READING

Questions 1 – 10:

This passage is adapted from David Malouf, "The Valley of Lagoons." ©2006 by David Malouf. The narrator remembers his childhood in Australia in the 1950s.

Braden McGowan had been my best friend since I was five years old. We started school on the same day, sharing a desk and keeping pace with one another through pot-hooks and the alphabet, time tables, cursive, and those scrolled and curlicued capitals demanded by our Queensland State School copybooks. We dawdled to and from school on our own circuitous route. Past the Vulcan Can Company, where long shiny cut-offs of raw tin were to be had, which we carted off in bundles to be turned into aids of our own devising, past the crushing-mill where we got sticks of sugar cane to chew. Narrow gauge lines ran to the mill from the many outlying farms, and you heard at all hours in the crushing season the noise of trundling, and the shrill whistle of the engine as a line of carts approached a crossing, and rumbled through or clanked to a halt.

In the afternoons after school and in the holidays, we played together in the paddocks and canebrakes of the McGowans' farm, being, as the mood took us, explorers, pirates, commandos, bushrangers, scouts on the track of outlaws.

Usually we had a troop of the McGowan dogs with us, who followed out of doggy curiosity and sometimes, in the belief that they had got the scent of what the game was, moiled around us or leapt adventurously ahead. But for the most part they simply lay and watched from the shade, till we stretched out beside them and let the game take its freer form of untrammeled thinking-aloud that was also, with its range of wild and rambling surmise, the revelation—even to ourselves, though we were too young as yet to know it—of bright, conjectural futures we would have admitted to no one else.

"You two are weird," Braden's brother Stuart told us, having caught on his way to the bails some extravagant passage of our talk.

Stuart was four years older. He and the eldest of the three brothers, Glen, had farm work to do in the afternoons after school. Braden in those days was still little and free to play.

They were rough kids, the McGowans.

I had come late into a family of girls, two sisters who, from the beginning, had made a pet of me. Going over to the McGowans' was an escape to another world. Different laws were in operation there from the ones I was used to. Old Mr. McGowan had a different notion of authority from the one my father followed. Quiet but firmer. His sons, who were so noisy and undisciplined outside, were subdued in his presence. Mrs. McGowan, unlike my mother, had no interests beyond the piles of food she brought to the table and the washing—her men's overalls and shirts and singlets, and the loads of sheets and pillowcases I saw her hoist out of the copper boiler when I came to collect Braden on Monday mornings.

She too had a softening influence on the boys. They might complain when she called them in from kicking a football round the yard, or working on a bike, to fetch in an armful of wood for the stove or to carry a basket of wet sheets to the line, and they squirmed when she tried to settle an upturned collar or hug them. But they did do what she asked in the end, and even submitted, with a good show of masculine reluctance, to hugging.

I liked the roughness and ease I found at the McGowans', but even more the formality, which was of a kind my parents would have wondered at and found odd, old-fashioned.

My sisters, Katie and Meg, were exuberantly opinionated. Our mealtimes were loud with argument in which we all talked over one another, our parents included, and the food itself was forgotten.

There was no arguing at the McGowans'. Glen and Stuart, rough and barefooted as they were, showed their hands before they were allowed to table, sat up straight, kept their elbows in.

They passed things without speaking. Barely spoke at all unless their father asked a question, or in response to a story he told, or to tell their mother how good the stew was in hope of a second helping.

I loved all this. When Braden began to have his own jobs to do after school, I stayed to help. I learned to milk, to clean out the bails, then stayed for the McGowans' early tea. I wanted to be one of them, or at least to be like them.

1. Over the course of the passage, the main focus shifts from

A. portraying characters' typical activities to recounting an unusual event.
B. describing an important relationship to characterizing a family.
C. expressing a character's feelings to explaining the circumstances behind them.
D. illustrating a specific occurrence to reflecting on a family's influence.

2. The passage indicates that while walking to and from school, Braden and the narrator

A. typically avoid certain parts of town.
B. generally prefer to take their time.
C. usually arrive late to their destination.
D. often try to meet up with other children.

3. The narrator's use of the words "trundling," "shrill whistle," "rumbled," and "clanked" (line 10-12) mainly serves to

A. detail the process by which the crushing-mill typically operates.
B. establish why the narrator finds this environment intriguing.
C. contrast the noise of the crushing-mill with the silence of the farm.
D. evoke the industrial atmosphere of a location from the narrator's childhood.

4. The second paragraph (line 13-16) mainly serves to

A. explain how the narrator and Braden became close friends.
B. emphasize the narrator and Braden's fascination with the farm.
C. present the narrator and Braden as active and imaginative.
D. depict how the narrator and Braden devise ways to avoid doing chores.

