2017 年 2 月 20 日

受験生各位

慶應義塾大学

2017 年度慶應義塾大学環境情報学部
一般入学試験における出題について

　2017 年 2 月 18 日(土)に実施しました慶應義塾大学環境情報学部の一般入学試験「数学または情報」および「数学および外国語」のうち「数学」の問題におきまして、一部内容に不備がありました。

　慎重に検討した結果、下記のとおり対応することといたしました。受験生の皆様には、多大なご迷惑をおかけしましたことを深くお詫び申し上げます。

記

1.　出題および不備の内容
　　「数学または情報」の 3 ページ「数学―I」および「数学および外国語」の 17 ページ「数学―III」において、設問の説明が一部不十分であったことが判明しました。

2.　採点および合否判定についての対応
　　当該箇所について、「数学」の科目を選択した受験生全員が正解を解答したものとみなして加点いたします。
　　　　・「数学または情報」　　解答欄(3)～(14)
　　　　・「数学および外国語」　　解答欄(63)～(74)

　なお、本学といたしましては、今後、このようなことを起こさぬよう、管理体制の強化に取り組んでまいります。何卒ご理解いただきますようお願い申し上げます。

以上

英語 - I

次の文章に関して、空欄補充問題と読解問題の二つがあります。まず、[31]から[40]の空所を埋めるのに、文脈的に最も適切な語を1から3の中から選び、その番号を解答欄（31）から（40）にマークしなさい。次に、内容に関する[41]から[45]の設問には、1から4の選択肢が付されています。そのうち、文章の内容からみて最も適切なものを選び、その番号を解答欄（41）から（45）にマークしなさい。

1   A self-driving car carrying a family of four on a rural two-lane highway spots a bouncing ball ahead.   As the vehicle approaches, a child runs out to retrieve the ball.   Should the car risk its passengers' lives by swerving to the side—where the edge of the road meets a steep cliff?   Or should the car continue on its path, ensuring its passengers' safety at the child's expense?   This scenario and many others pose moral and ethical dilemmas that carmakers, car buyers, and regulators must address before vehicles should be given full autonomy, according to a study published in *Science.*

2   The study highlights paradoxes facing carmakers, car buyers, and regulators as driverless technology [31](1. stagnates   2. declines   3. accelerates).   Most of the 1,928 research participants in the *Science* report indicated that they believed vehicles should be programmed to crash into something rather than run over pedestrians, even if that meant killing the vehicle's passengers.   "The algorithms that control autonomous vehicles will need to [32](1. revise   2. ignore   3. embed) moral principles guiding their decisions in situations of unavoidable harm," according to the authors.

3   Yet many of the same study participants [33](1. agreed with   2. balked at   3. played up) the idea of buying such a vehicle, preferring to ride in a driverless car that prioritizes their own safety above that of pedestrians.   The researchers concluded that if lawmakers were to prioritize pedestrians over passengers when [34](1. designing   2. manufacturing   3. regulating) self-driving vehicles, people would be less likely to buy those vehicles.   A shrinking market for driverless cars would slow their development despite research showing that autonomous vehicles could potentially reduce traffic, cut pollution, and save thousands of lives each year—human error [35](1. contributes to   2. prevents   3. stems from) 90 percent of all traffic accidents.

4   The researchers based their survey queries largely on an ethics thought experiment known as "the trolley problem."   There are several variations on the trolley problem but they mostly pose [36](1. historical   2. hypothetical   3. realistic) scenarios in which a trolley is on course to run over a group of people.   A person watching the events unfold must choose between an intervention that sacrifices one person for the good of the group or one that protects an individual at the expense of the group.

5   Some observers say a key flaw in the *Science* study is that it does not take into account how the artificial intelligence (AI) being developed to control driverless vehicles actually works. "This question of ethics has become a popular topic with people who don't work on the technology," says Ragunathan Rajkumar, a professor of electrical and computer engineering at Carnegie Mellon University. "AI does not have the same cognitive capabilities that we as humans have," he adds.

