

(English Instructions are provided in Page 2)

(修士課程用)

令和 4 年度

東京大学大学院新領域創成科学研究科
環境システム学専攻

注意事項

(専門科目 A)

令和 4 年 1 月 22 日 (土) 10 時 00 分～11 時 00 分

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. 問題は 4 ページから成っている。前半 2 ページは日本語版で、後半 2 ページは英語版である。落丁、乱丁、印刷不鮮明の箇所などがあった場合には申し出ること。
3. 解答用紙と草稿用紙に受験番号を記入せよ。氏名を記入してはならない。
4. 専門科目 A と記載された解答用紙 (2 枚) を使用すること。
5. すべての解答用紙に、解答する問題番号を明示すること。
6. 解答に関係のない記号、符号などを記入した答案は無効とする。
7. 草稿用紙は 1 枚使用して構わない。

(日本語の注意事項は 1 ページ目に記載)

Master Course

Entrance Examination 2022

Department of Environment Systems
Graduate School of Frontier Sciences
The University of Tokyo

Instructions

(Specialized Subject A)

22 January, 2022 10:00–11:00

1. Do not open the problem booklet until the examiner instructs you to do so.
2. The problem consists of 4 pages. The first 2 pages are Japanese version and the second 2 pages are English version. If you find pages blurred printing or pages missing in this booklet, notify an examiner immediately.
3. Write your examinee number in the specified space on each answer sheet and each sheet for notes. Do not write your name in these spaces.
4. Use the two answer sheets titled Specialized Subject A.
5. Specify the problem number on each answer sheet.
6. Any answer sheets with marks or symbols irrelevant to your answers will be considered invalid.
7. You can use one sheet for notes.

令和 4 年度入学試験
Entrance Examination 2022

東京大学大学院新領域創成科学研究科
環境システム学専攻
Department of Environment Systems
Graduate School of Frontier Sciences
The University of Tokyo

問題冊子

Problem Booklet

(専門科目 A)

(Specialized Subject A)

- ・ この問題冊子は試験終了後回収する。
オンライン試験の受験者は、試験終了後このファイルを削除すること。
This problem booklet will be collected after the examination.
Applicants taking the online examination must delete this file after the examination.

専門科目 A

日本語版 Japanese version

以下の A1～A3 のうちから一つを選び、文章を読んだうえで、下線部について、関連する具体的事例を挙げつつ、自分の意見や考えを含めて論じよ。なお、解答にあたっては、選択した文章の番号を解答用紙の問題番号の欄に記入し、解答用紙 2 枚以内で書くこと。

A1: Energy production from most renewable energy sources is typically intermittent, thus storage of the energy in batteries is necessary in order to cushion the effects of fluctuation in energy production. Chemical storage is more economical in comparison to batteries, and it also allows for the replacement of fossil-based fuels with carbon-free fuels, like hydrogen. Hydrogen can be produced renewably from green energy sources via the electrolysis of water for example, and can be utilized in combustion systems, in fuel cells, and as a reagent in chemical synthesis. Recent advances in and increased utilization of renewable energy systems have been accompanied by a significant increase in hydrogen production and utilization. However, the economic storage and transport of hydrogen remain important unsolved challenges for its sustainable utilization. (Kobayashi et al., 2019, *Proceedings of the Combustion Institute*, **37**, 109–133 の一部)

A2: Although local temperature changes may exert greater influence on urban ecosystems than global temperature increases at present, other aspects of regional and global climate change pose risks to cities. In particular, coastal cities would be exposed to rising sea level and any increased hurricane frequency caused by climate change. Thus, one important aspect of achieving urban sustainability is strengthening our ability to respond to the changing relation between urbanization and climate. For cities to effectively respond to global climate change, both mitigation and adaptation strategies—and economic markets for them—will be required. (Grimm et al., 2008, *Science*, **319**, 756–760 の一部)