5. It can reasonably be inferred from the passage that the narrator and Braden have a friendship in which they

A. help each other succeed at difficult subjects and tasks in school.
B. disagree with each other occasionally about how to approach their challenges.
C. amuse each other by urging their pets to participate in a variety of games.
D. trust each other with confessions about their personal hopes and dreams.

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

A. line 1-5 ("We started . . . copybooks")
B. line 17-20 ("Usually . . . ahead")
C. line 20-25 ("But . . . else")
D. line 26-30 ("You . . . play")

7. The passage most strongly suggests that the narrator views the McGowan boys as people who

A. would benefit from additional restrictions on their actions.
B. emulate the best qualities of their mother and father.
C. know how to demonstrate self-control when needed.
D. are unpredictable when confronted with unexpected situations.

8. As used in line 41, "collect" most nearly means

A. save.
B. contain.
C. arrange.
D. meet.

9. The passage most strongly suggests that one difference between the narrator's household and the McGowans' is that the

A. McGowans place a high value on their children displaying proper etiquette, whereas the narrator's parents find the idea of etiquette offensive.
B. McGowan children are expected to take responsibility for chores around the house, whereas the narrator and his sisters have few responsibilities at home.
C. narrator and his sisters are instructed to follow established rules, whereas the McGowan children need little prompting to adhere to traditional customs.
D. narrator's parents allow their children to share their honest perspectives on matters, whereas the McGowans expect their children to be more deferential.

10. In conjunction with line 52-54 ("Our . . . forgotten"), which choice provides the best evidence for the answer to the previous question?

A. line 42 ("She . . . boys")
B. line 46-48 ("But . . . hugging")
C. line 58-60 ("Barely . . . helping")
D. line 61-62 ("When . . . help")

Questions 11-21:

Line

Passage 1

Enemies of objectivity argue that because journalists must be free of bias to be objective, and because this is impossible, it follows that objectivity is a false ideal. As a group, journalists probably have more opinions than most, and it is very rare that a reporter starts working on a story without having some notion as to what happened—in other words, a point of view. But objectivity does not require that journalists be blank slates free of bias. In fact, objectivity is necessary precisely because they are biased.

. . . [Journalists] Bill Kovach and Tom Rosenstiel describe what they call “the lost meaning of objectivity.” As [they] point out, “In the original concept . . . the method is objective, not the journalist.” It was because journalists inevitably arrived with bias that they needed objectivity as a discipline to test that bias against the evidence so as to produce journalism that would be closer to truth.

They argue that the quickening of objectivity as the American journalistic standard was born of a desire to have a more scientific way of approaching news. . . . Scientists begin their research with assumptions. They have expectations of what will happen, but they don’t know what will happen. They have, in other words, their own opinions and beliefs—their point of view or even bias—about what is likely the truth, and they do their research to test those assumptions. Their objective, scientific inquiry is not one that is without bias, but one in which bias has to stand up to evidence and results.

This is the sensible and realistic approach to objectivity that might be termed *genuine objectivity*. It begins with the assumption that journalists have bias, and that their bias has to be tested and challenged by gathering facts and information that will either support it or knock it down.

Often, there is information that does both, and that ambiguity needs to be reported with the same dispassion with which a scientist would report variations in findings that were inconclusive.

Passage 2

[The scientific] ideal remains quite popular among journalists. They continue to fancy themselves as experts at providing objective and balanced information on critical pieces of information and as the only ones who can be trusted with providing an unbiased viewpoint.

This philosophy, however, is faulty even at its most basic foundation. . . . [I]n recent decades, numerous cracks have shown up in the facade of scientific objectivity among even physical scientists. Thanks to the research in the fields of the "sociology of science" and the "economics of science," there is increasing documentation illustrating what should have been obvious all along—namely that scientists are not immune to the effects of their own personal biases.

For example, scientists and researchers commonly assert that scientists are not meaningfully affected by the fact that, say, they receive large government grants or rely on certain public policies to make a living. Or, they insist that a scientist would not be diverted from a relentless pursuit of "truth," even if the truth revealed were to call into question the theories on which that scientist has based his or her entire career. In other words, we're told to believe that a scientist's ego or material needs has no effect on how he conducts himself. This is plausible, it is implied, because scientists are imbued with a special level of integrity and devotion to scientific inquiry.

Believing this, of course, requires a nearly heroic level of naivete as well as ignorance about the economic underpinnings of scientific research—or the social pressures under which scientists function.

There is no doubt that many scientists *try* to be objective. But this doesn't mean they actually *are* objective.

