I　次の英文を読んで，以下の設問に答えよ。(90 点)

Throughout history the role of technology and people's reactions to it have been remarkably consistent, and those who worry about new technology and its impact on society would do well to reflect on the history of paper.

We tend to think of "technology" as referring only to the development of physical devices, mechanical in the nineteenth century, and now electronic. But the word can also be applied, as Merriam-Webster's dictionary says, to any "practical application of knowledge."

Technological inventions have always arisen from necessity. [①] First came spoken language, then drawing, then pictographs, then alphabets, then phoneticism, then writing, and then paper. Paper was then followed by printing, moveable type, typewriters, machine-driven printers, and electronic word processors and the electronic printers that go with them. As needs present themselves, solutions are found. Every idea engenders a need for another. In this case, the original inventions — spoken and then written language — are not physical, man-made objects, and so are not "technology" in the traditional sense of the word. But the way they function in and influence society and history is like a technology — a founding technology. Speech was the wheel that eventually led to the cart that was paper.

Studying the history of paper exposes a number of historical misconceptions, the most important of which is this technological fallacy: the idea that technology changes society. [②] Society develops technology to address the changes that are taking place within it. To use a simple example, in China in 250 BCE, Meng Tian invented a paintbrush made from camel hair. His invention did not suddenly inspire the Chinese people to start writing and painting, or to develop calligraphy. Rather, Chinese society had already established a system of writing but had a growing urge for more written documents and more elaborate calligraphy. Their previous tool — a stick dipped in ink — could not meet the rising demand. Meng Tian found a device that made both writing and

calligraphy faster and of a far higher quality.

Chroniclers of the role of paper in history are given to extravagant pronouncements: Architecture would not have been possible without paper. Without paper, there would have been no Renaissance. If there had been no paper, the Industrial Revolution would not have been possible.

None of these statements is true. These developments came about because society had come to a point where they were needed. This is true of all technology, but in the case of paper, it is particularly clear.

As far as scholars can tell, the Chinese were the only people to invent papermaking, though the Mesoamericans may also have done so; because of the destruction of their culture by the Spanish, we cannot be sure. And yet paper came into use at very different times in very different cultures as societies evolved and developed a need for it and circumstances required a cheap and easy writing material.

Five centuries after paper was being used widely by the Chinese bureaucracy, Buddhist monks in Korea developed a need for paper also. They adopted the Chinese craft, and took it to Japan to spread their religion. A few centuries later, the Arabs, having become adept at mathematics, astronomy, accounting, and architecture, saw a need for paper and started making and using it throughout the Middle East, North Africa, and Spain.

The Europeans initially had no use for paper until more than a thousand years after the Chinese invented it. It was not that they had only just discovered the existence of paper, however. The Arabs had been trying to sell it to them for years. But it was not until they began learning the Arab ways of mathematics and science, and started expanding literacy, that parchment made from animal hides — their previous writing material — became too slow and expensive to make in the face of their fast-growing needs.

The growth of intellectual pursuits and government bureaucracy, along with the spread of ideas and the expansion of commerce, is what led to papermaking. But its international growth was a remarkably slow process. The use of printing

presses, steam engines, automobiles, and computers spread internationally over far shorter periods of time than did paper.

(1) Paper seems an unlikely invention — breaking wood or fabric down into its cellulose fibers, diluting them with water, and passing the resulting liquid over a screen so that it randomly weaves and forms a sheet is not an idea that would logically come to mind, especially in an age when no one knew what cellulose was. It is not an apparent next step like printing, which various societies would arrive at independently. Suppose no one had thought of paper? Other materials would have been found. Improved writing material *had* to be found, because the needs of society demanded it.

