

## Grade 11 Informational Mini-Assessment

### “Location, Location, Location”

Chapter 6 from *The Joy of X* by Steven Strogatz

This grade 11 mini-assessment is based on a chapter from a book about math and how it connects to everyday life. This text is considered to be worthy of students’ time to read and also meets the expectations for text complexity at grade 11. Assessments aligned to the Common Core State Standards (CCSS) will employ quality, complex texts such as this.

Questions aligned to the CCSS should be worthy of students’ time to answer and therefore do not focus on minor points of the text. Questions also may address several standards within the same question because complex texts tend to yield rich assessment questions that call for deep analysis. In this mini-assessment there are selected-response questions that address Reading Standards and one constructed-response question that addresses Reading, Writing, and Language Standards. There is also one item that replicates how technology may be used on assessments, but in paper and pencil format.

We encourage educators to give students the time that they need to read closely and write to the source. While we know that it is helpful to have students complete the mini-assessment in one class period, we encourage educators to allow additional time as is necessary.

#### The questions align to the following standards:

RI.11–12.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
RI.11–12.2	Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.
RI.11–12.3	Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.
RI.11–12.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
RI.11–12.5	Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.
RI.11–12.6	Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.

RST.11–12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
RST.11–12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST.11–12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context <i>relevant to grades 11-12 texts and topics</i> .
RST.11–12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
RST.11–12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
W.11–12.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
W.11–12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
W.11–12.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
L.11–12.1	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
L.11–12.2	Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
L.11–12.3	Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

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The assessment questions in this document align with the CCSS and reflect the instructional shifts implied by the standards. To learn more about these topics, please go to the following link:

[www.achievethecore.org](http://www.achievethecore.org)

## Grade 11 Mini-Assessment – “Location, Location, Location”

Today you will read a text about a variety of mathematical systems. You will then answer several questions based on this text. I will be happy to answer questions about the directions, but I will not help you with the answers to any questions. You will notice as you answer the questions that some of the questions have two parts. You should answer Part A of the question before you answer Part B, but you may go back and change your answer to Part A if you want to.

Take as long as you need to read and answer the questions. If you do not finish when class ends, come see me to discuss the ways you may have additional time.

Now read the passage and answer the questions. I encourage you to write notes in the margin as you read the text.

### Location, Location, Location

Chapter 6 from *The Joy of X* by Steven Strogatz

- 1 I'd walked past Ezra Cornell's statue hundreds of times without even glancing at his greenish likeness. But then one day I stepped back for a closer look.

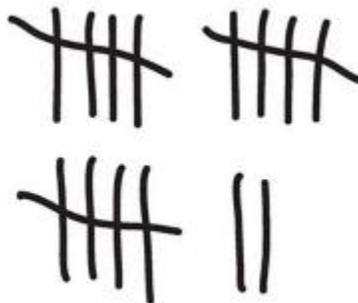


- 2 Ezra appears very outdoorsy and ruggedly dignified in his long coat, vest, and boots, his right hand resting on a walking stick and holding a rumpled, wide-brimmed hat. The monument comes across as unpretentious and disarmingly direct—much like the man himself, by all accounts.
- 3 Which is why it seems so discordant that Ezra's dates are inscribed on the pedestal in pompous Roman numerals:

EZRA CORNELL

MDCCCVII-MDCCCLXXIV

- 4 Why not write simply 1807-1874? Roman numerals may look impressive, but they're hard to read and cumbersome to use. Ezra would have little patience for that.
- 5 Finding a good way to represent numbers has always been a challenge. Since the dawn of civilization, people have tried various systems for writing numbers and reckoning with them, whether for trading, measuring land, or keeping track of the herd.
- 6 What nearly all of these systems have in common is that our biology is deeply embedded in them. Through the vagaries of evolution, we happen to have five fingers on each of two hands. That peculiar anatomical fact is reflected in the primitive system of tallying; for example, the number 17 is written as



- 7 Here, each of the vertical strokes in each group must have originally meant a finger. Maybe the diagonal slash was a thumb, folded across the other four fingers to make a fist?
- 8 Roman numerals are only slightly more sophisticated than tallies. You can spot the vestige of tallies in the way Romans wrote 2 and 3, as II, and III. Likewise, the diagonal slash is echoed in the shape of the Roman symbol for 5, V. But, 4 is an ambiguous case. Sometimes it's written as IIII, tally style (you'll often see this on fancy clocks), though more commonly it's written as IV. The positioning of a smaller number (I) to the left of the larger number (V) indicates that you're supposed to subtract I, rather than add it, as you would if you were stationed on the right. Thus IV means 4, whereas VI means 6.

