INDEX NO: ……....

UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2008/2009

KTT 111 – Inorganic Chemistry I
[Kimia Takorganik I]

Duration : 3 hours
[Masa : 3 jam]

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

Instructions:

Section A: (40 marks) comprising 40 multiple-choice questions (MCQ), has to be answered within the first hour of the examination on the OMR answer sheet provided. The completed OMR answer sheet will be collected 1 hour after the commencement of the examination.

Section B: (60 marks) consists of essay-type questions. Answer any **THREE** (3) questions. If a candidate answer more than three question only the first three questions in the answer sheet will be graded.

Answers each question on a new page.

You may answer the questions either in Bahasa Malaysia or in English.

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

Appendix: Table of relative atomic mass and physical constants.

SECTION B (60 marks) **[TIME: 2 HOURS]**

This section contains FIVE questions.

Answer any THREE questions.
Only the first THREE questions answered in the answer book will be marked. Supporting data constants needed for the questions are included on the last page.
You must start each question on a new page.

1. (a) How does Dalton's atomic theory account for the law of mass conservation and the law of definite proportions?

(5 marks)

(b) Magnesium has three naturally occurring isotopes, ^{24}Mg (isotopic mass 23.985) with 78.99 % abundance, ^{25}Mg (isotopic mass 24.986) with 10.00 % abundance, and a third isotope with 11.01 % abundance. Calculate the mass of the third isotope.

(4 marks)

(c) In Rutherford scattering experiment of alpha particle impinging on a thin gold foil, describe what happens to the alpha particles. How did the results of this experiment shape the modern view of atomic structure.

(6 marks)

(d) Explain the process of emission and absorption of light by an atom.

(5 marks)

2. (a) Aqueous $KMnO_4$ solution reacts with oxalic acid, $H_2C_2O_4$ in acidic solution according to the following equation (unbalanced):

$$MnO_4^-(aq) + H_2C_2O_4(aq) \rightarrow Mn^{2+}(aq) + CO_2(g)$$

0.2585 g $H_2C_2O_4$ was dissolved in approximately 100 mL of 0.5 M H_2SO_4 and titrated against $KMnO_4$ solution. At the end point, it was found that 22.35 mL $KMnO_4$ solution has been added. Calculate the molarity of the $KMnO_4$ solution.

(8 marks)

(b) In a naturally occurring solid material, the component atoms are bonded to each other. What are the three types of bonding that may exist in such material? Describe how these types of bonding reflect the properties of the respective materials.

(12 marks)

3. (a) What are the major trends that emerge when atomic radii are plotted versus atomic numbers. Describe the trends observed when first ionization energies are plotted versus atomic numbers. Give reasons for the observed trends.

(8 marks)

(b) Thallium has a ground state configuration $[Xe]4f^{14}5d^{10}6s^{2}6p^{1}$. Give the group and period for this element. Classify it as a main-group, a *d*-transition, or an *f*-transition element.

(3 marks)

(c) Carry out the following conversions:

(i) 5 pm = _____ cm = _____ nm

(ii) 8.5 cm^3 = _____ m^3 = _____ mm^3

(iii) 65.2 mg = _____ g = _____ pg

(5 marks)

(d) A bottle of 12.0 M hydrochloric acid has only 35.7 mL left in it. What will the HCl concentration be if the solution is diluted to 250.0 mL?

(4 marks)

4. (a) With the aid of suitable drawings, show that an fcc structure is actually a ccp arrangement.

(8 marks)

(b) A line of the Lyman series of the hydrogen atom spectrum has the wavelength 9.50 x 10^{-8} m. It results from a transition from an upper energy level to n = 1. What is the principle quantum number of the upper level?

(5 marks)

(c) Caproic acid contains carbon, hydrogen and oxygen. On combustion analysis, a 0.450 g sample of caproic acid gives 0.418 g of H_2O and 1.023 g of CO_2. What is the empirical formula of caproic acid? If the molecular mass of caproic acid is 116.2 amu, what is the molecular formula?

