



AMERICA'S PREMIERE TESTING READINESS PROGRAM

ACT[®]

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5 Ways to Increase Score Gains Using Cambridge's *Navigator Plus*

Navigator Plus is Cambridge's complete explanation guide to a previously administered test. It includes explanations for each item on the test, categorization for each item, an answer key, and more.

The following list provides suggestions for implementing the Navigator into your program to increase score gains.

- 1. Simulate test day as much as possible when proctoring tests.** Students will benefit from a testing experience that closely simulates what they will experience on test day. They will feel more confident if they know what to expect.
- 2. Follow up when you receive your data.** Use the reports you receive from Cambridge to cover the items your class struggled as a group to answer (see the Error Analysis report). Taking this step within two weeks of administering the test will ensure that your students haven't forgotten the items you cover and will be able to learn from their testing experiences.
- 3. Use the Pre-Assessment Item references in the *Victory* lesson to illustrate key points.** Your teacher's guide includes references to items on your pre-assessment that you can use as additional examples. Keep a copy of your pre-assessment test booklet handy so that you can cover these items with your students. Using pre-assessment items as additional examples helps students connect the concepts you are teaching with their test-day experiences.
- 4. Don't forget to review the wrong answers.** Many explanations in this Navigator packet include references to each wrong answer choice. Students will benefit from reviewing why each wrong answer is wrong so that they can recognize what makes the right answer correct and use the process of elimination to eliminate similar wrong answers in the future.
- 5. Pay attention to item categories.** Each item in this Navigator packet includes a category path that corresponds to the course concept outline in your *Victory* text as well as the categories listed in the Item Index of your *Victory* text. Use the Item Index to identify items students can use for further practice.

Category Paths

Throughout these explanations, each item includes a **Cambridge Category Path** which links the item to the Course Concept Outline in Cambridge's *Victory* series. For example:

Mathematics/Geometry/Triangles/Pythagorean Theorem

An item with this particular category path is found in the Mathematics Test (based on Level 1 of the category path, mathematics) and tests students' knowledge of geometry (Level 2 of the category path), more specifically of triangles (Level 3), and even more specifically of the Pythagorean theorem (Level 4). The *Victory* Mathematics Lesson includes a section on the Pythagorean theorem, which you can find by referencing the Course Concept Outline at the beginning of the mathematics section in the *Victory* book. Additionally, you can find items testing geometry, triangles, or the Pythagorean theorem using the Item Index at the end of the *Victory* Student Text and Teacher's Guide.



ACT ENGLISH TEST EXPLANATIONS

1. **(A) English/Production of Writing/Strategy/Appropriate Supporting Material.** While “impressively,” (B); “terrifically,” (C); and “superbly,” (D) could all describe sculptures that “delighted” the staff, further reading of the passage shows that the sculptures were more than any of these complimentary adjectives: These “delicate sculptures” (line 5) and their “tiny details” (line 7) were “awe-inspiring” (line 8), and “intricately,” (A), most effectively captures this description.
2. **(G) English/Conventions of Standard English/Sentence Structure/Unintended Meanings.** The sentence as written says that the sculptures were “delighted”—and inanimate objects aren’t capable of emotion. Both (H) and (J) make the same error. Only (G) correctly describes the staff as being delighted, not the sculptures.
3. **(A) English/Knowledge of Language/Vocabulary.** This question asks for the best verb for the sentence, which describes the first sculpture from the anonymous donor. Those at the library where it was found “dubbed” or “called” it the “poetree,” (A). “[S]pecified,” (B); “adorned,” (C); and “honored,” (D) would not make sense in this context.



In questions that test students’ vocabulary or language knowledge, the plug-and-play method often helps to find the right answer faster: Plug each answer choice into the sentence to find which one “plays” best or makes the most sense.

4. **(F) English/Conventions of Standard English/Punctuation/Commas.** Adding commas before, after, or between “scene” and/or “sculpture,” as (G), (H), and (J) do, either separates an adjective from the noun it modifies or separates the subject of the sentence from the verb, disrupting the flow and meaning of the sentence, so it is best to not add additional commas, (F).
5. **(C) English/Conventions of Standard English/Grammar and Usage/Subject-Verb Agreement.** While the subject and the verb in the clause as written are both singular, there is one problem: The needed “a” to show a singular subject before “horse” is missing. In (B), the article “a” is still missing, and the added apostrophe incorrectly makes the subject possessive. In (D), the article “a” is also missing, and the added apostrophe incorrectly makes “theater” possessive. Only (C) makes the needed correction so that the plural subject “horses” matches the plural verb “leap.”
6. **(F) English/Conventions of Standard English/Punctuation/Commas.** This sentence is best left written as is. The clause “crafted from the pages of a mystery novel” could be set off in commas or em dashes, but the punctuation would need to match on each side of the clause (before “crafted” and after “novel”). None of the answer choices add punctuation in the correct place, so (F) is the best answer.
7. **(D) English/Knowledge of Language/Style/Conciseness.** The sentence as written is needlessly wordy and repetitive: “More than a few additional” is simply “more” or “several,” and “places where literature and artifacts are related to books and writing” are “museums” and “libraries.” Only (D) correctly removes the unnecessary and repetitive language.



In questions that test concision, the shortest answer is usually the correct answer.

8. **(G) English/Production of Writing/Strategy/Effective Transitional Sentence.** This question asks for the best word to move or transition to the next idea. “Therefore,” (F), introduces an explanation to the previous idea, but in the previous sentences, only a few sculptures are described, so the introduction of 10 sculptures is not an explanation for the first sculpture; (H) makes the same error. “However” signals a contrast, but there is no contrast between the description in the previous sentences to the introduction

of 10 sculptures, so (J) can also be eliminated. Only (G) shows the correct sequence of ideas by starting with the first sculpture and “eventually” introducing ten.

9. **(C) English/Conventions of Standard English/Grammar and Usage/Subject-Verb Agreement.** The error in the original sentence is in the singular subject “creator” and the plural verb “are.” (B) corrects the error but introduces a new one: The singular pronoun “this” cannot modify the plural noun “sculptures.” (D) makes the same error and creates a different subject-verb agreement error: The plural subject “creators” does not match the singular verb “is.” Only (C) correctly uses a plural pronoun to modify “sculptures” and a singular verb to match the singular subject.
10. **(J) English/Knowledge of Language/Style/Conciseness.** The problem with the original sentence is needless wordiness: A person made the sculptures, not a “what,” so “whatever” in addition to “whoever” is unnecessary (the use of the colon also creates a grammatical error). (G) and (H) make the same error; only (J) correctly uses a phrase that quickly and accurately captures the meaning of the sentence.
11. **(C) English/Conventions of Standard English/Grammar and Usage/Pronoun Usage.** Finding the correct answer to this question requires looking back at the previous sentence, which states that the mystery artist revealed “her” gender. Because the phrase in this question also refers to the artist, the pronoun must match, (C). Both (A) and (D) incorrectly use a second-person pronoun, and (D) creates unnecessary possession.
12. **(F) English/Knowledge of Language/Style/Conciseness.** “Gratitude” and “thanks” are redundant—they both mean “thankful.” (G), (H), and (J) use multiple forms of these words, creating needless repetition. Only (F) uses concise language.
13. **(B) English/Production of Writing/Strategy/Appropriate Supporting Material.** This paragraph introduces the anonymous donor’s identity, and if the author deleted the last sentence, an explanation as to why she left the sculptures at libraries and museums—because she wanted to give thanks for “libraries, books, words, ideas”—would be missing, (B). The writer doesn’t claim to know the identity of the donor or that she is a librarian, so (A) and (D) are wrong, and the previous sentence already introduces the author as female, so (C) is also wrong.
14. **(J) English/Conventions of Standard English/Sentence Structure/Fragments.** The sentence as written does not include a main verb. This is easy to see when the parenthetical statement is removed: “...the creator of these exquisite sculptures who destroyed books...as a tiny gesture...” Only (J) corrects this error.
15. **(B) English/Conventions of Standard English/Sentence Structure/Problems of Coordination and Subordination.** The sentence as written uses the wrong connecting word: You can’t refashion books “with” cutting them. “[N]or,” (C) and “so,” (D) create similar errors. Only (B) uses the write connecting word to show that the creator of the sculptures cut books “and” refashioned them into elaborate works of art.
16. **(G) English/Conventions of Standard English/Punctuation/Commas.** The phrase “as Pollack is likely to point out” is a nonrestrictive clause—it isn’t necessary for the sentence to be complete—and nonrestrictive clauses must be set off by matching punctuation. Only (G) correctly places a comma before and after this clause. All other answer choices either leave out the needed comma before or after the clause.



TIP *In questions that test nonrestrictive clauses, remind students that these types of clauses must be set off by matching punctuation. Once they identify the clause, they simply have to find the answer that places the same punctuation before and after it.*

17. **(C) English/Conventions of Standard English/Punctuation/Commas and Dashes.** While the original sentence correctly sets off the nonrestrictive clause in matching commas, the comma after “staff” incorrectly separates the word from its modifier. (B) is wrong because the parentheses are placed around the number rather than the entire clause, and (D) is wrong because it adds an unnecessary comma after the number. Only (C) uses matching punctuation around the entire nonrestrictive clause without adding additional, unnecessary punctuation.
18. **(F) English/Conventions of Standard English/Punctuation/Commas.** The previous questions tested students’ knowledge of nonrestrictive clauses, but in this sentence the underlined clause is necessary to the sentence, so no commas are needed, (F). All other answer choices add commas that are not needed.
19. **(C) English/Production of Writing/Strategy/Effective Transitional Sentence.** The first sentence of this paragraph introduces a new idea, or a new challenge, so “finally,” a concluding word, is not the best choice to use in the beginning of the paragraph. We don’t yet know anything about the challenge, or what Pollock does to try to overcome it, so “next,” (B), and “also,” (D), do not correctly introduce Pollock’s steps either. Only (C) shows the correct sequence of events.

TIP *Concluding or explanatory words such as “therefore,” “last,” “finally,” etc., should almost never be used at the beginning of a passage as there isn’t enough information to conclude or explain, and students can quickly eliminate these types of answer choices.*

20. **(G) English/Conventions of Standard English/Punctuation/Apostrophes.** The original sentence incorrectly uses “then,” which refers to a sequence, instead of “than,” which is used for comparison and what is needed, here, to show that it would take Pollock and one other person more than one year’s worth of full work days to glue the corks. (J) makes the same error, and while (H) uses “than” correctly, moving the apostrophe makes “years” a plural possessive noun, and only one year is referred to, here. Only (G) uses the correct word and doesn’t introduce additional errors.

TIP *For simple homonyms, such as “then” vs. “than,” give students short, easy rules they can memorize (i.e., then = sequence, than = comparison). Because the answer choices always include the wrong version of the word, students can recall these rules to quickly eliminate the wrong answers.*

21. **(D) English/Production of Writing/Strategy/Effective Opening Sentence.** The previous paragraph introduces a challenge Pollock encountered, and this paragraph describes what Pollock did to overcome that challenge. (A) isn’t an effective opening sentence for the current paragraph because it isn’t clearly connected to the strategy described throughout it. (B) references one detail of the strategy described, so it is also wrong, and (C) is also wrong because the paragraph describes something Pollock does to keep his dream alive, not put it on hold. Only (D) correctly introduces the strategy described in the paragraph.
22. **(G) English/Knowledge of Language/Vocabulary.** This question asks for the most specific description of the assembled group of corks. “Pretty interesting” is vague and “certain” doesn’t provide much detail either, so both (F) and (H) can be eliminated, and removing the underlined portion leaves no description, so (J) is also wrong. “Hexagonal” is a specific type of shape, so (G) is the best answer.
23. **(C) English/Conventions of Standard English/Sentence Structure/Faulty Parallelism.** Words in succession must be in the same grammatical form. Here, the verbs “bind” and “shaping” are in the same succession, but are not in the same grammatical form, so (A) is wrong, and (B) and (D) make the same errors. Only (C) keeps the verbs in the same grammatical form, retaining parallel structure.

24. (H) *English/Production of Writing/Strategy/Appropriate Supporting Material*. This question ultimately asks for a synonym of “challenging.” “Proper” means “appropriate,” and “authentic” means “real” or “genuine,” so both (F) and (G) can be eliminated. “Grim” means “ominous” or “fierce,” so it is also wrong. “Rigorous” means “strict” or “severe” and usually refers to effort or hard work, so (H) is the best answer.
25. (B) *English/Conventions of Standard English/Grammar and Usage/Verb Tense*. “Saw” is the past tense verb of “see,” and past tense verbs usually follow a noun or subject—“had” is not part of past tense verbs or verb phrases, so (A) can be eliminated. “Seen,” the past participle of “see,” is used alongside “have,” “has,” “was,” or “were” and doesn’t stand on its own, so (C) is also wrong. (D) doesn’t have a verb tense error, but it’s not clear who “him” is, so it is also wrong. Only (B) uses the correct verb tense and doesn’t introduce additional errors.
26. (F) *English/Conventions of Standard English/Punctuation/Commas*. The phrase “But at a length of twenty-two feet” is an introductory, dependent clause that needs to be joined to a complete sentence with a comma. The sentence as written, (F), correctly does this. (G) breaks up the description of the length, (H) incorrectly uses a semi-colon to join a dependent clause to an independent clause, and (J) doesn’t include the needed punctuation to set off the introductory clause.
27. (C) *English/Conventions of Standard English/Sentence Structure/Problems of Coordination and Subordination*. This question asks for the best connecting word. The previous sentence states that Pollock imagined his boat in a swimming pool, but it ended up being a “masterpiece,” that is better suited “for” a grand voyage, (C). “[W]ith” refers to accompaniment, “to” to direction, and “as” to comparison—none of which show the right connection.
28. (F) *English/Conventions of Standard English/Sentence Structure/Problems of Subordination and Coordination*. This question asks for the correct pronoun. “Who” and “whom” are used to refer to people, and a company is not a person, so (H) and (J) can be eliminated. Additionally, “whom” should only be used to refer to a verb or preposition. “Which” is used to introduce nonrestrictive clauses—which must be set off by matching punctuation. Because there is no punctuation at the end of the clause (after “project), using “which” would create a grammatical error and disrupt the meaning of the sentence, so (J) is also wrong. “That” is correctly used to join the restrictive clause to the sentence, (F).
29. (D) *English/Knowledge of Language/Style/Conciseness*. The sentence as written is unnecessarily wordy. Portugal is a country—and it was introduced in the previous sentence. Additionally, the use of the demonstrative pronoun “[t]here” points to Portugal, so there is no need to repeat it as (B) and (C) do. (D) correctly eliminates the repetition.
30. (G) *English/Production of Writing/Organization/Passage-Level Structure*. The sentence the author wants to add refers to corks in general—they “all count.” It wouldn’t make sense to add this type of sentence at point A in the introduction since we don’t yet know why each cork counts, so (F) is wrong. At point C, the paragraph describes Pollock’s specific strategy to make his cork boat faster, which also doesn’t explain why each cork counts, (H), and at point D in paragraph 5, the final product of the boat is being described, and the added sentence doesn’t match this context either, so (J) is also wrong. The sentence is best placed in paragraph 2 at Point B after the description of how Pollock amassed his corks—each one counted toward his goal, (G).
31. (C) *English/Knowledge of Language/Style/Conciseness*. The sentence as written is repetitive, as the location of the sands, southeastern New Mexico, is given twice. (B) commits the same error, and, if the sentence were removed, the comparison “as white as” would be incomplete, so (D) is also wrong. (C) correctly eliminates the repetition and completes the thought.
32. (J) *English/Conventions of Standard English/Punctuation/Commas*. The comma in the original sentence breaks up the compound verb in the sentence (“melts and becomes”), as does (H). Because “and” in this



- phrase is not being used to join two complete sentences, no comma is needed. Putting “by a lightning blast” in parentheses breaks up the necessary phrase that describes “heated sand,” so (G) is also wrong. The best way to correct the error is to remove the comma, (J).
33. **(C) English/Production of Writing/Strategy/Appropriate Supporting Material.** This question asks for the best word that emphasizes how a fulgurite leaves its mark on the earth. The previous sentence states that a fulgurite is created when a lightning blast strikes and heats up sand, so the chosen word needs to reflect that process. The lightning is not “placed” (A) on the sand, nor “sketched” (B), nor “sent” (D). The lightning blast that heats up the sand and creates the fulgurite is “burned” into it, (C).
34. **(G) English/Conventions of Standard English/Punctuation/Commas.** If you take “though” out of the sentence, the sentence is still complete and grammatically correct; therefore, “though” is a nonrestrictive clause and must be set off in matching punctuation. (F), (H), and (J) either don’t include any commas or only include one, so the correct answer is (G).
35. **(A) English/Production of Writing/Strategy/Appropriate Supporting Material.** At this point in the paragraph, the writer has expressed the difficulty in identifying or seeing a fully intact fulgurite. Adding a sentence about fulgurites’ ease of excavation does not match this context, so (B) is wrong. An explanation of what a fulgurite is not or of how it can be made into jewelry also does not match this context, so (C) and (D) can also be eliminated. The sentence that explains why fulgurites are usually not intact—they break easily—is most clearly connected to the ideas in the rest of the paragraph, (A).
36. **(J) English/Conventions of Standard English/Sentence Structure/Fragments.** Here, two related ideas are being joined, and the question asks for the best way to make this connection. The use of “while” (F), “however,” (G), or “so,” (H) creates a sentence fragment, so the best way to connect these ideas and retain a grammatically complete sentence is to delete the word, (J).
37. **(C) English/Production of Writing/Organization/Effective Transitional Sentence.** This question asks for the best sentence to connect the ideas between the previous paragraph and the current paragraph. The previous paragraph ended by explaining that sometimes after heavy winds, fulgurites are revealed. The current paragraph is focused on the writer looking for an uncovered fulgurite, which means winds must be present. The only answer choice that references winds to make this connection is (C).
38. **(F) English/Conventions of Standard English/Sentence Structure/Run-On Sentences and Verb Tense.** “Scanned the area” means “to look” around the area, and adding “focused my gaze” or “looked closely” creates repetition, so (G) and (H) are wrong. The addition of “had it been” in (J) creates separation from the adverb “newly” and the word it modifies (“uncovered”) and makes the sentence’s meaning hard to follow. The most concise way to express the thought is to leave the sentence as is, (F).
39. **(D) English/Production of Writing/Organization/Effective Transitional Sentence.** This sentence is focused on why the writer hadn’t seen fulgurites before, and the next sentence explains what the fulgurites’ interior looks like. While the passage does make it clear that the writer didn’t know what to look for, this clause doesn’t connect to the contrasting word “though” in the next sentence, so (A) is wrong. The writer focuses on other items often found in sand also doesn’t contrast to the fulgurites’ interior, so (B) can also be eliminated. As for (C), there is no mention of any science experiment in the passage, so it is also wrong. The only answer choice that contrasts the fulgurites interior in the next sentence is (D), as it explains what their exterior or “surface” looks like.
40. **(H) English/Production of Writing/Strategy/Appropriate Supporting Material.** The question asks for the best word that describes a “sporadic” arrangement of bubbles in the glass. Because sporadic means “scattered,” the best answer will be close to that meaning. “[S]tain” means to discolor or smudge, so (F) can be eliminated, and “pointed” means “sharp,” so (G) is also wrong. “Covered” applies to an entire

area, not scattered or sporadic parts of an area, so (J) is wrong. “Speckled” refers to a number of patches or spots, so its meaning is most closely aligned to “sporadic,” (H).

