令和 3 年度 B 日程では、東京大学柏キャンパス試験会場での試験に加え、オンラインの追試験が行われました。この PDF ファイルの前半は試験会場での試験の過去問題、後半は追試験の過去問題です。

On the entrance examination schedule B, 2021, in addition to the onsite examination at the University of Tokyo Kashiwa Campus, the online additional examination was conducted. In this PDF file, the first part is the past problems of the onsite examination and the second part is the past problems of the online additional examination.

Entrance Examination 2021

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

Problem Booklet

(Specialized Subject)

23 January, 2021 (Sat)   10:30–11:45

Instructions

1. Do not open the problem booklet until the start of the examination is announced.
2. The problem booklet consists of 5 pages. If you find pages missing or blurred printing in this booklet, notify an examiner immediately.
3. Write your examinee number in the specified space on each answer sheet and memo paper. Do not write your name.
4. Answer both Question A and Question B. Choose any two of the five terms in Question B.
5. There are three answer sheets: One for Question A, and two for Question B. Use one answer sheet for each of the two terms in Question B.
6. Specify item number on each answer sheet for each question.
7. Any answer sheets with marks or symbols irrelevant to your answers will be considered invalid.
8. Do not tear out any part of the problem booklet, answer sheets, or memo paper.
9. Do not take the problem booklet, answer sheets, or memo paper with you when you leave.

Examinee number: _____   (Write your examinee number.)

Question A

Choose any one of the four terms listed below, and discuss the characteristics and problems relevant to the topic you choose from the aspect of environmental technology and countermeasures. Be sure to include your own opinions and point of view.
Do not exceed the 30 lines provided on the answer sheet. Write the number of the topic you have chosen (A1, etc.) on the answer sheet.

A1. Huge or Massive forest fires

A2. Biomass energy

A3. Regional land subsidence

A4. Well to wheel

(Specialized Subject continues to the next page.)

Question B

Choose any <u>two</u> of the 5 terms listed below, and describe what you know about each term you choose.
Use one answer sheet for each term, and write the number of the term you have chosen (B1, etc.) on each answer sheet. Do not exceed the 5 lines provided for each term on the answer sheet. You may use figures if you want.

B1. Fourier series

B2. Biot–Savart law

B3. Brownian motion

B4. Chromatography

B5. Significant digits (also known as Significant figures)

(The end of the problem)

(English Instructions are provided in Page 2)

<div align="right">（修士課程用）</div>

令和３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 3 年 1 月 31 日（日）　9 時 30 分〜10 時 30 分

1．試験開始の合図があるまで，問題ファイルを開かないこと．
2．問題ファイルは 2 ページから成っている．前半は日本語版で，後半は英語版である．
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．
8．試験中は常にカメラおよびマイクを ON にしておくこと．
9．ネットワークトラブル等が発生した場合は，直ちに環境システム学専攻入試委員に連絡を取り，指示を仰ぐこと．
　　TEL：070-1481-1372（海外から：+81-70-1481-1372）
　　上記がつながらない場合：04-7136-4696（海外から：+81-4-7136-4696）

（日本語の注意事項は **1** ページ目に記載）

Master Course

Entrance Examination 2021

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

Instructions

(Specialized Subject A)

31 January, 2021   9:30–10:30

1. Do not open the problem file until the examiner instructs you to do so.
2. The problem file consists of two pages. The first half is the Japanese version and the second half is the English version.
3. Write your examinee number in the specified space of each answer sheet and sheet for notes. Do not write your name in them.
4. Use two answer sheets described as 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.
8. Always keep the camera and microphone turned on during the examination.
9. Contact the Entrance examination committee, Department of Environment Systems, and follow the instructions if you encounter network problems etc.
    TEL: 070-1481-1372 (From countries other than Japan: +81-70-1481-1372)
    Call 04-7136-4696 if the above numbers do not work.
      (From countries other than Japan: +81-4-7136-4696)

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（A1 など）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

The face of Earth in the twenty-first century is affected in an unprecedented manner by the activities of humanity and the production and accumulation of human-made objects. Given the limitations of human cognition in the face of the immensity of the globe and the seeming infinity of the natural world, it is desirable to provide a rigorous and objective measure of the overall balance between the living and human-made. However, in spite of pioneering efforts, we lack a holistic picture that quantifies and compares the composition of the world in terms of both biological and human-made mass. (Elhacham et al., 2020, *Nature*, **588**, 442–444 の一部)

A2

In the late 1980s, as a result of increasing environmental awareness, emphasis gradually switched to waste prevention at source as opposed to waste remediation and pollution control by end-of-pipe solutions. The US Pollution Prevention Act of 1990 3 focused attention on the need to reduce environmental pollution and recognised that waste prevention at source not only eliminates the cost of waste treatment but actually strengthens economic competitiveness through more efficient use of raw materials. It led to a fundamental shift in the blueprint of the US Environmental Protection Agency (EPA) for environmental protection – from "end of pipe" waste treatment to waste prevention – and culminated in the introduction of the term Green Chemistry at the EPA in the early 1990s. (From Sheldon, 2017, *Green Chemistry*, **19**, 18–43 の一部)

