level in the Chilean Andes, where the dry, sparse air causes minimal distortion of the faint waves from the far reaches of the universe. Using 24 of the antennas—the final array will have 66—an international group led by astrophysicists at the University of Tokyo has taken the most detailed look yet at the heart of a star-forming region and found a chemical surprise.

The researchers trained ALMA on a very young star still forming in the constellation Taurus, about 450 light-years from Earth. As is typical at such an early stage, the star is encircled by an envelope and disk of gas and dust. The new telescope's power enabled the team to identify the chemical composition of the gases at different locations throughout this star- and planet-forming system. Previously, astronomers thought that the envelope and disk must be made up of the same gaseous molecules of hydrogen found throughout interstellar space plus dust particles made up of other elements. To the surprise of the University of Tokyo group, ALMA detected something different—sulfur monoxide gas—in a narrow band where the envelope meets the disk. Collisions between particles in the envelope and those in the rapidly spinning disk generate heat that thaws frozen sulfur monoxide molecules stuck to dust grains, explains Nami Sakai, an astrophysicist at the University of Tokyo. Sulfur

monoxide can't be detected when it is frozen to dust grains. But ALMA can spot it in its gaseous state. Knowing just what gases are swirling around young stars should lead to a better understanding of where and how elements found in planets, comets, and asteroids are formed. Sakai and colleagues report their findings online at *Nature*.

"These are beautiful data and very interesting results," says Ewine van Dishoeck, an astrophysicist at the Leiden Observatory in the Netherlands. "This work shows that ALMA will provide ample observational evidence" that will challenge theoretical models, adds astrophysicist Stéphane Guilloteau of University of Bordeaux in France. "This paper is a beautiful example of the new discovery [capabilities] offered by ALMA."

**CONTINUE**

20

A central idea of the passage is that the ALMA telescope

- A) has provided new details about the composition of gases around young stars.
- B) is limited to observing stars that are less than 450 light-years from Earth.
- C) has found that there are too few hydrogen molecules in interstellar space.
- D) allows astrophysicists to determine the density of stars as they form.

21

The image of a “doughnut-shaped envelope” in line 5 mainly serves to

- A) help readers visualize an unfamiliar situation.
- B) describe a tool used in a field of research.
- C) introduce humor into what is otherwise a serious scientific discussion.
- D) characterize the limits of current scientific knowledge.

22

As used in line 12, “check” most nearly means

- A) maintain.
- B) adopt.
- C) obstruct.
- D) verify.

23

According to the passage, what is an advantage of placing ALMA at a location high above sea level?

- A) There are few distractions from work at the remote observation site.
- B) There are fewer disturbing effects caused by Earth’s atmosphere.
- C) Reflection of sunlight off the ocean is minimized at that altitude.
- D) Distances to star-forming regions are slightly reduced.

24

As used in line 29, “stage” most nearly means

- A) phase.
- B) platform.
- C) portion.
- D) place.

25

Based on the passage, in which region surrounding other young stars should astronomers search if they wish to confirm the discovery around the young star in Taurus?

- A) The rapidly spinning inner disk
- B) The central section of the envelope
- C) The area of contact between the disk and the envelope
- D) The boundary where the envelope meets interstellar space



26

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 4-6 ("The gas . . . disk")
- B) Lines 30-33 ("The new . . . system")
- C) Lines 38-41 ("To the surprise . . . disk")
- D) Lines 48-51 ("Knowing . . . formed")

27

The main purpose of the third paragraph (lines 26-52) is to

- A) describe how dense molecular clouds acquire dust and particles from interstellar space.
- B) inform readers that scientists find gaseous hydrogen in all regions of interstellar space.
- C) introduce the techniques used to build telescopes such as ALMA.
- D) describe what ALMA enabled scientists to discover near a newly formed star.

28

Based on the passage, what can reasonably be inferred about how astrophysicists view ALMA?

- A) They believe that using it may yield a great deal of surprising data.
- B) They do not think that they will be able to improve the technology on which it relies.
- C) They worry that it is not powerful enough to determine the composition of dust particles.
- D) They think that it will be quickly replaced by a more sophisticated array.

29

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 20-25 ("Using . . . surprise")
- B) Lines 26-28 ("The researchers . . . Earth")
- C) Lines 53-55 ("These . . . Netherlands")
- D) Lines 60-61 ("This paper . . . ALMA")

**Questions 30–38 are based on the following passages.**

Passage 1 is adapted from ‘A’ [Anonymous], “Letter to Horace Greeley at the *New-York Daily Tribune* on the National Woman’s Rights Convention in Worcester, Massachusetts.” Originally published in 1850. Passage 2 is adapted from Horace Greeley, “Remarks to ‘A.’” Originally published in 1850.

**Passage 1**

It is clear that, if we are going to live, or have any private comforts, there must be dinners cooked, children’s faces must be washed, and there must be a home—a home to which the mind of the weary  
Line husband will turn to bear him up and urge him on in his toils for the inmates of that sanctuary—a home where he can for a time forget, in his wife’s and children’s society, the toils and troubles of this weary world—a home which he can never leave without  
5 carrying with him a new grace, a new strength, drawn from Woman’s influence, to enable him victoriously and manfully to withstand the trials and temptations of the world. Now, if Women are given the right to vote, to electioneer, to become  
10 stateswomen, why it is an incontrovertible fact (that is, if they attend properly to politics) that the dinners must go *uncooked*, the children’s faces *unwashed*, and home be forgotten—unless, indeed, the men exchange duties with them, as was proposed at the  
15 Convention, and stay at home and help their wives cook and wash the dishes.

So far from thinking Women “slaves,” I do not see how it can appear in such a light to any thinking mind, any true-hearted woman. There is something  
20 so superior about Woman that would make one shrink as from profanation at the idea of her mingling in public with “the sterner and *worse* sex”—a spiritualization that raises her far above the intrigues of politicians and the vulgarity of  
25 rowdies—a superiority which, if not acknowledged in words, is confessed in actions, even by men who, however degraded they may be, refrain from the slightest word or action that could be comment[ed] upon, in the presence of a woman.

30 The Women of the Worcester Convention seem to have entirely overlooked the immense power given to women in the form of Home Influence. What power can be greater than a mother’s holy and elevated example[?]. . .

40 We must also remember, that if women gained these absurd “rights,” they would be obliged to maintain them; and this they have not the strength to do; for which of the women at the Worcester Convention could knock a man down if he chose to  
45 stand up? and what man would come forward to protect a woman as long as she claimed to herself the right of self-protection?

**Passage 2**

That the full and equal enjoyment of Political Franchises would improve the lot of Woman, may be  
50 doubtful; but we are willing to give the Democratic theory a full and fair trial. Whenever so many Women shall petition for the Right of Suffrage as to indicate that a majority of the sex virtually concur in the demand, then we shall insist that the Franchise  
55 shall be extended to them. Being a disciple of the faith which holds that ‘all just government is founded on the *consent* of the *governed*,’ we could do not less, even though we knew that the Women would make a bad use of the power thus accorded them. Right first;  
60 Expediency afterward.

As to our correspondent’s fear that buttered toast will run short, and children’s faces get crusted over, in case the Political Rights of Women are recognized as equal to and identical with those of Men, we do  
65 not share it. We know people who supposed that, when Slavery was abolished, there could be no more boots blacked, no wood chopped, bacon fried, et cetera. But we see that all needful operations go on, though Slavery is abolished throughout this region.  
70 We see not why it may not be so in case the slavery of Woman should in like manner be abolished. . . .

Political franchises are but means to an end, which end is the securing of social and personal rights. Other classes have found the Elective  
75 Franchise serviceable toward the attainment of these rights, and we see not why it would lose its efficacy in the hands of Women. And as to the exposure of Women to insult and outrage in the Town or Ward Meeting, or at the Election, we trust the effect would  
80 be just opposite to that anticipated—namely, that men would be constrained by the presence of ladies to keep sober and behave themselves. The presence of Woman has this effect ever in those public assemblages honored by her presence; and we trust  
85 its virtue is far from having been exhausted.

As to Woman having to fight and knock down to maintain their Rights if once conceded, we don’t believe a word of it. Knock down whom? Certainly

not those who cheerfully concede them all they ask;  
 90 and if there are any of the other sort, such brutes as  
 choose to commence the game of knocking down,  
 [they] would be very sure to get enough of it before  
 coming to the Women.

One of the main ideas of Passage 1 is that

- A) children will suffer unduly if their mothers work outside the home.
- B) women in fact possess greater political power than men.
- C) home life would be harmed if women were allowed to exercise political authority.
- D) involvement in politics is equally challenging for men and women.

As used in line 1, "clear" most nearly means

- A) untroubled.
- B) innocent.
- C) smooth.
- D) obvious.

What main effect do the words "weary," "toils," and "troubles," used in lines 4-8, have on the tone of the first paragraph of Passage 1?

- A) They create a somber tone that reinforces the importance of the home as a retreat from the outside world.
- B) They create a sinister tone that suggests the danger of privileging the needs of children over those of adults.
- C) They create an aggravated tone that conveys irritation with the stresses of marriage.
- D) They create a discontented tone that underscores the hopelessness of domestic life.

In Passage 2, Greeley indicates that women must be given the right to vote when the majority of women demand it because

- A) women have been granted that right by the courts.
- B) granting that right is consistent with the idea of a government based on democratic principles.
- C) men have done a poor job of electing able officials without women's participation.
- D) the United States is out of step with other great nations in which women can vote.

Which statement can reasonably be inferred from Passage 2 about Greeley's position on women's right to vote?

- A) Although Greeley suspects he will be ostracized for supporting women's suffrage, he is willing to incur the risk.
- B) Although Greeley assumes that women, once granted the vote, will lose interest in politics, he considers it unfair to treat them as second-class citizens.
- C) Although Greeley has reservations about women properly exercising their right to vote, he feels that women are entitled to that right.
- D) Although Greeley is personally opposed to women's involvement in activities outside the home, he is sympathetic to women's desire to engage in politics.