41. **(B) English/Conventions of Standard English/Sentence Structure/Misplaced Modifiers.** The underlined clause, placed as is, creates a sentence with two consecutive verbs. The sentence would have the same problem if the clause was placed after “during,” so (C) is also wrong. Placing the clause after “cooling” would change the meaning of the sentence as it would say that the “rapid cooling” was “formed by air and moisture,” so (D) is also wrong. The only place in the sentence that doesn’t create double verbs or change the meaning is after “bubbles,” (B), which were “formed by air and moisture.”
42. **(F) English/Conventions of Standard English/Grammar and Usage/Verb Tense.** Here, Anne is telling the writer, in the midst of his search for a fulgurite, that they could find one at the gift shop. The verb phrase “for having unearthed” is a past participle that refers to an action that has been completed. Anne and the writer have not yet found a fulgurite or “unearthed their treasure,” so (G) can be eliminated. (H) states that the gift shop would unearth their treasure, not that they would be able to find the treasure there, so it is also wrong, and “unearthing” would mean that Anne and the writer are currently unearthing their treasure, but they are still looking for it, so (J) is also wrong. Only (F) uses the correct verb tense to express the idea.
43. **(C) English/Production of Writing/Organization/Paragraph-Level Structure.** In the previous sentence, Anna “laughed” and joked about being able to quickly find a fulgurite by buying one in the gift shop. Because she laughed, she was not being critical, so (A) can be eliminated, and her laugh also indicates that she was being light-hearted, not excited, so (D) is also wrong. Because she was the one who suggested the gift shop, if anyone was impatient it would be her, not the narrator, so (B) is also wrong. The sentence captures a joke about the ease of obtaining a fulgurite, (C).
44. **(G) English/Conventions of Standard English/Grammar and Usage/Pronoun Usage.** This question asks for identification of the appropriate pronoun. In the sentence, Anna wants to keep looking for fulgurites because of luck. Because Anna is the one who wants to keep looking and the passage is written from the narrator or writer’s perspective, not Anna’s, “my” is not the correct pronoun, so (H) is wrong, and the passage has been written in second, not third person, so “their,” (J) is also wrong. While later in the sentence the pronoun “our” is used, and it would be easy to assume its use is correct in this first part of the sentence, the passage clearly states that the writer has not looked or found fulgurites before, which means the writer can’t have any luck in that area and thus can’t be grouped with Anna, so (F) is also wrong. Anna is the only one who has had luck before and wants to keep looking so the best pronoun is “her,” (G).
45. **(A) English/Knowledge of Language/Vocabulary.** In the passage, the writer and Anna are looking for fulgurites on a beach in New Mexico, and this question asks for the best supporting material or new information for Anna’s luck finding fulgurites on other beaches. (B) is redundant because the writer already stated they were on a New Mexico beach; (C) commits a similar error in that it needlessly describes beach, and (D) introduces a green fulgurite, but the passage clearly states that Anne wanted to look for a white one (Paragraph 1). The only answer choice that adds new, supporting information for other beaches where Anne has found white fulgurites is (A).
46. **(F) English/Conventions of Standard English/Punctuation/Apostrophes.** The pronoun here refers to “facility,” which is a singular noun, so the plural “their” and “these” can be eliminated in (G), and (H). “Its” with an apostrophe signals the contraction “it is,” not the possessive pronoun for “it,” so (J) is also wrong. “Its” with no punctuation is the appropriate possessive pronoun.



TIP For pronoun questions, a quick process of elimination is to look for answer choices that do not agree with the pronoun's antecedent in number and then focus on determining the best answer from the answer choices that do.

47. **(B) English/Conventions of Standard English/Grammar and Usage/Subject-Verb Agreement.** This question can be a bit tricky as the nonrestrictive clause that modifies "facility" separates the subject of the sentence, "conditions," from the verb. "Conditions" is plural, so the verb must also be plural, and (A), (C), and (D) all use singular verb phrases, so the best answer is (B).
48. **(G) English/Conventions of Standard English/Punctuation/Commas.** The problem with the original sentence is that it has redundant punctuation: Because the clause in parentheses is already enclosed in punctuation, using a comma before the parenthesis is unnecessary. (C) commits the same error and incorrectly removes the comma needed after "Peak," so it is also wrong, and (D) can also be eliminated because it also incorrectly removes the comma after "Peak." The parenthetical phrase is part of an introductory or dependent clause that must be connected to the independent clause in the sentence with a comma after the closed parenthesis, so (G) is the best answer.

TIP Commas are almost never needed before parenthesis, so answer choices that include this unnecessary punctuation can quickly be eliminated.

49. **(D) English/Production of Writing/Strategy/Appropriate Supporting Material.** This question asks for the best answer to show that Mount Washington's weather can be extreme, and because most answer choices refer to weather, the best way to find the correct answer is to compare answers to see which one refers to the *most* extreme weather conditions. (A) refers to the mountain's height, so it is wrong, and (B) simply says that it's colder at the summit than at that base, which doesn't describe extreme conditions, so it can also be eliminated. (C) describes cold temperatures, but because Antarctica is a continent that is mostly covered in ice, temperatures likely get in the negative degrees, much lower than 5 degrees Fahrenheit, so (D) is the best answer.
50. **(F) English/Conventions of Standard English/Sentence Structure/Fragments.** Both clauses in this sentence are complete sentences, and they are correctly joined by a comma and a conjunction (and). However, if "that" or "if" is added to the second clause, it changes it from an independent clause to a dependent one, which creates a sentence fragment or incomplete thought, so (G) and (H) are wrong. (J) makes a similar error as "forcing" is not a complete verb phrase and also creates a sentence fragment. The sentence as written keeps the clause independent, (F).
51. **(B) English/Conventions of Standard English/Punctuation/Colons and Dashes and Semicolons and Commas.** The problem with the original sentence is that the parentheses break up the logical progression of ideas. The wind speed is a restrictive clause that is part of the main idea of the sentence and should not be enclosed in parentheses as additional but unnecessary material. (D) commits the same error. A semi-colon should be used to connect two complete sentences without a conjunction, but the second clause is a dependent clause, and an independent clause and a dependent clause cannot be joined with a semi-colon, so (C) is also wrong. Only (B) correctly removes the punctuation around the restrictive clause but retains appropriate punctuation to join the independent and dependent clauses.
52. **(F) English/Knowledge of Language/Style/Conciseness.** While adding "addition," "additionally," or "also" at the beginning of the sentence might seem to create an effective transition sentence, it creates repetition as "also" is used in the middle of the sentence, so the sentence is most concise as written, (F).
53. **(D) English/Conventions of Standard English/Sentence Structure/Faulty Parallelism.** Items in a sequence or list must be in the same grammatical structure, and this list is composed of nouns: "clouds," "ice physics," and "the atmosphere." Using "of" before each of these nouns is not necessarily wrong, but it would have to be used before each noun in the list, and it is absent before "atmosphere," so (A) is wrong,

and adding any other word or phrase to only one item in the list also disrupts parallel structure, so (B) and (C) are also wrong. Only (D) correctly uses a list of nouns to retain parallel structure.

54. **(H) English/Conventions of Standard English/Sentence Structure/Fragments.** The problem with the sentence as written is that it is incomplete. The use of “who” makes the clause dependent, not independent. (G) makes the same mistake, and the change to “forcing” in (J) makes an incomplete verb phrase, also creating a fragment. The best way to correct the problem is simply to remove “who” so that the sentence is complete, (H).
55. **(D) English/Production of Writing/Organization/Sentence-Level Structure.** “Though,” as used in the sentence as written, is a contrasting word, but the idea in this sentence isn’t at odds with the sentence that precedes it, so it is not an appropriate connecting word. (C) commits the same error. “Of course” is also not the best connecting phrase as how crews change shift in winter doesn’t clarify or clearly explain their twelve-hour shifts, so (B) is also wrong. The best option is to leave out any phrases that distort the relationship of the sentences, (D).
56. **(H) English/Conventions of Standard English/Sentence Structure/Unintended Meanings.** The sentence as written says that the crew grips the snow, but it is the vehicle that does this—similar to a “military tank.” (G) and (J) make the same error. The only answer that correctly shows that it is the vehicle gripping the snow is (H).
57. **(A) English/Conventions of Standard English/Sentence Structure/Problems of Coordination and Subordination.** There are two ways to join independent clauses: with a comma and a conjunction or with a semi-colon. If any of these elements are missing, the sentences should not be joined and stand as their own sentences. Because both clauses in question are independent clauses, one of these conditions needs to be met. (B) and (C) are missing the needed comma before the conjunction, and (D) is missing the conjunction, creating a comma splice, so the sentences should remain separated, (A).
58. **(G) English/Production of Writing/Strategy/Appropriate Supporting Material.** The previous sentence called out those who are bold and want to take a trip to the mountain. This sentence introduces a website, which can be accessed anywhere with an Internet connection, for those who want to get information about the mountain. This is the safer or less bold option, and those who are planning a trip to the mountain, love the outdoors, or who research weather, which is often extreme, would likely not be content with a website, so (F), (H) and (J) are wrong. Only (G) shows the contrast between the bold who likely want to visit and those who would rather read about it.
59. **(C) English/Production of Writing/Organization/Passage-Level Structure.** The sentence the writer is considering adding explains information, so it must be placed after a description of information so that “this” correctly points to that information. At Point A in Paragraph 1, (A), the reader has just been introduced to Mount Washington, so it wouldn’t make sense to place the sentence there. Point B in Paragraph 2, (B), is the beginning of the paragraph, and “this” wouldn’t point to any specific information, so it shouldn’t be placed there, either. At Point D in Paragraph 5, details about the various ways to find information about the mountain are being described, but general information can’t help create weather forecasts, so (D) is also wrong. The sentence is best placed at Point C in Paragraph 4 as it correctly points to the “data” or information that observers gather and send to the National Weather Service to create weather forecasts, (C).
60. **(J) English/Production of Writing/Strategy/Main Idea.** This question asks for the main idea of the passage as a whole. While it does describe how the mountain affects weather, it is focused only on Mount Washington, not how mountain ranges in general reflect weather patterns, so (F) and (G) are wrong. And, while the passage does delve into a bit of history in how scientists researched weather at the observatory, the passage overall is not focused on its history, (H). Instead, it is focused on giving an overview of the observatory and its research, (J).



61. (C) *English/Conventions of Standard English/Punctuation/Apostrophes*. There are two different types of “its”: “Its” without an apostrophe is singular possessive, and “it’s” with an apostrophe is a contraction for “it is.” Usually, to indicate a plural possessive, an apostrophe would be added after the “s,” but “it,” itself, is singular and cannot be made plural, so (A) is wrong. In this context, “it” also is not possessive (there’s nothing that belongs to “it”), so (B) and (D) are also wrong. The only answer choice that doesn’t use an incorrect form of “its” is (C).
62. (G) *English/Conventions of Standard English/Punctuation/Commas*. If names given in a sentence are not necessary for the sentence to be complete, they must be set off in commas. However, in this context, the engineer’s name is necessary to the grammatical structure of the sentence, so no commas are needed before or after his title or name, (G).
63. (D) *English/Knowledge of Language/Style/Conciseness*. “Revolutionized” means to fundamentally affect change, and using this type of language in conjunction with “revolutionized” is redundant, so (A) and (B) can be eliminated. As for (C), fundamental or revolutionary change also means that what was changed will never be the same, so it is also redundant. The only answer that eliminates repetitious words or ideas is (D).
64. (J) *English/Conventions of Standard English/Sentence Structure/Problems of Coordination and Subordination*. This sentence begins with a dependent clause that starts with the word “[w]hile”—which indicates a specific period of time. McCoy can’t work on wheel bearings and axels of trains after working at the railroad, so (F) is wrong. And “with that company” and “during this time” unnecessarily repeat the period of time that “while” already indicates, so (G) and (H) are also wrong. The best choice is to remove the redundant or illogical words that introduce the second clause in the sentence, (J).
65. (B) *English/Production of Writing/Strategy/Appropriate Supporting Material*. The sentence as written simply says that while McCoy worked at the railroad he was responsible for the wheel bearings and axels of trains. The rest of the paragraph moves into how this work led to McCoy’s first patent for automatic oiling or lubrication for train parts, and there is no clear connection to wheel bearings and axels of trains to the invention of this patent. If, however, the author changed “assigned to work on” with “responsible for oiling,” this connection would be more clear, (B). While the change does give more specifics on what McCoy’s responsibilities were, it does not detail the procedures he used, so (A) is wrong. (C) is wrong because the sentence that follows specifically states that train parts had to be oiled by hand, and (D) is wrong because whether McCoy worked for other railroad companies is not relevant to his role at this railroad or to his first patent.
66. (F) *English/Conventions of Standard English/Grammar and Usage/Diction*. All the answer choices for this question use a word that means “less,” so the context of the sentence needs to be analyzed to determine which of these related words makes the most sense. “Subtract” means to take away, and the number of stops are not being taken away, so (H) can be eliminated. “Lessening the frequency of number” is wordy and redundant: If the frequency of stops is lessened, so is the number of stops, so (G) is wrong. As for (J), “lower” means to move down, not that they are less frequent, so it is also wrong. (F) appropriately demonstrates that McCoy’s invention “reduced” the number of times the trains had to stop for parts to be oiled without being redundant.
67. (B) *English/Conventions of Standard English/Sentence Structure/Faulty Parallelism*. Items in a list or series must be in the same grammatical structure. In this sentence, there are two items in a series, the first being “reducing the number of maintenance stops.” The next item must follow this grammatical structure. (A) places the transitive verb “making” at the end of the clause, not at the beginning as the previous clause did, so it can be eliminated. (C) places the transitive verb at the beginning of the clause, but what follows is a verb, not a noun as in the previous clause, and (D) uses the verb “made” instead of the transitive verb “making,” so they are also wrong. Only (B) retains parallel structure by using a transitive verb followed by a noun in both clauses.

68. (F) *English/Production of Writing/Organization/Sentence-Level Structure*. This question asks for the best word or phrase to connect the idea in this sentence to the idea in the previous sentence. The previous sentence introduced the fact that McCoy applied similar principles from his automatic lubricating device to other factories, and the sentence at hand provides one way, or an example of how, these principles were applied, (F). “Subsequently,” (G); “regardless,” (H); and “however,” (J), are words that indicate a contrast, and no contrast is being made, here—an example is being introduced.
69. (D) *English/Conventions of Standard English/Sentence Structure/Fragments*. The problem with the sentence as written is that “therefore” is an explanatory or concluding word, but the beginning clause “[a]s with trains” already makes the connection between trains and machines, so “therefore” is redundant. (C) commits the same error. It’s also not clear how this similarity is a problem, so (B) is wrong. The best choice is to remove the underlined portion for clarity and concision, (D).
70. (F) *English/Conventions of Standard English/Punctuation/Commas and Grammar and Usage/Verb Tense*. “[R]ecognizing” begins a nonrestrictive clause—it is not necessary to the meaning and structure of the sentence—and is appropriately set off in commas, (F). Changing the “recognizing” to “would recognize” creates a sentence fragment, so (G) is wrong, and (J) is missing a conjunction before “designed” to make the sentence complete, so it is also wrong. As for (H), changing “recognizing” to “a recognition of” says that McCoy is a recognition, not that he was the one who recognized the similarities between train wheels and factory machines, so it is also wrong.
71. (C) *English/Knowledge of Language/Vocabulary*. In this sentence, the result of McCoy’s innovation for factory machines is explained: It increased production and profits. The question asks for the clearest and most precise explanation for how it did this. The machines being timeless does not explain how production and profits increased, so (A) can be eliminated, nor does rethinking operations, so (B) is also wrong. While using the machines differently does offer an explanation, (D), it doesn’t explain how they were used differently and is too vague to be clear and precise. The only answer choice that offers a logical explanation to show how McCoy’s innovation increased production and profits is (C): The machines ran continuously and thus were able to create more product.
72. (H) *English/Production of Writing/Strategy/Appropriate Supporting Material*. In the sentence in question, the phrase “and, as a result, profits” introduces an additional benefit to McCoy’s innovation. It does not mention factory dispute, (F); suggest that profits were more important than McCoy’s devices, (G); or say that workers were paid more, (J). The phrase provides support for the main idea of this section of the passage: McCoy’s device positively affected factories, (H).
73. (D) *English/Knowledge of Language/Style/Tone*. The problem with the original sentence is that it is ambiguous: To what does “it” refer? While (B) and (C) correct this error, the phrases “lend itself to superiority” and “give off the best result” are needlessly wordy compared to the succinct and clear “work well,” (D).
74. (F) *English/Production of Writing/Strategy/Effective Concluding Sentence*. This question asks for the best way to complete the last sentence of the passage. Because the sentence begins with the idea that McCoy’s inventions continue to benefit industries into the twentieth century, the last part of the sentence must build off that idea. McCoy’s induction into a hall of fame does not support how his inventions continue to benefit industries, (G), nor does announcing the genuineness of the passage, (J). As for (H), while it does relate to McCoy’s inventions having positive effects, it refers to only one industry—aluminum—and the first part of the sentence refers to industries in general. The best way to complete this sentence, and the passage, is to explain the overall positive effect or benefit McCoy’s inventions have on industries as a whole: They represent quality and authenticity, (F).
75. (D) *English/Production of Writing/Organization/Passage-Level Structure*. The author wants to add a sentence that explains why buyers weren’t interested in price when imitators tried to sell their product,



so the sentence needs to be placed in a section of the passage that covers imitators of McCoy's devices. At Point A in Paragraph 1, the phrase "the real McCoy"—and McCoy himself—are just being introduced, so (A) can be eliminated. At Point B in Paragraph 2, McCoy's lubricating invention is introduced, but there is not mention of imitators of this device, so (B) is also wrong. While at Point C in Paragraph 4, (C), imitators of McCoy's devices are described, it is not until after this point that the idea is introduced and the added sentence offers a detail about why imitators weren't successful, which needs to come after the idea is introduced, so the best place for the added sentence is at Point D in Paragraph 4, (D).