A3

Uncertainty analysis has received increasing attention in the field of building energy analysis because a number of variables that influence building thermal performance are inherently uncertain, such as occupant behaviour, thermal properties of building envelope, and weather conditions. Moreover, the development of modern uncertainty quantification techniques provides more advanced methods and tools to facilitate the research on uncertainty analysis for a better understanding of the nature of building energy and associated energy models. Therefore, uncertainty analysis has been widely implemented in various areas of building energy analysis, (Tian et al., 2018, *Renewable and Sustainable Energy Reviews*, **93**, 285–301 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, and read the entire extract you have chosen. Then, 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 (A1 etc.) in the problem number box on your answer sheet.　　Use two answer sheets for your answer.

A1

The face of Earth in the twenty-first century is affected in an unprecedented manner by the activities of humanity and the production and accumulation of human-made objects. Given the limitations of human cognition in the face of the immensity of the globe and the seeming infinity of the natural world, it is desirable to provide a rigorous and objective measure of the overall balance between the living and human-made. However, in spite of pioneering efforts, <u>we lack a holistic picture that quantifies and compares the composition of the world in terms of both biological and human-made mass</u>. (From Elhacham et al., 2020, *Nature*, **588**, 442–444.)

A2

In the late 1980s, as a result of increasing environmental awareness, emphasis gradually switched to waste prevention at source as opposed to waste remediation and pollution control by end-of-pipe solutions. The US Pollution Prevention Act of 1990 3 focused attention on the need to reduce environmental pollution and recognised that waste prevention at source not only eliminates the cost of waste treatment but actually strengthens economic competitiveness through more efficient use of raw materials. <u>It led to a fundamental shift</u> in the blueprint of the US Environmental Protection Agency (EPA) <u>for environmental protection – from "end of pipe" waste treatment to waste prevention – and culminated in the introduction of the term Green Chemistry</u> at the EPA in the early 1990s. (From Sheldon, 2017, *Green Chemistry*, **19**, 18–43.)

A3

Uncertainty analysis has received increasing attention in the field of building energy analysis because a number of variables that influence building thermal performance are inherently uncertain, such as occupant behaviour, thermal properties of building envelope, and weather conditions. Moreover, the development of modern uncertainty quantification techniques provides more advanced methods and tools to facilitate the research on uncertainty analysis for a better understanding of the nature of building energy and associated energy models. Therefore, <u>uncertainty analysis has been widely implemented in various areas</u> of building energy analysis, (From Tian et al., 2018, *Renewable and Sustainable Energy Reviews*, **93**, 285–301.)

(The end of the problem)

（修士課程用）

令和３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 3 年 1 月 31 日（日）　13 時 30 分〜14 時 00 分

１．試験開始の合図があるまで，問題ファイルを開かないこと．
２．問題ファイルは 6 ページから成っている．前半は日本語版で，後半は英語版である．
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．
９．試験中は常にカメラおよびマイクを ON にしておくこと．
１０．　ネットワークトラブル等が発生した場合は，直ちに環境システム学専攻入試委員
　　に連絡を取り，指示を仰ぐこと．
　　TEL：070-1481-1372（海外から：+81-70-1481-1372）
　　上記がつながらない場合：04-7136-4696（海外から：+81-4-7136-4696）

Master Course

Entrance Examination 2021

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

Instructions

(Specialized Subject B)

31 January, 2021　13:30–14:00

1. Do not open the problem file until the examiner instructs you to do so.
2. The problem file consists of six pages. The first half is the Japanese version and the second half is the English version.
3. Write your examinee number in the specified space of each answer sheet and sheet for notes. Do not write your name in them.
4. Specialized Subject B consists of eight problems. You must choose three problems to answer.
5. Use one answer sheet described as 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.
9. Always keep the camera and microphone turned on during the examination.
10. Contact the Entrance examination committee, Department of Environment Systems, and follow the instructions if you encounter network problems etc.
    TEL: 070-1481-1372 (From countries other than Japan: +81-70-1481-1372)
    Call 04-7136-4696 if the above numbers do not work.
    　(From countries other than Japan: +81-4-7136-4696)