6   Instead, autonomous vehicles make decisions based on speed, weather, road conditions, distance, and other data gathered by a variety of sensors, including cameras and radar. A driverless car will calculate a [37](1. course   2. cost   3. thread) of action based on how fast it is traveling as well as the speed of an object in its path, for example. The main challenge is in gathering and processing the necessary data quickly enough to avoid dangerous circumstances in the first place. Rajkumar acknowledges that this will not always be possible but he is [38](1. confident   2. skeptical   3. adamant) that in such cases it will come down to the vehicle essentially deciding who lives and who dies.

7   The study authors [39](1. almost   2. likewise   3. barely) acknowledge that their discussion of driverless vehicle moral dilemmas is a work in progress. They launched a Web site called Moral Machine to help gather more information about how people would prefer autonomous cars to react in different scenarios where passenger and pedestrian safety are [40](1. in alignment   2. at odds   3. unrelated). The site lets participants compare their responses and even offers the ability to construct new scenarios by tinkering with the number and type of people involved and whether they are obeying traffic laws at the time of the accident.

—Based on Greenemeier, L. (n.d.). *Scientific American.*

[41] Which of the following most likely represents the opinion of the researchers?
1. Self-driving cars will improve road safety.
2. Self-driving cars are too dangerous to be legal.
3. The market for self-driving cars is small.
4. Humans cannot be trusted with self-driving cars.

[42] Which of the following is an example of the "trolley problem?"

1. A group of people on a life raft with too many people must vote on which person must get out in order to keep the raft afloat.

2. Firefighters must choose between rescuing a famous scientist from the 4th floor of a burning research building or rescue her students from the 1st floor.

3. An airline pilot must choose between making an emergency landing on a highway with many cars on it or an unoccupied river.

4. Members of a jury must decide on whether a murderer should spend his life in prison, or receive the death penalty.

[43] Which of the following most likely represents Ragunathan Rajkumar's opinion on ethics in artificial intelligence (AI)?

1. AI researchers must be careful to program good ethics into their machines.

2. AI technology will make the study of ethics obsolete.

3. The decisions of AI are always the most ethical by design.

4. Ethics are not considered in the decisions made by AI technologies.

[44] According to the 6th paragraph, which of the following problems facing driverless cars is the most important?

1. Regulatory hurdles.

2. Technological development.

3. Moral quandaries.

4. Social acceptance.

[45] Which of the following would be the best title for this article?

1. The Future is Bright for Driverless Cars

2. Flawed Understanding of AI Abounds

3. Driverless Cars Will Face Moral Dilemmas

4. The Trolley Problem's Move to Cars

英語 - Ⅱ

次の文章に関して、空欄補充問題と読解問題の二つがあります。まず、[46]から[55]の空所を埋めるのに、文脈的に最も適切な語を 1 から 3 の中から選び、その番号を解答欄（46）から（55）にマークしなさい。次に、内容に関する[56]から[60]の設問には、1 から 4 の選択肢が付されています。そのうち、文章の内容からみて最も適切なものを選び、その番号を解答欄（56）から（60）にマークしなさい。

1   When they hear "biofuel," people tend to assume you're talking about corn.   That makes sense, given that corn is anticipated to provide 80 percent of this year's ethanol production—much more, say, than algae—until we consider a few numbers.

2   By all accounts, microalgae* is less land-intensive than corn production, and although it can pull double duty, providing high-quality feed for fish farms, it doesn't compete with food crops. [46](1. Furthermore   2. Nonetheless   3. Even so), even by the largely pro-corn Renewable Fuel Association's (RFA) water-consumption standards, corn ethanol is a thirsty fuel: Drinking 2.8 gallons of water for every gallon of fuel refined, corn is often outclassed in efficiency by algae-based fuels.

