Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	TECHNICAL SCIENCE II
COURSE CODE	:	DAS 12703
PROGRAMME	:	DAK
EXAMINATION DATE	:	JUNE 2017
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	PART A : ANSWER ALL QUESTIONS PART B : ANSWER **ONE (1)** QUESTION ONLY PART C : ANSWER **ONE (1)** QUESTION ONLY

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

PART A

Q1 (a) Copper and iron (generally in the form of steel) are two of the many metals used in designing machine with electrochemistry method. Refer standard reduction potentials in **Table Q1 (a).**

(i) Write half – reaction for anode and cathode.

(6 marks)

(ii) Determine the cell potential, $E°_{cell}$ for a galvanic cell composed of copper and iron. Assume standard conditions.

(2 marks)

(iii) Compose the cell diagram for the above galvanic cell.

(2 marks)

(b) Given 2 half – reactions

$$Ni^{2+}(aq) + 2e \rightleftharpoons Ni(s) \qquad E° = -0.25\ V$$

$$Cr^{3+}(aq) + 3e \rightleftharpoons Cr(s) \qquad E° = -0.74\ V$$

(i) Show the electrode reaction for this electrochemical series.

(6 marks)

(ii) Compute the overall cell reaction by giving a balanced equation.

(3 marks)

(iii) Calculate the cell potential, E when $[Ni^{2+}] = 1x10^{-3}$ M and $[Cr^{3+}] = 2.0\times10^{-3}$ M

(6 marks)

Q2 (a) If the cylinder E in **Figure Q2 (a)** has a weight of 135 N.

(i) Draw a free-body diagram for the force acting on cylinder E and F.

(3 marks)

(ii) Calculate the force in each cord AB, BC and CD needed to hold the system in the equilibrium position.

(10 marks)

(iii) Calculate the weight of the cylinder F.

(3 marks)

(b) (i) State Ohm's Law.

(1 mark)

(ii) A coil consists of 2000 turns of copper wire having a cross-sectional area of 0.8 mm^2. The mean length per turn is 80 cm and the resistivity of copper is 0.02 × 106 Ωm. Calculate the resistance of the coil and power absorbed by the coil when connected across 110 V d.c supply.

(8 marks)

PART B

Q3 (a) Many common titration involve the reaction of an acid with a base. If 24.75 mL of 0.503 M NaOH solution is used to titrate a 15.00 mL sample of sulfuric acid, H_2SO_4.

(i) Write the balance equation for this acid-base titration.

(4 marks)

(ii) Calculate the concentration of sulfuric acid.

(6 marks)

(b) MTBE (methyl *tert*-butyl ether) has been used as additive in gasoline. The compound is produced by reacting methanol and isobutene, according to the following equation:

$$CH_3OH + (CH_3)_2C{=}CH_2 \longrightarrow (CH_3)_3COCH_3$$

If 45.0 kg of methanol is allowed to react with 70.0 kg of isobutene, determine the maximum mass of MTBE that can be obtained.

(11 marks)

(c) The theoretical yield and the actual yield for various reactions are given below.

	Theoretical Yield	*Actual Yield*
Reaction 1	35.0 g	12.8 g
Reaction 2	9.3 g	120 mg
Reaction 3	3.7 metric tons	1250 kg
Reaction 4	40.0 g	41.0 g

Determine the corresponding percentage yields.

(4 marks)

Q4 (a) The rate of the reaction between haemoglobin (Hb) and carbon monoxide (CO) was studied at 20 °C. The following data were collected with all concentration units in μmol/L.

$[Hb]_0$ (μmol/L)	$[CO]_0$ (μmol/L)	Initial Rate (μmol/L.s)
2.21	1.00	0.619
4.42	1.00	1.240
4.42	3.00	3.710

(i) Determine the orders of this reaction with respect to Hb and CO.

(8 marks)

(ii) Identify rate law of the reaction.

(1 mark)

(iii) Calculate the value of the rate constant.

(3 marks)

(iv) Write the initial rate for an experiment with $[Hb]_0 = 3.36$ μmol/L and $[CO]_0 = 2.40$ μmol/L

(3 marks)

(b) We carry out the reaction $A \longrightarrow B + C$ at a particular temperature. As the reaction proceeds, we measure the molarity of the reactant, [A], at various times. The observed data are tabulated in the margin.

Time (min)	[A] (mol/L)
0.00	2.000
2.00	1.107
4.00	0.612
6.00	0.338
8.00	0.187
10.00	0.103

(i) Plot ln [A] versus time and $\frac{1}{A}$ versus time in given graph paper.

