



UNIVERSITY OF KELANIYA - SRI LANKA
FACULTY OF SCIENCE

Bachelor of Science Honors Degree Examination – October 2023

Academic Year 2021/2022– Semester I

CHEMISTRY

APCH 21652 - Soil Chemistry

Number of Questions: Four (04)

Time: Two (02) hours

Number of pages: Four (04)

Answer all questions.

Q1. Answer all parts.

A cultivator in Kalpitiya in the Puttalam district intends to grow large onions in his land.

A. The “fertility” of the land for the crop cultivated greatly depends on fertilizer and water management.

i) Define the term “fertility of soil” with respect to the above cultivation.

ii) Explain briefly how fertility depends on good water management.

iii) How does productivity differ from fertility of a soil? (35 marks)

B. One of the main problems of lands in Kalpitiya is the high sand content in soil. The cultivator gets the soil of the land analyzed by a soil analyst.

A representative sample weighing 542.00 g was oven dried over night at 105 °C and a weight loss of 73.00 g was detected. The dry sample was sieved through a 2.00 mm sieve and the fraction of particles left on the sieve after sieving weighed 82.80 g → rocks

The sample sieved through was treated with hydrogen peroxide and oven dried again. A further weight loss of 12.80 g was noticed. → organic matter

The sample was then divided into separates and weighed to find out that it contained 246.8 g of sand and 40.70 g of silt.

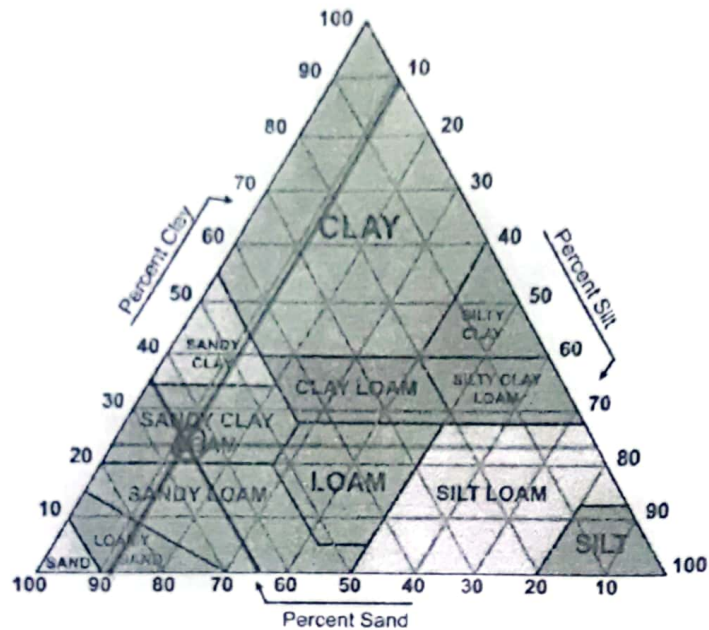
i) Using the soil triangle provided, find out the textural name of the soil in the above land.

ii) Briefly explain a method that can be applied for the separation of soil separates of a soil sample.

iii) The cation exchange capacity of this soil will be very low. What makes the CEC of this soil to be low? What consequences will this have on the water holding capacity and the nutrient level of this soil?

iv) High sand content in soil enhances percolation of inorganic salts. Stating what is meant by “percolation of inorganic salts”, briefly explain how the high level of sand would enhance this process.

(65 marks)



Q2. Answer all parts.

A. Marsh lands consists of very high levels of organic matter (10-20%).

- The soil in these lands is dark black in color and has a very high-water holding capacity. Using a diagram illustrate how these soils show this special feature.
- However, these soils once taken out from the marsh land and are exposed to the air, lose its color as well as its water holding capacity. Explain this observation.
- "Mixing soils in farmlands with soils obtained from marsh land will greatly improve soil quality and thereby will enhance the productivity of agricultural lands". Do you agree with this statement? Briefly explain your answer.

(35 marks)

B. 50.0 g each of dry soil samples from a land that is cultivated, in the dry zone are separately treated with 50.00 mL of the following solutions, stirred and left to settle. The decanted solutions are then titrated using a standard 0.01 M EDTA solution. The results obtained are listed below.

