Final Examination
2018/2019 Academic Session

June 2019

JIK414 – Chemistry and Environmental Pollution
(Kimia dan Pencemaran Alam Sekitar)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of **ELEVEN (11)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEBELAS (11)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini].*

Instructions : Answer **FIVE (5)** questions. Answer the questions in English. You may also answer the questions in Bahasa Malaysia, but not a mix of both languages.

*[**Arahan** : Jawab **LIMA (5)** soalan. Jawab soalan-soalan dalam Bahasa Inggeris. Anda juga dibenarkan menjawab soalan dalam Bahasa Malaysia, tetapi campuran antara kedua-dua bahasa ini tidak dibenarkan].*

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

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

1. (a). What is meant by the “hole” in the ozone layer, and what role have chlorofluorocarbons (CFCs) played in this? Illustrate you answer with relevant chemical equations.

Apakah yang dimaksudkan dengan "lubang" dalam lapisan ozon, dan apakah peranan yang dimainkan oleh chlorofluorocarbons (CFCs) ini? Ilustrasikan jawapan anda dengan persamaan kimia yang berkaitan.

(5 marks/*markah*)

(b). What is photochemical smog? What are the conditions required for the formation of photochemical smog? Some have suggested that we can control photochemical smog by limiting the production of ozone (O_3), since it is the most harmful component of smog. Explain why this approach did not work using relevant chemical equations?

Apakah asbut fotokimia? Apakah keadaan yang diperlukan untuk pembentukannya? Ada yang mencadangkan bahawa kita dapat mengawal asbut fotokimia dengan menghadkan pelepasan ozon (O_3), kerana ia adalah komponen paling berbahaya bagi kabut. Terangkan mengapa pendekatan ini tidak dapat mengawal pembentukan asbut fotokimia dengan menggunakan persamaan kimia yang berkaitan?

(8 marks/*markah*)

(c). Suppose the average concentration of SO_2 in an air sample is measured to be 0.4 mg/m^3 at 25 ^oC and 1 atm pressure. Does this exceed the (24 hour) air quality standard of 0.14 ppm?

Dengan anggapan purata kepekatan SO_2 dalam sampel udara diukur menjadi 0.4 mg/m^3 pada tekanan 25 ^oC dan 1 atm. Adakah ini melebihi standard kualiti udara (24 jam) 0.14 ppm?

(7 marks/*markah*)

2. (a). Define adiabatic lapse rate. What is the value of the adiabatic lapse rate? How does it affect atmospheric stability? Sketch the different stability categories and explain briefly.
Tentukan kadar langkau adiabatik. Apakah nilai kadar langkau adiabatik? Bagaimanakah ia menjejaskan kestabilan atmosfera? Lakarkan kategori kestabilan yang berbeza dan terangkan secara ringkas.

(9 marks/*markah*)

(b). Assuming that the air follows the adiabatic lapse rate, what should be the temperature on top of Mount Everest (Height = 8848m above sea level) if the temperature on sea level is at 25 ^{o}C?
Dengan mengandaikan bahawa udara mengikuti kadar langkau adiabatik, apakah suhu di atas Gunung Everest (Ketinggian = 8848m di atas paras laut) jika suhu di paras laut adalah 25 ^{o}C?

(6 marks/*markah*)

(c). Sketch and describe the stability conditions of fanning plume.
Lakarkan dan jelaskan keadaan kestabilan plum kekipas.

(5 marks/*markah*)

3. (a). Given a clear sunny summer afternoon in a rural area with average wind speed U_{10} of 4 m/s, contaminant emissions of 0.01 kg/s, and an effective stack height of 20 m. Find the ground level concentration 200 m directly downwind from the stack.
Diberikan petang musim panas yang cerah di kawasan luar bandar dengan purata kelajuan angin U_{10} daripada 4 m/s, emisi bahan cemar sebanyak 0.01 kg/s, dan ketinggian berkesan 20 m. Cari tahap kepekatan tanah 200 m secara langsung ke bawah dari timbunan.