There are other important lessons to be learned from the history of technology — and other commonly held fallacies. One is that new technology eliminates old. This rarely happens. Papyrus survived for centuries in the Mediterranean world after paper was introduced. Parchment remains in use. The invention of gas and electric heaters has not meant the end of fireplaces. Printing did not end penmanship, television did not kill radio, movies did not kill theater, and home videos did not kill movie theaters, although all these things were falsely predicted. Electronic calculators have not even ended the use of the abacus, and more than a century after Thomas Edison was awarded a patent for a commercially successful lightbulb in 1879, there are still four hundred candle manufacturers in the United States alone, employing some 7,000 workers with annual sales of more than $2 billion. In fact, the first decade of the twenty-first century showed a growth in candle sales, though the uses of candles have of course greatly changed. Something similar occurred with the manufacturing and use of parchment. New technology, rather than eliminating older technology, increases choices. Computers will no doubt change the role of paper, but it is extremely unlikely that paper will be eliminated.

The history of technology also shows that Luddites always lose. The original Luddites were artisanal workers in eighteenth- and early nineteenth-century Britain who protested the loss of their skilled jobs to machines operated by low-

wage, unskilled workers. Originally, the movement was active in a wide range of fields, including printing, but by the first decade of the nineteenth century, it was largely focused on the textile industry. It is uncertain why its proponents were called Luddites, but there was a mythical anti-machine rebel of the eighteenth century named Lud who, like Robin Hood, was said to live in Sherwood Forest. The Luddites opposed such technology as power looms, and they attacked mills, smashed machinery, and fought against the British Army. One mill owner was even assassinated, which led to the Frame Breaking Act of 1812, making it a capital crime to break machines. This eventually led to mass trials that crushed the movement.

Today, the term Luddite is used to mean someone who opposes new technology. And those who rail against the use of computers today are truly heirs to the Luddites, because the machine that the Luddites originally opposed, the mechanical loom, could be programmed to weave in various patterns through the use of punch cards — an early mechanical forerunner of the computer.

In his seminal work *Das Kapital*, Karl Marx said that the Luddites failed because they opposed the machines instead of the society. He observed: "The Luddites' mistake was that they failed to distinguish between machinery and its employment by capital, and to direct their attacks, not against the material instruments of production, but against the mode in which they are used."

In other words, it is futile to denounce technology itself. Rather, you have to try to change the operation of the society for which the technology was created. (2) 技術が新しくなるたびに，その新しい発明が過去のよいものすべてを破壊すると考え，非難する人々がいる。 This happened when the written word started to replace the oral word, when paper began replacing parchment, when printing started to take work away from scribes — and it is still happening today, with electronics threatening paper. In all these cases, the arguments against the new technology were similar: the functioning of the human brain was imperiled, we would lose the power of our memories, human contact would be diminished, and the warmth of human engagement would be lost.

These early outcries against technology went largely unheeded, much the same way warnings about computers are going unheeded today. It is true that the greater the aids to memory, the less we depend on our brain. But that does not mean that our minds are being destroyed. Illiterate people have better memories than literate people. But few would see that as an argument in favor of illiteracy. The introduction of the written word demonstrated that such aids, though they make us more dependent, also make us more powerful.

You cannot warn about what a new technology will do to a society because that society has already made the shift. That was Marx's point about the Luddites. Technology is only a facilitator. Society changes, and that change creates new needs. [③] The only way to stop the technology would be to reverse the changes in the society. Printing did not create the Protestant Reformation; the ideas and the will to spread them is what created printing presses. The Chinese bureaucrats and Buddhist monks were not created by paper. Paper was created for them.

To argue that a technology somehow changed society would entail a technology that radically changed the *direction* of society. But this simply never happens. A technology that is intended to redirect society will usually fail. In fact, most technology companies do not introduce new technology but new ways to use ideas that already exist. They spend a great deal of time and money on market research — that is, determining where society already wants to go. (3) Only once this direction is determined do they tailor a new product to meet that need.

[④] Some technology succeeds in a changing society and some fails. And even when an idea is right, the machine that introduces it to the society may not be. Cai Lun did not invent paper, Gutenberg did not invent the printing press, Robert Fulton did not invent the steamboat, and Thomas Edison did not invent the lightbulb. Rather, these were people who took existing ideas or machines that were not suiting society's needs and reworked them into technologies that did. It says something about our world that we seldom remember the person who came up with an idea, but canonize the pragmatist

who made it commercially viable. Already we have forgotten the people who created most of the important computer concepts and instead celebrate the people who became rich on them.