3   Algae biofuel frontrunner Algenol, for example, converts plentiful saltwater into biofuel with yields nearly 17 times higher than those of corn, while producing 1.4 gallons of fresh water per every gallon of fuel produced.   But simple consumption comparisons between corn and aquatic fuels are often [47](1. apples-to-oranges   2. carrots-to-sticks   3. coins-to-cats) affairs at best.   Much like the RFA's figure, which ignores that growing an ethanol-gallon's worth of corn costs 1,145 gallons of water, these simplistic metrics often miss something fundamental: Corn biofuel production consumes land, fertilizers, and water, whereas algae biofuel production can filter water, recycle runoff, and improve emissions.

4   John Decicco, a research professor at the University of Michigan Energy Institute, has debunked this misleading appraisal of corn perhaps better than anyone else.   He notes that the change in emissions in choosing corn ethanol over gas was "insignificant at best," and sometimes up to 70 percent worse.   This [48](1. benefit   2. deficiency   3. innovation) is largely thanks to the chemical breakdown of agricultural fertilizers trapped in soil, and the energy-intensive filtering of those that become runoff.

5   And [49](1. thereafter   2. thereby   3. therein) lies a fundamental difference between corn and aquatic biofuel platforms.   Looking only at the former, you'd walk away with the impression that biofuel must consume extravagant resources for, at best, a mediocre improvement over gas.   When you look at the latter you see how industrial pollution, CO_2, and runoff-laden wastewater can be recycled into fuel and new fertilizer.

[56] What is meant in the 2nd paragraph by the claim that microalgae can "pull double duty"?

1. It is twice as efficient as corn.

2. There are two kinds of microalgae.

3. It is half as big as corn.

4. It can be used for fuel and food.

[57] Which of the following is the main point the article is trying to make in the 2nd through 5th paragraphs?

1. Algae is cheaper than corn.

2. Algae produces more powerful fuel than corn.

3. Algae is more environmental than corn.

4. Algae is more popular than corn.

[58] Which of the following is meant in the 7th paragraph by the claim that "costs and yields simply aren't there yet"?

1. It is not possible to know how much it will cost or produce.

2. The research on costs and yields is ongoing.

3. It is still too expensive and inefficient.

4. It is not well-suited to all locations.

[59] Which of the following is meant by the phrase "its single-celled cousin" in the 9th paragraph?

1. Microalgae.

2. Corn.

3. Duckweed.

4. Kelp.

[60] Which of the following is meant by the phrase "biofuel remains a stepping stone to better solutions" in the final sentence?

1. Algae is a better biofuel than corn.

2. Biofuels will be inferior to future technologies.

3. Biofuels have not improved in a long time.

4. Corn is an impediment to producing better biofuels.

数学 − Ⅲ

下図のように，3つの甲円が交わっている．上甲円に含まれる丙円と2つの乙円は上甲円に接している．2つの上乙円はそれぞれ2つの下甲円に接している．また，丙円は2つの下甲円に接している．さらに，下甲円は互いに接し，下乙円は2つの下甲円に接し，これら3つの円は一つの直線に接している．
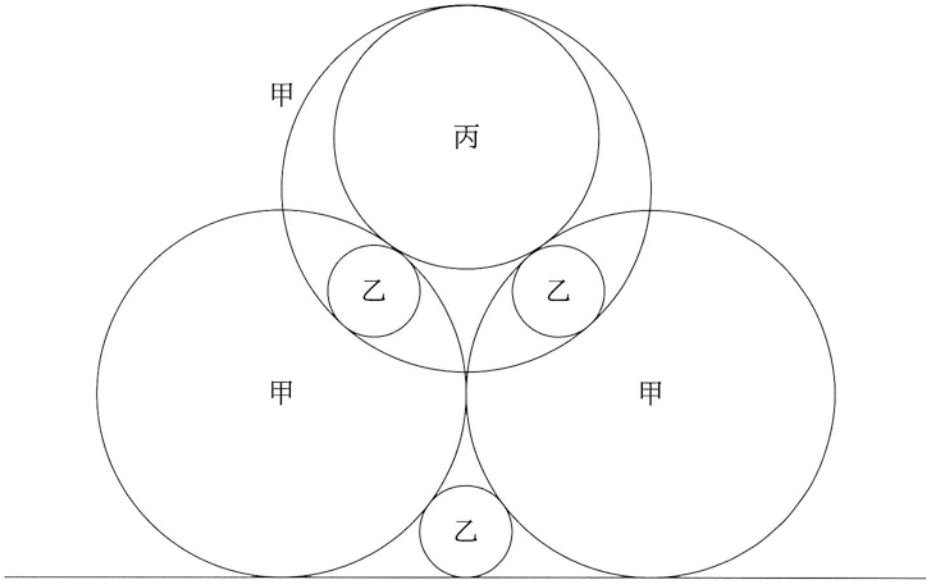
いま，乙円の直径を1寸とすると，甲円の直径は $\boxed{(61)}\,\boxed{(62)}$ 寸であり，上甲円の中心は直線から $\boxed{(63)}\,\boxed{(64)} + \sqrt{\boxed{(65)}\,\boxed{(66)}}$ 寸離れた位置にある．そして，丙円の直径は