(4 marks/*markah*)

(b). (i). Explain briefly how do toxic metals transport through the aquatic environment?

Terangkan secara ringkas bagaimana logam toksik diangkut melalui persekitaran akuatik?

(ii). Briefly discuss the processes of bioaccumulation and biomagnification,

Bincangkan secara ringkas proses bioakumulasi dan biomagnifikasi.

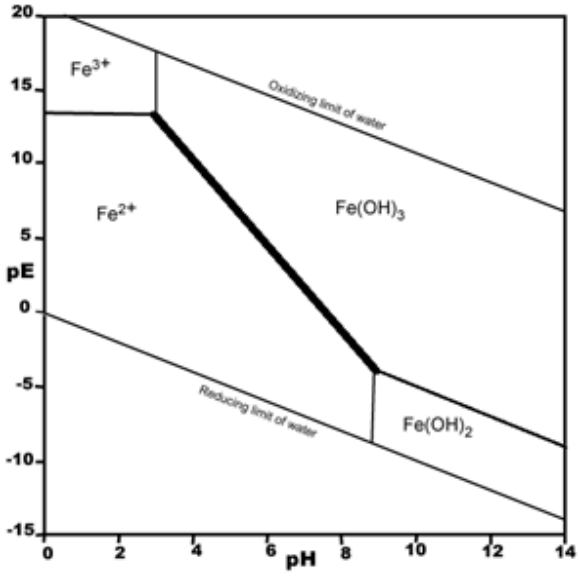
(10 marks/*markah*)

(c). Consider the depicted pE-pH diagram of iron in aquatic environment given below. At pH 6 and pE 2.58, what is the concentration of Fe^{2+} in equilibrium with $Fe(OH)_3$?

Pertimbangkan gambar rajah pE-pH besi dalam persekitaran akuatik. Pada pH 6 dan pE 2.58, apakah kepekatan Fe^{+2} dalam keseimbangan dengan $Fe(OH)_3$?

$Fe(OH)_3\ (s) + 3H^+ \longrightarrow Fe^{3+} + 3H_2O \qquad K'_{sp} = 9.1x10^3$

$Fe^{3+} + e^- \longrightarrow Fe^{2+} \qquad pE^0 = 13.2$



(6 marks/*markah*)

4. (a). Explain the effects of presence of a ligand on the behaviour of metal ions in the aquatic environment.
Terangkan kesan kehadiran ligan terhadap tingkah laku ion logam dalam persekitaran akuatik.

(6 marks/*markah*)

(b). Explain briefly, the BOD and COD tests, and how they relate to oxygen consuming wastes.
Jelaskan, secara ringkas, ujian BOD dan COD, dan bagaimana ia berkaitan dengan sisa-sisa yang menggunakan oksigen.

(8 marks/*markah*)

(c). A five-day BOD test is performed on a wastewater. 10 ml of "seed" are added to 20 L of dilution water. 30 ml of wastewater are added to a 300 ml BOD bottle and the remaining volume consists of "seeded" dilution water. The results of dissolved oxygen concentration of the diluted wastewater samples and blanks (seeded dilution water) was as following:
Ujian BOD selama lima hari dilakukan pada air buangan. 10 ml air "benih" ditambah kepada 20 L air pencairan. 30 ml sisa air ditambah kepada botol BOD 300 ml dan jumlah yang tinggal terdiri daripada air pencairan "biji". Keputusan kepekatan oksigen terlarut sampel air kumbahan dicairkan (air pencairan biji) adalah sebagai berikut:

Day	Seed Test DO (mg/L)	Sample Test DO (mg/L)
0	9	7.5
5	8.5	3.1

Calculate the five-day BOD for that wastewater?
Kira BOD selama lima hari untuk air kumbahan itu?

