KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

SECOND YEAR FIRST SEMISTER EXAMINATION

FOR THE DEGREE

OF

BACHELOR OF EDUCATION (SCIENCE)

AND

BACHELOR OF CHEMISTRY

COURSE CODE: SCH 211/214

COURSE TITLE: ATOMIC STRUCTURE AND CHEMICAL BONDING

INSTRUCTION: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

DATE: 15/06/2021 **TIME: 2-4 PM**

This paper contains 6 printed pages

(MAIN EXAMINATIONS)

Important constants

Plank's constant, $h = 6.626 \times 10^{-34}$ Js

Speed of light (in vacuum), $c = 2.998 \times 10^{8} ms^{-1}$

Rydberg's constant, $R_H = 1.0968 \times 10^{7} m^{-1}$

Mass of electron, $m_e = 9.11 \times 10^{-31} kg$

1Angstrom$=10^{-10}$m

$1J = 1\ kgm^2s^{-2}$

Electronic charge, $e = 1.602 \times 10^{-19} C$

Permittivity, $\varepsilon_0 = 8.854188 \times 10^{-12}\ C^2/Jm$

Question 1 (30 marks)

a) Explain two assumptions of Bohr model of the atom **(3 marks)**

ii) Explain the aspect of the Bohr Theory that is considered unsatisfactory as a result of the Heisenberg uncertainity principle **(3 marks)**

b) i)Calculate the shortest wavelength transition energy in the Paschen series **(3 marks)**

c) Explain what you understand with the term 'quantum theory' **(2 marks)**

d) Sketch the orbitals in $l = 1$ **(3 marks)**

e) ii) The normalized wave function for a particle in a box is given by $\Psi_n = \sqrt{\frac{2}{a} sin \frac{n\pi}{a} x}$; sketch curves for the variation of Ψ_n and Ψ_n^2 for n=3 with x for a particle in a one dimension box for $0<x<a$ **(4 marks)**

f) i State three principles of Aufbau principle for filling of electron configuration **(3 marks)**

ii) Write the electron configuration for **(2 marks)**

I) iron
II) Aluminium ion

g) Show hybridization of Carbon in CH_4 molecule **(3 marks)**

h) Account for the difference in melting points of Sodium chloride, 800°C and calcium chloride 772°C **(4 marks)**

Question 2 (20 marks)

a) For a particle in a one dimension box, $E_n = \frac{n^2h^2}{8ma^2}$, m=mass of particle, a= length of the box.

Calculate the energy difference between n=1 and n=2 levels for an electron confined to a one dimension box having length $4x10^{-10}$ m in joules **(2 marks)**

b) Identify the sub-shells in the possible combinations from the combinations below **(3 marks)**

Quantum nos.	N	l	m_l	Valence Sub-shells
Set a	1	0	0	
Set b	3	3	1	
Set c	2	1	-1	
Set d	3	2	2	
Set e	3	1	0	
Set f	2	0	1	

c) What is polarization of an anion **(2 marks)**

d) i) Define lattice energy **(2 marks)**

ii) Determine the lattice energy of sodium chloride given; ΔH_f= -413 kJ/mole, ΔH_{sub} = +109 kJ/mole, ΔH_{diss}=+119.5kJ/mole, ΔH_I=+496 kJ/mole, ΔH_{EA}= -350.5 kJ/mole **(5 marks)**

e) Why does ice float on water **(2 marks)**

f) State the effect of DeBroglie principle in development of quantum mechanics **(4 marks)**

Question 3 (20 marks)

a) What do you understand by 'penetration effect' **(2 marks)**

b)i) Define a period on a periodic table and state what d-block elements are **(2 marks)**

ci) Explain the trend in atomic radius and Z_{eff} across period 3 elements **(3 marks)**

ii) The atomic radius of sodium is bigger than its ionic radius while that of chlorine in the same period is smaller than the ionic radius. Explain **(4 marks)**

iii) Explain trend in the ionic size of the isoelectronic ions of sodium, magnesium and aluminium **(2 marks)**

d) Explain how electronegativity can be used to predict polarity on a molecule **(3 marks)**

e) Explain the relationship between trend in electronegativity and metallic character down group 2 **(4 marks)**

