2022 年 8 月 29 日　13:00〜15:00

B 都市工学専門
Urban Engineering Subjects

（1）　すべての解答用紙と下書用紙の所定の欄に、問題番号、受験番号を記入しなさい。<u>氏名を記入してはならない。</u>
Write the question number and your examinee number in the specified place of all answer sheets and draft sheets. <u>Do not write your name.</u>

（2）　都市環境工学専攻分野を志望する者は、<u>B－1〜B－7のうちから3問以上を選択し、解答しなさい。</u>
Those who apply to the Urban Environmental Engineering course should <u>choose and answer at least 3 questions from B-1 to B-7.</u>

（3）　都市計画専攻分野を志望する者は、<u>B－8〜B－15のうちから3問以上を選択し、解答しなさい。</u>
Those who apply to the Urban Planning course should <u>choose and answer at least 3 questions from B-8 to B-15.</u>

（4）　<u>答案は1問につき1枚を利用すること。</u>
<u>Answer each question on a separate answer sheet.</u>

（5）　（オンライン受験者のみ）問題ファイル（このファイル）は、答案アップロード終了後、指示に従い削除すること。削除していないことが判明した場合には不正行為となることがある。
(For online examinees only) After uploading your answer sheets, delete the question booklet file (this file) as indicated by the proctor. Not following this instruction will be regarded as misconduct.

（6）　（オンライン受験者のみ）解答終了後は監督者の指示に従い、<u>5枚の答案すべて</u>をアップロードすること。
(For online examinees only) Upload <u>all 5 answer sheets</u> as indicated by proctor.

（7）　（オンライン受験者のみ）問題のスクロールと拡大縮小のため、パソコンのマウスやトラックパッドの使用は認めるが、キーボードには触れてはならない。
(For online examinees only) Note that using a mouse or trackpad is allowed but touching a keyboard is prohibited.

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B－1 Water and Wastewater Engineering

Q.1　　Answer the following questions regarding water distribution pipes and sewer pipes.

(1) Concisely explain the differences in the mechanisms of water transportation between water distribution pipes and sewer pipes.
(2) Give examples of velocity formulas applied to design the diameter of water distribution pipes and storm water pipes, respectively.
(3) List the methods used in the design of water supply pipeline networks a) to avoid water cutoffs, b) to avoid stagnant water, and c) to minimize an area affected by pipeline failure, respectively.
(4) Explain how water distribution pipes should be designed when area with higher elevation is located in the downstream.

Q.2　　Answer the following questions regarding sludge generated by the rapid sand filtration and activated sludge methods.

(1) Describe the difference in the sludge compositions.
(2) Regarding sludge generated by each method, list 2 examples of effective sludge use for each case.

B－2　Hydraulics

Q.1　　　Explain the following terms concisely.

(1) Convective acceleration

(2) Viscous sublayer

(3) Friction velocity

(4) Alternate depths

Q.2　　　Consider a uniform flow in an open channel with a cross section as shown in Figure 1.
One side of the channel is vertical and the other has a side slope of $1:k$. Answer the
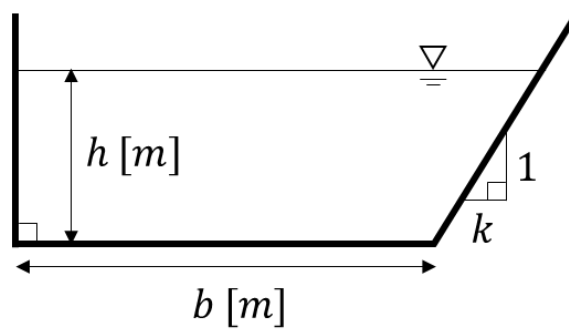following questions.

Figure 1

(1) Answer the wetted perimeter and hydraulic radius of the channel.

(2) Assuming the cross-sectional area of the flow and k are constant, determine the relationship
between b and h for the most efficient cross section.

(3) If k is also variable, find the value of k for the most efficient cross section.

Q.3 Two reservoirs are connected by a circular pipe with d [m] in diameter as shown in Figure 2. The flow rate between point A and point B is Q [m³/s] and water is discharged at $\frac{1}{2}Q$ [m³/s] from point B which is the middle point between point A and point C.

