2020年度入学試験問題

デザイン工学部A方式Ⅱ日程・理工学部A方式Ⅱ日程
生命科学部A方式Ⅱ日程

1 限　英　　語（90分）

〈注意事項〉

1. 試験開始の合図があるまで，問題冊子を開かないこと。
2. 解答はすべて解答用紙に記入しなさい。
3. マークシート解答方法については以下の注意事項を読みなさい。

マークシート解答方法についての注意

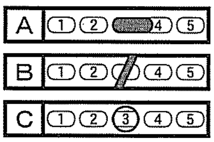
マークシート解答では，鉛筆でマークしたものを機械が直接読みとって採点する。したがって解答はHBの黒鉛筆でマークすること（万年筆，ボールペン，シャープペンシルなどを使用しないこと）。

記入上の注意

1. 記入例　　解答を3にマークする場合。

(1) 正しいマークの例

(2) 悪いマークの例



枠外にはみださないこと。

○でかこまないこと。

2. 解答を訂正する場合は，消しゴムでよく消してから，あらためてマークすること。
3. 解答用紙をよごしたり，折りまげたりしないこと。
4. 問題に指定された数よりも多くマークしないこと。

4. 問題冊子のページを切り離さないこと。

〔Ⅰ〕 ロボットを用いた海の生態系(ecosystem)の調査に関するつぎの英文を読み，設問に答えよ。

To study coral reefs[*1] and the creatures that live there, scientists sometimes use underwater drones.(a) But drones aren't perfect spies. Their propellers can tear up reefs and harm living things. Drones are also noisy, scaring animals away. A new robo-jellyfish(b) might be the answer.

Erik Engeberg is a mechanical engineer at Florida Atlantic University in Boca Raton. His team developed this new device. Think of this robot as a quieter, gentler ocean spy. Its soft body moves smoothly and silently through the water, so it won't harm reefs or disturb animals living around them. The robot also carries sensors to collect data.

The device has eight tentacles, which are made of soft silicone rubber and move like arms. Pumps on the underside of the robot take in seawater and direct it into the tentacles. The water fills up the tentacles, making them stretch [A]. Then power to the pumps briefly turns off. The tentacles now relax and water shoots back out of holes on the underside of the device. That rapidly escaping water pushes the jellyfish upwards.

The robot also has a hard case on top. This holds the electronics that control the jellyfish and store data. One of its components allows wireless communication with the jellyfish. That means someone can remotely steer the robot by making different tentacles move [B] different times. The hard case could hold sensors, too.

The researchers had practical reasons for modeling their device on jellyfish. "Real jellyfish only need small amounts of power to travel from one point to another," Engeberg says. "We wanted to really capture that quality in our jellyfish."

Jellyfish move slowly and gently. So does the robo-jelly. That's why the researchers think it won't frighten marine animals. What's more, Engeberg says, "The soft body [C] our jellyfish helps it to monitor ecosystems without damaging them." For example, the robot could carry a sensor to record ocean temperatures. The data it gathered could help scientists map where and when the ocean is warming because of climate change.

"Jellyfish have been moving around our oceans for millions of years, so they are excellent swimmers," says David Gruber. He's a marine biologist at Baruch College in New York City who was not involved in the development of the robot. "I'm always impressed when scientists get ideas [D] nature," Gruber says, "especially something as simple as the jellyfish."

Fighting climate change motivates Engeberg and his team. "I have a deep desire to help endangered reefs around the world," he says. He hopes his robo-jellyfish will help researchers study the otherwise hidden impacts of climate change at sea.

Tracking sea temperatures and other data can benefit people, too, by warning of worsening conditions. Warmer oceans can make storms more powerful and destructive. Warmer seawater also helps melt glaciers*2 from below, and this results in rising sea levels. And higher seas can lead to coastal flooding, or make low-lying islands disappear altogether.

The robotic jellyfish is a work in progress. "We are making a new version right now," Engeberg says. It swims deeper and can carry more sensors than the older model. This should make it an even better spy on the conditions affecting coral reefs worldwide.