Question 4 (20 marks)

a) Draw the Lewis structure for Ammonium ion **(2 marks)**

b) Draw the resonance structures for NO_3^- **(3 marks)**

c) ii) Give three statements of the Valence Shell Electron Pair Repulsion Theory **(3 marks)**

ii) Use Valence Bond Theory to explain the difference in the shapes of water and PF_5 **(4 marks)**

d)i) Use the theory of hybridization to draw and identify the sigma and pi bonds in the molecule, CH_2CH_2 **(4 marks)**

ii) Explain why all the bonds in cyclopenta-1, 3-diene, C_6H_5 are equal **(4 marks)**

QUESTION 5 (20 marks)

a) Explain why Phosphorus is able to form phosphorus pentachloride while nitrogen is not ~~able~~ **(2 marks)**

b) Draw the orbital correlation diagram for homonulear diatomic molecules of Helium **(3 marks)**

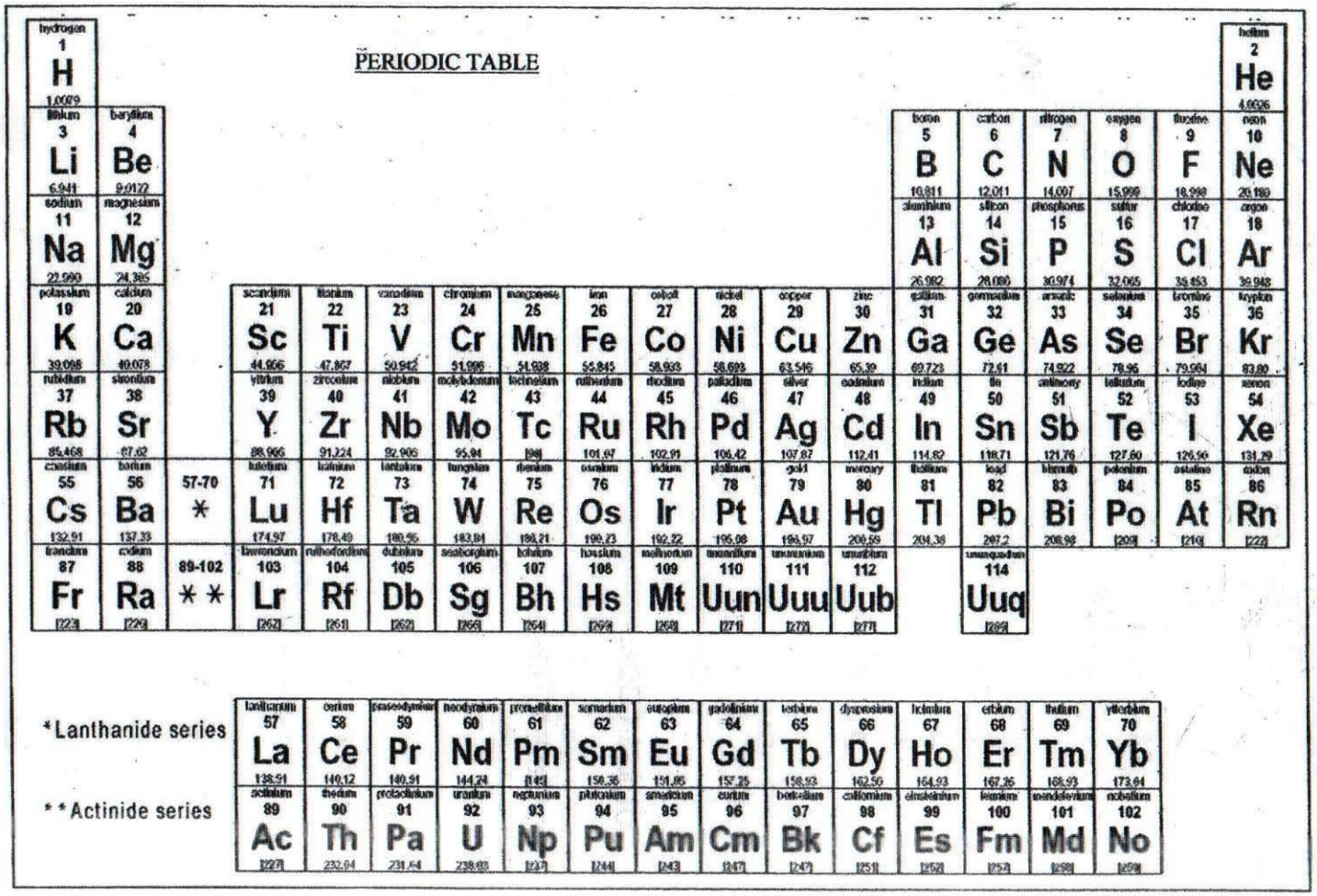
c) i) Using Molecular orbital theory explain the difference in the magnetism between; B_2, C_2 **(4 marks)**

ii) Write the ground state valence-electron configuration of He_2 **(3 marks)**

iii) Calculate the bond orders in the molecules in He_2 **(3 marks**

d) Comment on the ionization energy down group 2 elements **(2 marks)**

e) Calculate the effective nuclear charge on a 3p electron in a nickel atom (Ni=28) **(3 marks)**


