Final Examination
2017/2018 Academic Session

May/June 2018

JIK314 – Chemistry and Environmental Pollution
[Kimia dan Pencemaran Alam Sekitar]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **ELEVEN** printed pages before you begin the examination.

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.

All answers must be written in the answer booklet provided.

Each question is worth 20 marks and the mark for each sub question is given at the end of that question.

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

*Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEBELAS** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*

*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.*

Setiap jawapan mesti dijawab di dalam buku jawapan yang disediakan.

Setiap soalan bernilai 20 markah dan markah subsoalan diperlihatkan di penghujung subsoalan itu.

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

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1. (a). Ozone is an air pollutant - do you agree? Give justification to your answer.

Ozon adalah bahan pencemar udara - adakah anda bersetuju? Berikan alasan kepada jawapan anda.

(6 marks/*markah*)

(b). A one-cubic-meter sample of air was found to contain 80 μg/m^3 of SO_2. The temperature and pressure were 25 °C and 103.193 kPa when the air sample was taken. What was the SO_2 concentration in ppm?

Sampel satu meter padu udara didapati mengandungi 80 μg/m^3 SO_2. Suhu dan tekanan adalah 25 °C dan 103.193 kPa apabila sampel udara diambil. Apakah kepekatan SO_2 dalam ppm?

(4 marks/*markah*)

(c). What is smog? Describe the difference between London smog and Los Angeles smog? Mention the chemical reactions involved in both occurrence.

Apakah itu asbut? Terangkan perbezaan antara asbut London dan asbut Los Angeles? Nyatakan tindak balas kimia yang terlibat dalam kedua-dua kejadian.

(10 marks/*markah*)

2. (a). What are the major factors that influence the dispersion of smokestack plumes?

Apakah faktor-faktor utama yang mempengaruhi penyebaran kepulan dari cerobong asap?

(6 marks/*markah*)

(b). Sketch and describe the stability conditions of fumigation plume.

Lakarkan dan huraikan keadaan kestabilan kepulan jenis fumigasi.

(6 marks/*markah*)

(c). A coal-burning electric generating plant emits 1.1 kg min^{-1} of SO_2 from a stack with an effective height of 60 m. On a thinly overcast evening, with a wind speed of 5.0 m s^{-1}, what will be the ground level concentration of SO_2 500 m directly downwind from the stack?
Sebuah loji janakuasa elektrik yang membakar arang batu telah mengeluarkan 1.1 kg min^{-1} SO_2 dari suatu cerobong dengan ketinggian berkesan ialah 60 m. Pada suatu petang yang sedikit mendung, dengan kelajuan angin 5.0 m s^{-1}, apakah kepekatan SO_2 di paras bumi pada 500 m mengikut arah angin dari cerobong?

(8 marks/*markah*)

3. (a). State the major water pollutants and their sources.
Nyatakan pencemar-pencemar air yang utama dan sumber-sumbernya.

(10 marks/*markah*)

(b). Discuss the oxygen sag curve for pollution in streams.
Bincangkan keluk kendur oksigen bagi pencemaran dalam sungai.

(10 marks/*markah*)

4. (a). Describe the major processes involved in the nitrogen cycle, and draw a flowchart showing the chemical transformations it undergoes throughout the cycle.
Terangkan proses-proses utama yang terlibat dalam kitaran nitrogen, dan lukiskan suatu carta aliran untuk menunjukkan transformasi kimia yang dialami sepanjang kitaran tersebut.

(10 marks/*markah*)

(b). Explain the fundamental importance of phosphorus cycle, and draw a flowchart showing the chemical transformations it undergoes throughout the cycle.

Terangkan kepentingan asas kitaran fosforus, dan lukiskan suatu carta alir untuk menunjukkan transformasi kimia yang dialami sepanjang kitaran tersebut.