$$\frac{\boxed{(67)}\,\boxed{(68)} + \boxed{(69)}\,\boxed{(70)}\sqrt{\boxed{(71)}\,\boxed{(72)}}}{\boxed{(73)}\,\boxed{(74)}}$$

寸である．

数学－IV

つぎの命題を数学的帰納法を用いて証明する．選択肢よりもっとも適切なものを選び，その番号を解答欄にマークしなさい．証明後の例については，解答の数字を解答欄にマークしなさい．

命題　すべての自然数は $2^i3^j, (i, j = 0, 1, 2, \ldots)$ の形の数の和で書くことができる．ただし各項は他の項を割ることはないとする．

証明　$1 = 2^03^0$ より，1 は表すことができる．n より小さな自然数に対して命題が成り立つと仮定して n の場合を示す．n が $\boxed{(75)}$ のとき，$\dfrac{n}{\boxed{(76)}}$ は n より小さいので

$$\frac{n}{\boxed{(76)}} = a_1 + a_2 + \cdots + a_\ell$$

と命題を満たす形に書くことがでる．すなわち，各項は 2^i3^j の形をしており，他の項を割ることはない．したがって

$$n = \boxed{(76)}a_1 + \boxed{(76)}a_2 + \cdots + \boxed{(76)}a_\ell$$

は命題を満たすことがわかる．

n が $\boxed{(77)}$ のとき，自然数 k を $3^k \leqq n < 3^{\boxed{(78)}}$ となるように選ぶ．$n = 3^k$ であれば命題を満たす．$3^k < n$ のとき，$n - 3^k$ は $\boxed{(79)}$ なので，前半の議論により

$$n - 3^k = \boxed{(80)}b_1 + \boxed{(80)}b_2 + \cdots + \boxed{(80)}b_m$$

と命題を満たす形に書くことができる．よって

$$n = \boxed{(80)}b_1 + \boxed{(80)}b_2 + \cdots + \boxed{(80)}b_m + 3^k$$

である．$b_s \leqq \dfrac{n - 3^k}{\boxed{(80)}} < \dfrac{3^{\boxed{(81)}} - 3^k}{\boxed{(80)}} = 3^{\boxed{(82)}}$ より，b_s が 3^k で割られることはない．さらに，$\boxed{(80)}b_s$ が 3^k を割ることもない．よって n は命題を満たす形に書くことができる．

以上のことから n の場合も命題が成立し，数学的帰納法により命題が示された．　　　（証明終）

選択肢　(1)　1　(2)　2　　(3)　3　　(4)　$k - 1$

(5)　k　(6)　$k + 1$　(7)　偶数　(8)　奇数

例えば，2017 を証明の考え方によって決まる命題を満たす形に表すと

$$2017 = 2^{\boxed{(83)}} 3^{\boxed{(84)}} + 2^{\boxed{(85)}} 3^{\boxed{(86)}} + 2^{\boxed{(87)}} 3^{\boxed{(88)}} + 2^{\boxed{(89)}} 3^{\boxed{(90)}}$$

