Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2017/2018

COURSE NAME	:	CHEMISTRY FOR ENGINEERING TECHNOLOGY
COURSE CODE	:	BWM 12703
PROGRAMME CODE	:	BNA / BNB / BNC / BNN
EXAMINATION DATE	:	DECEMBER 2017/ JANUARY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	(A) ANSWER **ALL** QUESTIONS
		(B) ANSWER **ONE (1)** QUESTION ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

SECTION A

Q1 (a) "Oxygen is mainly responsible for the corrosion of most metallic substances when compared to other gases and chemicals".

(i) Identify the theory of corrosion from the phrase mentioned above.

(1 mark)

(ii) Interpret the rule that related to the role of corrosion product in the process of corrosion.

(2 marks)

(iii) Classify **THREE (3)** types of corrosion under this theory as answered in **Q1 (a)(i)**.

(3 marks)

(b) Explain the type of corrosion that contribute to the crack formation on the metal pipe as shown in **Figure Q1(b)**.

(4 marks)

(c) One of the key for corrosion control strategy is the selection of appropriate materials when designing the systems.

(i) Describe **TWO (2)** characteristics of the metal that can take into consideration when fabricating a system.

(4 marks)

(ii) Suggest the suitable material that can be used if a seawater storage tank is to be fabricated. Use the properties of the material to explain your answer.

(6 marks)

Q2 (a) Give systematic (IUPAC) name of the hydrocarbon shown in **Figure Q2(a)**. With the aid of molecular structure, show the reaction to prepare the hydrocarbon.

(3 marks)

(b) Functional groups are an atom or group of atoms that is responsible for the specific properties of an organic compound. Discuss with examples, **TWO (2)** common functional groups.

(3 marks)

(c) In structural isomerism, the atoms are arranged in completely different order.

(i) Illustrate with examples, **TWO (2)** types of structural isomerism.

(4 marks)

(ii) **Figure Q2(c)(ii)** is illustrated by the molecular formula of $C_3H_6O_2$. Categorize the type of structural isomerism for the structures and explain your answer.

(3 marks)

(d) Differentiate the types of alcohol and their compounds formed when undergo oxidation reaction with $K_2Cr_2O_7$ in the presence of H_2SO_4. Illustrate the chemical structure of each reaction.

(7 marks)

Q3 (a) Atomic absorption spectrometry (AAS) is an analytical technique that measures the concentration of elements. It is a sensitive instrument that it can measure down to parts per billion of a gram in a sample.

(i) Briefly describe the fundamental of AAS and illustrate a schematic diagram showing how it works.

(7 marks)

(ii) Based on your understanding on AAS instrument, show the applications of the AAS.

(3 marks)

(b) Instrument "X" was developed in order to overcome the limitations encountered with dispersive instruments by providing a device called an interferometer, which produce a unique type of signal that has all the frequencies encoded into it.

(i) Predict what is instrument "X" and distinguish the criteria for a compound that may absorb "X"-radiation in details.

(8 marks)

(ii) From your judgement in (b)(i), interpret the major advantages of "X".

(2 marks)

Q4 (a) (i) Calculate the pH of a 0.20 M aqueous solution of pyridine C_5H_5N. Given that the proton transfer equilibrium for pyridine are as below with Kb of 1.8 x 10^{-9}.

$$H_2O_{(l)} + C_5H_6N_{(aq)} \rightleftharpoons C_5H_6N^+{}_{(aq)} + OH^-{}_{(aq)}$$

(10 marks)

(b) (i) Hydrogen gas was cooled from 150 °C to 50 °C. Determine the gas original volume (in liter) if its new volume is 75 mL.

(3 marks)

(ii) In a mixture of helium, oxygen and methane in a 2.0 L container, the partial pressures of He and O2 are 13.6 kPa and 29.2 kPa respectively and the total pressure inside the container is 95.4 kPa. Determine the partial pressure of methane.

(7 marks)

SECTION B

Q5 (a) (i) Determine how much work in joules is done when the oxygen is compressed from a volume of 22.8 L and an external pressure of 1.20 atm to 12.0 L at a constant temperature?

(4 marks)

(ii) The compound diborane (B_2H_6) is used as a rocket fuel. The equation for the combustion of diborane is shown below:

$$B_2H_{6\,(g)} + 3\,O_{2\,(g)} \rightarrow B_2O_{3\,(s)} + 3\,H_2O_{(l)}$$

Calculate the enthalpy of combustion of diborane (B_2H_6) in kJ mol^{-1} using the following data:

$$2\,B_{(s)} + 3\,H_{2\,(g)} \rightarrow B_2H_{6\,(g)} \qquad \Delta H = 36\ kJ\ mol^{-1}$$

$$H_{2\,(g)} + \frac{1}{2}O_{2\,(g)} \rightarrow H_2O_{(l)} \qquad \Delta H = -286\ kJ\ mol^{-1}$$

$$2\,B_{(s)} + 1\frac{1}{2}O_{2\,(g)} \rightarrow B_2O_{3\,(s)} \qquad \Delta H = -1274\ kJ\ mol^{-1}$$

(6 marks)

(b) The data for the reaction $CO_{(g)} + NO_{2\,(g)} \rightarrow CO_{2\,(g)} + NO_{(g)}$ are tabulated in the **Table Q5(b)**. Determine the order of reaction and initial rate for experiment 4.