Another important lesson is that technology usually becomes less expensive over time, as well as more accessible and of lower quality. Paper is far less expensive now than it used to be, but eighteenth-century paper was of much better quality than nineteenth-century paper, which in turn was better than much of today's paper.

For more than a thousand years, papermaking was the mark of civilization: an advanced civilization was one that made paper. When the Spanish conquistador Hernán Cortés arrived in the New World in 1504, he was extremely impressed by the Aztecs. They had built the largest city in the world and were advanced in mathematics and astronomy, but it was their papermaking ability that most impressed him. To the Spaniard, a society that made paper was an advanced civilization.

Using the paper test as the mark of civilization yields a surprisingly different but not inaccurate picture of history. In this version, civilization begins in Asia in 250 BCE and spreads to the Arab world. For centuries, the Arabs were the world's dominant culture, while the Europeans were among the most backward people on Earth. They didn't read, they had no science, and they could not do simple math; even when tracking their own commerce, they had no need for paper. The "barbarians" who destroyed Rome in the fifth century were still barbarians in the eleventh century.

Most historians today emphasize that the "Dark Ages" were not nearly as dark as they were said to be. But it is irrefutable that the Europeans were far behind the Asians and Arabs in many ways. Christians had not reached the intellectual level of Muslims and Jews. This became obvious when the Christians took over Muslim Spain, destroying the civilization of Muslim al-Andalus, and when they systematically destroyed one of the most advanced civilizations in the world in Mexico, suppressing their language, religion, and culture, and burning their books.

When Europe finally began to develop, it did not do so in the geographic order that many today might assume it did. Italy developed from the south up, starting with Sicily. [⑤] Much of Europe also progressed by adopting Arab ideas, especially in the areas of mathematics, science, and accounting. Later in history, Europe's leap forward, to a position ahead of its Arab and Asian competitors, was facilitated by moveable type, a Chinese invention. The Europeans could make that invention work for them because, unlike the Asians and Arabs, they had an alphabet that was well suited for moveable type. (4)This also meant that Europeans got to write history the way they wanted it to be read.

[Adapted from Mark Kurlansky, *Paper: Paging Through History*. New York: Norton, 2016: xiii-xix.]

I-1. 下線部(1)では，なぜ unlikely だと言っているのか。その理由を 50 字以内の日本語で説明せよ。（句読点も文字数に含める。）

I-2. 下線部(2)を英語に訳せ。

I-3. 下線部(3)を日本語に訳せ。

I-4. 下線部(4)を日本語に訳せ。

I-5. 文中の空欄[①]から[⑤]に入れるのにもっとも適切な英文をAからEの中から選び，記号で答えよ。

A. Ireland developed far ahead of England.
B. It is exactly the reverse.
C. Not all technology is the future.
D. Numerous inventions preceded paper.
E. That is why the technology is brought in.

I -6. 以下の(i)と(ii)の答としてもっとも適切なものをＡからＥの中から選び，記号で答えよ。

(i) Choose a reason mentioned in the text why a new technology might not readily be adopted throughout a society.

A. A highly educated populace took time to carefully weigh the pros and cons of accepting a new technology.

B. Communication barriers such as linguistic and cultural differences slowed the spread of knowledge, ideas, and objects.

C. Governments imposed high import taxes on innovations originating from rival countries in order to protect their local economy.

D. Products that had already been in use were good enough to serve the society at its stage of development.

E. Societies refused extensive contact with outside groups for fear of being colonized or otherwise taken advantage of.

(ii) Choose from the following demands one which has NOT driven the large-scale acceptance of innovations across time and geography, according to the text.