- 9 The Babylonians were not nearly as attached to their fingers. Their numerical system was based on 60—a clear sign of their impeccable taste, for 60 is an exceptionally pleasant number. Its beauty is intrinsic and has nothing to do with human appendages. Sixty is the smallest number that can be divided evenly by 1, 2, 3, 4, 5, and 6. And that’s just for starts (there’s also 10, 12, 15, 20, and 30). Because of its promiscuous divisibility, 60 is much more congenial than 10 for any sort of calculation or measurement that involves cutting things into equal parts. When we divide an hour into 60 minutes, or a minute into 60 seconds, or a full circle into 360 degrees, we’re channeling the sages of ancient Babylon.
- 10 But the greatest legacy of the Babylonians is an idea that’s so commonplace today that few of us appreciate how subtle and ingenious it is.
- 11 To illustrate it, let’s consider our own Hindu-Arabic system, which incorporates the same idea in its modern form. Instead of 60, this system is based on ten symbols, 1, 2, 3, 4, 5, 6, 7, 8, 9, and, most brilliant, 0. These are called digits, naturally, from the Latin word for a finger or a toe.
- 12 The great innovation here is that even though this system is based on the number 10, there is no single symbol reserved for 10. Ten is marked by a position—the 10s place—instead of a symbol. The same is true for 100, or 1,000, or any other power of 10. Their distinguished status is signified not by a symbol but by a parking spot, a reserved piece of real estate. Location, location, location.
- 13 Contrast the elegance of this place-value system with the much cruder approach used in Roman numerals. You want 10? We’ve got 10, its X. We’ve also got 100 (C) and 1,000 (M), and we’ll even throw in a special symbol for the 5 family, V, L, and D, for 5, 50, and 500.
- 14 The Roman approach was to elevate a few favored numbers, give them their own symbols, and express all the other, second-class numbers as combinations of those.
- 15 Unfortunately, Roman numerals creaked and groaned when faced with anything larger than a few thousand. In a workaround solution that would nowadays be called a kludge, the scholars who were still using Roman numerals in the Middle Ages resorted to piling bars on top of the existing symbols to indicate multiplication by a thousand. For instance,  $\overline{\text{X}}$  meant ten thousand, and  $\overline{\text{M}}$  meant a thousand thousands or, in other words, a million. Multiplying by a billion (a thousand millions) was rarely necessary, but if you ever had to, you could always put a second bar on top of the  $\overline{\text{M}}$ . As you can see, the fun never stopped.
- 16 But in the Hindu-Arabic system, it’s a snap to write any number, no matter how big. All numbers can be expressed with the same ten digits, merely by slotting them into the right places. Furthermore, the notation is inherently concise. Every number less than a million, for example, can be expressed in six symbols or fewer. Try doing that with words, tallies, or Roman numerals.

- 17 Best of all, with a place-value system, ordinary people can learn to do arithmetic. You just have to master a few facts—the multiplication table and its counterpart for addition. Once you get those down, that’s all you’ll ever need. Any calculation involving any pair of numbers, no matter how big, can be performed by applying the same sets of facts, over and over again, recursively.
- 18 If it all sounds pretty mechanical, that’s precisely the point. With place-value systems, you can program a machine to do arithmetic. From the early days of mechanical calculators to the supercomputers of today, the automation of arithmetic was made possible by the beautiful idea of place value.
- 19 But the unsung hero in this story is 0. Without zero, the whole approach would collapse. It’s the placeholder that allows us to tell 1, 10, and 100 apart.
- 20 All place-value systems are based on some number called, appropriately enough, the base. Our system is base 10, or decimal (from the Latin root *decem*, meaning “ten”). After the ones place, the subsequent consecutive places represent tens, hundreds, thousands, and so on, each of which is a power of 10:
- $10 = 10^1$
- $100 = 10 \times 10 = 10^2$
- $1,000 = 10 \times 10 \times 10 = 10^3$ .
- 21 Given what I said earlier about the biological, as opposed to the logical, origin of our preference for the base 10, it’s natural to ask: Would some other base be more efficient, or easier to manipulate?
- 22 A strong case can be made for base 2, the famous and now ubiquitous binary system used in computers and all things digital, from cell phones to cameras. Of all of the possible bases, it requires the fewest symbols—just two of them, 0 and 1. As such, it meshes perfectly with the logic of electronic switches or anything that can toggle between two states—on or off, open or closed.
- 23 Binary takes some getting used to. Instead of powers of 10, it uses powers of 2. It still has a ones place like the decimal system, but the subsequent places now stand for twos, fours, and eights, because
- $2 = 2^1$
- $4 = 2 \times 2 = 2^2$
- $8 = 2 \times 2 \times 2 = 2^3$ .
- 24 Of course, we wouldn’t write the symbol 2, because it doesn’t exist in binary, just as there’s no single numeral for 10 in decimal. In binary, 2 is written as 10, meaning one 2 and zero 1s. Similarly, 4 would be written as 100 (one 4, zero 2s and zero 1s), and 8 would be 1000.