On the other hand, scientists have a better claim to objectivity than journalists. In many fields, scientists are constrained by whether or not their scientific knowledge is actually useful. Prescription drugs either work or they don't. New building materials and new chemical solutions either work or they don't.

Many physical scientists are thus limited in how they might indulge their biases by the successful application of their discoveries and conclusions.

Journalism has no such check on its own work, and thus we see the fundamental flaw in [the] attempt at making journalism "scientific." There's no practical measure of whether or not a news story has been communicated scientifically or not.

11. As used in line 2, “free of” most nearly means

A. uninterested in.
B. unworthy of.
C. uninfluenced by.
D. unaware of.

12. Which choice best supports the idea that Jones (Passage 1) believes that journalists have a responsibility to do their jobs even if there is conflicting information that may remain unresolved?

A. line 4-7 (“As a . . . view”)
B. line 12-15 (“It was . . . truth”)
C. line 22-24 (“Their . . . results”)
D. line 29-31 (“Often . . . inconclusive”)

13. The sentences in line 7-9, Passage 1 (“But . . . biased”) mainly serve to

A. criticize a familiar idea in order to analyze the significance of emerging research regarding that idea.
B. challenge an understanding of a concept in order to introduce a new perspective about that concept.
C. summarize the steps of a scientific method in order to discuss improvements to that method.
D. consider the implications of a belief in order to demonstrate the widespread cultural influence of that belief.

14. In Passage 1, the journalists Kovach and Rosenstiel draw an explicit distinction between a

A. characteristic of an individual and a characteristic of a process.
B. goal of a particular professional and a goal of an ordinary citizen.
C. source of a belief and the increasing popularity of that belief.
D. conclusion about the past and a reasonable expectation of the future.

15. According to Passage 1, the concept of genuine objectivity is based on the expectation that journalists

A. will strive to inform the public about the true state of affairs.
B. will be guided by evidence in confronting their biases.
C. can be trusted to provide an unbiased viewpoint on most topics.
D. struggle to overcome external influences related to their stories.

16. As used in line 35, “critical” most nearly means

A. severe.
B. humbling.
C. derogatory.
D. crucial.

17. Based on Passage 2, with which claim about objectivity would McMaken most likely agree?

A. Although objectivity is impossible, people in some fields pursue it more successfully than do people in other fields.
B. Although objectivity is difficult to achieve, it has become more possible in the present than it was in the past.
C. Although objectivity is a goal common to many disciplines, it can actually prove to be dangerous in certain circumstances.
D. Although objectivity is commendable, it should not be pursued to the exclusion of other worthy goals.

18. Which statement best describes the relationship between the two passages?

A. Passage 2 criticizes the motives of people who approve of the views discussed in Passage 1.
B. Passage 2 challenges the ultimate possibility of an outcome analyzed in Passage 1.
C. Passage 2 clarifies the historical context of the ideas examined in Passage 1.
D. Passage 2 confirms the accuracy of the research conclusions summarized in Passage 1.

19. Based on Passage 2, McMaken would most likely believe that journalists who follow the “more scientific way” (line 17), as described in Passage 1, may

A. discount evidence that undermines their opinions.
B. expose political influence shaping their research.
C. represent an elitist movement in their profession.
D. exaggerate the challenges of objective investigation.

20. Based on Passage 1, Jones would most likely respond to McMaken’s claim in line 39-43, Passage 2 (“Thanks . . . biases”) by

A. conceding that current research has changed the way that scientists are perceived.
B. agreeing that scientists may hold a personal perspective regarding their work.
C. arguing that the scientific method demonstrates an overall lack of bias in research.
D. suggesting that the effects of a lack of objectivity in science are not fully understood.

21. Which choice from Passage 1 provides the best evidence for the answer to the previous question?

A. line 2-4 (“Enemies . . . ideal”)
B. line 10-11 (“Journalists . . . objectivity”)
C. line 11-12 (“As they . . . journalist”)
D. line 20-22 (“They . . . assumptions”)

Questions 22-31:

This passage is adapted from Terri Cook, "Wormholes May Limit Landslides." ©2015 by American Geosciences Institute.

Emma Harrison, a graduate student at the University of Pennsylvania, had gone to northeastern Puerto Rico's Luquillo Mountains, which rise steeply from sea level up to 1,075 meters in elevation, to look into why erosion rates aren't as high as it seems they should be. Uplifted between about 37 million and 28 million years ago, this range is the first barrier on the island encountered by the prevailing easterly winds, which carry moisture from the Caribbean Sea. The resulting orographic effect[1] produces copious rainfall, exceeding 5 meters per year at higher elevations, where a dense rainforest thrives. "With the amount of precipitation [the area] gets, you should be eroding the range at a much quicker rate," Harrison explains. Whereas erosion rates in the Luquillos range from about 0.05 to 0.18 millimeters per year depending on elevation, rates are typically much higher in other high-precipitation tropical environments, she says; the mountains of Taiwan, for example, lose between 2.2 and 8.3 millimeters per year.

