

**National University of Lesotho**  
**Faculty of Agriculture**  
**Department of Soil Science and Resource Conservation**  
**SSR 3501-12: Soil Chemistry**

**Final Examination**

**JANUARY 2023**

**100 MARKS**

**3 HOURS**

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**INSTRUCTION**

The Exam has five parts. Answer ALL questions as per instructions provided.

**I. DEFINITIONS:** Please provide concise and appropriate definitions, for the following terms (2 pts each = 10 pts)

1. Adsorption
2. Isomorphous substitution
3. Chelation
4. Exchangeable acidity
5. Calcifuges

**II. FILL IN THE BLANKS:** For the following set of questions, please fill in the blank spaces the appropriate terms that best fit the statements provided. (2 pts each = 20 pts)

1. Replacing power of ions increases with \_\_\_\_\_.
2. A soil is considered to be fertile when the base saturation percentage is more than \_\_\_\_\_.
3. Five percent of humus contributes about \_\_\_\_\_ C mol /kg of CEC.
4. Ten percent of Kaolinite contributes about \_\_\_\_\_ C mol/kg.
5. When the exchange complex had adsorbed metals like \_\_\_\_\_, they are toxic to the crop plants.
6. A soil with a pH of 4 is considered as \_\_\_\_\_ acidic.
7. \_\_\_\_\_ is one effect of acidity on plants.
8. \_\_\_\_\_ is a plant/crop that could withstand strong acidity and do not prefer lime.
9. \_\_\_\_\_ is a human induced soil acidification.
10. \_\_\_\_\_ is a material, which contributes to system's resistance to change in pH when acids or bases are added

**III. TRUE or FALSE:** For the following set of questions, state whether the statement is true or false in the spaces provided. (2 pts each = 20 pts)

1. \_\_\_\_\_ Rubidium ( $Rb^+$ ) has higher replacing power than Cesium ( $Cs^+$ ).
2. \_\_\_\_\_ pH can affect the suitability of the soil as the home for soil-borne disease organisms.
3. \_\_\_\_\_ Salt concentrations in soils could be measured with ESP.
4. \_\_\_\_\_  $K^+$  could be more easily replaced than  $NH_4^+$ .
5. \_\_\_\_\_ Soil pH measures the logarithm of hydrogen ion concentrations.

6. \_\_\_\_\_ When the soil exchange complex has calcium the soil will have desirable physical properties.
7. \_\_\_\_\_ Nitrates are usually found in more concentrations than sulfates in saline soils.
8. \_\_\_\_\_ Clays could be acidic or alkaline depending on the adsorbed ion.
9. \_\_\_\_\_ Sodic soil is not a salt-affected soil.
10. \_\_\_\_\_ Humus is an active fraction of organic matter in soils.

**IV. DISCUSSIONS:** Provide the necessary explanations to the questions below. **(5pts each = 40 pts)**

1. Discuss four factors that influence Cation Exchange Capacity (CEC).
2. Discuss importance of ion exchange in soils and plants.
3. How does application of fertilizers on clays soils differ from that on sandy soils? Please explain.
4. Discuss three main causes of acidity and one common method used to reclaim acidic soils.
5. How do toxicities of aluminium and manganese affect plants? Please discuss.
6. Discuss the four common sources of salts in soils.
7. Discuss the importance of Carbon in soils from soil fertility and environmental aspects.
8. How do soils get contaminated from metals? How does organic matter contribute to metal removal from soils?

**V. CALCULATIONS:** Derive the appropriate calculations to arrive at the appropriate answers for the following set of questions. **(10 pts)**

1. How far does water move inside soils with very low infiltration rate in two weeks? Please provide your answer in feet. **(4 pts)**
2. If the concentrations of basic and acid cations of a soil sample brought from Mafeteng is as seen below, determine the CEC, BS and ESP of this soils: **(3 pts)**

$$\text{Ca}^{++} = 15$$

$$\text{Mg}^{++} = 15$$

$$\text{Na}^{+} = 45$$

$$\text{K}^{+} = 5$$

$$\text{Al}^{+3} = 5$$

$$\text{H}^{+} = 5 \text{ milliequivalents/l}$$

What will be the CEC of the soil? \_\_\_\_\_  
What will be the % Base Saturation? \_\_\_\_\_  
What will be the ESP? \_\_\_\_\_

3. What would be the ESP and SAR of a soil with the following elemental constituents:  
 $\text{Ca}^{++} = 40$ ;  $\text{Mg}^{++} = 32$ ;  $\text{Na}^+ = 90$ ;  $\text{K}^+ = 6$ ;  $\text{Al}^{+3} = 6$ ;  $\text{H}^+ = 6$  meq/l. (3 pts)

ESP = \_\_\_\_\_

SAR = \_\_\_\_\_

Is this a saline, or sodic or acidic soil? \_\_\_\_\_