MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC

YEAR ONE SECOND SEMESTER

SCHOOL OF PURE APPLIED AND HEALTH SCIENCES

MASTER OF SCIENCE IN CHEMISTRY

COURSE CODE: CHE 8213

COURSE TITLE: ATOMIC AND MOLECULAR SPECTROSCOPY

DATE: 23/5/24 **TIME: 1430-1630HRS**

INSTRUCTIONS TO CANDIDATES

Answer Question **ONE** and any other **TWO** questions.

QUESTIONONE (20 mks)

a) Calculate the shortest wavelength line in the Balmer series given that RH = 109677 cm^{-13} **(3mks)**
b) Write the term symbols arising from the ground-state configurations of Na **(4mks)**
c) To what orbitals may a 4*s* electron make electric-dipole allowed radiative transitions **(2mks)**
d) Calculate the number of orbitals for a 3s electron and state the sub shells for this shell **(4mks)**
e) When ultraviolet radiation of wavelength 58.4 nm from a helium lamp is directed on to a sample of xenon, electrons are ejected with a speed of 1790 ms^{-1}. Calculate the ionization energy of xenon **(3mks)**
f) Calculate the moment of inertia of an H_2O molecule around the axis defined by the bisector of the HOH angle. The HOH bond angle is 104.5° and the bond length is 95.7 pm **(3mks)**
g) Distinguish between singlet and triplet states **(1mk)**

QUESTION TWO (15 mks)

a) State the number and type of orbitals at n = 1, 2 and 3 respectively **(3mks)**
b) Describe any one type of atomic emission spectra **(3mks)**
c) An electronic transition takes place from n = 4 to n = 2. Calculate a) Wavelength b) frequency c) Energy emitted and state the name of the series (Take R_H = 109677 cm^{-1}, C = 3 x 10^8 ms^{-1}, h = 6.63 x 10^{-34}) **(5mks)**
d) Given the principal quantum number, n = 4, state the values of l and m_l for this shell **(2mks)**
e) Explain the Hund's rule **(2mks)**

QUESTION THREE (15 mks)

a) Distinguish penetration and shielding as used to describe atomic orbitals **(2mks)**

b) Calculate the effective nuclear charge of a Helium atom whose charge is 3.6875 C and shielding constant is 2. **(2mks)**

c) State and explain the electronic configuration of Nitrogen (Z = 7) **(3mks)**

d) Explain the effect of nuclear charge on the spin-orbit coupling **(3mks)**

e) The configuration . . . $4p^6 5d^1$ of rubidium has two levels at 25 700.56 cm^{-1} and 25 703.52 cm^{-1} above the ground state. What is the spin–orbit coupling constant in this excited state **(5mks)**

QUESTION FOUR (15 mks)

a) Which of the following transitions are allowed in the normal electronic emission spectrum of an atom: (a) 5d→2*s*, (b) 5*p*→3*s*, (c) 6*p*→4f **(3mks)**

b) Explain the origin of spin–orbit coupling and how it affects the appearance of a spectrum. **(4mks)**

c) State the electronic configurations of a helium atom in the singlet and triplet states **(2mks)**

d) Identify the levels of the configurations f^1 **(2mks)**

e) Find the terms that can arise from the configurations $f^1 d^1$ **(4mks)**

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