ACT MATHEMATICS TEST EXPLANATIONS

1. **(C) Mathematics/Number and Quantity/Rates and Proportions. CCRS: AVG.AF.1. CC: 7.RP.A.3.** The greater the quantity of eggs, the greater the number of servings, so set up a direct proportion and cross-multiply to solve for the missing quantity: $\frac{3 \text{ eggs}}{5 \text{ eggs}} = \frac{6 \text{ servings}}{x \text{ servings}} \Rightarrow x = \frac{6(5)}{3} = \frac{30}{3} = 10$.

TIP You can solve this item even faster by skipping the formality of a proportional equation: 3 eggs makes 6 servings, which is twice the number of servings as the number of eggs. Therefore, 5 eggs must make 10 servings.

2. **(K) Mathematics/Statistics and Probability/Probability. CCRS: AVG.SP.3. CC: 7.SP.C.7a.** Since Hiroko is NOT an officer, and there are 3 officers in the 35-member club, the total number of members from which the representative is chosen equals $35 - 3 = 32$. Therefore, the probability that Hiroko is chosen at random from the 32 non-officer members is 1 out of 32, or $\frac{1}{32}$.

3. **(B) Mathematics/Algebra and Functions/Manipulating Algebraic Expressions/Manipulating Expressions Involving Exponents. CCRS: ADV.NS.5. CC: HSN-RN.A.2.** Recall that if the exponential expressions on both sides of an equality have the same base, then the exponents are equal as well: if $x^a = x^b$, then $a = b$. In this case, $2^{2x+7} = 2^{15}$, so $2x + 7 = 15$. Solve this simplified equation for x : $2x + 7 = 15 \Rightarrow x = \frac{15-7}{2} = \frac{8}{2} = 4$.

TIP Alternatively, apply the “test-the-test” strategy. Substitute the values for x given in the answer choices into the equation and evaluate. The equation will hold true only for the correct value of x :

A. $x = 2$: $2^{2x+7} = 2^{15} \Rightarrow 2^{2(2)+7} = 2^{15} \Rightarrow 2^{11} \neq 2^{15}$ ✗

B. $x = 4$: $2^{2x+7} = 2^{15} \Rightarrow 2^{2(4)+7} = 2^{15} \Rightarrow 2^{15} = 2^{15}$ ✓

It is not necessary to continue evaluating answer choices.

4. **(J) Mathematics/Algebra and Functions/Evaluating, Interpreting, and Creating Algebraic Functions/Function Notation. CCRS: AVG.F.1. CC: HSF-IF.A.2.** Substitute 3 for x in the given function $f(x)$ and evaluate: $f(x) = 5x^2 - 7(4x + 3) \Rightarrow f(3) = 5(3)^2 - 7[4(3) + 3] = 5(9) - 7(12 + 3) = 45 - 7(15) = 45 - 105 = -60$.

TIP When you are evaluating expressions, equations, and functions, make sure you use the correct order of operations. An easy way to remember the order is Please Excuse My Dear Aunt Sally: Parentheses, Exponents, Multiplication and Division, Addition and Subtraction.

5. **(D) Mathematics/Statistics and Probability/Probability. CCRS: AVG+.SP.3. CC: 7.SP.C.7a.** The question asks for the probability that a bill drawn at random from a wallet is a twenty-dollar bill if the wallet contains 5 five-dollar bills, 7 ten-dollar bills, and 8 twenty-dollar bills. The probability is equal to the ratio of the number of twenty-dollar bills, 8, to the total number of bills, $5 + 7 + 8 = 20$. Therefore, the probability is $\frac{8}{20} = \frac{2}{5}$.



6. (H) *Mathematics/Algebra and Functions/Solving Simultaneous Equations and Evaluating, Interpreting, and Creating Algebraic Functions/Functions as Models. CCRS: ADV.A.4. CC: HSA-CED.A.3.* Begin by creating equations to represent the total charges for each of the book clubs, where C is the cost, in dollars, and n is the number of books read in a month. For ABC Book Club, the cost equation is $C = 40 + 2n$ and for Easy Book Club, the equation is $C = 35 + 3n$. To determine the number of books read that makes the charges equal, set the two cost equations as equal and solve for n : $40 + 2n = 35 + 3n \Rightarrow 3n - 2n = 40 - 35 \Rightarrow n = 5$.
7. (D) *Mathematics/Geometry/Lines and Angles. CCRS: AVG+.G.1. CC: 8.G.A.5.* Since the opposite sides of a parallelogram are both equal and parallel, the opposite angles of a parallelogram are equal: $\angle ADC = \angle ABC = 40^\circ$. The sum of the angles of any triangle is 180° , so $180^\circ = \angle CAD + \angle ACD + \angle ADC = \angle CAD + 57^\circ + 40^\circ \Rightarrow \angle CAD = 180^\circ - 97^\circ = 83^\circ$.

TIP *If you aren't able to solve this item directly, you can use the "meastimation" strategy to eliminate non-answers. While the figure is not necessarily drawn to scale, you can assume that the angles shown are drawn to scale relative to one another. Therefore, mark off the 40° angle on a piece of paper—the unknown angle is around twice the size of the 40° angle. This immediately eliminates (A) and (B). Furthermore, we can see that the 40° angle is less than half a 90° angle (which is equal to the corner of a sheet of paper), so it's likely to scale. Therefore, since the unknown angle is also less than a 90° angle (which also eliminates [E]), but more than twice the 40° angle, it's probably between 90° and 80° , so the correct answer is most likely (D).*

8. (G) *Mathematics/Algebra and Functions/Manipulating Algebraic Expressions/Evaluating Expressions. CCRS: BSC.A.1. CC: 6.EE.A.2c.* This item asks you to evaluate an expression. Substitute $\frac{1}{2}$ for x in the

expression and simplify:
$$\frac{8x - 3}{x} = \frac{8\left(\frac{1}{2}\right) - 3}{\frac{1}{2}} = (4 - 3)(2) = 2.$$

TIP *Recall that to clear a fraction from the denominator of a fraction, multiply by the reciprocal of the fraction in the denominator.*

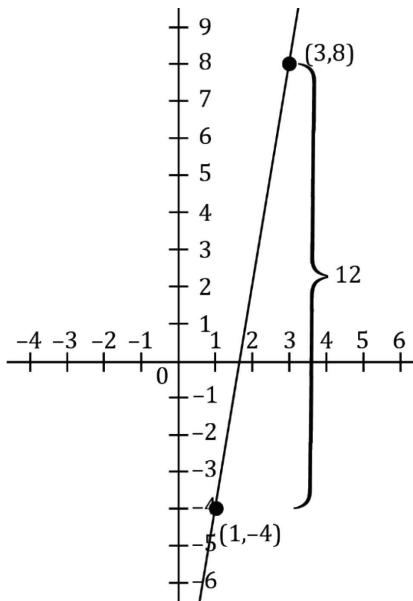
9. (D) *Mathematics/Algebra and Functions/Coordinate Geometry/Distance and Midpoint Formulas. CCRS: AVG+.G.11. CC: HSN-CN.C.7.* The midpoint (x, y) between two points (x_1, y_1) and (x_2, y_2) is

$$\left(\frac{x_2 + x_1}{2}, \frac{y_2 + y_1}{2}\right).$$

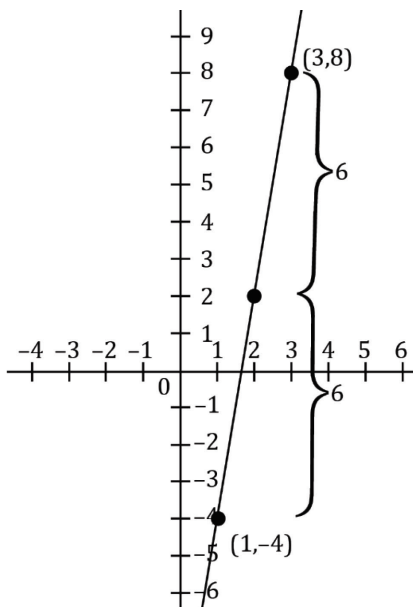
So, the midpoint between $(3, 8)$ and $(1, -4)$ is $\left(\frac{x_2 + x_1}{2}, \frac{y_2 + y_1}{2}\right) =$

$$\left(\frac{3 + 1}{2}, \frac{8 + (-4)}{2}\right) = \left(\frac{4}{2}, \frac{4}{2}\right) = (2, 2).$$

Another way to approach this item, especially if you don't remember the midpoint formula, is to draw the line in the xy -coordinate plane and step halfway between the ends in both the x - and y -directions:



The total distance between the x -coordinates of the endpoints is 2, so the x -coordinate of the midpoint is $\frac{2}{2} = 1$ to the left of 3, or 2 (or 1 to the right of 1). The total distance between the y -coordinates of the endpoints is 12, so the y -coordinate of the midpoint is $\frac{12}{2} = 6$ below 8, or 2 (or 6 above -4).



10. (G) *Mathematics/Algebra and Functions/Coordinate Geometry/Qualitative Behavior of Graphs of Functions*. CCRS: ADV.AF.3. CC: HSF-IF.B.4. The positive difference between the greatest water depth and the least water depth is equal to the difference between the y -axis measure at the peak and the y -axis measure at the trough: $12 - 6 = 6$ feet.



11. (D) **Mathematics/Algebra and Functions/Coordinate Geometry/Slope of a Line.** CCRS: AVG+.G.10. CC: 8.F.B.4. Substitute the x - and y -values of $(-2, 1)$ and $(2, -5)$ into the slope formula and simplify:

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-5 - 1}{2 - (-2)} = \frac{-6}{4} = -\frac{3}{2}.$$

12. (H) **Mathematics/Number and Quantity/Rates and Proportions and Algebra and Functions/Evaluating, Interpreting, and Creating Algebraic Functions/Functions as Models and Solving Algebraic Equations or Inequalities with One Variable/Simple Equations.** CCRS: ADV.AF.1. CC: HSA-CED.A.2. The \$221 fine for speeding is equal to the product of the rate \$17 per mile per hour over the posted speed limit and the difference between Kirk's speed, let's call it x , and the posted speed limit, 30 mph. Therefore, the

algebraic equation that describes the given scenario is $\$221 = \frac{\$17}{\text{mph}}(x \text{ mph} - 30 \text{ mph}) \Rightarrow 221 =$

$$17x - 17(30). \text{ Solve the equation for } x: x = \frac{221 + 510}{17} = \frac{731}{17} = 43 \text{ mph.}$$

- TIP** Alternatively, use the "process of elimination" and "test-the-test" strategies. The speed limit is 30 mph and the fine is applied only to miles per hour over the posted speed limit. This immediately eliminates (F) and (G), because these speeds are below the 30-mph speed limit. Test the remaining choices, starting with (H). If Kirk was traveling at 43 mph, he would be fined \$17 per mph over 30 mph, or \$17 for each of $43 - 30 = 13$ mph, or $\frac{\$17}{\text{mph}}(13 \text{ mph}) = \221 . Don't bother testing the remaining choices. (H) must be the correct answer.

13. (B) **Mathematics/Algebra and Functions/Solving Simultaneous Equations.** CCRS: ADV.A.4. CC: 8.EE.C.8b. The stem asks for the sum of the solutions to the system of linear equations, so solve for $x + y$ rather than x and y individually. Divide the x -equation by 8 and the y -equation by 2 and then add the equations:

$$\begin{array}{r} \frac{1}{8}(8x = 12) \\ + \frac{1}{2}(2y + 10 = 22) \\ \hline x + y + \frac{10}{2} = \frac{12}{8} + \frac{22}{2} \Rightarrow x + y = \frac{3}{2} + 11 - 5 = \frac{3}{2} + 6 = 7\frac{1}{2} \end{array}$$

14. (H) **Mathematics/Statistics and Probability/Measures of Center.** CCRS: EXP.SP.1. CC: HSA-CED.A.4. The median of a set of numbers is the middlemost number when the set is arranged in ascending or descending order. In this case, the average of the 5 scores is $\frac{s_1 + s_2 + s_3 + s_4 + s_5}{5}$ and the sum of the five

scores is 420, so the average is $\frac{420}{5} = 84$. The stem states that the average is equal to the median, so

$$\frac{s_1 + s_2 + s_3 + s_4 + s_5}{5} = \frac{s_1 + s_2 + 84 + s_4 + s_5}{5} = 84. \text{ Therefore, the sum of the 4 numbers that are not the}$$

median is $\frac{s_1 + s_2 + 84 + s_4 + s_5}{5} = 84 \Rightarrow s_1 + s_2 + s_4 + s_5 = 84(5) - 84 = 420 - 84 = 336$.

15. (D) **Mathematics/Number and Quantity/Basic Arithmetic Manipulations.** CCRS: AVG.NS.1. CC: 6.NS.C.7c. The value of an expression between absolute value symbols is always the nonnegative equivalent. Therefore, $||-8 + 4| - |3 - 9|| = ||-4| - |-6|| = |4 - 6| = |-2| = 2$.

16. (K) **Mathematics/Algebra and Functions/Manipulating Algebraic Expressions/Manipulating Expressions Involving Exponents.** CCRS: ADV.NS.5. CC: HSN-RN.A.2. Apply the rules for working with exponents, specifically $x^{mn} = (x^m)^n$ and $x^{\frac{m}{n}} = \sqrt[n]{x^m}$. Therefore, $x^{\frac{2}{3}} = (x^2)^{\frac{1}{3}} = \sqrt[3]{x^2}$.

TIP Alternatively, use the “plug-and-chug” strategy. Assume a value for x and evaluate the given exponential expression using a calculator. If $x = 2$, then $2^{\frac{2}{3}} \approx 1.59$. Now, substitute 2 for x in the answer choices and evaluate each using a calculator until you find the one that returns a value of 1.59:

- F. $\frac{x^2}{3} : \frac{2^2}{3} \approx 1.33$ ✗
 G. $\frac{x(2)}{3} : \frac{2(2)}{3} \approx 1.33$ ✗
 H. $\sqrt{x^3} : \sqrt{2^3} \approx 2.83$ ✗
 J. $\sqrt[3]{x} : \sqrt[3]{2} \approx 1.26$ ✗
 K. $\sqrt[3]{x^2} : \sqrt[3]{2^2} \approx 1.59$ ✓

17. (B) **Mathematics/Algebra and Functions/Coordinate Geometry/Slope-Intercept Form of a Linear Equation.** CCRS: AVG+.A.14. CC: 8.F.B.4. Rewrite the given equation in slope-intercept form, $y = mx + b$, where m is the slope and b is the y -intercept: $4x = 7y + 5 \Rightarrow 7y = 4x - 5 \Rightarrow y = \frac{4x - 5}{7} = \frac{4}{7}x - \frac{5}{7}$. So, the slope is $\frac{4}{7}$.

18. (K) **Mathematics/Number and Quantity/Properties of Numbers.** CCRS: ADV.NS.2. CC: 6.EE.B.5. For the sum of two integers to be always an odd integer, one must be even and one must be odd. For example, $1 + 2 = 3$, $2 + 3 = 5$, $3 + 4 = 7$, etc. Therefore, (K) is the correct choice.

TIP Alternatively, use the “process of elimination” strategy and eliminate the wrong choices by disproving each with a contrary example:

- F. Let m equal an odd integer (and n can equal odd or even): $m + n = 3 + 1 = 4$, which is even, so (F) is false.
 G. Let n equal an odd integer (and m can equal odd or even): $m + n = 1 + 3 = 4$, which is even, so (G) is false.
 H. Let m and n both equal odd integers: $m + n = 1 + 3 = 4$, which is even, so (H) is false.
 J. Let m and n both equal even integers: $m + n = 2 + 4 = 6$, which is even, so (J) is false.

Therefore, by the process of elimination, (K) must be correct.