A. the demand for greater options

B. the demand for lowered costs

C. the demand for fairer wages

D. the demand for increased quantity

E. the demand for quicker production

I -7. 次の 1 から 10 の文から，本文の内容に一致するものを 3 つ選び，番号で答えよ。

1. Meng Tian's invention of the camel-hair writing brush helped improve literacy in China by decreasing the cost of writing implements.
2. Immigrants from the Korean peninsula brought paper to Japan and used it to help establish a Chinese-style nation state.
3. In Karl Marx's opinion, the Luddites could not understand that manufacturing equipment was not to blame for the loss of their jobs.
4. Sixteenth-century Aztecs resembled Protestants during the Reformation regarding their discovery of a means to spread unconventional ideas.
5. Thomas Edison is widely remembered as a mere pragmatist who reworked existing ideas into technologies that were commercially viable.
6. While it is much cheaper to produce paper now than it was in the eighteenth century, paper today has, for the most part, degenerated in quality.
7. European intellectual activity surpassed that of Arabs and Asians between the 5th and 11th centuries thanks to Europeans' adoption of papermaking.
8. Chinese and Arabic are examples of languages with linguistic features that make them less troublesome to print using moveable type.
9. From the perspective of how people have developed and used paper, world history diverges from dominant Western narratives.
10. Calligraphy, clay tablets, papyrus, parchment, and typewriters are examples of writing technologies mentioned in the text.

Ⅱ　次の英文を読んで，以下の設問に答えよ。(60 点)

Over the centuries, the credentials needed to carry out scientific research have been in flux. Only recently has science become an occupation. (1)In earlier days, science was something for those with the luxury to dedicate their leisure time or spiritual time to follow their curiosity. In the 1600s, Antonie van Leeuwenhoek discovered microorganisms. His professional background? A cloth merchant who learned to make excellent lenses to judge the weave of fabrics. Eventually, he made lenses more powerful than microscopes at that time, which allowed him to curiously examine mucky pond water and plaque on teeth and find tiny life, earning him the title of father of microbiology. Gregor Mendel filled many of his days as a monk with experimental breeding of pea plants to understand how traits are hereditary. That earned him the title of father of genetics. Charles Darwin was a companion to Captain FitzRoy of the Beagle with time to see the world before planning to return and become a parson. Darwin's later days were part of a shift in science. Not only was science becoming a profession, the precursor to citizen science was beginning: Darwin and others started crowdsourcing for data through letters in which people shared their observations from around the world.

In more recent history, fellow citizen scientists have continued to accomplish the remarkable. Citizen science has contributed hugely to entomology. The mystery of monarch butterfly migration had long eluded scientists until Fred Urquhart and Norah Patterson began experimenting with techniques to affix unique tags to butterflies. Once these scientists identified a way to attach a tag to the butterfly without harming their sensitive wings, (2)可能な限り多くの蝶に彼らがタグを付けるのを手伝うためには，より多くの人々が必要であることに彼らは気がついた. In 1952, they asked for the help of thousands of volunteers and started a monarch tagging program, which eventually became the modern-day Monarch Watch. Then, in the mid-1970s, the first tagged monarch was spotted

in Mexico. It turned out to be tagged by a Minnesota* school teacher and two of his teenage students, which led to the discovery of the long-distance monarch migration from North America to Mexico in the fall and the return in the spring. The breakthrough was possible because thousands of volunteers had been capturing and tagging the wings of monarchs with postage-stamp-size stickers for decades. To this day people continue to tag monarchs and bring more discoveries, like making us aware of their current population decline.

The modern environmental movement was also inspired by citizen scientists. Rachel Carson's seminal book, *Silent Spring*, revealed the dangers of the pesticide DDT. Predatory birds, such as peregrine falcons, became endangered species because DDT thinned their eggshells. The discovery that their eggshells were thinning was possible because egg specimens found in museums had thicker eggshells. Non-professionals — citizen scientists — had collected those eggshells before the manufacturing of DDT began. (The hobby of collecting wild bird eggs was outlawed in the United States in 1916 with the Migratory Bird Treaty Act, which protected migratory birds, including their nests and eggs.)

(3) In the mid-1990s, citizen science was key to climate change negotiations. British scientists found that birds were laying their eggs earlier in the year because of climate change. The entire dataset, with hundreds of thousands of nesting records, was the result of decades of observations by birdwatchers scattered across England. In making the case for the Kyoto Protocol (the international treaty about climate change action), the British government relied on that research to show that climate change was not a "future" problem but a "now" or urgent problem because it was already affecting life on Earth.

