UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12203/DSK 1913
PROGRAMME	:	1 DAA/DAC/DAI/DAM 2 DAA 3 DDM/DDT
EXAMINATION DATE	:	APRIL/MAY 2011
DURATION	:	2 ½ HOURS
INSTRUCTIONS	:	ANSWER **ALL** QUESTIONS IN **PART A** AND **FOUR (4)** QUESTIONS IN **PART B**

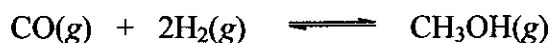THIS QUESTION PAPER CONSISTS OF THIRTEEN (13) PAGES

PART A

Q1 (a) Write the equilibrium expression, K_c for the following equations:

   (i) $3Cl_2(g) + NH_3(g) \rightleftharpoons NCl_3(g) + 3HCl(g)$

   (ii) $3CuO(s) + NH_3(g) \rightleftharpoons 3Cu(s) + N_2(g) + 3H_2O(g)$
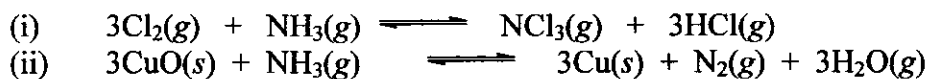
(2 marks)

(b) At 773 °C, $K_c = 0.40$ for the following reaction.

   $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

Find K_p.
$(R = 0.0821$ L.atm/mol.K$)$

(5 marks)

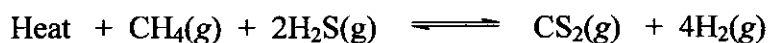(c) At high temperature, 0.50 mol of HBr was placed in a 1.00 L container where it decomposed according to the following equilibrium.

   $2HBr(g) + \rightleftharpoons H_2(g) + Br_2(g)$

At equilibrium, the concentration of Br_2 was 0.0955 M. What is K_c for the reaction?

(6 marks)

(d) Consider the equilibrium

   $Heat + CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$

In which direction will the equilibrium be shifted by the following changes?

   (i)   adding $H_2(g)$.
   (ii) increasing the temperature of the reaction mixture.

(2 marks)
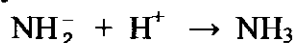
Q2 (a) Identify the acid, base and conjugate acid-base pairs in the following reaction:

   $H_2PO_4^- + CO_3^{2-} \rightleftharpoons HPO_4^{2-} + HCO_3^-$

(2 marks)

(b) Identify the Lewis acid and base in the following reaction.

$$NH_2^- + H^+ \rightarrow NH_3$$

(2 marks)

(c) Calculate the concentrations of H^+ and OH^- in a solution with a pH value of 13.28.
($K_w = 1.0 \times 10^{-14}$)

(5 marks)

(d) What is the pH of 0.15 M lactic acid?
($K_a = 1.4 \times 10^{-4}$)

(6 marks)

Q3 Given the following oxidation-reduction reaction :

$$Ni(s)/Ni^{2+}(aq) //Ag^+(aq) / Ag(s)$$

(i) Write the half-cell reactions at the anode and cathode and label as oxidation or reduction.

(ii) Write the balanced overall equation and identify the number of electrons transferred.

(iii) Calculate E°_{cell}. Is the reaction spontaneous?
($E^{\circ}_{Ag^+/Ag} = 0.80\ V$, $E^{\circ}_{Ni^{2+}/Ni} = -0.25\ V$)

(10 marks)

PART B

Q4 (a) In 214 g TNT, $C_7H_5N_3O_6$, calculate :

(i) the number of moles of TNT.
(ii) the number of N atoms.
(Relative atomic mass : H = 1, C = 12, N = 14, O = 16, $N_A = 6.022 \times 10^{23}$)

(4 marks)

(b) In the reaction :

$$2Si_2H_6 + 7O_2 \rightarrow 4SiO_2 + 6H_2O$$

If 8.4 moles of Si_2H_6 reacts with 15.1 moles O_2,

(i) Determine the limiting reactant.
(ii) What mass of SiO_2 is produced?
(Relative atomic mass : H = 1, O = 16, Si = 28)

(7 marks)

(c) 24.5 mL of 3.0 M solution of NaOH is diluted to 100.0 mL. Determine the final molarity of the solution.

(4 marks)

Q5 (a) (i) How many orbitals are there in an h subshell ($\ell = 5$)? What are the values of m_ℓ?
(ii) How many unpaired electrons are present in a ground state of an atom from Group 7 and 14?