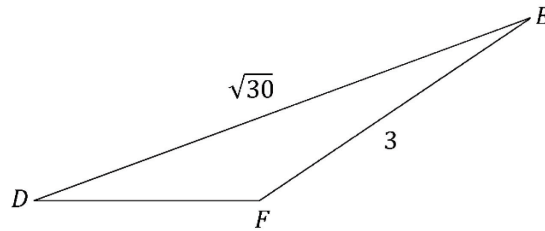
19. (B) **Mathematics/Geometry/Triangles/Pythagorean Theorem.** CCRS: ADV.G.2. CC: 8.G.B.8. The question asks for the distance of the midpoint of the hypotenuse from A but not the coordinates of the midpoint. Simply determine the length of the hypotenuse, \overline{AB} —half of this length is the distance of the midpoint from A . To find the hypotenuse of the right triangle, use the Pythagorean theorem: $\overline{AC}^2 + \overline{BC}^2 = \overline{AB}^2 \Rightarrow \overline{AB}^2 = 32^2 + 24^2 = 1,024 + 576 = 1,600 \Rightarrow \overline{AB} = \sqrt{1,600} = 40$. Therefore, the midpoint of \overline{AB} is $\frac{40}{2} = 20$ inches from A .

TIP Eliminate unreasonable answers. In a right triangle, the hypotenuse is the longest side. Therefore, the



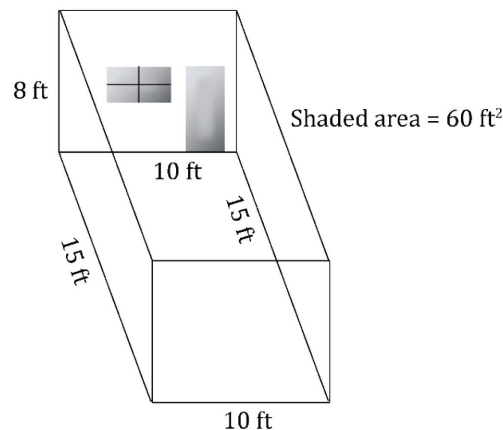
midpoint of the hypotenuse is less distance from A than the midpoint of \overline{AC} , which is 16 inches from A . This eliminates (A). Furthermore, the sum of any two sides has to be greater than the third side, so the hypotenuse must be less than $32 + 24 = 56$ inches, making the midpoint less than 28 inches from A . This eliminates (D) and (E). So, if forced to guess on this item, you'd have a 50/50 chance of guessing correctly between (B) and (C).

20. (K) **Mathematics/Geometry/Triangles/Properties of Triangles.** CCRS: EXP.G.4. CC: 7.G.B.2. To help conceptualize this problem, draw a sketch of the described triangle, with corners D , E , and F , and side lengths $\overline{DE} = \sqrt{30}$ and $\overline{EF} = 3$, where the length of side \overline{DF} is unknown:



Note that we don't know anything more about this triangle: we don't know the measure of the angles, or if it's a right triangle or an isosceles triangle, and so on. Therefore, nothing can be determined about the length of the third side.

21. (B) **Mathematics/Geometry/Rectangles and Squares and Complex Figures.** CCRS: AVG.G.5. CC: HSG-MG.A.3. To help conceptualize this problem, sketch the described room:



The question asks for the total surface area of the walls minus the combined area of the window and door. The total surface area of the walls is $2(10 \text{ feet})(8 \text{ feet}) + 2(15 \text{ feet})(8 \text{ feet}) = 160 + 240 = 400$ square feet. Now, subtract the area of the door and window: $400 - 60 = 340$ square feet of wall surface needs to be painted.

22. (F) **Mathematics/Algebra and Functions/Solving Simultaneous Equations and Evaluating, Interpreting, and Creating Algebraic Functions/Functions as Models and Geometry/Rectangles and Squares.** CCRS: ADV.A.4. CC: HSA-CED.A.3. Translate the description of the rectangle into a system of equations, where l represents the length and w represents the width. The length is 5 inches longer than the width, so $l = w + 5$ and the perimeter is 40 inches, so $40 = 2l + 2w$. Substitute $w + 5$ for l in the perimeter equation

and solve for w : $40 = 2l + 2w = 2(w + 5) + 2w = 2w + 10 + 2w = 4w + 10 \Rightarrow w = \frac{40 - 10}{4} = \frac{30}{4} = \frac{15}{2} = 7.5$ inches.

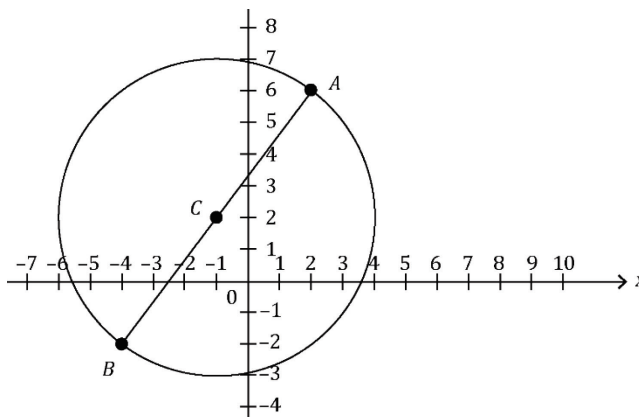
23. (C) **Mathematics/Number and Quantity/Percentages and Solving Algebraic Equations or Inequalities with One Variable/Simple Equations.** CCRS: BSC.AF.1. CC: 7.RP.A.3. According to the item stem, 8% of 60 is equal to $\frac{1}{5}$ of some number, let's call it x . Therefore, $0.08(60) = \frac{x}{5} \Rightarrow x = 5(0.08)(60) = 24$.

TIP Estimate and eliminate unreasonable answers. Without creating an equation for the percentage and solving for the unknown, you can still eliminate several obviously wrong answers. Let's estimate using 10% of 60, which is 6. Now, 6 is $\frac{1}{5}$ of 30, so 8% of 60 is $\frac{1}{5}$ of a number a little less than 30. Of the answers, only (C), 24, could possibly be correct.

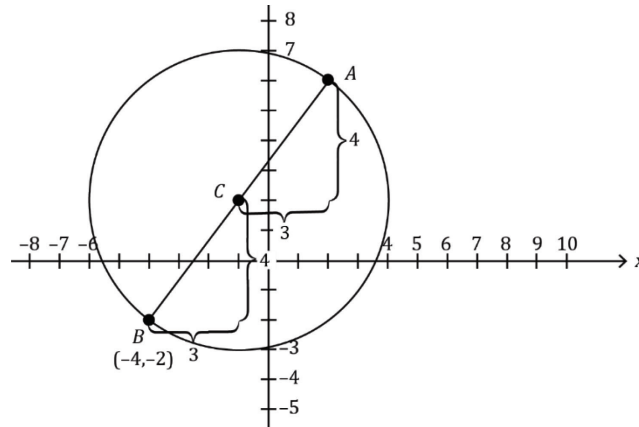
24. (J) **Mathematics/Algebra and Functions/Solving Algebraic Equations or Inequalities with One Variable/Simple Inequalities.** CCRS: AVG+.AF.2. CC: 6.EE.B.8. In order for the season pass to cost less than the cost of individual tickets (\$14 per game), the cost of the season pass (\$175) must be less than \$14 x , where x is the number of games: $175 < 14x$. Therefore, $x > \frac{175}{14} = 12.5$, so the minimum number of games for which the season pass is less than buying individual tickets is 13 games.

25. (A) **Mathematics/Number and Quantity/Scientific Notation.** CCRS: AVG+.A.11. CC: 8.EE.A.4. Even though the expression is presented in scientific notation, the same rules for working with exponents apply. Use them to simplify the given expression: $\frac{4.8 \times 10^{-7}}{1.6 \times 10^{-11}} = \frac{4.8 \times 10^{11}}{1.6 \times 10^7} = \frac{4.8 \times 10^{11-7}}{1.6} = \frac{4.8}{1.6} \times 10^4 = 3 \times 10^4$.

26. (H) **Mathematics/Algebra and Functions/Coordinate Geometry/Graphs of Quadratic Equations and Relations and Distance and Midpoint Formulas.** CCRS: ADV.AF.3. CC: HSG-GPE.B.7. To help conceptualize the problem, draw a sketch of the described circle in the coordinate plane:



To find the coordinates of B , you could use the midpoint formula for the midpoint coordinates of a line segment between two end points (x_1, y_1) and (x_2, y_2) , where these points correspond to A and B , and the midpoint coordinates correspond to the center of the circle C . However, it's simpler to "step" to the left and down to B from C the same number of x - and y -coordinates as A is to the right and up from C :



Therefore, the xy -coordinates of B are $(-4, -2)$.

To use the midpoint formula, create two equations for each of the midpoint coordinates: $\frac{x_2 + x_1}{2} = -1$

and $\frac{y_2 + y_1}{2} = 2$, where (x_1, y_1) are the coordinates of A , $(2, 6)$, and (x_2, y_2) are the coordinates of B .

Therefore, $\frac{x_2 + 2}{2} = -1 \Rightarrow x_2 = -1(2) - 2 = -4$ and $\frac{y_2 + 6}{2} = 2 \Rightarrow y_2 = 2(2) - 6 = -2$.

27. (A) **Mathematics/Algebra and Functions/Manipulating Expressions/Factoring Expressions. CCRS: EXP.A.3. CC: HSA-APR.B.2.** Since $64 = 4^3$, $x^3 - 64 = x^3 - 4^3$, which is the difference of two cubes. Recall that the difference of two cubes, $a^3 - b^3$, is equal to $(a - b)(a^2 + ab + b^2)$. In this case, $a = x$ and $b = 4$. Therefore, $x^3 - 64 = x^3 - 4^3 = (x - 4)(x^2 + 4x + 16)$. Therefore, $x - 4$ is a factor.

TIP Alternatively, apply the “test-the-test” strategy. Use polynomial long division to divide the given expression by the factors in the answer choices—only the correct factor will divide evenly.

A.

$$\begin{array}{r}
 x^2 + 4x + 16 \\
 x - 4 \overline{) x^3 - 64} \\
 \underline{-(x^3 - 4x^2)} \\
 4x^2 - 64 \\
 \underline{-(4x^2 - 16x)} \\
 16x - 64 \\
 \underline{-(16x - 64)} \\
 0
 \end{array}$$

Since $x - 4$ factors evenly into $x^3 - 64$, don't bother testing the remaining choices. (A) must be the correct answer.

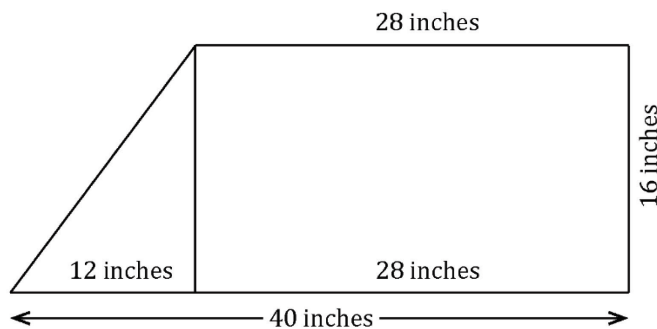
28. (H) **Mathematics/Algebra and Functions/Solving Simultaneous Equations and Evaluating, Interpreting, and Creating Algebraic Functions/Functions as Models and Statistics and Probability/Averages. CCRS: AVG+AF.2. CC: HSA-CED.A.3.** Create a system of equations for the two averages:

average₁ = $\frac{s_1 + s_2 + s_3 + 80}{4} = 90$ and average₂ = $\frac{s_1 + s_2 + s_3 + 96}{4}$. Solve the first equation for

$s_1 + s_2 + s_3$: $\frac{s_1 + s_2 + s_3 + 80}{4} = 90 \Rightarrow s_1 + s_2 + s_3 = 90(4) - 80 = 280$. Therefore, average₂ =

$$\frac{s_1 + s_2 + s_3 + 96}{4} = \frac{280 + 96}{4} = \frac{376}{4} = 94.$$

29. (E) *Mathematics/Number and Quantity/Properties of Numbers*. CCRS: BSC.NS.3. CC: 6.NS.C.6c. If $a = -2.5$, $a^2 = (-2.5)^2 = 6.25$. This point will be slightly to the right (more positive) than 6, as shown by the number line in (E). The point in (A) corresponds to -6.25 ; the point in (B) corresponds to -5 ; the point in (C) corresponds to 2.5 ; and the point in (D) corresponds to 5 .
30. (J) *Mathematics/Number and Quantity/Basic Arithmetic Manipulations*. CCRS: BSC.AF.1. CC: 7.EE.B.3. If Maria ate $\frac{2}{9}$ of the pizza, $\frac{7}{9}$ remains. Divide $\frac{7}{9}$ by 3 to determine the fraction of the whole pizza that each of the 3 brothers receives: $\frac{\frac{7}{9}}{3} = \frac{7}{9(3)} = \frac{7}{27}$.
31. (E) *Mathematics/Number and Quantity/Properties of Numbers*. CCRS: ADV.NS.1. CC: 4.OA.B.4. The item stem states that 1,001 is a product of the prime numbers 7, 11, and 13, so $1,001 = 7(11)(13)$. Find the prime factorization of 30,030 by recognizing that $30,030 = 30(1,001)$. Therefore, $30,030 = 30(7)(11)(13) = (2)(3)(5)(7)(11)(13)$.
32. (G) *Mathematics/Geometry/Triangles/Properties of Triangles and Rectangles and Squares*. CCRS: AVG+.G.6. CC: 6.G.A.1. This question asks you to find the area of the park, represented by a quadrilateral, which is comprised of a triangle and a rectangle:



So, the area of the quadrilateral is $Area_{\text{triangle}} + Area_{\text{rectangle}} = \frac{1}{2}(\text{base})(\text{height}) + (\text{width})(\text{length}) =$

$$\frac{1}{2}(12 \text{ inches})(16 \text{ inches}) + (16 \text{ inches})(28 \text{ inches}) = 96 + 448 = 544 \text{ square inches.}$$

33. (E) *Mathematics/Geometry/Triangles/Pythagorean Theorem and Complex Figures, and Number and Quantity/Rates and Proportions*. CCRS: AVG+.G.5. CC: 7.G.A.1. To determine the perimeter of the park, first determine the unknown side length, which is the hypotenuse of the triangle that combined with the rectangle make up the park's quadrilateral shape (as shown in the previous item). To find the hypotenuse h of the right triangle, use the Pythagorean theorem: $h^2 = 12^2 + 16^2 \Rightarrow h = \sqrt{12^2 + 16^2} =$



$\sqrt{144+256} = \sqrt{400} = 20$ inches. So, the perimeter of the quadrilateral, in inches, is $28 + 16 + 40 + 20 = 104$. However, the item stem asks for the perimeter in feet, so apply the given conversion ratio of

$$1 \text{ inch} = 1.5 \text{ feet: } 104 \text{ inches} \left(\frac{1.5 \text{ feet}}{1 \text{ inch}} \right) = 156 \text{ feet.}$$

34. (H) *Mathematics/Number and Quantity/Percentages*. CCRS: **AVG.AF.1**. CC: **7.RP.A.3**. To find what percentage the length of the south side of the park is of the length of the north side, use the “is-over-of” equation for percentages, cross-multiply, and solve for the percentage: $\frac{\text{is}}{\text{of}} = \frac{\%}{100} \Rightarrow \frac{40}{28} = \frac{\%}{100} \Rightarrow \% =$

$$\frac{40}{28}(100) = \frac{10}{7}(100) = 142\frac{6}{7}\%.$$

35. (C) *Mathematics/Geometry/Rectangles and Squares*. CCRS: **AVG.G.5**. CC: **7.G.A.1**. The width of the walkway around the cabin is equal to half the difference between 36 feet and 30 feet: $\frac{36-30}{2} = \frac{6}{2} = 3$ feet. Therefore, the total area of the walkway is $2(36[3]) + 2(24[3]) = 216 + 144 = 360$ square feet.

36. (J) *Mathematics/Number and Quantity/Basic Arithmetic Manipulations*. CCRS: **BSC.AF.2**. CC: **7.EE.B.3**. The total cost is the sum of the curtain costs and the ceiling fan costs. There are 4 windows, 3 of which are small and 1 is large: the small window curtains are \$39.50 each and the large window curtain is

twice the cost of the small. So, the curtain costs are $3 \text{ small windows} \left(\frac{\$39.50}{\text{small window}} \right) +$
 $1 \text{ large window} \left(\frac{2(\$39.50)}{\text{large window}} \right) = \$118.50 + \$79 = \197.50 . According to the figure, there are 3 rooms

in the cabin, so the total fan costs are $3 \text{ fans} \left(\frac{\$52}{\text{fan}} \right) = \156 . Therefore, the total costs are $\$197.50 + \$156 = \$353.50$. Rounded to the nearest whole dollar, the total costs are \$354.

37. (A) *Mathematics/Statistics and Probability/Probability*. CCRS: **ADV.SP.5**. CC: **7.SP.C.8a**. According to the last sentence of the introductory information, the chance of rain each day of the week is 20%. Therefore, the chance that it will rain two days in a row is equal to the product of the probability on each of the two days: $(20\%)(20\%) = (0.2)(0.2) = 0.04$.

38. (K) *Mathematics/Number and Quantity/Properties of Numbers*. CCRS: **ADV.NS.4**. CC: **8.EE.A.2**. Irrational numbers are real numbers not constructed from ratios of integers (which are rational numbers). Since $\sqrt{8} = \sqrt{2(4)} = 2\sqrt{2}$, replace $\sqrt{8}$ with $2\sqrt{2}$ in each of the answer choices and simplify. Only the correct choice will NOT be a ratio of two integers:

F. $\frac{\sqrt{2}}{\sqrt{8}} = \frac{\sqrt{2}}{2\sqrt{2}} = \frac{1}{2}$ ✗

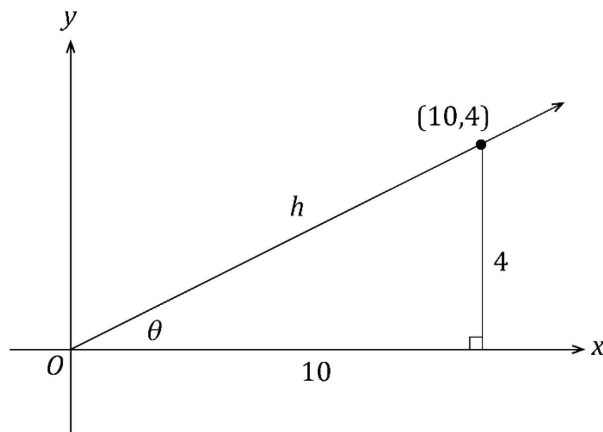
G. $\frac{\sqrt{8}}{\sqrt{2}} = \frac{2\sqrt{2}}{\sqrt{2}} = 2$ ✗

H. $(\sqrt{8})^2 = (2[\sqrt{2}])^2 = 2^2(\sqrt{2})^2 = 4(2) = 8$ ✗

J. $\sqrt{2} \times \sqrt{8} = \sqrt{2}(2\sqrt{2}) = 2(2) = 4$ ✗

At this point, don't bother evaluating the last choice—it must be correct since the other four choices are rational numbers. And indeed, (K) is an irrational number: $\sqrt{2} + \sqrt{8} = \sqrt{2} + 2\sqrt{2} = \sqrt{2}(1 + 2) = 3\sqrt{2}$.