(6 marks/*markah*)

5. (a). State the major **FIVE (5)** steps of the nitrogen cycle, and discuss the importance of nitrogen cycle in an ecosystem.
*Nyatakan **LIMA (5)** langkah utama kitaran nitrogen, dan bincangkan kepentingan kitaran nitrogen dalam ekosistem.*

(10 marks/*markah*)

(b). Explain the major pathway and specific role of phosphorus cycle in the food chain.
Jelaskan laluan utama dan peranan spesifik kitaran fosforus dalam rantaian makanan.

(10 marks/*markah*)

6. Describe and explain the components of Environmental Impact Assessment (EIA) report.
Nyata dan jelaskan komponen laporan penilaian impak alam sekitar (EIA).

(20 marks/*markah*)

APPENDIX

Some Related Formulas

$$BOD = \frac{(D_1 - D_2)}{P}$$

$$BOD = \frac{(D_1 - D_2) - (B_1 - B_2)f}{P}$$

$$C_{(x,y,z,H)} = \frac{Q}{2\pi\, u\, \sigma_y \sigma_z}\left[\exp\left(\frac{-y^2}{2\sigma_y^2}\right)\right]\left[\exp\left(\frac{-(z-H)^2}{2\sigma_z^2}\right) + \exp\left(\frac{-(z+H)^2}{2\sigma_z^2}\right)\right]$$

Relative atomic mass (RAM)

S = 32.07

O = 16.00

Table 1: Stability class categories

Surface Wind Speed[a] m/s	Day Incoming Solar Radiation			Night Cloudiness[e]	
	Strong[b]	Moderate[c]	Slight[d]	Cloudy (≥4/8)	Clear (≤3/8)
<2	A	A−B[f]	B	E	F
2−3	A−B	B	C	E	F
3−5	B	B−C	C	D	E
5−6	C	C−D	D	D	D
>6	C	D	D	D	D

[a] Surface wind speed is measured at 10 m above the ground.

[b] Corresponds to clear summer day with sun higher than 60° above the horizon.

[c] Corresponds to a summer day with a few broken clouds, or a clear day with sun 35-60° above the horizon.

[d] Corresponds to a fall afternoon, or a cloudy summer day, or a clear summer day with sun 15-35°.

[e] Cloudiness is defined as the fraction of sky covered by clouds.

[f] For A−B, B−C, or C−D conditions, average the values obtained for each.

[*] A = Very unstable D = Neutral
B = Moderately unstable E = Slightly stable
C = Slightly unstable F = Stable
Regardless of wind speed, Class D should be assumed for overcast conditions, day or night.

Table 2: Power law exponents for wind profile calculations

Exponent *p* values for rural and urban regimes					
Stability class	**Rural**	**Urban**	**Stability class**	**Rural**	**Urban**
A	0.07	0.15	D	0.15	0.25
B	0.07	0.15	E	0.35	0.30
C	0.10	0.20	F	0.55	0.30

