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Test begins on the next page.

Reading Test

65 MINUTES, 52 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 1-10 are based on the following passage.

This passage is from Carlos Ruiz Zafón, *The Angel's Game*. ©2008 by Dragonworks, S.L. Translation ©2009 by Lucia Graves. The narrator, a writer, recalls his childhood in early twentieth-century Barcelona.

Even then my only friends were made of paper and ink. At school I had learned to read and write long before the other children. Where my school friends saw notches of ink on incomprehensible pages, I saw light, streets, and people. Words and the mystery of their hidden science fascinated me, and I saw in them a key with which I could unlock a boundless world, a safe haven from that home, those streets, and those troubled days in which even I could sense that only a limited fortune awaited me. My father didn't like to see books in the house. There was something about them—apart from the letters he could not decipher—that offended him. He used to tell me that as soon as I was ten he would send me off to work and that I'd better get rid of all my scatterbrained ideas if I didn't want to end up a loser, a nobody. I used to hide my books under the mattress and wait for him to go out or fall asleep so that I could read. Once he caught me reading at night and flew into a rage. He tore the book from my hands and flung it out of the window.

"If I catch you wasting electricity again, reading all this nonsense, you'll be sorry."

My father was not a miser and, despite the hardships we suffered, whenever he could he gave me a few coins so that I could buy myself some treats like the other children. He was convinced that I spent them on licorice sticks, sunflower seeds, or sweets, but I would keep them in a coffee tin under the bed, and when I'd collected four or five reales I'd secretly rush out to buy myself a book.

My favorite place in the whole city was the Sempere & Sons bookshop on Calle Santa Ana. It smelled of old paper and dust and it was my sanctuary, my refuge. The bookseller would let me sit on a chair in a corner and read any book I liked to my heart's content. He hardly ever allowed me to pay for the books he placed in my hands, but when he wasn't looking I'd leave the coins I'd managed to collect on the counter before I left. It was only small change—if I'd had to buy a book with that pittance, I would probably have been able to afford only a booklet of cigarette papers. When it was time for me to leave, I would do so dragging my feet, a weight on my soul. If it had been up to me, I would have stayed there forever.

One Christmas Sempere gave me the best gift I have ever received. It was an old volume, read and experienced to the full.

"*Great Expectations*, by Charles Dickens," I read on the cover.

I was aware that Sempere knew a few authors who frequented his establishment and, judging by the care with which he handled the volume, I thought perhaps this Mr. Dickens was one of them.

"A friend of yours?"

"A lifelong friend. And from now on, he's your friend too."

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CONTINUE

That afternoon I took my new friend home, hidden under my clothes so that my father wouldn't see it. It was a rainy winter, with days as gray as lead, and I read *Great Expectations* about nine times, partly because I had no other book at hand, partly because I did not think there could be a better one in the whole world and I was beginning to suspect that Mr. Dickens had written it just for me. Soon I was convinced that I didn't want to do anything else in life but learn to do what Mr. Dickens had done.

1

Over the course of the passage, the main focus shifts from a

A) general discussion of the narrator's love of reading to a portrayal of an influential incident.

B) depiction of the narrator's father to an examination of an author with whom the narrator becomes enchanted.

C) symbolic representation of a skill the narrator possesses to an example of its application.

D) tale about the hardships of the narrator's childhood to an analysis of the effects of those hardships.

2

The main purpose of lines 1-10 ("Even . . . awaited me") is to

A) introduce the characters who play a part in the narrator's story.

B) list the difficult conditions the narrator endured in childhood.

C) describe the passion that drives the actions the narrator recounts.

D) depict the narrator's aspirations before he met Sempere.

3

With which of the following statements about his father would the narrator most likely agree?

A) He lacked affection for the narrator.

B) He disliked any unnecessary use of money.

C) He would not have approved of Sempere's gift.

D) He objected to the writings of Charles Dickens.

4

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

A) Lines 24-27 ("My father . . . children")

B) Lines 35-37 ("The bookseller . . . content")

C) Lines 37-38 ("He hardly . . . hands")

D) Lines 59-61 ("That afternoon . . . see it")

5

It can reasonably be inferred from the passage that the main reason that the narrator considers *Great Expectations* to be the best gift he ever received is because

A) reading the book convinced him that he wanted to be a writer.

B) he'd only ever been given sweets and snacks as gifts in the past.

C) the gift meant that Sempere held him in high regard.

D) Sempere was a friend of the book's author.

6

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

A) Lines 38-40 ("when . . . left")

B) Lines 48-49 ("It was . . . full")

C) Lines 52-55 ("I was . . . them")

D) Lines 66-68 ("Soon . . . done")

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CONTINUE

7

The narrator indicates that he pays Sempere

A) less than Sempere expects him to pay for the books.

B) nothing, because Sempere won't take his money.

C) the money he makes selling sweets to the other children.

D) much less for the books than they are worth.

8

As used in line 44, "weight" most nearly means

A) bulk.

B) burden.

C) force.

D) clout.

9

The word "friend" is used twice in lines 57-58 to

A) underline the importance of the narrator's connection to Sempere.

B) stress how friendships helped the narrator deal with his difficult home situation.

C) emphasize the emotional connection Sempere feels to reading.

D) imply that the narrator's sentiments caused him to make an irrational decision.

10

Which statement best characterizes the relationship between Sempere and Charles Dickens?

A) Sempere models his own writing after Dickens's style.

B) Sempere is an avid admirer of Dickens's work.

C) Sempere feels a personal connection to details of Dickens's biography.

D) Sempere considers himself to be Dickens's most appreciative reader.

Questions 11-21 are based on the following passage and supplementary material.

This passage is adapted from Jeffrey Mervis, "Why Null Results Rarely See the Light of Day." ©2014 by American Association for the Advancement of Science.

The question of what to do with null results—when researchers fail to see an effect that should be detectable—has long been hotly debated among those conducting medical trials, where the results can have a big impact on lives and corporate bottom lines. More recently, the debate has spread to the social and behavioral sciences, which also have the potential to sway public and social policy. There were little hard data, however, on how often or why null results were squelched. "Yes, it's true that null results are not as exciting," political scientist Gary King of Harvard University says. "But I suspect another reason they are rarely published is that there are many, many ways to produce null results by messing up. So they are much harder to interpret."

In a recent study, Stanford political economist Neil Malhotra and two of his graduate students examined every study since 2002 that was funded by a competitive grants program called TESS (Time-sharing Experiments for the Social Sciences). TESS allows scientists to order up Internet-based surveys of a representative sample of US adults to test a particular hypothesis (for example, whether voters tend to favor legislators who boast of bringing federal dollars to their districts over those who tout a focus on policy matters).

Malhotra's team tracked down working papers from most of the experiments that weren't published, and for the rest asked grantees what had happened to their results. In their e-mailed responses, some scientists cited deeper problems with a study or more pressing matters—but many also believed the journals just wouldn't be interested. "The unfortunate reality of the publishing world [is] that null effects do not tell a clear story," said one scientist. Said another, "Never published, definitely disappointed to not see any major effects."

Their answers suggest to Malhotra that rescuing findings from the file drawer will require a shift in expectations. "What needs to change is the culture—the author's belief about what will happen if the research is written up," he says.

Not unexpectedly, the statistical strength of the findings made a huge difference in whether they were ever published. Overall, 42% of the experiments

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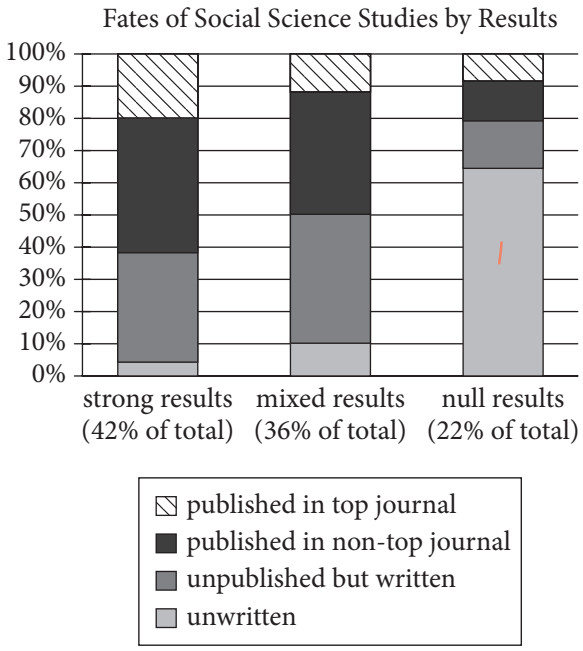
produced statistically significant results. Of those, 62% were ultimately published, compared with 21% of the null results. However, the Stanford team was surprised that researchers didn't even write up 65% of the experiments that yielded a null finding.

Scientists not involved in the study praise its "clever" design. "It's a very important paper" that "starts to put numbers on things we want to understand," says economist Edward Miguel of the University of California, Berkeley.

He and others note that the bias against null studies can waste time and money when researchers devise new studies replicating strategies already found to be ineffective. Worse, if researchers publish significant results from similar experiments in the future, they could look stronger than they should because the earlier null studies are ignored. Even more troubling to Malhotra was the fact that two scientists whose initial studies "didn't work out" went on to publish results based on a smaller sample. "The non-TESS version of the same study, in which we used a student sample, did yield fruit," noted one investigator.

A registry for data generated by all experiments would address these problems, the authors argue. They say it should also include a "preanalysis" plan, that is, a detailed description of what the scientist hopes to achieve and how the data will be analyzed. Such plans would help deter researchers from tweaking their analyses after the data are collected in search of more publishable results.



Adapted from Annie Franco, Neil Malhotra, and Gabor Simonovits, "Publication Bias in the Social Sciences: Unlocking the File Drawer." ©2014 by American Association for the Advancement of Science.

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CONTINUE

11

The passage primarily serves to

A) discuss recent findings concerning scientific studies and dispute a widely held belief about the publication of social science research.

B) explain a common practice in the reporting of research studies and summarize a study that provides support for a change to that practice.

C) describe the shortcomings in current approaches to medical trials and recommend the implementation of a government database.

D) provide context as part of a call for stricter controls on social science research and challenge publishers to alter their mindsets.

12

As used in line 21, "allows" most nearly means

A) admits.

B) tolerates.

C) grants.

D) enables.

13

As used in line 43, "strength" most nearly means

A) attribution.

B) exertion.

C) toughness.

D) significance.

14

The passage indicates that a problem with failing to document null results is that

A) the results of related studies will be misleading.

B) researchers may overlook promising areas of study.

C) mistakes in the collection of null results may be overlooked.

D) the bias against null results will be disregarded.

15

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

A) Lines 38-40 ("Their . . . expectations")

B) Lines 48-50 ("However . . . finding")

C) Lines 56-59 ("He and . . . ineffective")

D) Lines 59-62 ("Worse . . . ignored")

16

Based on the passage, to which of the following hypothetical situations would Malhotra most strongly object?

A) A research team refuses to publish null results in anything less than a top journal.

B) A research team excludes the portion of data that produced null results when reporting its results in a journal.