専門科目 B

日本語版　Japanese version

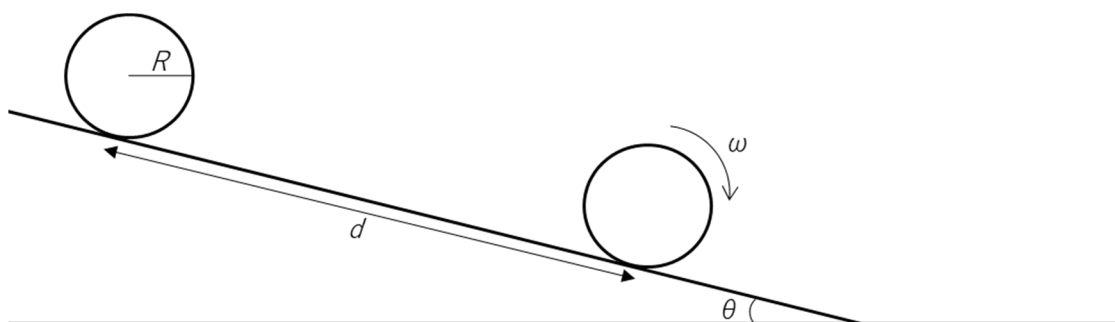以下の B1〜B8 から 3 問を選んで解答せよ。解答用紙には、枠で区切られている 3 つの解答欄がある。解答は、設問ごとに、解答用紙の 1 つの枠内に収まるように記述し、各枠の左上にある欄に選択した設問番号を記すこと。

B1. 屋上緑化がヒートアイランド現象の緩和に寄与する理由を、「日射」、「顕熱」、「潜熱」、「排熱」の 4 つの語句を用いて説明せよ。

B2. 海産魚におけるセシウムとポリ塩化ビフェニル（PCB）の生物濃縮係数はそれぞれ $10 \sim 10^2$ 程度、$10^5 \sim 10^6$ 程度と報告されている。PCB の方が生物濃縮性係数が大きい理由を説明せよ。

B3. 実数 x, y, z が $x + 2y + 3z = 4$ を満たすとき、$x^2 + y^2 + z^2$ の最小値と、そのときの x, y, z の値を求めよ。
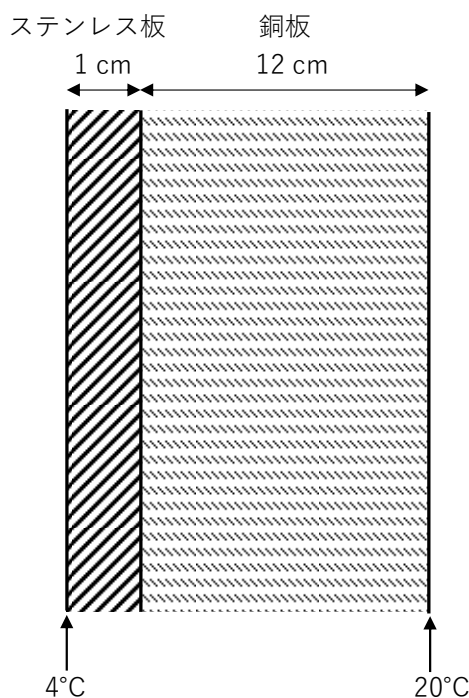
B4. 3 進法で 20^{21} と表される数は、3 進法で何桁の数となるか。桁数を、3 進法で答えよ。

B5. 水平面と角度 θ をなす斜面上に半径 R、長さ L、密度 ρ の一様な円柱が静置されている。この円柱が、図のように、斜面上を滑ることなく距離 d だけ転がり落ちたときの、円柱の角速度 ω を求めよ。ただし、重力加速度を g とする。

（問題は次ページに続く）

B6. 厚さ 1 cm のステンレス板と厚さ 12 cm の銅板が接合され、図のようにステンレス板の表面が 4℃、銅板の表面が 20℃に保持されている。このとき、接合面における温度を求めよ。ただし、このステンレスと銅の熱伝導率を、それぞれ 2.0×10^1 W m^{-1} K^{-1}、4.0×10^2 W m^{-1} K^{-1} とする。

ステンレス板　　　銅板

1 cm　　　　12 cm

4℃　　　　　　　　　20℃

B7. 濃度 100 mg L^{-1} のフタル酸（$C_6H_4(COOH)_2$）水溶液の、理論的酸素要求量を求めよ。

B8. $A + B \rightarrow$ products の式で表される化学反応について、反応速度 r は反応物 A、B の濃度 C_A、C_B の各 1 次に比例する（$r = kC_A C_B$: k は速度定数）。原料中の B の濃度は 2.0×10^1 mol m^{-3} であり、A の濃度に比べて大過剰であるため、この反応は A の擬一次反応であるとみなせるとする。反応を開始してから、A の濃度が初期濃度の 1/10 になるまでの時間を求めよ。ただし、k の値は 2.5×10^{-4} m^3 mol^{-1} sec^{-1} とする。必要であれば、$\ln 2 = 0.693$、$\ln 5 = 1.61$ を用いてよい。