(7 marks)

5. A red-brown poisonous gas, NO_2 was produced by the oxidation of NO gas during the manufacture of nitric acid *via* Ostwald process. NO_2 dimerizes to N_2O_4 (*via* the N-N) upon cooling and solidification. NO_2 is paramagnetic while N_2O_4 is diamagnetic. X-ray diffraction study of the solid N_2O_4 shows that the structure is planar.

(a) Draw a complete molecular orbital energy level diagram of NO.

(8 marks)

(b) Draw the Lewis structure for NO_2 and N_2O_4.

(2 marks)

(c) Based on (a) and (b) above, describe the magnetism in NO, NO_2 and N_2O_4.

(4 marks)

(d) By applying the VSEPR theory, explain the planarity in solid N_2O_4.

(6 marks)

BAHAGIAN B (60 markah) **[MASA: 2 JAM]**

Bahagian ini mengandungi LIMA soalan.

Jawab sebarang TIGA soalan
Hanya TIGA jawapan yang pertama akan diperiksa. Data pemalar fizikal disertakan dalam Lampiran.
Jawab setiap soalan pada muka surat yang baru.

1. (a) Bagaimanakah teori atom Dalton mengambil kira hukum pengabadian jisim dan hukum perkadaran tertentu?

(5 markah)

(b) Magnesium mempunyai tiga isotop semulajadi, ^{24}Mg (jisim isotop 23.985) dengan kelimpahan 78.99 %, ^{25}Mg (jisim isotop 24.986) dengan kelimpahan 10.00 %, isoto p ketiga dengan kelimpahan 11.01 %. Kirakan isotop yang ketiga itu.

(4 markah)

(c) Dalam ujikaji penyerakan Rutherford di mana partikel alfa disasarkan kepada kepingan emas nipis, jelaskan apa yang berlaku kepada partikel alfa tersebut. Bagaimanakah keputusan ujikaji itu membentuk pemahaman moden tentang struktur atom.

(6 markah)

(d) Terangkan proses pemancaran dan penyerapan cahaya oleh atom.

(5 markah)

2. (a) Satu larutan akues $KMnO_4$ bertindakbalas dengan asid oksalik, $H_2C_2O_4$ dalam larutan berasid mengikut persamaan di bawah (tidak seimbang):

$$MnO_4^-(aq) + H_2C_2O_4(aq) \rightarrow Mn^{2+}(aq) + CO_2(g)$$

$H_2C_2O_4$ sebanyak 0.2585 g telah dilarutkan di dalam lebih kurang 100 mL 0.5 M H_2SO_4 dan di titratkan melawan larutan $KMnO_4$. Pada takat akhir, di dapati 22.35 mL larutan $KMnO_4$ telah di tambah. Kirakan kemolaran larutan $KMnO_4$ tersebut.

(8 markah)

(b) Dalam bahan pepejal semulajadi, atom-atom komponen adalah terikat antara satu sama lain. Apakah tiga jenis ikatan yang mungkin wujud dalam bahan seperti itu? Jelaskan bagaimana ikatan ini menggambarkan sifat-sifat bahan tersebut.

(12 markah)

3. (a) Nyatakan tren utama yang kelihatan bila jejari atom di plot melawan nombor atom. Nyatakan tren utama yang dilihat bila tenaga pengionan pertama di plot melawan nombor atom. Berikan sebab kepada tren tersebut.

(8 markah)

(b) Talium mempunyai konfigurasi asas elektron $[Xe]4f^{14}5d^{10}6s^{2}6p^{1}$. Berikan kumpulan dan kala untuk unsur ini. Kelaskan ia sama ada kumpulan utama peralihan-*d* atau peralihan-*f*.

