令和3年度特色入試問題

《 農学部 地域環境工学科 》

小論文試験

250 点 満 点

（注　意）

1. 問題冊子および解答冊子は係員の指示があるまで開かないこと。
2. 問題冊子は表紙のほかに8ページある。
3. 解答冊子は問題ごとに1冊ずつある（全部で3冊ある）。
   それぞれの解答冊子は表紙のほかに各6ページある。
4. 試験開始後，解答冊子の表紙所定欄に受験番号・氏名をはっきり記入すること。
   表紙には，これら以外のことを書いてはならない。
5. 解答はすべて解答冊子の指定された箇所に記入すること。
6. 解答に関係のないことを書いた答案は無効にすることがある。
7. 解答冊子は，どのページも切り離してはならない。
8. 問題冊子は持ち帰ること。解答冊子は持ち帰ってはならない。
9. 解答は日本語で記入すること。

問題１　次の英文を読んで問１～問４に答えなさい．（80 点）

Throughout the centuries, generations of farmers, herders, pastoralists, hunters, gatherers, and fisherfolk have developed complex, diverse, and locally adapted livelihood systems managed with time-tested ingenious combinations of techniques, knowledge, and practices that have generally led to community food security, sustainable natural resource management, high levels of biodiversity (particularly in the tropics), and preservation of cultural identity. These microcosms of agricultural heritage can be found throughout the world and together are estimated to cover about five million hectares, and to support about two billion people. At the same time, these systems provide a series of cultural and ecological services to humankind as a whole, such as the management and maintenance of unique landscapes and biodiversity, a wealth of traditional knowledge, local crop, animal and fish species and varieties, myriad other ecological services, and autochthonous forms of socio-cultural organization that have evolved to ensure adequate management of local resources and, often, a high degree of social equity. It is no wonder that they have been lately conceived as ***Globally Important Agricultural Heritage Systems*** (***GIAHS***).

In GIAHS, humans are keystone species – they manage, organize and structure the landscape at different scales. Further, GIAHS are 'keystone systems' in various senses. First, they often represent the only means known for humans to occupy specific marginal environments and landscapes without degrading them, while at the same time providing most if not all of the essential goods and services that are required. Second, they are necessary to maintain specific configurations of biodiversity and agrobiodiversity (both above and below ground), and specific landscapes and their ecological services. Third, they are based upon historically evolved and culturally embedded group decision-making processes and related institutions that exhibit capacities for adaptation, innovation, conflict resolution, and transmission of sets of knowledge and values that are also specifically adapted to particular biotic and abiotic conditions. All of these variables – production systems, biodiversity and ecological services, and institutions – are interrelated in complex ways; should any of them change very substantially, their systems would possibly cross thresholds into very different configurations or states.

GIAHS are social-ecological systems in which their ***stewards*** (***the populations who have co-created and sustain them***) have had to continuously adapt and innovate just to keep up with shocks, disturbances and change of all types – ecological, economic, political and cultural. Many GIAHS have successfully coped with colonialism, major and repeated changes in national and regional governance systems and policies, exploitation of their resources on the part of outsiders, internal and external conflict (including invasion and warfare), as well as substantial changes in local ecology (climate, vegetation cover, soil fertility, water availability). Most GIAHS have exhibited an ability to support substantial demographic change and to increase output over time. Nevertheless, many have also disappeared, and most that remain are under threat due to technological, economic, ecological, and cultural change drivers, which very often are related to government policies that actively seek to transform these systems into different states since their populations are perceived to be 'backward' or 'poor' and their resource base 'undeveloped'.

Change in these traditional systems has been especially rapid since the beginning of the 20th century. In the 21st century, the pace of change has accelerated and the number of shocks and disturbances has increased, and will likely continue to increase in a non-linear and largely unpredictable fashion. GIAHS social-ecological systems are highly dependent upon ecosystem services and accumulated local knowledge and cultural institutions that will be especially stressed given existing global and local change drivers. GIAHS are also generally found in regions that are especially vulnerable to such change drivers: most, for example, are located in regions where biodiversity extinctions are the highest in the world. Major global challenges that GIAHS stewards must confront, often simultaneously, include demographic change, major species extinctions and changes in range of species, increasing climatic variability and shocks together with water stress, increasing energy costs and scarcity of energy resources leading to higher prices for food and other essentials, general economic instability and decreases in welfare; and increasing tensions over resource access and environmental problems, and hence conflict at local, regional, or international scales, all of which can threaten food security and lead to increases in poverty.

