UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	CHEMISTRY FOR ENGINEERING TECHNOLOGY
COURSE CODE	:	BWM 12703
PROGRAMME	:	1 BNB / BNL / BNN
EXAMINATION DATE	:	DECEMBER 2012 / JANUARY 2013
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **ALL** QUESTIONS IN **SECTION A** AND ANY **ONE (1)** QUESTION IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

SECTION A

Q1 (a) Use the data in the given Appendix (refer **TABLE 1**) to calculate the equilibrium constant at 25 °C for the reaction :

$$6\ Br^-(aq) + Cr_2O_7^{2-}(aq) + 14\ H^+(aq) \rightarrow 3\ Br_2(aq) + 2\ Cr^{3+}(aq) + 7\ H_2O(l)$$

(5 marks)

(b) A constant current of 30.0 A is passed through an aqueous solution of NaCl for 1.0 h. How many liters of Cl_2 gas at STP will be produced (use data in **TABLE 1**)?

(5 marks)

(c) Discuss the following in detail with the aid of diagrams and examples :

(i) Cathodic protection by sacrificial anodes.
(ii) Mechanism and preventions of pitting corrosion

(8 marks)

(d) Explain **FOUR** limitations of using inhibitors in corrosion prevention.

(2 marks)

Q2 (a) Identify the functional groups in aspartame, a sweetener. The chemical structure is as **FIGURE 1**.

(3 marks)

(b) Draw the structural formula of each of the following:
(i) *trans*-1-bromo-2-chloroethene
(ii) 4-ethylaniline
(iii) cyclohexyl methyl ether

(6 marks)

(c) Complete the chemical equation involving hydrocarbons below (name and structural formula):

(i) $CH_3–CH_3$ $\underset{\text{Reduction}}{\overset{\text{Oxidation}}{\rightleftharpoons}}$ $CH_3–CH_2–OH$ $\underset{\text{Reduction}}{\overset{\text{Oxidation}}{\rightleftharpoons}}$ [?]

(ii) $CH_3–HC=O$ $\xrightarrow{[\ ?\ ]}$ $CH_3–(OH)C=O$

(iii) [‖] + H–O–H $\xrightarrow{H^+}$ [?]

(6 marks)

(d) By using a 3–C aldehyde as example, describe the reaction in a Tollens' Test. Include all reagents involved and the expected outcome.

(5 marks)

Q3 (a) Degree of crystallinity (DOC) for polypropylene sample can be measured via Instrument Y. Suggest the name of instrument Y and briefly describe its principle and applications.

(8 marks)

(b) What type of samples can be investigated via X-ray diffraction (XRD)? Explain how the identification of samples using XRD differs from X-ray fluorescence (XRF).

(4 marks)

(c) Can X-ray fluorescence (XRF) be used to study qualitative and quantitative elemental analyses of samples? Explain your answer.

(4 marks)

(d) Discuss **FOUR** differences between Atomic absorption spectroscopy (AAS) and Ultraviolet–visible spectroscopy (UV-VIS).

(4 marks)

Q4 (a) Isopropyl alcohol, a substance sold as rubbing alcohol, is composed of C, H, and O. Combustion of 0.255 g of isopropyl alcohol produces 0.561 g of CO_2 and 0.306 g of H_2O. The molar mass of Isopropyl alcohol is 60.1 g mol^{-1}. Determine the molecular formula of isopropyl alcohol.

(8 marks)

(b) Bromine is a highly reactive liquid, while krypton is an inert gas. Explain this difference based on their electron configurations.

(2 marks)

(c) Consider the redox reaction:

$$2\,K(s) + Cl_2(g) \rightarrow 2\,KCl(s)$$

(i) Draw the Lewis structures for each reactant and product.
(ii) Determine which reactant was oxidized and which one was reduced.

(4 marks)

d) Discuss the following terms with the aid of diagrams :

(i) Metallic bond
(ii) Dipole-dipole forces

(6 marks)

SECTION B

Q5 (a) Isooctane, C_8H_{18}, is the component of gasoline from which the term *octane rating* derives.

(i) Write a balanced equation for the combustion of isooctane to yield CO_2 and H_2O.

(ii) Assuming that gasoline is 100 % isooctane. The density of isooctane is 0.792 g ml^{-1}. In this experiment, isooctane burns to produce only CO_2 and H_2O. What mass of CO_2 in kilograms is produced each year by the annual gasoline consumption of 4.6×10^{10} L?