(4 marks)

(ii) Determine the order of the reaction.

(2 marks)

(iii) Write the rate – law expression for this reaction.

(1 mark)

(iv) Calculate the value of k at this temperature.

(3 marks)

PART C

Q5 (a) (i) Define the concept of kinematics and dynamics.

(2 marks)

(ii) Ahmad throw a ball vertically upward from the roof of a tall building. The ball leaves his hand at a point even with the roof railing with an upward speed of 15 ms^{-1}. The ball is then free fall. On its way back down, it just misses the railing. At the location of the building, $g = 9.81\ ms^{-2}$. Calculate the position and velocity of the ball at 1.00 s and 4.00 s after leaving his hand.

(10 marks)

(b) **Figure Q5 (b)** shows a box with a mass $m_1 = 15$ kg go down a distances on an inclined plane with a slope of angle $\alpha = 30^{\circ}$ when the box is coupled by a rope and a pulley to a bucket with mass m_2 at an acceleration, $a = 1.5\ ms^{-2}$. Given the coefficient of the kinetic friction $\mu k = 0.15$.

(i) Calculate the tension of the string.

(10 marks)

(ii) Calculate the mass of the block hanging off the back of the ramp.

(3 marks)

Q6 (a) (i) State the Hooke's Law.

(1 mark)

(ii) A cylindrical specimen of a titanium alloy having an elastic modulus of 108 GPa and an original diameter of 3.9 mm will experience only elastic deformation when a tensile load of 2000 N is applied. Compute the maximum length in mm of the specimen before deformation if the maximum allowable elongation is 0.42 mm.

(8 marks)

(b) A solid lead sphere of volume $0.50m^3$ lowered to a depth of water of pressure 2.0×10^7 N/m^2. If the bulk modulus is 7.7×10^9 N/m^2, determine the change in volume of the sphere.

(4 marks)

(c) A copper cylinder is stacked end to end with a brass cylinder. The length of the copper and brass cylinder are 20.0 mm and 40.0 mm respectively. Each cylinder has a diameter 70 mm. A compressive force F = 6550 N is applied to the right end of the brass cylinder. Determine the new length of each cylinder. (Given : $Y_{copper} = 110$ GPa, $Y_{brass} = 90$ Gpa)

(12 marks)

~ END OF QUESTION ~

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FIGURES

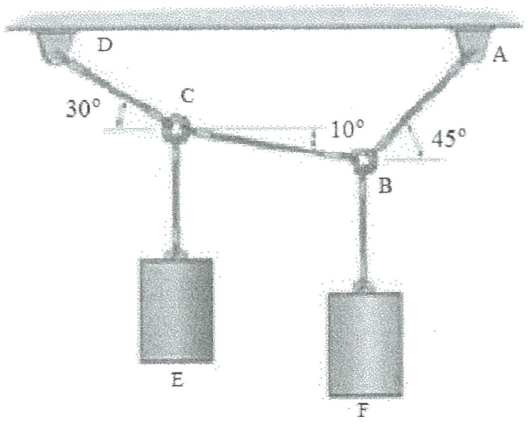

Figure Q2 (a)

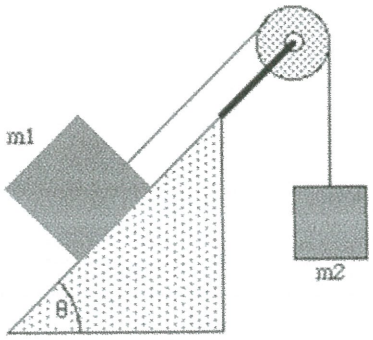

Figure Q5 (b)

