UNIVERSITI SAINS MALAYSIA

First Semester Examination
2010/2011 Academic Session

November 2010

IEG 101 – INTRODUCTION TO ENVIRONMENTAL SCIENCE
[PENGANTAR SAINS PERSEKITARAN]

Duration: 3 hours
Masa: [3 jam]

Please check that this examination paper consists of   NINE   pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi   SEMBILAN   muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer FIVE questions. You may answer the questions either in Bahasa Malaysia or in English.

[Arahan: Jawab LIMA   soalan.   Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

PART A   (ANSWER ALL QUESTIONS)

1. A sample of water having a pH of 7 has the following concentrations of ions as shown in Table 1.

    Table 1

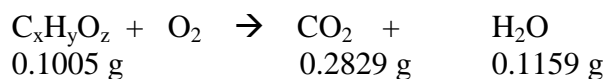 | Ion | Conc. mg/L | M.W. mg/mmol |
    |---|---|---|
    | Ca^{2+} | 60.0 | 40.1 |
    | Mg^{2+} | 20.0 | 24.3 |
    | Na^+ | 11.8 | 23.0 |
    | K^+ | 7.0 | 39.1 |
    | HCO_3^- | 110.0 | 61.0 |
    | SO_4^{2-} | 127.7 | 96.1 |
    | Cl^- | 30.9 | 35.5 |

    Calculate the Total Hardness, Carbonate Hardness, Non carbonate Hardness and Alkalinity

    Given:

    $$K_a = \frac{[CO_3^{2-}][H^+]}{[HCO_3^-]} = 10^{-10.33} = 4.67 \times 10^{-11}$$

    (20 Marks)

2. (a) Menthol ($C_xH_yO_z$) is composed of C, H, and O. A 0.1005 g sample of menthol is combusted, producing 0.2829 g of CO_2 and 0.1159 g H_2O.

    $$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$$
    0.1005 g   0.2829 g   0.1159 g

    (i) What is the empirical formula of menthol?
    (ii) If the Molecular Mass of menthol is 156 g/mol, what is the molecular formula?
         (Atomic Masses are: C=12, O=16, H=1)

    (10 Marks)

(b)   Stock solutions of H_2SO_4, HCl, NaOH, KCl and $(COOH)_2$ were prepared and diluted with water to 100 mL each using volumetric flasks as shown in the Table 2. Calculate the pH of the final solutions.

Table 2

No.	Reagents	Volume to be diluted to 100 mL
1	0.5 M H_2SO_4 Sulphuric acid	1 mL
2	2 M HCl Hydrochloric acid	5 mL
3	0.1 N NaOH Sodium hydroxide	10 mL
4	1M KCl Potassium chloride	14 mL
5	0.1M $(COOH)_2$ Oxalic acid	5 mL

(10 Marks)

3. (a)   Define and explain the following with suitable examples:

        (i)   Accuracy & Precision
        (ii) Coagulation and Flocculation

(10 Marks)

    (b)   Explain the Oxygen cycle and its role in the environment.

(10 Marks)

4. (a)   Give a brief explanation of the major detrimental effects of phosphorus in any receiving water body.

(4 Marks)

    (b)   (i)   Define total dissolve solid (TDS)
          (ii) List **TWO** possible sources of TDS
          (iii) State **TWO** effects of TDS to environment

(6 Marks)

    (c)   Briefly explain the following statements:
          (i)   Microbes as nitrogen fixer
          (ii) Microbes as decomposer

(10 Marks)

PART B **(ANSWER ONE QUESTION ONLY)**

5. (a) Given below are phases involved when bacteria is grown in a closed system, such as a test tube.

   (i) Lag phase
   (ii) Exponential phase
   (iii) Stationary phase
   (iv) Death phase

   Briefly explain the behaviour of bacteria in each of the above phases

   (8 Marks)

(b) A city of 100,000 people discharges 1048 L/s of treated sewage having an ultimate dissolved oxygen (DO) of 1.8 mg/L into a river with a flow of 7.1 m^3/s and velocity of 36.6 cm/sec. Upstream of the discharge point, the river has a DO of 7.6 mg/L. The saturation DO is 8.5 mg/L.

   Calculate the:

   (i) initial DO concentration of the river
   (ii) initial DO deficit of the river

   Given:

   $$DO\left(Q_w + Q_r\right) = Q_w DO_w + Q_r DO_r$$

   $$D + DO = DO_s$$

   (8 Marks)

(c) Write notes on the following

   (i) Obligate aerobes
   (ii) Facultative anaerobes

   (4 Marks)

6. (a) Explain the basic principles and applications of the following techniques in the purification of water:

   (i) Ion-Exchange
   (ii) Reverse Osmosis

   (10 Marks)

   (b) A student collected samples for the analysis of CODs and diluted each of them 1000 times in order to bring them in the range suitable for the spectrophotometer detection limit. The analysis was done in triplicate and the mean of the three readings were calculated. The mean values were then multiplied by 1000 to get the CODs of the samples and reported as shown in Table 3. Determine the errors in reporting the results and correct them using the rules of significant figures.