39. (D) *Mathematics/Geometry/Trigonometry/Definitions of the Six Trigonometric Functions*. CCRS: ADV.G.4. CC: HSG-SRT.C.8. For this item, identify which of the trigonometric functions utilizes the information presented and requested in the item stem:



The lengths of the sides opposite and adjacent to the θ angle are given and the item stem asks for the value of $\tan \theta$. Recall that $\tan \theta = \frac{\text{Length of the Side Opposite } \theta}{\text{Length of the Side Adjacent } \theta}$. Therefore, $\tan \theta = \frac{4}{10} = \frac{2}{5}$.

TIP Remember the definitions of sine, cosine, and tangent using the mnemonic SOH-CAH-TOA:

$$\text{Sine} = \frac{\text{Opposite}}{\text{Hypotenuse}}; \text{Cosine} = \frac{\text{Adjacent}}{\text{Hypotenuse}}; \text{and } \text{Tangent} = \frac{\text{Opposite}}{\text{Adjacent}}.$$

40. (K) *Mathematics/Algebra and Functions/Solving Algebraic Equations or Inequalities with One Variable/Equations Involving Absolute Value*. CCRS: EXP.A.1. CC: HSA-REI.B.3. Isolate the absolute value expression on one side of the equality: $|2x - 8| + 3 = 5 \Rightarrow |2x - 8| = 5 - 3 = 2$. Now, write the two derived equations using the definition of absolute value: $2x - 8 = 2$ and $2x - 8 = -2$. This eliminates (F), (H), and (J). To choose between (G) and (K), note that $2x - 8 = -2$ is the same as $-(2x - 8) = 2$. Therefore, (K) is the correct pair of equations.
41. (A) *Mathematics/Statistics and Probability/Data Representation/Tables*. CCRS: PRE.SP.2. CC: 8.SP.A.4. The table gives the cumulative number of students as a function of score range. The word “cumulative” indicates that each successive count includes the previous count. So, the 65-80 interval includes the 65-70 interval, and the difference corresponds to the 71-80 interval. Since the count for the 65-70 interval is 12 and the count for the 65-80 interval is 13, the difference, which corresponds to the 71-80 interval, is a count of $13 - 12 = 1$. Therefore, 1 student has a test score in the interval 71-80.
42. (G) *Mathematics/Algebra and Functions/Manipulating Algebraic Expressions/Logarithmic Expressions*. CCRS: EXP.F.7. CC: HSF-BF.B.5. According to the item, the number of decibels d produced by a sound of intensity I is given by the logarithmic equation $d = 10 \log \left(\frac{I}{K} \right)$, where K is a constant. The item stem asks for the number of decibels produced by a sound of intensity 1,000 times K , or $1,000K$. Substitute $1,000K$ for K in the equation and evaluate: $d = 10 \log \left(\frac{I}{K} \right) = 10 \log \left(\frac{1,000K}{K} \right) = 10 \log(1,000)$. If you remember the



definition of logarithms, you'll know that $\log(1,000) = 3$, so $10\log(1,000) = 10(3) = 30$. Otherwise, use your calculator to determine the value of $10\log(1,000)$.

TIP The logarithmic function $y = \log_a x$ is defined to be equivalent to the exponential equation $x = a^y$. If the a subscript is not included, it is presumed to be 10. Therefore, $\log x = y$ is the power that 10 must be raised to equal x .

43. (C) **Mathematics/Numbers and Quantity/Percentages and Statistics and Probability/Data Representation/Tables. CCRS: AVG.AF.1. CC: 7.RP.A.3.** The table gives the number of three types of attempted and the percentages of each successful shot type. Convert each percentage to a number of successful shots:

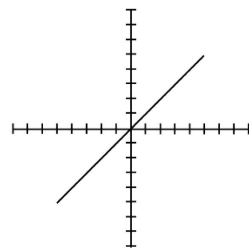
$$1\text{-point: } 0.75(80) = 60$$

$$2\text{-point: } 0.9(60) = 54$$

$$3\text{-point: } 0.25(60) = 15$$

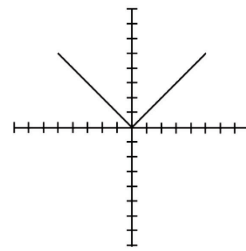
Therefore, the total number of points is $1(60) + 2(54) + 3(15) = 60 + 108 + 45 = 213$.

44. (F) **Mathematics/Algebra and Functions/Coordinate Geometry/Graphs of Linear Equations. CCRS: EXP.AF.6. CC: HSG-CO.A.2.** The graphs of $y = x$ and $y = |x|$ are both graphs with which you should be familiar:



$$y = x$$

The identity function



$$y = |x|$$

The absolute value function

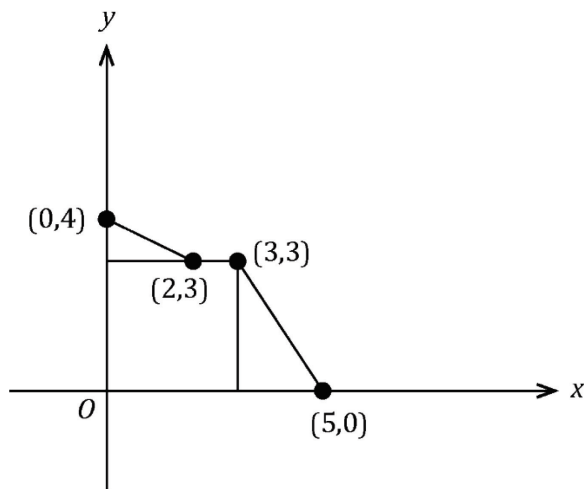
To determine how the graph $y = |x|$ changes with the transformation $y = |x - 6|$, consider how the vertex of the graph $y = |x|$ changes with $y = |x - 6|$. The vertex is the value for which $y = 0$, so set the expression in the absolute value equal to 0: $x = 0$ and $x - 6 = 0 \Rightarrow x = 6$. The difference between $x = 0$ and $x = 6$ is a translation to the right of 6 coordinate units. Therefore, (F) must be the correct answer.

TIP Recall that for the general form of an absolute value equation $f(x) = a|(x - h)| + k$, the variable a is an indication of how far the graph stretches vertically, while the variables h and k indicate how far the graph shifts horizontally and vertically, respectively.

45. (A) **Mathematics/Geometry/Solids and Complex Figures. CCRS: ADV.G.1. CC: 7.G.B.6.** The volume of the solid toy soldier is equal to the volume of water displaced when it is submerged in water. Before the toy was submerged, the volume of water in the container is equal to the product of the length and width of the container and the height of the water: $(\text{length})(\text{width})(\text{height}) = (8)(6)(4) = 192 \text{ cm}^3$. After the toy is submerged, the volume is $(8)(6)(6.6) = 316.8 \text{ cm}^3$. The volume of the toy is equal to the difference between the two volumes: $316.8 - 192 = 124.8 \approx 125 \text{ cm}^3$.

TIP This Mathematics problem requires basic science knowledge: the volume of an object is equal to the volume of displaced water when the object is submersed in water.

46. (J) **Mathematics/Geometry/Solids and Complex Figures. CCRS: EXP.G.5. CC: HSG-GMD.A.3.** The item asks for the expression that gives the volume of the box filled with packing material, which corresponds to the difference in volume between the cube and the cylinder. The volume of the box is $(\text{side})^3 = (18)^3 \text{ in}^3$ and the volume of the cylinder is $\pi(\text{radius})^2(\text{height}) = \pi(6)^2(12) \text{ in}^3$. Therefore, the volume filled with packing material, in cubic inches, is $18^3 - \pi(6)^2(12)$.
47. (B) **Mathematics/Geometry/Rectangles and Squares. CCRS: AVG+G.6. CC: 7.G.B.6.** The item stem asks for the area of the floor in square yards, but the length and width are given in units of feet. Convert the measurements to yards: $15 \text{ feet} \left(\frac{1 \text{ yard}}{3 \text{ feet}} \right) = 5 \text{ yards}$ and $21 \text{ feet} \left(\frac{1 \text{ yard}}{3 \text{ feet}} \right) = 7 \text{ yards}$. Therefore, the area of the floor, in square yards, is $(5)(7) = 35$.
48. (G) **Mathematics/Statistics and Probability/Data Representation/Bar, Cumulative, and Line Graphs. CCRS: AVGT.AF.3. CC: 6.SP.B.5a.** Compare the fares on the two graphs for a 5-mile trip. Notice in the graphs that solid circles represent a data point, but empty circles do not—the fare increases a whole dollar with each whole mile traveled. The ABC Cabs graph shows the fare for 5 miles is \$12 and the Tary Taxicabs graph shows the fare for 5 miles is \$9. Therefore, the cheaper fare of the two companies is \$9.
49. (B) **Mathematics/Geometry/Complex Figures, Triangles/Properties of Triangles, Rectangles and Squares and Coordinate Geometry/The Coordinate System. CCRS: EXP.G.5. CC: HSG-GPE.B.7.** Break up the area of the region bounded by the function $f(x)$ and the positive x -axis and y -axis into two triangles and rectangles:



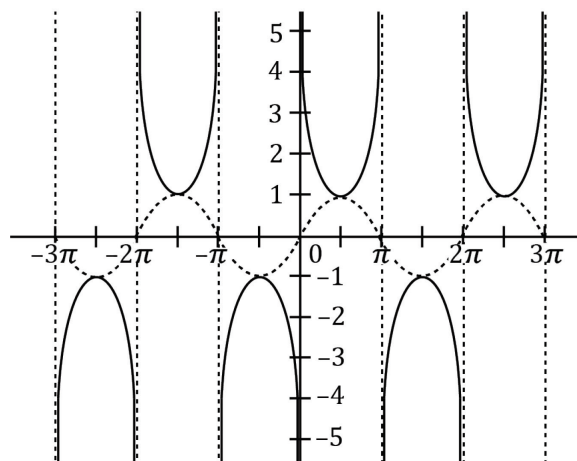
The bounded area has an area equal to the sum of the areas of the two triangle and the area of the square. The area of a triangle is $\frac{(\text{base})(\text{height})}{2}$ and the area of a square is $(\text{side})^2$. Therefore, the bounded area, in square coordinate units, is $\frac{(2-0)(4-3)}{2} + \frac{(5-3)(3-0)}{2} + (3-0)^2 = \frac{2(1)}{2} + \frac{2(3)}{2} + 9 = 1 + 3 + 9 = 13$.



50. (J) *Mathematics/Algebra/Solving Quadratic Equations and Relations and Solving Simultaneous Equations and Evaluating, Interpreting, and Creating Algebraic Functions/Functions as Models. CCRS: ADV.A.5. CC: HSA-REI.B.4b.* Create a system of simultaneous equations, where x represents the lesser number and y represents the greater number: $x + y = 151$ and $x = 19 + \sqrt{y}$. Solve the second equation for y : $x = 19 + \sqrt{y} \Rightarrow \sqrt{y} = x - 19 \Rightarrow y = (x - 19)^2 = (x - 19)(x - 19) = x^2 - 38x + 361$. Substitute the quadratic expression for y in the first equation and rewrite in standard quadratic form: $x + y = 151 \Rightarrow x + x^2 - 38x + 361 = 151 \Rightarrow x^2 - 37x + 210 = 0$. Since it's not immediately evident how to factor the quadratic equation to solve for x , use the quadratic formula: if $ax^2 + bx + c = 0$, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. So, $x = \frac{-(-37) \pm \sqrt{(-37)^2 - 4(210)}}{2} = \frac{37 \pm \sqrt{529}}{2} = \frac{37 \pm 23}{2} = 30$ and 7 . Substitute each of these into the first equation to find the corresponding values for y : $y = 151 - 30 = 121$ and $y = 151 - 7 = 144$. Finally, subtract the corresponding x -values since the item stem asks for the difference between the greater and lesser numbers: $121 - 30 = 91$ and $144 - 7 = 137$. Only 91 is given in the answer choices, so 91 must be the correct answer.
51. (C) *Mathematics/Statistics and Probability/Measures of Center. CCRS: EXP.SP.1. CC: 6.SP.B.5c.* The median of a set of numbers is the middle value when the numbers are arranged in ascending or descending order (or the average of the two middle values if the set has an even number of values). The mode of a set of numbers is the value with the greatest frequency. Since the median of the numbers 41, 35, 30, X , Y , 15 is 25, the average of 30 and X is 25, which means X is 20. Since the mode is 15, Y must also be 15. Now, calculate the mean (or average): $\frac{41 + 35 + 30 + 20 + 15 + 15}{6} = \frac{156}{6} = 26$.
52. (F) *Mathematics/Algebra/Solving Quadratic Equations and Relations and Solving Simultaneous Equations. CCRS: ADV.A.5. CC: HAS-REI.C.6.* Substitute x^2 for y in the second equation and rewrite it in standard quadratic form: $rx + sy = t \Rightarrow sx^2 + rx - t = 0$. The solutions to the quadratic are given by the quadratic formula: if $ax^2 + bx + c = 0$, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. Therefore, $x = \frac{-r \pm \sqrt{r^2 - 4s(-t)}}{2s} = \frac{-r \pm \sqrt{r^2 + 4st}}{2s}$. This will return two real number values for x only if the discriminant (the expression under the square root) is greater than 0. Therefore, $r^2 + 4st > 0$.
- TIP** Recall that if the discriminant from the quadratic formula, $b^2 - 4ac$ is positive, the quadratic equation will have two real solutions. If the discriminant is equal to 0, the quadratic has only one real solution. And if the discriminant is less than 0, the quadratic has no real solutions (the solutions are imaginary numbers).
53. (A) *Mathematics/Algebra and Functions/Evaluating Sequences. CCRS: ADV.F.3. CC: HSF-BF.A.2.* An arithmetic sequence has a constant difference between consecutive terms. The arithmetic sequence formula is $a_n = d(n - 1) + a_1$, where n is the number of the term, d is the difference between terms, and a_1 is the first term. Since the 3rd term is 13 and the 4th term is 18, we know the difference between consecutive terms is $18 - 13 = 5$, and the 2nd term is $13 - 5 = 8$ and the 1st term is $8 - 5 = 3$. Therefore, the 50th term is $d(n - 1) + a_1 = 5(50 - 1) + 3 = 5(49) + 3 = 248$.
54. (H) *Mathematics/Geometry/Trigonometry/Trigonometric Relationships and Graphs of Trigonometric Functions. CCRS: EXP.F.6. CC: HSF-TF.B.5.* To answer this item, recall the trigonometric identity

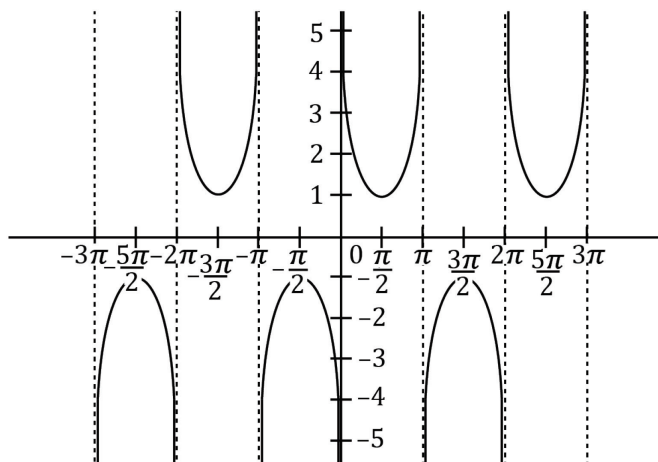
$\sin^2 x + \cos^2 x = 1$. Therefore, $y = \sin^2 x + \cos^2 x = 1$ for all values of x over the domain $-\frac{\pi}{2} \leq x \leq \frac{\pi}{2}$, which is represented by a horizontal line segment at $x = 1$ in the xy -coordinate plane, as in (H).

55. (E) *Mathematics/Geometry/Trigonometry/Graphs of Trigonometric Functions*. CCRS: EXP.F.5. CC: HSF-TF.B.5. A graph of the sine function $y = A\sin(Bx + C) + D$ has an amplitude A , a period $\frac{2\pi}{B}$, a phase shift $-\frac{C}{B}$, and a vertical shift D . The sine function has a period of 2π and the cosecant function is the reciprocal of the sine function:



The graph of the cosecant function shows that it has the same period as the sine function. Since the period of $y = \sin(4x)$ is $\frac{2\pi}{B}$ where $B = 4$, the period of $y = \csc(4x)$ is also $\frac{2\pi}{B} = \frac{2\pi}{4} = \frac{\pi}{2}$.

TIP You can also solve this item by using your graphing calculator to graph the function $y = \csc(4x)$ and identifying the period of the function from the resulting graph:



56. (H) *Mathematics/Statistics and Probability/Probability*. CCRS: AVG+.SP.3. CC: 7.SP.C.7a. The total number of points awarded on any toss of the coins is equal to the sum of the points for each coin that



lands faceup, which for each coin is equal to the product 3 and the probability that the coin lands faceup, which is one-half. Therefore, the total point count is $3\left(\frac{1}{2}\right) + 3\left(\frac{1}{2}\right) + 3\left(\frac{1}{2}\right) = 3\left(\frac{3}{2}\right) = \frac{9}{2}$.