(10 marks/*markah*)

5. (a). Explain how Hg^{2+} ion is transformed into methylmercury and dimethylmercury in aquatic environment. Why these organomercury compounds are more toxic and can be bioaccumulated as compare to its original Hg^{2+} ion?

Terangkan bagaimana ion Hg^{2+} berubah menjadi metilmerkuri dan dimetilmerkuri dalam persekitaran akuatik. Mengapa sebatian organomerkuri ini lebih toksik dan boleh bioakumulasi berbanding dengan ion Hg^{2+} yang asal?

(10 marks/*markah*)

(b). Calculate the equilibrium ratio of concentrations of NH_4^+ to NO_3^- at a pH of 6.0

(i). for aerobic water with pE = +11

(ii). for anaerobic water with pE = -3

The redox half reaction is given as:

Kirakan nisbah keseimbangan kepekatan NH_4^+ ke NO_3^- pada pH 6.0

(i). untuk air aerobik yang mempunyai pE = +11

(ii). untuk air anaerobik yang mempunyai pE = -3

Tindak balas separa redoks diberikan di bawah:

$$\frac{1}{8}NO_3^- + \frac{5}{4}H^+ + e^- \rightarrow \frac{1}{8}NH_4^+ + \frac{3}{8}H_2O; \quad pE^0 = +14.15$$

(6 marks/*markah*)

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(c). What are the suitable sample containers and storage conditions for metal ion analysis of water samples?
A*pakah bekas dan keadaan penyimpanan sampel yang sesuai digunakan untuk analisis ion logam dalam sampel air?*

(4 marks/*markah*)

6. (a). Define BOD and COD, and explain why their values for the same water sample can differ slightly.
Takrifkan BOD dan COD, dan jelaskan mengapa nilainya sedikit berbeza untuk sampel air yang sama.

(5 marks/*markah*)

(b). A 25-mL sample of river water was titrated with 0.0010 M $Na_2Cr_2O_7$ and required 8.7 mL to reach the end point. What is the COD value, in milligrams of O_2 per liter, of the sample?
Suatu sampel 25-mL air sungai dititrat dengan 0.0010 M $Na_2Cr_2O_7$ dan memerlukan 8.7 mL untuk mencapai titik akhir. Apakah nilai COD, dalam miligram O_2 per liter, sampel tersebut?

(5 marks/*markah*)

(c). A BOD analysis was carried out on a wastewater sample from a factory. For this analysis, 10 mL of the wastewater was placed inside several BOD bottles and then each diluted to 300 mL. Results from this series of test is listed in the table below.

Suatu analisis BOD telah dilakukan ke atas sampel air buangan sebuah kilang. Untuk analisis ini, 10 mL air buangan tersebut dimasukkan ke dalam beberapa botol BOD dan dicairkan kepada 300 mL. Keputusan daripada ujian bersiri ini disenaraikan di dalam jadual di bawah:

Day	DO (mg/L)
0	9
1	9
2	9
3	6
4	5
5	4
6	3
7	2
8	1
9	0.5

(i). Determine the BOD_5 value for this wastewater.

(ii). Calculate the value of ultimate BOD.

(iii). Explain what happen on the first two days of incubation.

(iv). Why the BOD value for day nine is unacceptable?

(i). Tentukan nilai BOD_5 untuk air buangan ini.

(ii). Kira nilai BOD muktamad.

(iii). Terangkan apa yang berlaku pada dua hari pertama pengeraman.

(iv). Kenapa nilai BOD untuk hari kesembilan tidak boleh diterima?