（これで日本語版の問題は終わりです）

3

Specialized Subject B

English version　英語版

Choose any <u>three</u> problems from problems B1–B8 to answer. The answer sheet contains three answer boxes. Your entire written answer for each question must stay within one box on the answer sheet. Please write the number of the chosen question in the small box on the top left corner of each answer box.
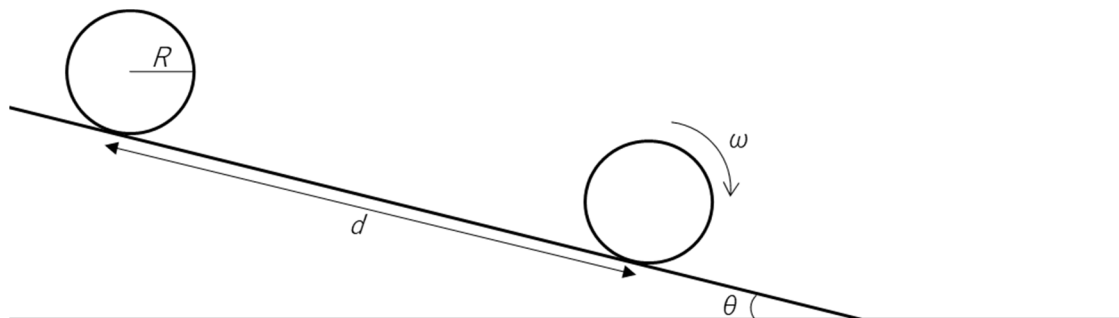
B1. Using the following four terms: "solar radiation", "sensible heat", "latent heat", and "exhaust heat", explain why green roofs contribute to the mitigation of the heat island effect.

B2. Bioconcentration factor of marine fish for cesium and polychlorinated biphenyl (PCB) is reported to be approximately $10 - 10^2$ and approximately $10^5 - 10^6$, respectively. Explain why PCB shows a relatively higher bioconcentration factor.

B3. Consider real numbers x, y, and z that satisfy $x + 2y + 3z = 4$. Find the minimum value of $x^2 + y^2 + z^2$ and also provide the values of x, y, and z that determine the minimum value.
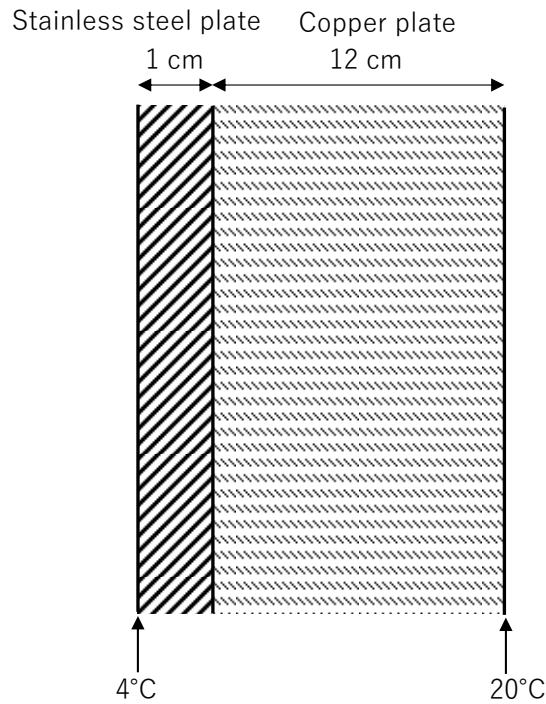
B4. Consider a number 20^{21} which is expressed in a ternary number system (i.e., base 3). In a ternary representation, what is the number of digits in 20^{21}? Express the answer as a ternary representation.

B5. A uniform cylinder with radius R, length L, and density ρ rests on an inclined plane with an angle θ from the horizontal. When the cylinder rolls down a distance d on this plane without slipping (as shown in the figure), what will the angular velocity ω of this cylinder be? Use g as the gravitational acceleration.

(Problem continues to the next page.)

B6. A stainless steel plate with a thickness of 1 cm and a copper plate with a thickness of 12 cm are attached together, as shown in the figure. When the surface of the stainless steel plate is kept at 4°C and the surface of the copper plate is kept at 20°C, find the temperature at the interface. Assume that the thermal conductivity of this stainless steel and copper is 2.0×10^1 W m^{-1} K^{-1} and 4.0×10^2 W m^{-1} K^{-1}, respectively.

Stainless steel plate   Copper plate
        1 cm   12 cm

4°C   20°C

B7. Determine the theoretical oxygen demand for an aqueous solution of phthalic acid ($C_6H_4(COOH)_2$) with a concentration of 100 mg L^{-1}.

B8. For a chemical reaction that is expressed as "A + B → products", the reaction rate r is proportional to the concentrations of reactants A (C_A) and B (C_B) as $r = kC_AC_B$ (k : rate constant). Because the concentration of B in the feedstock is 2.0×10^1 mol m^{-3} , which is much larger than that of A, this reaction can be regarded as a pseudo-first-order reaction with respect to A. After the start of the reaction, how long does it take for the concentration of A to be 1/10 of its initial value? Assume that k is 2.5×10^{-4} m^3 mol^{-1} sec^{-1}. If necessary, use $\ln 2 = 0.693$ and $\ln 5 = 1.61$.