(iii) How many moles of air are necessary for the combustion of 1 mol of isooctane, assuming that air is 21.0 % O_2 by volume? What is the volume in liters of the air at STP?

(10 marks)

(b) Oxalic acid, $H_2C_2O_4$ is a diprotic acid that exists in plants such as rhubarb and spinach. Calculate the pH and the concentration of $C_2O_4^{2-}$ ions in 0.20 M $H_2C_2O_4$.

($K_{a1} = 5.9 \times 10^{-2}$; $K_{a2} = 6.4 \times 10^{-5}$)

(7 marks)

(c) Adam ran home so fast and when he reached home, he blew gently through a straw into a pink solution containing phenolphthalein for 15-30 seconds. What happened to the solution? What could this be due to?

(3 marks)

Q6 (a) In a calorimetry experiment, 1.5 g of magnesium was combined with 125.0 mL of 1.0 M HCl. The initial temperature was 25.0 °C and the final temperature was 72.3 °C. Calculate:

(i) the heat involved in the reaction.

(ii) the enthalpy of reaction per mole of magnesium used.

(The specific heat of water is 4.184 J g^{-1} $°C^{-1}$)

(6 marks)

(b) Use the standard heat of formation data given in **TABLE 2** to calculate the standard enthalpy change for the combustion of ethanol, CH_3CH_2OH yielding CO_2 and H_2O.

(4 marks)

(c) Oxides of nitrogen are a major source of air pollution. One reaction which occurs in such polluted air is shown below.

$$2\,NO(g) + O_2(g) \rightarrow 2\,NO_2(g)$$

In order to investigate that the rate of the above reaction is dependent on nitrogen monoxide (NO), oxygen concentration was kept constant whereas different concentrations of NO were used. The time taken for a fixed amount of nitrogen dioxide (NO_2) gas to be produced is shown in **TABLE 3**.

(i) What is the significance of the products $(\mathbf{C}\times\mathbf{t})$ and $(\mathbf{C}^2\times\mathbf{t})$?
(ii) Hence, find the order of the reaction with respect to NO concentration.

(4 marks)

(d) The following mechanism has been proposed for the decomposition of ozone to oxygen.

$$O_3(g) \rightleftharpoons O_2(g) + O(g)$$

$$O(g) + O_3(g) \longrightarrow 2\,O_2(g)$$

The experimental rate law for the decomposition of ozone is second order in ozone and inverse first order in molecular oxygen :

$$\text{Rate} = -\frac{\Delta[O_3]}{\Delta t} = k\frac{[O_3]^2}{O_2}$$

(i) Write a balanced equation for the overall reaction.
(ii) Show that the proposed mechanism is consistent with the experimental rate law.
(iii) Relate the rate constant k to the rate constants for the elementary reactions.

(6 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2012/2013 PROGRAMME : 1 BNB / BNL / BNN
COURSE : CHEMISTRY FOR ENGINEERING TECHNOLOGY COURSE CODE : BWM 12703

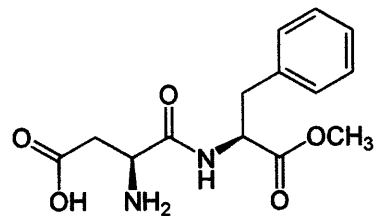

FIGURE 1: The chemical structure of aspartame

TABLE 1: Standard Electrode Potentials in Aqueous Solution at 25°C

Cathode (Reduction) Half-Reaction	Standard Potential E° (volts)
$Li^+(aq) + e^- \rightarrow Li(s)$	-3.04
$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$	-2.76
$Na^+(aq) + e^- \rightarrow Na(s)$	-2.71
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	-2.38
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.76
$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	-0.74
$ClO^-(aq) + H_2O(l) + 2e^- \rightarrow Cl^-(aq) + 2OH^-(aq)$	0.90
$2Hg^{2+}(aq) + 2e^- \rightarrow Hg_2^{2+}(aq)$	0.90
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O(l)$	0.96
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	1.07
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$	1.23
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$	1.33
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	1.36

TABLE 2: The standard heats of formation

Compound	ΔH_f^o (kJ/mol)
CH_3CH_2OH	-1368
CO_2	-393.51
H_2O	-285.63

TABLE 3: Rate of reaction on different concentrations of NO

Experiment	Initial concentration of NO (g), **C** / mol L^{-1}	Time, **t** / s	Product (**C**×**t**) / mol L^{-1} s	Product ($\mathbf{C^2}$×**t**) / mol^2 L^{-2} s
1	0.02	125	2.50	0.05
2	0.03	56	1.68	0.05
3	0.05	20	1.00	0.05

