UNIVERSITI SAINS MALAYSIA

PEPERIKSAAN KURSUS SEMASA CUTI PANJANG
ACADEMIC SESSION 2007/2008

JUNE 2008

JIK 218 – SYSTEMATIC CHEMISTRY AND NUCLEUS CHEMISTRY
[KIMIA BERSISTEM DAN KIMIA NUKLEUS]

Duration : 3 hours
[Masa : 3 jam]

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

Answer **SEMUA** questions. You may answer **either** in Bahasa Malaysia or in English.

All answers must be written in the answer booklet provided.

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

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

*Jawab **SEMUA** soalan. Anda dibenarkan menjawab soalan **sama ada** dalam Bahasa Malaysia atau Bahasa Inggeris.*

Setiap jawapan mesti dijawab di dalam buku jawapan yang disediakan.

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

1. (a) Use Slater's rules to estimate values of Z_{eff} for (i) a 4s electron and (ii) a 3d electron in a V atom.

(b) Using your answer to question 1(a), explain why the valence configuration of the ground state of a V^+ ion is likely to be $3d^3 4s^1$ rather than $3d^2 4s^2$.

(c) Confirm that the experimentally observed electronic configuration of K, is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$, is energetically more stable than the configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$.

(d) The first four ionization energies of an atom X are 403, 2633, 3900 and 5080 kJ mol^{-1}. Suggest to what periodic group X belongs and give reasons for your choice.

(a) Gunakan peraturan Slater untuk menganggarkan nilai Z_{eff} bagi (i) elektron 4s (ii) elektron 3d dalam atom V.

(b) Dengan menggunakan jawapan anda untuk soalan 1(a), jelaskan mengapa konfigurasi keadaan asas ion V^+ lebih mungkin menjadi $3d^3 4s^1$ daripada $3d^2 4s^2$.

(c) Sahkan bahawa konfigurasi electron bagi K yang diperolehi dari eksperimen, $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$, adalah lebih stabil dari aspek tenaga daripada konfigurasi $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$.

(d) Empat tenaga pengionan pertama atom X ialah 403, 2633, 3900 and 5080 kJ mol^{-1}. Cadangkan kumpulan berkala manakah atom X berada dan beri alasan kepada jawapan anda.

(20 marks)

2. (a) Write equations for the following processes, noting appropriate conditions :

(i) electrolysis of water
(ii) electrolysis of molten LiH
(iii) CaH_2 reacting with water
(iv) Mg treated with dilute nitric acid
(v) combustion of H_2
(vi) reaction of H_2 with CuO

Tuliskan persamaan bagi proses-proses berikut dengan mengambilkira keadaan yang sesuai :

(i) elektrolisis air
(ii) elektrolisis LiH lakur
(iii) tindakbalas CaH_2 dengan air
(iv) tindakbalas Mg dengan asid nitrik cair
(v) pembakaran H_2
(vi) tindakbalas H_2 dengan CuO

(12 marks)

(b) A compound **C** was isolated from the reaction between a group 1 metal **M** and O_2. **C** reacts with water to give only MOH, while **M** reacts in a controlled manner with water giving MOH and another product **D**. Suggest identities for **M, C** and **D**. Write equations for the reactions described. Compare the reaction of **M** with O_2, with those of the other group I metals with O_2.

*Suatu sebatian **C** telah diasingkan dari tindakbalas di antara logam kumpulan 1 **M** dan O_2. **C** bertindakbalas dengan air untuk menghasilkan hanya MOH, manakala **M** bertindakbalas secara terkawal dengan air untuk menghasilkan MOH dan satu lagi hasil **D**. Cadangkan identiti **M, C** dan **D**. Tuliskan persamaan bagi tindakbalas tersebut. Bandingkan tindakbalas **M** dan O_2 dengan tindakbalas **M** dengan logam kumpulan 1 yang lain.*

(8 marks)

3. (a) The major industrial use of carbon is as a reducing agent. Write equations for THREE (3) important uses of carbon as a reducing agent.

Kegunaan utama karbon dalam industri ialah sebagai agen penurunan. Tuliskan persamaan untuk TIGA (3) kegunaan penting karbon sebagai agen penurunan.

(6 marks)

(b) Suggest why catenation is more common for C than for Si, Ge and Sn. Why is this relevant to the formation of families of saturated hydrocarbon molecules?

Cadangkan kenapa pengkatenan lebih biasa bagi C berbanding Si, Ge dan Sn. Mengapakah hal ini relevan kepada pembentukan kumpulan molekul hidrokarbon tepu?

(6 marks)

(c) List FIVE (5) chemical properties of Li that makes it diagonally related to Mg rather than vertically related to the other alkali metals.

Senaraikan LIMA (5) sifat kimia bagi Li yang membuatkan ia mempunyai hubungan pepenjuru dengan Mg, dan bukannya hubungan menegak dengan logam-logam alkali lain dalam kumpulannya.