A3: Water scarcity is one of the most serious global challenges of our time. Presently, over one-third of the world's population lives in water-stressed countries and by 2025, this figure is predicted to rise to nearly two-thirds. The challenge of providing ample and safe drinking water is further complicated by population growth, industrialization, contamination of available freshwater resources, and climate change. At the same time, greater recognition of the broad societal and ecological benefits that stem from adequate water resources—economic vitality, public health, national security, and ecosystem health—is motivating the search for technological solutions to water shortages. (Elimelech and Phillip, 2011, *Science*, **333**, 712–717 の一部)

(これで日本語版の問題は終わりです)

Specialized Subject A

English version 英語版

Choose one of the three extracts (A1 – A3) below. After reading the entire extract you have chosen, discuss the underlined statement, using related case examples and expressing your personal opinions. Be sure to write the number of the extract you have chosen in the problem number box on each answer sheet. Use two answer sheets for your answer.

A1: Energy production from most renewable energy sources is typically intermittent, thus storage of the energy in batteries is necessary in order to cushion the effects of fluctuation in energy production. Chemical storage is more economical in comparison to batteries, and it also allows for the replacement of fossil-based fuels with carbon-free fuels, like hydrogen. Hydrogen can be produced renewably from green energy sources via the electrolysis of water for example, and can be utilized in combustion systems, in fuel cells, and as a reagent in chemical synthesis. Recent advances in and increased utilization of renewable energy systems have been accompanied by a significant increase in hydrogen production and utilization. However, the economic storage and transport of hydrogen remain important unsolved challenges for its sustainable utilization. (From Kobayashi et al., 2019, *Proceedings of the Combustion Institute*, **37**, 109–133)

A2: Although local temperature changes may exert greater influence on urban ecosystems than global temperature increases at present, other aspects of regional and global climate change pose risks to cities. In particular, coastal cities would be exposed to rising sea level and any increased hurricane frequency caused by climate change. Thus, one important aspect of achieving urban sustainability is strengthening our ability to respond to the changing relation between urbanization and climate. For cities to effectively respond to global climate change, both mitigation and adaptation strategies—and economic markets for them—will be required. (From Grimm et al., 2008, *Science*, **319**, 756–760)

A3: Water scarcity is one of the most serious global challenges of our time. Presently, over one-third of the world's population lives in water-stressed countries and by 2025, this figure is predicted to rise to nearly two-thirds. The challenge of providing ample and safe drinking water is further complicated by population growth, industrialization, contamination of available freshwater resources, and climate change. At the same time, greater recognition of the broad societal and ecological benefits that stem from adequate water resources—economic vitality, public health, national security, and ecosystem health—is motivating the search for technological solutions to water shortages. (From Elimelech and Phillip, 2011, *Science*, **333**, 712–717)

(The end of the problem)

(English Instructions are provided in Page 2)

(修士課程用)

令和 4 年度

東京大学大学院新領域創成科学研究科
環境システム学専攻

注意事項

(専門科目 B)

令和 4 年 1 月 22 日 (土) 14 時 00 分～14 時 30 分

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. 問題冊子は 6 ページから成っている。前半 3 ページは日本語版で、後半 3 ページは英語版である。落丁、乱丁、印刷不鮮明の箇所などがあった場合には申し出ること。
3. 解答用紙と草稿用紙に受験番号を記入せよ。氏名を記入してはならない。
4. 専門科目 B は 8 つの問題から成る。3 問を選択して解答せよ。
5. 専門科目 B と記載された解答用紙 (1 枚) を使用すること。
6. 解答欄の左上にある欄に、解答する問題番号をそれぞれ明示すること。
7. 解答に関係のない記号、符号などを記入した答案は無効とする。
8. 草稿用紙は 1 枚使用して構わない。

(日本語の注意事項は 1 ページ目に記載)

Master Course

Entrance Examination 2022

Department of Environment Systems
Graduate School of Frontier Sciences
The University of Tokyo

Instructions

(Specialized Subject B)

22 January, 2022 14:00–14:30

1. Do not open the problem booklet until the examiner instructs you to do so.
2. The problem booklet consists of 6 pages. The first 3 pages are the Japanese version and the second 3 pages are the English version. If you find blurred printing or pages missing in the booklet, notify an examiner immediately.
3. Write your examinee number in the specified space on each answer sheet and each sheet for notes. Do not write your name in these spaces.
4. Specialized Subject B consists of eight problems. You must choose three problems to answer.
5. Use the one answer sheet titled Specialized Subject B.
6. Specify the problem number in the box to the top left of each answer box.
7. Any answer sheets with marks or symbols irrelevant to your answers will be considered invalid.
8. You can use one sheet for notes.

