

University of Ruhuna- Faculty of Technology

Bachelor of Engineering Technology

Level 1 (Semester 1) Examination, July 2017

Course Unit: TMS 1122 Chemistry of Materials

Time Allowed 2 hours

Answer all Four (04) questions

All symbols have their usual meaning .

01. Answer all parts

(a) What are isotopes? Give some examples of isotopes.

(10 marks)

(b) Write the electronic configuration of each of the following elements and the most stable ions of them: Be, Na, Al, Cl, Ca

(15 marks)

(c) Define the following.

(i) Hund's Rule

(ii) Aufbau Principle

(iii) Pauli Exclusion principle

(30 marks)

(d) (i) An electron in an atom can initially be assigned a set of four quantum numbers. Name the four quantum numbers.

(10 marks)

(ii) Using the definitions of above quantum numbers, derive the maximum numbers of electrons that can be found in the first, second, and third shell?

(15 marks)

(e) What are the possible quantum numbers for the electron in the following electronic configurations?

(i) $3p^1$

(ii) $4f^1$

(20 marks)

02. Answer all parts

(a) When NaHCO_3 is heated, it decomposes to Na_2CO_3 , CO_2 and H_2O .

(i) Write a chemical equation to represent this decomposition.

(05 marks)

(ii) Balance the above equation and hence give the stoichiometry.

(10 marks)

(iii) If 42 g of NaHCO_3 was heated, calculate the mass of each species obtained as products. Molar mass of $\text{NaHCO}_3 = 84 \text{ g mol}^{-1}$, $\text{Na}_2\text{CO}_3 = 106 \text{ g mol}^{-1}$, $\text{CO}_2 = 44 \text{ g mol}^{-1}$ and $\text{H}_2\text{O} = 18 \text{ g mol}^{-1}$.

(15 marks)

(b) The sulphur present in 0.1000 g of an organic compound was precipitated as barium sulphate. A precipitate of 0.1852 g of dry BaSO_4 was obtained. Atomic mass of $\text{Ba} = 137 \text{ g mol}^{-1}$, $\text{S} = 32 \text{ g mol}^{-1}$ and $\text{O} = 16 \text{ g mol}^{-1}$.

(i) Calculate the molar mass of BaSO_4 .

(05 marks)

(ii) How many moles of BaSO_4 are precipitated?

(05 marks)

(iii) How many moles of S are present in the precipitated BaSO_4 in above (ii)?

(05 marks)

(iv) Calculate the mass of S.

(10 marks)

(v) Calculate the percentage of S in the original organic compound.

(15 marks)

(c) 4.0000 g of NaOH was dissolved in water to make a 500.00 cm^3 NaOH solution. Then 25.00 cm^3 of prepared solution was diluted to 1000.00 cm^3 . Calculate the concentration of new solution. Atomic masses of $\text{Na} = 23.0 \text{ g mol}^{-1}$ and $\text{H} = 1.0 \text{ g mol}^{-1}$.

(30 marks)

03. Answer all parts

(a) Give the following definitions of an acid and a base:

- (i) Arrhenius,
- (ii) Bronsted-Lowry,
- (iii) Lewis,

(12 marks)

(b) (i) Name the following acids and indicate whether they are strong or weak:



(08 marks)

(ii) Name the following bases and indicate whether they are strong or weak:



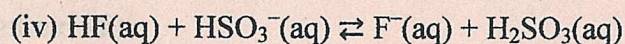
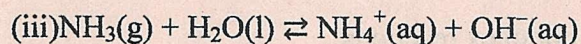
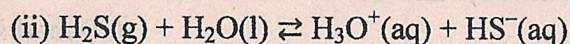
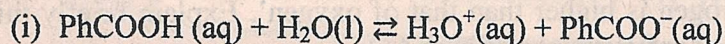
(06 marks)

(c) (i) Write an equation for the hydrofluoric acid, HF(aq), dissociation in water

(ii) Write the equilibrium constant, K_a, expression for the dissociation of HF(aq) in water.

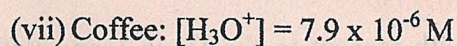
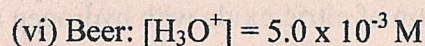
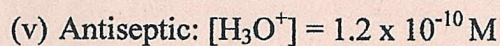
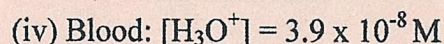
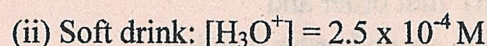
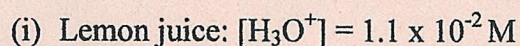
(10 marks)

(d) Identify the acid, base, conjugate acid and conjugate base for each of the following.