(4 marks)

(b) For Br ($Z = 35$)

(i) Write the full ground state electronic configuration.
(ii) Identify the number of core electrons and the valence electrons in Br.
(iii) Write a full set of quantum numbers (n, ℓ, m_ℓ, m_s) of the electron gained when a Br⁻ ion forms from a Br atom.
(iv) Describe whether Br is paramagnet or diamagnet in its atom and ionic form.

(6 marks)

(c) What oxides are formed by nitrogen? Give two chemical formulas and chemical names of the oxides of nitrogen.

(2 marks)

(d) Explain the contradict trends of atomic radius and ionization energy in the Periodic Table.
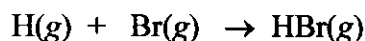
(3 marks)

Q6 (a) (i) Which of the following are exceptions to the Lewis octet rule? BeF_2 or SO_3.

(ii) Use formal charge to prove that the structure you choose in (i) is stable.
(Atomic number, Z: Be = 4, O = 8, F = 9, S = 16)

(6 marks)

(b) Draw Lewis structure and the resonance forms of NO_2F (N is central atom).
(Atomic number, Z: N = 7, O = 8, F = 9)

(6 marks)

(c) Explain why the strength of hydrogen bonding in water is stronger than in ammonia.
(Electronegativity: H = 2.1, O = 3.44, N = 3.04)

(3 marks)

Q7 (a) Boron forms a variety of unusual compounds with hydrogen. A chemist isolated 6.3 mg of one of the boron hydrides in a glass bulb with a volume of 385 mL at 25.0 °C and a bulb pressure of 11 torr.

(i) What is the molecular mass of this hydride?
(ii) Which is likely to be its molecular formula, BH_3, B_2H_6 or B_4H_{10}?
(Relative atomic mass: B = 10.8, H = 1, R = 0.0821 L.atm/mol.K)

(6 marks)

(b) What are the mole percents of the components of air inside the lungs when they have the following partial pressures? For N_2 570 torr, O_2 103 torr, CO_2 40 torr and water vapor 47 torr.

(5 marks)

(c) (i) Write Graham's Law of Effusion.
(ii) An unknown gas X effuses 1.65 times faster than C_3H_8. Calculate the molecular mass of gas X?
(Relative atomic mass: C = 12, H = 1)

(4 marks)

Q8 (a) When 1.00 g of ethanol (C_2H_5OH) is burned in air, -29.7 kJ of heat is liberated.

(i) Calculate the heat of combustion in kJ/mol.
(ii) Write the thermochemical equation for the enthalpy of combustion, ΔH_c^o of ethanol (C_2H_5OH).
(Relative atomic mass: H =1, C = 12, O = 16)

(6 marks)

(b) (i) Calculate the enthalpy change, ΔH^o for the reaction

$$H(g) + Br(g) \rightarrow HBr(g)$$

Given :
$H_2(g) \rightarrow 2H(g)$, $\quad\quad\quad \Delta H^o_{rxn} = 436.4$ kJ
$Br_2(g) \rightarrow 2Br(g)$, $\quad\quad\quad \Delta H^o_{rxn} = 192.5$ kJ
$H_2(g) + Br_2(g) \rightarrow 2HBr(g)$, $\quad \Delta H^o_{rxn} = -104$ kJ

(ii) $H(g) + Br(g) \rightarrow HBr(g)$

Does the above equation represent the thermochemical equation, ΔH_f^o of HBr? Give suitable explanation to support your answer.

(9 marks)

Q9 (a) The oxidation of NO produces the brownish gas NO_2, a component of air pollution. The rate law for the reaction is Rate $= k[NO]^2[O_2]$

$$2NO + O_2 \rightarrow 2NO_2$$
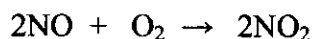
(i) Write the rate expression for the reaction.
(ii) What is the order with respect to each reactant and the overall order of the reaction?
(iii) Calculate the rate of the reaction given :
$k = 7.1 \times 10^9$ M^{-2} s^{-1}
$[NO] = 1.0 \times 10^{-3}$ M
$[O_2] = 3.4 \times 10^{-2}$ M

(7 marks)

(b) The decomposition of N_2O_5 is a first order reaction with half-life, $t_{\frac{1}{2}} = 1.32 \times 10^3$ s.

(i) Find the rate constant, k.

(ii) If the initial concentration of N_2O_5 is 0.20 M, what is the concentration after 10 minutes?
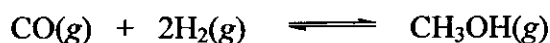
(8 marks)

BAHAGIAN A

S1 (a) Tuliskan ungkapan keseimbangan, K_c bagi tindak balas berikut:

    (i) $3Cl_2(g) + NH_3(g) \rightleftharpoons NCl_3(g) + 3HCl(g)$

    (ii) $3CuO(p) + NH_3(g) \rightleftharpoons 3Cu(p) + N_2(g) + 3H_2O(g)$

(2 markah)

(b) Pada 773 °C, $K_c = 0.40$ bagi tindak balas berikut.