(10 marks/*markah*)

APPENDIX

Related Formulas

$$\mathrm{BOD} = \frac{(\mathrm{D}_1 - \mathrm{D}_2)}{\mathrm{P}}$$

$$\mathrm{BOD} = \frac{(\mathrm{D}_1 - \mathrm{D}_2) - (\mathrm{B}_1 - \mathrm{B}_2)\,\mathrm{f}}{\mathrm{P}}$$

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

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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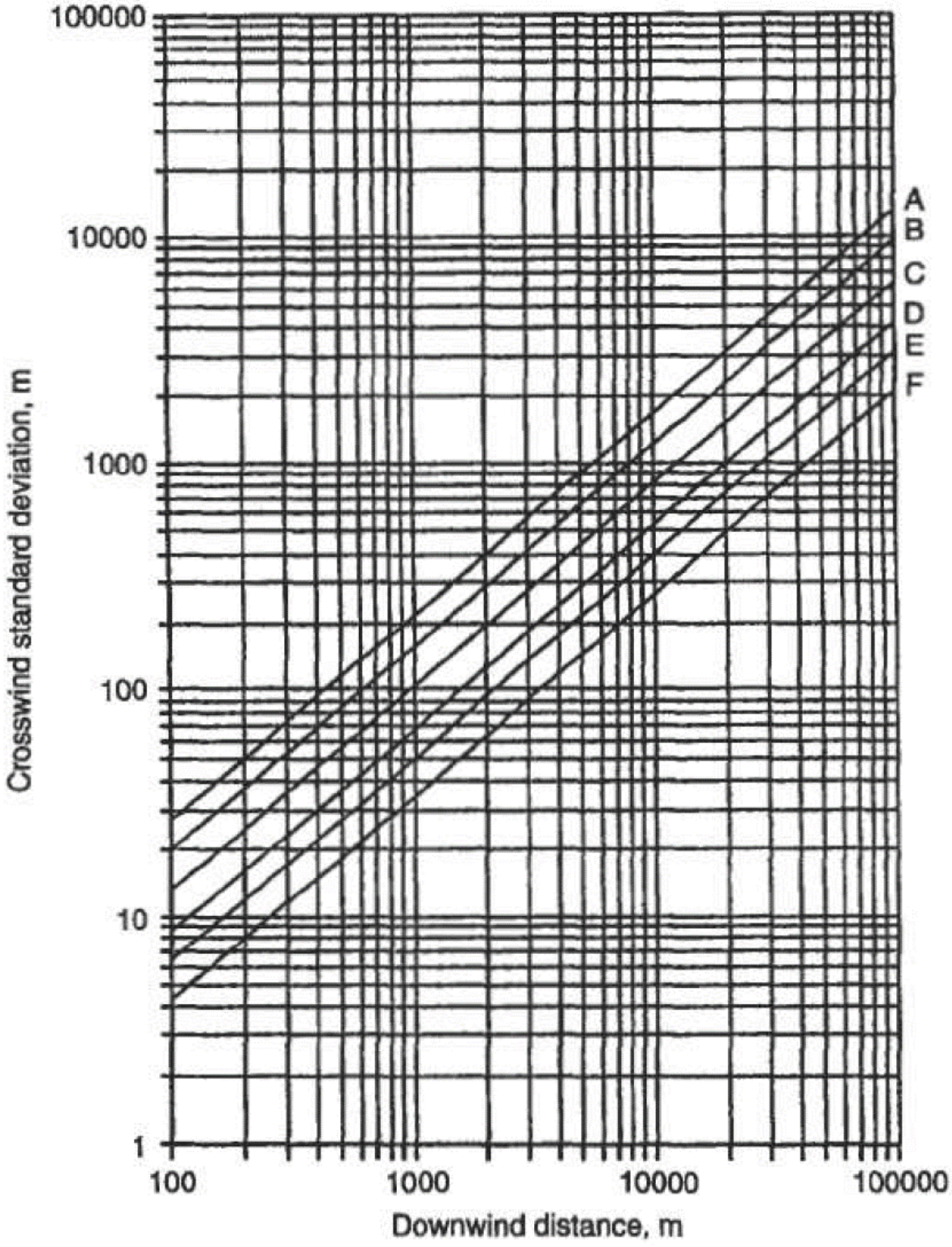