C) A research team unknowingly repeats a study that produced null results for another research team.

D) A research team performs a follow-up study that expands the scope of an initial study that produced null results.

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CONTINUE

17

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

A) Lines 36-37 ("Said . . . effects")
B) Lines 45-48 ("Overall . . . null results")
C) Lines 62-68 ("Even . . . investigator")
D) Lines 69-73 ("A registry . . . analyzed")

18

The last paragraph serves mainly to

A) propose a future research project to deal with some of the shortcomings of current publishing practices noted in the passage.
B) introduce a possible solution to problems discussed in the passage regarding the reporting of social science studies.
C) summarize the findings of a study about experimental results explained in the passage.
D) reinforce the importance of reexamining the results of all social science trials.

19

According to the graph, social science studies yielding strong results were

A) unwritten over 50 percent of the time.
B) unpublished but written 50 percent of the time.
C) published in a top journal approximately 20 percent of the time.
D) published in a non-top journal almost 80 percent of the time.

20

Which of the following statements is supported by the graph?

A) Studies with mixed results were just as likely to be published as they were to be left either unpublished or unwritten.
B) Studies with mixed results occurred more frequently than did studies with strong and null results combined.
C) Studies with mixed results were more likely to be published in top journals than they were to be published in non-top journals.
D) Studies with mixed results were the most common type of social science studies.

21

Which statement from the passage is most directly reflected by the data presented in the graph?

A) Lines 30-33 ("In their . . . interested")
B) Lines 33-36 ("The unfortunate . . . scientist")
C) Lines 43-45 ("Not unexpectedly . . . published")
D) Lines 52-55 ("It's a . . . Berkeley")

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Questions 22-31 are based on the following passage and supplementary material.

This passage is adapted from Rachel Ehrenberg, "Salt Stretches in Nanoworld." ©2009 by Society for Science & the Public. The "nanoworld" is the world observed on a scale one billionth that of ordinary human experience.

Inflexible old salt becomes a softy in the nanoworld, stretching like taffy to more than twice its length, researchers report. The findings may lead to new approaches for making nanowires that could end up in solar cells or electronic circuits. The work also suggests that these ultra-tiny salt wires may already exist in sea spray and large underground salt deposits.

"We think nanowires are special and go to great lengths to make them," says study coauthor Nathan Moore of Sandia National Laboratories in Albuquerque. "Maybe they are more common than we think."

Metals such as gold or lead, in which bonding angles are loosey-goosey, can stretch out at temperatures well below their melting points. But scientists don't expect this superplasticity in a rigid, crystalline material like salt, Moore says.

This unusual behavior highlights that different forces rule the nanoworld, says theoretical physicist Krzysztof Kempa of Boston College. "Forget about gravity. It plays no role," he says. Surface tension and electrostatic forces are much more important at this scale.

Moore and his colleagues discovered salt's stretchiness accidently. They were investigating how water sticks to a surface such as salt and created a super-dry salt sample for testing. After cleaving a chunk of salt about the size of a sugar cube with a razor, the scientists guided a microscope that detects forces toward the surface. When the tip was far away there was no measured force, but within about seven nanometers a very strong attraction rapidly developed between the diamond tip of the microscope and the salt. The salt actually stretched out to glom on to the microscope tip. Using an electron microscope to see what was happening, the researchers observed the nanowires.

The initial attraction between the tip and salt might be due to electrostatic forces, perhaps good old van der Waals interactions,[1] the researchers speculate. Several mechanisms might lead to the elasticity, including the excessive surface tension found in the nanoworld (the same tension that allows a water strider to skim the surface of a pond).

The surface tension is so strong that as the microscope pulls away from the salt, the salt stretches, Kempa says. "The inside has no choice but to rearrange the atoms, rather than break," he says.

This bizarre behavior is actually mirrored in the macroworld, the researchers say. Huge underground deposits of salt can bend like plastic, but water is believed to play a role at these scales. Perhaps salty nanowires are present in these deposits as well.

"Sodium chloride[2] is everywhere—in the air, in our bodies," Moore says. "This may change our view of things, of what's happening at the nanoscale."

The work also suggests new techniques for making nanowires, which are often created through nano-imprinting techniques, Kempa says. "We invoke the intuition of the macroworld," he says. "Maybe instead of stamping [nanowires] we should be nano-pulling them."

1 Attractive forces between nearby atoms

2 Common salt

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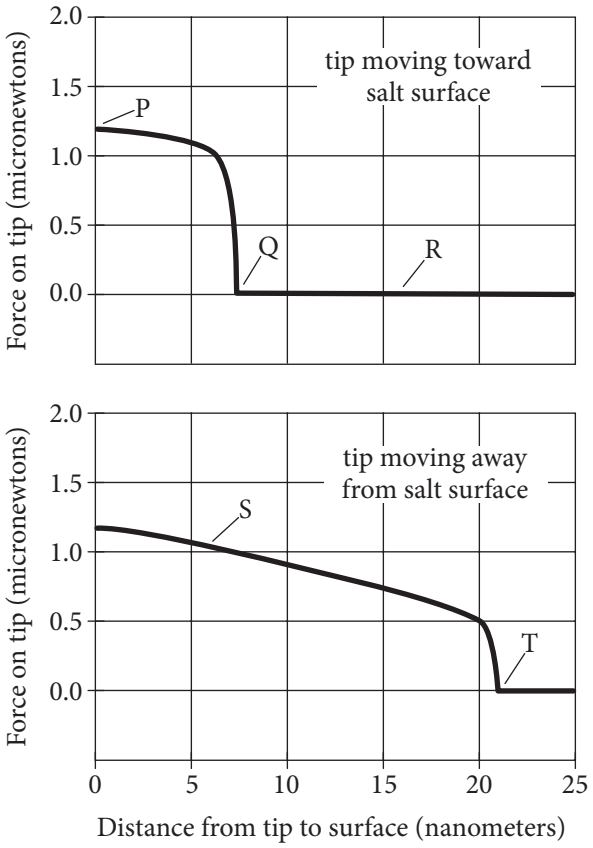
CONTINUE

Interaction of Microscope Tip with Salt Surface



Adapted from Moore et al., "Superplastic Nanowires Pulled from the Surface of Common Salt." ©2009 by American Chemical Society.

22

One central idea of the passage is that

A) sometimes materials behave contrary to expectations.

B) systems can be described in terms of inputs and outputs.

C) models of materials have both strengths and weaknesses.

D) properties of systems differ from the properties of their parts.

23

Which choice best describes the overall structure of the passage?

A) A list of several ways in which salt's properties differ from researchers' expectations

B) A presentation of a hypothesis regarding salt behavior, description of an associated experiment, and explanation of why the results weaken the hypothesis

C) A description of two salt crystal experiments, the apparent disagreement in their results, and the resolution by more sensitive equipment

D) An introduction to an interesting salt property, description of its discovery, and speculation regarding its application

24

Which choice provides the best evidence for the claim that Moore's group was surprised to observe salt stretching?

A) Lines 17-18 ("But . . . says")

B) Lines 26-28 ("They were . . . testing")

C) Lines 36-38 ("Using . . . nanowires")

D) Lines 55-56 ("Sodium . . . says")

25

As used in line 20, "rule" most nearly means

A) mark.

B) control.

C) declare.

D) restrain.

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CONTINUE

26

According to the passage, researchers have identified which mechanism as potentially responsible for the initial attraction between the microscope tip and the salt?

A) Gravity
B) Nano-imprinting
C) Surface tension
D) Van der Waals interactions

27

As used in line 42, "lead to" most nearly means

A) guide to.
B) result in.
C) point toward.
D) start with.

28

Based on the passage, which choice best describes the relationship between salt behavior in the nanoworld and in the macroworld?

A) In both the nanoworld and the macroworld, salt can be flexible.
B) Salt flexibility is expected in the nanoworld but is surprising in the macroworld.
C) Salt nanowires were initially observed in the nanoworld and later observed in the macroworld.
D) In the nanoworld, salt's interactions with water lead to very different properties than they do in the macroworld.

29

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

A) Lines 12-13 ("Maybe . . . think")
B) Lines 22-24 ("Surface . . . scale")
C) Lines 39-42 ("The initial . . . speculate")
D) Lines 51-53 ("Huge . . . scales")

30

According to the information in the graph, when the microscope tip is moving away from the salt surface and is 15 nanometers from the surface, what is the approximate force on the microscope tip, in micronewtons?

A) 0
B) 0.25
C) 0.75
D) 1.25

31

Based on the passage and the graph, which label on the graph indicates the point at which a salt nanowire breaks?

A) P
B) Q
C) R
D) T

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CONTINUE

Questions 32-41 are based on the following passages.

These passages are adapted from the Lincoln-Douglas debates. Passage 1 is from a statement by Stephen Douglas. Passage 2 is from a statement by Abraham Lincoln. Douglas and Lincoln engaged in a series of debates while competing for a US Senate seat in 1858.

Passage 1

Mr. Lincoln likens that bond of the Federal Constitution, joining Free and Slave States together, to a house divided against itself, and says that it is contrary to the law of God, and cannot stand. When did he learn, and by what authority does he proclaim, that this Government is contrary to the law of God and cannot stand? It has stood thus divided into Free and Slave States from its organization up to this day. During that period we have increased from four millions to thirty millions of people; we have extended our territory from the Mississippi to the Pacific Ocean; we have acquired the Floridas and Texas, and other territory sufficient to double our geographical extent; we have increased in population, in wealth, and in power beyond any example on earth; we have risen from a weak and feeble power to become the terror and admiration of the civilized world; and all this has been done under a Constitution which Mr. Lincoln, in substance, says is in violation of the law of God; and under a Union divided into Free and Slave States, which Mr. Lincoln thinks, because of such division, cannot stand. Surely, Mr. Lincoln is a wiser man than those who framed the Government. . . .

I now come back to the question, why cannot this Union exist forever, divided into Free and Slave States, as our fathers made it? It can thus exist if each State will carry out the principles upon which our institutions were founded; to wit, the right of each State to do as it pleases, without meddling with its neighbors. Just act upon that great principle, and this Union will not only live forever, but it will extend and expand until it covers the whole continent, and makes this confederacy one grand, ocean-bound Republic. We must bear in mind that we are yet a young nation, growing with a rapidity unequalled in the history of the world, that our national increase is great, and that the emigration from the old world is increasing, requiring us to expand and acquire new territory from time to time, in order to give our people land to live upon. If we live upon the principle of State rights and State sovereignty, each State regulating its own affairs and minding its own business, we can go on and extend indefinitely, just as fast and as far as we need the territory. . . .

Passage 2

In complaining of what I said in my speech at Springfield, in which he says I accepted my nomination for the Senatorship . . . he again quotes that portion in which I said that "a house divided against itself cannot stand." Let me say a word in regard to that matter. He tries to persuade us that there must be a variety in the different institutions of the States of the Union; that that variety necessarily proceeds from the variety of soil, climate, of the face of the country, and the difference in the natural features of the States. I agree to all that. Have these very matters ever produced any difficulty among us? Not at all. Have we ever had any quarrel over the fact that they have laws in Louisiana designed to regulate the commerce that springs from the production of sugar? Or because we have a different class relative to the production of flour in this State? Have they produced any differences? Not at all. They are the very cements of this Union. They don't make the house a "house divided against itself." They are the props that hold up the house and sustain the Union.