PERIODIC TABLE
hydrogen 1 H 1.0079
helium 2 He 4.0026
lithium 3 Li 6.941
beryllium 4 Be 9.0122
boron 5 B 10.811
carbon 6 C 12.011
nitrogen 7 N 14.007
oxygen 8 O 15.999
fluorine 9 F 18.998
neon 10 Ne 20.180
sodium 11 Na 22.990
magnesium 12 Mg 24.305
aluminium 13 Al 26.982
silicon 14 Si 28.086
phosphorus 15 P 30.974
sulfur 16 S 32.065
chlorine 17 Cl 35.453
argon 18 Ar 39.948
potassium 19 K 39.098
calcium 20 Ca 40.078
scandium 21 Sc 44.956
titanium 22 Ti 47.867
vanadium 23 V 50.942
chromium 24 Cr 51.996
manganese 25 Mn 54.938
iron 26 Fe 55.845
cobalt 27 Co 58.933
nickel 28 Ni 58.693
copper 29 Cu 63.546
zinc 30 Zn 65.39
gallium 31 Ga 69.723
germanium 32 Ge 72.61
arsenic 33 As 74.922
selenium 34 Se 78.96
bromine 35 Br 79.904
krypton 36 Kr 83.80
rubidium 37 Rb 85.468
strontium 38 Sr 87.62
yttrium 39 Y 88.906
zirconium 40 Zr 91.224
niobium 41 Nb 92.906
molybdenum 42 Mo 95.94
technetium 43 Tc [98]
ruthenium 44 Ru 101.07
rhodium 45 Rh 102.91
palladium 46 Pd 106.42
silver 47 Ag 107.87
cadmium 48 Cd 112.41
indium 49 In 114.82
tin 50 Sn 118.71
antimony 51 Sb 121.76
tellurium 52 Te 127.60
iodine 53 I 126.90
xenon 54 Xe 131.29
caesium 55 Cs 132.91
barium 56 Ba 137.33
57-70 *
lutetium 71 Lu 174.97
hafnium 72 Hf 178.49
tantalum 73 Ta 180.95
tungsten 74 W 183.84
rhenium 75 Re 186.21
osmium 76 Os 190.23
iridium 77 Ir 192.22
platinum 78 Pt 195.08
gold 79 Au 196.97
mercury 80 Hg 200.59
thallium 81 Tl 204.38
lead 82 Pb 207.2
bismuth 83 Bi 208.98
polonium 84 Po [209]
astatine 85 At [210]
radon 86 Rn [222]
francium 87 Fr [223]
radium 88 Ra [226]
89-102 * *
lawrencium 103 Lr [262]
rutherfordium 104 Rf [261]
dubnium 105 Db [262]
seaborgium 106 Sg [266]
bohrium 107 Bh [264]
hassium 108 Hs [269]
meitnerium 109 Mt [268]
ununnilium 110 Uun [271]
unnunium 111 Uuu [272]
unnumbium 112 Uub [277]
ununquadium 114 Uuq [289]
* Lanthanide series
lanthanum 57 La 138.91
cerium 58 Ce 140.12
praseodymium 59 Pr 140.91
neodymium 60 Nd 144.24
promethium 61 Pm [145]
samarium 62 Sm 150.36
europium 63 Eu 151.96
gadolinium 64 Gd 157.25
terbium 65 Tb 158.93
dysprosium 66 Dy 162.50
holmium 67 Ho 164.93
erbium 68 Er 167.26
thulium 69 Tm 168.93
ytterbium 70 Yb 173.04
* * Actinide series
actinium 89 Ac [227]
thorium 90 Th 232.04
protactinium 91 Pa 231.04
uranium 92 U 238.03
neptunium 93 Np [237]
plutonium 94 Pu [244]
americium 95 Am [243]
curium 96 Cm [247]
berkelium 97 Bk [247]
californium 98 Cf [251]
einsteinium 99 Es [252]
fermium 100 Fm [257]
mendelevium 101 Md [258]
nobelium 102 No [259]