UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Sciences

BSc Environmental Health

MAIN EXAMINATION PAPER DECEMBER 2012

TITLE OF PAPER	:	INDUSTRIAL WASTE MANAGEMENT I
COURSE CODE	:	EHS:553
DURATION	:	2 HOURS
MARKS	:	100
INSTRUCTIONS	:	THERE ARE FIVE QUESTIONS IN THIS EXAM
	:	ANSWER ANY 4 OF THE 5 QUESTIONS
	:	EACH QUESTION CARRIES 25 MARKS
	:	NO PAPER SHOULD BE BROUGHT INTO OR OUT OF THE EXAMINATION ROOM
	:	

QUESTION ONE (25 Marks)

1A. Discuss the impact of the presence of bio-refractory chemicals on industrial wastewater treatment and suggest methods of treating such types of wastewaters.

.....[5 Marks]

1B. Characterize the quality of wastewater generated from each of the following industries:

i. Tannery
ii. Brewery
iii. Pulp and paper
iv. Oil refinery
v. Sugar processing.

.....[8 Marks]

1C. If you are working in a certain industry as person in charge of waste management, outline the waste management plan and the important activities that you will prescribe to manage the wastes from the industry. .....[5 Marks]

1D. A regular monitoring test of a given heavy metal on an industrial waste water effluent gave a value of 11 µg/L. The number of repetition measurements was 6. The standard deviation has been established as 1µg/L. If the maximum effluent limit for the heavy metal was 10µg/L, determine whether there is significant difference between the measured concentration and the effluent limit. The critical t value at 95% confidence level for 6 repetitions is given as 2.776. .....[7 Marks]

QUESTION TWO (25 Marks)

An industry is required to equalize its waste water and discharge it such that the industrial outflow shown in Figure Q1 below is achieved. As shown in Figure Q1, the industry is required to have maximum discharge during minimum municipal waste water flow and minimum industrial discharge during maximum (peak) municipal waste water flow. The hourly industrial inflow in to the balancing tank is constant from 0hr to 12 hr and is 0.35 Million liters per hour. The industry is shut between 12hr and 24 hr so that there is no waste water inflow in to the equalization tank during this period. The BOD of the municipal waste water is constant at 200 mg/L. The BOD of the industrial waste water flow is also constant at 1600 mg/L.

2A. Determine the volume in million liters of the equalization tank required. ...[17 Marks]

2B. Calculate the maximum and minimum BOD in the combined waste water after mixing with industrial flow and comment on these values. .....[8 Marks]

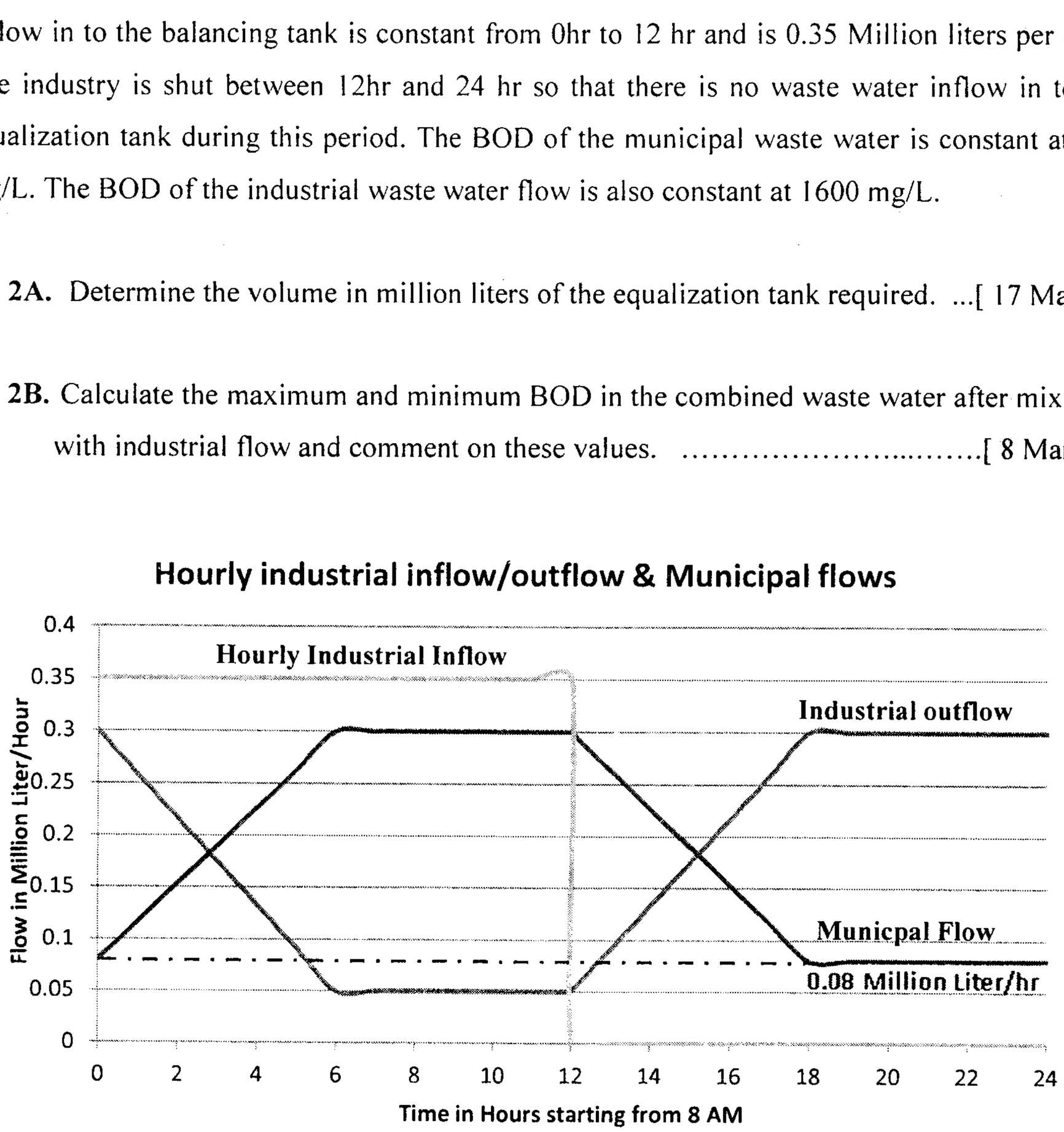

Figure Q1

QUESTION THREE (25 Marks)

3A. Differentiate between physical emulsions and chemical emulsions.

