UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR OF TECHNOLOGY *CHEMICAL ENGINEERING*
SUBJECT	:	**ENVIRONMENTAL ENGINEERING 3B**
CODE	:	**ENVCHB3**
DATE	:	SUMMER EXAMINATION 23 NOVEMBER 2019
DURATION	:	(SESSION 1) 08:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	73

EXAMINER(S)	:	DR R HUBERTS
MODERATOR	:	DR TJ PILUSA
NUMBER OF PAGES	:	3 PAGES

REQUIREMENTS	:	Use of scientific (non-programmable) calculator is permitted (only one per candidate)

HINTS AND INSTRUCTIONS TO CANDIDATE(S):

- **ATTEMPT ALL QUESTIONS**. Please answer each question to the best of your ability.
- Write your details (module name and code, ID number, student number etc.) on script(s).
- Number each question clearly; questions may be answered in any order.
- Make sure that you read each question carefully before attempting to answer the question.
- Transfer the answers accurately onto Blackboard (Bb).

Question Zero **[Total: 2 Marks]**

Please record your calculations in the script provided neatly and numbered according to the question numbering. No need to write text-based questions in your script too.

Question One **[Total: 6 Marks]**

1.1 Professional engineers have the reponisbility to ensure that the processes they are desinging or working on meet with the legislated requirements of the country. Match three features of the legislation with the relevant South African acts on Bb. **[3]**

1.2 Identify examples where what happens on a chemical plant is part of a passive , re-active, and cleaner production strategy. **[3]**

Question Two **[Total: 30 Marks]**

2.1 You are using the membrane-filter technique to enumerate the number of organisms in the water of a river flowing pass a village. You have filtered five varying volumes of water, given on Bb, and incubated at $45^{o}C$ by placing the used 100m diameter filters in petri dishes on top of a 2mm thick M-FC medium which has been adsorbed into an adsorbent pad. The appearance of the incubated petri dishes is shown below.

A B C D E

2.1.1 Each dot on a petri dish represents the descendants of one organism filtered out of the water and is known as a colony. If an organism takes 15min to grow and divide into two (generation time), how many bacteria will be in a colony after a time given on Bb? **[2]**

2.1.2 What type of organism are you testing for? **[2]**

2.1.3 How many bacteria are present per units of volume usually reported? **[6]**

2.2 K_2PtCl_6 is used to determine which water standard? **[1]**

2.3 In the last stage of methane production by anaerobic bacteria, acetate, an intermediate breakdown product, is converted to methane.

2.3.1 Write an equation for this reaction in your script for the transfer of one electron, without taking bacterial growth in consideration. **[4]**

2.3.2 Calculate the free energy change in kcal(electron mol)$^{-1}$ for the methane production reaction in the previous question. **[2]**

2.3.3 Is the production of methane as represented by the equation spontaneous? Why? **[2]**

2.4. The concentration of active chlorophyll a on the surface of a body of water undergoing eutrophication is given on Bb. Assume that the chlorophyll is illuminated with optimum light intensity. K_N and K_P are 25µgl^{-1} and 10µgl^{-1} respectively. If [N] and [P] are 10µgl^{-1} and 50µgl^{-1} respectively, calculate R_4, the rate of chlorophyll growth, in µgl^{-1}d^{-1}. Assume that μ_{pm20}=2 per day, k_{s4} = 0.14 per day and k_d = 0.05 per day, and a mean temperature of 20^{o}C. **[11]**

Question Three **[Total: 16 Marks]**

3.1 Identify surface runoff, precipitation, transpiration, evaporation, infiltration and percolation movements in a diagram of the hydrologic cycle. **[6]**

3.2 A well, the diameter of 0.7m, was constructed in a confined aquifer containing coarse sand and of thickness given on Bb, and is operating steadily. The top of the confined aquifer is 40m below the surface. The original piezometric surface is 10m below ground level. An observation well 3m away has a drawdown of 4m, while the other one 25m away has a drawdown of 2.5m. Draw an annotated diagram of the well and relevant surroundings in your script and calculate the pumped water flowrate from the well in m^{3}d^{-1}. Where appropriate, take average properties. **[10]**

Question Four **[Total: 19 Marks]**

4.1 A highly efficient cyclone is being designed to treat air containing the solids detailed in the accompanying table. The settling velocities of the different solid particles have been determined as shown. The settling velocity of the particle size that just is removed 100% will be given on Bb.

Range	wt%	d	v_i
0-10	8	5	0.00672
10-20	10	15	0.06048
20-30	12	25	0.168
30-40	15	35	0.32928
40-50	19	45	0.54432
50-60	14	55	0.81312
60-70	13	65	1.13568
70-80	9	75	1.512

4.1.1 What is the fraction of solids that has been removed from the air? **[7]**

4.1.2 If one kg of solid enters the cyclone, how many grams enter as 15 micron particles, and how many grams exit as 15 micron particles? **[5]**

4.2 Air containing a volatile organic pollutant (which has an activation energy of 150000Jmol^{-1} and a pre-exponential factor of 8×10^8s^{-1}) needs to be treated by incineration at a temperature of 1000K. What incineration time is required to achieve the percentage removal of the pollutant given on Bb? **[7]**

END **[Total: 73 Marks]**