(The end of the problem)

令和 3 年度 B 日程では、東京大学柏キャンパス試験会場での試験に加え、オンラインの追
試験が行われました。この PDF ファイルの前半は試験会場での試験の過去問題、後半は追
試験の過去問題です。

On the entrance examination schedule B, 2021, in addition to the onsite examination at the
University of Tokyo Kashiwa Campus, the online additional examination was conducted. In
this PDF file, the first part is the past problems of the onsite examination and the second part
is the past problems of the online additional examination.

令和 **3** 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

大学院入学試験問題

（専門科目）

令和 **3** 年 **1** 月 **23** 日（土）　**10** 時 **30** 分〜**11** 時 **45** 分

注 意 事 項

1．試験開始の合図があるまで，この問題冊子を開かないこと．
2．本冊子は **5** ページから成っている．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．解答用紙および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．問題 A と問題 B の両方に解答すること．問題 B については，5 問の中から **2 問を選んで解答**すること．
5．解答用紙が 3 枚渡されるが，**問題 A には 1 枚，問題 B には 2 枚使用する．問題 B では 1 問につき解答用紙 1 枚を使用**すること．
6．解答用紙の最初に，解答する問題番号を明示すること．
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．解答用紙および問題冊子，草稿用紙は，切り取ってはならない．
9．解答用紙および問題冊子，草稿用紙は，持ち帰らないこと．

受験番号：＿＿＿＿＿＿＿＿＿＿＿＿　　　　　（左に受験番号を記入せよ）

問題 A

次の 4 つの語句の中から 1 つを選んで、選んだ語句に関連する特徴や問題点を、環境技術や環境対策の観点から論ぜよ。その際に、自分の考えを含めて記述すること。解答用紙 30 行以内で書くこと。解答用紙には、選んだ問題番号（例えば A1）を明記せよ。

A1. 大規模森林火災

A2. バイオマスエネルギー

A3. 広域地盤沈下

A4. Well to wheel (油井から車輪まで)

問題 B

次の 5 つの用語の中から 2 つを選んで、その用語について知るところをそれぞれ解答用紙 5 行以内で記述せよ。必要に応じて、図を用いても良い。1 つの用語につき 1 枚の解答用紙を用い、それぞれの解答用紙に選んだ問題番号（例えば B1）を明記せよ。

B1. フーリエ級数

B2. ビオ・サバールの法則

B3. ブラウン運動

B4. クロマトグラフィー

B5. 有効数字

（これで問題は終わりです）

(English Instructions are provided in Page 2)

<div align="right">（修士課程用）</div>

令和３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 3 年 1 月 31 日（日）　9 時 30 分～10 時 30 分

1．試験開始の合図があるまで，問題ファイルを開かないこと．
2．問題ファイルは 2 ページから成っている．前半は日本語版で，後半は英語版である．
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．
8．試験中は常にカメラおよびマイクを ON にしておくこと．
9．ネットワークトラブル等が発生した場合は，直ちに環境システム学専攻入試委員に連絡を取り，指示を仰ぐこと．
　　TEL：070-1481-1372（海外から：+81-70-1481-1372）
　　上記がつながらない場合：04-7136-4696（海外から：+81-4-7136-4696）

（日本語の注意事項は **1** ページ目に記載）

Master Course

Entrance Examination 2021

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

Instructions

(Specialized Subject A)

31 January, 2021　9:30–10:30

1. Do not open the problem file until the examiner instructs you to do so.
2. The problem file consists of two pages. The first half is the Japanese version and the second half is the English version.
3. Write your examinee number in the specified space of each answer sheet and sheet for notes. <u>Do not write your name in them</u>.
4. <u>Use two answer sheets described as Specialized Subject A</u>.
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. <u>You can use one sheet for notes</u>.
8. Always keep the camera and microphone turned on during the examination.
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    TEL: 070-1481-1372 (From countries other than Japan: +81-70-1481-1372)
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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（A1 など）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

The face of Earth in the twenty-first century is affected in an unprecedented manner by the activities of humanity and the production and accumulation of human-made objects. Given the limitations of human cognition in the face of the immensity of the globe and the seeming infinity of the natural world, it is desirable to provide a rigorous and objective measure of the overall balance between the living and human-made. However, in spite of pioneering efforts, <u>we lack a holistic picture that quantifies and compares the composition of the world in terms of both biological and human-made mass</u>. (Elhacham et al., 2020, *Nature*, **588**, 442–444 の一部)