(10 marks)

Q6 (a) Ethanoic acid reacts with aluminium hydroxide to form water and aluminium acetate via the following reaction:

$$CH_3COOH + Al(OH)_3 \rightarrow H_2O + Al(C_2H_3O_2)_3$$

(i) Express the balanced chemical equation mentioned above.

(3 marks)

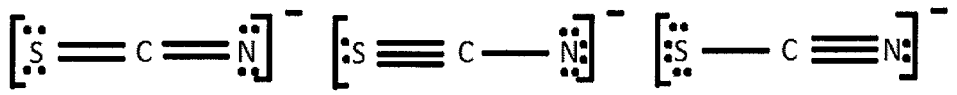
(ii) Determine the mass of aluminium acetate that can be made from 125 grams of ethanoic acid and 275 grams of aluminium hydroxide.

(7 marks)

(b) The physical properties such as melting point,boiling point, vapor pressure, evaporation and viscosity are related to the strength of attractive forces between molecules. Illustrate with the aid of diagrams **TWO (2)** types of forces of attraction or repulsion between neighboring particles.

(3 marks)

(c) Three possible skeletal structures of thiocyanate ion, SCN^- are shown as below:



(A) (B) (C)

Use the formal charge calculation to explain the most dominant structure for this ion.
(7 marks)

- END OF QUESTIONS -

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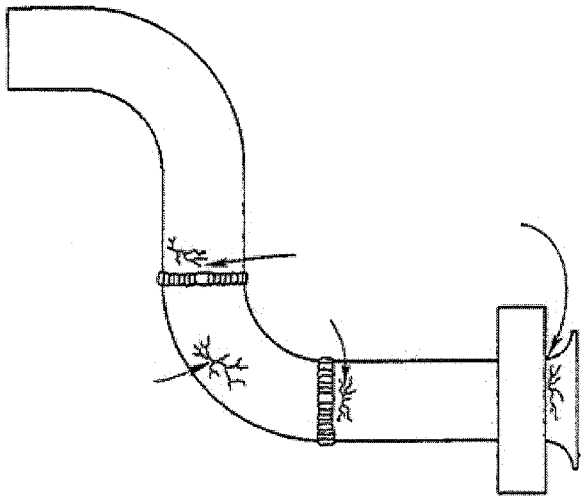

Figure Q1(b)

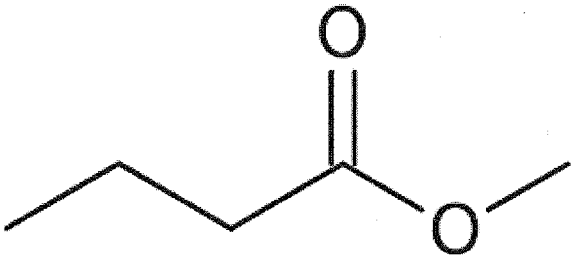

Figure Q2(a)

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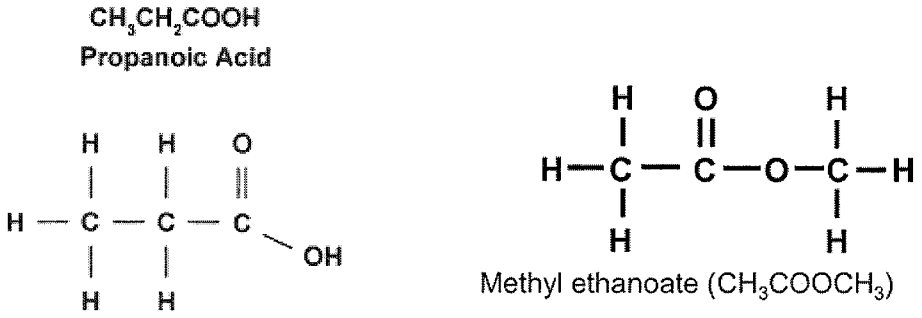

Figure Q2(c)(ii)

Table Q5 (b): Data collection for the reaction at certain temperature.

Experiment	$[CO]$, (M)	$[NO_2]$, (M)	*Initial rate*, Ms^{-1}
1	$5\,x\,10^{-4}$	$3.6\,x\,10^{-5}$	$3.4\,x\,10^{-8}$
2	$5\,x\,10^{-4}$	$1.8\,x\,10^{-5}$	$1.7\,x\,10^{-8}$
3	$1\,x\,10^{-3}$	$3.6\,x\,10^{-5}$	$6.8\,x\,10^{-8}$
4	$1.5\,x\,10^{-3}$	$7.2\,x\,10^{-5}$	?

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

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Atomic number and mass

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)				