

UNIVERSITEIT VAN PRETORIA / UNIVERSITY OF PRETORIA  
DEPARTEMENT PLANTPRODUKSIE EN GRONDKUNDE /  
DEPARTMENT OF PLANT PRODUCTION AND SOIL SCIENCE

GKD 250

Introductory Soil Science / Inleidende Grondkunde

March / Maart 2009

Time / Tyd: 60 min

Total / Totaal: 40

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**Question 1 / Vraag 1**

Differentiate between soil texture and soil structure/ Onderskei tussen *tussen grondtekstuur en grondstruktuur* (4)

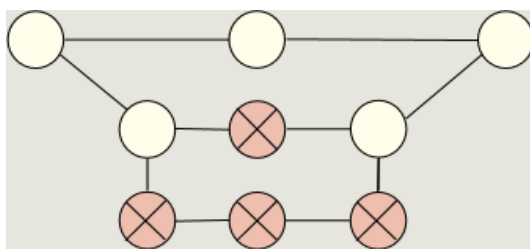
**Soil texture:** The relative proportion/ fraction/ percentage (1 mark) sand, slit and clay in a soil sample (1 mark).

**Soil Structure:** The grouping/arrangement/aggregation (1 mark) of soil particles (mineral + organic material) into secondary particles, units or peds/aggregates (1 mark).

**Question 2 / Vraag 2**

a) Explain, with appropriate sketches, the differences between 1:1 and 2:1 clay minerals. / Verduidelik anhand van gepaste sketse die verskille tussen 1:1 en 2:1 kleimineraal. (6)

### 1:1 Clay mineral

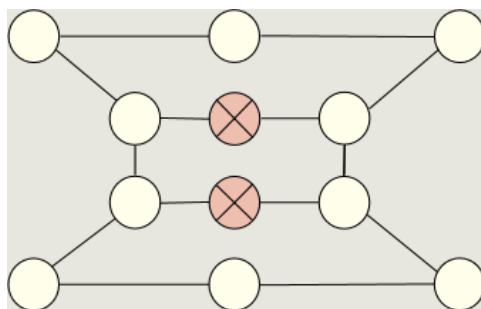


#### Mark allocation:

1. Correct short hand drawing of an 1:1 clay **(1 mark)**;
2. Clearly showing that it consists of one tetrahedral and one octahedral sheet **(1 mark)**;
- 3) Correctly showing the positions of oxygen and hydroxides **((1 mark).**

**(3 marks)**

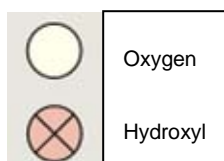
### 2:1 Clay mineral



#### Mark allocation:

1. Correct short hand drawing of an 2:1 clay **(1 mark)**;
2. Clearly showing that it consists of two tetrahedral sheets and one octahedral sheet **(1 mark)**;
- 3) Correctly showing the positions of oxygen and hydroxides **((1 mark).**

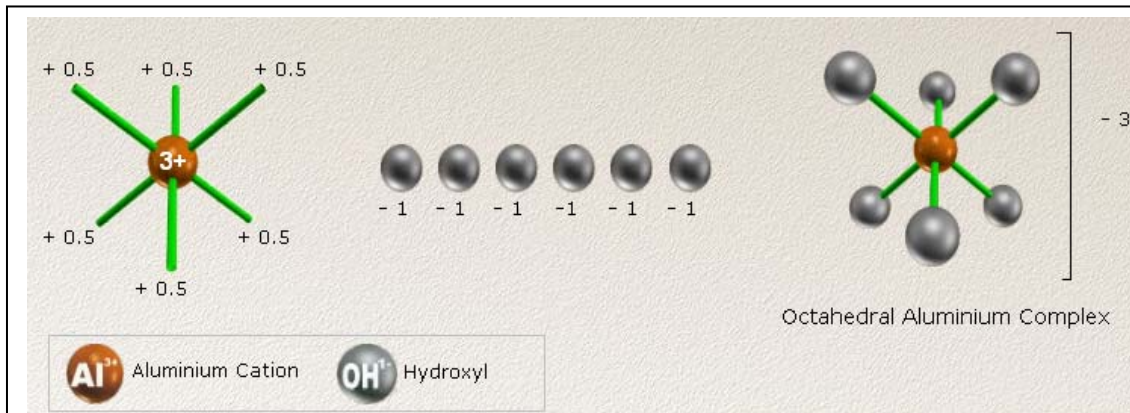
**(3 marks)**



### Question 3 / Vraag 3

Sketch an aluminium octahedron. / Teken an aluminium octahedron.