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 55-59 ("Being . . . them")
- B) Lines 59-60 ("Right . . . afterward")
- C) Lines 61-65 ("As to . . . share it")
- D) Lines 70-71 ("We see . . . abolished")

Based on Passage 2, Greeley would most likely view the concerns about women's neglect of household duties expressed in Passage 1 as

- A) amusing, because they suggest an inability to conceive of men undertaking such duties.
- B) pervasive, because many people have publicly expressed such concerns.
- C) troubling, because they hint at larger fears that are not so easily overcome.
- D) exaggerated, because past concerns of a similar nature have proved to be overblown.

The author of Passage 1 would most likely concede that Greeley's claim regarding women's potential exposure to insult and outrage is

- A) somewhat plausible, since men rarely consider the needs of anyone but themselves.
- B) mostly correct, since men's pride usually ensures chivalrous behavior.
- C) generally true, since men's behavior would be tempered by women's virtuousness.
- D) largely accurate, since most men would be likely to ignore the threat of public censure.

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 22-24 ("So far . . . true-hearted woman")
- B) Lines 24-34 ("There . . . a woman")
- C) Lines 40-43 ("We must . . . to do")
- D) Lines 43-47 ("for which . . . self-protection")



**Questions 39-47 are based on the following passage and supplementary material.**

This passage is adapted from Rachel Nuwer, "Wereplant Releases Its Pollen by the Light of the Full Moon." ©2015 by The Smithsonian Institution. *Ephedra foeminea* is a Mediterranean shrub.

*Ephedra*'s relatives, which first arose about 130 million years ago in the Early Cretaceous, likely served as dinosaur food. Like others of their kind, *Ephedra* plants don't have flowers and instead secrete droplets of pollen-laden liquid from their cones. Some species let the wind ferry drops between cones, but the liquid is also high in sugar, which attracts insects.

Catarina Rydin, a botanist at the University of Stockholm, suspects that *Ephedra* might have saved itself from extinction by shifting from a predominantly insect-pollinated system to one dependent on wind, based on observations she has made in the fossil record. "Historically, climate change has occurred repeatedly, not least in the aftermath of the meteorite impact 65 million years ago, and wind-pollination may have been a safer method to ensure reproduction during such times," she says. "It is thus possible that insect-pollinated species of *Ephedra* had a greater risk of becoming extinct."

To better understand the plants and their evolution, Rydin and her doctoral student, Kristina Bolinder, headed down to Greece, where they scrambled over rocks to count insects and keep an eye out for pollen droplets. They had already determined that *E. distachya*, one of *E. foeminea*'s close relatives, sent its pollen riding on the wind—a finding that matches most other *Ephedra* species researchers have taken the time to study. But *E. foeminea*'s pollination methods remained more elusive. Even after its cones appeared, they refused to open, and the usual suspects among insect pollinators seemed uninterested.

One night over a Greek dinner, the two began musing about something they'd recently read about nocturnal insects using the moon to navigate. Suddenly an idea struck: Could *E. foeminea*'s pollination somehow be connected to the lunar cycle? "It started as a joke that evening, I should say," Rydin says.

Still, the joke seemed plausible enough that she and Bolinder decided to investigate. They eagerly bided their time in the field, reading up about

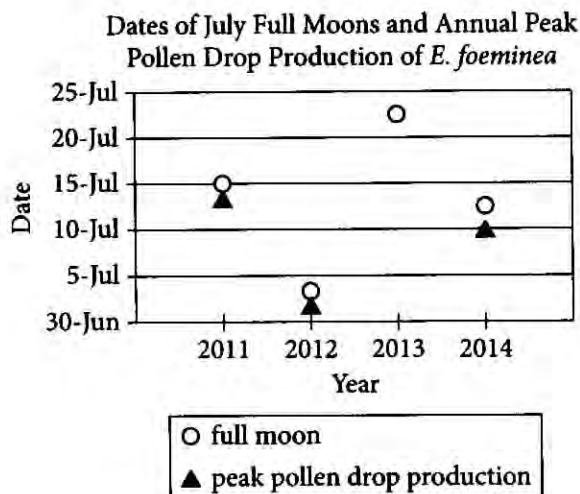
nocturnal pollination and counting down the nights until the July full moon. On that long-awaited evening, the researchers strategically positioned themselves in an open field of *E. foeminea* and waited. As the moon rose in the cloudless sky, its soft glow revealed droplets of pollen, which shimmered and sparkled on the brightly colored cones. "We may be biased," Rydin says, "but we found it ever so beautiful."

Whereas most nocturnally blooming plants have white flowers to help pollinators find them in the dark, *E. foeminea*'s cones are red and yellow, and they emit no discernable scent. "It became clear to us that the glittering probably is the means of nocturnal attraction that we had searched for but not found before," Rydin says. That display likely acts as a homing beacon for insects, including the flies and moths that the researchers observed alighting on *E. foeminea* that evening.

Although the light of the half moon would likely be sufficient to illuminate the pollen, the full moon alone remains up throughout the entire night, so the researchers think that *E. foeminea* maximizes the effect for efficiency. "Only at full moon do the insects have a moon to navigate by during the entire night," Rydin says.

So far, the researchers only have that one spectacular display, backed up by a scattering of historical data that seems to support the pattern. While some pollen drops did appear during the full moons of August and September, there were significantly fewer cones, suggesting that *E. foeminea*, like its relatives, peaks in summer. As such, many mysteries remain.





Note: Pollen drop production data not available for 2013.

Adapted from Catarina Rydin and Kristina Bolinder, "Moonlight Pollination in the Gymnosperm *Ephedra* (Gnetales)." ©2015 by The Royal Society.

Based on the passage, what led Rydin and Bolinder initially to hypothesize that *E. foeminea* pollination is in some way connected to the moon?

- A) Fellow scientists recommended that hypothesis as a possibility.
- B) They noticed a decrease in daytime insect activity during a full moon.
- C) Other researchers had linked nocturnal insect behavior to the moon.
- D) They observed a reflective quality in the pollen.

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 32-34 ("Even . . . uninterested")
- B) Lines 35-37 ("One . . . navigate")
- C) Lines 49-52 ("As the . . . cones")
- D) Lines 60-63 ("That . . . evening")

The passage suggests that Rydin and Bolinder might have had a "biased" perspective (lines 52-53) during their full moon observation because they

- A) were happy because it seemed that their hunch was about to be confirmed.
- B) regretted their inability to find a pollination source.
- C) appreciated the way the light from the pollen droplets helped them to identify the insects.
- D) were anxious to share their discovery of a new pollination method.

Based on the passage, what is the most likely reason *E. foeminea*'s pollen display does not occur during the half moon?

- A) The half moon is not bright enough to aid the insects in navigation.
- B) The half moon interferes with the insects' daily cycle of activity.
- C) The half moon is visible for fewer hours of the night than the full moon is.
- D) The half moon does not have the gravitational pull of the full moon.

The main effect of using the phrase "shimmered and sparkled" (line 51) and the word "glittering" (line 58) to describe *E. foeminea*'s pollen droplets is to

- A) explain why the droplets were functional in spite of an unpleasant odor.
- B) pinpoint a result of evolutionary change since the Early Cretaceous period.
- C) hint at why scientists were driven to discover *Ephedra*'s pollination process.
- D) provide a vivid description of the qualities that attracted insects to the droplets.

11

As used in line 72, "backed up" most nearly means

- A) reversed.
- B) reinforced.
- C) blocked.
- D) substituted.

15

Which statement most accurately describes *E. foeminea*'s pollen drop production as depicted in the graph?

- A) It peaks shortly before the full moon.
- B) It peaks shortly after the full moon.
- C) It peaks at exactly the same time each year.
- D) It peaks at different times among various populations.

16

Which finding shown in the graph supports the passage's assertion that *E. foeminea* shares characteristics with some other *Ephedra* species?

- A) *E. foeminea*'s peak pollen drop production coincides with full moons.
- B) *E. foeminea*'s peak pollen drop production occurs in July.
- C) The timing of *E. foeminea*'s peak pollen drop production varies from year to year.
- D) The association of *E. foeminea*'s peak pollen drop production with the full moon has become weaker over time.

17

Which choice provides the best evidence for the answer to the previous question?

- A) Lines 3-5 ("Like . . . cones")
- B) Lines 26-30 ("They had . . . study")
- C) Lines 43-46 ("They eagerly . . . moon")
- D) Lines 74-77 ("While . . . summer")

# STOP

**If you finish before time is called, you may check your work on this section only.  
Do not turn to any other section.**

**No Test Material On This Page**

## Writing and Language Test

35 MINUTES, 44 QUESTIONS

Turn to Section 2 of your answer sheet to answer the questions in this section.

### DIRECTIONS

Each passage below is accompanied by a number of questions. For some questions, you will consider how the passage might be revised to improve the expression of ideas. For other questions, you will consider how the passage might be edited to correct errors in sentence structure, usage, or punctuation. A passage or a question may be accompanied by one or more graphics (such as a table or graph) that you will consider as you make revising and editing decisions.

Some questions will direct you to an underlined portion of a passage. Other questions will direct you to a location in a passage or ask you to think about the passage as a whole.

After reading each passage, choose the answer to each question that most effectively improves the quality of writing in the passage or that makes the passage conform to the conventions of standard written English. Many questions include a "NO CHANGE" option. Choose that option if you think the best choice is to leave the relevant portion of the passage as it is.

Questions 1-11 are based on the following passage.

### Planting the Delta Blues

As the Mississippi dusk settled on Dockery Farms on Saturday **1** evenings' in the early 1900s, hundreds would cross a one-lane bridge to hear the blues. There, bluesmen played and sang in a repurposed home they called the Frolicking House. Once a week, the furniture

- 1**
- A) NO CHANGE
  - B) evening's in the early 1900s, hundred's
  - C) evenings in the early 1900s, hundreds
  - D) evenings' in the early 1900s, hundreds'



was placed outdoors to make room for the burgeoning crowd, and wall-sized mirrors reflected coal oil lanterns, setting the house aglow and **2** irradiating the way for stragglers. For anyone who could pay a twenty-five-cent fee, there was space inside next to the musicians, who sometimes played until dawn.

So began the Delta blues, **3** an influential style of music that originated among the African American farmhands of the Delta region of northwest Mississippi and was characterized by uneven rhyme schemes, moaning vocals, and mixes of sung and spoken passages. Dockery Farms, a forty-square-mile farming community with about 3,000 residents in its heyday, **4** fell into decline after the introduction of the mechanical cotton picker in 1944. It was the home base of, among others, blues pioneer Charley Patton, whose family had moved to the farm in search of work in about 1900. At Dockery, Patton met Henry Sloan, about whom little is known except that he taught Patton to play guitar, **5** while that changed both Patton's life and American music.