A2

In the late 1980s, as a result of increasing environmental awareness, emphasis gradually switched to waste prevention at source as opposed to waste remediation and pollution control by end-of-pipe solutions. The US Pollution Prevention Act of 1990 3 focused attention on the need to reduce environmental pollution and recognised that waste prevention at source not only eliminates the cost of waste treatment but actually strengthens economic competitiveness through more efficient use of raw materials. <u>It led to a fundamental shift</u> in the blueprint of the US Environmental Protection Agency (EPA) <u>for environmental protection – from "end of pipe" waste treatment to waste prevention – and culminated in the introduction of the term Green Chemistry</u> at the EPA in the early 1990s. (From Sheldon, 2017, *Green Chemistry*, **19**, 18–43 の一部)

A3

Uncertainty analysis has received increasing attention in the field of building energy analysis because a number of variables that influence building thermal performance are inherently uncertain, such as occupant behaviour, thermal properties of building envelope, and weather conditions. Moreover, the development of modern uncertainty quantification techniques provides more advanced methods and tools to facilitate the research on uncertainty analysis for a better understanding of the nature of building energy and associated energy models. Therefore, <u>uncertainty analysis has been widely implemented in various areas</u> of building energy analysis, (Tian et al., 2018, *Renewable and Sustainable Energy Reviews*, **93**, 285–301 の一部)

（これで日本語版の問題は終わりです）

2

Specialized Subject A

English version　英語版

Choose one of the three extracts (A1 – A3) below, and read the entire extract you have chosen. Then, 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 (A1 etc.) in the problem number box on your answer sheet. Use two answer sheets for your answer.

A1

The face of Earth in the twenty-first century is affected in an unprecedented manner by the activities of humanity and the production and accumulation of human-made objects. Given the limitations of human cognition in the face of the immensity of the globe and the seeming infinity of the natural world, it is desirable to provide a rigorous and objective measure of the overall balance between the living and human-made. However, in spite of pioneering efforts, we lack a holistic picture that quantifies and compares the composition of the world in terms of both biological and human-made mass. (From Elhacham et al., 2020, *Nature*, **588**, 442–444.)

A2

In the late 1980s, as a result of increasing environmental awareness, emphasis gradually switched to waste prevention at source as opposed to waste remediation and pollution control by end-of-pipe solutions. The US Pollution Prevention Act of 1990 3 focused attention on the need to reduce environmental pollution and recognised that waste prevention at source not only eliminates the cost of waste treatment but actually strengthens economic competitiveness through more efficient use of raw materials. It led to a fundamental shift in the blueprint of the US Environmental Protection Agency (EPA) for environmental protection – from "end of pipe" waste treatment to waste prevention – and culminated in the introduction of the term Green Chemistry at the EPA in the early 1990s. (From Sheldon, 2017, *Green Chemistry*, **19**, 18–43.)

A3

Uncertainty analysis has received increasing attention in the field of building energy analysis because a number of variables that influence building thermal performance are inherently uncertain, such as occupant behaviour, thermal properties of building envelope, and weather conditions. Moreover, the development of modern uncertainty quantification techniques provides more advanced methods and tools to facilitate the research on uncertainty analysis for a better understanding of the nature of building energy and associated energy models. Therefore, uncertainty analysis has been widely implemented in various areas of building energy analysis, (From Tian et al., 2018, *Renewable and Sustainable Energy Reviews*, **93**, 285–301.)

(The end of the problem)

(English Instructions are provided in Page 2)

<div align="right">（修士課程用）</div>

令和３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 3 年 1 月 31 日（日）　13 時 30 分～14 時 00 分

1．試験開始の合図があるまで，問題ファイルを開かないこと．
2．問題ファイルは 6 ページから成っている．前半は日本語版で，後半は英語版である．
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．
9．試験中は常にカメラおよびマイクを ON にしておくこと．
10．　ネットワークトラブル等が発生した場合は，直ちに環境システム学専攻入試委員に連絡を取り，指示を仰ぐこと．
　　TEL：070-1481-1372（海外から：+81-70-1481-1372）
　　上記がつながらない場合：04-7136-4696（海外から：+81-4-7136-4696）

（日本語の注意事項は **1** ページ目に記載）

Entrance Examination 2021

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

Instructions

(Specialized Subject B)

31 January, 2021　13:30–14:00

1. Do not open the problem file until the examiner instructs you to do so.
2. The problem file consists of six pages. The first half is the Japanese version and the second half is the English version.
3. Write your examinee number in the specified space of each answer sheet and sheet for notes. Do not write your name in them.
4. Specialized Subject B consists of eight problems. You must choose three problems to answer.
5. Use one answer sheet described as 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.
9. Always keep the camera and microphone turned on during the examination.
10. Contact the Entrance examination committee, Department of Environment Systems, and follow the instructions if you encounter network problems etc.
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専門科目 B