     $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$
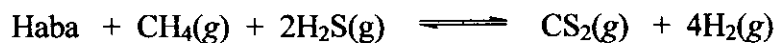
Cari K_p.
($R = 0.0821$ L.atm/mol.K)

(5 markah)

(c) Pada suhu tinggi, 0.50 mol HBr ditempatkan dalam sebuah bekas 1.00 L di mana is diuraikan mematuhi keseimbangan berikut:

     $2HBr(g) + \rightleftharpoons H_2(g) + Br_2(g)$

Pada keseimbangan, kepekatan Br_2 adalah 0.0955 M. Apakah K_c bagi tindak balas tersebut?

(6 markah)

(d) Pertimbangkan keseimbangan berikut:

     Haba + $CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$

Pada arah manakah keseimbangan akan teranjak akibat perubahan berikut:

(i) Menambah $H_2(g)$.
(ii) Meningkatkan suhu campuran tindak balas.

(2 markah)

S2 (a) Kenalpastikan asid, bes dan pasangan asid-bes konjugat bagi tindak balas berikut:

$$H_2PO_4^- + CO_3^{2-} \rightleftharpoons HPO_4^{2-} + HCO_3^-$$

(2 markah)

(b) Kenalpasti asid dan bes Lewis bagi tindak balas berikut:

$$NH_2^- + H^+ \rightarrow NH_3$$

(2 markah)

(c) Hitungkan kepekatan bagi H^+ dan OH^- dalam larutan dengan nilai pH 13.28. ($K_w = 1.4 \times 10^{-14}$)

(5 markah)

(d) Apakah pH bagi 0.15 M asid laktik?
($K_a = 1.4 \times 10^{-4}$)

(6 markah)

S3 (a) Diberi tindak balas pengoksidaan-penurunan seperti berikut:

$$Ni(p)/Ni^{2+}(ak) //Ag^+(ak) / Ag(p)$$

(i) Tuliskan persamaan setengah tindak balas di anod dan katod dan beri label sama ada pengoksidaan atau penurunan.
(ii) Tuliskan persamaan keseluruhan yang seimbang dan kenalpasti bilangan elektron yang dipindahkan.
(iii) Hitung E_{cell}^o. Adakah tindak balas spontan?

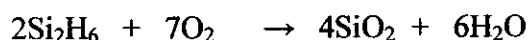($E_{Ag^+/Ag}^o = 0.80\,V$, $E_{Ni^{2+}/Ni}^o = -0.25\,V$)

(10 markah)

BAHAGIAN B

S4 (a) Dalam 214 g TNT, $C_7H_5N_3O_6$, hitung:

(i) Bilangan mol TNT.
(ii) Bilangan bagi atom N.
(Jisim atom Relatif: $H = 1$, $C = 12$, $N = 14$, $O = 16$, $N_A = 6.022 \times 10^{23}$)

(4 markah)

(b) Dalam tindak balas:

$$2Si_2H_6 \ + \ 7O_2 \ \rightarrow \ 4SiO_2 \ + \ 6H_2O$$

Jika 8.4 mol Si_2H_6 bertindak balas dengan 15.1 mol O_2,

(i) Tentukan reaktan penghad.
(ii) Apakah jisim SiO_2 yang akan dihasilkan?
(iii) (Jisim atom relatif: $H = 1$, $O = 16$, $Si = 28$)

(7 markah)

(c) 24.5 mL larutan NaOH 3.0 M dicairkan kepada 100.0 mL. Tentukan kemolaran akhir bagi larutan.

(4 markah)

S5 (a) (i) Berapa banyakkah orbital di dalam subpetala ($\ell = 5$)? Apakah nilai bagi m_ℓ?
(ii) Berapa banyak elektron tak berpasangan yang terdapat pada keadaan asas dalam suatu atom dari Kumpulan 7 dan 14?

(4 markah)

(b) Bagi Br ($Z = 35$),

(i) Tulis konfigurasi elektron penuh pada keadaan asas.
(ii) Kenalpasti bilangan elektron teras (dalam) dan elektron luar bagi Br.
(iii) Tuliskan set nombor kuantum (n, ℓ, m_ℓ, m_s) bagi elektron yang diperoleh apabila ion Br⁻ terbentuk daripada atom Br.
(iv) Gambarkan sama ada Br adalah paramagnet atau diamagnet dalam bentuk atom dan ion.