25 The implications reach far beyond math. Our world has been changed by the power of 2. In the past few decades, we've come to realize that *all* information—not just numbers, but also language, images, and sound—can be encoded in streams of zeros and ones.

26 Which brings us back to Ezra Cornell.

27 Tucked at the rear of his monument, and almost completely obscured, is a telegraph machine—a modest reminder of his role in the creation of Western Union and the tying together of the North American continent.



28 As a carpenter turned entrepreneur, Cornell worked for Samuel Morse, whose name lives on in the code of dots and dashes through which the English language was reduced to the clicks of a telegraph key. Those two little symbols were the technological forerunners of today's zeros and ones.

29 Morse entrusted Cornell to build the nation's first telegraph line, a link from Baltimore to the U.S. Capitol, in Washington, D.C. From the very start it seemed that he had an inkling of what his

dots and dashes would bring. When the line was officially opened, on May 24, 1844, Morse sent the first message down the wire: “What hath God wrought.”

Excerpts and photographs from *THE JOY OF X: A Guided Tour of Math, from One to Infinity* by Steven Strogatz. Copyright (c) 2012 by Steven Strogatz. Reprinted with permission of Houghton Mifflin Harcourt Publishing Company. All rights reserved.

## QUESTIONS

1. This item has two parts. Answer Part A and then answer Part B.

**Part A: What does the word *concise* mean as used in paragraph 16?**

- A. basic and repetitive
- B. worth the effort
- C. thoughtfully defined
- D. graceful and sophisticated

**Part B: Which two sentences from the text help the reader understand the meaning of *concise*?**

- A. “Ten is marked by a position—the 10s place—instead of a symbol.”
- B. “All numbers can be expressed with the same 10 digits, merely by slotting them into the right places.”
- C. “Every number less than a million, for example, can be expressed in six symbols or fewer.”
- D. “Try doing that with words, tallies, or Roman numerals.”
- E. “With place-value systems, you can program a machine to do arithmetic.”
- F. “It’s the placeholder that allows us to tell 1, 10, and 100 apart.”

**2. The following item has two parts. Answer Part A and then answer Part B.**

**Part A: Which two central ideas are developed throughout the text?**

- A. Ezra Cornell was instrumental in advancing communications in the modern world.
- B. Roman numerals perform some functions better than others, so they are preferable to the more primitive tally system.
- C. Though most ancient cultures developed distinct ways of writing numbers, the system most people use today originated in ancient Babylon.
- D. As people have struggled to find efficient ways to represent numbers, systems have become more sophisticated.
- E. The development of new number systems has contributed to advancement of modern technology.
- F. Place value systems are preferable to tally systems, even though they both share a similar origin.

**Part B: Select two sentences from the text that contribute to the development of the ideas selected in Part A.**

- A. "Since the dawn of civilization, people have tried various systems for writing numbers and reckoning with them, whether for trading, measuring land, or keeping track of the heard."
- B. "What nearly all of these systems have in common is that our biology is deeply embedded in them."
- C. "But the greatest legacy of the Babylonians is the idea that's so commonplace today that few of us appreciate how subtle and ingenious it is."
- D. "Unfortunately, Roman numerals creaked and groaned when faced with anything larger than a few thousand."
- E. "Of course, we wouldn't write the symbol 2, because it doesn't exist in binary, just as there's no single numeral for 10 in decimal."
- F. "In the past few decades, we've come to realize that *all* information—not just numbers, but also language, images, and sound—can be encoded in streams of zeroes and ones."

**3. How does the explanation of a base 2 place value system develop the author's explanation of number systems?**

- A. It refines the idea that there are multiple efficient ways to manipulate numbers.
- B. It highlights the belief that number systems are primarily based on human biology.
- C. It develops the thought that modern number systems are influenced by the thinking of the ancient Babylonians.
- D. It supports the explanation that the base 10 system is the most efficient way to express numbers.

**4. This item has two parts. Answer Part A and then answer Part B.**

**Part A: What can the reader conclude about the zero's role in the base 10 place-value system?**

- A. It indicates absence.
- B. It indicates the position of a number.
- C. It proves that a number can be divided evenly.
- D. It reveals the number that the numeric system is based on.