となる．ただし，項は 2 のべきの大きい順 ($\boxed{(83)} > \boxed{(85)} > \boxed{(87)} > \boxed{(89)}$) とする．

数学 – Ⅴ

A 氏，B 氏，C 氏は起業したいと思っているが，1 人では不可能で，最低 2 人が組む必要があるとする．3 人が組めば 72 億円の利益が見込め，A 氏と B 氏が組めば 50 億円，A 氏と C 氏が組めば 32 億円，B 氏と C 氏が組めば 20 億円の利益が見込めるとする．いま，3 人が組んで起業した結果 72 億円の利益が得られたとき，その分配について考える．以下では，A 氏，B 氏，C 氏のそれぞれの分配額を x, y, z で表す．

(1) 3 人で組んだ場合に，2 人で組んだ場合以上の利益の分配を，それぞれが要求すると

$$
\begin{cases}
x, y, z \geqq 0 & \cdots\cdots ① \\
x + y + z = 72 & \cdots\cdots ② \\
x + y \geqq 50 & \cdots\cdots ③ \\
x + z \geqq 32 & \cdots\cdots ④ \\
y + z \geqq 20 & \cdots\cdots ⑤
\end{cases}
\quad (単位: 億円)
$$

となる．ここで，② は 3 人の分配額の合計が得られた利益の 72 億円になることを表し，③ は A 氏と B 氏の分配額の合計は 2 人が組んだ場合に見込める利益の 50 億円以上になることを両氏が要求することを表し，④ は A 氏と C 氏の分配額の合計は 2 人が組んだ場合に見込める利益の 32 億円以上になることを両氏が要求することを表し，⑤ は B 氏と C 氏の分配額の合計は 2 人が組んだ場合に見込める利益の 20 億円以上になることを両氏が要求することを表している．

これらの条件を満たす各人の分配額の中で，A 氏の分配額が最小となる分配額の組み合わせは，$x = \boxed{(91)}\boxed{(92)}, y = \boxed{(93)}\boxed{(94)}, z = \boxed{(95)}\boxed{(96)}$ である．(単位: 億円)

(2) 次に，(1) の条件のうち ③ 〜 ⑤ を仮定せず，① と ② のみを仮定すると

$$
\begin{cases}
x, y, z \geqq 0 & \cdots\cdots ① \\
x + y + z = 72 & \cdots\cdots ② \qquad (\text{単位: 億円})
\end{cases}
$$

となる．ここで，$50 - (x + y)$ を AB 両氏の不満，$32 - (x + z)$ を AC 両氏の不満，$20 - (y + z)$ を BC 両氏の不満，$-x$ を A 氏の不満，$-y$ を B 氏の不満，$-z$ を C 氏の不満と定義し，これらを小さくする分配を考える．このように不満を定義した理由は，A 氏と B 氏が組めば 50 億円の利益を見込めたのであるから，分配額との差 $50 - (x + y)$ が大きいほど AB 両氏のいわゆる不満は大きいと考えたからである．AC 両氏の不満，BC 両氏の不満についても同様である．また，A 氏の不満を $-x$ としたのは，A 氏の分配が大きいほどいわゆる不満は小さくなると考えたからである．B 氏の不満，C 氏の不満についても同様である．なお，不満は負の値になる場合もあることに注意すること．

いま，これらの不満の最大値を M とすると，明らかに AB 両氏の不満，AC 両氏の不満，BC 両氏の不満，A 氏の不満，B 氏の不満，C 氏の不満はいずれも M 以下となる．このとき，M を最小化する z の値は $\boxed{(97)}\boxed{(98)}$ であり，x の範囲は $\boxed{(99)}\boxed{(100)} \leqq x \leqq \boxed{(101)}\boxed{(102)}$ となる．(単位: 億円)