出典：Tyler Berrigan. "This Robotic Jellyfish Is a Climate Spy." *Science News for Students*. (Dec. 18, 2018) (一部改変)

語注*

*1 coral reefs: サンゴ礁

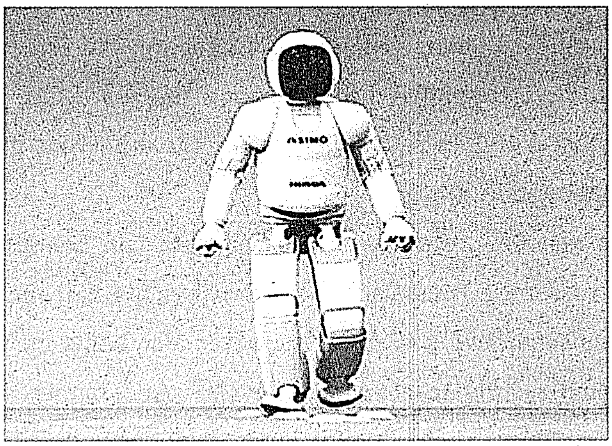
*2 glaciers: 氷河

問1　空欄 [A] ～ [D] に入る最も適切な語をそれぞれイ～へから一つ選び，その記号を解答用紙にマークせよ。ただし，同じ選択肢を二度使用してはならない。

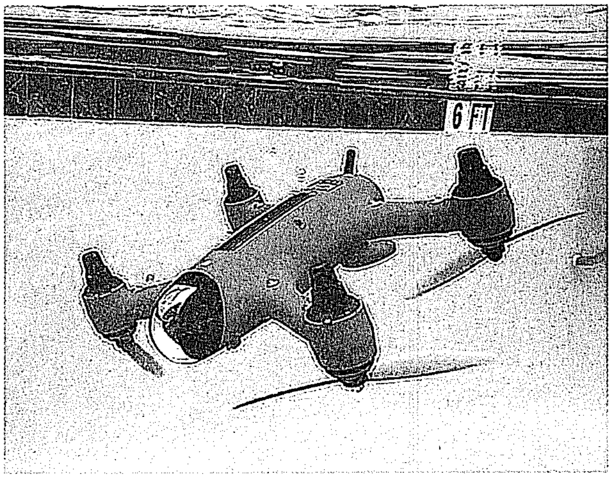
イ　at	ロ　on	ハ　in
ニ　out	ホ　from	ヘ　of

問2　下線部(a) "underwater drones" および(b) "robo-jellyfish" に相当するロボットをそれぞれイ～ニから一つ選び，その記号を解答用紙にマークせよ。ただし，同じ選択肢を二度使用してはならない。

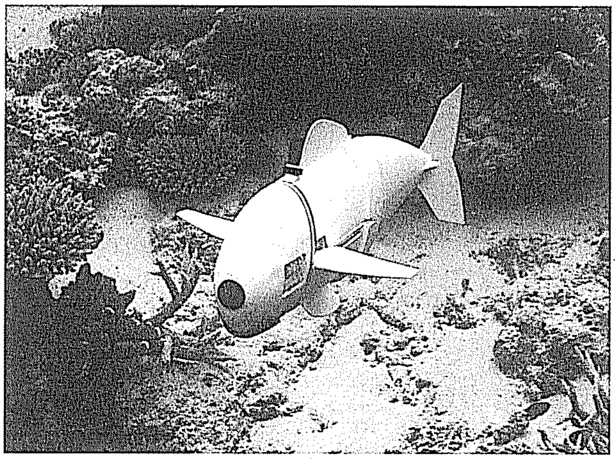
イ



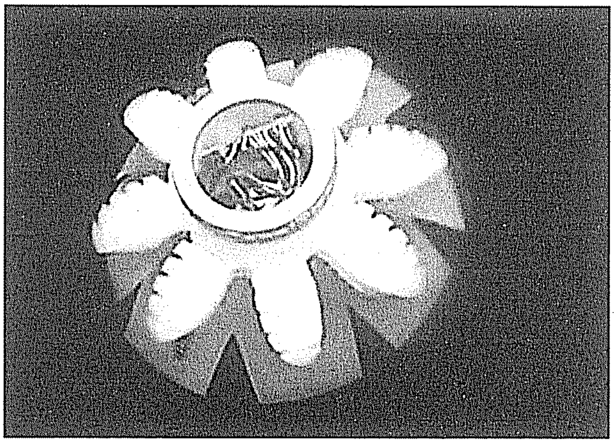
ロ



ハ



ニ



問 3　Erik Engeberg の研究チームが開発した robo-jellyfish の説明として正しいものをイ～ホから三つ選び，その記号を解答用紙にマークせよ。

イ　It moves upwards when seawater is pumped into the tentacles.