	Solution used to treat soil sample	Volume of EDTA used
a	50.0 mL of deionized water	5.00 mL
b	50.0 mL of 0.10 M NaCl solution	22.00 mL
c	50.0 mL of 0.10 M HCl solution	26.00 mL

- (a) Assuming that the only titrable ion in the soil samples is calcium; explain the above observations.

- (b) Calculate the cation exchange capacity (under field conditions) and the total CEC of the soil sample using the result of the above experiments?
- (c) Organic soils have very large CEC values, but these values are highly dependent on the soil pH. Explain this observation. (35 marks)

C. Farmers add lime to land cultivated in the previous year as a common practice in agriculture.

- Explain the need of liming farmland before reusing it for cultivation.
- Liming farmland can cause harmful effects to the environment. Briefly explain this statement.
- How does liming affect the availability of soil nutrients to crops? Briefly explain. (30 marks)

Q3. Answer all parts.

A. A farmer who plans to cultivate carrots in his land of 12.0 ha (1 ha = 10,000 m²) in the next season sends soil samples from his land to an analyst. Part of the report he received is shown below.

bulk density = 1.455 g cm ⁻³	particle density = 2.550 g cm ⁻³
soil type = silty loam	soil pH = 6.4
moisture content = 09.4 %	amount of N = 0.030 g per kg of dry soil
amount of P (given as P ₂ O ₅) = 0.087 g per kg of dry soil	
percent available P = 28% of total P	no significant amount of K ⁺ ions.

Carrots are best grown in sandy loam soil with a slightly acidic pH and require only about 80.0 kg of N per ha and 130.0 kg of mobile phosphorous (as P₂O₅) per ha. And about 180 kg potassium ions per ha.

The farmer intends to use DAP (diammonium phosphate[(NH₄)₂HPO₄]) as the main fertilizer in his cultivation and MOP (muriate of potash (KCl))

Assuming that only the nutrients in the top layer of soil (30 cm) is accessible to the plants.

- Calculate (a) the percent N and percent P (as % P₂O₅) in the DAP fertilizer.
(b) the NPK value of MOP fertilizer, separately. (25 marks)
- Calculate the minimum amount of each fertilizer that the farmer should add to get a good yield. (25 marks)
- How would the application of fertilizer to this land affect the availability of phosphorus to plants? (10 marks)
- What would be the effect of ammonium ions in the fertilizer on the soil pH? Briefly explain your answer. (15 marks)

(relative atomic masses; O =16.00, C=12.00, N=14.00, H=1.00, P=31.00, K =39.00, Cl = 35.5 and S =32.00)

B. Most of the land plants respire through their root system.

- a) 'The addition of organic fertilizer heavily helps soils to transport gasses that are exchanged in respiration, thus increasing fertility of a soil'. Explain this statement.
- b) Calculate the porosity of the soil of which the analysis is shown in Q3 and thereby determine the gas volume transported via the pore system.

(25 marks)

Q4. Answer all parts.

A. Compare five of the following pairs of practices/processes that are linked to agriculture and soil chemistry. Include advantages and drawbacks of both processes in your comparisons.

- a. Tilling by the use of animals and 'minimal tillage' using instruments.
- b. Burning vegetation/ leftovers from crop plants and liming.
- ☒ c. Growing side crops like alfalfa or pineapples and crop rotation.
- d. Use of natural pesticides (eg. neem leaves, chrysanthemums) and use of synthetic pesticides (eg. Glyphosate)
- e. Growing in open land and green house cultivation.
- f. Flood irrigation, use of pumped water and use of sprinklers & drip irrigation.
- g. Applying fertilizer as 'broadcasting' (spreading on allover surface of soil) and injection to soil.

(5 x 08 marks)

B. Disposal of plastics has become a major global problem in recent years. Comment on the advantages and drawbacks in disposal/treatment methods given below for plastic wastes.

- a. Open land dumping
- b. Burying
- c. Burning and Incineration
- d. Reuse and recycling
- e. Dissolvable and Biodegradable plastics

(5 x 06 marks)

C. Algal blooms occur in brackish (mix of salt and fresh water) and freshwater bodies and can be a great threat to the environment.

- a. What is the main cause of these occurrences and why are they common in warm shallow areas?
- b. What are the environmental threats that algal blooms can cause?
- c. List three chemical parameters of the soil of land near to these affected waterbodies that are directly linked to the cause for the phenomena. (30 marks)