**Part B: Which paragraph begins to develop the answer in Part A?**

- A. Paragraph 9
- B. Paragraph 11
- C. Paragraph 12
- D. Paragraph 13

5. Fill in the chart by writing each number system (listed below the chart) next to its correct description.

System	Description
	based on the repeated use of two symbols and place value
	assigns symbols to numbers of significance
	responsible for the idea that one number can be the basis for the entire system
	uses base ten and the zero to express any number

Systems

ancient Babylonian

ancient Roman

modern Hindu-Arabic

binary

6. This item has two parts. Answer Part A and then answer Part B.

**Part A: Why does the author most likely begin and end the passage with a description of Ezra Cornell's statue?**

- A. By analyzing the fact that the statue is inscribed with Roman numerals, the author introduces the idea that some systems are based on digits rather than logic.
- B. By mentioning the telegraph machine at the rear of the statue, the author expresses his admiration for someone who used numbers to become a pioneer of automation.
- C. In describing the depiction of the dates on the statue and Cornell's accomplishments, the author establishes a link between numbers and human history, progress, and communication.
- D. In focusing on the representation of Cornell's dignified nature, the author connects his admiration for place value systems with his admiration for Cornell.

**Part B: How does the answer to Part A impact the meaning of the passage?**

- A. It introduces the claim that numbers play a large part in shaping our world.
- B. It introduces the belief that numbers are more important than spoken language.
- C. It introduces the idea that anyone can master numbers with minimal effort.
- D. It introduces the argument that humans have finally developed a near-perfect number system.

**7. This item has two parts. Answer Part A and then answer Part B.**

**Part A: Which sentence explains how the author structures his claims in the article?**

- A.** He explains the strengths of several different number systems by highlighting the ways each deals with very large numbers.
- B.** He traces the evolution of different number systems throughout history by explaining how each system compares with the ones that preceded it.
- C.** He defines several different number systems by explaining how each relates to the ten digits on the human hand.
- D.** He describes the different number systems that have been used at various points in history by defining the importance of place value in each system.

**Part B: Which sentence explains how the structure of the article contributes to the author's argument?**

- A.** It provides compelling support for the claim that technology cannot advance without the development of systems that fail first.
- B.** It accentuates the claim that all number systems can be improved as time progresses.
- C.** It emphasizes the claim that the search for a practical ways to manipulate numbers has contributed to advances in society.
- D.** It explains the claim that base 10 is the most important advancement in the development of number systems.

8. Select the three most likely reasons the author begins his discussion of number systems with the overview the tally system and the human hand.

- A. to emphasize that the need for numbers stems from a problem that has always existed
- B. to introduce the idea that inherently complex numbers can be boiled down to something as simple as biology
- C. to present a detail supporting his belief that the Babylonians were unable to improve number systems
- D. to contribute to the explanation as to why the Hindu-Arabic system is based on the number 10
- E. to illustrate that cultures with a tally system did not do arithmetic
- F. to support the idea that the Romans invented the first number system
- G. to introduce point that number systems became much more sophisticated over time

9. Which sentence best states how the author develops his point of view regarding Roman numerals?

- A. He compares the diagonal slash to the thumb to show his belief that Roman numerals elegantly represent the human hand.
- B. He explains the simple logic of the position of the smaller number in relation to the larger number to show how patterns can make Roman numerals easier to use.
- C. He uses words such as “pompous” and describes using them as “creaking” to show that he believes Roman numerals may look impressive, but are actually an inefficient way of doing calculations.
- D. He states that “the fun never stopped” to show that, while Roman numerals were inefficient, calculations using Roman numerals were still enjoyable.





## Information for Teachers: Quantitative and Qualitative Analyses of the Text

Regular practice with complex texts is necessary to prepare students for college and career readiness. The text for this mini-assessment is placed at grade 11 for the purpose of this exemplar. This section of the exemplar explains the process that was used to place the text at grade 11 and the reasons that it meets the expectations for text complexity in Reading Standard 10. “Appendix A of the Common Core” and the “Supplement to Appendix A: New Research on Text Complexity” lay out a research-based process for selecting complex texts.

1. Place a text or excerpt within a **grade band** based on at least one<sup>1</sup> quantitative measure according to the research-based conversion table provided in the “Supplement to Appendix A: New Research on Text Complexity” ([www.corestandards.org/resources](http://www.corestandards.org/resources)).
2. Place a text or excerpt at a **grade-level** based on a qualitative analysis.