.....[5 Marks]

3B. Draw a schematic representation of floatation system with recirculation.

.....[5 Marks]

3C. Describe the treatment techniques employed to remove i) physical emulsions ii) chemical emulsions.

.....[5 Marks]

3D. List seven techniques of dewatering used for sludge produced from industrial waste water treatment plants.

.....[5 Marks]

3E. Describe the three commonly used anions for the precipitation of heavy metals in industrial waste waters. List them in order of their precipitation potential (i.e. from the highest precipitation potential to the lowest).

.....[5 Marks]

QUESTION FOUR (25 Marks)

4A. Compare and contrast i) precipitation and ii) ion exchange for the removal of heavy metals from industrial waste waters?

.....[5 Marks]

4B. In what situations is chemical oxidation the preferred method for the treatment of industrial wastes?

.....[5 Marks]

4C. List the advantages and disadvantages of using i) Hydrogen peroxide ii) chlorine and iii) Ozone for the oxidation of compounds present in industrial waste waters.

.....[5 Marks]

4D. For what kind of wastewaters is wet air oxidation used?

.....[5 Marks]

4E. List the chemicals used for the regeneration of the following ion exchangers:

i. Sodium-based cation exchanger .....[2 Marks)

ii. Hydrogen-based cation exchanger. ....[1 Mark]

iii. Hydroxide based anion exchanger. .....[2 marks]

QUESTION FIVE (25 Marks)

An industrial waste water with a daily discharge of 150 m^3/day of waste containing 60 mg/L of Cr^{6+} , 24 mg/L of Cu , 30 mg/L of Zn and 5 mg/L of O_2 is to be treated daily by using SO_2. Using the chemical equations and atomic weights provided in the periodic table below, compute

A. The daily requirement of SO_2 in kg/day.

.....[9 Marks]

B. The daily requirement of lime ($Ca(OH)_2$) in kg/day at 90% purity.

.....[8 Marks]

C. The daily production of sludge on dry weight basis.

.....[8 Marks]

<u>Chemical equations needed for calculation</u>

$$SO_2 + H_2O \leftrightarrow H_2SO_3$$

$$2H_2CrO_4 + 3H_2SO_3 \leftrightarrow Cr_2(SO_4)_3 + 5H_2O$$

$$H_2SO_3 + (1/2)O_2 \leftrightarrow H_2SO_4$$

$$Cr_2(SO_4)_3 + 3Ca(OH)_2 \leftrightarrow 2\,Cr(OH)_3 + 3CaSO_4$$

$$H_2SO_4 + Ca(OH)_2 \leftrightarrow 2Cr(OH)_3 + 3CaSO_4$$

$$CuSO_4 + CaSO_4 \leftrightarrow Cu(OH)_2 + CaSO_4$$

$$ZnSO_4 + Ca(OH)_2 \leftrightarrow Zn(OH)_2 + CaSO_4$$

Periodic Table of the Elements

Atomic Number 6

Symbol C

Name Carbon

Average Atomic Mass 12.0107

Hydrogen
Semiconductors
(also known as metalloids)

Metals
Alkali metals
Alkaline earth metals
Transition metals
Other metals

Nonmetals
Halogens
Noble gases
Other nonmetals

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
1	1 H Hydrogen 1.007 94																	2 He Helium 4.002 60
2	3 Li Lithium 6.941	4 Be Beryllium 9.012 182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.998 4032	10 Ne Neon 20.1797
3	11 Na Sodium 22.989 769 28	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981 5386	14 Si Silicon 28.0855	15 P Phosphorus 30.973 762	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948
4	19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955 912	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938 045	26 Fe Iron 55.845	27 Co Cobalt 58.933 195	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.409	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.921 60	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798
5	37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.905 85	40 Zr Zirconium 91.224	41 Nb Niobium 92.906 38	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905 50	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.904 47	54 Xe Xenon 131.293
6	55 Cs Cesium 132.905 4519	56 Ba Barium 137.327	57 La Lanthanum 138.905 47	72 Hf Hafnium 178.49	73 Ta Tantalum 180.947 88	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.084	79 Au Gold 196.966 569	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.980 40	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub* Ununbium (285)		114 Uuq* Ununquadium (289)		116 Uuh* Ununhexium (292)		

* The systematic names and symbols for elements greater than 111 will be used until the approval of trivial names by the IUPAC

The discoveries of elements with atomic numbers 112, 114, and 116 have been reported but not fully confirmed

58 Ce Cerium 140.116	59 Pr Praseodymium 140.907 65	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925 35	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930 32	68 Er Erbium 167.259	69 Tm Thulium 168.934 21	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th Thorium 232.038 06	91 Pa Protactinium 231.035 88	92 U Uranium 238.028 91	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

The atomic masses listed in this table reflect the precision of current measurements. (Each value listed in parentheses is the mass number of that radioactive element's most stable or most common isotope.)