(3 markah)

(c) Buat penukaran berikut:

(i) 5 pm = _____ cm = _____ nm

(ii) 8.5 cm^3 = _____ m^3 = _____ mm^3

(iii) 65.2 mg = _____ g = _____ pg

(5 markah)

(d) Sebotol asid hidroklorik 12.0 M hanya tinggal sebanyak 35.7 mL di dalamnya. Apakah kepekatan asid HCl ini jika larutan itu dicairkan kepada 250.0 mL?

(4 markah)

4. (a) Dengan menggunakan lakaran yang sesuai, tunjukkan bahawa struktur fcc adalah sebenarnya susunan ccp.

(8 markah)

(b) Satu garisan siri Lyman untuk spektrum atom hidrogen mempunyai jarakgelombang 9.50×10^{-8} m. Ia terhasil melalui perpindahan dari aras tenaga atas ke n = 1. Apakah nombor kuantum prinsipal aras atas tersebut?

(5 markah)

(c) Asid kaproik mengandungi karbon, hidrogen dan oksigen. Dalam satu analisis pembakaran, satu sampel 0.450 g asid kaproik memberi 0.418 g H_2O dan 1.023 g CO_2. Apakah formula empirik asid kaproik? Jika jisim molekul asid kaproik adalah 116.2 amu, apakah formula molekulnya?

(7 markah)

5. Satu gas beracun berwarna merah-koko, NO_2 dihasilkan secara pengoksidaan gas NO semasa proses membuat asid nitrik melalui proses Ostwald. NO_2 mengdimer kepada N_2O_4 (melalui N-N) semasa menyejuk dan menjadi pepejal. NO_2 adalah paramagnetik manakala N_2O_4 adalah diamagnetik. Kajian pembelauan X-ray ke atas pepejal N_2O_4 menunjukkan bahawa strukturnya ialah planar.

(a) Lukiskan gambarajah lengkap aras tenaga orbital molekul untuk NO.

(8 markah)

(b) Lukiskan struktur Lewis untuk NO_2 dan N_2O_4.

(2 markah)

(c) Berdasarkan kepada (a) dan (b) di atas, jelaskan sifat magnet dalam NO, NO_2 dan N_2O_4.

(4 markah)

(d) Dengan menggunakan teori VSEPR, jelaskan tentang sifat planar pepejal N_2O_4

(6 markah)

oooOOooo

APPENDIX:

