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TATI

UNIVERSITY COLLEGE TATI (UCTATI)

FINAL EXAMINATION QUESTION BOOKLET

COURSE CODE	: FSC 1084
COURSE	: CHEMISTRY II
SEMESTER/SESSION	: 3 - 2023/2024
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.

2. All answers should be written in answer booklet.

3. Write legibly and draw sketches wherever required.

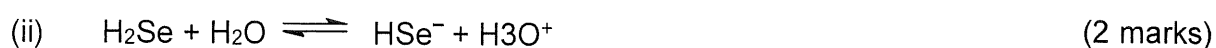4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS <u>8</u> PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1 (25 MARKS)

a) By applying Brønsted-Lowry theory, identify the conjugate acid-base pairs for the following chemical equation:

    (i) $CN^- + H_3O^+ \rightleftharpoons HCN + H_2O$ (2 marks)

    (ii) $H_2Se + H_2O \rightleftharpoons HSe^- + H3O^+$ (2 marks)

b) There are three primary theories of acid and bases; Arrhenius, Brønsted-Lowry and Lewis theory. Interpret these three theories based on their definition.
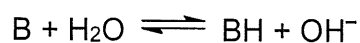   (6 marks)

c) Boric acid, H_3BO_3 is a weak acid. The concentration of solution used for the experiment is 0.2 M and the K_a value is 7.3×10^{-10} M.

$$H_3BO_3 \rightleftharpoons H_2BO_3^- + H^+$$
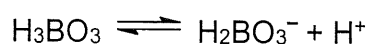
Solve the following:

    (i) $[H^+]$ (4 marks)

    (ii)   pH   (3 marks)

d) Solution B is a weak base. The pH of 0.024 M of solution B is 11.06.

$$B + H_2O \rightleftharpoons BH + OH^-$$

Calculate the following:

    (i)   pOH   (2 marks)

    (ii) $[OH^-]$ (3 marks)

    (iii) K_b (3 marks)
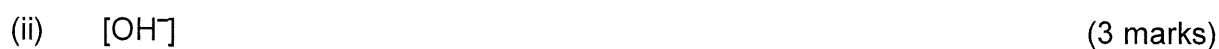
QUESTION 2 (25 MARKS)

a) Given the redox reaction:

$$MnO_2(s) + 4H^+ (aq) + 2Cl^- (aq) \longrightarrow Mn^{2+}(aq) + 2H_2O(l) + Cl_2(g)$$
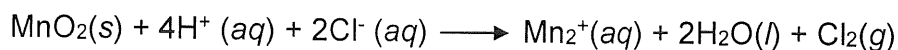
     (i)   Predict the oxidation number for Mn in MnO_2. (4 marks)

     (ii)   Choose the oxidizing agent and the reducing agent. (4 marks)

b) For the following voltaic cell reaction (at standard condition), Zn and Cu are used as the electrodes in their respective ionic solution ($ZnSO_4$ and $CuSO_4$):

     (i)   Construct the schematic diagram for the voltaic cell. (4 marks)

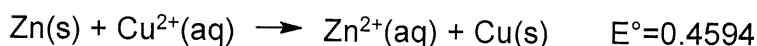   (ii)   Write two half-cell reactions that takes place at anode and cathode. (4 marks)

     (iii) State the total cell reaction. (2 marks)

d) Calculate the cell potential (E_{cell}) of this reaction at 25°C.

     $Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$ $E° = 0.4594$

     The concentration are $[Zn^{2+}] = 0.020$ M, $[Cu^{2+}] = 0.004$ M (5 marks)

e) State **two (2)** similarities between galvanic cell and electrolytic cell. (2 marks)

## QUESTION 3   (25 MARKS)

a)   A reaction below has a first order reaction. The rate constant of the reaction is 4.5×10^{-3} s^{-1}.

$$2 N_2O_5 \longrightarrow 4 NO_2 + O_2$$

   (i)   Write the rate expression for the reaction.   (2 marks)

   (ii)   Find the rate of reaction if concentration of N_2O_5 is 2.5M.   (3 marks)

   (iii) Calculate the concentration of N_2O_5 remaining after 450s if the
          initial concentration of N_2O_5 is 2.0 M.   (3 marks)

   (iv)   Discover the half-life (t½) of the reaction.   (3 marks)

b)   The oxidation of hydrogen sulphide by oxygen is first order with respect to both H_2S and O_2.

$$2H_2S \text{ (g)} + O_2\text{(g)} \longrightarrow 2S\text{(s)} + 2H_2O \text{ (l)}$$
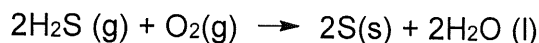
   Compute:
   (i)   The rate expression for reaction.   (2 marks)