At the Luquillo Critical Zone Observatory—one of 10 such National Science Foundation-funded observatories focused on studying the so-called critical zone between the treetops and the base of weathered rock—researchers like Harrison are working to understand why these mountains are still as high as they are. Intrigued by the abundance and prodigious activity of endogeic worms[2] at her field site, Harrison wondered whether their presence could influence weathering in the Luquillos. Previous studies had found that landslides account for most of the erosion in the lush, tropical and steep environment of the Luquillos, and that removing earthworms from an experimental plot in the mountains greatly increased surface runoff and the downhill transport of fine organic matter.

What were the earthworms doing to the soil to create such a difference? Along with undergraduate Aria Kovalovich, Harrison constructed several clear earthworm nests that were thin enough to allow the team to observe worm tunneling in two dimensions. After placing endogeic worms and soil native to the Luquillos in the nests, the researchers stored them in a dark room, pulling them out once per day to photograph the worms' progress. Using image-processing software, the researchers then quantified changes in the amounts of material excavated in the tunnels from day to day. After two weeks, they also measured the nests' bulk densities and their permeability to water.

On average, the soil in the experimental nests was compacted by 4.3 percent, the team reported. "It's very rare to see [levels of] compaction like that," Harrison says. "It was really surprising; we had

actually thought that there would be an increase in the volume of the soil," she adds, because worms are often observed to churn up and aerate soils.

There could be several reasons for the compaction, Harrison explains. First, as the earthworms burrow, they push the dirt surrounding the tunnels together, reducing pore space between soil particles. In addition, when soil particles are ingested and later excreted by worms, the particles tend to be compacted, she says. The soil is also compacted when earthworm tunnels collapse.

Based on the experiments, the researchers concluded that earthworms are significant biological agents that actively restructure the Luquillo soils, and that the worms' tunnel networks increase the rate at which precipitation filters through the soil. This allows water to drain more rapidly from the clay-rich surface where landslides most frequently occur. The end result, according to the team's hypothesis, is fewer landslides and a slower rate of erosion in the Luquillo Mountains.

22. According to the passage, the location of the Luquillo Mountains in northeastern Puerto Rico is important because it

A. enables the Luquillos to support an unusually diverse array of earthworms.
B. leads to the Luquillos' receiving an especially large amount of precipitation.
C. ensures that the Luquillos are shielded from the effects of the prevailing winds.
D. protects the Luquillos from the high erosion rates seen in other areas of the island.

23. As used in line 10, "should" is best understood as

A. expressing an expectation.
B. acknowledging an obligation.
C. indicating a condition.
D. signaling an intention.

24. In the first paragraph, the author refers to the mountains of Taiwan primarily to

A. offer a counterexample that emphasizes the variability in the erosion rate in the Luquillos.
B. provide a comparison that illustrates the relatively low erosion rate in the Luquillos.
C. highlight the erosion rate typically found in mountains that are taller than the Luquillos.
D. show a contrast between the erosion rate in mountain ranges with low rainfall and the erosion rate in the Luquillos.

25. Based on the passage, which choice best describes the scientific understanding of erosion in the Luquillo Mountains before Harrison conducted her experiment?

A. Scientists had data indicating that erosion in the Luquillos encourages the proliferation of earthworms but did not know why erosion had this effect.
B. Scientists had a theory that erosion rates in the Luquillos are influenced by the activity of animals but did not know which ones.
C. Scientists had reason to believe that earthworms contribute to reduced erosion in the Luquillos but did not know how they contributed.
D. Scientists had evidence suggesting that erosion in the Luquillos varies with precipitation but did not know the extent of the variation.

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

A. line 1-7 (“Emma . . . Sea”)
B. line 9-15 (“With . . . year”)
C. line 16-20 (“At the . . . are”)
D. line 22-28 (“Previous . . . difference”)

27. As used in line 33, “progress” most nearly means

A. activity.
B. maturation.
C. improvement.
D. increase.

28. According to the passage, how do endogeic worms indirectly promote soil compaction?

A. Empty spaces in the soil are eliminated when their tunnels cave in.
B. Their body weight compresses the soil beneath them as they move.
C. Rainwater that runs through their tunnels melds soil particles together.
D. Dense surface clay sticks to their bodies and gets carried underground.