But has it been so with this element of slavery? Have we not always had quarrels and difficulties over it? And when will we cease to have quarrels over it? Like causes produce like effects. It is worth while to observe that we have generally had comparative peace upon the slavery question, and that there has been no cause for alarm until it was excited by the effort to spread it into new territory. Whenever it has been limited to its present bounds, and there has been no effort to spread it, there has been peace. All the trouble and convulsion has proceeded from efforts to spread it over more territory. It was thus at the date of the Missouri Compromise. It was so again with the annexation of Texas; so with the territory acquired by the Mexican War; and it is so now. Whenever there has been an effort to spread it there has been agitation and resistance. . . . Do you think that the nature of man will be changed, that the same causes that produced agitation at one time will not have the same effect at another?

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CONTINUE

32

In the first paragraph of Passage 1, the main purpose of Douglas's discussion of the growth of the territory and population of the United States is to

A) provide context for Douglas's defense of continued expansion.

B) suggest that the division into free and slave states does not endanger the Union.

C) imply that Lincoln is unaware of basic facts concerning the country.

D) account for the image of the United States as powerful and admirable.

33

What does Passage 1 suggest about the US government's provisions for the institution of slavery, as framed in the Constitution?

A) They included no means for reconciling differences between free states and slave states.

B) They anticipated the Union's expansion into western territories.

C) They provided a good basic structure that does not need to be changed.

D) They were founded on an assumption that slavery was necessary for economic growth.

34

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

A) Lines 10-16 ("we have . . . earth")

B) Lines 25-27 ("I now . . . made it")

C) Lines 35-39 ("We must . . . increasing")

D) Lines 41-45 ("If we . . . territory")

35

As used in line 67, "element" most nearly means

A) ingredient.

B) environment.

C) factor.

D) quality.

36

Based on Passage 2, Lincoln would be most likely to agree with which claim about the controversy over slavery?

A) It can be ended only if Northern states act unilaterally to abolish slavery throughout the United States.

B) It would abate if attempts to introduce slavery to regions where it is not practiced were abandoned.

C) It has been exacerbated by the ambiguity of laws regulating the holding of slaves.

D) It is fueled in part by differences in religion and social values from state to state.

37

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

A) Lines 56-61 ("I agree . . . sugar")

B) Lines 64-66 ("They don't . . . Union")

C) Lines 74-76 ("Whenever . . . peace")

D) Lines 83-86 ("Do you . . . another")

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CONTINUE

38

As used in line 84, "nature" most nearly means

A) force.
B) simplicity.
C) world.
D) character.

39

Which choice identifies a central tension between the two passages?

A) Douglas proposes changes to federal policies on slavery, but Lincoln argues that such changes would enjoy no popular support.
B) Douglas expresses concerns about the economic impact of abolition, but Lincoln dismisses those concerns as irrelevant.
C) Douglas criticizes Lincoln for finding fault with the Constitution, and Lincoln argues that this criticism misrepresents his position.
D) Douglas offers an interpretation of federal law that conflicts with Lincoln's, and Lincoln implies that Douglas's interpretation is poorly reasoned.

40

Both passages discuss the issue of slavery in relationship to

A) the expansion of the Union.
B) questions of morality.
C) religious toleration.
D) laws regulating commerce.

41

In the context of each passage as a whole, the questions in lines 25-27 of Passage 1 and lines 67-69 of Passage 2 primarily function to help each speaker

A) cast doubt on the other's sincerity.
B) criticize the other's methods.
C) reproach the other's actions.
D) undermine the other's argument.

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CONTINUE

Questions 42-52 are based on the following passage.

This passage is adapted from Daniel Chamovitz, *What a Plant Knows: A Field Guide to the Senses*. ©2012 by Daniel Chamovitz.

The Venus flytrap [*Dionaea muscipula*] needs to know when an ideal meal is crawling across its leaves. Closing its trap requires a huge expense of energy, and reopening the trap can take several hours, so *Dionaea* only wants to spring closed when it's sure that the dawdling insect visiting its surface is large enough to be worth its time. The large black hairs on their lobes allow the Venus flytraps to literally feel their prey, and they act as triggers that spring the trap closed when the proper prey makes its way across the trap. If the insect touches just one hair, the trap will not spring shut; but a large enough bug will likely touch two hairs within about twenty seconds, and that signal springs the Venus flytrap into action.

We can look at this system as analogous to short-term memory. First, the flytrap encodes the information (forms the memory) that something (it doesn't know what) has touched one of its hairs. Then it stores this information for a number of seconds (retains the memory) and finally retrieves this information (recalls the memory) once a second hair is touched. If a small ant takes a while to get from one hair to the next, the trap will have forgotten the first touch by the time the ant brushes up against the next hair. In other words, it loses the storage of the information, doesn't close, and the ant happily meanders on. How does the plant encode and store the information from the unassuming bug's encounter with the first hair? How does it remember the first touch in order to react upon the second?

Scientists have been puzzled by these questions ever since John Burdon-Sanderson's early report on the physiology of the Venus flytrap in 1882. A century later, Dieter Hodick and Andreas Sievers at the University of Bonn in Germany proposed that the flytrap stored information regarding how many hairs have been touched in the electric charge of its leaf. Their model is quite elegant in its simplicity. In their studies, they discovered that touching a trigger hair on the Venus flytrap causes an electric action potential [a temporary reversal in the electrical polarity of a cell membrane] that induces calcium channels to open in the trap (this coupling of action potentials and the opening of calcium channels is similar to the processes that occur during communication between human neurons), thus causing a rapid increase in the concentration of calcium ions.

They proposed that the trap requires a relatively high concentration of calcium in order to close and that a single action potential from just one trigger hair being touched does not reach this level. Therefore, a second hair needs to be stimulated to push the calcium concentration over this threshold and spring the trap. The encoding of the information requires maintaining a high enough level of calcium so that a second increase (triggered by touching the second hair) pushes the total concentration of calcium over the threshold. As the calcium ion concentrations dissipate over time, if the second touch and potential don't happen quickly, the final concentration after the second trigger won't be high enough to close the trap, and the memory is lost.

Subsequent research supports this model. Alexander Volkov and his colleagues at Oakwood University in Alabama first demonstrated that it is indeed electricity that causes the Venus flytrap to close. To test the model they rigged up very fine electrodes and applied an electrical current to the open lobes of the trap. This made the trap close without any direct touch to its trigger hairs (while they didn't measure calcium levels, the current likely led to increases). When they modified this experiment by altering the amount of electrical current, Volkov could determine the exact electrical charge needed for the trap to close. As long as fourteen microcoulombs—a tiny bit more than the static electricity generated by rubbing two balloons together—flowed between the two electrodes, the trap closed. This could come as one large burst or as a series of smaller charges within twenty seconds. If it took longer than twenty seconds to accumulate the total charge, the trap would remain open.

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CONTINUE

42

The primary purpose of the passage is to

A) discuss findings that offer a scientific explanation for the Venus flytrap's closing action.

B) present research that suggests that the Venus flytrap's predatory behavior is both complex and unique among plants.

C) identify the process by which the Venus flytrap's closing action has evolved.

D) provide a brief overview of the Venus flytrap and its predatory behavior.

43

Based on the passage, a significant advantage of the Venus flytrap's requirement for multiple triggers is that it

A) enables the plant to identify the species of its prey.

B) conserves the plant's calcium reserves.

C) safeguards the plant's energy supply.

D) prevents the plant from closing before capturing its prey.

44

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

A) Lines 3-7 ("Closing . . . time")

B) Lines 7-11 ("The large . . . across the trap")

C) Lines 11-14 ("If the . . . action")

D) Lines 16-18 ("First . . . hairs")

45

The use of the phrases "dawdling insect" (line 6), "happily meanders" (line 27), and "unassuming bug's encounter" (lines 28-29) in the first two paragraphs establishes a tone that is

A) academic.

B) melodramatic.

C) informal.

D) mocking.

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CONTINUE

46

In the second paragraph (lines 15-31), the discussion of short-term memory primarily functions to

A) clarify an explanation of what prompts the Venus flytrap to close.

B) advance a controversial hypothesis about the function of electric charges found in the leaf of the Venus flytrap.

C) stress the distinction between the strategies of the Venus flytrap and the strategies of human beings.

D) emphasize the Venus flytrap's capacity for retaining detailed information about its prey.

47

According to the passage, which statement best explains why the Venus flytrap requires a second trigger hair to be touched within a short amount of time in order for its trap to close?

A) The second trigger produces an electrical charge that reverses the charge produced by the first trigger.

B) The second trigger stabilizes the surge of calcium ions created by the first trigger.

C) The second trigger prompts the calcium channels to open.

D) The second trigger provides a necessary supplement to the calcium concentration released by the first trigger.

48

Which choice describes a scenario in which Hodick and Sievers's model predicts that a Venus flytrap will NOT close around an insect?

A) A large insect's second contact with the plant's trigger hairs results in a total calcium ion concentration above the trap's threshold.

B) A large insect makes contact with a second trigger hair after a period of inactivity during which calcium ion concentrations have diminished appreciably.

C) A large insect's contact with the plant's trigger hairs causes calcium channels to open in the trap.

D) A large insect's contact with a second trigger hair occurs within ten seconds of its contact with the first trigger hair.

49

As used in line 67, "demonstrated" most nearly means

A) protested.

B) established.

C) performed.

D) argued.

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CONTINUE

50

Based on the passage, what potential criticism might be made of Volkov's testing of Hodick and Sievers's model?

A) Volkov's understanding of Hodick and Sievers's model was incorrect.

B) Volkov's measurements did not corroborate a central element of Hodick and Sievers's model.

C) Volkov's direct application of an electrical current would have been objectionable to Hodick and Sievers.

D) Volkov's technology was not available to Hodick and Sievers.

51

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

A) Lines 66-69 ("Alexander . . . close")

B) Lines 69-71 ("To test . . . trap")

C) Lines 71-74 ("This . . . increases")

D) Lines 74-77 ("When . . . close")

52

Based on the passage, in studying the Venus flytrap, Volkov and his colleagues made the most extensive use of which type of evidence?

A) Mathematical models to predict the electrical charge required to close the Venus flytrap

B) Analysis of data collected from previous researchers' work involving the Venus flytrap's response to electricity

C) Information obtained from monitoring the Venus flytrap's response to varying amounts of electrical current

D) Published theories of scientists who developed earlier models of the Venus flytrap

STOP

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

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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 and supplementary material.

Compost: Don't Waste This Waste

Over the past generation, people in many parts of the United States have become accustomed to dividing their household waste products into different categories for recycling. 1 Regardless, paper may go in one container, glass and aluminum in another, regular garbage in a third. Recently, some US cities have added a new category: compost, organic matter such as food scraps and yard debris. Like paper or glass recycling, composting demands a certain amount of effort from the

1

A) NO CHANGE
B) However,
C) Furthermore,
D) For example,

public in order to be successful. But the inconveniences of composting are far outweighed by its benefits.