57. (B) *Mathematics/Number and Quantity/Matrices and Vectors and Algebra and Functions/Solving Quadratic Equations and Relations. CCRS: EXP.NS.6. CC: HSA-REI.B.4b.* According to the item stem, the determinant of a 2×2 matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is $ad - bc$. So, the determinant of the matrix $\begin{bmatrix} k & 4 \\ 3 & k \end{bmatrix}$ is

$k(k) - 4(3) = k^2 - 12$. Set this equal to k and rewrite it in standard quadratic form:

$k^2 - 12 = k \Rightarrow k^2 - k - 12 = 0$. Either factor using the reverse FOIL method or the quadratic formula. In this case, the factor pattern is easily discernable: $k^2 - k - 12 = (k - 4)(k + 3) = (k - 4)(k + 3)$. Double-check by multiplying the binomials: $(k - 4)(k + 3) = k^2 + 3k - 4k - 12 = k^2 - k - 12$. Since this checks, the possible values for k are 4 and -3 . The item stem asks for the positive real value of k , so 4 must be the correct answer.

58. (F) *Mathematics/Number and Quantity/Complex Numbers. CCRS: EXP.NS.4. CC: HSN-CN.A.2.* Work out the first several values for i^n , where $i^2 = -1$:

$$i^0 = 1$$

$$i^1 = \sqrt{i^2} = \sqrt{-1}$$

$$i^2 = -1$$

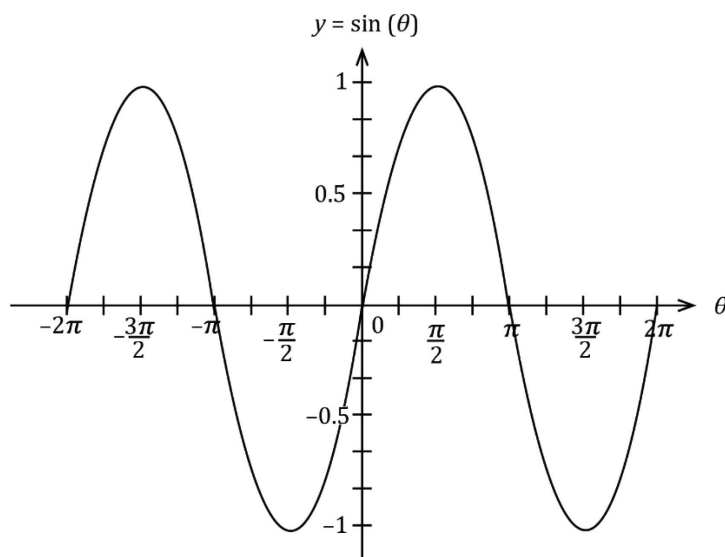
$$i^3 = i(i^2) = \sqrt{-1}(-1) = -\sqrt{-1}$$

$$i^4 = (i^2)^2 = (-1)^2 = 1$$

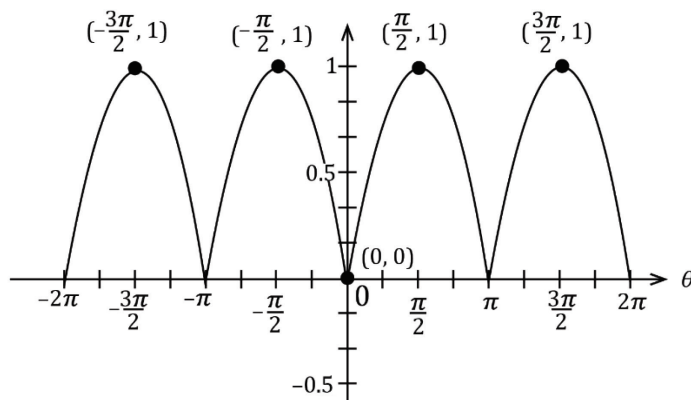
$$i^5 = i(i^4) = i(1) = \sqrt{-1}$$

And so on, as the values repeat from i^0 through i^3 . Looking at these values, we see that $i^n = 1$ for i^0 , i^4 , i^8 , i^{12} , etc. Now, check the answer choices, starting with (F): if n is divided by 4, the remainder is 0 and this is true for $n = 0, 4, 8, 12$, etc. Don't bother checking the remaining choices. (F) must be the correct answer.

59. (A) *Mathematics/Geometry/Trigonometry/Graphs of Trigonometric Functions*. CCRS: EXP.F.5. CC: HSF-TF.B.5. First, start with the graph of the sine function, $y = \sin \theta$:



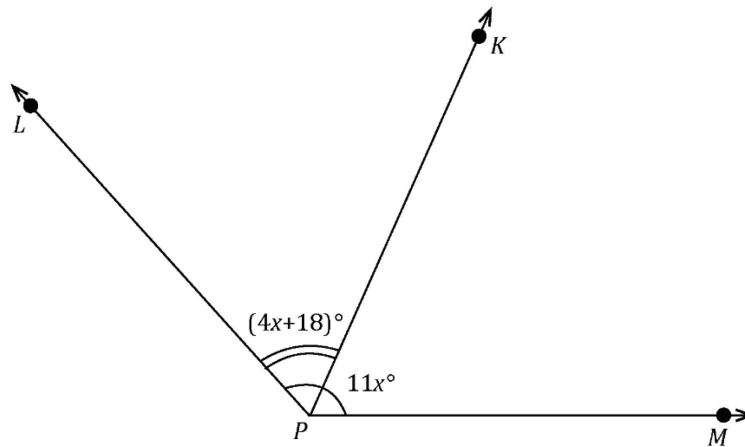
And the graph of $|\sin \theta|$ is as follows:



This graphs shows that for $-\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2}$, $|\sin \theta|$ is never greater than 1, but it is equal to 1 for value of θ equal to $-\frac{\pi}{2}$ and $\frac{\pi}{2}$.



60. (K) *Mathematics/Geometry/Lines and Angles*. CCRS: AVG+.G.1. CC: 7.G.B.5. Draw a sketch of the given information:



Since ray \overline{PK} bisects $\angle LPM$, $2(4x + 18)^\circ = 11x^\circ$, so $8x + 36 = 11x \Rightarrow 36 = 11x - 8x = 3x \Rightarrow x = \frac{36}{3} = 12$.

And $\angle KPM = \angle LPK = (4x + 18)^\circ = (4[12] + 18)^\circ = (48 + 18)^\circ = 66^\circ$.

ACT READING TEST EXPLANATIONS

Passage I

1. **(A) Reading/Craft and Structure/Main Idea.** This question asks for the best description of the person telling the story, which is really asking about the main idea of the story the narrator tells. The passage does not say that the narrator won competitions early in the season (he lost them), nor does it chronicle his swimming career from childhood to high school, so (C) and (D) can be eliminated. While the narrator does try out for the Junior Nationals and remembers the missed opportunities that led him to this event, (B), the narrator isn't only remembering these events and the swim, he explains how they served as motivation in the swim, so the best answer is (A).
2. **(G) Reading/Key Ideas and Details/Development.** This question asks for the event that took place first—not the one that was mentioned in the passage first. Most of the story describes the swim race, and standing at the blocks at the Sunday time trial, (F), and hearing a boy from the rival school cheering the narrator on, (J), are part of the swim race. The 500-yard freestyle, though, happened the day before this meet (lines 5–7), so (H) happened before (F) and (J). The narrator breaks up the story of the swim race to remember something that happened in late September the year before (lines 44–45): On “that day” (line 54), the narrator jumped out over the diving well, so chronologically, (G) happened before (H), making (G) the best answer.



Often, stories are not told in chronological order, so when a question asks about chronology, often the best way to find the right answer is to look for flashbacks to a previous time.

3. **(A) Reading/Craft and Structure/Development.** When the narrator begins his swim race, he wasn't just the only one in the race, he was “practically the only one in the natatorium” (lines 22–24). In the previous paragraph, the narrator states that he believed a win was possible under the “right confluence of circumstances” (line 19), which included an “energetic meet” (line 20). Without people, there wouldn't be much energy, so (B) is wrong, and the narrator didn't believe that he could go any faster than he did the previous day in the race he lost (lines 25–27), meaning the narrator did not have a rush of energy before the race, so (D) is also wrong. As for (C), the lack of spectators has no bearing on the coach's pacing with the sound of the horn, so it is also wrong. The lack of people, and thus the lack of energy, is a direct contradiction to the narrator's “right confluence of circumstances,” illustrating that the race doesn't meet the ideal conditions, (A).
4. **(J) Reading/Key Ideas and Details/Explicit Detail.** The narrator states that for the Junior Nationals, he is swimming the 1,000-yard freestyle (lines 16–17), which means that the swim race that most of the rest of the passage describes refers to that race, so when the narrator says that sometimes a moment makes the “world slow[] down” (line 38), allowing the “opportunity to reflect in real-time rather than retrospect” (lines 39–40), this description describes his “moment”: the 1,000-yard freestyle race. The passage explicitly states that time slowed down, not sped up, so (F) and (G) are wrong. And, while (H) does use the correct answer that time slowed down, the passage states that this time allows the opportunity to reflect, not move in slow motion, so (J) is the best answer.
5. **(C) Reading/Key Ideas and Details/Explicit Detail.** In the last paragraph, the narrator makes profound observations about the time trial, about swimming, and about life. He states that “if no one else cared, then the swim was [his] alone” (lines 72–73) because it was what he wanted “now.” The narrator didn't train for this time trial for a year because it was “thrown together at the last minute” (line 11), so (B) can be eliminated. While the narrator does say that practicing for races was “in pursuit of an end that seemed always one step farther on” (lines 78–79), and that swimming “is a constant choice between the now and the later” (lines 75–76), he also says that he had “long understood” (line 75) these things, so he



wasn't understanding them for the first time, so (A) and (D) are also wrong. Instead, the narrator realized how "little" the swim mattered in the world; it was important only to him, (C).

6. **(G) Reading/Key Ideas and Details/Vocabulary.** At the beginning of the passage, the narrator describes several races he had lost that had prevented him from qualifying for the Junior Nationals: He had lost the day before, and he missed the cut the previous year. In line 80, then, the narrator uses the "end" to describe his last chance to make the Junior Nationals, (G). Since the narrator wants to win this race to qualify for another, it is not his final pursuit of fitness, so (F) can be eliminated. While in the sentences that precede the use of "end" in line 80 do remember Friday night practices, in this sentence, the narrator shifts back to the race, so the "end" does not refer to the Friday practices or his memory of them and (H) can also be eliminated. As for (J), the last sentences of the passage, after the use of "end," describe how the narrator "cashed in" all his energy to sprint and win the race, which means he didn't realize he won until after his use of "end," so (J) is also wrong.
7. **(D) Reading/Key Ideas and Details/Explicit Detail.** In the first paragraph, the author describes the time trial in Houston as "an informal, unadvertised event thrown together at the last minute" (lines 10–11), (D). The passage states that the only races that were swum were those "the swimmers requested to swim," most of which were sprints (lines 12–13), so (A) and (C) are wrong, and while the narrator does say that this time trial is his last chance at qualifying for Junior Nationals, he also says that the time trial was unadvertised, so (C) is also wrong.



The correct answer for an Explicit Detail item will, as the name states, be stated explicitly in the passage, so look for specific words or phrases in the item stem or answer choices that are also found in the passage.

8. **(H) Reading/Craft and Structure/Implied Idea.** In the sentences before the statement in question, the "boy from a rival high school" (line 31) is introduced, but this boy does not actually make this statement. Rather, the narrator infers or speculates the meaning of the boy's finger pointing, (H). (F) and (G) attribute the statement to the boy, so they are both wrong, and there is nothing in the passage to indicate that the narrator was angry and was contemplating a response, so (J) is also wrong.
9. **(C) Reading/Key Ideas and Details/Explicit Detail.** At the end of the fourth paragraph, the narrator remembers the last time he practiced in an outdoor pool before spending the rest of the season in a "dank and moldy indoor pool" (line 48). The word "dank" refers to an overly moist area, which usually creates "mold"—neither of which describe a productive or liberating environment, so (A) and (B) can be eliminated. While these descriptions are certainly not appealing, it's not clear how they would cause less competition or who would be engaging in said (less) competition, so (D) is also wrong. A "dank and moldy indoor pool" is less appealing than the "open sky" (line 47), (C).
10. **(F) Reading/Key Ideas and Details/Development.** In the last paragraph of the passage, the narrator shifts back from his memory of catching the flag line to the race at hand. When he hears the word "Jump!" he was "thinking about that day" (line 66), so he was remembering his teammates calling out the same thing (line 58), most likely using that memory as motivation, (F). Because at this point in the trial the narrator had already dove off the blocks and into the water (line 24), he wouldn't be shouting "Jump!" nor would the boy cheering him on, so (G) and (H) are wrong. And, a horn started his race that day (line 24), not the words "Jump!" so (J) is also wrong.

Passage II

11. **(D) Reading/Craft and Structure/Development.** The first paragraph of Passage A introduces Valivov and the central Asian crossroads of Alma-Ata Kazakhstan, and the phrases in question describe where you find apples in this region's mountains. "Thickets" shows that apples were found in large numbers that "stretched every direction" and created a colorful and "extensive forest" of apples. The volume or

- magnitude of the apples is emphasized, so it must have been stunning, (D). These phrases deal with apples found in the mountains, not the mountains themselves, so (A) is wrong, and there is no mention of difficulty in distinguishing between apple varieties, so (B) is also wrong. As for (C), these phrases focus on the variety and magnitude of apples, not plant species in general, so (C) is also wrong.
12. **(G) Reading/Integration of Knowledge and Ideas/Implied Idea.** The answer to this question can be found in the surrounding context around the statement in question. In lines 17–19, the author states that the domesticated apples Valivov found in the Alma-Ata looked like those in grocery stores, and the previous sentence states that Valivov thought he had found the modern apple’s ancestor in the Tian Shan mountains. Since modern apples are those found in grocery store, it can be inferred that the author makes this comparison to support the previous point of finding the modern apple’s ancestor, (G). There is no information provided in the passage that supports Tian Shan apples being harvested for grocery stores, that Tian Shan apples are among the most popular, or that Valivov found new apple varieties, so (F), (H), and (J) are wrong.
13. **(D) Reading/Key Ideas and Details/Explicit Detail.** In the last paragraph of Passage A, the details from each answer choice are provided. All answer choices present the information provided in different ways, so students need to find the answer that matches the way it is presented in the passage. At least “157 other plant species found in Kazakhstan are either direct precursors or wild relatives of domesticated crops, including 90 per cent of all cultivated temperate fruits” (lines 32–36). This means that 157 plant species are descendants of domesticated crop, and 90 percent of those crops are cultivated temperate fruits. (A) attributes the 157 not to plant species, but to the cultivated temperate fruits, and (B) is wrong for a similar reason: It attributes the 90 percent to the plant species, not to the cultivated temperate fruits. (C) says that 90 percent are apples, which is only one type of fruit, so it is also wrong. Only (D) correctly represents the information the way it is presented in the passage.
14. **(J) Reading/Key Ideas and Details/Explicit Detail.** In Passage B, Valivov is introduced in the first paragraph, but the detail the question asks for is found near the end of the next paragraph. After moving from Valivov to the importance of knowing where food comes from, the author loops back to Valivov to introduce why he was “personally motivated to become an agricultural scientist” (lines 67–68): He witnessed “several famines during the czarist era of Russia” (lines 68–69) and hoped “the number of Russian families suffering from hunger might be reduced” (lines 72–73), (J). The passage doesn’t state that Valivov wanted to be published or famous, so (F) and (G) are wrong, and it also doesn’t state that he suffered from a personal financial crisis, so (H) is also wrong.
15. **(A) Reading/Craft and Structure/Development.** “Whittle away” means to gradually reduce an amount, and in the last paragraph of Passage B, the author uses statistics to show how apple varieties have been “whittled away” in North America. Because the question doesn’t ask about the numbers, the answer lies in what the numbers represent: the number of apple varieties gradually lost from “nursery catalogs, farmer’s markets, and the American table” (lines 87–89), (A). “Whittled away” doesn’t mean to modify or weed out, so (B) and (C) can quickly be eliminated, and while “pared down” is closer in meaning to “whittle away,” there is no mention of nursery catalogs only wanting to feature a few varieties, so (D) is also wrong.
16. **(G) Reading/Craft and Structure/Vocabulary.** In lines 82–83, some 16,000 apple varieties have been “named and nurtured.” Apples can’t be “encouraged” and it’s not clear what they would be nominated for, so (F) can be eliminated. Apples also can’t be fed, so (J) is also wrong. As for (H), there isn’t enough context to know why the apples are being pointed to or what they are being groomed for, so it is also wrong. The best way to show that the apple varieties were named and nurtured or cared for to be able to have such a large number is “identified” and “cultivated,” (G).
17. **(B) Reading/Key Ideas and Details/Implied Idea.** The third paragraph of Passage B speaks to the return to “centers of crop diversity,” such as forests and orchards, when society “whittles the resistance” in



- these areas to their “breaking point” (lines 78–79). When something is brought or reduced to its breaking point, it is ready to give way, which is a problem. (A) and (C) speak to preferences, not problems, so they can be eliminated. While this paragraph does refer to “plant breeders, pathologists, and entomologists,” the problem is not in a dispute among these people; they are the ones who are researching a way to fix the problem, so (D) is also wrong. In the previous paragraph, the passage states that knowing where our food comes from is of paramount importance in cultivating crops, so when problems arise with a crop, it is most likely that experts concerned with keeping society fed return to the forests and orchards to research the variety, (B).
18. **(H) Reading/Integration of Knowledge and Ideas/Tone.** Passage A details the origins of apples and the “Father of Apples,” Valivov. Its language, such as “thickets of wild apples stretching in every direction, an extensive forest of fruit coloured russet red, creamy yellow, and vibrant pink” (lines 6–8) and “apple seedlings are known to grow up through the cracks in the pavement” (lines 41–42) paint a picture of a region sprawling with beautiful, colorful apples everywhere. Passage B, while also about apples, focuses less on their abundance and beauty and more on the dangers of apple varieties and other plants “whittling away.” Passage A then, has a much more light-hearted approach than Passage B, and “defensive,” (F); “solemn,” (G); and “accusatory,” (J) are all serious tones. The only answer choice that captures the awestruck or celebratory language of Passage A and the caution or warning in Passage B is (H).
19. **(A) Reading/Integration of Knowledge and Ideas/Explicit Detail.** Passage A focuses more on Valivov and his discovery of apples’ ancestry than Passage B, which is focused on the reduction in apple varieties. Neither passage is concerned with the methods Valivov used to prove the ancestry of the apple in the Tian Shan region, so (B) can be eliminated. Both passages use statistics or numbers to show just how many varieties of apples can be found in the Tian Shan region, so (C) can also be eliminated. And while the author of Passage B is more concerned than the author of Passage A with expert research, the author is more concerned with the need for research because the number of diverse crops, including apple varieties, is being reduced, not which regions have the greatest diversity, so (D) is also wrong. The author of Passage B is concerned with the reduction of crops, and apple varieties in particular, while the author of Passage A is more concerned with their abundance in the Tian Shan region, so the best answer is (A).
20. **(H) Reading/Integration of Knowledge and Ideas/Explicit Detail.** The quote from Passage A is referenced in Passage B, but in a different context. Passage B quotes Salova, who explains why Valivov was likely so “amazed” by the apple forest. Salova, then, is paraphrasing or explaining Valivo’s words, (H). The author of Passage B clearly attributes Valivov’s amazement at the apples in the Tian Shan region to Salova’s quote, not his own imagination, so (F) is wrong. And, while Passage B does reference USDA scientists and Bussey, the context in that section (the last paragraph of Passage B) deals with the apple variety reduction, not its abundance that amazed Valivov, so (G) and (J) are also wrong.