TABLE 4: Gas constant values with different units

R	Unit
0.0821	L.atm/mol.K
8.3145×10^3	L.Pa/mol.K
8.3145	J/K.mol
8.3145	m^3.Pa/K.mol

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2012/2013 PROGRAMME : 1 BNB / BNL / BNN
COURSE : CHEMISTRY FOR ENGINEERING TECHNOLOGY COURSE CODE : BWM 12703

TABLE 5: Mass of Atoms

Element	Symbol	Atomic number (Z)	Atomic mass (A)	Element	Symbol	Atomic number (Z)	Atomic mass (A)
Actinium	Ac	89	227.0278	Mercury	Hg	80	200.59
Aluminum	Al	13	26.98154	Molybdenum	Mo	42	95.94
Americium	Am	95	(243)	Neodymium	Nd	60	144.24
Antimony	Sb	51	121.75	Neon	Ne	10	20.179
Argon	Ar	18	39.948	Neptunium	Np	93	237.0482
Arsenic	As	33	74.9216	Nickel	Ni	28	58.70
Astatine	At	85	(210)	Niobium	Nb	41	92.9064
Barium	Ba	56	137.33	Nitrogen	N	7	14.0067
Berkelium	Bk	97	(247)	Nobelium	No	102	(259)
Beryllium	Be	4	9.01218	Osmium	Os	76	190.2
Bismuth	Bi	83	208.9804	Oxygen	O	8	15.9994
Boron	B	5	10.81	Palladium	Pd	46	106.4
Bromine	Br	35	79.904	Phosphorus	P	15	30.97376
Cadmium	Cd	48	112.41	Platinum	Pt	78	195.09
Calcium	Ca	20	40.08	Plutonium	Pu	94	(244)
Californium	Cf	98	(251)	Polonium	Po	84	(209)
Carbon	C	6	12.011	Potassium	K	19	39.0983
Cerium	Ce	58	140.12	Praseodymium	Pr	59	140.9077
Cesium	Cs	55	132.9054	Promethium	Pm	61	(145)
Chlorine	Cl	17	35.453	Protactinium	Pa	91	231.0359
Chromium	Cr	24	51.996	Radium	Ra	88	226.0254
Cobalt	Co	27	58.9332	Radon	Rn	86	(222)
Copper	Cu	29	63.546	Rhenium	Re	75	186.207
Curium	Cm	96	(247)	Rhodium	Rh	45	102.9055
Dysprosium	Dy	66	162.50	Rubidium	Rb	37	85.4678
Einsteinium	Es	99	(254)	Ruthenium	Ru	44	101.07
Erbium	Er	68	167.26	Samarium	Sm	62	150.4
Europium	Eu	63	151.96	Scandium	Sc	21	44.9559
Fermium	Fm	100	(257)	Selenium	Se	34	78.96
Fluorine	F	9	18.998403	Silicon	Si	14	28.0855
Francium	Fr	87	(223)	Silver	Ag	47	107.868
Gadolinium	Gd	64	157.25	Sodium	Na	11	22.98977
Gallium	Ga	31	69.72	Strontium	Sr	38	87.62
Germanium	Ge	32	72.59	Sulfur	S	16	32.06
Gold	Au	79	196.9665	Tantalum	Ta	73	180.9479
Hafnium	Hf	72	178.49	Technetium	Tc	43	(97)
Helium	He	2	4.00260	Tellurium	Te	52	127.60
Holmium	Ho	67	164.9304	Terbium	Tb	65	158.9254
Hydrogen	H	1	1.0079	Thallium	Tl	81	204.37
Indium	In	49	114.82	Thorium	Th	90	232.0381
Iodine	I	53	126.9045	Thulium	Tm	69	168.9342
Iridium	Ir	77	192.22	Tin	Sn	50	118.69
Iron	Fe	26	55.847	Titanium	Ti	22	47.90
Krypton	Kr	36	83.80	Tungsten	W	74	183.85
Lanthanum	La	57	138.9055	Uranium	U	92	238.029
Lawrencium	Lr	103	(260)	Vanadium	V	23	50.9414
Lead	Pb	82	207.2	Xenon	Xe	54	131.30
Lithium	Li	3	6.941	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.97	Yttrium	Y	39	88.9059
Magnesium	Mg	12	24.305	Zinc	Zn	30	65.38
Manganese	Mn	25	54.9380	Zirconium	Zr	40	91.22
Mendelevium	Md	101	(258)				