Most people think of banana peels, eggshells, and dead leaves as "waste," but compost is actually a valuable resource with multiple practical uses. When utilized as a garden fertilizer, compost provides nutrients to soil and improves plant growth while deterring or killing pests and preventing some plant diseases. It also enhances soil texture, encouraging healthy roots and minimizing or 2 annihilating the need for chemical fertilizers. Better than soil at holding moisture, compost minimizes water waste and storm runoff, 3 it increases savings on watering costs, and helps reduce erosion on embankments near bodies of water. In large 4 quantities, which one would expect to see when it is collected for an entire municipality), compost can be converted into a natural gas that can be used as fuel for transportation or heating and cooling systems.

2

Which choice best maintains the style and tone of the passage?

A) NO CHANGE
B) eliminating
C) ousting
D) closing the door on

3

A) NO CHANGE
B) savings increase
C) increases savings
D) also it increases savings

4

A) NO CHANGE
B) quantities (which
C) quantities which
D) quantities; (which

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CONTINUE

In spite of all compost's potential uses, however, most of this so-called waste is wasted. According to the Environmental Protection Agency (EPA), over 5 13 million tons of metal ended up in US landfills in 2009, along with over 13 million tons of yard debris. Remarkably, 6 less glass was discarded in landfills in that year than any other substance, including plastics or paper. Even 7 worse, then the squandering of this useful resource is the fact that compost in landfills cannot break down due to the lack of necessary air and moisture.

5

The writer wants to include information from the graph that is consistent with the description of compost in the passage. Which choice most effectively accomplishes this goal?

A) NO CHANGE
B) 6 million tons of rubber and leather
C) 10 million tons of textiles
D) 33 million tons of food waste

6

The writer wants to support the paragraph's main idea with accurate, relevant information from the graph. Which choice most effectively accomplishes this goal?

A) NO CHANGE
B) more metal
C) more food waste
D) more yard waste

7

A) NO CHANGE
B) worse than
C) worse then
D) worse, than

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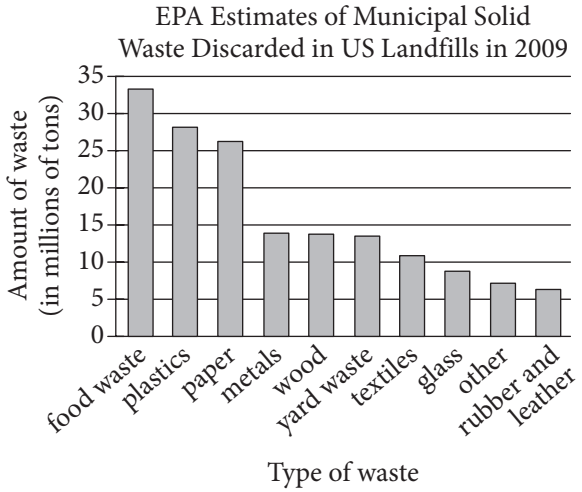
CONTINUE

As a result, organic material that is sent to landfills

8 <u>contribute</u> to the release of methane, a very

9 <u>potent</u> greenhouse gas.



Adapted from Food Waste Disposal. ©n.d. by Food Waste Disposal, LLC.

8

A) NO CHANGE
B) are contributing
C) contributes
D) have contributed

9

A) NO CHANGE
B) sturdy
C) influential
D) commanding

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CONTINUE

10 While composting can sometimes lead to accidental pollution through the release of methane gas, cities such as San Francisco and Seattle have instituted mandatory composting laws requiring individuals and businesses to use separate bins for compostable waste. This strict approach may not work everywhere. However, given the clear benefits of composting and the environmental costs of not composting, all municipalities should encourage their residents either to create their own compost piles for use in backyard gardens **11** or to dispose of compostable materials in bins for collection.

10

Which choice provides the most effective transition from the previous paragraph?

A) NO CHANGE
B) Though government regulations vary,
C) Armed with these facts,
D) Mindful of this setback,

11

A) NO CHANGE
B) nor
C) but
D) and

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CONTINUE

Questions 12-22 are based on the following passage.

A Lion's Share of Luck

It's the beginning of February, and as they do every year, thousands of people line H Street, the heart of Chinatown in Washington, DC. The crowd has gathered to celebrate Lunar New Year. The street is a sea of **12** red. Red is the traditional Chinese color of luck and happiness. Buildings are **13** draped with festive, red, banners, and garlands. Lampposts are strung with crimson paper lanterns, which bob in the crisp winter breeze. The eager spectators await the highlight of the New Year parade: the lion dance.

Experts agree that the lion dance originated in the Han dynasty (206 BCE–220 CE); however, there is little agreement about the dance's original purpose. Some evidence suggests that the earliest version of the dance was an attempt to ward off an evil spirit; **14** lions are obviously very fierce. Another theory is that an emperor, upon waking from a dream about a lion, hired an artist to

12

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

A) red,
B) red; in addition, red is
C) red; in other words, red is
D) red, the color; that is

13

A) NO CHANGE
B) draped, with festive red banners,
C) draped with festive red banners—
D) draped with festive red banners

14

Which choice most effectively completes the explanation of a possible origin of the lion dance?

A) NO CHANGE
B) the evil spirit was called Nian.
C) villagers dressed in lion costumes to scare the spirit away.
D) the precise location of the village remains lost to history.

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CONTINUE

choreograph the dance. **15** The current function of the dance is celebration.

The lion dance requires the strength, grace, and coordination of two dancers, **16** both of whom are almost completely hidden by the elaborate bamboo and papier-mâché lion costume that they maneuver. One person operates the lion's head as the other guides the torso and tail. Many of the moves in the dance, such as jumps, rolls, and kicks, are similar to **17** martial arts and acrobatics. The dancers must be synchronized with the music accompanying the dance—drums, cymbals, and gongs that supply the lion's roar—as well as with each other.

15

Which choice most effectively concludes the paragraph?

A) NO CHANGE
B) It turns out that the origins of the lion dance are irrelevant.
C) Whatever its origins, today the lion dance is a joyous spectacle, a celebration of the promise of the New Year.
D) Things are different these days, of course.

16

A) NO CHANGE
B) of which both
C) both of them
D) both

17

A) NO CHANGE
B) the disciplines of martial arts and acrobatics.
C) martial artists and acrobats.
D) those in martial arts and acrobatics.

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CONTINUE

[1] While there are many regional variations of the lion dance costume, all make extensive use of symbols and colors. [2] The lion's head is often adorned with a phoenix **18** (a mythical bird) or a tortoise (for longevity). [3] Green lions encourage friendliness. [4] Golden and red lions represent liveliness and bravery, respectively. [5] Their older counterparts, yellow and white lions, dance more slowly and deliberately. [6] In some variations, lions of different colors are different ages, and they move accordingly. [7] Black lions are the youngest; therefore, they dance quickly and playfully. [8] The appearance of the lions varies, but their message is consistent: Happy New Year. **19**

18

Which choice provides information that is most consistent in style and content with the information about the symbolism of the tortoise?

A) NO CHANGE
B) (for new beginnings)
C) (from Chinese mythology)
D) (for symbolic reasons)

19

To make this paragraph most logical, sentence 5 should be placed

A) where it is now.
B) after sentence 1.
C) after sentence 3.
D) after sentence 7.

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CONTINUE

As the parade winds its way through Chinatown, the music crescendos, and the lion dance reaches **20** it's climax with the "plucking of the greens." Approaching a doorway in which dangles a red envelope filled with green paper money, the **21** lion's teeth snare the envelope. It then chews up the bills and spits out the **22** money-filled envelope instead of chewing it up. The crowd cheers for the lion dancers and for the prosperity and good fortune their dance foretells.

20

A) NO CHANGE
B) its
C) there
D) their

21

A) NO CHANGE
B) lion snares the envelope with its teeth.
C) envelope is snared by the lion with its teeth.
D) teeth of the lion snare the envelope.

22

A) NO CHANGE
B) envelope that had been dangling from the doorway.
C) envelope that had the money in it.
D) envelope.

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CONTINUE

Questions 23-33 are based on the following passage.

Court Reporting: Humans v. Machines

Court reporters for years have been the record keepers of the court, taking **23** scrupulous notes during **24** hearings; depositions, and other legal proceedings. Despite the increasing use of digital recording technologies, court reporters still play a vital role in

23

Which choice best fits with the tone of the rest of the passage?

A) NO CHANGE
B) super-rigorous
C) spot-on
D) intense

24

A) NO CHANGE
B) hearings; depositions;
C) hearings, depositions,
D) hearings, depositions;

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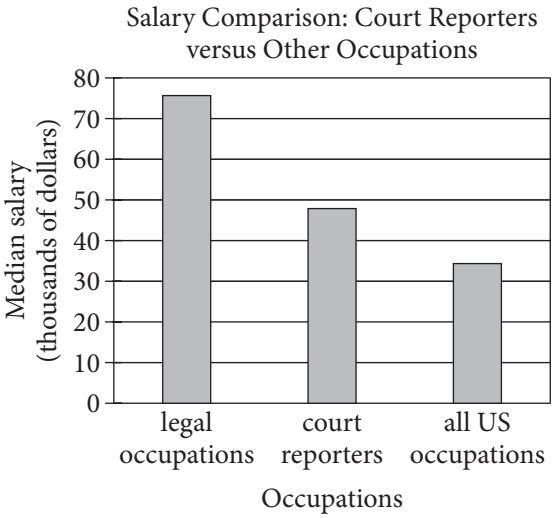
CONTINUE

courtrooms. 25 Although machines can easily make digital audio recordings of court events, they lack the nuance of human court reporters in providing a precise record.

[1] Court reporters record the spoken word in real time, most commonly using the technique of stenography. [2] A stenotype machine allows a person to type about 200 words per minute (the speed of speech is about 180 words per minute). [3] The typed words are instantaneously translated onto a computer screen for the judge to view, and the transcript is used later by people who want to review the case, such as journalists and lawyers. [4] Digital audio recording is becoming increasingly popular in courtrooms across the United States, with six states using solely audio recordings for

25

At this point, the writer is considering adding the following graph.



Adapted from Bureau of Labor Statistics, US Department of Labor, *Occupational Outlook Handbook, 2014–15 Edition*.

Should the writer make this addition here?

A) Yes, because it supports the claim that court reporting is an important part of a trial.

B) Yes, because it offers a relevant counterpoint to the argument that the use of digital recorders is on the rise.

C) No, because it presents information that is not directly related to the paragraph's discussion of the role of court reporters.

D) No, because it does not provide information about the pay scale for more experienced court reporters.

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CONTINUE

general jurisdiction sessions. [5] Proponents of going digital say that technology is the easiest way to get the most accurate record of the proceedings, as the machine records everything faithfully as it occurs and is not 26 subject to human errors such as mishearing or mistyping. [6] However, with the rise of high-quality recording technology, reliance on court reporters 27 as a record keeper is decreasing. 28

26

A) NO CHANGE
B) subjected to
C) subjected from
D) subject for

27

A) NO CHANGE
B) each as record keepers
C) as record keepers
D) to be a record keeper

28

To make this paragraph most logical, sentence 6 should be placed

A) where it is now.
B) after sentence 1.
C) after sentence 3.
D) after sentence 4.