Figure 1: Horizontal dispersion coefficient σ_y

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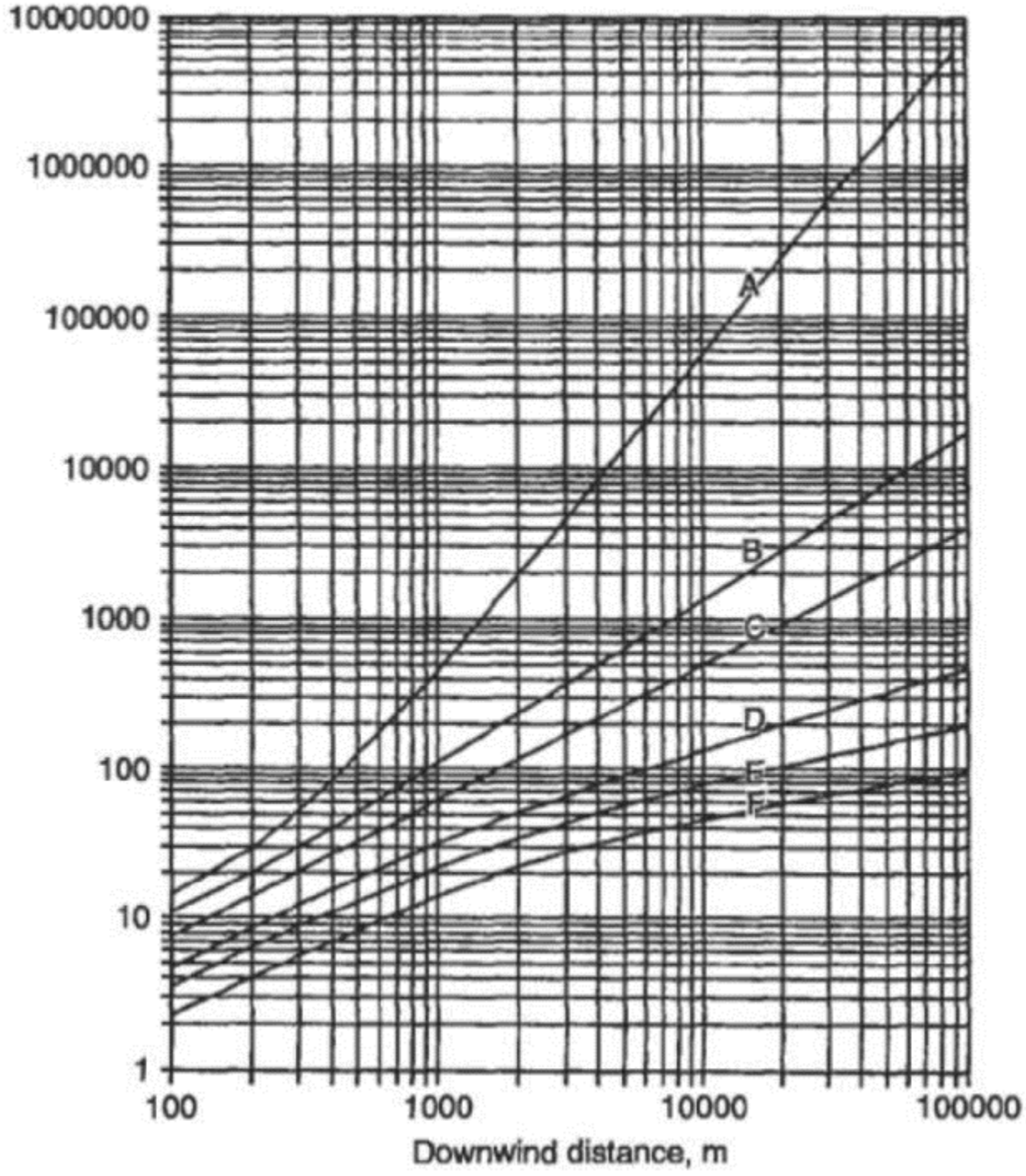

Figure 2: Vertical dispersion coefficient σ_z

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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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