29. Which finding, if true, would best support the conclusions of Harrison’s team as presented in the passage?

A. The orographic effect that occurs in the Luquillos does not occur in most high-precipitation tropical mountain ranges.
B. The density of the soil in the Luquillos is approximately the same as that found in most high-precipitation tropical mountain ranges.
C. The tunnels made by endogeic worms in the Luquillos are smaller than those typically found in high-precipitation tropical mountain ranges.
D. The endogeic worms common in the Luquillos are typically absent from high-precipitation tropical mountain ranges.

30. Based on the passage, if endogeic worms were removed from the Luquillos, one likely result would be that

A. landslides would become less frequent but more intense than they currently are.
B. rainwater would remain at the soil surface for longer than it currently does.
C. soil particles would be separated by less pore space than they currently are.
D. the soil surface would contain more clay than it currently does.

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

A. line 42-44 (“First . . . particles”)
B. line 46-47 (“The soil . . . collapse”)
C. line 51-53 (“This . . . occur”)
D. line 53-54 (“The end . . . Mountains”)

Questions 32-41:

This passage and figure 1 are adapted from Kartik Hosanagar, A Human's Guide to Machine Intelligence: How Algorithms Are Shaping Our Lives and How We Can Stay in Control. ©2019 by Kartik Hosanagar. Many commercial websites make automated purchase recommendations to users based on past behavior on the sites.

Line

In Chris Anderson's book *The Long Tail*, he suggested that the main effect of automated recommendations would be to help people move from the world of hits to a world of niches—obscure products that are closer to our individual preferences but never get our attention in mainstream markets.

Like many others, I thought the idea made sense—up until the spring of 2006, when a PhD class I was teaching forced me to reconsider the notion entirely.

We were discussing the design of personalization algorithms used by Netflix, Amazon, and other online firms. Daniel Fleder, one of my students, asked if the design of common algorithms might not actually do the opposite—that is, reduce the diversity of items we consume. He suggested that collaborative filtering algorithms might be biased toward popular, rather than obscure, items because they recommend items based on what others are consuming.

Fleder's question intrigued me, and that summer we launched what became a series of studies on how algorithmic recommendations affect product discovery, and whether they aid or hurt niche products. In the first study I did with Fleder, we argued that because common recommendation algorithms promote products based on past sales and ratings ("people who bought X also bought Y"), they cannot recommend products that have only limited historical data, even if these products were likely to be rated favorably. That would skew the recommendations toward already popular products. We developed simulations of several commonly used recommendation algorithms to test the theory, and they indeed demonstrated that these algorithms can create a rich-get-richer effect for popular items.

To further test the theory, in a second study with Dokyun Lee at Carnegie Mellon University, we ran an experiment in partnership with a leading online retailer in Canada. A control group of about 500,000 users made purchase decisions without any exposure to algorithmic recommendations. A second group of 100,000 users was shown recommendations of the "people who bought X also bought Y" variety whenever they visited a product page.

We found, as expected, that recommendations increased purchases across multiple product categories, ranging from apparel and appliances to toys and video games. But purchase diversity is where the results got interesting. For the control group, the bottom 40 percent of products (in terms of the frequency with which the products are purchased) generated roughly 5 percent of purchases

made on the site, and the bottom 80 percent about 37 percent of purchases. The market share of niche products was even lower under recommendations. For example, the bottom 80 percent of products now generated only 27 percent of purchases.

In addition to market share, we also looked at absolute sales of the products. Surprisingly, we found that the total sales of niche items went up. How is it possible that they were selling more at the same time that their market share was decreasing?

The answer to the puzzle lies in the fact that the sales for all items—niche as well as blockbuster—are greater under recommendations. Personalized recommendations help consumers discover many relevant items, and so they purchase far more than they did in the absence of recommendations. Although both niche and blockbuster items were purchased more, the gains were far greater for popular products than niche ones. As a result, niche sellers might notice that sales have risen, and individuals might notice they are consuming more esoteric items than before. But niche products are losing overall market share (and potentially consumer mindshare) under algorithmic recommendations.

Figure 1

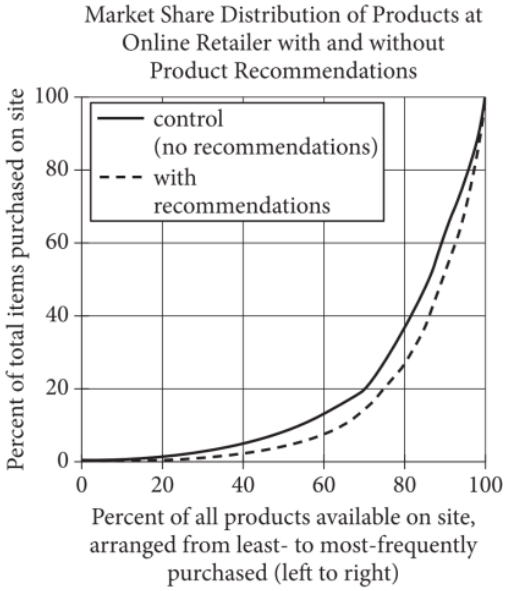


Figure 2

Average Number of Items Viewed or Purchased from Online Retailer's Website, by Type of Recommendation Provided to Users