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CONTINUE

Champions of court reporting, though, argue the 29 opposite. They argue that with the increased reliance on technology, errors actually increase. Because digital systems record 30 indiscriminately; they cannot discern important parts of the proceedings from other noises in the courtroom. 31 Despite this, a digital device does indeed record everything, but that includes loud noises, such as a book dropping, that can make the actual words spoken impossible to hear. A court reporter, however,

29

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

A) opposite, such
B) opposite—
C) opposite, which is
D) opposite; their opinion is

30

A) NO CHANGE
B) indiscriminately, they
C) indiscriminately. They
D) indiscriminately, therefore they

31

A) NO CHANGE
B) In other words,
C) Therefore,
D) Consequently,

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CONTINUE

can distinguish between the words 32 and distinguish between the extrinsic noises that need not be recorded. Also, if a witness mumbles, a human court reporter can pause court proceedings to ask the witness to repeat what he or she said. In some cases, digital recording 33 makes it necessary for the judge to make additional announcements at the beginning of a trial. Increasing use of technology is "a transition from accurate records to adequate records," says Bob Tate, president of the Certified Court Reporters Association of New Jersey.

Despite the apparent benefits of using digital recording systems in courtrooms, there is still a need for the human touch in legal proceedings. At least for the foreseeable future, machines simply cannot replicate the invaluable clarification skills and adaptability of human court reporters.

32

A) NO CHANGE
B) also between the
C) and when there are
D) and the

33

Which choice provides the best supporting example for the main idea of the paragraph?

A) NO CHANGE
B) requires a courtroom monitor to ensure the equipment is functioning properly.
C) leads to changes in the roles and duties of several members of the courtroom staff.
D) has led to the need for retrial because of indistinct testimony from key witnesses.

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CONTINUE

Questions 34-44 are based on the following passage.

Fire in Space

On Earth, fire provides light, heat, and comfort. Its creation, by a process called combustion, requires a chemical reaction between a fuel source and oxygen. The shape that fire assumes on Earth is a result of gravitational influence and the movement of molecules. In the microgravity environment of space, 34 moreover, combustion and the resulting fire behave in fundamentally different ways than they do on Earth—differences that have important implications for researchers.

A group of engineering students from the University of California at San Diego (UCSD), for example, 35 tried to find a method to make their biofuel combustion study (fuels derived from once-living material) free of the drawbacks researchers face on Earth. The standard method involves burning droplets of fuel, but Earth's gravitational influence causes the droplets to lose

34

A) NO CHANGE
B) however,
C) accordingly,
D) subsequently,

35

A) NO CHANGE
B) strove for a method to make their study of biofuel combustion
C) looked for a method to study biofuel combustion
D) sought a method to study combustion of biofuels

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CONTINUE

spherical symmetry while burning. This 36 deformation results in subtle variations in density that both 37 causes uneven heat flow and limits the size of the droplets that can be tested. Specially designed "drop towers" 38 built for this purpose reduce these problems, but they provide no more than 10 seconds of microgravity, and droplet size is still too small to produce accurate models of combustion rates. 39 The UCSD students understood that these limitations had to be surmounted. As part of the program, researchers fly their experiments aboard aircraft that simulate the microgravity environment of space. The aircraft accomplish this feat by flying in parabolic paths instead of horizontal ones. On the plane's ascent, passengers feel twice Earth's gravitational pull, but for brief periods at the peak of the trajectory,

36

Which choice provides the most precise description of the phenomenon depicted in the previous sentence?

A) NO CHANGE
B) alteration
C) transformation
D) modification

37

A) NO CHANGE
B) cause uneven heat flow and limit
C) cause uneven heat flow and limits
D) has caused uneven heat flow and has limited

38

A) NO CHANGE
B) intended for this use
C) constructed for this function
D) DELETE the underlined portion.

39

Which choice provides the most effective transition between ideas in the paragraph?

A) NO CHANGE
B) The UCSD group sought to overcome these difficulties by participating in NASA's Microgravity University program.
C) The engineering group realized that aircraft might be the tools they were looking for.
D) Thus, for the UCSD group, drop towers were not an adequate solution.

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CONTINUE

40 "weightlessness" or microgravity similar to what is experienced in space, is achieved.

These flights allowed the UCSD students to experience microgravity 41 . Specifically, they 42 investigated the combustion of biofuel droplets in microgravity for twice as long as could be accomplished

40

A) NO CHANGE
B) "weightlessness" or microgravity, similar to what is experienced, in space
C) "weightlessness" or, microgravity, similar to what is experienced in space
D) "weightlessness," or microgravity similar to what is experienced in space,

41

At this point, the writer is considering adding the following.

and perform their experiment without traveling into space

Should the writer make this addition here?

A) Yes, because it elaborates on the advantage the students gained from the flights.
B) Yes, because it reveals that the students did not actually go into space, a point that the previous paragraph does not address.
C) No, because it shifts focus away from the students' experiences while on the flights.
D) No, because it restates what has already been said in the sentence.

42

A) NO CHANGE
B) could investigate
C) were investigating
D) were able to investigate

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CONTINUE

in drop towers and to perform tests with larger droplets. The larger, **43** spherically symmetric droplets burned longer and gave the students more reliable data on combustion rates of biofuels because the droplets' uniform shape reduced the variations in density that hinder tests performed in normal gravity. The students hope the new data will aid future research by improving theoretical models of biofuel combustion. Better combustion-rate models may even lead to the production of more fuel-efficient engines and improved **44** techniques, for fighting fires in space or at future outposts on the Moon and Mars.

43

Which choice most effectively establishes that the UCSD students' approach had solved a problem, mentioned earlier in the passage, relating to burning fuel on Earth?

A) NO CHANGE
B) combustible
C) microgravity-influenced
D) biofuel-derived

44

A) NO CHANGE
B) techniques for fighting fires, in space or at future outposts
C) techniques for fighting fires in space or at future outposts
D) techniques for fighting fires in space, or at future outposts,

STOP

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

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Math Test – No Calculator

25 MINUTES, 20 QUESTIONS

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

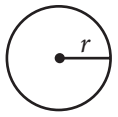
DIRECTIONS

For questions 1-15, solve each problem, choose the best answer from the choices provided, and fill in the corresponding circle on your answer sheet. **For questions 16-20**, solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 16 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

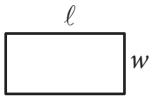
NOTES

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.

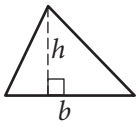
REFERENCE



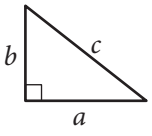
$A = \pi r^2$
$C = 2\pi r$



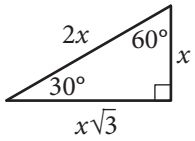
$A = \ell w$

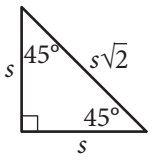


$A = \frac{1}{2}bh$

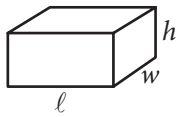


$c^2 = a^2 + b^2$

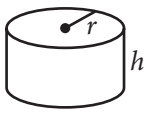




Special Right Triangles

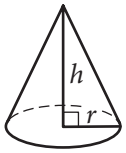


$V = \ell wh$

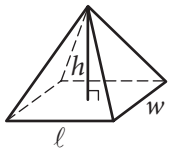


$V = \pi r^2 h$

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



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



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

The number of degrees of arc in a circle is 360.
The number of radians of arc in a circle is 2π.
The sum of the measures in degrees of the angles of a triangle is 180.

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CONTINUE

1

$$3x + x + x + x - 3 - 2 = 7 + x + x$$

In the equation above, what is the value of x ?

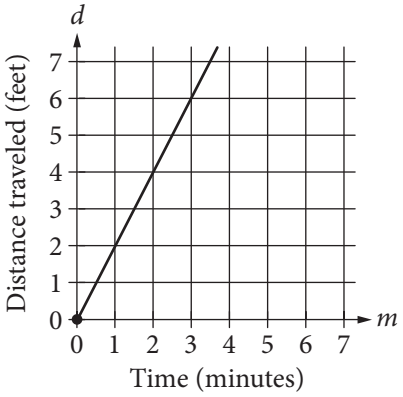
A) $-\frac{5}{7}$

B) 1

C) $\frac{12}{7}$

D) 3

2



The graph above shows the distance traveled d, in feet, by a product on a conveyor belt m minutes after the product is placed on the belt. Which of the following equations correctly relates d and m ?

A) $d = 2m$

B) $d = \frac{1}{2}m$

C) $d = m + 2$

D) $d = 2m + 2$

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CONTINUE

3

The formula below is often used by project managers to compute E, the estimated time to complete a job, where O is the shortest completion time, P is the longest completion time, and M is the most likely completion time.

$$E = \frac{O + 4M + P}{6}$$

Which of the following correctly gives P in terms of E, O, and M ?

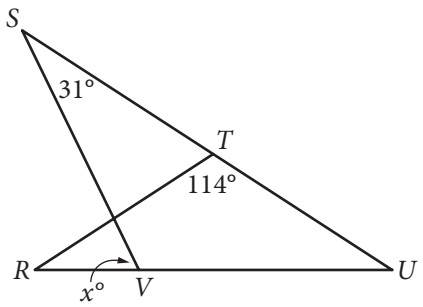
A) $P = 6E - O - 4M$

B) $P = -6E + O + 4M$

C) $P = \frac{O + 4M + E}{6}$

D) $P = \frac{O + 4M - E}{6}$

4



In the figure above, $RT = TU$. What is the value of x ?

A) 72

B) 66

C) 64

D) 58

5

The width of a rectangular dance floor is w feet. The length of the floor is 6 feet longer than its width. Which of the following expresses the perimeter, in feet, of the dance floor in terms of w ?

A) $2w + 6$

B) $4w + 12$

C) $w^2 + 6$

D) $w^2 + 6w$

6

$$y > 2x - 1$$

$$2x > 5$$

Which of the following consists of the y-coordinates of all the points that satisfy the system of inequalities above?

A) $y > 6$

B) $y > 4$

C) $y > \frac{5}{2}$

D) $y > \frac{3}{2}$

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CONTINUE

7

$$\sqrt{2x+6}+4=x+3$$

What is the solution set of the equation above?

A) $\{-1\}$

B) $\{5\}$

C) $\{-1, 5\}$

D) $\{0, -1, 5\}$

8

$$f(x)=x^3-9x$$
$$g(x)=x^2-2x-3$$

Which of the following expressions is equivalent to $\frac{f(x)}{g(x)}$, for $x > 3$?

A) $\frac{1}{x+1}$

B) $\frac{x+3}{x+1}$

C) $\frac{x(x-3)}{x+1}$

D) $\frac{x(x+3)}{x+1}$

9

$$(x-6)^2+(y+5)^2=16$$

In the xy-plane, the graph of the equation above is a circle. Point P is on the circle and has coordinates $(10, -5)$. If $\overline{PQ}$ is a diameter of the circle, what are the coordinates of point Q ?