ロ　It is harmless to the surrounding environment.

ハ　It moves slowly and gently through the water.

ニ　Its entire body is made of soft materials.

ホ　It can be remotely controlled by an operator.

問4　ロボットのモデルに jellyfish を採用した理由として，Erik Engeberg の研究チームが挙げていないものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ　Jellyfish don't disturb marine life since they move slowly and gently.

ロ　Jellyfish have soft bodies suitable for monitoring ecosystems.

ハ　Jellyfish have been excellent swimmers for millions of years.

ニ　Jellyfish need minimum power to move around.

問5　海水温上昇によって引き起こされる事象として本文中で挙げられているものをイ～ニから二つ選び，その記号を解答用紙にマークせよ。

イ　coastal flooding

ロ　high tides

ハ　more frequent storms

ニ　sinking low-lying islands

問6　現在開発中の最新の robo-jellyfish の説明として正しいものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ　They are expected to be used for commercial purposes.

ロ　They are expected to be able to swim in shallower water.

ハ　They can better detect what conditions endanger coral reefs.

ニ　They can carry more sensors due to their light body weight.

〔Ⅱ〕 つぎの設問に答えよ。

問 1　アメンボ(water strider)に関するつぎの英文を読み，空欄 [A] ～ [E] に入る最も適切な語をそれぞれイ～ヘから一つ選び，その記号を解答用紙にマークせよ。ただし，同じ選択肢を二度使用してはならない。

Water striders can stand on water because their small size allows them to take advantage of surface tension forces, which [A] due to the attraction of water molecules to each other. At your body size, water surfaces [B] quite weak. You can step into a bathtub or stick straws into a drink without a second thought. Water striders, however, are so tiny and light that they are sensitive to forces that you would [C] very small. This is why they can exploit surface tension forces. That is, a water strider's low weight of only 10 milligrams is enough to [D] but not break water surfaces. They support water striders' weight just like a trampoline supports your weight. Thus, water striders [E] a world different from yours, and the forces acting on an animal depend upon its body size.

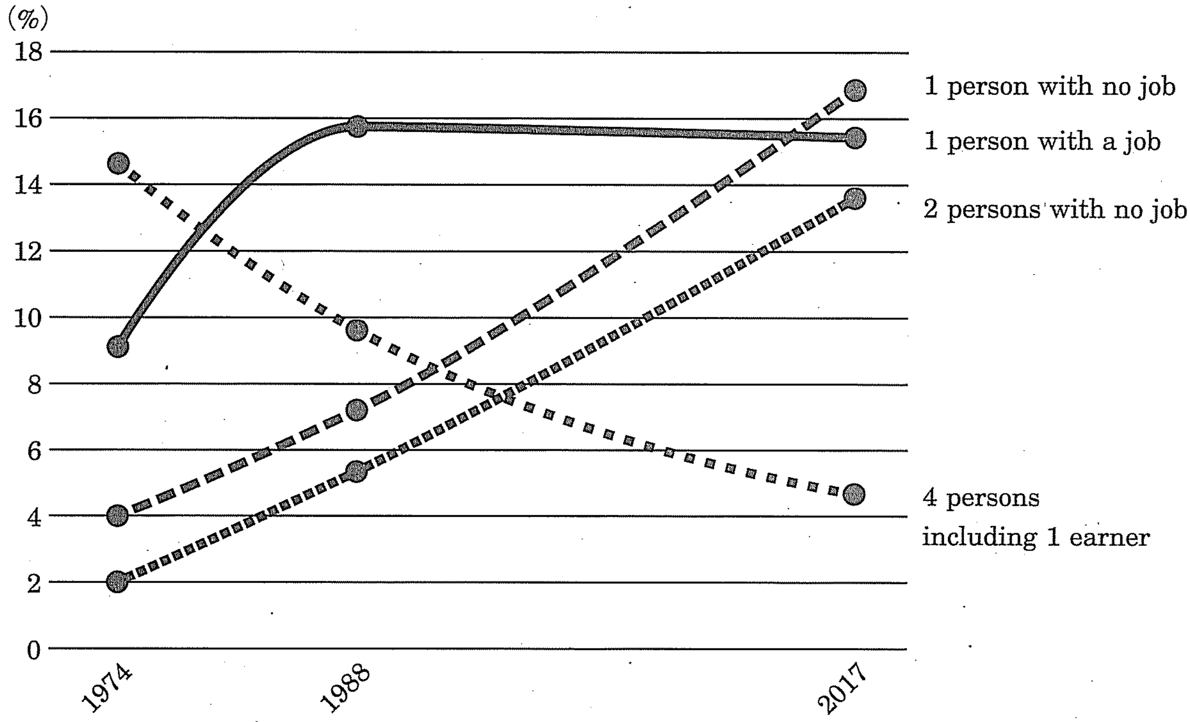
出典：David L. Hu. *How to Walk on Water and Climb up Walls.* Princeton University Press. (Nov. 13, 2018) (一部改変)