Assume that the volumes of the two reservoirs are large enough to have a constant water level difference of H [m]. Only friction loss is considered, while local loss is negligible. Use π for circumference ratio, f for friction factor, g [m/s²] for gravitational acceleration, and ρ [kg/m³] for water density. Answer the following questions.
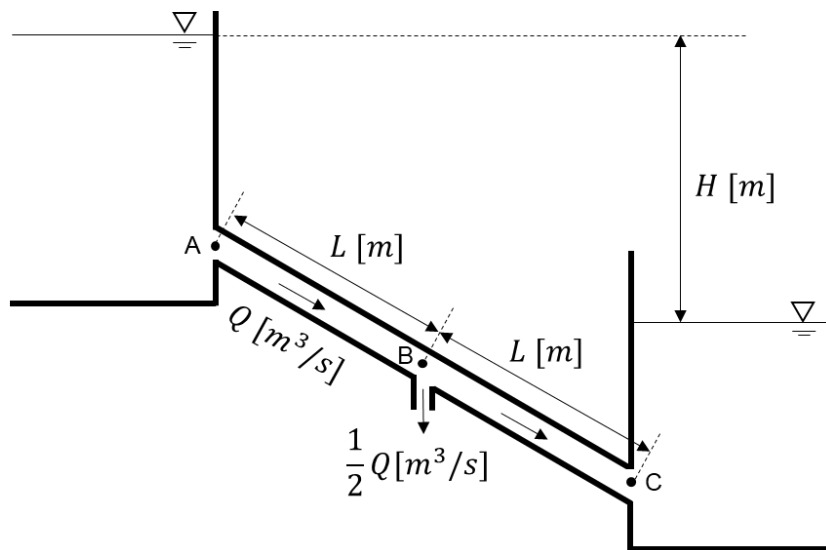

Figure 2

(1) Answer the total energy loss [Pa] between the two reservoirs.
(2) Determine the flow rate Q [m³/s] between point A and point B.
(3) Draw the energy line between two reservoirs.

Ｂ－３　Water Environment

Q.1　Answer the following questions on the environment of enclosed water bodies.

(1)　Explain the recent status of nutrient control and countermeasures at the Seto Inland Sea in Japan.

(2)　Explain the mechanism of seasonal mixing and stratification of lake water in the temperate zone, and explain the impact of climate change on this phenomenon and on lake water environments.

Q.2　Explain the various discharge processes of rainfall in urban area to rivers and other receiving waterbodies with a diagram. Loss of water in the processes should be included in the explanation. Assume that the urban area is covered by pervious and impervious surfaces and has a combined sewer system.

Q.3　Explain the following terms concisely.

(1)　Streeter-Phelps equation

(2)　Vollenweider model

(3)　Non-point source pollution

B－4　Environmental Microbiology

Statements I to V are related to microbial reactions. Answer the questions (1) to (6) regarding these statements.

I.　In order to decrease (A), which is the main greenhouse gas emitted from paddy fields, non-submerged (mid-drying) period is extended.

II.　Ammonium ions from fertilizers such as ammonium sulfate become nitrate ions via nitrite ions through nitrification.

III.　When sewer manholes are inspected, ventilation is ensured to prevent oxygen depletion and (B) poisoning.

IV.　Biological phosphorus removal in activated sludge processes makes use of the storage function of (C) accumulating bacteria.

V.　Soil contaminated with trichlorethylene is purified by using bio-(D) or bio-(E).

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(1)　Answer the appropriate words to complete (A) to (E).

(2)　Regarding I, explain the reason for extending the non-submerged period as a countermeasure against (A) emission from paddy fields, referring to the microbial reaction wherein (A) is emitted.

(3)　Regarding II, show the underlined reaction formula, and answer the amount of oxygen required for complete nitrification of ammonium ions produced from 1 mol of ammonium sulfate.

(4)　Regarding III, explain the microbial reaction where (B) is produced, referring to an electron donor and an electron acceptor.

(5)　Regarding IV, explain how phosphorus is removed.

(6)　Explain the two types of purification methods underlined in V by identifying their differences.

B－5 Environmental Chemistry and Reaction

Q.1   Write the appropriate words or phrases to complete rectangles (a) to (j).

(1) Dehalogenation of alkyl halide

There are two kinds of dehalogenation reactions of alkyl halides: namely, [(a)] and [(b)]. Among these, [(a)] is promoted by the presence of [(c)], and is likely to proceed with [(d)] hydrocarbons. Among the dehalogenation reactions, the reactions wherein a hydrocarbon moves to the position of dehalogenated carbon from other positions are called [(e)].