日本語版　Japanese version

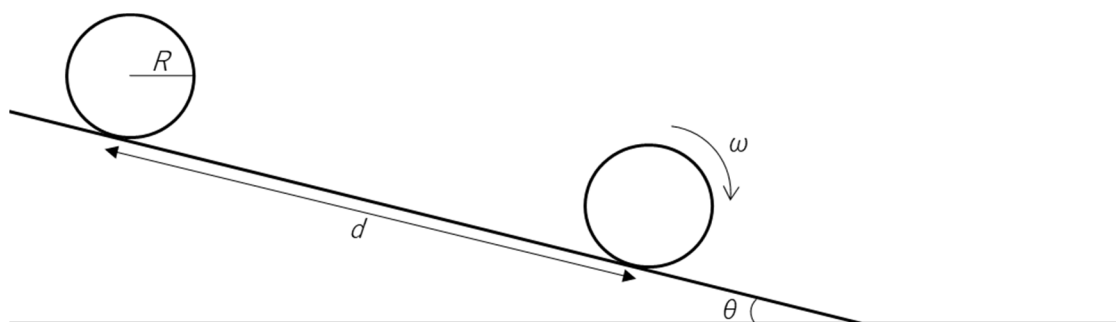以下の B1〜B8 から 3 問を選んで解答せよ。解答用紙には、枠で区切られている 3 つの解答欄がある。解答は、設問ごとに、解答用紙の 1 つの枠内に収まるように記述し、各枠の左上にある欄に選択した設問番号を記すこと。

B1. 屋上緑化がヒートアイランド現象の緩和に寄与する理由を、「日射」、「顕熱」、「潜熱」、「排熱」の 4 つの語句を用いて説明せよ。

B2. 海産魚におけるセシウムとポリ塩化ビフェニル（PCB）の生物濃縮係数はそれぞれ 10〜10^2 程度、10^5〜10^6 程度と報告されている。PCB の方が生物濃縮性係数が大きい理由を説明せよ。

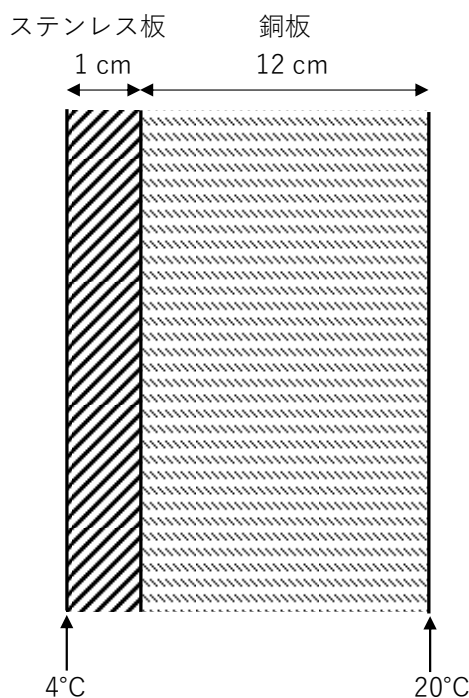B3. 実数 x, y, z が $x + 2y + 3z = 4$ を満たすとき、$x^2 + y^2 + z^2$ の最小値と、そのときの x, y, z の値を求めよ。

B4. 　3 進法で 20^{21} と表される数は、3 進法で何桁の数となるか。桁数を、3 進法で答えよ。

B5. 水平面と角度 θ をなす斜面上に半径 R、長さ L、密度 ρ の一様な円柱が静置されている。この円柱が、図のように、斜面上を滑ることなく距離 d だけ転がり落ちたときの、円柱の角速度 ω を求めよ。ただし、重力加速度を g とする。

（問題は次ページに続く）

2

B6. 厚さ 1 cm のステンレス板と厚さ 12 cm の銅板が接合され、図のようにステンレス板の表面が 4℃、銅板の表面が 20℃に保持されている。このとき、接合面における温度を求めよ。ただし、このステンレスと銅の熱伝導率を、それぞれ 2.0×10^1 W m^{-1} K^{-1}、4.0×10^2 W m^{-1} K^{-1} とする。

B7. 濃度 100 mg L^{-1} のフタル酸（$C_6H_4(COOH)_2$）水溶液の、理論的酸素要求量を求めよ。

B8. $A + B \rightarrow$ products の式で表される化学反応について、反応速度 r は反応物 A、B の濃度 C_A、C_B の各 1 次に比例する（$r = kC_AC_B$：k は速度定数）。原料中の B の濃度は 2.0×10^1 mol m^{-3} であり、A の濃度に比べて大過剰であるため、この反応は A の擬一次反応であるとみなせるとする。反応を開始してから、A の濃度が初期濃度の 1/10 になるまでの時間を求めよ。ただし、k の値は 2.5×10^{-4} m^3 mol^{-1} sec^{-1} とする。必要であれば、$\ln 2 = 0.693$、$\ln 5 = 1.61$ を用いてよい。