A) $(2, -5)$

B) $(6, -1)$

C) $(6, -5)$

D) $(6, -9)$

10

A group of 202 people went on an overnight camping trip, taking 60 tents with them. Some of the tents held 2 people each, and the rest held 4 people each. Assuming all the tents were filled to capacity and every person got to sleep in a tent, exactly how many of the tents were 2-person tents?

A) 30

B) 20

C) 19

D) 18

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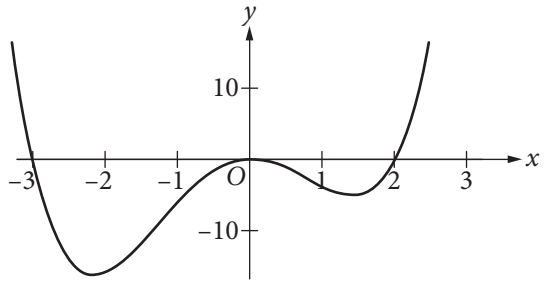
CONTINUE

11



Which of the following could be the equation of the graph above?

A) $y = x(x-2)(x+3)$

B) $y = x^2(x-2)(x+3)$

C) $y = x(x+2)(x-3)$

D) $y = x^2(x+2)(x-3)$

12

If $\frac{2a}{b} = \frac{1}{2}$, what is the value of $\frac{b}{a}$?

A) $\frac{1}{8}$

B) $\frac{1}{4}$

C) 2

D) 4

13

Oil and gas production in a certain area dropped from 4 million barrels in 2000 to 1.9 million barrels in 2013. Assuming that the oil and gas production decreased at a constant rate, which of the following linear functions f best models the production, in millions of barrels, t years after the year 2000?

A) $f(t) = \frac{21}{130}t + 4$

B) $f(t) = \frac{19}{130}t + 4$

C) $f(t) = -\frac{21}{130}t + 4$

D) $f(t) = -\frac{19}{130}t + 4$

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CONTINUE

14

$$y = x^2 + 3x - 7$$
$$y - 5x + 8 = 0$$

How many solutions are there to the system of equations above?

A) There are exactly 4 solutions.

B) There are exactly 2 solutions.

C) There is exactly 1 solution.

D) There are no solutions.

15

$$g(x) = 2x - 1$$
$$h(x) = 1 - g(x)$$

The functions g and h are defined above. What is the value of $h(0)$?

A) -2

B) 0

C) 1

D) 2

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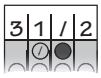
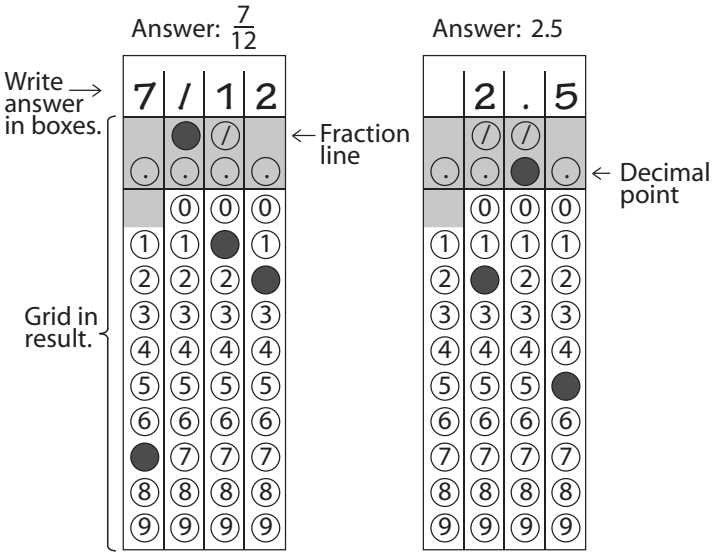
CONTINUE

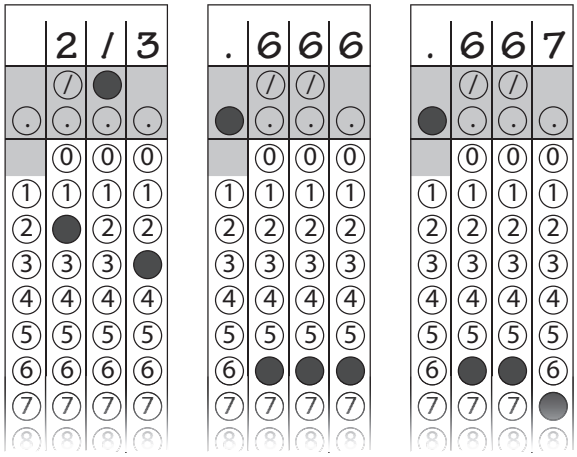
DIRECTIONS

For questions 16-20, solve the problem and enter your answer in the grid, as described below, on the answer sheet.

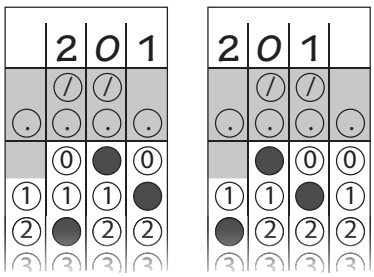
1. Although not required, it is suggested that you write your answer in the boxes at the top of the columns to help you fill in the circles accurately. You will receive credit only if the circles are filled in correctly.
2. Mark no more than one circle in any column.
3. No question has a negative answer.
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  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.



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



Answer: 201 – either position is correct



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

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CONTINUE

16

$$x^2 + x - 12 = 0$$

If a is a solution of the equation above and $a > 0$, what is the value of a ?

17

The sum of $-2x^2 + x + 31$ and $3x^2 + 7x - 8$ can be written in the form $ax^2 + bx + c$, where a, b, and c are constants. What is the value of $a + b + c$?

18

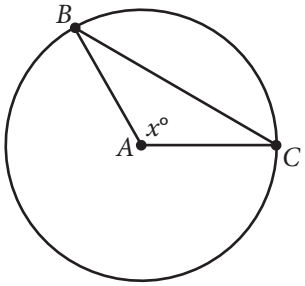
$$-x + y = -3.5$$
$$x + 3y = 9.5$$

If (x, y) satisfies the system of equations above, what is the value of y ?

19

A start-up company opened with 8 employees. The company's growth plan assumes that 2 new employees will be hired each quarter (every 3 months) for the first 5 years. If an equation is written in the form $y = ax + b$ to represent the number of employees, y, employed by the company x quarters after the company opened, what is the value of b ?

20



Note: Figure not drawn to scale.

In the circle above, point A is the center and the length of arc $\overset{\frown}{BC}$ is $\frac{2}{5}$ of the circumference of the circle. What is the value of x ?

STOP

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

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Math Test – Calculator

55 MINUTES, 38 QUESTIONS

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

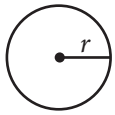
DIRECTIONS

For questions 1-30, solve each problem, choose the best answer from the choices provided, and fill in the corresponding circle on your answer sheet. **For questions 31-38**, solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 31 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

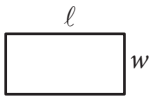
NOTES

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.

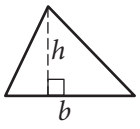
REFERENCE



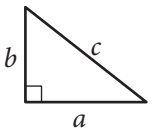
$A = \pi r^2$
$C = 2\pi r$



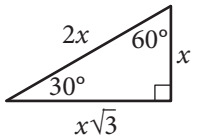
$A = \ell w$

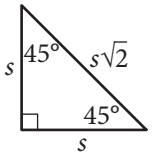


$A = \frac{1}{2}bh$

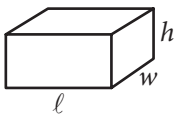


$c^2 = a^2 + b^2$

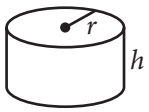




Special Right Triangles

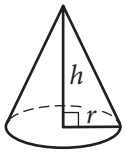


$V = \ell wh$

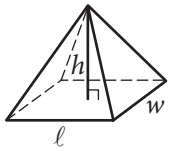


$V = \pi r^2 h$

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



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



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

The number of degrees of arc in a circle is 360.
The number of radians of arc in a circle is 2π.
The sum of the measures in degrees of the angles of a triangle is 180.

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CONTINUE

1

One pound of grapes costs $2. At this rate, how many dollars will c pounds of grapes cost?

A) $2c$

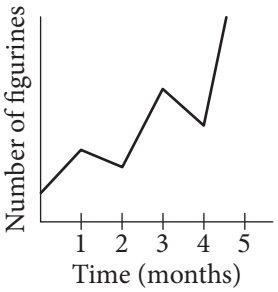
B) $2 + c$

C) $\frac{2}{c}$

D) $\frac{c}{2}$

2

Tracy collects, sells, and trades figurines, and she tracks the number of figurines in her collection on the graph below.



On what interval did the number of figurines decrease the fastest?

A) Between 1 and 2 months

B) Between 2 and 3 months

C) Between 3 and 4 months

D) Between 4 and 5 months

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CONTINUE

3

In a random sample of 200 cars of a particular model, 3 have a manufacturing defect. At this rate, how many of 10,000 cars of the same model will have a manufacturing defect?

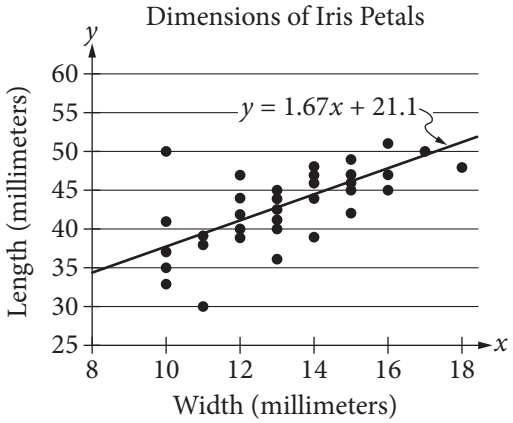
A) 150

B) 200

C) 250

D) 300

4



The scatterplot above shows data collected on the lengths and widths of *Iris setosa* petals. A line of best fit for the data is also shown. Based on the line of best fit, if the width of an *Iris setosa* petal is 19 millimeters, what is the predicted length, in millimeters, of the petal?

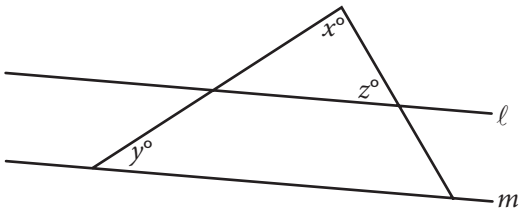
A) 21.10

B) 31.73

C) 52.83

D) 55.27

5



Note: Figure not drawn to scale.

In the figure above, lines ℓ and m are parallel, $y = 20$, and $z = 60$. What is the value of x ?