修士課程
Master Course

令和 4 年度入学試験
Entrance Examination 2022

東京大学大学院新領域創成科学研究科
環境システム学専攻
Department of Environment Systems
Graduate School of Frontier Sciences
The University of Tokyo

問題冊子

Problem Booklet

(専門科目 B)

(Specialized Subject B)

- ・ この問題冊子は試験終了後回収する。
オンライン試験の受験者は、試験終了後このファイルを削除すること。
This problem booklet will be collected after the examination.
Applicants taking the online examination must delete this file after the examination.

専門科目 B

日本語版 Japanese version

以下の B1～B8 から 3 問を選んで解答せよ。解答用紙には、枠で区切られている 3 つの解答欄がある。解答は、設問ごとに、解答用紙の 1 つの枠内に収まるように記述し、各枠の左上にある欄に選択した設問番号を記すこと。

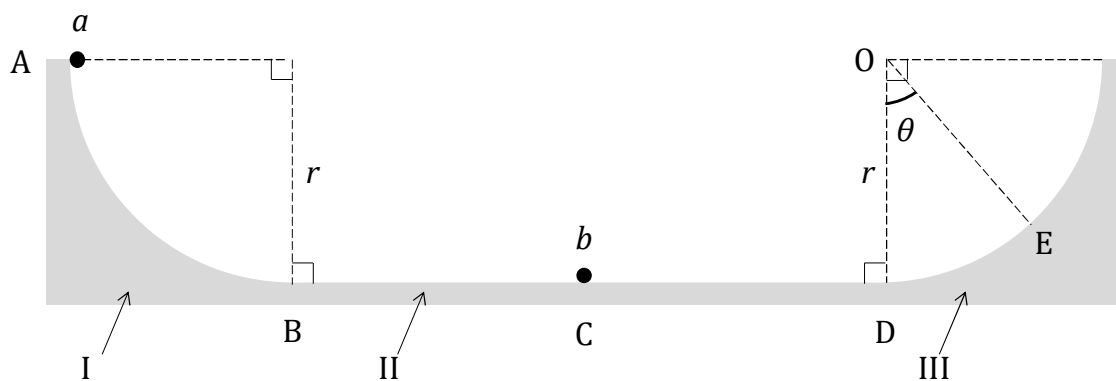
B1. ESG 投資の拡大は、気候変動などの地球環境問題の解決に繋がると期待されている。その理由を「非財務情報」、「企業価値」、「温室効果ガス」の 3 つの語句を用いて説明せよ。

B2. 受信したメールが迷惑メールか非迷惑メールかを判定するシステムを開発した。このシステムでは、迷惑メールを迷惑メールとして正しく判定する確率は 95%、非迷惑メールを非迷惑メールとして正しく判定する確率は 80%である。このシステムを導入したところ、受信したメールのうち 30%が迷惑メールであると判定された。実際の迷惑メールの割合を求めよ。

B3. $0 < \theta < \pi/2$ 、 $\sin 2\theta = \cos 3\theta$ のとき、 $\sin \theta$ を求めよ。途中の考え方も示すこと。