Type of recommendation provided	Average number of items viewed		Average number of items purchased	
	number	% increase from control	number	% increase from control
"People who viewed this item also viewed"	11.50	11%	2.46	0.8%
"People who purchased this item also purchased"	10.38	0.5%	2.56	5%
Control (no recommendation provided)	10.32	-	2.44	-

32. Which claim about product personalization algorithms can most reasonably be inferred from the passage?

A. They are more popular in the United States than they are in other countries.
B. They require a critical threshold of information in order to work.
C. They encourage consumers to share their favorite products with others.
D. They were designed by online businesses to simplify purchase decisions for their customers.

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

A. line 9-12 (“We were . . . consume”)
B. line 12-15 (“He suggested . . . consuming”)
C. line 18-23 (“In the . . . favorably”)
D. line 28-30 (“To further . . . Canada”)

34. As used in line 20, “promote” most nearly means

A. raise.
B. improve.
C. accelerate.
D. advertise.

35. As used in line 25-26, “demonstrated” most nearly means

A. illustrated.
B. declared.
C. objected.
D. instructed.

36. A marketing executive argues that the studies discussed in the passage provide evidence that product recommendation algorithms benefit only sellers of popular products. Is the executive correct?

A. No, because automated recommendations help increase purchases of less popular items as well as more popular items.
B. No, because automated recommendations were designed to increase sales of less popular products.
C. Yes, because automated recommendations increase the range of popular items viewed by customers.
D. Yes, because automated recommendations increase sales of the most frequently purchased items.

37. In line 57-58, the phrase in parentheses (“and . . . mindshare”) serves mainly to

A. provide an alternative explanation for the results described in the passage.
B. offer a likely reason for the unanticipated results examined in the passage.
C. suggest a potential effect beyond those directly discussed in the passage.
D. acknowledge the limitations of the research methods presented in the passage.

38. Which statement is best supported by the data presented in figure 1?

A. More products were available to purchase for the control group than were available to the group receiving recommendations.
B. The percentage of total items purchased both with and without recommendations was similar for the 20 percent least frequently purchased items.
C. The difference in the percentage of total items purchased between the control group and the group receiving recommendations increased as the cost of items increased.
D. Nearly 40 percent of the items purchased by the control group came from the top 95 percent of most frequently purchased items.

39. Which statement on the effect of recommendations on niche products is best supported by the passage and data presented in figure 1?

A. Algorithmic recommendations reduce the likelihood that a shopper will purchase a niche product over a popular product.
B. The overall market share for niche products will increase with consistent use of algorithmic recommendations.
C. Algorithmic recommendations increase purchase diversity in multiple product categories.
D. The total number of sales, for both niche and popular products, will not change with algorithmic recommendations.

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

A. line 30-34 (“A control . . . page”)
B. line 35-37 (“We found . . . games”)
C. line 38-41 (“For the . . . purchases”)
D. line 41-44 (“The market . . . purchases”)

41. According to figure 2, the average number of items purchased in the “people who purchased this item also purchased” group was

A. 2.44.
B. 2.46.
C. 2.56.
D. 10.38.

Questions 42-52:

This passage is adapted from Maria Temming, "How Ancient Oceans of Magma May Have Boosted Earth's Oxygen Levels." ©2019 by Society for Science & the Public.

Line

We may have ancient magma oceans to thank for Earth's breathable air.

Shortly after the planet's formation about 4.5 billion years ago, the mantle somehow became much richer in oxygen than it was originally. That rock began leaking molecules like carbon dioxide and water into the oxygen-poor atmosphere—helping to jump-start conditions suitable for life some 2 billion years before the Great Oxidation Event, when the amount of molecular oxygen in the atmosphere skyrocketed.

The cause of that chemical transition in the mantle has been a mystery. Now, new lab experiments suggest that chemical reactions involving iron in early Earth's magma oceans tipped the chemical balance of the mantle in favor of more oxygen-rich compounds, researchers report.

"This is more than a chemical curiosity. . . . It's profoundly important because it really sets the stage for all of Earth's subsequent evolution," says Jonathan Tucker, a geochemist at the Carnegie Institution for Science in Washington, D.C., who was not involved in the work. "The oxidation state of the Earth, and planets in general, is a very, very important factor controlling habitability."