（出典 Patricia Howard, Rajindra Puri, LauraJane Smith, and Miguel Altierri, *Globally Important Agricultural Heritage Systems: A Scientific Conceptual Framework and Strategic Principles*, Food and Agriculture Organization of the United Nations, Retrieved August 1, 2020, http://www.fao.org/3/ap025e/ap025e.pdf を一部改変）

（語注）herder：牛飼い，pastoralist：羊飼い，fisherfolk：漁民，heritage：遺産，ecology：生態学，myriad：無数の，autochthonous：土地固有の，configuration：形状，

agrobiodiversity : 農業生物多様性, embedded : 埋め込まれた, adaptation : 適応, biotic : 生物の, abiotic : 非生物の, exploitation : 搾取, demographic : 人口統計の, vulnerable : 脆弱な, simultaneously : 同時に

問 1　第 1 段落において，GIAHS はどのようなものであると認識されているか，説明しなさい．

問 2　第 2 段落の下線部の例として，本文中では 3 点を挙げられている．それぞれ説明しなさい．

問 3　第 3 段落の下線部を訳しなさい．

問 4　第 4 段落では，GIAHS や GIAHS stewards はどのような状況にあると述べられているか，300 字程度で説明しなさい．

問題 2　以下の１）～７）の問いに答えなさい．ただし，重力加速度は g とする．（90 点）

図 1 のように，傾きの角 θ の滑らかな斜面上にばね定数 k のばねの一端を固定し，他端で質量 m の物体を支えたところ，物体は斜面上の点 A で静止した．このとき，ばねは自然の長さから x だけ縮んでいた．

１）このとき，斜面に平行な方向の物体に働く力の釣り合いの式を示しなさい．

この物体をばねが自然の長さから $3x$ だけ縮むまで押し下げて静かにはなしたところ，物体は斜面を上り始め，斜面上の点 B でばねから離れて斜面上の点 C に到達した後，点 C から斜面を下り始めた．

２）点 A と点 B の間の距離 AB を，x を用いて表しなさい．

３）点 B と点 C の間の距離 BC を，x を用いて表しなさい．

４）点 C から斜面を下り始めた後，この物体はどのような運動をするか述べなさい．

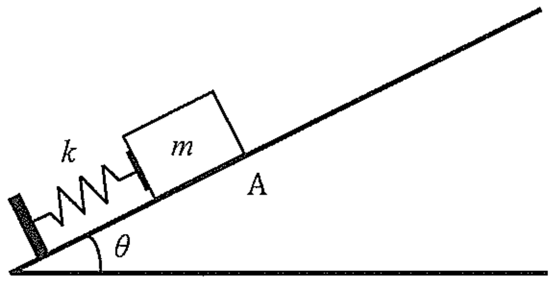

図 1

次に，これらの物体とばねを使って，図２のように，傾きの角 θ のあらい斜面上にばねの一端を固定し，他端に物体を固定した．ばねが自然の長さから $\frac{x}{2}$ だけ縮んだ状態になる位置に物体を置いたところ，物体はその位置で静止した．

５） このとき物体が斜面から受ける静止摩擦力の大きさを k，x を用いて表しなさい．

次に，ばねが自然の長さから $3x$ だけ伸びた状態になる位置に物体を置いたところ，物体はその位置で静止した．

６） このとき物体が斜面から受ける静止摩擦力の大きさを k，x を用いて表しなさい．

ばねの自然の長さからの伸びが $3x$ よりも大きくなる位置には，物体を静止させることはできなかった．

７） 静止摩擦係数 μ を，θ を用いて表しなさい．

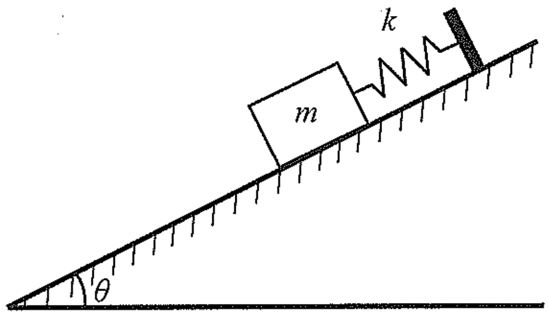

図２

問題3　次の英文を読んで問1〜問3に答えなさい．なお，25℃における飽和水蒸気圧は31.69 hPaである．（80点）

Water is an important component of nearly all food materials, and plays a decisive role in dictating the physical properties, quality and microbial, chemical and biochemical degradation of the food material. For most food materials, unless the moisture content is reduced below 50% (wet basis), much of the water content is freely available to behave physically as pure water with properties such as vapor pressure equal to pure water. As moisture content is lowered further, a point will be reached at which the water becomes less active in that it cannot act physically or chemically as pure water. For example, it cannot freeze or act as a solvent or reactant. In this state, it is considered to be bound water.