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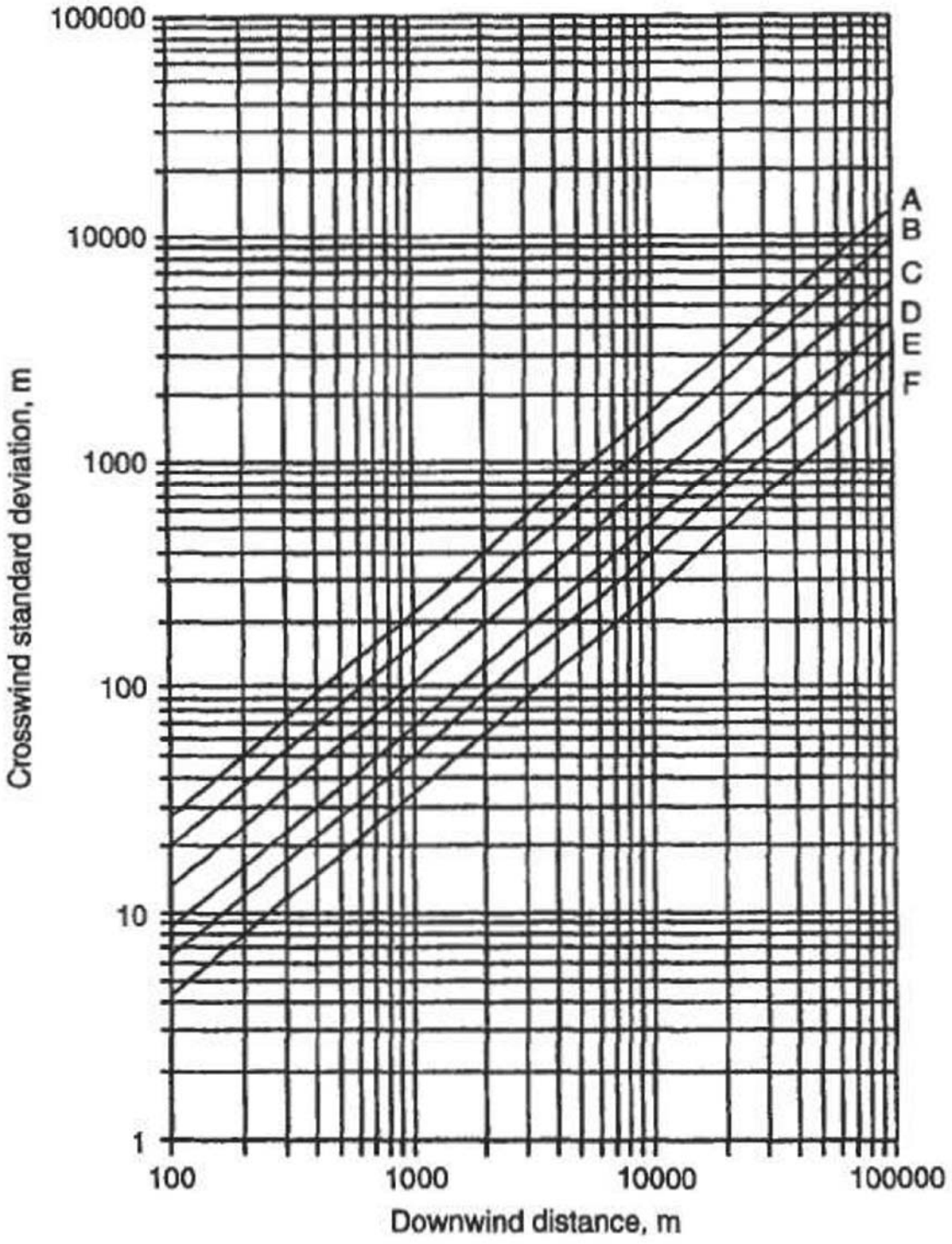