   (ii)   The reaction rate if the concentration of H_2S and O_2 are 5×10^{-6} M
          and 2.0×10^{-4} M, respectively. The rate constant, k is 4.0×10^{-5}
          mol^{-1} s^{-1}.   (4 marks)

c)   The following data were obtained for the following reaction.
     CH_4 (g) + 2 O_2 (g) $\longrightarrow$ CO_2 (g) + 2 H_2O (l),
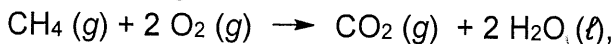
Experiment	[CH$_4$]	[O$_2$]	Rate of reaction (mol L^{-1} s^{-1})
A	0.20	0.30	6.73×10^{-3}
B	0.20	0.40	8.97×10^{-3}
C	0.40	0.30	2.69×10^{-2}

   (i)   Identify the order of the reaction with respect to CH_4, O_2 and   (6 marks)
          overall.

   (ii)   Write the rate expression for the reaction.   (2 marks)

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QUESTION 4 (25 MARKS)

a) Show **three (3)** steps in free radical polymerization process by using ethylene as monomer. (6 marks)

b) Differentiate the properties of High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE). (6 marks)

c) Describe composite material in term of definition and give **two (2)** examples of composite materials. (5 marks)

d) Water pollution is a serious problem in Malaysia and impacts negatively on the sustainability of water resources. Analyze **four (4)** causes that might contribute to water pollution and justify **four (4)** ways to overcome this issue. (8 marks)

---End of question-------------------------------------

APPENDIX I

THE PERIODIC TABLE

Legend:
- SYMBOL
- ATOMIC NUMBER
- ATOMIC WEIGHT
- NAME

( ) = ESTIMATES

HAYDEN
HM
McNEIL
SPECIALTY
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1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
H 1 1.008 Hydrogen																	**He** 2 4.00 Helium
Li 3 6.94 Lithium	**Be** 4 9.01 Beryllium											**B** 5 10.81 Boron	**C** 6 12.01 Carbon	**N** 7 14.01 Nitrogen	**O** 8 16.00 Oxygen	**F** 9 19.00 Fluorine	**Ne** 10 20.18 Neon
Na 11 22.99 Sodium	**Mg** 12 24.31 Magnesium											**Al** 13 26.98 Aluminum	**Si** 14 28.09 Silicon	**P** 15 30.97 Phosphorus	**S** 16 32.07 Sulfur	**Cl** 17 35.45 Chlorine	**Ar** 18 39.95 Argon
K 19 39.10 Potassium	**Ca** 20 40.08 Calcium	**Sc** 21 44.96 Scandium	**Ti** 22 47.88 Titanium	**V** 23 50.94 Vanadium	**Cr** 24 52.00 Chromium	**Mn** 25 54.94 Manganese	**Fe** 26 55.85 Iron	**Co** 27 58.93 Cobalt	**Ni** 28 58.69 Nickel	**Cu** 29 63.55 Copper	**Zn** 30 65.39 Zinc	**Ga** 31 69.72 Gallium	**Ge** 32 72.61 Germanium	**As** 33 74.92 Arsenic	**Se** 34 78.96 Selenium	**Br** 35 79.90 Bromine	**Kr** 36 83.80 Krypton
Rb 37 85.47 Rubidium	**Sr** 38 87.62 Strontium	**Y** 39 88.91 Yttrium	**Zr** 40 91.22 Zirconium	**Nb** 41 92.91 Niobium	**Mo** 42 95.94 Molybdenum	**Tc** 43 (97.9) Technetium	**Ru** 44 101.07 Ruthenium	**Rh** 45 102.91 Rhodium	**Pd** 46 106.42 Palladium	**Ag** 47 107.87 Silver	**Cd** 48 112.41 Cadmium	**In** 49 114.82 Indium	**Sn** 50 118.71 Tin	**Sb** 51 121.76 Antimony	**Te** 52 127.60 Tellurium	**I** 53 126.90 Iodine	**Xe** 54 131.29 Xenon
Cs 55 132.91 Cesium	**Ba** 56 137.33 Barium	**La** 57 138.91 Lanthanum	**Hf** 72 178.49 Hafnium	**Ta** 73 180.95 Tantalum	**W** 74 183.85 Tungsten	**Re** 75 186.21 Rhenium	**Os** 76 190.2 Osmium	**Ir** 77 192.22 Iridium	**Pt** 78 195.08 Platinum	**Au** 79 196.97 Gold	**Hg** 80 200.59 Mercury	**Tl** 81 204.38 Thallium	**Pb** 82 207.2 Lead	**Bi** 83 208.98 Bismuth	**Po** 84 (209) Polonium	**At** 85 (210) Astatine	**Rn** 86 (222) Radon
Fr 87 223.02 Francium	**Ra** 88 226.03 Radium	**Ac** 89 227.03 Actinium	**Rf** 104 (261) Rutherfordium	**Db** 105 (262) Dubnium	**Sg** 106 (263) Seaborgium	**Bh** 107 (262) Bohrium	**Hs** 108 (265) Hassium	**Mt** 109 (268) Meitnerium	Unnamed Discovery 110 Nov 1994	Unnamed Discovery 111 Nov 1994	Unnamed Discovery 112 1996		Unnamed Discovery 114 1999		Unnamed Discovery 116 1999		Unnamed Discovery 118 1999