2

- A) NO CHANGE
- B) illuminating
- C) illustrating
- D) elucidating

3

- A) NO CHANGE
- B) an on-point
- C) an awesome
- D) a top-notch

1

Which choice most clearly conveys a central idea of the passage?

- A) NO CHANGE
- B) was the epicenter of this music.
- C) originally included post offices, picnic grounds, and elementary schools.
- D) was bought by William Dockery with a gift from his grandmother.

5

- A) NO CHANGE
- B) so that it ended up changing
- C) which would change
- D) until a change came to

Patton, who soon was making enough from his performances to call himself a professional musician, **6** suffered from a heart condition. He spun his guitar while playing and slapped the body of the instrument for rhythmic **7** effect; he even perfected startling tricks like playing behind his head and plucking the strings with his teeth, to the delight of listeners. **8** His songs, first recorded in 1929, could be about anything from love affairs to floods to an insect—the cotton-eating boll weevil, immortalized in Patton’s “Mississippi Boweavil Blues.” Patton and other bluesmen like Tommy Johnson and Son House traveled around Mississippi, playing at dance halls and parties, spreading **9** his distinctive style and affecting stories across the eastern United States.

Which choice most effectively introduces the list of examples in the next sentence in the paragraph?

- A) NO CHANGE
- B) gave guitar lessons to Howlin’ Wolf, another blues musician.
- C) had a brother who fought in the First World War.
- D) astonished crowds with his inventive guitar work.

- A) NO CHANGE
- B) effect; and,
- C) effect: but
- D) effect,

Which choice most clearly connects the information in the previous sentence to the information immediately after the underlined portion?

- A) NO CHANGE
- B) Such antics framed stories told in song that were often mournful but were sometimes humorous as well,
- C) Other blues musicians, such as Willie Brown, were influenced by Patton’s ability to sing
- D) Patton, who would one day be banished from Dockery Farms, recorded songs

- A) NO CHANGE
- B) one’s
- C) their
- D) its

As more and more African Americans moved northward in the 1920s, many Delta musicians were drawn to Chicago in search of day jobs in factories—and audiences at night. Recording companies **10** began, to take note, of Chicago’s music boom, and by 1926, propelled by the blues’ rising popularity, record sales by African American artists reached \$5 million. The Chicago blues musicians built on the guitar- and harmonica-driven tunes of the Delta, adding percussion sections and eventually electronic amplification. But even with these modernizations, **11** Chicago quickly became the center of blues music for the country.

10

- A) NO CHANGE
- B) began to take note;
- C) began to take note:
- D) began to take note

11

The writer wants a conclusion that refers back to the discussion of the origin of blues music. Which choice best accomplishes this goal?

- A) NO CHANGE
- B) blues was still characterized by the wailing sound created by the bottleneck slide technique.
- C) more opportunities for recording and performing were on the horizon, especially with the rise of blues clubs.
- D) the memory of Mississippi’s fields remained in the background, inspiring new generations of musicians.

Questions 12-22 are based on the following passage and supplementary material.

### The Detection of Gravitational Waves

Roughly a billion years ago, and roughly a billion light-years from Earth, two massive black holes spiraled inward and merged. In the early morning hours of September 14, 2015, evidence of the collision arrived on Earth **12** in the form of gravitational waves. The detection of the waves, which travel at the speed of light, was the culmination of years of work and resulted in both excitement and a sense of validation among the researchers at the Laser Interferometer Gravitational-Wave Observatory, or LIGO. "This is the signal that we wanted to see from the beginning of this whole quest," said **13** physicist, Rainer Weiss, inventor of the measuring technique used by LIGO.

**12**

The writer is considering deleting the underlined portion and ending the sentence with "Earth." Should the underlined portion be kept or deleted?

- A) Kept, because it introduces a key term in the passage, "gravitational waves," which sets up the information that follows.
- B) Kept, because it helps the reader understand the relationship between gravitational waves and gravity.
- C) Deleted, because it is redundant in combination with the rest of the information about gravitational waves in the passage.
- D) Deleted, because it mentions gravitational waves' "form," which is only loosely relevant at this point in the passage.

**13**

- A) NO CHANGE
- B) physicist, Rainer Weiss
- C) physicist Rainer Weiss,
- D) physicist Rainer Weiss

**14** It also proved something Albert Einstein had hypothesized almost one hundred years earlier. In 1916, thinking about the acceleration of massive objects through what he termed space-time (the so-called “fabric” of the universe, combining the three dimensions of space with time), **15** Einstein’s conclusion was that the objects’ motion would create ripples, or waves, in space-time. Unfortunately, the gravitational waves Einstein predicted were **16** so faint and he feared they would never be detected.

11

Which choice provides the best transition from the previous paragraph to the information that follows in this paragraph?

- A) NO CHANGE
- B) Weiss, a professor of physics at the Massachusetts Institute of Technology, was one of three researchers to propose the LIGO project in the 1980s.
- C) Albert Einstein published his general theory of relativity in 1915, and Arthur Eddington confirmed key aspects of the theory in 1919.
- D) LIGO continues to improve: it is expected in the near future to increase both its sensitivity and the volume of space it can survey.

15

- A) NO CHANGE
- B) Einstein concluded that the motion of the objects
- C) the objects’ motion, concluded Einstein,
- D) the motion of the objects, Einstein concluded,

16

- A) NO CHANGE
- B) faint and so
- C) so faint that
- D) faint so that



By 2015, 17 however, the twin facilities of LIGO 18 have achieved a level of sensitivity that would allow Einstein's ideas about gravitational waves to be tested empirically. Each of these two L-shaped observatories, one located in Louisiana and one in Washington State, consists of two 2.5-mile-long tubes set at a 90° angle. Laser beams travel down each tube through a nearly perfect 19 vacuum are reflected by mirrors to detectors where the tubes meet. The detectors are extremely 20 sensitive. The detectors can tell if a gravitational wave has compressed or stretched the distance to either mirror by just 1/10,000 the width of a proton.

17

- A) NO CHANGE
- B) moreover,
- C) therefore,
- D) then,

18

- A) NO CHANGE
- B) will achieve
- C) would have achieved
- D) had achieved

19

- A) NO CHANGE
- B) vacuum being
- C) vacuum, they are
- D) vacuum and are

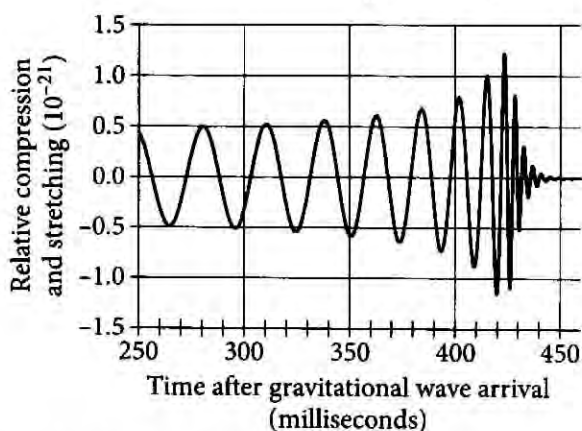
20

Which choice most effectively combines the sentences at the underlined portion?

- A) sensitive because they can
- B) sensitive, in addition to being able to
- C) sensitive: they can
- D) sensitive in order to

On that September morning, researchers at both facilities observed a series of gravitational waves that rapidly increased in intensity until they peaked about **21** 250 milliseconds after they began, and then dampened almost to zero after 440 milliseconds. These observations are consistent with the scenario of two black holes merging.

Relative Change in Distance between LIGO Mirror and Detector at Washington Facility



Adapted from B. P. Abbott et al., "Observation of Gravitational Waves from a Binary Black Hole Merger." ©2016 by B. P. Abbott et al.

LIGO physicists spent a month **22** discrediting every possible alternate explanation for their observation. "[It] was a heavy responsibility," said Gabriela González, a professor of physics and astronomy at Louisiana State University who also works at LIGO. "This was the first detection of gravitational waves, so there was no room for a mistake." But by 2016, the LIGO team was able to confidently, and proudly, proclaim its accomplishment. As Weiss said on the day the findings were announced, "It's going to be the wave of the future!"

21

Which choice offers an accurate interpretation of the data in the graph?

- A) NO CHANGE
- B) 400
- C) 425
- D) 450

22

- A) NO CHANGE
- B) disregarding
- C) calling out
- D) ruling out

Questions 23-33 are based on the following passage.

### Fulton's Folly

More than a decade after **23** their invention in 1787, the steamboat had yet to catch on. Most people **24** beheld steamboats as slow, noisy, and impractical; many were suspicious of the boats' smoke-spewing engines that seemed on the verge of exploding. American inventor and entrepreneur Robert Fulton, however, had grand plans for steamboat technology. With every faith that steam-powered vessels could be a viable form of commercial transportation, he designed a new steamboat. In 1803, he launched his ship on Paris's Seine River—where it promptly sank.

23

- A) NO CHANGE
- B) its
- C) it's
- D) there

24

- A) NO CHANGE
- B) idealized
- C) regarded
- D) observed

After returning to the United States three years later, Fulton decided to try again: this time he built a ship **25** for commercial use rather than for government or naval use. While the Paris steamboat was 66 feet long, with a single paddle wheel and an 8-horsepower engine, his new steamboat—which came to be known as the **26** Clermont—was 150 feet long, with two paddle wheels and a 24-horsepower engine. With his earlier failure still fresh **27** through the public's mind, the new boat was dubbed "Fulton's Folly." The boat's launch in August 1807 in New York City attracted a large crowd of people who were expecting to witness another disaster.

25

Which choice best sets up the information in the next sentence?

- A) NO CHANGE
- B) that would attract even more attention than his earlier ventures.
- C) that would be improved upon further in future years.
- D) that was larger, sturdier, and more technologically advanced than his earlier vessel.