Passage III

21. **(C) Reading/Key Ideas and Details/Explicit Detail.** The answer to this question is found in the fifth paragraph that states that Berry’s “geniality might help explain his failure to court history’s favor: it wasn’t in his nature to call attention to himself or his playing” (lines 34–36). Because “failure to court history’s favor” ultimately means he isn’t well-known—a sentiment that echoes an idea presented in the first paragraph: “you’ve never heard of Chu Berry before” (line 12)—Berry’s personality kept him out of the spotlight, (C). No details in the passage support the idea that Berry’s personality was off-putting or that he was misunderstood as a snob, so (A) and (D) are wrong. As for (B), while Berry is described as genial, the passage describes him practicing often and offers no evidence to support the idea that he socialized more than he practiced, so it is also wrong.

22. **(G) Reading/Craft and Structure/Development.** The author mentions Berry’s solo in “Oh, Lady Be Good” in the first paragraph, praising his performance as “no less than the musical personification of mind and body working together in divine tandem” (lines 8–10). There is no mention in this section of Berry’s earlier or later work, nor is there a comparison of Berry’s performance to Count Basie’s, so (H) and (J) can be eliminated. While the author does state that most people haven’t heard of Berry after praising his performance of “Oh, Lady Be Good,” the author uses this praise to show that it’s a “wonder” why Berry isn’t well known, not to show that people don’t know who he is, so (F) is also wrong. The author describes Berry’s “Oh, Lady Be Good” performance to give an example of his strong musicianship, (G).
23. **(D) Reading/Craft and Structure/Explicit Detail.** The first sentence of the second paragraph presents the reason why most people haven’t heard of Berry: “[A] lot of hard-core jazz buffs don’t know much about him” either (lines 13–14). There are no details in the passage to suggest that the author is trying criticize jazz scholarship or show that he knows more than jazz scholars, so (A) and (B) are wrong, and there is no mention of Berry needing secrecy to preserve his family’s privacy, so (C) is also wrong. The author is using the fact that most jazz enthusiasts don’t know much about Berry to show the reader why someone who isn’t a jazz enthusiast wouldn’t know much about him either, (D).
24. **(H) Reading/Key Ideas and Details/Explicit Detail.** The answer to this question is found in the second paragraph. Berry “did not cut many sessions himself . . . and when he soloed, he worked within the recording constraints of the era and swing genre” (lines 17–20): The music was fast moving, and solos lasted a “mere 32 beats” (line 21), (H). The entire passage is focused on praising Berry and explaining why no one knows much about him, despite his musical prowess, so (F) can be eliminated. While the passage does state that Berry often played ensembles, he played these instead of solos to not draw more attention (lines 42–45), so (G) is also wrong. As for (J), there is no information in the passage that mentions Berry preferring short solos to long ones, so it is also wrong.
25. **(D) Reading/Key Ideas and Details/Explicit Detail.** Berry, as described in the passage, played during the era of swing music, that was “fodder for dance parties, not music worthy of study” (line 33), (D). Lines 18–21 explicitly state that the swing genre had short solos, not long ones, which means soloists didn’t have enough time to show off their skills, so (A) can be eliminated. While swing may have been most appreciated by young people at dance parties, there is no explicit mention of this detail in the passage, so (B) is also wrong. And, the fourth paragraph describes the difficulty the swing genre created for musicians because it was part of the “prejudices and expectations of the listening public” (lines 30–31), showing that swing music’s popularity had a significant impact on musicians, so (C) is also wrong.
26. **(F) Reading/Craft and Structure/Vocabulary.** “Court,” as used in line 35, refers to Berry as a musician not being famous in the music or jazz world. While “courting” often refers to romantically pursuing someone, a spot in music history is not a romantic pursuit, so (G) is wrong. Berry is also not dangerously provoking a spot in history, (H), nor is he passing judgment on it. Rather, Berry didn’t attract infamy in jazz, (F).

TIP *Some Vocabulary items test meanings of words students may be familiar with. If students encounter such items, they can usually eliminate the most common meanings of the word because, more likely than not, those familiar meanings will not be the correct answer.*

27. **(C) Reading/Key Ideas and Details/Development.** In the seventh paragraph, the author of the passage states that jazz orchestras of the swing era were “fronted by musical directors/arrangers . . . who drew the acclaim” (lines 60–61). The sidemen, then, “were musical traveling salesmen who sold someone else’s wares” (lines 61–63). This means that the directors or arrangers received were the showmen, and the band members were the “sidemen” who helped or supported the directors and arrangers, (C). There is no mention of how any of the musicians in the passage traveled or of them having side jobs, so (A) and (B) are wrong, and while the author does portray the band members or “sidemen” as working hard, there is no mention of working hard to get hired, so (D) is also wrong.



28. (J) *Reading/Key Ideas and Details/Explicit Detail.* This question is straight forward: Find “Blues in C Sharp Minor” in the passage and look for its descriptors. Line 71 says that “Blues in C Sharp Minor” is “odd, haunting, and ultimately relaxing,” (J).
29. (A) *Reading/Key Ideas and Details/Explicit Detail.* In the last paragraph, the author introduces the song “A Ghost of a Chance,” and in lines 77–78 states that it is the “sole recording in Berry’s career to feature him from start to finish,” (A). There is no mention of Berry switching the type of saxophone he usually plays, (B), or of it being his only public performance in 1950, (C). As for (D), the last paragraph describes the “flourishes, angles, [and] ornamentations” (lines 85–86) in the song, so Berry’s performance couldn’t have blended in the background.
30. (F) *Reading/Craft and Structure/Implied Idea.* In line 85, the author compares Berry’s solo in “A Ghost of a Chance”—a performance that is rife with indulgence: “flourishes, angles, ornamentations, reflexivity” (lines 85–86)—to a cathedral, which is usually an opulent church building with intricate architectural details. While the title of the song sounds a bit sad and cathedrals can often invoke a somber attitude, the descriptions in the comparison clearly point to intricacies, not mood, so (G) can be eliminated. The descriptions in the comparison also praise Berry’s solo, not show his skill was no longer great, so (H) is also wrong. Earlier in the passage, the author clearly states that band members like Berry were “sidemen” to the director or arranger—the person who leads the band—so (J) is also wrong. The author most likely makes this comparison to show the solo was intricate and awe-inspiring, much like cathedrals are, (F).

Passage IV

31. (D) *Reading/Key Ideas and Details/Main Idea.* This question asks for the main idea of the passage. While the passage does state that Bailin was a graduate student, this is a small detail, not the main idea, so (A) can be eliminated. The last paragraph states that the angular momenta of the Milky Way and the Sagittarius Dwarf are identical, which offers “solid circumstantial evidence that the interaction of the Sagittarius Dwarf and the Milky Way disk created the warp in our galaxy” (lines 86–89), and “solid circumstantial evidence” is more than at best circumstantial evidence, so (C) is also wrong. Additionally, the measurements and the evidence is only a detail about the main idea of the passage, not the main idea itself. While the passage does state that the Sagittarius Dwarf’s “matter [is] being drawn out” (line 47) and now looks like “strands of spaghetti” (lines 45–46), the destruction of the Sagittarius Dwarf is also a detail, not the main idea, so (B) is also wrong. The passage focuses on two galaxies: The Milky Way and the Sagittarius Dwarf and presents research and evidence to show that the gravity between these galaxies creates the warp in the Milky Way, as the second paragraph states, (D).

TIP *Reviewing the first few paragraphs and the last paragraph can help identify the main idea of the passage quickly as the main idea is introduced in the beginning and brought to a conclusion in the end.*

32. (H) *Reading/Key Ideas and Details/Implied Idea.* Line 33 refers to “an innovative analysis of the problem.” “The” is a demonstrative article—it points to something specific, so the question is, “To what does problem does ‘the’ refer?” A quick look at the previous sentence gives the answer: “[A] number of physical properties can warp a galaxy, so it’s a matter of figuring out which scenario applies” (lines 31–33), (H).
33. (B) *Reading/Key Ideas and Details/Implied Idea.* Lines 35–36 introduce Bailin’s analysis of the problem of how physical properties can warp a galaxy, which “has implicated a small satellite galaxy currently being ripped to shreds by the gravity of the Milky Way.” The first sentence of the next paragraph introduces the Sagittarius Dwarf, so it can be reasonably inferred that the small satellite galaxy Bailin’s analysis implicated is the Sagittarius Dwarf, (B). Additionally, lines 35–36 describe this small satellite galaxy as “being ripped to shreds,” which matches the description attributed to the Sagittarius Dwarf as

“strands of spaghetti” (lines 45–46). The Small Magellanic Cloud is referenced only to show that it is too far away to warp the Milky Way, so (A) is wrong, and there is no mention of a hypothetical galaxy or an unnamed galaxy, so (C) and (D) are also wrong.

34. **(J) Reading/Key Ideas and Details/Application.** The first two paragraphs of the passage introduce the Milky Way and describe its warped shape. In the third paragraph, Bailin and his study is introduced, a study that “has implicated” the Sagittarius Dwarf. The fourth and fifth paragraphs explain the Sagittarius Dwarf and then move into the link needed to connect it to the rotation of the Milky Way’s disk. The sixth paragraph describes Bailin’s study that finds this link, and the last paragraph explains what its results provide: “solid circumstantial evidence that the interaction of the Sagittarius Dwarf with the Milky Way disk created the warp in our galaxy” (lines 86–88). The first few paragraphs of the passage describe the warp in the Milky Way’s disk, which means astronomers already knew it was there, so (F) can be eliminated. Most of the passage is focused on the Milky Way’s orbital connection to the Sagittarius Dwarf, not on shifting the focus to the center of the Milky Way, so (G) is wrong, and the problem is not in the basic assumptions held by most astronomers, it is in the absence of an answer as to why the Milky Way’s disk is warped (lines 26–27), so (H) is also wrong. Only (J) captures scientists’ assumption that wasn’t “proven” until Bailin’s study.
35. **(C) Reading/Key Ideas and Details/Explicit Detail.** The answer to this question can be found in the last paragraph. When Bailin compared the angular momentum of the Milky Way’s disk to that of the Sagittarius Dwarf, he found, “for the first time, within the margins of measurement error, that the two angular momenta are identical in both quantity and direction” (lines 79–81), (C). All other answer choices distort the information specifically stated in the passage.
36. **(G) Reading/Key Ideas and Details/Explicit Detail.** The first paragraph of the passage describes the Milky Way in detail and provides the answer to the question. The “plum” is the “slightly oblong central bulge” (lines 3–4) that is “comprised mostly of older stars” (lines 5–6) and “includes a black hole two and a half million times the mass of the Sun” (lines 7–8), (G). The disk of the Milky Way, not the central bulge, is made up of 80 percent of the galaxies stars (line 12), so (F) is wrong. The central bulge protrudes “above and below the galactic plane” (line 5) and is not comprised of it or dwarf planets, so (H) is wrong. As for (J), the passage gives explicit detail of what comprises the Milky Way and does not state that any part of it is made up of unidentified matter, so it is also wrong.
37. **(A) Reading/Craft and Structure/Development.** The author refers to the swirling pattern of a hurricane in the middle of the second paragraph (lines 18–20). The beginning of this paragraph speaks to the problems with the previous metaphor used to describe the Milky Way galaxy, the plum and pizza, which “breaks down if you push it” (lines 15–16). The next sentence explains how the plum-and-pizza metaphor breaks down: The “galactic disk isn’t a rigid body, but a loose agglomeration of matter streaming around a common center of gravity” (lines 16–18). The swirling pattern of a hurricane is then referred to in parentheses to show it “far better resembles” (line 19) the galaxy than the plum-and-pizza metaphor. If it is a better metaphor, it shows the shortcomings of the plum-and-pizza metaphor, (A). The hurricane is a new metaphor, which means another new one is not needed, so (B) can be eliminated. While the comparisons in the metaphors speak to the Milky Way’s unique characteristics, the purpose of the metaphors is not to emphasize these characteristics, but to explain them using concepts that are more familiar, so (C) is wrong, and the hurricane metaphor doesn’t refer to gravitational tides, so (D) is also wrong.
38. **(G) Reading/Key Ideas and Details/Explicit Detail.** This question can be a bit tricky, since most of the answer choices refer to a comparison or metaphor used at some point in the passage, so the key is finding the comparison that refers specifically to the Milky Way’s disk warp. A pasta maker churning out spaghetti is the metaphor used to describe the Sagittarius Dwarf (lines 45–47), (F); a thin crust pizza with a plum in the middle describes the shape of the Milky way galaxy in general (lines 2–3), (H); and two figure skaters coming together for a combination spin describes the angular momentum of two



objects (lines 70–71), (J)—none of which describe the Milky Way’s disk warp. The only metaphor that does describe the warp is pizza dough being spun by a chef (lines 21–22), (G).

39. **(A) Reading/Key Ideas and Details/Explicit Detail.** The fourth paragraph of the passage describes the Sagittarius Dwarf and includes a description of its orbit: “[I]t appears to be in a roughly polar orbit around the Milky Way” (lines 39–40), (A). There is no mention of any forty-five-degree angle in the passage, (B), nor is there any information that suggests the Sagittarius Dwarf follows, (C), or ever followed the movement of the Milky Way’s stars, (D).
40. **(J) Reading/Key Ideas and Details/Explicit Detail.** A quick scan of the passage for angular momentum takes you to the sixth paragraph, where the author states that Bailin, in an effort to find a link between the orbital motion of the Milky Way and the rotation of the Sagittarius Dwarf, based his analysis on angular momentum or “the measure of how much a system is spinning or rotating” (lines 65–66), (J). While this section of the passage does reference objects moving in a straight line having momentum (lines 66–67), this statement is used to relate objects moving in a straight line to those that have angular momentum or are spinning or rotating, so (G) is wrong, and there is no mention of vertical deviation or gravitational pull when describing angular momentum, so (F) and (H) are also wrong.

ACT SCIENCE TEST EXPLANATIONS

Passage I

1. **(C) Science/Interpretation of Data/Comprehension. CCRS: AVG.DA.1.** In Figure 1, the white bars represent the mass of cheese remaining after 0, 4, 16, 24, and 28 hours. After 4 hours, the height of the white bar corresponds to 185 mg of cheese.
2. **(J) Science/Evaluation of Models/Analysis. CCRS: AVG.MOD.1.** The data in Figure 1 indicates which food the cockroaches prefer most—the less food that remains over time, the greater the cockroaches like the food and the better the food would be for placement in cockroach traps. According to Figure 1, the food that decreases the most over time is peanuts, as represented by the striped bars.
3. **(B) Science/Interpretation of Data/Analysis. CCRS: EXP.DA.1.** First, consider Figure 2 to determine the order of the four foods according to percent by mass of proteins, from lowest to highest: cat food < cheese < ham < peanuts. Next, consider Figure 1 to determine how the mass of each food remaining at 28 hours changes as the percent by mass of protein increases: as the percent mass by protein increases (from cat food to peanuts), the mass of each food remaining at 28 hours decreases only.
4. **(J) Science/Evaluation of Models/Analysis. CCRS: AVG.MOD.1.** If the cockroaches eat a given type of food during each of the food intervals as shown in Figure 1, the amount of food would decrease with each interval. According to Figure 1, the heights of the bars representing each food type decrease with each successive time interval, indicating that the cockroaches eat all four types of food during each interval.
5. **(A) Science/Evaluation of Models/Analysis. CCRS: AVG+.MOD.2.** This item asks you to determine whether the data in Figure 1 supports the prediction that the cockroaches would eat more ham than cat food by the end of the study. According to Figure 1, over 28 hours, the amount of cat food decreased from 200 mg to about 165 mg, while the amount of ham decreased from 200 mg to about 110 mg. Therefore, the data supports the prediction and shows that the amount of cat food remaining after 28 hours was approximately $165 - 110 = 55$ mg more than the amount of ham remaining.
6. **(G) Science/Interpretation of Data/Analysis. CCRS: AVG+.DA.2.** The amount of water in each food type given in Table 1 corresponds to a percentage. For more than 100 mg of a 200 mg mass to be water, the corresponding percentage of water by mass (last column) must be at least 50%. This is true only for cat food (66.2%) and ham (57.1%).