B4. n が正の整数のとき、 $2022!/2^n$ は整数になるが、 $2022!/2^{n+1}$ は整数にならなかった。 n を求めよ。

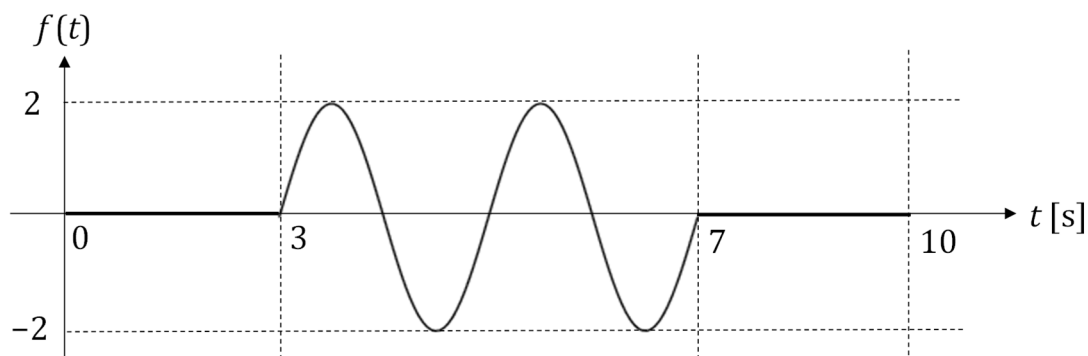
B5. 半径 r の円形の滑り台 I と平面台 II、半径 r の円形の滑り台 III が水平な床の上に下図のように位置 B、D で連結され、段差をつくることなく設置されている。質量 m_1 の質点 a を滑り台 I の上端 A から静かに離したところ、滑り台 I に沿って運動し、その後平面 II 上の位置 C に静止した状態で置かれていた質量 m_2 ($m_1 < m_2$) の質点 b に完全弾性衝突した。その瞬間、質点 b は動き出し、滑り台 III に沿って位置 E まで到達した後、戻っていった。ここで、図中の $\angle DOE$ を θ とする。 $\cos \theta$ を m_1 、 m_2 で表せ。なお、全て鉛直の同一平面内にあるとし、空気抵抗と摩擦は無視できるものとする。重力加速度は g である。



(問題は次ページに続く)

B6. ある録音機に正弦波が 2 周期分収録された。収録時間は 10 s であった。収録された信号は下図で表される。この信号を $f(t)$ とするとき、 $f(t)$ のフーリエ変換 $F(\omega)$ を求めよ。

必要であれば $\sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$ を用いてよい。ここで j は虚数単位である。



B7. 物質の臨界点は、圧力 P 、部分モル体積 V_m を用いて、 $\frac{dP}{dV_m} = 0$ 、 $\frac{d^2P}{dV_m^2} = 0$ で定義される。

気体の状態方程式が $P = \frac{RT}{V_m - b} - \frac{a}{V_m^2}$ (a 、 b は定数、 R は気体定数、 T は温度) で表される
とき、臨界点における圧力 P_c を a 、 b を用いて表せ。途中の考え方も示すこと。

B8. NH_3 と NH_4Cl の混合水溶液では、少量の酸や塩基が加えられても、溶液の pH がほとんど変動しない。その理由を説明せよ。

(これで日本語版の問題は終わりです)

Specialized Subject B

English version 英語版

Choose three problems from B1–B8, and answer them. There are three answer boxes on the answer sheet. Write the number of the chosen question in the box to the top left of each box. For each question, answers must be written within one box on the answer sheet.

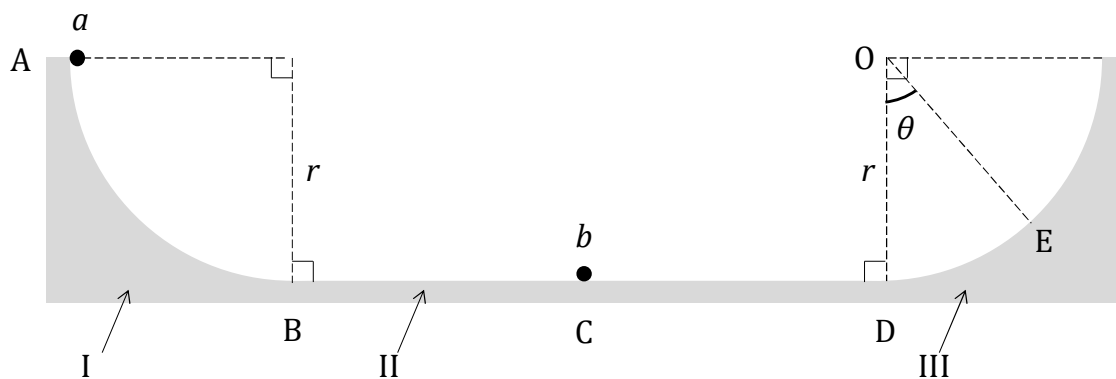
B1. The expansion of ESG investment is expected to solve global environmental problems such as climate change. Explain possible reasons using the following three terms; “non-financial information”, “corporate value”, and “greenhouse gas”.