26

- A) NO CHANGE
- B) *Clermont,*
- C) *Clermont*
- D) *Clermont:*

27

- A) NO CHANGE
- B) from
- C) among
- D) in

Fulton was intent on proving them wrong. Along with forty passengers, he embarked on a 150-mile upriver journey to Albany, New York. Just minutes into the voyage, though, the boat's engine stopped. In the tense moments after the **28** engine's roar ceased, the ships' passengers began to murmur anxiously: it seemed certain that history was doomed to repeat itself. Fulton, however, fixed the engine problem within thirty minutes. When the *Clermont* once again began to move at full speed, Fulton recalled, "none seemed willing to trust the evidence of their own senses." **29** Provoking a feeling of astonishment, the *Clermont* not only completed the 150-mile trip to Albany but did so relatively quickly. **30** Whereas a sailboat would have taken about four days to reach Albany, Fulton's steamboat got there in just thirty-two hours.

- 28**
- A) NO CHANGE
  - B) engine's roar ceased, the ships
  - C) engine's roar ceased, the ship's
  - D) engines roar ceased, the ships

- 29**
- A) NO CHANGE
  - B) Surprising literally everyone in the world,
  - C) Throwing everyone for a loop,
  - D) To the amazement of all,

**30**

The writer is considering deleting the underlined portion of the sentence. Should the underlined portion be kept or deleted?

- A) Kept, because it helps support the claim made in the previous sentence about the speed of the *Clermont*.
- B) Kept, because it introduces a valid counterargument to the paragraph's claims about the *Clermont*.
- C) Deleted, because it interrupts the paragraph's narrative with an unrelated detail about sailboats.
- D) Deleted, because it unnecessarily repeats information about the length of the trip to Albany.



31 Though Fulton was interested in many types of steam-powered vessels, the steamboat quickly became a popular mode of travel. Shortly thereafter, Fulton began running three round-trips from New York City to Albany every two 32 weeks, by 1812, steamboats operated on six major rivers. Connecting different parts of the country, steamboats made it possible for people to travel greater distances in less time; 33 nevertheless, they enabled manufacturers to transport goods such as crops, lumber, and coal more efficiently. Fulton's unlikely success decisively transformed river transit in the nineteenth century: once regarded as an oddity, steamboats became indispensable to travel and trade in the United States.

31

Which choice provides the best transition from the previous paragraph?

- A) NO CHANGE
- B) Changing commercial transportation,
- C) With Fulton's acute business sense,
- D) After the *Clermont*'s first successful voyage,

32

- A) NO CHANGE
- B) weeks, and
- C) weeks, then,
- D) weeks

33

- A) NO CHANGE
- B) however,
- C) moreover,
- D) for example,

Questions 34-44 are based on the following passage and supplementary material.

### Nutritionists, Licensed to Practice

Nutrition science examines the health effects of food and dietary supplements. Professionals who work in this field are often referred to as nutritionists, but in fact that term has no legal definition and does not represent any specific training. The titles of registered dietitian (RD) and certified nutrition specialist (CNS), **34** nonetheless, are legally regulated in the United States. Because **35** they represent rigorous standards, those who wish to pursue careers in nutrition science will find that **36** working in this field is both challenging and rewarding.

34

- A) NO CHANGE
- B) on the other hand,
- C) at any rate,
- D) indeed,

35

- A) NO CHANGE
- B) some
- C) these titles
- D) professionals

36

Which choice provides the most effective introduction to the main discussion of the passage?

- A) NO CHANGE
- B) their job prospects improve significantly through certification.
- C) becoming an RD or CNS will help them promote health and wellness.
- D) the certification process will depend on their individual goals.

RD and CNS certifications grant access to nutrition science jobs that have broad impact. An RD gives practical advice on nutrition and works with the general public in places like hospitals, government agencies, and food corporations. RDs **37** plan balanced meals for hospitals and school cafeterias, for example, and run campaigns on the negative effects of junk food. To pursue this career, an RD must have a bachelor's degree in a relevant **38** field (such as biology or nutrition science), complete a supervised clinical work program, and pass an examination by the Commission on Dietetic Registration. **39** A CNS must additionally earn a graduate degree, pass a qualifying **40** test: by the Board for Certification of Nutrition Specialists, and commit to ongoing professional training. Only a CNS can work in highly specialized fields such as medical nutrition **41** therapy. Medical nutrition therapy uses nutrition science to treat existing medical conditions (for example, to identify patients' food allergies or manage sugar levels of people with diabetes).

37

Which choice best supports the information provided in the previous sentence?

- A) NO CHANGE
- B) need to have a well-rounded education,
- C) conduct their duties face to face,
- D) have a solid background in the sciences,

38

- A) NO CHANGE
- B) field (such as biology or nutrition science)
- C) field, (such as biology or nutrition science),
- D) field, (such as biology or nutrition science)

39

- A) NO CHANGE
- B) A CNS must additionally also
- C) What's more, a CNS must additionally
- D) A CNS, too, must additionally

40

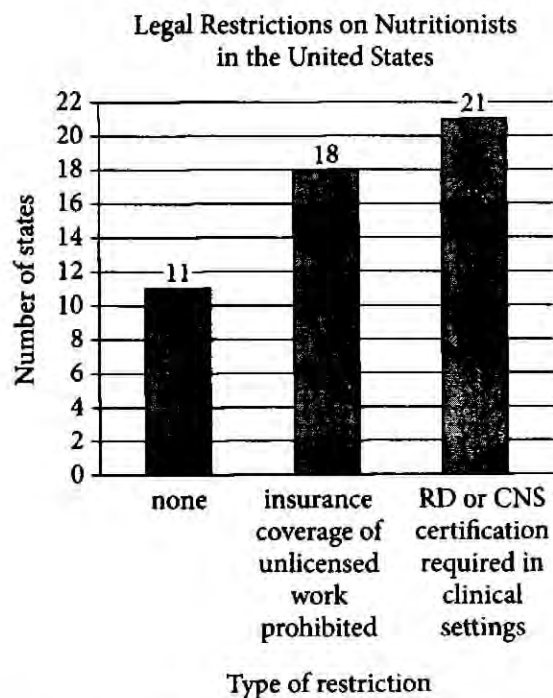
- A) NO CHANGE
- B) test, by
- C) test by:
- D) test by

41

Which choice most effectively combines the sentences at the underlined portion?

- A) therapy, and this therapy
- B) therapy, which
- C) therapy—and it
- D) therapy; as a therapy, it

Nutritionists without the RD or CNS credential may face limited job prospects. In the United States, 21 states require RD or CNS certification for work in clinical settings like hospitals or doctors' offices. Although that leaves 29 states in which people can legally practice nutritional counseling without **12** certification, however, the complexities of the health care industry also impact job availability. In **13** 11 states, for example, insurance companies are barred by law from paying for unlicensed work; this means that patients would have to pay for their own care from unlicensed nutritionists and are therefore less likely to hire one. Even in the 11 states that have no legal restrictions on unlicensed nutritionists, many insurance companies have their own policies against covering the costs of these practitioners.



Adapted from "Nutrition Career Requirement Laws by State." ©2016 by NutritionED.org.

12

- A) NO CHANGE
- B) certification; however,
- C) certification, but
- D) certification,

13

Which choice offers the most accurate interpretation of the data from the graph?

- A) NO CHANGE
- B) 21 states,
- C) 18 states,
- D) every state,

With these legal and financial considerations shaping the nutrition science job **44** market, RD or CNS certification is the best path to job security in the field. The time and expense of extended nutrition science education and training is repaid in access to a wide range of stable and fulfilling nutrition-related work opportunities.

11

- A) NO CHANGE
- B) market:
- C) market
- D) market,

**STOP**

**If you finish before time is called, you may check your work on this section only.  
Do not turn to any other section.**





# Math Test – No Calculator

25 MINUTES, 17 QUESTIONS

Turn to Section 3 of your answer sheet to answer the questions in this section.

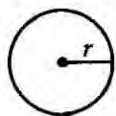
## DIRECTIONS

For questions 1-13, solve each problem, choose the best answer from the choices provided, and fill in the corresponding bubble on your answer sheet. For questions 14-17, solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 14 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

## NOTES

1. The use of a calculator is **not permitted**.
2. All variables and expressions used represent real numbers unless otherwise indicated.
3. Figures provided in this test are drawn to scale unless otherwise indicated.
4. All figures lie in a plane unless otherwise indicated.
5. Unless otherwise indicated, the domain of a given function  $f$  is the set of all real numbers  $x$  for which  $f(x)$  is a real number.

## REFERENCE

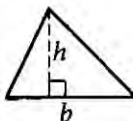


$$A = \pi r^2$$

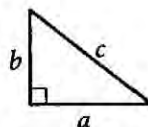
$$C = 2\pi r$$



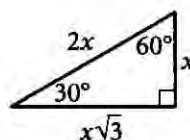
$$A = \ell w$$



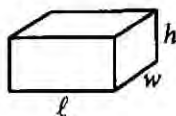
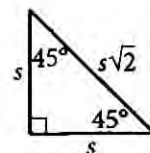
$$A = \frac{1}{2}bh$$



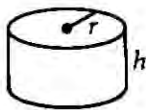
$$c^2 = a^2 + b^2$$



Special Right Triangles



$$V = \ell wh$$



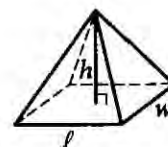
$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}\ell wh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.



1

$$4x + 3y = 24$$

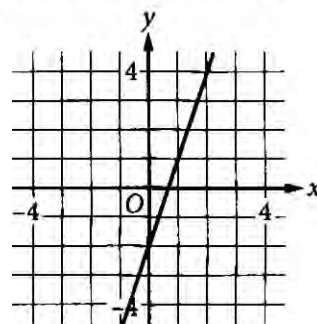
Mario purchased 4 binders that cost  $x$  dollars each and 3 notebooks that cost  $y$  dollars each. If the given equation represents this situation, which of the following is the best interpretation of 24 in this context?

- A) The total cost, in dollars, for all binders purchased
- B) The total cost, in dollars, for all notebooks purchased
- C) The total cost, in dollars, for all binders and notebooks purchased
- D) The difference in the total cost, in dollars, between the number of binders and notebooks purchased

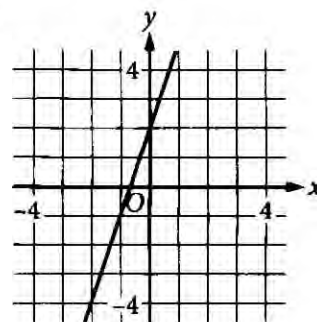
2

The function  $c$  is defined by  $c(x) = 2x + 3$ . Which of the following is the graph of  $y = c(x)$ ?