(2) Radical reactions

One kind of the radical generation reactions is generation of radicals from cleavage of diatomic molecules such as chlorine molecules (Cl_2). In these reactions, homolysis reactions are those reactions that generate [(f)], and heterolysis reactions are those reactions that generate [(g)]. Destruction and depletion of ozone layer is one of the environmental reactions that involve radicals. The ozone destruction reaction proceeds when ozone depleting substances such as [(h)] used for detergents, coolants, forming agents or sprays, move up and reach [(i)], and they react with ultraviolet rays from the sun and form radicals that destruct ozone molecules. The radicals formed in this way react with other molecules and generate more radicals, and thus these reactions are called [(j)].

Q.2   Briefly answer the following questions.

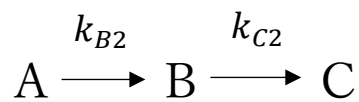(1) Parallel reactions and sequential reactions.
Among the reactions that produce chemical substances B and C from a chemical substance A, a parallel reaction produces 1 mole of B and C at the same time from 1 mole of A as shown below;

$$A \underset{k_{C1}}{\overset{k_{B1}}{\diagup\diagdown}} \begin{matrix} B \\ \\ C \end{matrix}$$
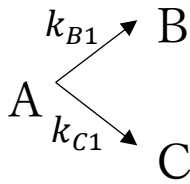
where the production rate coefficients for B and C are denoted as k_{B1} and k_{C1}, respectively. Alternatively, a sequential reaction is a reaction that produces 1 mole of B from 1 mole of A, and then produces 1 mole of C from 1 mole of B, as shown below.

$$A \xrightarrow{k_{B2}} B \xrightarrow{k_{C2}} C$$

where the production rate coefficients for B and C are denoted as k_{B2} and k_{C2}, respectively. For both parallel and sequential reactions, answer the reaction rate equations of the concentrations of B and C in terms of the concentrations of A, B and/or C. Use [A], [B], and [C] for the concentrations of A, B and C, respectively.

(2) The relationship between water temperature and pH.

It is known that the pH value of pure water at 25°C is 7.0. Explain how the pH changes when the water is heated above 25°C.

(3) Quantum yield in photochemical reactions.

Explain the meaning of quantum yield in photochemical reactions caused by absorption of light. In general, the quantum yields are less than unity; however, there are photochemical reactions wherein their quantum yields are greater than unity. Explain the reason(s) for greater quantum yields than unity in those photochemical reactions.

Ｂ－６ Global Environment Engineering

Q.1 The figure below describes pathways of environmental impacts from environmental burdens and resource consumption (inventories) through impact categories (midpoints) to areas of protection (endpoints). Answer the following questions regarding this figure.
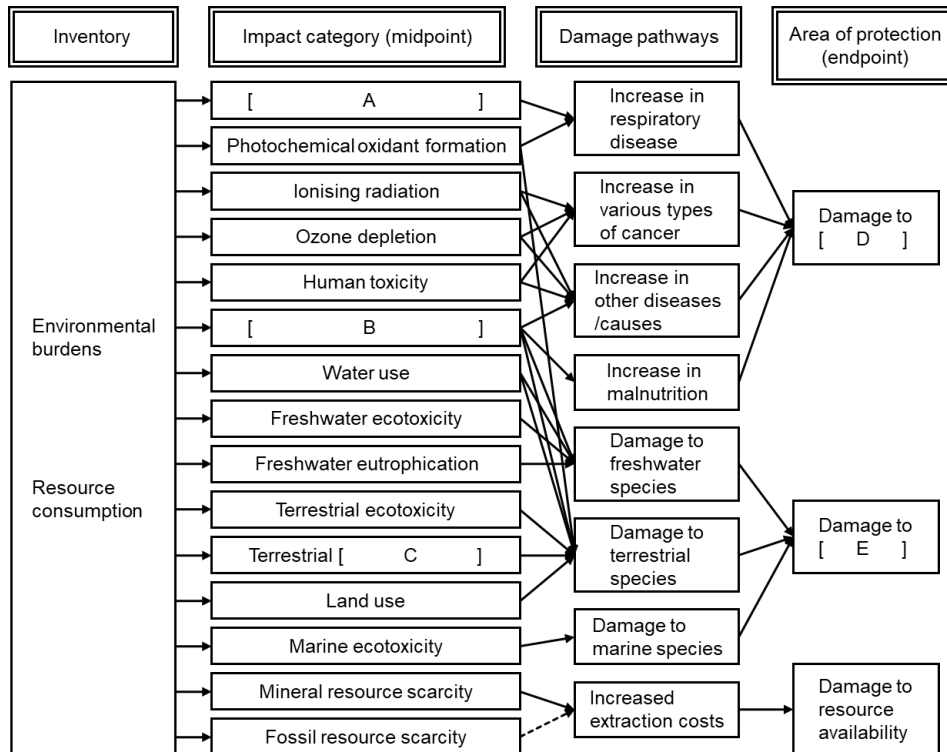
(1) Select an impact category or an area of protection which corresponds to each of A to E in the figure, respectively, from the five terms below.