(4)



Mark allocation:

- 1) Correct coordination number (CN = 6) **(1 mark)**;
- 2) Show the correct location of Al and OH groups **(2 mark)**;
- 3) Correct structure showing coordinative environment **(1 mark)**.

### Question 4 / Vraag 4

Give and briefly discuss the essential criteria that soil must meet to be considered a growth medium for plants. / Gee en bespreek kortliks die essensiële kriteria waaraan grond moet voldoen om beskou te word as 'n goeie groeimeidium

(6)

**Marks were given, adding up to a maximum of six, to any of the following facts:**

1. Physically support plants enabling roots to support the above ground mass **(1 mark)**.  
This can be in the order of several tons when, for example, large forest trees are considered;
2. Aeration for roots, or in other words, sufficient macro porosity and drainage **(1 mark)**;
3. Moisture supply and storage, sufficient micro porosity **(1 mark)**;
4. Moderation of root zone and near-ground air temperature **(1 mark)**;
5. Ability to buffer or moderate soil pH of the root zone **(1 mark)**;
6. An environment relatively free of phytotoxins **(1 mark)**;
7. Provides elements essential for plants to complete their live cycles **(1 mark)** and;
8. Have the ability to immobilise phytotoxins and to protect plants **(1 mark)**,

### Question 5 / Vraag 5

What are the functions of a) fungi and b) chemolithoautotrophic bacteria in the soil ecosystem? / *Wat is die funksies van a) fungi en b) chemolithoautotrofiese bakterieë in die grond ekosisteem?* (10)

**Marks were given, adding up to a maximum of ten, to any of the following facts:**

a) Fungi

- Fungi occupy the **second trophic level in the soil food web (1 mark)**
- Fungi are the principle agents involved in the breakdown of highly resistant **ligninious compounds (1 mark)**;
- The ability of fungi to breakdown lignin opens up the wood resource for other organisms to continue the decomposition process **(1 mark)**;
- Fungi play an important role in the transformation of cellulose, sugars, proteins **(1 mark)** and especially lignin to **humus (1 mark)**.

b) Chemolithoautotrophic bacteria

- Chemolithoautotrophic bacteria are involved in key steps in the biochemical cycling of nutrients **(1 mark)**, essential in maintaining soil fertility **(1 mark)** and also soil formation **(1 mark)**. Chemolithoautotrophy bacteria are also exclusively involved in the sulphur (S), iron (Fe), manganese (Mn) and hydrogen cycles:
- Nitrifying bacteria are involved in the oxidation of ammonium ( $\text{NH}_4^+$ ) to nitrate ( $\text{NO}_3^-$ ).
- Sulphur-oxidising bacteria oxidise reduced forms of sulphur, e.g. sulphides, hydrogen sulphides and elemental sulphur, to sulphate **(1 mark)**;
- Iron-oxidising bacteria oxidise divalent ferrous iron, e.g. in pyrite ( $\text{FeS}$ ), to trivalent ferric(oxy)hydroxides **(1 mark)**;
- Manganese-oxidising bacteria oxidise divalent manganese to trivalent manganese **(1 mark)**;
- Hydrogen-oxidising bacteria oxidise hydrogen to water **(1 mark)**.

### Question 6 / Vraag 6

6.1. A soil with a clay content of 57 % is a: / *'n Grond met 'n klei-inhoud van 57 % is 'n:*

- a) Sand;
- b) Sandy clay loam / *Sand klei leem*;
- c) Loamy sand / *Leem sand*;
- e) Sandy loam / *Sand leem*.

d) Clay / *Klei*;

(2)

6.2. The following organisms are the most abundant in numbers: / *Die volgende organismes is die meeste in getalle:*

a) Fungi;

b) Bacteria / *Bakterieë*;

c) Earthworms / *Erdwurms*;

d) Actinomycetes.

(2)

6.3. The first trophic level is occupied by: / *Die eerste trofiese vlak bestaan uit:*

a) Autotrophic organisms / *Outotrofiese organismes*;

b) Heterotrophic organisms / *Heterotrofiese organismes*;

c) Chemolithoautotrophic organisms / *Chemolithoautotrofiese organismes*;

d) Primary feeders / *Primêre voeders*.