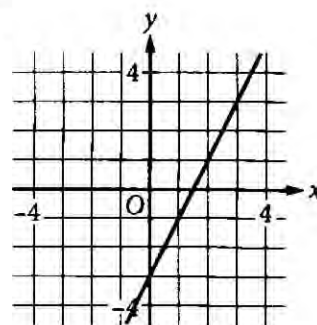
A)



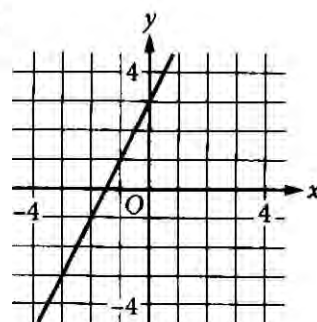
B)



C)



D)





3

A city's total expense budget for one year was  $x$  million dollars. The city budgeted  $y$  million dollars for departmental expenses and 201 million dollars for all other expenses. Which of the following represents the relationship between  $x$  and  $y$  in this context?

- A)  $x + y = 201$
- B)  $x - y = 201$
- C)  $2x - y = 201$
- D)  $y - x = 201$

4

$$y \leq x$$

$$y \leq -x$$

Which of the following ordered pairs  $(x, y)$  is a solution to the system of inequalities above?

- A)  $(1, 0)$
- B)  $(-1, 0)$
- C)  $(0, 1)$
- D)  $(0, -1)$

5

If  $2(x - 5) + 3(x - 5) = 10$ , what is the value of  $x - 5$ ?

- A) 2
- B) 5
- C) 7
- D) 12

6

$$6x^2 + 5x - 7 = 0$$

What are the solutions to the given equation?

- A)  $\frac{-5 \pm \sqrt{25 + 168}}{12}$
- B)  $\frac{-6 \pm \sqrt{25 + 168}}{12}$
- C)  $\frac{-5 \pm \sqrt{36 - 168}}{12}$
- D)  $\frac{-6 \pm \sqrt{36 - 168}}{12}$



$$(2x + 5)^2 - (x - 2) + 2(x + 3)$$

Which of the following is equivalent to the expression above?

- A)  $4x^2 + 21x + 33$
- B)  $4x^2 + 21x + 29$
- C)  $4x^2 + x + 29$
- D)  $4x^2 + x + 33$

8

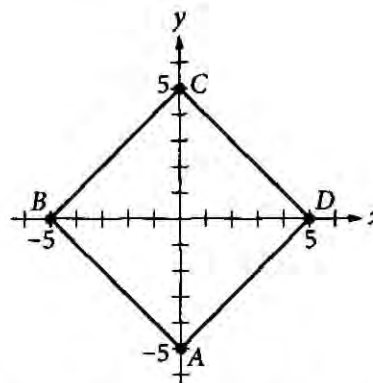
What is the  $y$ -intercept of the graph of  $y = 3^{x+3}$  in the  $xy$ -plane?

- A)  $(0, 0)$
- B)  $(0, 3)$
- C)  $(0, 9)$
- D)  $(0, 27)$

Which expression is equivalent to  $\sqrt{16x^{16}}$ , where  $x > 0$ ?

- A)  $4x^4$
- B)  $4x^8$
- C)  $8x^4$
- D)  $8x^8$

10



In the  $xy$ -plane shown, square  $ABCD$  has its diagonals on the  $x$ - and  $y$ -axes. What is the area, in square units, of the square?

- A) 20
- B) 25
- C) 50
- D) 100



12

$$\begin{aligned}x^2 &= 6x + y \\y &= -6x + 36\end{aligned}$$

A solution to the given system of equations is  $(x, y)$ . Which of the following is a possible value of  $xy$ ?

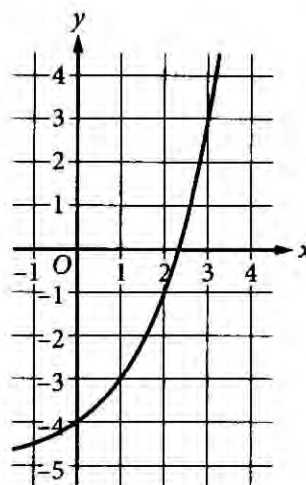
- A) 0
- B) 6
- C) 12
- D) 36

13

Ms. Tabanelli deposits \$20,000 in an account that has a 5% annual interest rate compounded yearly. If she does not add to or withdraw from the account for 2 years, how much interest will she have earned for the 2-year period?

- A) \$50
- B) \$550
- C) \$2,000
- D) \$2,050

13



What is an equation of the graph shown?

- A)  $y = 2^x + 4$
- B)  $y = 2^x - 4$
- C)  $y = 2^x - 5$
- D)  $y = 2^x + 5$

### DIRECTIONS

**For questions 14-17, solve the problem and enter your answer in the grid, as described below, on the answer sheet.**

1. Although not required, it is suggested that you write your answer in the boxes at the top of the columns to help you fill in the bubbles accurately. You will receive credit only if the bubbles are filled in correctly.
2. Mark no more than one bubble in any column.
3. No question has a negative answer.
4. Some problems may have more than one correct answer. In such cases, grid only one answer.
5. **Mixed numbers** such as  $3\frac{1}{2}$  must be gridded as 3.5 or  $7/2$ . (If 

|                       |                       |                       |                       |
|-----------------------|-----------------------|-----------------------|-----------------------|
| 3                     | 1                     | /                     | 2                     |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

 is entered into the grid, it will be interpreted as  $\frac{31}{2}$ , not  $3\frac{1}{2}$ .)
6. **Decimal answers:** If you obtain a decimal answer with more digits than the grid can accommodate, it may be either rounded or truncated, but it must fill the entire grid.

**Answer:**  $\frac{7}{12}$

Write  
answer in  
boxes.

|   |   |   |   |
|---|---|---|---|
| 7 | / | 1 | 2 |
| ● | ● | / |   |
| ○ | ○ | ○ | ○ |
|   | 0 | 0 | 0 |
| ① | ① | ● | ① |
| ② | ② | ② | ● |
| ③ | ③ | ③ | ③ |
| ④ | ④ | ④ | ④ |
| ⑤ | ⑤ | ⑤ | ⑤ |
| ⑥ | ⑥ | ⑥ | ⑥ |
| ● | ⑦ | ⑦ | ⑦ |
| ⑧ | ⑧ | ⑧ | ⑧ |
| ⑨ | ⑨ | ⑨ | ⑨ |

Fraction  
line

**Answer: 2.5**

|   |   |   |   |
|---|---|---|---|
|   | 2 | . | 5 |
| ○ | ⑦ | ⑦ |   |
| ○ | ○ | ● | ○ |
|   | 0 | 0 | 0 |
| ① | ① | ① | ① |
| ② | ● | ② | ② |
| ③ | ③ | ③ | ③ |
| ④ | ④ | ④ | ④ |
| ⑤ | ⑤ | ⑤ | ● |
| ⑥ | ⑥ | ⑥ | ⑥ |
| ⑦ | ⑦ | ⑦ | ⑦ |
| ⑧ | ⑧ | ⑧ | ⑧ |
| ⑨ | ⑨ | ⑨ | ⑨ |

Decimal point

**Acceptable ways to grid  $\frac{2}{3}$  are:**

|   | 2 | / | 3 |
|---|---|---|---|
|   | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 |

|   |   |   |   |
|---|---|---|---|
| . | 6 | 6 | 6 |
|   | 1 | 1 |   |
|   | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 |   |   |   |
| 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 |

|   |   |   |   |
|---|---|---|---|
| . | 6 | 6 | 7 |
|   | 0 | 0 |   |
|   | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 |   |   | 6 |
| 7 | 7 | 7 |   |
| 8 | 8 | 8 |   |

**Answer: 201 – either position is correct**

|                                  |                                  |                                  |                                  |
|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
|                                  | 2                                | 0                                | 1                                |
|                                  | <input checked="" type="radio"/> | <input checked="" type="radio"/> |                                  |
| <input checked="" type="radio"/> | <input checked="" type="radio"/> | <input checked="" type="radio"/> | <input checked="" type="radio"/> |
|                                  | <input type="radio"/>            | <input type="radio"/>            | <input type="radio"/>            |
| <input type="radio"/>            | <input type="radio"/>            | <input type="radio"/>            | <input type="radio"/>            |
| <input type="radio"/>            | <input type="radio"/>            | <input type="radio"/>            | <input type="radio"/>            |
| <input type="radio"/>            | <input type="radio"/>            | <input type="radio"/>            | <input type="radio"/>            |

|   |              |              |   |
|---|--------------|--------------|---|
| 2 | 0            | 1            |   |
|   | <del>1</del> | <del>1</del> |   |
| 0 | 0            | 0            | 0 |
|   |              | 0            | 0 |
| 1 | 1            |              | 1 |
|   | 2            | 2            | 2 |
| 3 | 3            | 3            | 3 |

**NOTE:**

You may start your answers in any column, space permitting. Columns you don't need to use should be left blank.





11

The function  $g$  is defined by  $g(x) = \frac{1}{2}x - 1$ . What is the value of  $g(6)$ ?

15

$$3(2x - 1) = 4x + 12$$

What value of  $x$  satisfies the equation above?

16

$$y = \frac{1}{2}x + 8$$

$$y = cx + 10$$

In the system of equations above,  $c$  is a constant. If the system has no solution, what is the value of  $c$ ?

17

If  $\frac{1}{x} + \frac{1}{3x} = 5$ , what is the value of  $\frac{3x}{4}$ ?

**STOP**

**If you finish before time is called, you may check your work on this section only.  
Do not turn to any other section.**

**No Test Material On This Page**



# Math Test – Calculator

45 MINUTES, 31 QUESTIONS

Turn to Section 4 of your answer sheet to answer the questions in this section.