イ　require　　ロ　experience　　ハ　find
ニ　arise　　ホ　appear　　ヘ　bend

問２　日本における世帯構成の推移に関するつぎの英文とグラフを読み，設問に答えよ。

This graph shows the changes in the percentage of Japanese households by the number of persons and earners from 1974 to 2017. In 1974, right after the end of Japan's high-growth years, a four-member household with one earner was the most common type of household at [A] % of the total. But this household type slipped to [(a)] place with 9.7% in 1988 during Japan's bubble economy, and to last place with [B] % in 2017.

The shift is marked by a steady rise in the number of single-person households. In 2017, household units of one person with no job were the most common group, accounting for 16.9% of the total. Households consisting of a single earner living alone stood at [C] %. Together, they made up about [(b)] of all households in Japan.



Percentages of Japanese Households from 1974 to 2017

出典：Mariko Eiraku. "The Changing Japanese Household." *NHK Newsline from Tokyo.* (Aug. 15, 2018) (一部改変)

(1) 英文中の空欄 [A] ～ [C] に入る最も適切な数字をそれぞれイ～トから一つ選び，その記号を解答用紙にマークせよ。ただし，同じ選択肢を二度使用してはならない。

イ 4.6　　ロ 5.6　　ハ 7.2　　ニ 9.9

ホ 13.8　　ヘ 14.6　　ト 15.6

(2) 英文中の空欄 [(a)] [(b)] に入る最も適切な語(句)をそれぞれイ～ヘから一つ選び，その記号を解答用紙にマークせよ。ただし，同じ選択肢を二度使用してはならない。

イ first　　ロ second　　ハ third

ニ a half　　ホ a third　　ヘ two thirds

〔Ⅲ〕「もし人が突然1秒間に1フィートずつ上昇しはじめたらどうなりますか？」という質問にサイエンスライターが回答したつぎの英文を読み，設問に答えよ。

<Question>

If you suddenly began rising steadily at the speed of one foot per second, what would happen?

<Answer>

A foot per second isn't so fast; it's actually slower than a typical elevator. It would take you five to seven seconds to rise out of arm's reach, depending on how tall your friends are.

After 30 seconds, you would be 30 feet—9 meters—off the ground. If you know [X], you will realize that this is the last chance for your friend on the ground to toss you a sandwich or a water bottle.

After a minute or two, you would be above the trees. For the most part, you would still be about as comfortable as you were on the ground. If it's a slightly windy day, it would probably get chillier due to the stronger wind above the tree line.

After 10 minutes, you would be above all but the tallest skyscrapers, and after 25 minutes, you would pass the top of the Empire State Building. The air at this height is about 3% thinner than it is at the surface. Fortunately, your body handles such changes in air pressure all the time. Your ears might hurt, but you wouldn't really notice anything else.

A foot per second is pretty close to a kilometer per hour, so after an hour, you'll be about a kilometer off the ground. At this point, you'll definitely start to get chilly. If you have a coat, you'll still be OK, though you might also notice the wind blowing.