   [Human health; Acidification; Fine particulate matter formation; Climate change; Ecosystems]

(2) Give three examples of substances (environmental burdens) which contribute to the impact category A, and explain the mechanism through which emissions of those substances cause damages on the corresponding area of protection in seven to fifteen lines.

(3) Explain an indicator that expresses the damage to the area of protection D in five to seven lines.
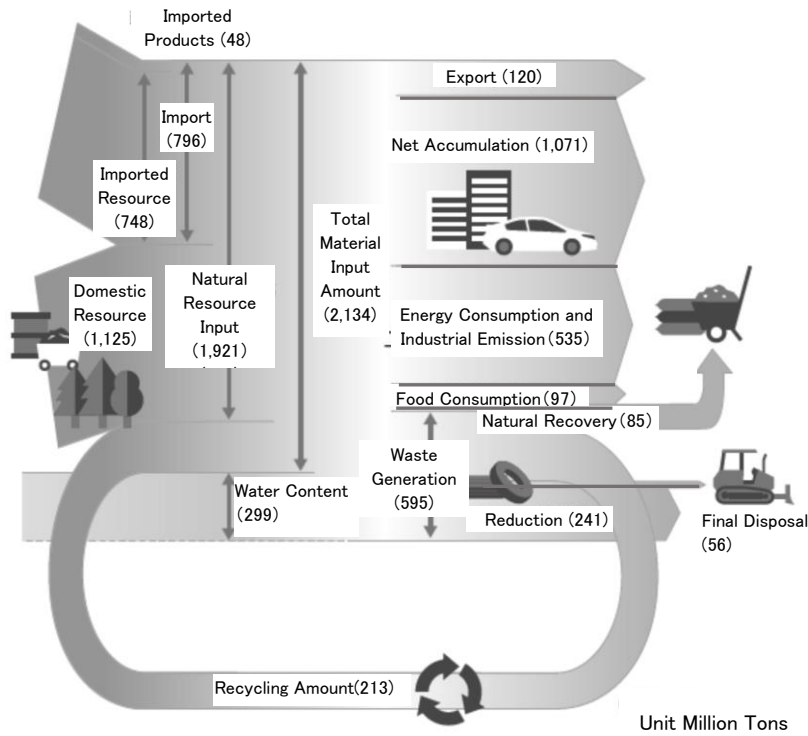
Q.2 Explain the following pairs of terms (1) and (2) in seven to fifteen lines, respectively, so as to clarify the relationships between the terms.
(1) "Microplastics" and "Bioplastics"
(2) "Flood" and "Adaptation to climate change"

Ｂ－7 Waste Management and Material Cycles

Q.1 The charts below provide material flows of Japan in Fiscal Year (FY) 2000 and FY 2019. Based on them, answer the following questions.