(6 markah)

(c) Apakah oksida yang dibentuk oleh nitrogen? Berikan dua formula kimia dan nama kimia bagi oksida nitrogen.

(2 markah)

(d) Jelaskan perkalaan yang bertentangan bagi jejari atom dan tenaga pengionan dalam Jadual berkala.

(3 markah)

S6 (a) (i) Yang manakah antara berikut merupakan pengecualian kepada Aturan Oktet Lewis? BeF_2 atau SO_3. Tunjukkan jalan.
(ii) Gunakan cas formal untuk membuktikan bahawa struktur yang dipilih dalam (i) adalah stabil.

(6 markah)

(b) Lukis struktur Lewis dan struktur resonan bagi NO_2F (N sebagai pusat). (Nombor atom, Z: N = 7, O = 8, F = 9)

(6 markah)

(c) Jelaskan mengapa kekuatan ikatan hidrogen dalam air lebih kuat berbanding di dalam ammonia.
(Elektronegativiti: H = 2.1, O = 3.44, N = 3.04)

(3 markah)

S7 (a) Boron membentuk berbagai sebatian luar biasa dengan hidrogen. Seorang ahli kimia mengasingkan 6.3 mg daripada salah satu hidrida boron dalam mentol kaca dengan sisipadu 385 mL pada 25.0 °C dan tekanan dalam mentol 11 torr.

(i) Apakah jisim molekul bagi hidrida ini?
(ii) Yang mana antara berikut adalah formula molekulnya, BH_3, B_2H_6 atau B_4H_{10}?
(Jisim atom relatif: B = 10.8, H = 1, R = 0.0821 L.atm/mol.K)

(6 markah)

(b)   Apakah peratusan mol bagi komponen udara dalam paru-paru apabila tekanan separa bagi gas-gas adalah seperti berikut? Bagi N_2 570 torr, O_2 103 torr, CO_2 40 torr dan wap air 47 torr.

(5 markah)

(c)   (i)   Tuliskan Hukum Pembauran (Efusi) yang diterbitkan oleh Graham.

        (ii)   Suatu gas, X membaur 1.65 kali lebih cepat daripada gas C_3H_8.
                Hitungkan jisim molekul bagi gas X?
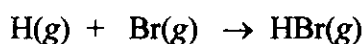   (Jisim atom relatif: C = 12, H = 1)

(4 markah)

S8   (a)   Apabila 1.00 g etanol (C_2H_5OH) dibakar dalam udara, - 29.7 kJ haba dibebaskan.

        (i)   Hitungkan haba pembakaran dalam kJ/mol.

        (ii)   Tuliskan persamaan termokimia bagi entalpi pembakaran, ΔH_c^o etanol (C_2H_5OH).
                (Jisim atom relatif: H =1, C = 12, O = 16)

(6 markah)

(b)   (i)   Hitungkan perubahan entalpi, ΔH^o bagi tindak balas:

                $H(g)$ + $Br(g)$ → $HBr(g)$

                Diberi :
                $H_2(g)$ → $2H(g)$, ΔH_{tbls}^o = 436.4 kJ
                $Br_2(g)$ → $2Br(g)$, ΔH_{tbls}^o = 192.5 kJ
                $H_2(g)$ + $Br_2(g)$ → $2HBr(g)$, ΔH_{tbls}^o = −104 kJ

        (ii) $H(g)$ + $Br(g)$ → $HBr(g)$

                Adakah tindak balas di atas mewakili ΔH_f^o bagi HBr? Berikan penjelasan yang sesuai untuk jawapan anda.

(9 markah)

12

S9 (a) Pengoksidaan NO menghasilkan gas perang NO_2, satu komponen dalam pencemaran udara. Hukum kadar bagi tindak balas adalah $= k[NO]^2 [O_2]$

$$2NO + O_2 \rightarrow 2NO_2$$

(i) Tuliskan ungkapan kadar bagi tindak balas.

(ii) Apakah tertib terhadap reaktan dan tertib keseluruhan tindak balas?

(iii) Hitungkan kadar bagi tindak balas, diberi:
$k = 7.1 \times 10^9 \, M^{-2} \, s^{-1}$
$[NO] = 1.0 \times 10^{-3} \, M$
$[O_2] = 3.4 \times 10^{-2} \, M$

(7 markah)

(b) Peguraian N_2O_5 adalah tertib pertama dengan tempoh setengah hayat, $t_{1/2} = 1.32 \times 10^3$ s.

(i) Kirakan pemalar kadar, k.

(ii) Jika kepekatan asal N_2O_5 ialah 0.20 M, apakah kepekatannya selepas 10 minit?

(8 markah)