(8 marks)

4. (a) Use the VSEPR (Valence Shell Electron Pair Repulsion) theory to predict the structures of

(i) H_2Se
(ii) $[H_3S]^+$
(iii) SO_2
(iv) SF_4
(v) SF_6

Gunakan teori PPEPV (Penolakan Pasangan Elektron Petala Valens) untuk meramalkan struktur

(i) H_2Se
(ii) $[H_3S]^+$
(iii) SO_2
(iv) SF_4
(v) SF_6

(8 marks)

(b) Explain the following observations :

(i) Although the hydrogen bonding in HF is stronger than that in H_2O, water has the higher boiling point.
(ii) Silver chloride and silver iodide are soluble in saturated aqueous KI, but insoluble in saturated aqueous KCl.
(iii) Al_2Cl_6 and I_2Cl_6 are not isostructural.

Jelaskan pemerhatian berikut :

(i) Walaupun pengikatan hidrogen dalam HF lebih kuat daripada pengikatan hidrogen dalam H_2O, air mempunyai takat didih yang lebih tinggi.
(ii) Argentum klorida dan argentum iodida melarut dalam KI akueus tepu tetapi tidak larut dalam KCl akueus tepu.
(iii) Al_2Cl_6 dan I_2Cl_6 bukannya berisostruktur.

(6 marks)

(c) Explain why, on going from monomeric $BeCl_2$ to dimeric $(BeCl)_2$ to polymeric $(BeCl_2)_n$, the environment of the Be atom changes from linear to trigonal planar to tetrahedral.

Jelaskan mengapa, apabila bergerak dari $BeCl_2$ monomerik ke $(BeCl)_2$ dimerik, ke $(BeCl_2)_n$ polimerik, persekitaran atom Be berubah dari linear ke satah trigonal ke tetrahedral.

(6 marks)

5. (a) Write balanced nuclear equations for the following process :

(i) rubidium-90 undergoes beta decay
(ii) selenium-72 undergoes electron capture
(iii) krypton-76 undergoes positron emission
(iv) radium-226 emits alpha radiation.

Tuliskan persamaan berimbang untuk proses-proses berikut :

(i) rubidium-90 mengalami pereputan beta
(ii) selenium-72 mengalami penangkapan elektron
(iii) krypton-76 mengalami proses pemancaran positron
(iv) radium-226 memancar radiasi alfa

(b) How much energy must be supplied to break a single aluminium-27 nucleus into separated protons and neutrons if an aluminium-27 atom has a mass of 26.9815386 amu? How much energy is required for 100.0 grams of aluminium-27?

Berapa banyak tenaga yang perlu dibekalkan untuk memisahkan satu nukleus aluminium-27 kepada proton dan neutron jika jisim satu atom aluminium-27 ialah 26.9815386 amu? Berapakah tenaga yang diperlukan untuk 100.0 gram aluminium-27?

(12 marks)

FUNDAMENTAL CONSTANTS*

Atomic mass unit	1 amu	=	$1.66053873 \times 10^{-24}$ g
	1 g	=	$6.02214199 \times 10^{23}$ amu
Avogadro's number	N	=	$6.02214199 \times 10^{23}$ / mol
Boltzmann's constant	k	=	$1.3806503 \times 10^{-23}$ J/K
Electron charge	e	=	$1.602176462 \times 10^{-19}$ C
Faraday's constant	F	=	9.64853415×10^{4} C/mol
Gas constant	R	=	0.082058205 L-atm/ mol-K
Mass of electron	m_e	=	5.485799×10^{-4} amu
		=	$9.10938188 \times 10^{-28}$ g
Mass of neutron	m_n	=	1.0086649 amu
		=	$1.67492716 \times 10^{-24}$ g
Mass of proton	m_p	=	1.0072765 amu
		=	$1.67262158 \times 10^{-24}$ g
Pi	π	=	3.1415927
Planck's constant	h	=	$6.62606876 \times 10^{-34}$ J–s
Speed of light	c	=	2.99792458×10^{8} m/s

WebElements: the periodic table on the world-wide web

www.webelements.com

Key: element name / atomic number / symbol / atomic weight (mean relative mass)

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
hydrogen 1 H 1.0079																		helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122												boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305												aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078		scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.38	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62		yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.96	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lawrencium 103 Lr [262]	rutherfordium 104 Rf [267]	dubnium 105 Db [268]	seaborgium 106 Sg [271]	bohrium 107 Bh [272]	hassium 108 Hs [270]	meitnerium 109 Mt [276]	darmstadtium 110 Ds [281]	roentgenium 111 Rg [280]	ununbium 112 Uub [285]	ununtrium 113 Uut [284]	ununquadium 114 Uuq [289]	ununpentium 115 Uup [288]	ununhexium 116 Uuh [293]	ununseptium 117 Uus —	ununoctium 118 Uuo [294]

*lanthanoids	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.06
**actinoids	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

Symbols and names: the symbols and names of the elements, and their spellings are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org/). Names have yet to be proposed for the most recently discovered elements beyond 112 and so those used here are IUPAC's temporary systematic names. In the USA and some other countries the spellings aluminum and cesium are normal while in the UK and elsewhere the common spelling is sulphur.
Group labels: the numeric system (1–18) used here is the current IUPAC convention.
Atomic weights (mean relative masses): Apart from the heaviest elements, these are the IUPAC 2007 values and given to 5 significant figures. Elements for which the atomic weight is given within square brackets have no stable nuclides and are represented by the element's longest lived isotope reported at the time of writing.

 For updates to this table see http://www.webelements.com/nexus/Printable_Periodic_Table (Version date: 21 September 2007).

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