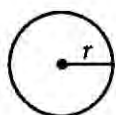
## DIRECTIONS

For questions 1-27, solve each problem, choose the best answer from the choices provided, and fill in the corresponding bubble on your answer sheet. For questions 28-31, solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 28 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

## NOTES

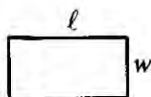
1. The use of a calculator is permitted.
2. All variables and expressions used represent real numbers unless otherwise indicated.
3. Figures provided in this test are drawn to scale unless otherwise indicated.
4. All figures lie in a plane unless otherwise indicated.
5. Unless otherwise indicated, the domain of a given function  $f$  is the set of all real numbers  $x$  for which  $f(x)$  is a real number.

## REFERENCE

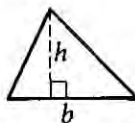


$$A = \pi r^2$$

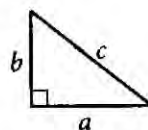
$$C = 2\pi r$$



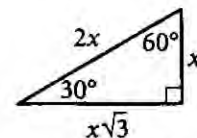
$$A = \ell w$$



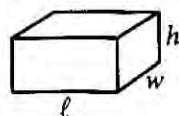
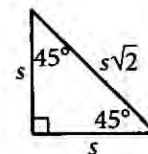
$$A = \frac{1}{2}bh$$



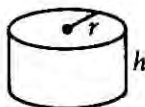
$$c^2 = a^2 + b^2$$



Special Right Triangles



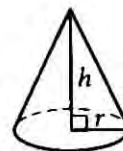
$$V = \ell wh$$



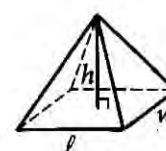
$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}\ell wh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.



1

The distance between two towns is 3 miles. What is the distance between these two towns, in feet? (1 mile = 5,280 feet)

- A) 1,760
- B) 5,283
- C) 15,840
- D) 21,120

2

During a sale, the original prices of all the items in a clothing store have been reduced by 20%. What is the sale price of a jacket with an original price of \$50?

- A) \$12
- B) \$30
- C) \$36
- D) \$40



Questions 3 and 4 refer to the following information.

On May 16, 2011, the space shuttle *Endeavour* launched for the last time. The total mass of the entire spacecraft includes the *Endeavour* shuttle, its external rockets, its fuel tank, and its fuel. The total mass of the entire spacecraft changed as fuel was used. The model below shows the predicted mass  $m$ , in thousands of kilograms, of the entire spacecraft  $t$  seconds after the launch.

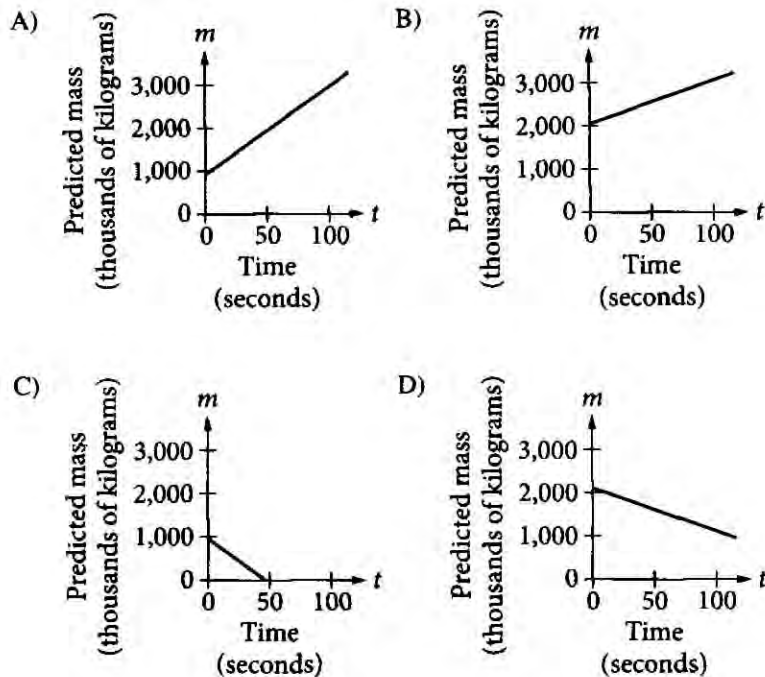
$$m = 2,050 - 9.75t, 0 \leq t \leq 120$$

According to the given model, what was the predicted mass, in thousands of kilograms, of the entire spacecraft 60 seconds after launch?

- A) 585
- B) 1,465
- C) 1,995
- D) 2,635



Which of the following graphs represents the relationship between  $t$  and  $m$ ?



9, 9, 10.5, 11, 11.5, 12, 12

The given data show the age, in years, of 7 domesticated sheep. Based on these data, which of the following statements about these sheep is true?

- A) The median age is equal to the mean age.
- B) The median age is greater than the mean age.
- C) The range of ages is equal to the mean age.
- D) The range of ages is greater than the mean age.





6

Data set A: 5, 5, 5, 5, 5, 5, 5, 5

Data set B: 5, 5, 5, 5, 5, 5, 5, 5, 100

Which of the following statements about the means and medians of data set A and data set B is true?

- A) Only the means are different.
- B) Only the medians are different.
- C) Both the means and the medians are different.
- D) Neither the means nor the medians are different.

7

The Danyang-Kunshan Grand Bridge in China has a length of 164.8 kilometers. Which of the following best approximates the length, in miles, of the Danyang-Kunshan Grand Bridge?  
(1 kilometer = 0.6214 mile)

- A) 265.2
- B) 165.4
- C) 164.2
- D) 102.4

8

$$(1 - x)(x + 2)^2(x + 3) = 0$$

Which of the following is a solution to the equation above?

- A) -2
- B) -1
- C) 2
- D) 3

9

A gold dredge is a machine that was used in the early 1900s to extract gold from a river or pond. The amount of dirt a gold dredge can dig in 1 minute is equal to the amount it would take 3 people, each digging at the same rate, to dig in 1 day. At this rate, how many days would it take 1 person to dig as much dirt as a gold dredge can dig in 30 minutes?

- A) 30
- B) 45
- C) 60
- D) 90

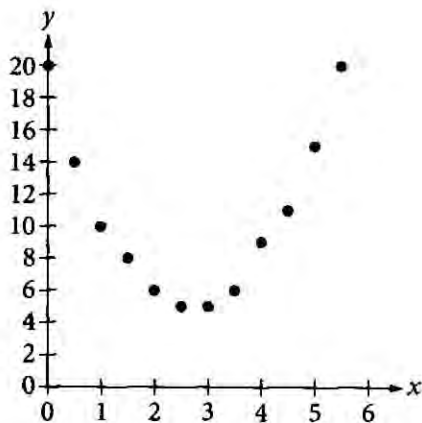


10

A store manager reviewed the receipts from 80 customers who were selected at random from all the customers who made purchases last Thursday. Of those selected, 20 receipts showed that the customer had purchased fruit. If 1,500 customers made purchases last Thursday, which of the following is the most appropriate conclusion?

- A) Exactly 75 customers must have purchased fruit last Thursday.
- B) Exactly 375 customers must have purchased fruit last Thursday.
- C) The best estimate for the number of customers who purchased fruit last Thursday is 75.
- D) The best estimate for the number of customers who purchased fruit last Thursday is 375.

11



Of the following, which is the best model for the data in the scatterplot?

- A)  $y = 2x^2 - 11x - 20$
- B)  $y = 2x^2 - 11x + 20$
- C)  $y = 2x^2 - 5x - 3$
- D)  $y = 2x^2 - 5x + 3$

12

A right circular cylinder has a volume of  $45\pi$ . If the height of the cylinder is 5, what is the radius of the cylinder?

- A) 3
- B) 4.5
- C) 9
- D) 40

13

$$\begin{aligned} w &= a + 2 \\ z &= a \end{aligned}$$

The equations above define  $w$  and  $z$  in terms of  $a$ . What is  $2wz$  in terms of  $a$ ?

- A)  $2a + 2$
- B)  $4a + 4$
- C)  $2a^2 + 2$
- D)  $2a^2 + 4a$



11

Which of the following represents the result of increasing the quantity  $x$  by 5%, where  $x > 0$ ?

- A)  $5x$
- B)  $1.05x$
- C)  $1.005x$
- D)  $0.5x$

15

$$H = 120p + 60$$

The Karvonen formula above shows the relationship between Alice's target heart rate  $H$ , in beats per minute (bpm), and the intensity level  $p$  of different activities. When  $p = 0$ , Alice has a resting heart rate. When  $p = 1$ , Alice has her maximum heart rate. It is recommended that  $p$  be between 0.5 and 0.85 for Alice when she trains. Which of the following inequalities describes Alice's target training heart rate?

- A)  $120 \leq H \leq 162$
- B)  $102 \leq H \leq 120$
- C)  $60 \leq H \leq 162$
- D)  $60 \leq H \leq 102$

16

If  $4x - \frac{1}{2} = -5$ , what is the value of  $8x - 1$ ?

- A) 2
- B)  $-\frac{9}{8}$
- C)  $-\frac{5}{2}$
- D) -10



Questions 17 and 18 refer to the following information.

| State      | Power capacity |        |      |       |
|------------|----------------|--------|------|-------|
|            | Low            | Medium | High | Total |
| Texas      | 4              | 2      | 3    | 9     |
| California | 1              | 0      | 1    | 2     |
| Oregon     | 1              | 0      | 1    | 2     |
| Indiana    | 0              | 2      | 0    | 2     |
| Colorado   | 1              | 1      | 0    | 2     |
| Iowa       | 2              | 0      | 0    | 2     |
| Oklahoma   | 1              | 0      | 0    | 1     |
| Total      | 10             | 5      | 5    | 20    |

The table shows the distribution, by location and power capacity (maximum rate of power generation) of the twenty largest wind projects in the United States in 2013. The total power capacity of the nine wind projects located in Texas was 4,952 megawatts (MW), and the total power capacity of the twenty wind projects was 11,037 MW in 2013.

17

If one of the projects in Texas that is represented in the table is selected at random, what is the probability that the project selected had a medium or high power capacity?

- A)  $\frac{2}{9}$
- B)  $\frac{3}{9}$
- C)  $\frac{4}{9}$
- D)  $\frac{5}{9}$

18

The amount of energy produced in one hour at a rate of one megawatt is one megawatt-hour. If each of the nine Texas wind projects in 2013 had operated continuously for 24 hours at the maximum rate of power generation, approximately how many megawatt-hours of energy would the nine projects have produced?