At about two hours, the temperature would drop below freezing. The wind would also, most likely, be blowing. If you have any exposed skin, this is where frostbite[*1] would start to become a concern. At this point, the air pressure would fall below what you would experience in an airliner cabin, and the effects would start to become more significant. However, unless you had a warm coat, the temperature would be a bigger problem.

Over the next two hours, the air would drop to about −18℃. Assuming for a moment that you survived the lack of oxygen, at some point you could not resist hypothermia[*2]. But when?

According to a model by two Canadian researchers, <u>the main factor</u> (a) would be your clothes. If you were nude, probably you could not resist hypothermia somewhere around the five-hour mark, before your oxygen ran out. If you were <u>bundled up</u> (b), you might be frostbitten, but you would probably make it until about 8,000 meters. At this point, you would be seriously bothered by the lack of oxygen. And the chances are very slim that you would go beyond the eight-hour mark.

What would happen if you continued into space? Two million years later, your frozen body, still moving along steadily at a foot per second, would leave the solar system.

Clyde Tombaugh, the astronomer who discovered <u>Pluto</u> (c), died in 1997. A portion of his remains was placed on the *New Horizons* spacecraft, which will fly past several planets—Saturn, Uranus, Neptune—and Pluto, and then continue out of the solar system. It's true that your imaginary foot-per-second trip would be cold and unpleasant. But when the sun becomes a red giant in four billion years and swallows the earth, <u>you and Clyde would be the only ones to escape</u> (d).

出典：Randall Munroe. *What If?* John Murray Press. (2014) (一部改変)

語注*

[*1] frostbite: しもやけ・凍傷

[*2] hypothermia: 低体温症

問１ [X] に入る内容として最もふさわしいものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ how to make a delicious sandwich

ロ the maximum height a person can throw

ハ the height of the tallest person

ニ the height limit of buildings

問２ 以下の表(1)および(2)において，人が上昇を開始してから(A)と(B)の高さに到達するまでの所要時間として，最も適切な組み合わせをそれぞれイ～ニから一つ選び，その記号を解答用紙にマークせよ。

(1)

	イ	ロ	ハ	ニ
(A) 木のてっぺんの高さ	30秒	30秒	2分	2分
(B) Empire State Building の最上部の高さ	10分	25分	10分	25分

(2)

	イ	ロ	ハ	ニ
(A) 気圧が地上の97%になる高さ	10分	10分	25分	25分
(B) 気圧が旅客機内と同程度の高さ	2時間	4時間	2時間	4時間

問３ 下線部(a) “the main factor” によって，人が耐えられる時間にどれくらいの差が生じるか，最も適切なものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ 1時間　　ロ 3時間　　ハ 5時間　　ニ 8時間

問４ 下線部(b) “bundled up” の言い換えとして最も適切なものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ dressing up　　ロ wearing a lot

ハ tied up　　ニ a little tired

問5　下線部(c) "Pluto" の意味に最も近いものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ　an object, called a planet until 2006, that goes around the sun, usually beyond the farthest planet in the solar system

ロ　a shining object you can see in the sky at night, which moves around the earth every 28 days

ハ　a device that has been sent into space and goes around the earth, the moon, etc., used for radio, television, and other electronic communication

ニ　a large ball of burning gas in space that can be seen as a point of light moving across the night sky

問6　下線部(d) "you and Clyde would be the only ones to escape" の理由として最も適切なものをイ～ホから一つ選び，その記号を解答用紙にマークせよ。

イ　because you and Clyde would ride a spacecraft together

ロ　because you and Clyde would move at high speed

ハ　because you and Clyde would return to the earth

ニ　because you and Clyde would be frozen

ホ　because you and Clyde would be far from the solar system

〔Ⅳ〕 つぎの設問に答えよ。

問1　(1)〜(5)において，最も強いアクセントのある位置が他の三つと異なる語をそれぞれイ〜ニから一つ選び，その記号を解答用紙にマークせよ。

(1) イ fa-tigue　ロ bal-ance
ハ com-merce　ニ earth-quake

(2) イ con-fess　ロ ex-cel
ハ pub-lish　ニ main-tain

(3) イ dec-o-rate　ロ en-cour-age
ハ oc-cu-py　ニ crit-i-cize

(4) イ con-ti-nent　ロ ob-sta-cle
ハ mech-a-nism　ニ phy-si-cian

(5) イ ac-a-dem-ic　ロ ap-prox-i-mate
ハ in-dus-tri-al　ニ e-quiv-a-lent

問２ (1)〜(6)において，英文中に入る語(句)として最も適切なものをそれぞれイ〜ニから一つ選び，その記号を解答用紙にマークせよ。

(1) The new method offers many advantages [ ] the conventional method.