Early in Earth's history, the planet was pummeled by planetesimals [small solid bodies formed from accumulating dust], which could have created oceans of molten rock that dipped hundreds of kilometers deep into the mantle. Scientists have suspected that intense pressure in such magma oceans forced oxygen-containing ferrous iron to split into two different kinds of iron: one richer in oxygen, called ferric iron, and oxygen-free metal iron. This heavy metallic iron would have sunk into the Earth's core, leaving the mantle dominated by more oxygen-rich ferric iron.

To test that idea, geochemists at the University of Bayreuth in Germany performed lab experiments that simulated conditions about 600 kilometers deep inside a magma ocean. While heating synthetic mantle material to thousands of degrees Celsius, the researchers used anvils to crush the molten samples with pressures up to more than 20 gigapascals.

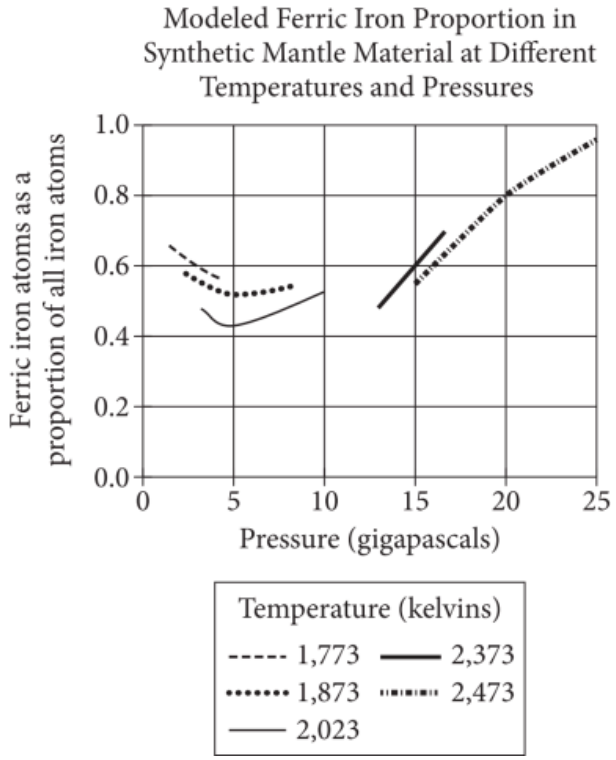
"That's the equivalent of putting the entire mass of the Eiffel Tower on an object the size of a golf ball," says Katherine Armstrong, now at the University of California, Davis.

Armstrong and colleagues measured the amounts of ferrous and ferric iron in samples before and after exposure to these extreme conditions. No matter how much ferrous iron was originally in the rock, at the highest pressures 96 percent of the iron in the final product was the oxygen-rich ferric iron.

That finding indicates that deep in a magma ocean, ferric iron is more stable, Armstrong explains. Any ferrous iron at those depths would be liable to decompose into ferric iron, shedding metallic iron that would sink to the core.

These results are “pretty convincing” evidence that the chemical breakdown of ferrous iron in magma oceans could have helped boost the relative abundance of oxygen in the early Earth’s mantle, Tucker says. But it’s not yet clear whether this chemical process was the only one that contributed to the uptick of oxygen in early Earth’s atmosphere, he adds.

Afu Lin, a mineral physicist at the University of Texas at Austin who wasn’t involved in the work, similarly finds the decomposition of ferrous iron a plausible explanation for Earth’s oxygen-rich atmosphere. Researchers could help validate this account, he says, by searching for chemical signatures of the process in early Earth rocks and superdeep diamonds from the mantle.



Adapted from Katherine Armstrong et al., “Deep Magma Ocean Formation Set the Oxidation State of Earth’s Mantle.” ©2019 by American Association for the Advancement of Science.

42. Which choice best supports the idea that Armstrong and colleagues' hypothesis about ferrous iron decomposition in early Earth's magma may have implications beyond its effect on the oxygen content in early Earth's mantle?

A. line 3-5 ("Shortly . . . originally")
B. line 9-10 ("The cause . . . mystery")
C. line 45-47 ("These . . . says")
D. line 47-49 ("But . . . adds")

43. As used in line 13, "curiosity" most nearly means

A. investigation.
B. oddity.
C. eagerness.
D. trinket.

44. The main purpose of the fourth paragraph (line 13-18) is to

A. consider other fields of study that might be affected by the researchers' results.
B. detail the level of progress that had been achieved before the current study.
C. convey the importance of understanding the phenomenon explored in the research.
D. acknowledge that the results of the research do not entirely explain the phenomenon being studied.