【FY 2000】

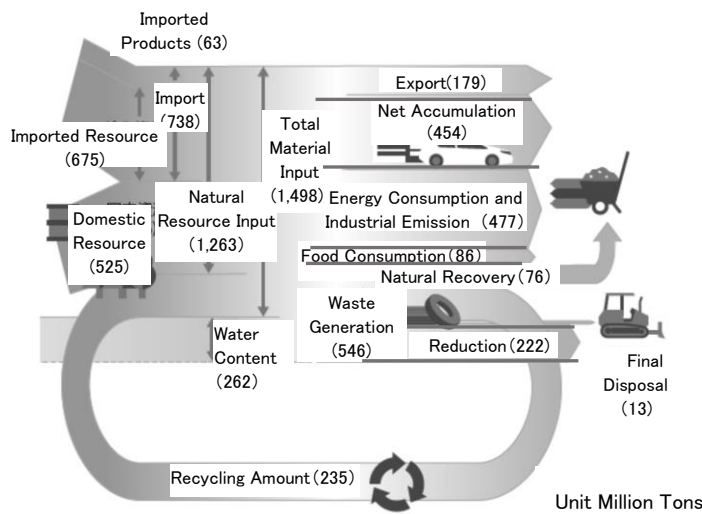Imported Products（48）
Export（120）
Import（796）
Net Accumulation（1,071）
Imported Resource（748）
Total Material Input Amount（2,134）
Domestic Resource（1,125）
Natural Resource Input（1,921）
Energy Consumption and Industrial Emission（535）
Food Consumption（97）
Natural Recovery（85）
Water Content（299）
Waste Generation（595）
Reduction（241）
Final Disposal（56）
Recycling Amount（213）
Unit Million Tons

【FY2019】

Imported Products（63）
Export（179）
Import（738）
Net Accumulation（454）
Imported Resource（675）
Total Material Input（1,498）
Domestic Resource（525）
Natural Resource Input（1,263）
Energy Consumption and Industrial Emission（477）
Food Consumption（86）
Natural Recovery（76）
Water Content（262）
Waste Generation（546）
Reduction（222）
Final Disposal（13）
Recycling Amount（235）
Unit Million Tons

Chart Extracted and Modified from FY 2022 Environment-Recycle Society-Bio-diversity White Book, Min. of the Environment

（1）　　　Evaluate the following indicators for each year.
　　　　①　Recycle utilization ratio (input)
　　　　②　Recycle utilization ratio (output)

（2）　　　Explain the reasons for the changes of the two indicators above, as well as final waste disposal amounts, from FY 2000 to 2019, with regard to technical factors and socio-economic factors including policy and regulation systems.

（3）　　　Resource Productivity (RP) is the estimated GDP/Natural Resource Input for each year. RP improved from 250,000 to 450,000 yen/ton and the Fourth Recycle Society Basic Plan sets the target to increase 490,000 yen/ton by FY2025. Explain　①　reasons for RP increase by FY2019,　②　concrete measures to improve by FY2025, and　③　difficulties and hurdles to realize the measures.

Q.2　　　Explain the following pairs of terms of (1), (2), and (3) highlighting their differences. Then, explain possible methodologies to further improve the current environmental management systems related to (1), (2), and (3), respectively.

（1）　　　2R and 3R
（2）　　　"Down Recycling" and "Horizontal Recycling"
（3）　　　"Circular Regions" and "Circulating and Ecological Spheres"

Ｂ－8　Urban Planning

Q.1　Answer the following questions regarding modern urban planning.

(1)　Briefly explain the characteristics of the modern urban planning developed in Western Europe from the late 19th century to the 1960s from the viewpoint of the purpose, system, implementing authorities, etc.

(2)　Briefly explain the characteristics of Japanese modern urban planning (until the City Planning Act in 1968) by comparing it with Western modern urban planning.

Q.2　Answer the following questions regarding "urban renaissance."

(1)　Explain the concept of urban renewal.

(2)　Briefly discuss the characteristics of "urban renaissance" based on the Act on Special Measures concerning Urban Renaissance in Japan, and compare it to the concept of urban renewal.

Ｂ － ９ Urban Design

Q.1 Explain the following technical terms in about 7 lines each, with regard to their practical
examples and their contribution to urban design.

(1) Transit Mall
(2) Act on Maintenance and Improvement of Historic Landscape in Japan
(3) Ecotone

Q.2 Five SDGs (Sustainable Development Goals) that can be directly related to sustainable urban
environment are listed below. Select 2 among these 5 and explain how urban design practice
can contribute to meeting these goals in about 7 lines for each.

(1) Affordable and Clean Energy
(2) Sustainable Cities and Communities
(3) Responsible Consumption and Production
(4) Life Below Water
(5) Life on Land

Ｂ－１０　Urban Housing

Read the quotation (partially modified) from the current "Housing Improvement Policy" (*Jyutaku Seibi Houshin*) for X ward in Tokyo and answer questions below. You may answer the questions assuming the special wards in general, not just X ward.