The way in which water is bound to the internal structure of the food, the degree to which it is freely available to act as a solvent, to vaporize or freeze, or the degree to which it is chemically bound and unavailable can all be reflected by an ability to specify the water activity of a food material. ・・・(中略)・・・The water activity of a food can be thought of as the equilibrium relative humidity of the food material. When a food sample comes into equilibrium with the atmosphere surrounding it, the water activity in the food sample becomes equal to the relative humidity of the atmosphere surrounding it. Once this equilibrium is reached, the food sample neither gains nor loses moisture over time.

・・・(中略)・・・

The equilibrium relative humidity described above comes about as a result of a two-step process involving transfer of water vapor between the food sample and the surrounding fluid atmosphere. In one step, water vapor must transfer across the boundary surface of the sample in the form of adsorption or desorption, depending upon whether water vapor is entering or existing the sample. The second step involves diffusion, or absorption, of the water vapor into or out of the interior tissue structure of the sample. These two combined processes require considerable time to be accomplished, especially the diffusion process.

・・・(中略)・・・

Recall further that the definition of relative humidity in a mixture of air and water vapor is the ratio of amount of water vapor in the mixture divided by the maximum amount of water vapor that could be held by the air at that condition (saturation). Mathematically, this ratio is the same as the ratio of water vapor partial pressure divided by saturation pressure.

・・・(中略)・・・

The normally high moisture content in most fresh foods is largely the reason they are so perishable. If left unprotected without being processed or preserved in any way, they will deteriorate rapidly as a result of various microbial, chemical and biochemical reactions. In order for these reactions to proceed, most of them require abundant availability of free water to act as a solvent and for hydraulic transport of molecules across semi-permeable membranes, essential for microbial metabolism, within the food. For this reason one of the most effective methods of food preservation is to reduce the moisture content until the water activity is low enough that the amount of free water needed to support any of the degradation reactions that might take place is not available. This is the principle behind the storage stability and long shelf life of dehydrated foods.

As the water activity is brought below 1 and lowered further in a food, the rates of these reactions begin to slow down. They proceed more slowly with further lowering water activity, which translates into longer and longer shelf life. The actual shelf life of any specific food product at a given water activity may vary depending on structure and composition of the food material, and spoilage mechanism of concern. The shelf life of a food will be limited by any one of a series of spoilage mechanisms that can destroy the food. These include microbial activity (bacteria, yeasts and moulds), enzyme activity, browning reactions, and lipid oxidation (rancidity). Of all these reactions, microbial activity is by far the most sensitive to water activity, having the greatest need for available free water. Table 1 lists the minimum values of water activity needed for the growth of different microorganisms.

・・・(中略)・・・

Water activity dictates whether or not a reaction will take place in a food, and if so, at what rate. Therefore the objective of most food dehydration processes is to bring the food product to a specified water activity. However, the engineer responsible for the design and operation of the food dehydration process can only be concerned about moisture content. The food drying equipment is designed only to remove moisture, and only moisture content can be measured and controlled on the factory floor (not water activity).

Table 1. Minimum water activity for population growth

water activity	lower limit for growth of
0.91-0.95	most bacteria
0.88	most yeasts
0.80	most moulds

（出典：Ludger O. Figura and Arthur A. Teixeira (2007). *Food Physics: Physical Properties – Measurement and Applications.* Springer を一部改変）

（語注）microbial：微生物の，solvent：溶媒，reactant：反応物，bound water：結合水，water activity：水分活性，equilibrium：平衡，adsorption：吸着，desorption：脱離，saturation：飽和，deteriorate：劣化する，free water：自由水，hydraulic：水力の，semi-permeable membrane：半透膜，shelf life：保存可能期間，dehydrated：無水の，bacteria：細菌，yeast：酵母，mould：カビ，browning：褐色化，lipid oxidation：脂質酸化，rancidity：酸敗，microorganism：微生物

問1　5 mm 角の立方体に裁断したパンを 25℃に保った直径 4 cm，高さ 1 cm の円筒型容器の中に密閉し，十分時間が経過した後に容器内部の水蒸気圧を測定したところ 2.70 kPa であった．このとき，容器内の相対湿度を求めなさい．また，このパンを長期保存した際に増殖することが予想される微生物を Table 1 の中から全て選びなさい．

問2　短時間で正確に食品の水分活性を測定するためには，どのような点に留意して何を測定する必要があるか説明しなさい．

問3　食品保存の観点から，水分含量ではなく水分活性に着目する必要性を述べなさい．