Today, with the internet and smartphones, science is in flux again. Millions of people, each with their own occupation (and many too young to have an occupation yet), share their observations and help process data. Volunteers work online to transcribe thousands of old letters, some originating with Darwin, others from Shakespeare, and others from war diaries. People are needed to turn

handwriting into digital text because automation with optical recognition software can't decipher handwriting as well as the human eye. Today, fields like biochemistry advance because people use their free time as players in online games because the human mind is better at spatial reasoning than computers. In the Eterna game, players design RNA, the blueprints that make proteins. In Foldit, a game to solve puzzles of how proteins fold, some players discovered the folded shape of a particular protein associated with AIDS in monkeys. As environmental and health sensors like Fitbits and air-quality monitors become lower cost, people without science credentials are assessing the quality of their environment, providing a check on industries to make sure regulations are followed. In ports like Oakland, California, with significant truck traffic, and in New Orleans, Louisiana, with petrochemical refineries, communities organized by the West Oakland Environmental Indicators Project and Louisiana Bucket Brigade have discovered excessive exposures to pollution where scientists and regulatory enforcers have failed to look. Across the world, eyes of citizen scientists have discovered that endangered monk seals were attempting to recolonize the Mediterranean Sea, that invasive ladybirds in England were rapidly expanding their range, and three new species of dancing peacock spiders in Australia.

Looking across history, what's revealed is that in many areas of study the only way to keep advancing (4) the frontiers is for scientists to collaborate, not just with each other, but with everyone.

*Minnesota　アメリカ合衆国内陸の北部にある州の一つ

[Adapted from Darlene Cavalier, Catherine Hoffman, and Caren Cooper, *The Field Guide to Citizen Science: How You Can Contribute to Scientific Research and Make a Difference*. Portland, Oregon: Timber Press, 2020: 15–17.]

Ⅱ-1. 下線部(1)を日本語に訳せ。

Ⅱ-2. 下線部(2)を英語に訳せ。

Ⅱ-3. 下線部(3)に関連して，京都議定書(Kyoto Protocol)をめぐるイギリス政府の交渉において市民科学が果たした役割とその意義とは何か。60字以内の日本語で説明せよ。(句読点も文字数に含める。)

Ⅱ-4. 下線部(4)を日本語に訳せ。

Ⅱ-5. 以下の(i)と(ii)の答としてもっとも適切なものを(i)についてはAからG，(ii)についてはAからEの中から選び，記号で答えよ。

(i) According to paragraph 3, in which order did the following events happen? Choose one from A to G.

ア. Rachael Carson published *Silent Spring*.
イ. Predatory birds faced a crisis because of their thinned eggshells.
ウ. Citizen scientists legally gathered eggshell samples.
エ. The pesticide DDT was manufactured.

A. ア → イ → ウ → エ
B. ア → ウ → エ → イ
C. イ → ア → ウ → エ
D. イ → ウ → エ → ア
E. ウ → イ → エ → ア
F. ウ → エ → イ → ア
G. エ → イ → ウ → ア

(ii) Look at the double underlined part in paragraph 5. What does the author mean by "science is in flux again"? Choose one from A to E.

A. A traditional scientific approach is considered particularly important in assessing new surroundings or environments.

B. Citizen scientists today are significantly affecting the world of science like their predecessors did.

C. It happens that the history of science is more often than not marked by images of water.

D. Scientists are constantly facing problems that have arisen over and over again in human history.

E. Scientists are reluctant to accept ideas from different occupations to create new theories.

Ⅱ-6. 次の1から7の文から，本文の内容に一致するものを2つ選び，番号で答えよ。

1. Antonie van Leeuwenhoek encouraged his fellow citizen scientists to make science their profession as he dedicated his life to lens making and microorganisms.
2. A Minnesota school teacher and two of his teenage students reported evidence that monarch butterflies travel from North America to Mexico.
3. Tagging monarchs has led to an understanding of their migration patterns and an awareness of their decline in numbers.
4. Citizen scientists meet online to translate letters written by Darwin and Shakespeare.
5. Computers go beyond human capacity for spatial reasoning, efficiently analyzing handwritten letters and proteins.
6. Health monitors can record the quality of air, detect protein folding, and provide detailed data for the advancement of science.
7. Observations by citizen scientists have led to discoveries of new species and brought to light behaviors of endangered sea animals.