Passage II

7. **(C) Science/Evaluation of Models/Comprehension. CCRS: AVG.MOD.1.** First, consider Student 1's prediction for whether two samples are composed of the same substance: if two samples have the same value for all five properties listed in the table, then they are composed of the same substance. According to the table, all five properties (mass, volume, density, melting point, and boiling point) are the same for Samples C/D and Samples E/F. Only Samples C/D are given the answer choices.
8. **(J) Science/Evaluation of Models/Comprehension. CCRS: AVG.MOD.1.** First, consider Student 3's prediction for whether two samples are composed of the same substance: if two samples have the same mass, volume, and density, then they are composed of the same substance. According to the table, these three properties (mass, volume, and density) are the same for Samples A/B, C/D, E/F, and G/H. Only Samples G/H are given in the answer choices.



9. (C) **Science/Scientific Investigation/Analysis. CCRS: ACG+.EXD.2.** This item asks whether Sample A would be a solid or a liquid at 1 atm of pressure and 250°C. According to the table, Sample A has a melting point of 126°C, which means below 126°C, Sample A is a solid and above 126°C, it is a liquid (until it reaches the boiling point at 747°C, at which point it becomes a gas). Therefore, at 250°C, Sample A is a liquid because its melting point is 126°C.

10. (J) **Science/Evaluation of Models/Analysis. CCRS: AVG+.MOD.5.** Let's recap the student explanations for how the data can be used to predict whether two samples are composed of the same substance:

Student 1: same values for all five properties

Student 2: same values for three or more of the five properties

Student 3: same values for mass, volume, and density

Student 4: same values for density, melting point, and boiling point

Therefore, none of the students would say that two samples can be composed of the same substance if they only have the same density.

11. (A) **Science/Evaluation of Models/Analysis. CCRS: AVG+.MOD.5.** According to the table, Sample A and Sample B have the same mass, volume, and density. Only Students 2 and 3 would agree that these samples are composed of the same substance because at least three properties are the same (Student 2) and these three properties are mass, volume, and density (Student 3).

12. (F) **Science/Evaluation of Models/Application. CCRS: AVG+.MOD.2.** For two samples to be composed of the same substance, Student 2 says they must have the same values for three or more of the five properties and Student 4 says they must have the same density, melting point, and boiling point. The statement in the item stem says that the two samples have the same mass, volume, density, and boiling point, which is four of the five properties, so Student 2 would agree with the statement. However, since the melting points are not the same, Student 4 would not agree with the statement.

13. (A) **Science/Interpretation of Data/Analysis. CCRS: AVG+.DA.5.** According to the table, Sample D's melting point is 237°C and its boiling point is 885°C (both at 1 atm of pressure). So, Sample D is a solid at 20°C and a gas at 890°C. Therefore, the density is lower at 890°C in the gas state than it would be in the solid state (below 237°C). Gases generally have lower densities than do solids.



This item requires some basic science knowledge about relative densities of gases, liquids, and solids. Generally, solids are denser than liquid, which is denser than gas of a particular substance. In the liquid phase, molecules are freer and can move around more than in the solid phase, so the substance is less dense as a gas than as a solid. Gas molecules move at high speed with large separation between one another. Therefore gases are less dense than liquids.

Passage III

14. (H) **Science/Interpretation of Data/Analysis. CCRS: EXP.DA.1.** The Ni data is shown in both Figure 1 and Figure 2 by open squares. According to Figure 2, approximately 128 mL of Ni gas was collected at 30°C. According to Figure 1, 128 mL of Ni gas was collected for 0.30 g of Ni.

15. (B) **Science/Scientific Investigation/Comprehension. CCRS: AVG.EXD.1.** According to the descriptions of Experiment 1 and Figure 1, five different masses each of Fe, Ni, and Zn were tested at one temperature: 30°C. According to the descriptions of Experiment 2 and Figure 2, one mass each of Fe, Ni, and Zn were tested at five different temperatures: 10°C, 20°C, 30°C, 40°C, and 50°C. Therefore, one temperature was tested in Experiment 1 and five temperatures were tested in Experiment 2.

16. (J) *Science/Scientific Investigation/Comprehension*. CCRS: AVG.EXD.1. The best approach to an item like this is to test the veracity of each answer choice, until you find one that can't be proven false. Both (F) and (G) are false because three metals—Fe, Ni, and Zn—were tested in both experiments. And (H) is false because five different masses of each metal were tested in Experiment 1 and one mass of each metal was tested in Experiment 2, which is the opposite of (H). Therefore, by the process of elimination, (J) must be correct. Indeed, (J) is the opposite of (H) and true: Experiment 1 tested multiple masses of each metal and Experiment 2 tested one mass of each metal.
17. (A) *Science/Scientific Investigation/Comprehension*. CCRS: AVG.EXD.3. Again, the best approach is to check each answer choice: only the correct choice will have the same value for both experiments. According to the last paragraph of the introductory information, “the atmospheric pressure was 758 mm Hg throughout all 3 steps” in each trial of the experiments, so (A) is correct. As for the other choices, (B) is wrong because five different masses of each metal were tested in Experiment 1 and only one mass of each metal was tested in Experiment 2. (C) is wrong because one temperature was tested in Experiment 1 and five different temperatures were tested in Experiment 2. And (D) is wrong because the collected gas volumes vary in both experiments, as indicated by Figures 1 and 2.
18. (H) *Science/Scientific Investigation/Analysis*. CCRS: AVG+.EXD.2. The item stem asks about a temperature of 5°C being tested in Experiment 2, and the corresponding volume of Zn gas collected, so extrapolate to the left of the existing data point at 10°C—which for Zn (empty triangle) is approximately 107 mL. The volume of gas collected decreases with decreasing temperature, so the volume of gas collected at 5°C would likely be less than that collected at 10°C, which corresponds to less than 107 mL.
19. (A) *Science/Interpretation of Data/Application*. CCRS: AVG+.DA.4. The introductory information gives the balanced equation for the production of H₂ gas when a metal (M) is placed in hydrochloric acid (HCl): $M + 2HCl \rightarrow MCl_2 + H_2$. Recall that the coefficient of each reactant and product refers to the number of molecules of that reactant or product. So, every 2 moles of HCL produces 1 mole of H₂, and 10 moles of HCL would produce 5 moles of H₂.
- TIP** *This item requires some basic science knowledge about balanced chemical equations. A chemical equation is balanced when the number of each type of atom is equal on the two sides. The subscripts on reactants and products indicate the number of atoms of the preceding element. The coefficient on a molecule (or atom) indicates the number of molecules required for the equation to be balanced.*
20. (G) *Science/Scientific Investigation/Analysis*. CCRS: EXP.EXD.2. First, determine the expected volume of Zn gas that will be collected from a 0.25 g sample of Zn. According to Figure 1, a 0.25 g sample of Zn (empty triangles) produces approximately 95 mL of gas. Since the graduated cylinder is replaced with test tubes of volume 60 mL, two test tubes (60 + 60 = 120 mL) would be required to collect 95 mL of gas.

Passage IV

21. (C) *Science/Interpretation of Data/Comprehension*. CCRS: AVG.DA.1. The y-axis on the right side of the graph in Figure 2 corresponds to the voltage V_S , as indicated by the dashed wave function. According to the data, the maximum positive value of the V_S data was approximately 250 V.
22. (H) *Science/Interpretation of Data/Analysis*. CCRS: AVG+.DA.2. The period for V_L , represented in Figure 3 as a dashed wave function, has a peak at 0 msec and next reaches the same peak at 20 msec. Therefore, the period of the V_L wave function is $20 - 0 = 20$ msec.
23. (C) *Science/Interpretation of Data/Analysis*. CCRS: EXP.DA.1. This item requires comparison of the voltage wave functions in both Figures 2 and 3 to determine which one varies the least over the 20 msec



- interval. First, compare the wave functions in Figure 3: the dashed V_L wave varies the least: from 50 V to -50 V. Now, check Figure 2: the dashed V_S wave varies from 250 V to -250 V. Therefore, the V_L voltage varies the least over the 20 msec interval.
24. (H) **Science/Interpretation of Data/Application. CCRS: AVG+.DA.5.** According to the definition of polarity given in the item stem, the two voltages that are always completely opposite—i.e., when one is at a peak, the other is at a trough, and vice versa—are the two with opposite polarity. First, look at Figure 3: the dashed wave function for V_L has peaks that coincide with the troughs of the dotted wave function for V_C , and vice versa. Therefore, V_L and V_C are always opposite in polarity.
25. (D) **Science/Interpretation of Data/Analysis. CCRS: BSC.DA.3.** According to the first sentence of the introductory material following Figure 1, “electric current can flow through the circuit either clockwise (positive current) or counterclockwise (negative current).” So, a negative current corresponds to current flowing counterclockwise through the circuit. The current of the circuit is shown in Figure 2 by the solid wave function—it’s negative between 10 msec and 20 msec, but zero at 10 msec and 20 msec. Of the answer choices, only 15 msec falls between 10 msec and 20 msec.
26. (J) **Science/Interpretation of Data/Application. CCRS: EXP.DA.2.** According to the table given in the item stem, the charge on the capacitor increased from 7 msec to a peak at 10 msec and then decreased back to its 7 msec value at 13 msec. Check how the wave functions for I and V_C change over the same interval. According to Figure 2, I is decreasing throughout the interval 7 msec to 13 msec. According to Figure 3, V_C is increasing throughout the interval 7 msec to 10 msec and is decreasing from 10 msec to 13 msec. Therefore, both the charge and V_C increased and then decreased over the given time interval.

Passage V

27. (C) **Science/Interpretation of Data/Analysis. CCRS: AVG+.DA.1.** According to the introductory information, a strain of bacteria that prevents synthetization of the amino acid histidine are called His^- , whereas exposure of these bacteria to mutagens can cause the bacteria to regain the ability to synthesize histidine, which means the bacteria is His^+ revertant. Table 1 lists the mutagens applied to dishes 2 through 5, and Table 2 shows the number of His^+ revertant colonies growing in the presence of said mutagen. According to Table 2, the greatest number of His^+ revertants in a dish corresponds to Dish 4. And Table 1 indicates that Dish 4 was treated with Substance N.
28. (F) **Science/Scientific Investigation/Comprehension. CCRS: AVG.EXD.3.** According to the introductory material and Figure 2, mutagens that induce His^- bacteria to become His^+ revertants were added to Dishes 2 through 5. The remaining dish, Dish 1, was not treated with any mutagens and therefore serves as control for whether some of the bacteria became His^+ revertants without the addition of a mutagen.
29. (B) **Science/Interpretation of Data/Analysis. CCRS: AVG+.DA.1.** The least mutagenic substance will be the one that results in the least number of colonies growing in the treated dish. According to Table 2, the order of treated dishes, from least number of colonies to most, is $5 < 2 < 3 < 4$. According to Table 1, this order translates to the substance order $P < L < M < N$.
30. (F) **Science/Evaluation of Models/Application. CCRS: AVG+.DA.5.** According to the table given in the item stem, as the concentration of Substance P increases, the number of bacteria colonies increases. As per the introductory information, an increase in the number of bacteria colonies corresponds to an increase in the number of mutagens. Therefore, as the concentration of Substance P increases, its potential to cause mutations increases only.

31. **(D) Science/Scientific Investigation/Comprehension. CCRS: AVG2.EXD.2.** According to the introductory information, each of the five dishes were treated with agar. Then, His⁻ *S. Typhimurium* bacteria cells were added to each dish. And for Dishes 2 through 5, suspected mutagens were mixed with the bacteria added to each dish. Therefore, since the bacteria added to each dish were histidine negative and Dish 1 (control) was not treated with a suspected mutagen, the control dish lacked these two substances.
32. **(F) Science/Evaluation of Models/Analysis. CCRS: AVG+.DA.1.** For this type of item, the best approach is to check the veracity of the claims made in the answer choices. The number of colonies that become His⁺ revertant after exposure to a mutagen substance corresponds to the number of colonies listed in Table 2. As for (F), the number of colonies after treatment with Substance M (Dish 3) is 25, while the number of colonies after treatment with Substance L (Dish 2) is 14. Since 25 is approximately twice 14, so don't bother testing the remaining choices. (F) must be the correct choice. Indeed, (G) is false because Substance L (Dish 2) resulted in 14 colonies and Substance M (Dish 3) resulted in 25 colonies, and 14 is not twice 25. (H) is false because Substance M (Dish 3) resulted in 25 colonies and Substance L (Dish 2) resulted in 14 colonies, and 25 is not 4 times 14. Finally, (J) is false because Substance L (Dish 2) resulted in 14 colonies and Substance M (Dish 3) resulted in 25 colonies, and 14 is not 4 times 25.
33. **(D) Science/Scientific Investigation/Comprehension. CCRS: AVG.EXD.2.** Reason through each choice to determine whether it gives a likely reason for why the particular strain of *S. typhimurium*—which lacks normal DNA repair mechanisms—was chosen for the study. (A) suggests it is because the bacteria shouldn't synthesize any DNA, but the ability to synthesize histidines—which would be possible due to a DNA mutation—is key to the study, so (A) is wrong. (B) is wrong because the ability to synthesize any protein is not the focus of the study—the focus is the ability to synthesize a DNA mutation that allows for a specific histidine synthesis. As for (C), the mutation itself—which allows for histidine synthesis—is the point of the study, so allowing the bacteria to repair the mutation would undermine it. Therefore, by the process of elimination, (D) must be the correct choice. Indeed, (D) is correct for the same reason that (C) is wrong: the bacteria should not be able to repair the mutation caused by the substance, since this ability to cause mutation is what's being studied.

Passage VI

34. **(G) Science/Scientific Investigation/Comprehension. CCRS: BSC.EXD.2.** The point of the experiment is to examine how the volume of runoff from melting ice is affected by wind speed and by the presence of sand beneath the ice. Therefore, the researchers would not want to use anything that would otherwise slow the flow of water or absorb the water. This immediately eliminates (H) and (J) since both of these involve absorbing water. To choose between (F) and (G), you must know the definitions of “porous/nonporous” and “permeable/impermeable.” A porous material has minute spaces or holes through which liquid or air may pass. And similarly, a permeable material (or membrane) allows liquids or gases to pass through it. Therefore, the plastic, unlike wood, is nonporous and impermeable, thereby incapable of absorbing water.
35. **(A) Science/Scientific Investigation/Application. CCRS: EXP.EXD.2.** This item asks for how the results from Experiment 2 would change if the study was conducted at -1°C instead of 18°C . Ask yourself: what is the difference between -1°C and 18°C ? This requires some basic science knowledge, to which the answer choices themselves point: water freezes at 0°C . Since -1°C is below the freezing temperature of water, immediately eliminate (B) and (D). To choose between (A) and (C), determine whether more or less water would flow if at freezing temperature: the flow would be near or at zero because -1°C is below the freezing point of water.



36. (J) *Science/Interpretation of Data/Analysis*. CCRS: AVG.DA.1. According to Figure 1, the volume of runoff per 20 minutes tapers off over time for all four trials. Two trials have runoff volumes of 0 before the 500 minute mark: wind speed = 1.0 (circle) and 2.5 (diamond) m/sec.

37. (D) *Science/Interpretation of Data/Analysis*. CCRS: AVG+.DA.2. Figure 2 summarizes the data from Study 2. According to Figure 2, the trial with the greatest maximum value corresponds to the one without a sand layer (empty circles)—the maximum is approximately 1,375 mL. This eliminates (A) and (B). To choose between (C) and (D), calculate the difference between the times corresponding to zero runoff volume the maximum runoff volume for each trial in Figure 2:

Trial with sand layer (filled circles): $480 - 80 = 400$ minutes

Trial without sand layer (empty circles): $380 - 40 = 240$ minutes

Therefore, the trial with the shorter time from maximum to zero is without a sand layer, and (D) is correct.

38. (J) *Science/Interpretation of Data/Application*. CCRS: AVG.DA.3. This item requires translation of the data for runoff volume at 200 minutes for the four wind speeds in Figure 1:

0 m/s (filled squares): 480 mL

0.5 m/s (filled stars): 600 mL

1.0 m/s (filled circles): 600 mL

2.5 m/s (filled diamonds): 200 mL

Note that the scale of Figure 1 makes precisely reading values very difficult. However, approximations are all that are necessary. The important point is to notice that the runoff volume values for the 0.5 m/s and 1.0 m/s wind speeds are about the same, while the 0 m/s value is less, and the 2.5 m/s value is the least. Based on even this simple qualitative comparison of the values, it's clear that the correct graph must be (J).

39. (B) *Science/Scientific Investigation/Comprehension*. CCRS: AVG.EXD.2. The best approach to this item is to test the answer choices: only the correct choice will be varied in Study 1 but constant in Study 2. As for (A), the depth of sand layer was constant in Study 1, but Study 2 had trials both with and without a sand layer, so (A) is wrong. As for (B), the wind speed was varied for the four trials in Study 1 but constant (1.0 m/sec, the same as Trial 2 in Study 1) in Study 2. Therefore, (B) must be the correct choice. Indeed, (C) is wrong because the tilt of the box is constant (10°) for both studies and (D) is wrong because melted chipped ice was used in both studies.

40. (G) *Science/Interpretation of Data/Analysis*. CCRS: BSC.DA.3. According to the figure in the introductory information, the length of the box is 120 cm and the width is 60 cm. And according to the description of Study 1, the layer of the dry sand is 30 cm deep. Therefore, the volume of the sand layer in the box is $30 \text{ cm} \times 60 \text{ cm} \times 120 \text{ cm}$.