National Examination May 2008

04 Env B9, Environmental Chemistry/Microbiology

3 hours duration

NOTES

1 This examination has two sections ***CHEMISTRY*** and ***MICROBIOLOGY*** The Chemistry portion of the examination has ***SIX*** **(6)** questions and the Microbiology section has ***NINE (9)*** questions The ***Fifteen*** (15) questions constitute a complete examination paper

2 Each question is of the value indicated There are ***50*** marks for the ***Chemistry*** portion and ***50*** marks for the ***Microbiology*** portion of this examination The total possible examination mark is ***100***

3 This is a **CLOSED BOOK EXAM** An 8 ½ x 11 aid sheet (both sides) A Casio or Sharp calculator is permitted

4 If doubt exists as to the interpretation of any examination question the candidate is urged to submit with the answer paper a clear statement of any assumption made for the solution of the examination question

5 Clarity and organization of the answers are important

SECTION 1 CHEMISTRY (6 questions, 50 marks)

10 **1 DEFINE**

1 1 saturated solution
1 2 normality
1 3 Henry s Law
1 4 molecular weight
1 5 ORP
1 6 NTU
1 7 solute
1 8 alkalinity
1 9 mole fraction
1 10 buffer

8 **2** Name and briefly state the role of 4 Chemical Unit Processes used in water/wastewater treatment engineering

12 **3** Estimate the **mass** and **volume** of sludge produced from untreated wastewater **without** and **with** the use of ferric chloride for the enhanced removal of TSS Also estimate the amount of lime required to completely neutralize the addition of the specified ferric chloride dose Assume that 60 percent of the TSS is removed in the primary settling tank without the addition of chemicals and that the addition of ferric chloride results in an increased removal of TSS to 87 percent Also assume that the following data apply

1	wastewater flow rate m^3/d	1 000
2	wastewater TSS mg/L	200
3	wastewater alkalinity as $CaCO_3$ mg/L	150
4	ferric chloride ($FeCl_3$) added kg/1 000 m^3	50
5	raw sludge properties	
	specific gravity	1 03
	moisture content	94
6	chemical sludge properties	
	specific gravity	1 05
	moisture content	92 5

$$2FeCl_3 + 3Ca(HCO_3)_2 \leftrightarrow 2Fe(OH)_3 + 3CaCl_2 + 6CO_2$$

$$2FeCl_3 + 3Ca(OH)_2 \leftrightarrow 2Fe(OH)_3 + 3CaCl_2$$

question 3 continued on page 3 of 4

question 3 continued

atomic weights

C = 12 0
Cl = 35 5
Fe = 55 8
Ca = 40 1

suggested answer format

TREATMENT	SLUDGE	
	Mass kg/d	*Volume m^3/d*
without chemical precipitation		
with chemical precipitation		

3 **4** Name the factors influencing the action of disinfectants

5 **5** Sketch and label a process flow diagram that shows a process sequence for the reclamation of water from a raw municipal wastewater

12 **6** The elemental composition of an organic material was determined to be

C = 52 85 % dry weight	C = 12
H = 6 48 % dry weight	H = 1
O = 24 76 % dry weight	O = 16
N = 15 12% dry weight	N = 14

How many kg of oxygen are required for the complete oxidation of 24 kg of this material?

50 Chemistry sub total mark

Section 2 Microbiology is on page 4 of 4

SECTION 2 MICROBIOLOGY (9 questions, 50 marks)

10 **1 DEFINE**

1 1 endemic
1 2 chemoautotrophic
1 3 virulence
1 4 trihalomethanes
1 5 protozoa
1 6 binary fission
1 7 virus
1 8 epidemic
1 9 psychrotrop
1 10 bacteria

5 **2** A batch culture of 100 unicellular bacteria has grown from a single bacterium in two hours through exponential growth Assuming continued exponential growth how many bacteria will the culture have after one additional hour?

3 **3** Are you more likely to get sick by drinking water from a polluted stream in the winter or in the summer? Give details of your reasoning

3 **4** Why is filtration of water without chlorination or UV partially effective in controlling pathogenic bacteria?

5 **5** What are coliforms? Why is *Escherichia coli* considered an indicator of pollution? Why are the results from the coliform test considered to be presumptive?

6 **6** Describe and compare the nutritional requirements of autotrophic and heterotrophic bacteria

5 **7** Name 5 waterborne diseases

8 **8** Draw a typical bacterial cell identify and describe the major components and their functions

5 **9** Draw a growth death curve for a bacterial culture Label the axes and all phases of the curve and briefly explain the diagram

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50 Microbiology sub total mark

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100 TOTAL POSSIBLE EXAMINATION MARK