Q.1　The following is a statement regarding the positioning of the "Housing Improvement Policy".
This policy takes [A] for X ward as the upper-level plan and is positioned as one of the thematic policies and plans of [B] for X ward. It has the character of a ward-specific housing master plan of the wider-area plan [D] based on [C].
(1)　Fill in the blanks from A to D, where C is the name of an act.
(2)　List two examples of possible "thematic policies and plans" related to housing policy, excluding the "Housing Improvement Policy."

Q.2　The following is a statement on "promotion of housing support for persons requiring special assistance in securing housing," one of the measures in the "Housing Improvement Policy."
To support secure lifestyles of residents, the facilitation of moving into private rental housing for persons requiring special assistance in securing housing, and the integrated support for housing and living for diverse household situations by the housing support council are needed.
(1)　List three members of the "housing support council," that are specifically exemplified in the Act on Promotion of Offering of Rental Housing to Persons Requiring Special Assistance in Securing Housing (*Jyutaku Kakuho Youhairyosha nitaisuru Chintai Jyutaku no Kyokyu no Sokushin nikansuru Houritsu*).
(2)　Explain the context in which the facilitation of moving into private rental housing is needed, and list two support measures to address the context assuming elderly people as the "persons requiring special assistance in securing housing."

Q.3　The following is a statement on "support for maintenance and rehabilitation of condominiums," one of the measures in the "Housing Improvement Policy."
There are many medium/small condominiums in X ward. In their maintenance and management, so-called "two aging problems," i.e., aging buildings and aging residents, may become more apparent and serious in the future.
(1)　List two sets of problems and possible support measures by the ward regarding the aging buildings.
(2)　List two sets of problems and possible support measures by the ward regarding the aging residents.

B－１１　Urban Disaster Management

Q.1　For each of the following statements, mark with "〇" (a circle) the ones that are correct, and for the incorrect statements, provide the correct statement in about 1 to 2 lines.

(1)　Fragility curves explain probability of building damages by intensity of ground motion, and structure and age of buildings.

(2)　If the Japanese Meteorological Agency Magnitude (M_{jma}) is two units larger, the energy of the earthquake will be about 100 times larger.

(3)　The return period of earthquakes is about several decades to hundreds of years, regardless of the type of earthquake, such as earthquake on the subduction interface boundary and active fault earthquake.

(4)　Ground liquefaction occurs not only in low-lying areas near coasts estuaries and reclaimed land, but also in plateaus such as the Tama area in Tokyo.

(5)　Once the ground was liquefied, the water in soil will be removed and the ground will be sufficiently compacted, therefore liquefaction will never occur again.

(6)　The ground subsided in the whole affected coastal areas in the Great East Japan Earthquake. The main reason was that the water in the stratum under the ground flows out to the surface due to the ground shaking.

(7)　The probability of occurrence of a "Southern Central Tokyo Inland Earthquake" which is a kind of Tokyo inland earthquake, is estimated to be 70% in 30 years.

(8)　The "New Fire Prevention Regulations" by the Tokyo Metropolitan Government relax regulations on floor area ratio to promote rebuilding and impose regulations for fire prevention that are stricter than those in the fire prevention districts of the Building Standards Act.

Q.2　Regarding flood damage control measures for urbanized areas, name 2 measures for (i) catchment basins and (ii) flood plains, respectively, and explain them in 1 to 2 lines each (4 measures in total, in about 4 to 8 lines).

B − 1 2   Urban Analysis

Answer all the following questions.

Q.1   Consider a virtual tourist area with two points along a road that extends straight from a railway station. Let O be the position of the station, and A and B be the positions of the two points (See the figure below). It is assumed that all tourists who get off at the station behave as follows.

   (a) At first, tourists who get off at the station always visit point A next.
   (b) After visiting point A, tourists proceed to O or B with equal probability.
   (c) After visiting point B, all tourists proceed to A.
   (d) If a tourist returns to point O, then the tourist will take train from the station and leave this tourist area with a probability of p ($\neq 0$). Otherwise, the tourist will go back to A.
   (e) Both the distances between O and A and that between A and B are 1km.