   Table 3

Sample Number	CODs of diluted Samples (mg/L)	Average COD (mg/L)	COD of Samples (mg/L)
1.	273, 277, 271	821/3=273.66	273660
2.	839, 844, 844	2527/3=842.33	842330
3.	753,759, 755	2267/3=755.66	755660

   (10 Marks)

1. *Satu sampel air pada pH 7 mempunyai kepekatan ion seperti yang ditunjukkan dalam Jadual 1*

   Jadual 1

Ion	Conc. mg/L	M.W. mg/mmol
Ca^{2+}	60.0	40.1
Mg^{2+}	20.0	24.3
Na^+	11.8	23.0
K^+	7.0	39.1
HCO_3^-	110.0	61.0
SO_4^{2-}	127.7	96.1
Cl^-	30.9	35.5

   Hitung jumlah kekerasan, kekerasan karbonat, kekerasan bukan karbonat dan Alkaliniti
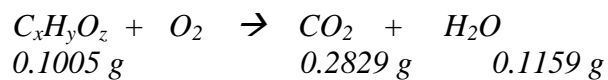
   Diberi:

   $$K_a = \frac{[CO_3^{2-}][H^+]}{[HCO_3^-]} = 10^{-10.33} = 4.67 \times 10^{-11}$$

   (20 Markah)

2. *(a)   Mentol ($C_xH_yO_z$) terdiri daripada C, H, dan O. Satu sampel 0.1005 g mentol dibakar, menghasilkan 0.2829 g CO_2 dan H_2O 0.1159 g.*

   (i)   Apakah formula empirik mentol tersebut?

   $$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$$
   0.1005 g   0.2829 g   0.1159 g

   (ii)   Jika Jisim Molekul mentol tersebut ialah 156 g /mol, apakah formula molekul tersebut?
   (Jisim Atom Relatif adalah: C = 12, O = 16, H = 1)

   (10 Markah)

(b) Larutan stok H_2SO_4, HCl, NaOH, KCl dan $(COOH)_2$ disediakan dan dicairkan menggunakan air sehingga 100 mL masing-masing menggunakan kelalang isipadu seperti yang ditunjukkan dalam Jadual 2. Hitung pH larutan akhir.

Jadual 2

No.	Reagen	Isipadu yang akan dicairkan
1	0.5 M H_2SO_4 Asid sulfurik	1 mL
2	2 M HCl Asid hidroklorik	5 mL
3	0.1 N NaOH Natrium hidroksida	10 mL
4	1M KCl Kalium klorida	14 mL
5	0.1M $(COOH)_2$ Asid oksalik	5 mL

(10 Markah)

3. (a) Takrifkan dan jelaskan yang berikut menggunakan contoh-contoh yang sesuai:

   (i) Kejituan dan Kepersisan
   (ii) Pengentalan dan Pembukuan

(10 Markah)

   (b) Jelaskan Kitaran Oksigen dan peranannya dalam persekitaran.

(10 Markah)

4. (a) Berikan penerangan ringkas kesan utama fosforus yang merosakkan mana-mana badan air yang menerimanya.

(4 Markah)

   (b) (i) Takrif jumlah pepejal terlarut (TDS)
   (ii) Senaraikan **DUA** kemungkinan sumber TDS
   (iii) Nyatakan **DUA** kesan TDS terhadap alam sekitar

(6 Markah)

   (c) Secara ringkas jelaskan pernyataan berikut:

   (i) Mikrob sebagai pengikat nitrogen
   (ii) Mikrob sebagai pengurai

(10 Markah)

BAHAGIAN B   **(JAWAB SATU SOALAN SAHAJA)**

5.   (a)   *Di bawah merupakan fasa-fasa yang berlaku apabila bakteria tumbuh di dalam sistem tertutup seperti tabung uji.*

      (i)   *Fasa lambat*
      (ii)   *Fasa eksponen*
      (iii) *Fasa pegun*
      (iv)   *Fasa kematian*

      Merujuk kepada setiap satu fasa di atas secara ringkas terangkan tingkahlaku bakteria.

(8 Markah)

   (b)   *Sebuah bandar yang mempunyai populasi penduduk seramai 100,000 orang mendiscas 1048 L/s sisa kumbahan yang mengandungi oksigen terlarut (DO) muktamad sebanyak 1.8 mg/L ke dalam sungai yang beraliran 7.1 m^3/s dan halaju 36.6 cm/s. Di hulu sungai jauh daripada titik pelepasaan, DO nya adalah sebanyak 7.6 mg/L. Nilai oksigen tepu bagi sebatang sungai ialah 8.5 mg/L.*

      Tentukan:

      (i)   *kepekatan awal oksigen terlarut (DO) sungai tersebut*
      (ii)   *defisit awal oksigen terlarut sungai tersebut*

      Diberi:

      $$DO\left(Q_w + Q_r\right) = Q_w DO_w + Q_r DO_r$$

      $$D + DO = DO_s$$

(8 Markah)

   (c)   *Tuliskan berkenaan pernyataan berikut:*

      (i)   *aerob obligat*
      (ii)   *anaerob fakultatif*

(4 Markah)

6. (a) Jelaskan prinsip-prinsip asas dan pelaksanaan teknik-teknik berikut dalam pemurnian air:

   (i) Penukaran-Ion
   (ii) Osmosis Songsang

   (10 Markah)

(b) Seorang pelajar mengumpul sampel untuk analisis COD. Setiap sampel tersebut dicairkan 1000 kali supaya berada dalam julat kesanan spektrofotometer. Analisis dilakukan dalam triplikat dan min dihitung. Nilai min kemudian didarabkan dengan 1000 untuk mendapatkan bacaan COD dan dilaporkan seperti dalam Jadual 3. Tentukan ralat dalam melaporkan keputusan dan betulkan dengan menggunakan peraturan nombor signifikan.

Jadual 3

Nombor Sampel	Sampel COD dicairkan (mg/L)	Min COD (mg /L)	Sampel COD (mg /L)
1.	273, 277, 271	821/3=273.66	273660
2.	839, 844, 844	2527/3=842.33	842330
3.	753,759, 755	2267/3=755.66	755660

(10 Markah)

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