



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING
BACHELOR OF SCIENCE IN CIVIL ENGINEERING
SUPPLEMENTARY EXAMINATION

ECU 100: CHEMISTRY FOR ENGINEERS 1

DATE: 30/8/2017

TIME: 8:30 – 10:30 AM

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory**.
- Answer any **two** questions from section **B**.

Required Data/Information

- Mass of electron (m) = 9.1079×10^{-31} Kg, electronic charge (e) = 1.602×10^{-19} C
- **Rydberg's constant (R)** = $10\,973\,731.6 \text{ m}^{-1}$, **Planck's constant (h)** = 6.63×10^{-34} Js
- ϵ_0 – **permittivity of free space** $8.854188 \times 10^{-12} \text{ C}^2 \text{ s}^2 \text{ Kg}^{-1} \text{ m}^{-3}$
- **Z**- nuclear charge
- $1 \text{ eV} = 1.6022 \times 10^{-19} \text{ J}$.



SECTION A (30 MARKS) COMPULSARY

QUESTION ONE

- a) Briefly describe the following;
- Rutherford's atomic structure model (4 marks)
 - Photoelectric effect (2 marks)
- b) A sodium atom has 11 protons, 12 neutrons, and 11 electrons. What is the mass number of this atom? (2 marks)
- c) Which electromagnetic waves have the longest wavelengths and shortest frequencies? (1 mark)
- d) Explain the two factors affecting maximum kinetic energy of photoelectrons (6 marks)
- e) If a photon of wavelength 530 nm hits a metal surface (work function is 3.45×10^{-19} J), calculate the velocity of the photoelectron produced (4 marks)
- f) Calculate the energy of an electron in a hydrogen, $n=6$ level (2 marks)
- g) List all the allowed combinations of the four quantum numbers (n, l, m_l, m_s) for a 4d orbital, and predict the total number of electrons it can contain (5 marks)
- h) Write the electronic configuration for the following elements
- Potassium (2 marks)
 - Magnesium (2 marks)

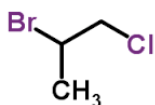
SECTION B: ATTEMPT ANY TWO QUESTIONS (20 MARKS EACH)

QUESTION TWO

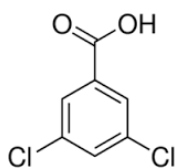
- a) Define the following terms;
- Pfund series (2 marks)
 - Electromagnetic radiation (2 marks)
- b) Show that Rydberg's constant (R) = $1.097 \times 10^7 \text{m}^{-1}$ (5 marks)
- c) Explain why elements produce their own characteristic colors when they emit photons (2 marks)
- d) An electron falls from energy level 6 to 1 in a hydrogen emission spectrum;
- Which series does it represent (2 marks)
 - Calculate its corresponding wavelength and frequency (4 marks)
- e) One of the electron transitions in a hydrogen atom produces infrared light with a wavelength of 746.4 nm. What amount of energy causes this transition? (3 marks)

QUESTION THREE

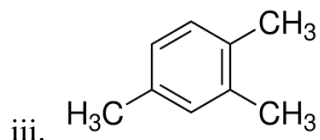
- a) Define the following terms and give a relevant example;
- i. Alkanes (2 marks)
 - ii. Polymerization (2 marks)
- b) Provide the IUPAC names for the following organic compounds (3 marks)



i.



ii.

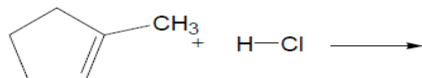
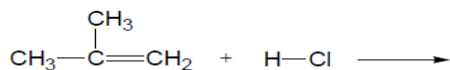


iii.

- c) Draw structural formulae for the following molecules:

- i. 4-ethyl-cis-2-hexene (1 mark)
 - ii. ethylbenzene (1 mark)
 - iii. *meta*-ethyltoluene (1 mark)
 - iv. 3-phenylheptane (1 mark)
- d) Chlorine, bromine and iodine all react with alkenes such as ethane in an addition reaction
- i. Write the equation for the chlorination of ethene and name the product (2 marks)
 - ii. How does the vigour of the reaction change as you go from chlorine to bromine to iodine (1 mark)

- e) Complete the following reactions and indicate the major product in each case (6 marks)



QUESTION FOUR

- a) In Quantum mechanics, four quantum numbers are needed to characterize completely each electron in an atom. List and describe the four quantum numbers (8 marks)
- b) Write the quantum numbers that represent the following electrons: (2 marks)
- $6p^2$
 - $3s^2$
- c) List all the allowed combinations of the four quantum numbers (n, l, m_l, m_s) for electrons in a $2p$ orbital and predict the maximum number of electrons the $2p$ subshell can accommodate. (3 marks)
- d) Draw the $3d_z^2$ orbital (2 marks)
- e) Use an orbital diagram to illustrate the aufbau principle, the Pauli exclusion principle, and Hund's rule for each element
- Carbon (3 marks)
 - Sulfur (2 marks)

QUESTION FIVE

- a) Define the following terms;
- Aufbaus principle (2 marks)
 - Hunds rule (2 marks)
- b) According to the periodic table provided, arrange the following elements in order of the increasing atomic radius; rubidium, silver, aluminium and carbon. Explain your answer (3 marks)

- c) Study group 15 in the periodic table and indicate which element has the strongest metallic character. Explain your answer (2 marks)
- d) Calculate the effective nuclear charge on a 2p electron in a Phosphorus (P) atom. Given that the number of neutrons and mass number of Pd is 15 and 31 respectively. (3 marks)
- e) Periodic table is a chart in which elements having similar chemical and physical properties are arranged in groups.
- Elements Y (not its actual symbol) has atomic number 50. To which period and group does it belong? Show how you arrived at your answer. (4 marks)
 - Draw and label energy level diagram for a multi-electron atom like Calcium (4 marks)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.0079	2																2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.409	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71 *	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 #	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (270)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (291)		118 Uuo (294)
* Lanthanide series																	
	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97		
# Actinide series																	
	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)		