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

GKD 320
SOIL CHEMISTRY / GRONDCHEMIE

Internal examiner / Interne eksaminator: Mr P.C. de Jager
External examiner / Eksterne eksaminator: Mr Teunis Vahrmeijer

Exam / Eksamen
November 2010
Time / Tyd: 120 min
Marks / Punte : 60

Question 1 / Vraag 1

1.1. Calculate the activity of Ca^{2+} and SO_4^{2-} in a solution of 0.050 M $\text{Ca}(\text{NO}_3)_2$ and 0.010 M MgSO_4 . Use the Davis equation, assume $A = 0.5$. / Bereken die aktiwiteit van Ca^{2+} en SO_4^{2-} in 'n 0.050 M $\text{Ca}(\text{NO}_3)_2$ en 0.010 M MgSO_4 oplossing. Gebruik die Davies vergelyking, neem aan $A = 0.5$. (8)

1.2. Define chelation with reference to the specific ligands involved in the soils solution and discuss the influence it has on the plant availability of trace elements and also soil forming processes. / Definieer chelasie met verwysing na die spesifieke ligande betrokke in die grondoplossing en die invloed op die plantbeskikbaarheid van spoorelemente en ook grondformasie. (10)

Question 2 / Vraag 2

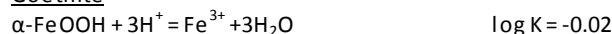
The presence of arsenic in the soil environment is of great concern and enters the soil system through pesticide use. The toxicity of arsenic in the soil environment is dependent on its speciation. Arsenate (AsO_4^{3-}) is not as toxic as arsenite (AsO_3^{3-}) and also not as mobile in the soil environment. / Die teenwoordigheid van arseen in die grondomgewing is 'n groeiende kommer en beland in die sisteem deur die toediening van sekere gifstowwe wat gebruik word. Die toksisiteit van arseen in die omgewing is 'n funksie van sy spesiesering. Arsenaat (AsO_4^{3-}) is nie so toksies soos arseniet (AsO_3^{3-}) nie en minder mobiel in die grondomgewing.

Answer the following questions with the information below: / Antwoord die volgende vrae met die informasie wat hieronder gegee is:

Fe(III) reduction



Goethite



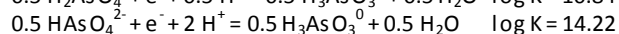
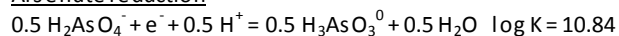
Arsenate speciation



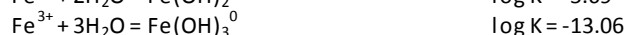
Arsenite speciation



Arsenate reduction



Fe(III) hydrolysis species



- 2.1. Which of these two As species chemistry is close to that of phosphate? Give sufficient proof. / *Watter een van die As spesies se chemie is naby aan die van fosfaat? Gee genoegsame bewyse.* (6)
- 2.2. What is the dominant arsenate and arsenite species at pH 7? / *Wat is die dominante arsenaat en arsenite spesies by pH = 7.* (6)
- 2.3. Can goethite prevent the reduction of arsenate to arsenite in the soil at pH = 7? Use above information to derive the appropriate chemical equation. / *Kan goethiet die reduksie van arsenaat verhoed by 'n pH = 7. Gebruik bogenoemde informasie om gepaste reaksie vergelyking uit te werk.* (10)

Question 3 / Vraag 3

- 3.1. Compare inner sphere complexation and outer sphere complexation on mineral surface on hand of appropriate illustration as well as the environmental relevance thereof. / *Vergelyk binnesfeer en buitsfeer kompleksering op mineraaloppervlaktes aan hand van gepaste illustrations en ook die omgewings relevansie daarvan.* (10)
- 3.2. Discuss the basic characteristics associated with cation exchange reactions. / *Bespreek die basiese eienskappe wat ge-assosieer word met katioon uitruilingsreaksies.* (5)
- 3.3. Humus has a myriad of functional groups including carboxylic (-COOH, pKa = 5) and alcoholic functional groups (R-OH, pKa = 12). What will the net charge of organic material be at a pH of 6? Substantiate your answer with appropriate reaction mechanism and calculations. / *Humus het verskeie funksionele groepe insluitende carboksiel (-COOH, pKa = 5) en alkohol (R-OH, pKa = 12) groepe. Wat sal die net oppervlaktelading wees van organiese materiaal by 'n pH van 6? Staaf jou antwoorde met gepaste reaksie vergelykings en berekeninge.* (5)