Table of relative atomic mass and physical constants

Symbol	Name	Atomic Wt		Symbol	Name	Atomic Wt
Ac	Actinium	[227]		**Mo**	Molybdenum	95.94(2)
Al	Aluminium	26.981538(2)		**Nd**	Neodymium	144.24(3)
Am	Americium	[243]		**Ne**	Neon	20.1797(6)
Sb	Antimony	121.760(1)		**Np**	Neptunium	[237]
Ar	Argon	39.948(1)		**Ni**	Nickel	58.6934(2)
As	Arsenic	74.92160(2)		**Nb**	Niobium	92.90638(2)
At	Astatine	[210]		**N**	Nitrogen	14.0067(2)
Ba	Barium	137.327(7)		**No**	Nobelium	[259]
Bk	Berkelium	[247]		**Os**	Osmium	190.23(3)
Be	Beryllium	9.012182(3)		**O**	Oxygen	15.9994(3)
Bi	Bismuth	208.98038(2)		**Pd**	Palladium	106.42(1)
Bh	Bohrium	[264]		**P**	Phosphorus	30.973761(2)
B	Boron	10.811(7)		**Pt**	Platinum	195.078(2)
Br	Bromine	79.904(1)		**Pu**	Plutonium	[244]
Cd	Cadmium	112.411(8)		**Po**	Polonium	[209]
Cs	Caesium	132.90545(2)		**K**	Potassium	39.0983(1)
Ca	Calcium	40.078(4)		**Pr**	Praseodymium	140.90765(2)
Cf	Californium	[251]		**Pm**	Promethium	[145]
C	Carbon	12.0107(8)		**Pa**	Protactinium	231.03588(2)
Ce	Cerium	140.116(1)		**Ra**	Radium	[226]
Cl	Chlorine	35.453(2)		**Rn**	Radon	[222]
Cr	Chromium	51.9961(6)		**Re**	Rhenium	186.207(1)
Co	Cobalt	58.933200(9)		**Rh**	Rhodium	102.90550(2)
Cu	Copper	63.546(3)		**Rb**	Rubidium	85.4678(3)
Cm	Curium	[247]		**Ru**	Ruthenium	101.07(2)
Db	Dubnium	[262]		**Rf**	Rutherfordium	[261]
Dy	Dysprosium	162.500(1)		**Sm**	Samarium	150.36(3)
Es	Einsteinium	[252]		**Sc**	Scandium	44.955910(8)
Er	Erbium	167.259(3)		**Sg**	Seaborgium	[266]
Eu	Europium	151.964(1)		**Se**	Selenium	78.96(3)
Fm	Fermium	[257]		**Si**	Silicon	28.0855(3)
F	Fluorine	18.9984032(5)		**Ag**	Silver	107.8682(2)
Fr	Francium	[223]		**Na**	Sodium	22.989770(2)
Gd	Gadolinium	157.25(3)		**Sr**	Strontium	87.62(1)
Ga	Gallium	69.723(1)		**S**	Sulfur	32.065(5)
Ge	Germanium	72.64(1)		**Ta**	Tantalum	180.9479(1)
Au	Gold	196.96655(2)		**Tc**	Technetium	[98]
Hf	Hafnium	178.49(2)		**Te**	Tellurium	127.60(3)
Hs	Hassium	[277]		**Tb**	Terbium	158.92534(2)
He	Helium	4.002602(2)		**Tl**	Thallium	204.3833(2)
Ho	Holmium	164.93032(2)		**Th**	Thorium	232.0381(1)
H	Hydrogen	1.00794(7)		**Tm**	Thulium	168.93421(2)
In	Indium	114.818(3)		**Sn**	Tin	118.710(7)

I	Iodine	126.90447(3)		**Ti**	Titanium	47.867(1)
Ir	Iridium	192.217(3)		**W**	Tungsten	183.84(1)
Fe	Iron	55.845(2)		**Uub**	Ununbium	[285]
Kr	Krypton	83.798(2)		**Uuh**	Ununhexium	
La	Lanthanum	138.9055(2)		**Uun**	Ununnilium	[281]
Lr	Lawrencium	[262]		**Uuo**	Ununoctium	
Pb	Lead	207.2(1)		**Uuq**	Ununquadium	[289]
Li	Lithium	[6.941(2)]		**Uuu**	Unununium	[272]
Lu	Lutetium	174.967(1)		**U**	Uranium	238.02891(3)
Mg	Magnesium	24.3050(6)		**V**	Vanadium	50.9415(1)
Mn	Manganese	54.938049(9)		**Xe**	Xenon	131.293(6)
Mt	Meitnerium	[268]		**Yb**	Ytterbium	173.04(3)
Md	Mendelevium	[258]		**Y**	Yttrium	88.90585(2)
Hg	Mercury	200.59(2)		**Zn**	Zinc	65.409(4)
				Zr	Zirconium	91.224(2)

Physical constants:

1 amu = 1.6606×10^{-24} g	1 electron volt = 1.6022×10^{-19} J = 96.485 kJ mol^{-1}.
N_A = 6.022×10^{23} particles mol^{-1}	π = 3.1416
R = 0.08206 L atm mol^{-1} K^{-1} = 1.987 cal mol^{-1} K^{-1} = 8.3145 J mol^{-1} K^{-1} = 8.3145 kPa dm^3 mol^{-1} K^{-1}	R_H = 1.0968×10^5 cm^{-1} (Rydberg constant)
h = 6.6262×10^{-34} J s. = 6.6262×10^{-27} erg s.	
c = 2.9979×10^8 m s^{-1}.	
e = 1.60219×10^{-19} coulomb	