<b>“Location, Location, Location”</b>	<b>Quantitative Measure #1</b>	<b>Quantitative Measure #2</b>
	Lexile: 1430	Flesch-Kincaid: 9.6

After gathering the quantitative measures, the next step is to place the quantitative scores in the Conversion Table found in the “Supplement to Appendix A” ([www.corestandards.org/resources](http://www.corestandards.org/resources)) and determine the **grade band** of the text. Note the overlap in the measures at the 11-CCR band, which indicates agreement between the two quantitative tools for the higher band.

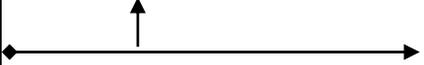
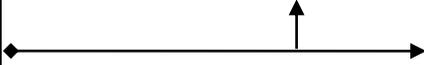
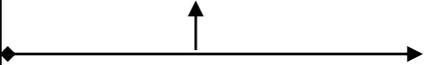
Figure 1 reproduces the conversion table from the Supplement to Appendix A, showing how the initial results from Flesch-Kincaid and the Lexile measure were converted to grade bands.

**Figure 1: Updated Text Complexity Grade Bands and Associated Ranges from Multiple Measures<sup>7</sup>**

Common Core Band	ATOS	Degrees of Reading Power®	Flesch-Kincaid <sup>d</sup>	The Lexile Framework®	Reading Maturity	SourceRater
2 <sup>nd</sup> – 3 <sup>rd</sup>	2.75 – 5.14	42 – 54	1.98 – 5.34	420 – 820	3.53 – 6.13	0.05 – 2.48
4 <sup>th</sup> – 5 <sup>th</sup>	4.97 – 7.03	52 – 60	4.51 – 7.73	740 – 1010	5.42 – 7.92	0.84 – 5.75
6 <sup>th</sup> – 8 <sup>th</sup>	7.00 – 9.98	57 – 67	6.51 – 10.34	925 – 1185	7.04 – 9.57	4.11 – 10.66
9 <sup>th</sup> – 10 <sup>th</sup>	9.67 – 12.01	62 – 72	8.32 – 12.12	1050 – 1335	8.41 – 10.81	9.02 – 13.93
11 <sup>th</sup> – CCR	11.20 – 14.10	67 – 74	10.34 – 14.2	1185 – 1385	9.57 – 12.00	12.30 – 14.50

<sup>1</sup> For higher stakes tests, it is recommended that two corresponding text complexity measures be used to place a text in a grade band. When two measures are used, both placing the text in the same **band**, the results provide additional assurance that the text selected is appropriate for the band.

To find the **grade-level** of the text within the designated grade band, engage in a systematic analysis of the characteristics of the text. The characteristics that should be analyzed by doing a qualitative analysis, a sample of which can be found in Appendix A of the CCSS. ([www.corestandards.org](http://www.corestandards.org)).

Qualitative Analysis	"Location, Location, Location"	Where to place within the band?					
Category	Notes and comments on text, support for placement in this band	Too Low	Early-mid 11	Mid-end 11	Early – mid 12	End 12	NOT suited to band
Structure: (both story structure or form of piece)	This excerpt, primarily chronologically, describing the evolution of number systems throughout history, beginning with Roman numerals and the Babylonian system based on 60 to the more modern binary system used in computers. The images, though simple, are supplementary and helpful to the reader’s comprehension by providing context for the description of the Cornell statue as well as some of the more abstract mathematical concepts (e.g., how Roman Numerals handle larger numbers using a bar).						
Language Clarity and Conventions	The text includes a mix of simple and compound sentences, with more complex constructions ( <i>But in the Hindu-Arabic system, it’s a snap to write any number, no matter how big.</i> ). Vocabulary is fairly complex ( <i>unpretentious, reckoning, vestige, appendages</i> ). Additionally, there are many instances of domain specific vocabulary, however these words should be familiar to the average high school student ( <i>digit, place-value systems, and placeholder</i> ).						
Knowledge Demands (life, content, cultural/literary)	To understand the text, it would be helpful for students to have some familiarity with the concept of number systems, for example, Roman Numerals. The article contains a mix of recognizable ideas and abstract concepts that may be challenging to some students.						
Levels of Meaning (chiefly literary)/ Purpose (chiefly informational)	The main purpose of the article is implied, but easy to infer. From paragraph 5, “Finding a good way to represent numbers has always been a challenge. Since the dawn of civilization, people have tried various systems for writing numbers and reckoning with them, whether for trading, measuring land, or keeping track of the herd.”						
<b>Overall placement: Grade 11</b>	<b>Justification: Because of this text’s chronological order, vocabulary, and knowledge demands, this text has been placed at 11<sup>th</sup> grade.</b>						