イ against　ロ on　ハ for　ニ over

(2) There are many cases [ ] such rules are not realistic.

イ where　ロ what　ハ which　ニ why

(3) I suggested [ ] go home as soon as possible.

イ her to　ロ that she was better to

ハ that she should　ニ for her to

(4) There is something about America that I find really [ ].

イ exciting　ロ excited

ハ to be excited　ニ be exciting

(5) I am sure I locked the door. I clearly remember [ ] it.

イ to lock　ロ locking

ハ to have locked　ニ being locked

(6) What I said was stupid. I wish I [ ] anything.

イ hardly said　ロ didn't say

ハ wasn't saying　ニ hadn't said

問3　(1)〜(6)において，それぞれ下の語(句)イ〜ホを並べ替えて空所を補い，最も適切な文を完成させよ。解答は2番目と4番目に入るものの記号を解答用紙にそれぞれマークせよ。なお，文頭の大文字・小文字の区別は問わない。

(1) I [ ] [2] [ ] [4] [ ] the most poisonous spiders in the world live in Australia.

イ　to hear　　ロ　surprised　　ハ　some of

ニ　that　　ホ　was

(2) At sushi-go-round restaurants, you can [ ] [2] [ ] [4] [ ] yourself from the conveyor belt.

イ　sushi　　ロ　by　　ハ　choose

ニ　favorite　　ホ　your

(3) In Japanese fairy tales, foxes [ ] [2] [ ] [4] [ ] .

イ　believed　　ロ　disguising themselves　　ハ　by

ニ　were　　ホ　to trick people

(4) [ ] [2] two [ ] atoms and one [4] atom, [ ] is one of the most important resources on the earth and essential for living organisms.

イ　water　　ロ　oxygen　　ハ　of

ニ　hydrogen　　ホ　composed

(5) The human brain [ ] [2] [ ] [4] [ ] complex languages and thus pass along new knowledge from generation to generation.

イ to　　ロ possible　　ハ made

ニ it　　ホ develop

(6) She is the only woman who I [ ] [2] [ ] [4] [ ] .

イ with　　ロ been　　ハ in

ニ have ever　　ホ love

〔V〕 ローマ時代のコンクリート技術をめぐるつぎの英文を読み，設問に答えよ。

More than two thousand years ago, a Roman scholar wrote that concrete structures in harbors, exposed to the saltwater waves, become "a single stone mass that resists the damage from the waves and get stronger every day." While modern marine concrete structures weaken within decades, 2,000-year-old Roman concrete harbor structures endure to this day. They are even stronger now than when they were first constructed.

Why does Roman concrete have a particularly long life? Marie Jackson, a geologist at the University of Utah, analyzed the minerals in Roman marine concrete. She and her colleagues have recently found that seawater filtering through the concrete for many years leads to the growth of binding minerals that give the concrete added strength.

Previous Research: Minerals in Roman Concrete

It is known that when Romans made concrete, they first mixed volcanic*1 ash with lime*2 and seawater. Then they incorporated pieces of volcanic rock into this paste to make the concrete stronger. The combination of ash, seawater, and lime produces a short-term chemical reaction called a pozzolanic reaction. This reaction, which glues together the particles in the paste and hardens the concrete, has been thought to give strength to Roman concrete. The concrete thus made was used in many architectural structures, including ancient Roman temples and massive structures that protected harbors from the open sea.

With these facts in mind, Jackson and her colleagues first studied other factors that made marine concrete in Rome so <u>resilient</u>(1). One important factor, they realized, is the presence of an exceptionally rare mineral, aluminous tobermorite (Al-tobermorite), in the concrete. When this mineral is crystalized, it forms fibers and plates in the concrete and prevents cracks from getting wider.