45. Based on the passage, which finding, if true, would most likely call into question the explanation for the levels of ferric iron in Earth's mantle put forth by Armstrong and colleagues?

A. The amount of oxygen-containing molecules in the atmosphere before the Great Oxidation Event was much higher than was initially believed.
B. The pressures in the ancient magma oceans were insufficient to result in the processes investigated in the laboratory.
C. The pressures deep inside the ancient mantle changed more frequently than scientists had originally estimated.
D. Reactions that form ferric iron can occur in conditions similar to those found beneath the ancient mantle.

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

A. line 5-8 ("That . . . skyrocketed")
B. line 10-12 ("Now . . . report")
C. line 19-22 ("Early . . . mantle")
D. line 22-25 ("Scientists . . . iron")

47. The main purpose of the seventh paragraph (line 32-34) is to

A. illustrate the extreme conditions in the simulation by describing a hypothetical situation.
B. explain the challenges the researchers faced by using an analogy that references well-known objects.
C. attempt to clarify a common misconception about mantle pressure through an example.
D. suggest that the pressures used in previous studies were inaccurate by demonstrating their unlikelihood.

48. Based on the passage, the design of the lab experiments performed by Armstrong and colleagues helped to rule out which potential explanation for their findings?

A. At high pressures, differences in the proportion of ferric iron produced by the experiments could be attributed to differences in the initial amount of ferrous iron added to the synthetic mantle.
B. At high pressures, differences in the initial temperature of the ferrous iron could affect the rate that ferric iron was able to stabilize within the experimental mantle material.
C. The magnitude of the change in pressure during the experiments might have influenced the speed at which the ferrous iron converted to create ferric iron in the synthetic mantle.
D. Changes in the concentration of ferric iron could result from variations in ferrous iron that was gathered from multiple sources.

49. As used in line 45, “boost” most nearly means

A. inspire.
B. adjust.
C. increase.
D. publicize.

50. Which statement about the proportion of ferric iron is best supported by the data in the graph?

A. The lowest proportion of ferric iron was produced at a temperature of 2,373 kelvins and between 10 and 15 gigapascals of pressure.
B. When 5 gigapascals of pressure was applied, the proportion of ferric iron was higher at a temperature of 2,023 kelvins than at 1,873 kelvins.
C. The greatest proportion of ferric iron was produced at a temperature of 2,473 kelvins and 25 gigapascals of pressure.
D. When 15 gigapascals of pressure was applied, the proportion of ferric iron was higher at a temperature of 2,473 kelvins than at 2,373 kelvins.

51. Based on the graph, which statement best represents the findings about the proportion of ferric iron created at different temperatures and different pressures?

A. As pressure increased, the proportion of ferric iron decreased at 1,773 kelvins but increased at 2,473 kelvins.
B. The proportion of ferric iron increased with rising pressure only when applied at 2,473 kelvins.
C. Similar proportions of ferric iron occurred at 2,473 kelvins and at 1,773 kelvins as long as the pressure remained under 10 gigapascals.
D. An increase in pressure always produced an increase in the proportion of ferric iron at every temperature applied.

52. Based on the passage, which statement best explains the data presented in the graph regarding the proportion of ferric iron measured at 5 gigapascals of pressure and at 20 gigapascals of pressure?

A. There was a higher proportion of ferric iron at 20 gigapascals of pressure than at 5 gigapascals of pressure, because the proximity of the oxygen and iron molecules increased the chances that they were able to react.
B. There was a lower proportion of ferric iron at 20 gigapascals of pressure than at 5 gigapascals of pressure, because oxygen atoms were able to escape into the atmosphere from the ferrous iron in the synthetic mantle.
C. There was a higher proportion of ferric iron at 5 gigapascals of pressure than at 20 gigapascals of pressure, because a greater amount of metal iron was able to sink through the synthetic mantle material in moderate conditions.
D. There was a lower proportion of ferric iron at 5 gigapascals of pressure than at 20 gigapascals of pressure, because ferrous iron was able to withstand the stress of the lower pressure without converting to two kinds of iron.

Reading				
Question	**Answer**		**Question**	**Answer**
1	B		27	A
2	B		28	A
3	D		29	D
4	C		30	B
5	D		31	C
6	C		32	B
7	C		33	C
8	D		34	D
9	D		35	A
10	C		36	A
11	C		37	C
12	D		38	B
13	B		39	A
14	A		40	D
15	B		41	C
16	D		42	D
17	A		43	B
18	B		44	C
19	A		45	B
20	B		46	D
21	D		47	A
22	B		48	A
23	A		49	C
24	B		50	C
25	C		51	A
26	D		52	D