(16 marks)

(e) Calculate the pH of each of the following solutions and classify the solution as acidic or basic:



(24 marks)

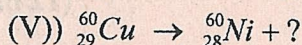
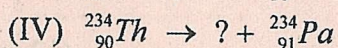
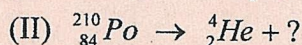
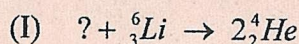
(f) Write a balanced *net ionic* equation for the reaction between solutions of HNO₂ and KOH.

(02 marks)

(g) (i) What is the difference between nuclear fusion and nuclear fission?

(04 marks)

(ii) Balance each of the following nuclear equations and indicate the type of nuclear reaction (α -emission, β -emission, fission, fusion, or "other")



(15 marks)

(iii) Name three uses of nuclear reactions

(03 marks)

04. Answer all parts

(a)

(i) Define the term "ionization energy".

(10 marks)

(ii) Give three factors that affect the ionization energy of an element.

(10 marks)

(iii) Mention the relation of the above factors with the ionization energy.

(10 marks)

(iv) 'The first ionization energy of nitrogen is higher than that of oxygen'. Explain briefly this statement considering the electronic configurations of N and O.

(20 marks)

(b) Distinguish between the elementary reactions and complex reactions.

(20 marks)

(c) Sketch the graphs of the variation of concentration with time for:

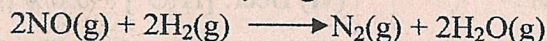
(i) zero order,

(ii) first order and

(iii) second order reactions

(15 marks)

(d) The reaction of nitric oxide with hydrogen at 1280 °C is



It is found experimentally that the order of the reaction with respect to the H_2 is 1 and with respect to the NO is 3.

(i) Give an expression for the rate law.

(10 marks)

(ii) What is the overall order of the reaction?

(05 marks)

Chemistry Reference Sheet

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A									1B	2B	3A	4A	5A	6A	7A	8A
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H Hydrogen 1.01	He Helium 4.00	Li Lithium 6.94	Be Beryllium 9.01	B Boron 10.81	C Carbon 12.01	N Nitrogen 14.01	O Oxygen 16.00	F Fluorine 19.00	Ne Neon 20.18	Na Sodium 22.99	Mg Magnesium 24.31	Al Aluminum 26.98	Si Silicon 28.09	P Phosphorus 30.97	S Sulfur 32.07	Cl Chlorine 35.45	Ar Argon 39.95
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K Potassium 39.10	Ca Calcium 40.08	Sc Scandium 44.96	Ti Titanium 47.87	V Vanadium 50.94	Cr Chromium 52.00	Mn Manganese 54.94	Fe Iron 55.85	Co Cobalt 58.93	Ni Nickel 58.69	Cu Copper 63.55	Zn Zinc 65.39	Ga Gallium 69.72	Ge Germanium 72.61	As Arsenic 74.92	Se Selenium 78.96	Br Bromine 79.90	Kr Krypton 83.80
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb Rubidium 85.47	Sr Strontium 87.62	Y Yttrium 88.91	Zr Zirconium 91.22	Nb Niobium 92.91	Mo Molybdenum 95.94	Tc Technetium (98)	Ru Ruthenium 101.07	Rh Rhodium 102.91	Pd Palladium 106.42	Ag Silver 107.87	Cd Cadmium 112.41	In Indium 114.82	Sn Tin 118.71	Sb Antimony 121.76	Te Tellurium 127.60	I Iodine 126.90	Xe Xenon 131.29
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs Cesium 132.91	Ba Barium 137.33	La Lanthanum 138.91	Hf Hafnium 178.49	Ta Tantalum 180.95	W Tungsten 183.84	Re Rhenium 186.21	Os Osmium 190.23	Ir Iridium 192.22	Pt Platinum 195.08	Au Gold 196.97	Hg Mercury 200.59	Tl Thallium 204.38	Pb Lead 207.2	Bi Bismuth 208.98	Po Polonium (209)	At Astatine (210)	Rn Radon (222)
87	88	89	104	105	106	107	108	109									
Fr Francium (223)	Ra Radium (226)	Ac Actinium (227)	Rf Rutherfordium (261)	Db Dubnium (262)	Sg Seaborgium (266)	Bh Bohrium (264)	Hs Hassium (269)	Mt Meitnerium (268)									

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce Cerium 140.12	Pr Praseodymium 140.91	Nd Neodymium 144.24	Pm Promethium (145)	Sm Samarium 150.36	Eu Europium 151.96	Gd Gadolinium 157.25	Tb Terbium 158.93	Dy Dysprosium 162.50	Ho Holmium 164.93	Er Erbium 167.26	Tm Thulium 168.93	Yb Ytterbium 173.04	Lu Lutetium 174.97
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th Thorium 232.04	Pa Protactinium 231.04	U Uranium 238.03	Np Neptunium (237)	Pu Plutonium (244)	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)	Lr Lawrencium (262)

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.

Key

11	Atomic number
Na	Element symbol
Sodium	Element name
22.99	Average atomic mass