## Question Annotations & Correct Answer and Distractor Rationale

Question Number	Correct Answer(s)	Standards	Rationales for Answer Options
<b>1, Part A</b>	<b>A</b>	<b>RI.11–12.4, RI.11–12.1</b>	<p><b>A.</b> This is the correct answer. “Basic and repetitive” defines concise as it is used in this text. The author describe how most numbers can “be expressed in six symbols or fewer,” implying conciseness.</p> <p><b>B.</b> Though something that is concise may require some effort, “worth the effort” does not define the term as it is used in the text.</p> <p><b>C.</b> Though something that is concise may be “thoughtfully defined,” this does not actually give the meaning of the term.</p> <p><b>D.</b> Though things that are concise are often “graceful and sophisticated,” the term means is not defined as such in the text.</p>
<b>1, Part B</b>	<b>B, C</b>		<p><b>A.</b> This sentence explains the 10s place, rather than the process for expressing numbers in the Hindu-Arabic system.</p> <p><b>B.</b> This is a correct answer. This sentence explains the limited number of digits used and the repetitive process for expressing them.</p> <p><b>C.</b> This is a correct answer. This sentence provides an example of the basic and repetitive nature of expressing numbers in this system because of the limited number of symbols that can be used.</p> <p><b>D.</b> This sentence reminds readers of the burden of expressing large numbers with other systems.</p> <p><b>E.</b> This sentence explains a benefit of the concise Hindu-Arabic system, but does not explain how such a system is simple and repetitive to use.</p> <p><b>F.</b> This sentence explains the importance of zero, not the concise nature of the Hindu-Arabic system.</p>

Question Number	Correct Answer(s)	Standards	Rationales for Answer Options
2, Part A	D, E	RI.11–12.2, RI.11–12.1	<p><b>A.</b> Although Cornell is referenced, the majority of the text focuses on how numbers are represented and then used in modern technology.</p> <p><b>B.</b> The author does say that Roman numerals are “slightly more sophisticated than tallies,” but the focus is on number systems as a whole, and not the distinction between two early systems.</p> <p><b>C.</b> Although our number system is based on that of the Babylonians, this statement is an important detail explaining the development of number systems, and not a central idea of the text as a whole.</p> <p><b>D.</b> This is a correct answer. Paragraphs 1–20 focus on the evolution and increasing sophistication of number systems, including the Roman, Hindu-Arabic, and Babylonian systems.</p> <p><b>E.</b> This is a correct answer. Paragraphs 21–29 focus on the role of number systems in modern technology.</p> <p><b>F.</b> Although the author expresses admiration for place value systems, the statement that they share the same origins is inaccurate. He states that the Babylonians “were not nearly as attached to their fingers....” emphasizing the differences in origin of place value and tally systems.</p>
2, Part B	A, F	RI.11–12.2, RI.11–12.1	<p><b>A.</b> This is a correct answer. This sentence explains various purposes of number systems throughout history.</p> <p><b>B.</b> The central ideas focus on the increasing sophistication of number systems and how the systems have impacted technology, not what they have in common.</p> <p><b>C.</b> This sentence highlights a feature of only one number system, not a central idea about all of the systems explained in the text.</p> <p><b>D.</b> This sentence highlights a pitfall of the Roman system, not a central idea about all of the systems explained in the text.</p> <p><b>E.</b> This sentence highlights a detail of how to represent numbers in different number systems, not a central idea about all of the systems explained in the text.</p> <p><b>F.</b> This is a correct answer. This sentence explains how number systems have contributed to modern technology.</p>
3	A	RI.11–12.3, RI.11–12.1	<p><b>A.</b> This is the correct answer. The author’s explanation of the binary system enhances the idea that there is not only one way to easily manipulate or represent numbers.</p> <p><b>B.</b> Although several of the systems described in the text are based on human biology, with bases of ten mirroring the number of human fingers, the binary system is not.</p> <p><b>C.</b> The binary system is not based on the Babylonian system.</p> <p><b>D.</b> The binary system is based on a base of two, rather than ten.</p>