ALKALI METALS
ALKALI EARTH METALS
HALOGENS
NOBLE GASES

LANTHANIDES:

Ce 58 140.12 Cerium	**Pr** 59 140.91 Praseodymium	**Nd** 60 144.24 Neodymium	**Pm** 61 (145) Promethium	**Sm** 62 150.36 Samarium	**Eu** 63 152.97 Europium	**Gd** 64 157.25 Gadolinium	**Tb** 65 158.93 Terbium	**Dy** 66 162.50 Dysprosium	**Ho** 67 164.93 Holmium	**Er** 68 167.26 Erbium	**Tm** 69 168.93 Thulium	**Yb** 70 173.04 Ytterbium	**Lu** 71 174.97 Lutetium

ACTINIDES:

Th 90 232.04 Thorium	**Pa** 91 231.04 Protactinium	**U** 92 238.03 Uranium	**Np** 93 237.05 Neptunium	**Pu** 94 (240) Plutonium	**Am** 95 243.06 Americium	**Cm** 96 (247) Curium	**Bk** 97 (248) Berkelium	**Cf** 98 (251) Californium	**Es** 99 252.08 Einsteinium	**Fm** 100 257.10 Fermium	**Md** 101 (257) Mendelevium	**No** 102 259.10 Nobelium	**Lr** 103 262.11 Lawrencium

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APPENDIX II

$$K_a = \frac{[A^-][H^+]}{[HA]}$$

Common Prefixes For Organic Chemistry Nomenclature	
Prefix	Carbon Atom Number
Meth-	1
Eth-	2
Prop-	3
But-	4
Pent-	5
Hex-	6
Hept-	7
Oct-	8
Non-	9
Dec-	10

$$E^0{}_{cell} = E^0{}_{red} - E^0{}_{oxid}$$

$$E = E^0 - \frac{0.0592}{n} \log Q_c$$

Summary of the Kinetics of Zero-Order, First-Order and Second-Order Reactions

Order	Rate Law	Concentration-Time Equation	Half-Life
0	rate = k	$[A] - [A]_0 = -kt$	$t_{1/2} = \dfrac{[A]_0}{2k}$
1	rate = $k[A]$	$\ln[A] - \ln[A]_0 = -kt$	$t_{1/2} = \dfrac{\ln 2}{k}$
2	rate = $k[A]^2$	$\dfrac{1}{[A]} - \dfrac{1}{[A]_0} = kt$	$t_{1/2} = \dfrac{1}{k[A]_0}$

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APPENDIX III

TABLE 19.1
Standard Electrode (Reduction) Potentials in Aqueous Solution at 25°C[a]

Cathode (Reduction) Half-Reaction	Standard Potential, $E°$ (V)
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	−3.04
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	−2.71
$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	−2.38
$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$	−1.66
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	−0.83
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	−0.76
$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s)$	−0.74
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	−0.41
$Cd^{2+}(aq) + 2e^- \rightleftharpoons Cd(s)$	−0.40
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	−0.23
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	−0.14
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	−0.13
$Fe^{3+}(aq) + 3e^- \rightleftharpoons Fe(s)$	−0.04
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	0.15
$Cu^{2+}(aq) + e^- \rightleftharpoons Cu^+(aq)$	0.16
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	0.34
$IO^-(aq) + H_2O(l) + 2e^- \rightleftharpoons I^-(aq) + 2OH^-(aq)$	0.49
$Cu^+(aq) + e^- \rightleftharpoons Cu(s)$	0.52
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	0.54
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	0.77
$Hg_2^{2+}(aq) + 2e^- \rightleftharpoons 2Hg(l)$	0.80
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	0.80
$Hg^{2+}(aq) + 2e^- \rightleftharpoons Hg(l)$	0.85
$ClO^-(aq) + H_2O(l) + 2e^- \rightleftharpoons Cl^-(aq) + 2OH^-(aq)$	0.90
$2Hg^{2+}(aq) + 2e^- \rightleftharpoons Hg_2^{2+}(aq)$	0.90
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightleftharpoons NO(g) + 2H_2O(l)$	0.96
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	1.07
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	1.23
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l)$	1.33
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	1.36
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$	1.49
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	1.78
$S_2O_8^{2-}(aq) + 2e^- \rightleftharpoons 2SO_4^{2-}(aq)$	2.01
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	2.87

[a] See Appendix I for a more extensive table.