B2. We have developed a system to determine whether a received e-mail is spam or non-spam. This system has a 95% probability of correctly determining a spam e-mail as spam, and an 80% probability of correctly determining a non-spam e-mail as non-spam. When this system was installed, 30% of the received e-mails were determined to be spam e-mails. Find the actual percentage of spam e-mails.

B3. If $0 < \theta < \pi/2$ and $\sin 2\theta = \cos 3\theta$, find $\sin \theta$. Show the derivation process as well.

B4. When n is a positive integer, $2022!/2^n$ is an integer but $2022!/2^{n+1}$ is not an integer. Find n .

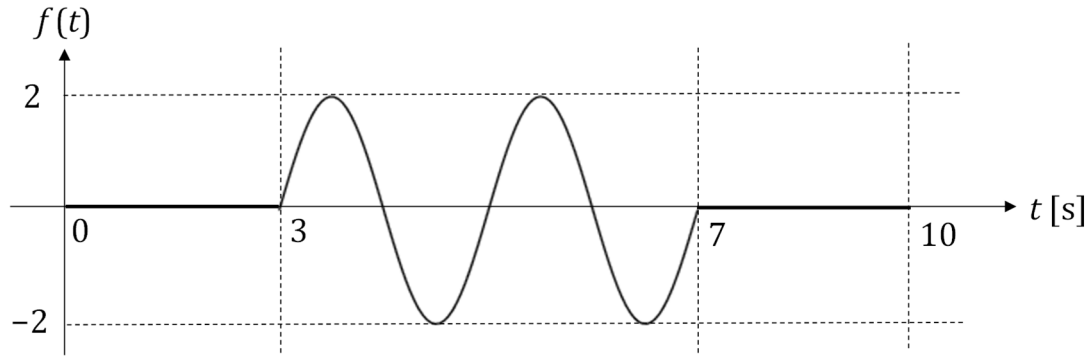
B5. A circular slide I with radius r , a flat plane II, and a circular slide III with radius r are connected at positions B and D on a horizontal floor without interruption as shown in the figure. When a point mass a of mass m_1 was gently released from the top A of the slide I, it moved along the slide and then had a perfect elastic collision with a point mass b of mass m_2 ($m_1 < m_2$), which was placed stationary at position C on the plane. At that moment, the point mass b started to move and reached position E along the slide III, and then returned. Here, $\angle DOE$ in the figure is θ . Express $\cos\theta$ in terms of m_1 and m_2 . Assume that all objects are in the same vertical plane, and air resistance and friction are negligible. The gravitational acceleration is g .



(Problem continues to the next page.)

B6. A recording device recorded a sine wave for two cycles. The recording time was 10 s. The recorded signal is shown in the figure. Let this signal be $f(t)$, and find the Fourier transform

$F(\omega)$ of $f(t)$. If necessary, use $\sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$. Here, j is the imaginary unit.



B7. The critical point of a substance is expressed as $\frac{dP}{dV_m} = 0$, $\frac{d^2P}{dV_m^2} = 0$, using pressure, P , and

partial molar volume, V_m . When the equation of state of a gas is expressed as $P = \frac{RT}{V_m - b} - \frac{a}{V_m^2}$

(a and b are constants, R designates gas constant, T designates temperature), express the pressure at the critical point P_C with a and b . Show the derivation process as well.

B8. In a mixed aqueous solution of NH_3 and NH_4Cl , the change in pH of the solution is very little even when a small amount of acid or base is added. Explain the reason.

(The end of the problem)