Question Number	Correct Answer(s)	Standards	Rationales for Answer Options		
4, Part A	B	RST.11–12.8, RI.11–12.3, RI.11–12.1	<p><b>A.</b> Although zero can indicate a lack of something, in the base 10 place-value system, it serves as a placeholder.</p> <p><b>B.</b> This is the correct answer. According to paragraph 12, zero’s “distinguished status is signified not by a symbol but by a parking spot, a reserved piece of real estate.”</p> <p><b>C.</b> Although numbers ending in zero can be divided evenly, that is not the role of zeros in the place-value system.</p> <p><b>D.</b> The Hindu-Arabic system is based on ten, rather than zero.</p>		
4, Part B	C		<p><b>A.</b> Paragraph 9 focuses on the Babylonian’s base on 60, not zero.</p> <p><b>B.</b> Paragraph 11 focuses on the Hindu-Arabic base of 10, not zero.</p> <p><b>C.</b> This is the correct answer. According to Paragraph 12, “The great innovation here is that even though this system is based on the number 10, there is no single symbol reserved for 10.”</p> <p><b>D.</b> Paragraph 13 focuses on the Roman numeral system’s approach to place-value, not zero.</p>		
5	See right column.	RST.11–12.4, RST.11–12.2, RST.11–12.1	<b>System</b>	<b>Description</b>	<b>Rationale</b>
			binary	Based on the repeated use of two symbols and place value	According to Paragraph 22, “A strong case can be made for base 2, the famous and now ubiquitous binary system...” and “Of all of the possible bases, it requires the fewest symbols—just two of them, 0 and 1.”
			ancient Roman	assigns symbols to numbers of significance	According to Paragraph 14, “The Roman approach was to elevate a few favored numbers, give them their own symbols, and express all the other, second-class numbers as combinations of those.”
			ancient Babylonian	responsible for the idea that one number can be the basis for the entire system	According to Paragraph 9, “Their numerical system was based on 60.”
			modern Hindu-Arabic	uses base ten and the zero to express any number	According to Paragraphs 16 and 19, “All numbers can be expressed with the same ten digits,” and “But the unsung hero in this story is 0.”

Question Number	Correct Answer(s)	Standards	Rationales for Answer Options
6, Part A	C	RST.11–12.6, RST.11–12.2, RST.11–12.1, RI.11–12.5, RI.11–12.1	<p><b>A.</b> Although the statue is inscribed with Roman numerals, this is a minor detail relative to Cornell’s accomplishments and the progression of systems throughout history.</p> <p><b>B.</b> Although the author does conclude with a detail about the telegraph machine, the focus of the article is on a variety of systems developed throughout history.</p> <p><b>C.</b> This is the correct answer. Cornell’s role in modern technology provides a specific example of the author’s claim that advances in mathematical systems contributed to the development of new technology.</p> <p><b>D.</b> The appearance of the statue and the author’s admiration of Cornell is a minor detail compared to the author’s overall argument that progressions in number systems led to advances in technology.</p>
6, Part B	A		<p><b>A.</b> This is the correct answer. By providing a real world example of how a number system contributed to the development of a new technology, the author shows how prevalent such systems are in our daily lives.</p> <p><b>B.</b> Although the importance of numbers is evident from this text, the author does not suggest a comparison between numbers and spoken language.</p> <p><b>C.</b> Although Paragraph 17 says, “ordinary people can learn to do arithmetic,” the author mentions that the dates on Cornell’s statue are “hard to read and cumbersome.”</p> <p><b>D.</b> Given the numerous examples and iterations of systems mentioned in the article, the article does not suggest that the current number system is the pinnacle.</p>
7, Part A	B	RI.11–12.5, RI.11–12.1	<p><b>A.</b> Although the author explains several number systems, he focuses on a variety of their attributes, which does not always include easily handling large numbers.</p> <p><b>B.</b> This is the correct answer. The author describes various number systems throughout history, including those of the Romans, Babylonians, and Hindu-Arabic.</p> <p><b>C.</b> Although the author explains several number systems, not all of the systems relate to the ten digits on the human hand.</p> <p><b>D.</b> Although the author explains several number systems, not all of the systems use place values.</p>