（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 any <u>three</u> problems from problems B1–B8 to answer. The answer sheet contains three answer boxes. Your entire written answer for each question must stay within one box on the answer sheet. Please write the number of the chosen question in the small box on the top left corner of each answer box.
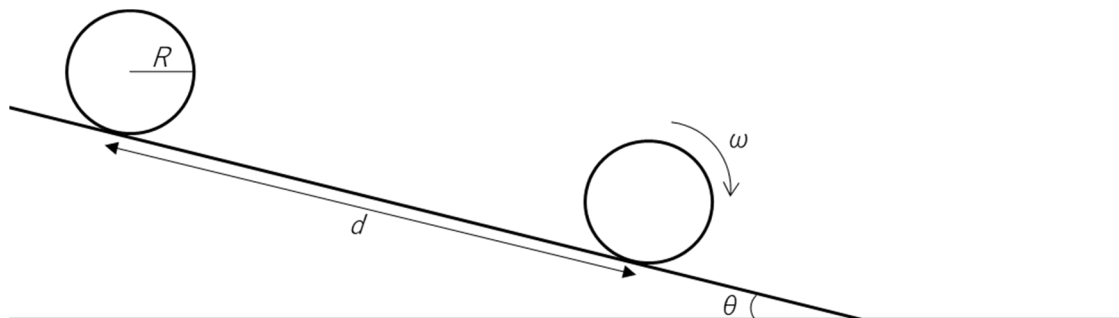
B1. Using the following four terms: "solar radiation", "sensible heat", "latent heat", and "exhaust heat", explain why green roofs contribute to the mitigation of the heat island effect.

B2. Bioconcentration factor of marine fish for cesium and polychlorinated biphenyl (PCB) is reported to be approximately $10 - 10^2$ and approximately $10^5 - 10^6$, respectively. Explain why PCB shows a relatively higher bioconcentration factor.

B3. Consider real numbers x, y, and z that satisfy $x + 2y + 3z = 4$. Find the minimum value of $x^2 + y^2 + z^2$ and also provide the values of x, y, and z that determine the minimum value.
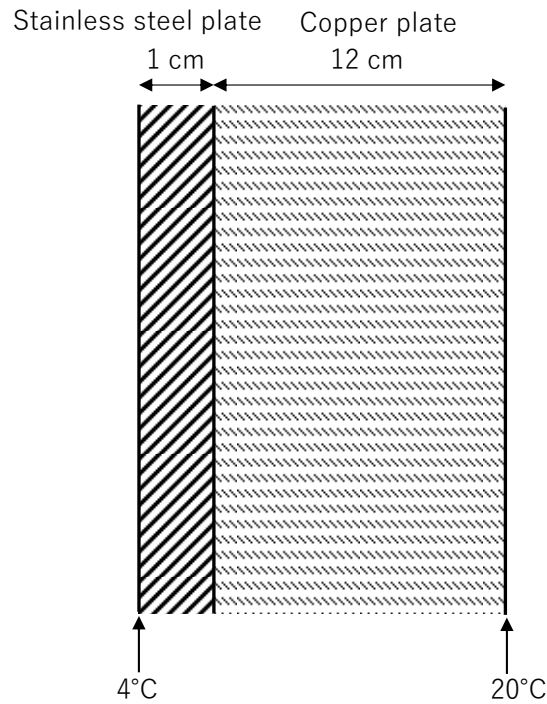
B4. Consider a number 20^{21} which is expressed in a ternary number system (i.e., base 3). In a ternary representation, what is the number of digits in 20^{21}? Express the answer as a ternary representation.

B5. A uniform cylinder with radius R, length L, and density ρ rests on an inclined plane with an angle θ from the horizontal. When the cylinder rolls down a distance d on this plane without slipping (as shown in the figure), what will the angular velocity ω of this cylinder be? Use g as the gravitational acceleration.

(Problem continues to the next page.)

5

B6. A stainless steel plate with a thickness of 1 cm and a copper plate with a thickness of 12 cm are attached together, as shown in the figure. When the surface of the stainless steel plate is kept at 4°C and the surface of the copper plate is kept at 20°C, find the temperature at the interface. Assume that the thermal conductivity of this stainless steel and copper is 2.0×10^1 W m^{-1} K^{-1} and 4.0×10^2 W m^{-1} K^{-1}, respectively.

Stainless steel plate   Copper plate
1 cm   12 cm

4°C   20°C

B7. Determine the theoretical oxygen demand for an aqueous solution of phthalic acid $(C_6H_4(COOH)_2)$ with a concentration of 100 mg L^{-1}.

B8. For a chemical reaction that is expressed as "A + B → products", the reaction rate r is proportional to the concentrations of reactants A (C_A) and B (C_B) as $r = kC_AC_B$ (k : rate constant). Because the concentration of B in the feedstock is 2.0×10^1 mol m^{-3} , which is much larger than that of A, this reaction can be regarded as a pseudo-first-order reaction with respect to A. After the start of the reaction, how long does it take for the concentration of A to be 1/10 of its initial value? Assume that k is 2.5×10^{-4} m^3 mol^{-1} sec^{-1}. If necessary, use ln 2 = 0.693 and ln 5 = 1.61.

(The end of the problem)