A) 120

B) 100

C) 90

D) 80

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CONTINUE

6

Two types of tickets were sold for a concert held at an amphitheater. Tickets to sit on a bench during the concert cost $75 each, and tickets to sit on the lawn during the concert cost $40 each. Organizers of the concert announced that 350 tickets had been sold and that $19,250 had been raised through ticket sales alone. Which of the following systems of equations could be used to find the number of tickets for bench seats, B, and the number of tickets for lawn seats, L, that were sold for the concert?

A) $(75B)(40L) = 1{,}950$
$B + L = 350$

B) $40B + 75L = 19{,}250$
$B + L = 350$

C) $75B + 40L = 350$
$B + L = 19{,}250$

D) $75B + 40L = 19{,}250$
$B + L = 350$

7

In the xy-plane, the graph of which of the following equations is a line with a slope of 3 ?

A) $y = \frac{1}{3}x$

B) $y = x - 3$

C) $y = 3x + 2$

D) $y = 6x + 3$

8

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

In the equation above, which of the following is a possible value of $x + 1$?

A) $1 - \sqrt{2}$

B) $\sqrt{2}$

C) 2

D) 4

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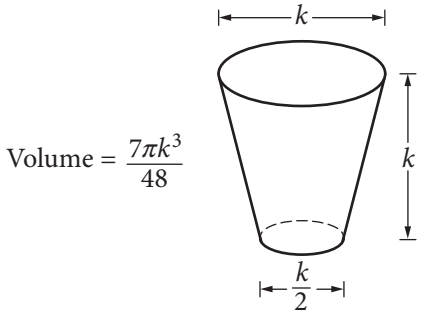
CONTINUE

Questions 9-11 refer to the following information.



The glass pictured above can hold a maximum volume of 473 cubic centimeters, which is approximately 16 fluid ounces.

9

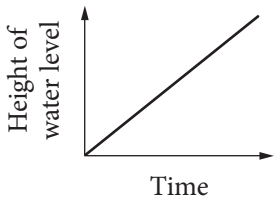
What is the value of k, in centimeters?

A) 2.52
B) 7.67
C) 7.79
D) 10.11

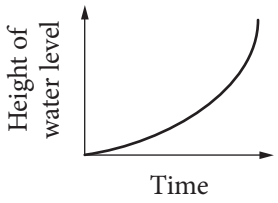
10

Water pours into the glass slowly and at a constant rate. Which of the following graphs best illustrates the height of the water level in the glass as it fills?

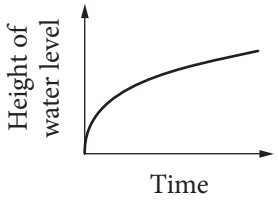
A)



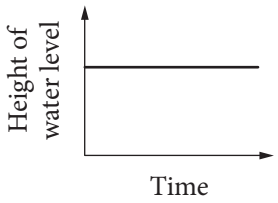
B)



C)



D)



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CONTINUE

11

Jenny has a pitcher that contains 1 gallon of water. How many times could Jenny completely fill the glass with 1 gallon of water? (1 gallon = 128 fluid ounces)

A) 16

B) 8

C) 4

D) 3

12

Roberto is an insurance agent who sells two types of policies: a $50,000 policy and a $100,000 policy. Last month, his goal was to sell at least 57 insurance policies. While he did not meet his goal, the total value of the policies he sold was over $3,000,000. Which of the following systems of inequalities describes x, the possible number of $50,000 policies, and y, the possible number of $100,000 policies, that Roberto sold last month?

A) $x + y < 57$
$50{,}000x + 100{,}000y < 3{,}000{,}000$

B) $x + y > 57$
$50{,}000x + 100{,}000y > 3{,}000{,}000$

C) $x + y < 57$
$50{,}000x + 100{,}000y > 3{,}000{,}000$

D) $x + y > 57$
$50{,}000x + 100{,}000y < 3{,}000{,}000$

13

If $a^{-\frac{1}{2}} = x$, where $a > 0$, what is a in terms of x ?

A) $\sqrt{x}$

B) $-\sqrt{x}$

C) $\frac{1}{x^2}$

D) $-\frac{1}{x^2}$

14

Which of the following is a value of x for which the expression $\frac{-3}{x^2 + 3x - 10}$ is undefined?

A) -3

B) -2

C) 0

D) 2

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CONTINUE

15

A granite block in the shape of a right rectangular prism has dimensions 30 centimeters by 40 centimeters by 50 centimeters. The block has a density of 2.8 grams per cubic centimeter. What is the mass of the block, in grams? (Density is mass per unit volume.)

A) 336

B) 3,360

C) 16,800

D) 168,000

16

Number of Adults Contracting Colds

	Cold	No cold	Total
Vitamin C	21	129	150
Sugar pill	33	117	150
Total	54	246	300

The table shows the results of a research study that investigated the therapeutic value of vitamin C in preventing colds. A random sample of 300 adults received either a vitamin C pill or a sugar pill each day during a 2-week period, and the adults reported whether they contracted a cold during that time period. What proportion of adults who received a sugar pill reported contracting a cold?

A) $\frac{11}{18}$

B) $\frac{11}{50}$

C) $\frac{9}{50}$

D) $\frac{11}{100}$

17

Ages of 20 Students Enrolled in a College Class

Age	Frequency
18	6
19	5
20	4
21	2
22	1
23	1
30	1

The table above shows the distribution of ages of the 20 students enrolled in a college class. Which of the following gives the correct order of the mean, median, and mode of the ages?

A) mode < median < mean

B) mode < mean < median

C) median < mode < mean

D) mean < mode < median

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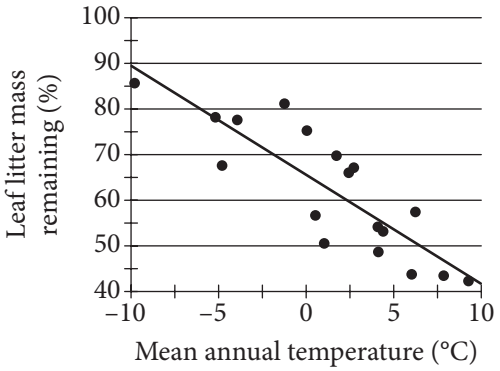
CONTINUE

18

The figure below shows the relationship between the percent of leaf litter mass remaining after decomposing for 3 years and the mean annual temperature, in degrees Celsius (°C), in 18 forests in Canada. A line of best fit is also shown.



A particular forest in Canada, whose data is not included in the figure, had a mean annual temperature of −2°C. Based on the line of best fit, which of the following is closest to the predicted percent of leaf litter mass remaining in this particular forest after decomposing for 3 years?

A) 50%

B) 63%

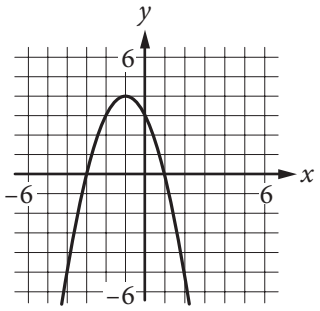
C) 70%

D) 82%

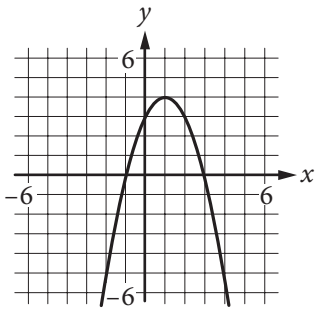
19

The range of the polynomial function f is the set of real numbers less than or equal to 4. If the zeros of f are -3 and 1, which of the following could be the graph of $y = f(x)$ in the xy-plane?

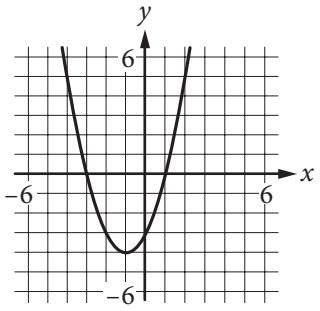
A)



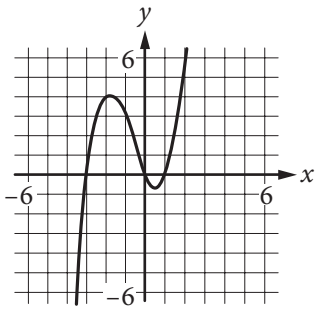
B)



C)



D)



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20

The average annual energy cost for a certain home is $4,334. The homeowner plans to spend $25,000 to install a geothermal heating system. The homeowner estimates that the average annual energy cost will then be $2,712. Which of the following inequalities can be solved to find t, the number of years after installation at which the total amount of energy cost savings will exceed the installation cost?

A) $25{,}000 > (4{,}334 - 2{,}712)\,t$

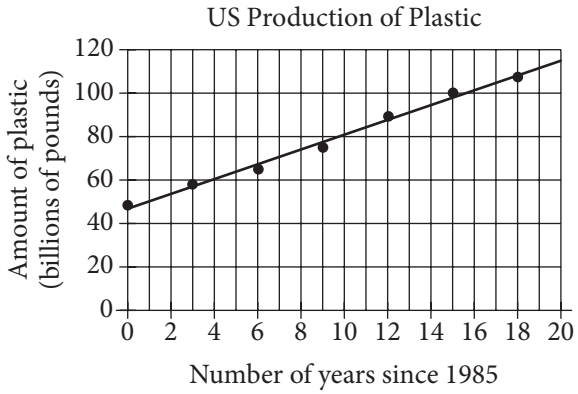
B) $25{,}000 < (4{,}334 - 2{,}712)\,t$

C) $25{,}000 - 4{,}334 > 2{,}712t$

D) $25{,}000 > \dfrac{4{,}332}{2{,}712}\,t$

Questions 21 and 22 refer to the following information.

Between 1985 and 2003, data were collected every three years on the amount of plastic produced annually in the United States, in billions of pounds. The graph below shows the data and a line of best fit. The equation of the line of best fit is $y = 3.39x + 46.89$, where x is the number of years since 1985 and y is the amount of plastic produced annually, in billions of pounds.



21

Which of the following is the best interpretation of the number 3.39 in the context of the problem?

A) The amount of plastic, in billions of pounds, produced in the United States during the year 1985

B) The number of years it took the United States to produce 1 billion pounds of plastic

C) The average annual plastic production, in billions of pounds, in the United States from 1985 to 2003

D) The average annual increase, in billions of pounds, of plastic produced per year in the United States from 1985 to 2003

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CONTINUE

22

Which of the following is closest to the percent increase in the billions of pounds of plastic produced in the United States from 2000 to 2003?

A) 10%

B) 44%

C) 77%

D) 110%

23

$$M = 1{,}800(1.02)^{t}$$

The equation above models the number of members, M, of a gym t years after the gym opens. Of the following, which equation models the number of members of the gym q quarter years after the gym opens?

A) $M = 1{,}800(1.02)^{\frac{q}{4}}$

B) $M = 1{,}800(1.02)^{4q}$

C) $M = 1{,}800(1.005)^{4q}$

D) $M = 1{,}800(1.082)^{q}$

24

For the finale of a TV show, viewers could use either social media or a text message to vote for their favorite of two contestants. The contestant receiving more than 50% of the vote won. An estimated 10% of the viewers voted, and 30% of the votes were cast on social media. Contestant 2 earned 70% of the votes cast using social media and 40% of the votes cast using a text message. Based on this information, which of the following is an accurate conclusion?