Figure 1: Horizontal dispersion coefficient σ_y

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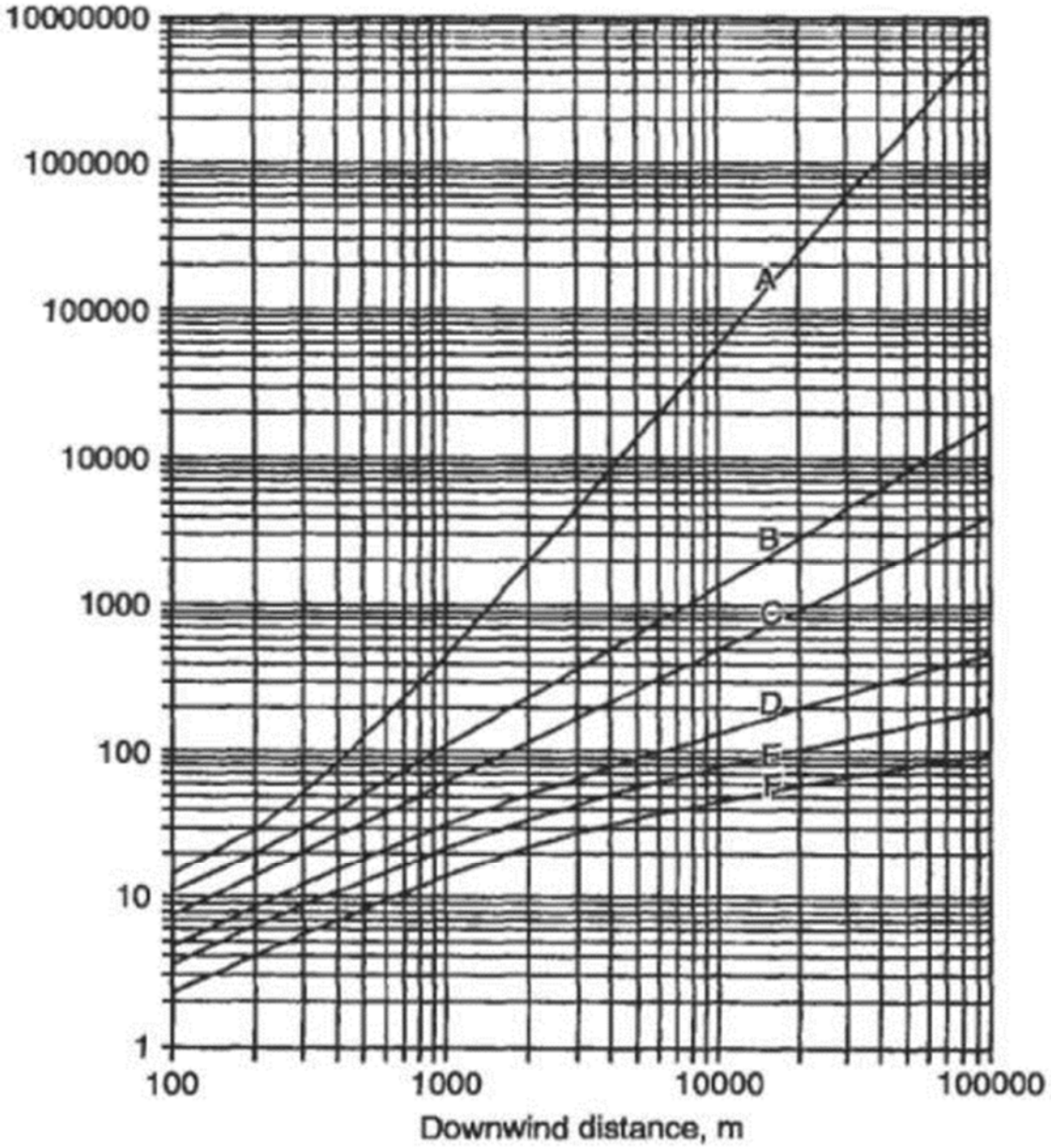

Figure 2: Vertical dispersion coefficient σ_z

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Table 3: Coefficient for σ_y

Atmospheric stability classes	Distance downwind (m) x < 10,000		Distance downwind (m) x ≥ 10,000	
	c	d	c	d
A = 1	.495	.873	.606	.851
B = 2	.310	.897	.523	.840
C = 3	.197	.908	.285	.867
DD = 4	.122	.916	.193	.865
DN = 5	.122	.916	.193	.865
E = 6	.0934	.912	.141	.868
F = 7	.0625	.911	.080	.884

Table 4: Coefficient for σ_z

Atmospheric stability classes	Distance downwind (m) 100 < x ≤ 500		Distance downwind (m) 500 < x ≤ 5000		Distance downwind (m) 5000 < x	
	a	b	a	b	a	b
A = 1	.0383	0.1281	.0002539	2.089	.000254	2.089
B = 2	.1393	.9467	.04936	1.114	.04936	1.114
C = 3	.1120	.9100	.1014	.926	.1154	.9109
DD = 4	.0856	.865	.2591	.6869	.7368	.5642
DN = 5	.0818	.8155	.2527	.6341	1.297	.4421
E = 6	.1094	.7657	.2452	.6358	.9204	.4805
F = 7	.05645	.8050	.1930	.6072	1.505	.3662

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