(2)

6.4. The clay fraction consists of particles of the following size fraction: / *Die kleifraksie bestaan uit deeltjies van die volgende groottefraksie:*

a) 2.00 – 0.05 mm;

b) < 2  $\mu$ m;

c) > 2 mm;

d) 0.05 mm – 0.002 mm;

(2)

6.5. *Nitrosomonas* bacteria are: / *Nitrosomonas bakterieë is:*

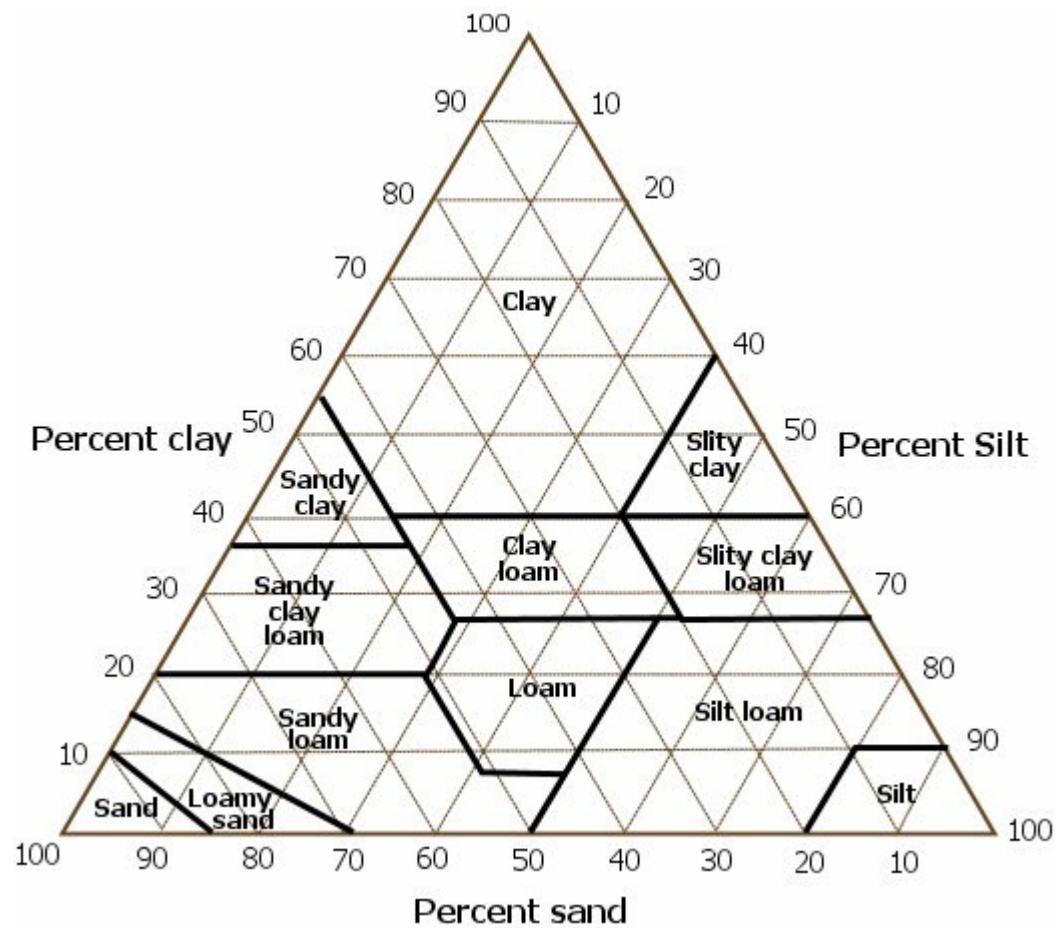
a) Strictly anaerobic organisms / *Uitsluitlik anaerobiese organismes*;

b) Responsible for lignin breakdown / *Verantwoordelik vir die afbraak van lignien*;

c) Heterotrophic organisms / *Heterotrofiese organismes*;

- d) Responsible for oxidation of nitrite to nitrate / *Verantwoordelik vir die oksidasie van nitriet na nitraat*

(2)



**Figure 1** Texture Triangle. *Tekstuur driehoek.*