A) If all viewers had voted, Contestant 2 would have won.

B) Viewers voting by social media were likely to be younger than viewers voting by text message.

C) If all viewers who voted had voted by social media instead of by text message, Contestant 2 would have won.

D) Viewers voting by social media were more likely to prefer Contestant 2 than were viewers voting by text message.

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CONTINUE

25

Population of Greenleaf, Idaho

Year	Population
2000	862
2010	846

The table above shows the population of Greenleaf, Idaho, for the years 2000 and 2010. If the relationship between population and year is linear, which of the following functions P models the population of Greenleaf t years after 2000?

A) $P(t) = 862 - 1.6t$

B) $P(t) = 862 - 16t$

C) $P(t) = 862 + 16(t - 2{,}000)$

D) $P(t) = 862 - 1.6(t - 2{,}000)$

26

To determine the mean number of children per household in a community, Tabitha surveyed 20 families at a playground. For the 20 families surveyed, the mean number of children per household was 2.4. Which of the following statements must be true?

A) The mean number of children per household in the community is 2.4.

B) A determination about the mean number of children per household in the community should not be made because the sample size is too small.

C) The sampling method is flawed and may produce a biased estimate of the mean number of children per household in the community.

D) The sampling method is not flawed and is likely to produce an unbiased estimate of the mean number of children per household in the community.

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CONTINUE

27

In the xy-plane, the point (p, r) lies on the line with equation $y = x + b$, where b is a constant. The point with coordinates $(2p, 5r)$ lies on the line with equation $y = 2x + b$. If $p \neq 0$, what is the value of $\frac{r}{p}$?

A) $\frac{2}{5}$

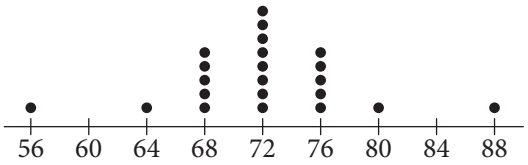
B) $\frac{3}{4}$

C) $\frac{4}{3}$

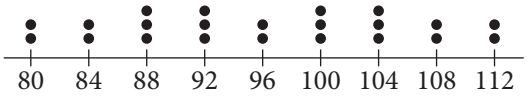
D) $\frac{5}{2}$

28

The 22 students in a health class conducted an experiment in which they each recorded their pulse rates, in beats per minute, before and after completing a light exercise routine. The dot plots below display the results.



Beats per minute before exercise



Beats per minute after exercise

Let s_1 and r_1 be the standard deviation and range, respectively, of the data before exercise, and let s_2 and r_2 be the standard deviation and range, respectively, of the data after exercise. Which of the following is true?

A) $s_1 = s_2$ and $r_1 = r_2$

B) $s_1 < s_2$ and $r_1 < r_2$

C) $s_1 > s_2$ and $r_1 > r_2$

D) $s_1 \neq s_2$ and $r_1 = r_2$

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CONTINUE

29

A photocopy machine is initially loaded with 5,000 sheets of paper. The machine starts a large job and copies at a constant rate. After 20 minutes, it has used 30% of the paper. Which of the following equations models the number of sheets of paper, p, remaining in the machine m minutes after the machine started printing?

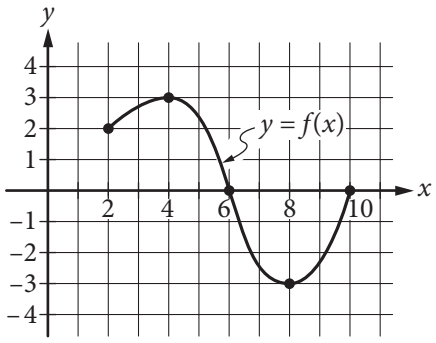
A) $p = 5{,}000 - 20m$

B) $p = 5{,}000 - 75m$

C) $p = 5{,}000(0.3)^{\frac{m}{20}}$

D) $p = 5{,}000(0.7)^{\frac{m}{20}}$

30



x	$g(x)$
−2	1
−1	2
0	3
1	4
2	5
3	6
4	7

The complete graph of the function f and a table of values for the function g are shown above. The maximum value of f is k. What is the value of $g(k)$?

A) 7

B) 6

C) 3

D) 0

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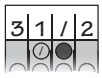
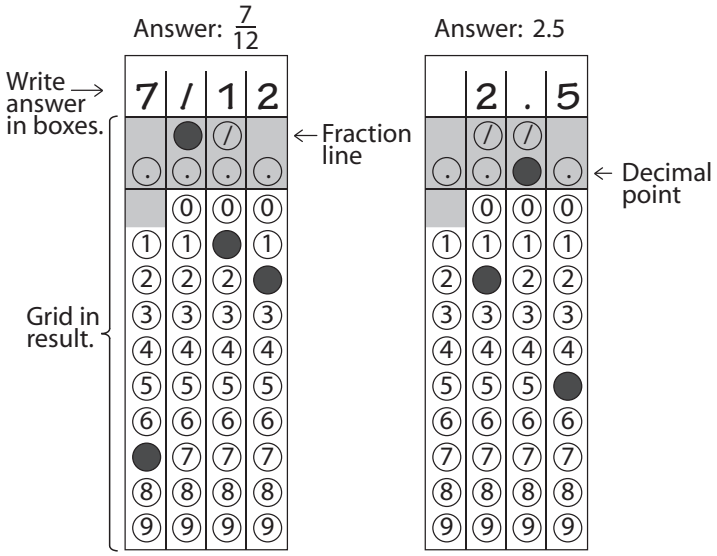
CONTINUE

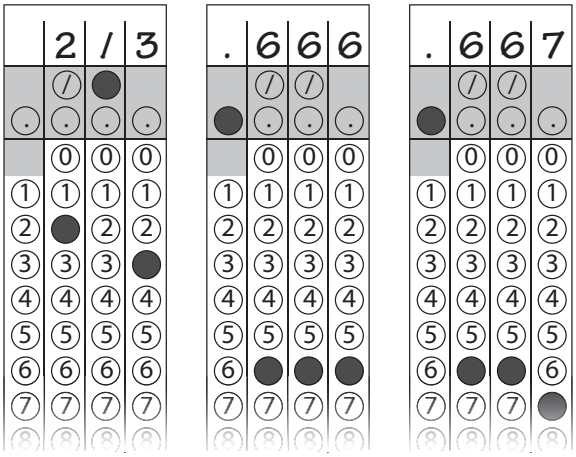
DIRECTIONS

For questions 31-38, solve the problem and enter your answer in the grid, as described below, on the answer sheet.

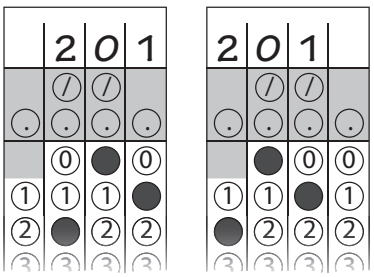
1. Although not required, it is suggested that you write your answer in the boxes at the top of the columns to help you fill in the circles accurately. You will receive credit only if the circles are filled in correctly.
2. Mark no more than one circle in any column.
3. No question has a negative answer.
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  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.



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



Answer: 201 – either position is correct



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

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CONTINUE

31

There are two atoms of hydrogen and one atom of oxygen in one molecule of water. How many atoms of hydrogen are there in 51 molecules of water?

32

$$x - \frac{1}{2}a = 0$$

If $x = 1$ in the equation above, what is the value of a ?

33

In the xy-plane, the equations $x + 2y = 10$ and $3x + 6y = c$ represent the same line for some constant c. What is the value of c ?

34

On April 18, 1775, Paul Revere set off on his midnight ride from Charlestown to Lexington. If he had ridden straight to Lexington without stopping, he would have traveled 11 miles in 26 minutes. In such a ride, what would the average speed of his horse have been, to the nearest tenth of a mile per hour?

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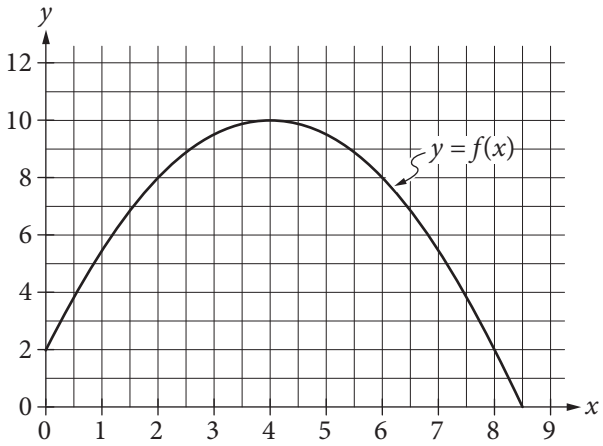
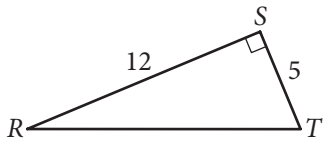
35



The graph of the function f, defined by $f(x) = -\frac{1}{2}(x-4)^2 + 10$, is shown in the xy-plane above. If the function g (not shown) is defined by $g(x) = -x + 10$, what is one possible value of a such that $f(a) = g(a)$?

36



In triangle RST above, point W (not shown) lies on $\overline{RT}$. What is the value of $\cos(\angle RSW) - \sin(\angle WST)$?

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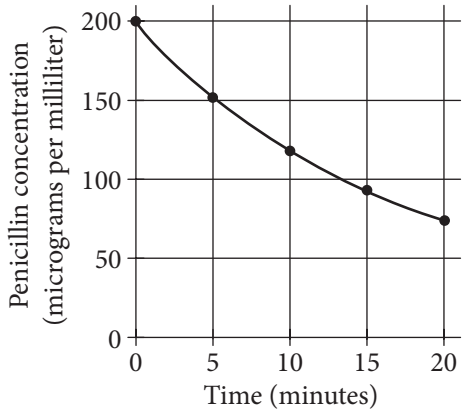
CONTINUE

Questions 37 and 38 refer to the following information.

Minutes after injection	Penicillin concentration (micrograms per milliliter)
0	200
5	152
10	118
15	93
20	74



When a patient receives a penicillin injection, the kidneys begin removing the penicillin from the body. The table and graph above show the penicillin concentration in a patient's bloodstream at 5-minute intervals for the 20 minutes immediately following a one-time penicillin injection.

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CONTINUE

37

According to the table, how many more micrograms of penicillin are present in 10 milliliters of blood drawn from the patient 5 minutes after the injection than are present in 8 milliliters of blood drawn 10 minutes after the injection?

38

The penicillin concentration, in micrograms per milliliter, in the patient's bloodstream t minutes after the penicillin injection is modeled by the function P defined by $P(t) = 200b^{\frac{t}{5}}$. If P approximates the values in the table to within 10 micrograms per milliliter, what is the value of b, rounded to the nearest tenth?

STOP

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

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