- A) 200
- B) 5,000
- C) 11,000
- D) 120,000

19

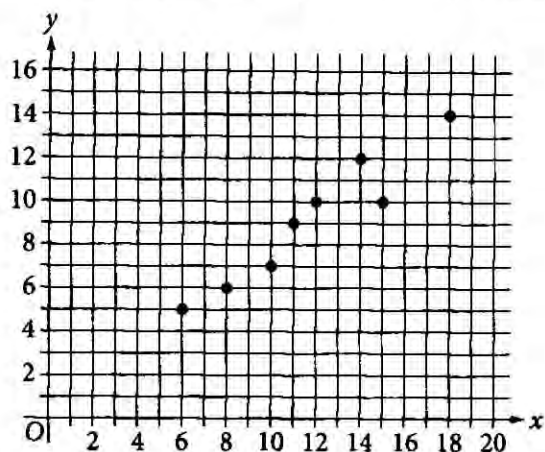
$$f(x) = x^2 + bx + 5$$

In the given function,  $b$  is a constant. If  $f(1) = 0$ , what is the value of  $f(3)$ ?

- A) -6
- B) -4
- C) -3
- D) 5



20



Of the following equations, which could be an equation of a line of best fit for the data points shown in the  $xy$ -plane above?

- A)  $y = 0.3 + 0.8x$
- B)  $y = 0.8 + 0.3x$
- C)  $y = 0.8 + 4x$
- D)  $y = 4 + 0.8x$

21

In an article about exercise, it is estimated that a 160-pound adult uses 200 calories for every 30 minutes of hiking and 150 calories for every 30 minutes of bicycling. An adult who weighs 160 pounds has completed 1 hour of bicycling. Based on the article, how many hours should the adult hike to use a total of 1,900 calories from bicycling and hiking?

- A) 9.5
- B) 8.75
- C) 6
- D) 4

22

In the  $xy$ -plane, the graph of  $y = x^2 - 9$  intersects line  $p$  at  $(1, a)$  and  $(5, b)$ , where  $a$  and  $b$  are constants. What is the slope of line  $p$ ?

- A) 6
- B) 2
- C) -2
- D) -6

23

What is the minimum value of the function  $f$  defined by  $f(x) = (x - 2)^2 - 4$ ?

- A) -4
- B) -2
- C) 2
- D) 4



24

Which of the following is true about the values of  $2^x$  and  $2x + 2$  for  $x > 0$ ?

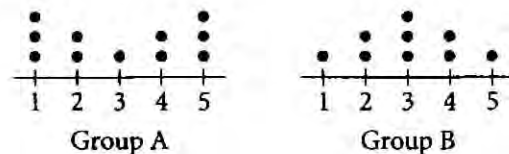
- A) For all  $x > 0$ , it is true that  $2^x < 2x + 2$ .
- B) For all  $x > 0$ , it is true that  $2^x > 2x + 2$ .
- C) There is a constant  $c$  such that if  $0 < x < c$ , then  $2^x < 2x + 2$ , but if  $x > c$ , then  $2^x > 2x + 2$ .
- D) There is a constant  $c$  such that if  $0 < x < c$ , then  $2^x > 2x + 2$ , but if  $x > c$ , then  $2^x < 2x + 2$ .

25

During a month, Morgan ran  $r$  miles at 5 miles per hour and biked  $b$  miles at 10 miles per hour. She ran and biked a total of 200 miles that month, and she biked for twice as many hours as she ran. What is the total number of miles that Morgan biked during the month?

- A) 80
- B) 100
- C) 120
- D) 160

26



The dot plots summarize two data sets. How does the mean of group A compare to the mean of group B?

- A) The mean of group A is greater than the mean of group B.
- B) The mean of group A is less than the mean of group B.
- C) The mean of group A is equal to the mean of group B.
- D) There is not enough information given to compare the means.

27

$$\begin{aligned}\frac{x}{2} + 2y &= 14 \\ x - \frac{y}{2} &= 1\end{aligned}$$

In the system of equations above, what is the value of  $\frac{x}{2}$ ?

- A)  $\frac{1}{2}$
- B) 1
- C)  $\frac{3}{2}$
- D) 2



### DIRECTIONS

**For questions 28–31, solve the problem and enter your answer in the grid, as described below, on the answer sheet.**

1. Although not required, it is suggested that you write your answer in the boxes at the top of the columns to help you fill in the bubbles accurately. You will receive credit only if the bubbles are filled in correctly.
2. Mark no more than one bubble in any column.
3. No question has a negative answer.
4. Some problems may have more than one correct answer. In such cases, grid only one answer.
5. **Mixed numbers** such as  $3\frac{1}{2}$  must be gridded as 3.5 or  $7/2$ . (If 

|                       |                       |                       |                       |
|-----------------------|-----------------------|-----------------------|-----------------------|
| 3                     | 1                     | /                     | 2                     |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

 is entered into the grid, it will be interpreted as  $\frac{31}{2}$ , not  $3\frac{1}{2}$ .)
6. **Decimal answers:** If you obtain a decimal answer with more digits than the grid can accommodate, it may be either rounded or truncated, but it must fill the entire grid.

**Answer:**  $\frac{7}{12}$

Write  
answer in  $\longrightarrow$   
boxes.

|   |   |   |   |
|---|---|---|---|
| 7 | / | 1 | 2 |
|   | ● | ⑦ |   |
| ○ | ● | ○ | ○ |
|   | 0 | 0 | 0 |
| ① | ① | ● | ① |
| ② | ② | ② | ● |
| ③ | ③ | ③ | ③ |
| ④ | ④ | ④ | ④ |
| ⑤ | ⑤ | ⑤ | ⑤ |
| ⑥ | ⑥ | ⑥ | ⑥ |
| ● | ⑦ | ⑦ | ⑦ |
| ⑧ | ⑧ | ⑧ | ⑧ |
| ⑨ | ⑨ | ⑨ | ⑨ |

← Fraction line

**Answer: 2.5**

|                                                                                     |                                                                                     |                                                                                     |                                                                                     |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                                                                                     | 2                                                                                   | .                                                                                   | 5                                                                                   |
|                                                                                     |  |  |                                                                                     |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Decimal point

**Acceptable ways to grid  $\frac{2}{3}$  are:**

|   | 2 | / | 3 |
|---|---|---|---|
|   | 7 |   |   |
| 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 |   | 2 | 2 |
| 3 | 3 | 3 |   |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 |

|   |   |   |   |
|---|---|---|---|
| . | 6 | 6 | 6 |
|   | 7 | 7 |   |
|   | . | . | . |
|   | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 |   |   |   |
| 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 |

|   |   |   |   |
|---|---|---|---|
| . | 6 | 6 | 7 |
|   | 1 | 1 |   |
|   | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 |   |   | 6 |
| 7 | 7 | 7 |   |
| 8 | 8 | 8 | 8 |

**Answer: 201 – either position is correct**

|   |   |   |   |
|---|---|---|---|
|   | 2 | 0 | 1 |
|   | 1 | 1 |   |
| 0 | 0 | 0 | 0 |
|   | 0 |   | 0 |
| 1 | 1 | 1 |   |
| 2 |   | 2 | 2 |
| 3 | 3 | 3 | 3 |

|              |              |              |              |
|--------------|--------------|--------------|--------------|
| 2            | 0            | 1            |              |
|              | <del>1</del> | <del>1</del> |              |
| <del>0</del> | <del>0</del> | <del>0</del> | <del>0</del> |
|              | ●            | 0            | 0            |
| 1            | 1            | ●            | 1            |
| ●            | 2            | 2            | 2            |
| 3            | 3            | 3            | 3            |

**NOTE:**  
You may start your answers in any column, space permitting. Columns you don't need to use should be left blank.



| $x$ | $f(x)$ |
|-----|--------|
| 1   | $a$    |
| 2   | $a^5$  |
| 3   | $a^9$  |

For the exponential function  $f$ , the table above shows several values of  $x$  and their corresponding values of  $f(x)$ , where  $a$  is a constant greater than 1. If  $k$  is a constant and  $f(k) = a^{29}$ , what is the value of  $k$ ?

$$(a - 12)x = a + 8$$

In the equation above,  $a$  is a constant. If the equation has no solutions, what is the value of  $a$ ?

Questions 30 and 31 refer to the following information.

|               | Phone | Email |
|---------------|-------|-------|
| Dinner dance  | 55%   | 80%   |
| Football game | 20%   | 10%   |
| Picnic        | 20%   | 5%    |
| Pool party    | 5%    | 5%    |
| Total         | 100%  | 100%  |

An alumni association survey asked each high school graduate to select the one activity he or she preferred for the association's next event. Some of the people responded by phone, and the others responded by email. The table above shows the distribution of preferred activity, in percent, for each response type used.

30

If 40 of the people who responded by phone preferred a picnic, how many of the people who responded by phone preferred a dinner dance?

31

For the survey, the number of email responses was twice the number of phone responses. If a person who preferred a picnic is selected at random, what is the probability that the person responded by email?

# STOP

If you finish before time is called, you may check your work on this section only.  
Do not turn to any other section.

# Score Conversion

Score conversions show how raw scores are converted into test scores, cross-test scores, and subscores.

## IMPORTANT TO NOTE

- The section score for the Evidence-Based Reading and Writing section is calculated by adding the Reading Test score to the Writing and Language Test score and multiplying that figure by 10.
- The section score for the Math section is calculated by multiplying the Math Test score by 20.
- There is no advantage or disadvantage in taking any particular test form.
- On every test, certain scores are not available, and are referred to as “score gaps.” Score gaps emerge as a result of a statistical process called *equating* in which the number of questions answered correctly and the difficulty of the questions are both considered when scoring across the different tests taken nationwide. Although the College Board works to develop tests with the same level of difficulty, the questions in them differ and therefore some can be slightly easier or harder than others. This can influence the placement of the score gaps throughout the scaled score range. With equating, test scores are equivalent and valid, regardless of when students tested or the level of difficulty of the test they took.

**NOTE:** Score conversions will not be available for the Saturday, October 19 test form or for schools participating in the test administration study or research group.