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Formulae

List of formula

$$v_{ave} = \frac{x_f - x_i}{t}$$

$$a_{ave} = \frac{v_f - v_i}{t}$$

$$v = u + at$$

$$v^2 = u^2 + 2as$$

$$s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}(u + v)t$$

$$R = \frac{\rho L}{A}$$

List of constant value

Gravitational acceleration, $g = 9.81\ \text{m}\cdot\text{s}^{-2}$

1 feet = 12 inch

1 mile = 1609 meter

1 inch = 2.54 cm

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List of chemical elements

Atomic Sym. No.	*Atomic Weight*	*Name*	*Sym.*	*Atomic No.*	*Atomic Weight*	*Name*	
1	1.01	Hydrogen	H	31	69.72	Gallium	Ga
2	4.00	Helium	He	32	72.64	Germanium	Ge
3	6.94	Lithium	Li	33	74.92	Arsenic	As
4	9.01	Beryllium	Be	34	78.96	Selenium	Se
5	10.81	Boron	B	35	79.90	Bromine	Br
6	12.01	Carbon	C	36	83.80	Krypton	Kr
7	14.01	Nitrogen	N	37	85.47	Rubidium	Rb
8	16.00	Oxygen	O	38	87.62	Strontium	Sr
9	19.00	Fluorine	F	39	88.91	Yttrium	Y
10	20.18	Neon	Ne	40	91.22	Zirconium	Zr
11	22.99	Sodium	Na	41	92.91	Niobium	Nb
12	24.31	Magnesium	Mg	42	95.94	Molybdenum	Mo
13	26.98	Aluminum	Al	43	98.00	Technetium	Tc
14	28.09	Silicon	Si	44	101.07	Ruthenium	Ru
15	30.97	Phosphorus	P	45	102.91	Rhodium	Rh
16	32.07	Sulfur	S	46	106.42	Palladium	Pd
17	35.45	Chlorine	Cl	47	107.87	Silver	Ag
18	39.95	Argon	Ar	48	112.41	Cadmium	Cd
19	39.10	Potassium	K	49	114.82	Indium	In
20	40.08	Calcium	Ca	50	118.71	Tin	Sn
21	44.96	Scandium	Sc	51	121.76	Antimony	Sb
22	47.87	Titanium	Ti	52	127.60	Tellurium	Te
23	50.94	Vanadium	V	53	126.90	Iodine	I
24	52.00	Chromium	Cr	54	131.29	Xenon	Xe
25	54.94	Manganese	Mn	55	132.91	Cesium	Cs
26	55.85	Iron	Fe	56	137.33	Barium	Ba
27	58.93	Cobalt	Co	57	138.91	Lanthanum	La
28	58.69	Nickel	Ni	58	140.12	Cerium	Ce
29	63.55	Copper	Cu	59	140.91	Praseodymium	Pr
30	65.39	Zinc	Zn	60	144.24	Neodymium	Nd

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List of chemical elements

Atomic No.	*Atomic Weight*	*Name*	*Sym.*	*Atomic No.*	*Atomic Weight*	*Name*	*Sym.*
61	145.00	Promethium	Pm	91	231.04	Protactinium	Pa
62	150.36	Samarium	Sm	92	238.03	Uranium	U
63	151.96	Europium	Eu	93	237.00	Neptunium	Np
64	157.25	Gadolinium	Gd	94	244.00	Plutonium	Pu
65	158.93	Terbium	Tb	95	243.00	Americium	Am
66	162.50	Dysprosium	Dy	96	247.00	Curium	Cm
67	164.93	Holmium	Ho	97	247.00	Berkelium	Bk
68	167.26	Erbium	Er	98	251.00	Californium	Cf
69	168.93	Thulium	Tm	99	252.00	Einsteinium	Es
70	173.04	Ytterbium	Yb	100	257.00	Fermium	Fm
71	174.97	Lutetium	Lu	101	258.00	Mendelevium	Md
72	178.49	Hafnium	Hf	102	259.00	Nobelium	No
73	180.95	Tantalum	Ta	103	262.00	Lawrencium	Lr
74	183.84	Tungsten	W	104	261.00	Rutherfordium	Rf
75	186.21	Rhenium	Re	105	262.00	Dubnium	Db
76	190.23	Osmium	Os	106	266.00	Seaborgium	Sg
77	192.22	Iridium	Ir	107	264.00	Bohrium	Bh
78	195.08	Platinum	Pt	108	277.00	Hassium	Hs
79	196.97	Gold	Au	109	268.00	Meitnerium	Mt
80	200.59	Mercury	Hg				
81	204.38	Thallium	Tl				
82	207.20	Lead	Pb				
83	208.98	Bismuth	Bi				
84	209.00	Polonium	Po				
85	210.00	Astatine	At				
86	222.00	Radon	Rn				
87	223.00	Francium	Fr				
88	226.00	Radium	Ra				
89	227.00	Actinium	Ac				
90	232.04	Thorium	Th				

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Table

Reduction reaction	Standard Reduction Potential
$Zn^{2+} + 2\,e^- \longrightarrow Zn$	-0.7630
$Fe^{2+} + 2\,e^- \longrightarrow Fe$	-0.4400
$2\,H^+ + 2e^- \longrightarrow H_2$	0.0000
$Cu^{2+} + 2\,e^- \longrightarrow Cu$	+0.3370
$Fe^{3+} + e^- \longrightarrow Fe^{2+}$	+0.7710
$Ag^+ + e^- \longrightarrow Ag$	+0.7994

Table Q1 (a)