The presence of Al-tobermorite surprised Jackson. "It's very difficult to make," she says of the mineral. <u>Synthesizing</u>(2) it in the laboratory requires temperatures higher than 80℃, and results in only small quantities. Then how did it get into Roman concrete?

The Latest Research: Seawater Helps

In 2017, Jackson and other researchers further examined the Roman concrete in the harbor structures, this time with various high-tech methods. They noticed Al-tobermorite in small holes and spaces throughout the concrete. Jackson says, "We researchers know that (a) rocks change. So how did the change happen in the long-lasting Roman concrete?"

The team reasoned that seawater, as it filtered through the concrete for many years, slowly reacted with the lime and the volcanic ash. And they concluded that the product of this reaction ultimately allowed new minerals, particularly Al-tobermorite, to grow at seawater temperatures (14℃ to 28℃). These minerals form crystals that increase the concrete's (3) durability, long after the initial pozzolanic reaction. Thus, the scientists revealed that the Romans didn't initially put Al-tobermorite in their concrete. Instead, the mineral formed over a long time through chemical reactions with the seawater.

This process would normally be harmful for modern materials. Modern concrete, which is made up of cement paste, sand, and rock, is intended to be non-reactive after it hardens. Still, its surface reacts with the surrounding environment, and the reactions could damage and crack the concrete. "Such reaction occurs throughout the world. It's one of the main causes of destruction of modern concrete structures," Jackson says. "In contrast, we're looking at (b) a process that takes advantage of chemical exchange with seawater."

出典："How Seawater Strengthens Ancient Roman Concrete." *Unews*. The University of Utah. (July 3, 2017) (一部改変)

語注*

*1 volcanic: 火山の

*2 lime: 石灰

問１　文脈に照らして，下線部(1)〜(3)に最も近い意味の語をそれぞれイ〜ニから一つ選び，その記号を解答用紙にマークせよ。

(1) resilient

イ complicated　　ロ delicate

ハ simple　　ニ tough

(2) synthesizing

イ analyzing　　ロ producing

ハ calculating　　ニ enlarging

(3) durability

イ flexibility　　ロ difficulty

ハ permanence　　ニ uniqueness

問２　以下の(1)〜(4)はコンクリートの特徴を説明した英文である。それぞれに当てはまるのはどのコンクリートか，本文の内容に照らして最も適切なものをイ〜ハから一つ選び，その記号を解答用紙にマークせよ。

(1) This kind of concrete lasts less than a hundred years.

(2) This kind of concrete continues to become stronger long after it first hardens.

(3) This kind of concrete contains volcanic ash as one of the important ingredients.

(4) This kind of concrete is chemically reactive after it hardens.

イ	Roman marine concrete のみに当てはまる
ロ	modern concrete のみに当てはまる
ハ	Roman marine concrete と modern concrete の両方に当てはまる

問3　下線部(a)“rocks change”は，ここでは具体的にどのような現象を指しているか。最も適切なものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ　Certain chemical conditions transform rocks into concrete.

ロ　Flows of water gradually wear down rocks.

ハ　Large earthquakes move even heavy pieces of rock.

ニ　The chemical composition of rocks is not permanent.

問4　下線部(b)“a process that takes advantage of chemical exchange with seawater”が指す内容として最も適切なものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ　Seawater strengthens Roman concrete by extending the pozzolanic reaction.

ロ　Seawater strengthens modern concrete by extending the pozzolanic reaction.

ハ　Chemical reactions with seawater increase the strength of Roman concrete.

ニ　Chemical reactions with seawater increase the strength of modern concrete.

問5　本文の内容に照らして，Marie Jackson の研究チームによる最新の発見として最も重要なものをイ～ニから一つ選び，その記号を解答用紙にマークせよ。

イ　Crystals of Al-tobermorite have grown in Roman concrete over many years.

ロ　Crystals of Al-tobermorite are found in Roman concrete.

ハ　Roman concrete is made from volcanic ash, lime, and seawater.

ニ　Roman concrete structures are stronger today than when they were first constructed.