O   A   B
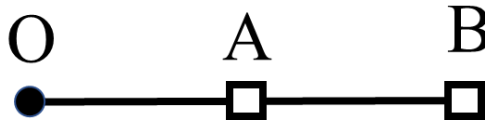
Assuming that the process above continues as far as the tourist stays in this tourist area, answer the following questions.

(1)   Using p, express the probability that a tourist who gets off at the station will leave this area without visiting point B.

(2)   Using p, express the expected number of visits to point A and B by a tourist who gets off at the station, respectively.

(3)   Using p, express the expected road distance traveled by a tourist who gets off at the station before leaving this area.

Q.2   Interview surveys are often used in social surveys. Answer the following questions assuming that you are interviewing store owners about the use of vacant stores in shopping streets in provincial cities where vacant stores have become noticeable in recent years.

(1)   What kind of questions should you prepare for the interview regarding the use of vacant stores? Set and state the purpose of the survey as appropriate, and give examples of five questions that you think are important.

(2)   Interview results often tend to be qualitative. Describe what kind of quantitative analysis method is available to make it as objective as possible.

B－13　Urban Transportation Planning

Q.1　The urban public transportation system of a regional core city in Japan is exclusively composed of conventional fixed-route buses. However, it has been proposed to replace the congested trunk lines with newly introduced BRT (Bus Rapid Transit) lines and reorganize the network to separate trunk and feeder services. Answer the following questions.

(1)　Name three important characteristics of BRT compared to conventional fixed-route bus. Then, provide and explain two elements of the design and operation of BRT stops which contribute to the realization of all three characteristics.

(2)　Concretely explain two benefits of reorganizing the public transportation network as described above from the viewpoint of the transportation service supply, considering the recent background in Japan (in about five lines in total).

(3)　It is planned to forecast the demand of the BRT using a disaggregated mode choice model. Provide and explain concretely two merits of using a model estimated from stated preference data compared to that from revealed preference data (in about five lines in total).

Q.2　Explain each of the following pairs of terms in four to seven lines by paying attention to mutual relationships and/or differences.

(1)　"Pedestrian-vehicle coexistence street" and "Shared space"

(2)　"Financial analysis" and "Economic analysis" for the evaluation of transportation investment projects

B－14　Regional Planning

Q.1　Read each sentence related to regional planning in Japan and answer "○" (a circle) if each sentence is appropriate and if not, revise <u>the underlined phrase</u> using almost the same number of words.

(1)　<u>A "50% commuting area," in which more than half of the commuters commute to the central city,</u> is a representative area that represents the extent of an area composed of several municipalities based on the status of commuters.

(2)　Master plans for urban planning areas (the policies for improvement, development and preservation of the city planning areas) stipulated in the City Planning Act of Japan are <u>established by prefectures as plans always including the administrative areas of multiple municipalities</u>.

(3)　<u>Only cities, towns and villages</u> can establish wide-area cooperatives (Koiki Rengo).

(4)　Due to the so-called "Great Heisei Consolidation" (Heisei no Daigappei) the number of municipalities in Japan decreased to <u>approximately one forth</u> between January 2000 and August 2022.

(5)　The Initiative for Residential Self-sustaining Areas (Teiju Jiritsuken) is the national government scheme, through which <u>prefectures establish zones comprising several municipalities (cities, towns and/or villages) and encourages them to work together.</u>

Q.2 Answer the following questions.

(1)　Raise and discuss in about nine lines two general advantages of promoting urban policies through inter-municipal cooperation among multiple municipalities, rather than independently or through consolidations, including the explanation on why each advantage arises.

(2)　Raise and discuss in about nine lines two general reasons why inter-municipal cooperation in urban policies is not easily implemented, regardless of some of its advantages.

B－1 5　Landscape Planning・Environmental Design

Q.1　Briefly explain the following four words in landscape planning within 3 to 4 lines each.

(1)　Rain garden
(2)　Park system proposed by F. L. Olmsted
(3)　Satoyama
(4)　Green visibility rate

Q.2　Answer the following three questions on the PFI system used for parks.

(1)　Explain what is "PFI" an abbreviation for, and the characteristics of the PFI system within 3 to 4 lines.
(2)　Explain concretely, within 4 to 5 lines, how can the PFI system be applied to parks?
(3)　What should be considered when applying the PFI system to parks? Answer by focusing on (a) the public nature of parks, and (b) impacts of the application on the surroundings within 4 to 5 lines each.