## Wednesday, Oct. 16 Test Form

| Raw Score<br>(# of correct<br>answers) | Reading<br>Test Score | Writing and<br>Language<br>Test Score | Math<br>Test Score |
|----------------------------------------|-----------------------|---------------------------------------|--------------------|
| 48                                     |                       |                                       | 38                 |
| 47                                     | 38                    |                                       | 37                 |
| 46                                     | 36                    |                                       | 36.5               |
| 45                                     | 35                    |                                       | 35.5               |
| 44                                     | 34                    | 38                                    | 34.5               |
| 43                                     | 33                    | 37                                    | 33.5               |
| 42                                     | 32                    | 35                                    | 32.5               |
| 41                                     | 32                    | 34                                    | 32                 |
| 40                                     | 31                    | 33                                    | 31.5               |
| 39                                     | 30                    | 33                                    | 31                 |
| 38                                     | 29                    | 32                                    | 30.5               |
| 37                                     | 29                    | 31                                    | 30                 |
| 36                                     | 28                    | 30                                    | 29.5               |
| 35                                     | 28                    | 30                                    | 29.5               |
| 34                                     | 27                    | 29                                    | 29                 |
| 33                                     | 27                    | 28                                    | 28.5               |
| 32                                     | 26                    | 28                                    | 28.5               |
| 31                                     | 26                    | 27                                    | 28                 |
| 30                                     | 26                    | 27                                    | 27.5               |
| 29                                     | 25                    | 26                                    | 27.5               |
| 28                                     | 25                    | 26                                    | 27                 |
| 27                                     | 24                    | 25                                    | 26.5               |
| 26                                     | 24                    | 25                                    | 26.5               |
| 25                                     | 23                    | 24                                    | 26                 |
| 24                                     | 23                    | 23                                    | 25.5               |
| 23                                     | 22                    | 23                                    | 25                 |
| 22                                     | 22                    | 22                                    | 25                 |
| 21                                     | 21                    | 21                                    | 24.5               |
| 20                                     | 21                    | 21                                    | 24                 |
| 19                                     | 20                    | 20                                    | 23.5               |
| 18                                     | 20                    | 20                                    | 23                 |
| 17                                     | 20                    | 19                                    | 22.5               |
| 16                                     | 19                    | 18                                    | 22.5               |
| 15                                     | 19                    | 18                                    | 22                 |
| 14                                     | 18                    | 17                                    | 21.5               |
| 13                                     | 18                    | 17                                    | 20.5               |
| 12                                     | 17                    | 16                                    | 20                 |
| 11                                     | 17                    | 16                                    | 19.5               |
| 10                                     | 16                    | 15                                    | 18.5               |
| 9                                      | 16                    | 15                                    | 18                 |
| 8                                      | 15                    | 14                                    | 17                 |
| 7                                      | 14                    | 14                                    | 16.5               |
| 6                                      | 13                    | 13                                    | 15.5               |
| 5                                      | 12                    | 12                                    | 14                 |
| 4                                      | 11                    | 11                                    | 13                 |
| 3                                      | 10                    | 11                                    | 11.5               |
| 2                                      | 9                     | 10                                    | 10.5               |
| 1                                      | 9                     | 9                                     | 9.5                |
| 0                                      | 8                     | 8                                     | 8                  |

# Answer Key

## Wednesday, Oct. 16, Answer Key 1

| Reading Test | Writing and Language Test | Math Test – No Calculator |
|--------------|---------------------------|---------------------------|
| SECTION 1    | SECTION 2                 | SECTION 3                 |
| 1 A          | 1 C                       | 1 C                       |
| 2 B          | 2 B                       | 2 D                       |
| 3 B          | 3 A                       | 3 B                       |
| 4 D          | 4 B                       | 4 D                       |
| 5 D          | 5 C                       | 5 A                       |
| 6 C          | 6 D                       | 6 A                       |
| 7 B          | 7 A                       | 7 A                       |
| 8 D          | 8 B                       | 8 D                       |
| 9 A          | 9 C                       | 9 B                       |
| 10 C         | 10 D                      | 10 C                      |
| 11 C         | 11 D                      | 11 A                      |
| 12 A         | 12 A                      | 12 D                      |
| 13 A         | 13 C                      | 13 C                      |
| 14 B         | 14 A                      | 14 2                      |
| 15 D         | 15 B                      | 15 $15/2, 7.5$            |
| 16 D         | 16 C                      | 16 $1/2, .5$              |
| 17 B         | 17 A                      | 17 $1/5, .2$              |
| 18 C         | 18 D                      |                           |
| 19 B         | 19 D                      |                           |
| 20 A         | 20 C                      |                           |
| 21 A         | 21 C                      |                           |
| 22 D         | 22 D                      |                           |
| 23 B         | 23 B                      |                           |
| 24 A         | 24 C                      |                           |
| 25 C         | 25 D                      |                           |
| 26 C         | 26 A                      |                           |
| 27 D         | 27 D                      |                           |
| 28 A         | 28 C                      |                           |
| 29 D         | 29 D                      |                           |
| 30 C         | 30 A                      |                           |
| 31 D         | 31 D                      |                           |
| 32 A         | 32 B                      |                           |
| 33 B         | 33 C                      |                           |
| 34 C         | 34 B                      |                           |
| 35 A         | 35 C                      |                           |
| 36 D         | 36 B                      |                           |
| 37 C         | 37 A                      |                           |
| 38 B         | 38 A                      |                           |
| 39 C         | 39 A                      |                           |
| 40 B         | 40 D                      |                           |
| 41 A         | 41 B                      |                           |
| 42 C         | 42 D                      |                           |
| 43 D         | 43 C                      |                           |
| 44 B         | 44 D                      |                           |
| 45 A         |                           |                           |
| 46 B         |                           |                           |
| 47 D         |                           |                           |

| Math Test – Calculator |
|------------------------|
| SECTION 4              |
| 1 C                    |
| 2 D                    |
| 3 B                    |
| 4 D                    |
| 5 B                    |
| 6 A                    |
| 7 D                    |
| 8 A                    |
| 9 D                    |
| 10 D                   |
| 11 B                   |
| 12 A                   |
| 13 D                   |
| 14 B                   |
| 15 A                   |
| 16 D                   |
| 17 D                   |
| 18 D                   |
| 19 B                   |
| 20 A                   |
| 21 D                   |
| 22 A                   |
| 23 A                   |
| 24 C                   |
| 25 D                   |
| 26 C                   |
| 27 D                   |
| 28 8                   |
| 29 12                  |
| 30 110                 |
| 31 $1/3, .333$         |

**NOTE:** For more detailed information about scores, visit [psat.org/resources](https://psat.org/resources).

## Wednesday, Oct. 16, Answer Key 2

| Reading Test | Writing and Language Test | Math Test – No Calculator |
|--------------|---------------------------|---------------------------|
| SECTION 1    | SECTION 2                 | SECTION 3                 |
| 1 A          | 1 C                       | 1 D                       |
| 2 B          | 2 B                       | 2 B                       |
| 3 B          | 3 A                       | 3 D                       |
| 4 D          | 4 B                       | 4 A                       |
| 5 C          | 5 C                       | 5 C                       |
| 6 D          | 6 D                       | 6 C                       |
| 7 B          | 7 A                       | 7 A                       |
| 8 D          | 8 B                       | 8 A                       |
| 9 A          | 9 C                       | 9 D                       |
| 10 C         | 10 D                      | 10 B                      |
| 11 C         | 11 D                      | 11 D                      |
| 12 A         | 12 A                      | 12 C                      |
| 13 A         | 13 C                      | 13 A                      |
| 14 B         | 14 A                      | 14 $15/2, 7.5$            |
| 15 D         | 15 B                      | 15 2                      |
| 16 D         | 16 C                      | 16 $1/2, .5$              |
| 17 C         | 17 A                      | 17 $1/5, .2$              |
| 18 B         | 18 D                      |                           |
| 19 B         | 19 D                      |                           |
| 20 A         | 20 C                      |                           |
| 21 A         | 21 C                      |                           |
| 22 D         | 22 D                      |                           |
| 23 A         | 23 B                      |                           |
| 24 C         | 24 C                      |                           |
| 25 C         | 25 B                      |                           |
| 26 B         | 26 A                      |                           |
| 27 D         | 27 A                      |                           |
| 28 A         | 28 A                      |                           |
| 29 D         | 29 D                      |                           |
| 30 D         | 30 B                      |                           |
| 31 A         | 31 D                      |                           |
| 32 C         | 32 C                      |                           |
| 33 B         | 33 D                      |                           |
| 34 C         | 34 B                      |                           |
| 35 A         | 35 C                      |                           |
| 36 D         | 36 D                      |                           |
| 37 C         | 37 A                      |                           |
| 38 B         | 38 D                      |                           |
| 39 C         | 39 C                      |                           |
| 40 B         | 40 D                      |                           |
| 41 A         | 41 A                      |                           |
| 42 C         | 42 D                      |                           |
| 43 D         | 43 B                      |                           |
| 44 B         | 44 C                      |                           |
| 45 B         |                           |                           |
| 46 D         |                           |                           |
| 47 A         |                           |                           |

| Math Test – Calculator |
|------------------------|
| SECTION 4              |
| 1 B                    |
| 2 C                    |
| 3 D                    |
| 4 B                    |
| 5 D                    |
| 6 A                    |
| 7 D                    |
| 8 D                    |
| 9 A                    |
| 10 D                   |
| 11 A                   |
| 12 B                   |
| 13 A                   |
| 14 D                   |
| 15 B                   |
| 16 D                   |
| 17 D                   |
| 18 B                   |
| 19 A                   |
| 20 D                   |
| 21 A                   |
| 22 C                   |
| 23 D                   |
| 24 D                   |
| 25 A                   |
| 26 C                   |
| 27 D                   |
| 28 12                  |
| 29 8                   |
| 30 110                 |
| 31 $1/3, .333$         |

**NOTE:** For the Wednesday, Oct. 16, test form, though the order of the test questions may differ, the test questions themselves do not.

**NOTE:** For schools participating in the test administration study in fall 2019, correct answers will not be provided. Correct answers will also not be provided for the Saturday, Oct. 19, test form.