Question Number	Correct Answer(s)	Standards	Rationales for Answer Options
7, Part B	C		<p><b>A.</b> Although the author concludes his analysis with the modern binary system, he does not purport that technology hinges on past failures.</p> <p><b>B.</b> Although the systems in the text evolved over time, not all number systems are used for the same purpose and are not necessarily improvements over past systems.</p> <p><b>C.</b> This is the correct answer. The author concludes the text with a real-world example, the telegraph, which was possible due to the advancements of number systems.</p> <p><b>D.</b> Although the author does call the base 10 concept a “great innovation,” he does not claim that it is the most important advancement.</p>
8	A, D, G	<p><b>RST.11–12.6,</b> <b>RST.11–12.1</b></p>	<p><b>A.</b> This is a correct answer. This example demonstrates how long-standing this need has been.</p> <p><b>B.</b> Although there is a link between the tally system and human biology, that link is not based solely on the complexity of representing numbers.</p> <p><b>C.</b> In Paragraph 9, the author explains how the Babylonians improved upon the Roman numeral system by basing theirs on 60.</p> <p><b>D.</b> This is a correct answer. According to Paragraph 11, the Hindu-Arabic system is based on ten digits.</p> <p><b>E.</b> According to Paragraph 8, Roman numerals, based on tallies, are situated to indicate subtraction or addition.</p> <p><b>F.</b> Although the author explains the Roman number system at the beginning of the text, the text does not claim that this was the first number system.</p> <p><b>G.</b> This is a correct answer. Through the number systems discussed in the text, the refinement of the systems has developed from crude tallies to the two-digit binary system.</p>
9	C	<p><b>RI.11–12.6,</b> <b>RI.11–12.1</b></p>	<p><b>A.</b> According to Paragraph 8, “Roman numerals are only slightly more sophisticated than tallies,” which is the crudest system described in the article.</p> <p><b>B.</b> Although the author explains how Roman numerals are ordered to suggest addition or subtraction, he highlights the number four as an “ambiguous case.”</p> <p><b>C.</b> This is the correct answer. In Paragraph 15, Roman numerals are described: “creaked and groaned when faced with anything larger than a few thousand.”</p> <p><b>D.</b> This phrase shows that this number system was able to indicate very large numbers, even if inefficiently doing so.</p>

Question Number	Correct Answer(s)	Standards	Rationales for Answer Options
10	See right column	<b>W.11–12.2,</b> <b>W.11–12.4,</b> <b>W.11–12.9</b> <b>RI.11–12.6,</b> <b>RI.11–12.3,</b> <b>RI.11–12.1,</b> <b>RST.11–12.1,</b> <b>L.11–12.1,</b> <b>L.11-12.2,</b> <b>L.11-12.3</b>	<p><b>A top score response will include:</b></p> <ul style="list-style-type: none"> <li>• The author feels that the base-10 place-value system is a vitally important advancement.</li> <li>• One method he uses to convey his point of view is rhapsodic language when discussing the place-value system: <ul style="list-style-type: none"> <li>○ In paragraph 10, he refers to it as “subtle and ingenious”</li> <li>○ In paragraph 12, he mentions “great innovation”</li> <li>○ In paragraph 13, he mentions “elegance”</li> <li>○ In paragraph 18, he calls it a “beautiful idea”</li> </ul> </li> <li>• Another method he uses is comparison; he unfavorably compares Roman numerals to base-10 place-value: <ul style="list-style-type: none"> <li>○ He says Roman numerals take a “much cruder approach” (para 13)</li> <li>○ He describes how Roman numerals make it hard to write big numbers (para 15)</li> <li>○ He then shows how the Hindu-Arabic system, which is a place value system, makes it “a snap” to write any number, “no matter how big” (para 16)</li> </ul> </li> <li>• The author supports the idea that base-10 place value is “ingenious” by showing that: <ul style="list-style-type: none"> <li>○ It is logical</li> <li>○ It makes it possible to write any number</li> <li>○ It makes arithmetic possible, for both people and machines</li> </ul> </li> </ul>

## Additional Resources for Assessment and CCSS Implementation

**Shift 1 – Complexity:** *Regular practice with complex text and its academic language*

- See Appendix B for examples of informational and literary complex texts  
[http://www.corestandards.org/assets/Appendix\\_B.pdf](http://www.corestandards.org/assets/Appendix_B.pdf)
- See the Text Complexity Collection on [www.achievethecore.org](http://www.achievethecore.org)

**Shift 2 – Evidence:** *Reading, writing, and speaking grounded in evidence from text, both literary and informational*

- See Close Reading Exemplars for ways to engage students in close reading on  
<http://www.achievethecore.org/steal-these-tools/close-reading-exemplars>
- See the Basal Alignment Project for examples of text-dependent questions  
<http://www.achievethecore.org/basal-alignment-project>

**Shift 3 – Knowledge:** *Building knowledge through content-rich nonfiction*

- See Appendix B for examples of informational and literary complex texts  
[http://www.corestandards.org/assets/Appendix\\_B.pdf](http://www.corestandards.org/assets/Appendix_B.pdf)

**Sample Scoring Rubric for Text-Based Writing Prompts:**

[http://achievethecore.org/content/upload/Scoring\\_Rubric\\_for\\_Text-Based\\_Writing\\_Prompts.pdf](http://achievethecore.org/content/upload/Scoring_Rubric_for_Text-Based_Writing_Prompts.pdf)