NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 6
COURSE NAME: MODERN PHYSICS	**COURSE CODE:** MPH602S
SESSION: JANUARY 2023	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	**PROF ONJEFU SYLVANUS**
MODERATOR:	**MR INDONGO VAINO**

PERMISSIBLE MATERIALS

Non-Programmable Calculator

THIS QUESTION PAPER CONSISTS OF 4 PAGES
(Including this front page)

Physical Constant

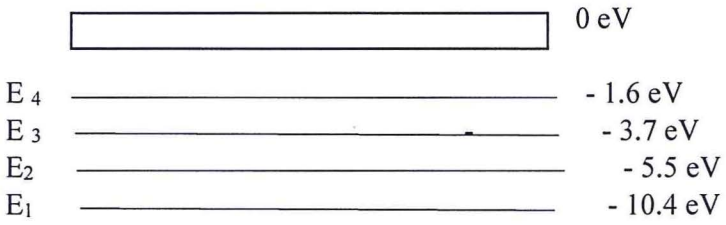
Electron mass	$m_e = 9.11x10^{-31}\,kg$
Proton mass	$m_p = 1.6736x10^{-27}\,kg$
Planck constant	h = 6.626 x 10^{-34}J
Speed of light	c = 3 x10^{8} m/s
1eV	1.6 x 10^{-19}

QUESTION 1 **[18]**

1.1 Explain the electron-cloud model and which region the cloud is being dense and more diffused. (6)

1.2 Explain the term excitation energy. (2)

1.3 The figure below gives the energy level for mercury atom:



If a bombarding electron has energy 6.7 eV,

1.3.1 To what level will the mercury atom be excited? (3)

1.4 What will be that wavelength of the light emitted if the mercury atom drops from this excited state to the second level? [Take h = 6.626 x 10^{-34}J; c = 3 x10^{8} m/s]. (3)

1.5 Show that the photon in a 1240 nm infrared beam have energies of 1.00 eV. (4)

QUESTION 2 **[20]**

2.1 Define work function. (2)

2.2 The work function of sodium metal is 2.3 eV. What is the longest wavelength light that can cause photoelectron emission from sodium? (6)

2.3 Calculate the minimum wavelength of X-rays when a voltage of 40 kV is applied to the X-ray tube. (4)

2.4 An electron falls from rest through a potential difference of 100 V. What is its de Broglie wavelength? (8)

QUESTION 3 **[21]**

3.1 Determine the de Broglie wavelength for a particle moving with a speed 2.0×10^{6} m/s if the particle is;

3.1.1 a 0.20 kg. (4)

3.1.2 an electron. (4)

3.1.3 a proton. (4)

3.2 Explain a blackbody and a blackbody radiation. (3)

3.3 The isotope ${}^{14}_{6}C$ has a half-life of 5730 years. If at some time a sample contain 1.00×10^{22} carbon-14 nuclei, what is the activity of the sample? (6)

QUESTION 4 **[20]**

4.1 Using **Compton Effect**: X-rays of wavelength 0.140 nm are scattered from a thin slice of carbon. What will be the wavelengths of X-rays scattered at;

4.1.1 0° (3)

4.1.2 90° (3)

4.1.3 180° (3)

4.2 What wavelength does a hydrogen atom emit as its excited electron falls from the n = 5 state to the n=2 state? Answer to three significant figures. (7)

4.3 Compute the energy of a photon of blue light of wavelength 450 nm. Give your answer in electron volt. (4)

QUESTION 5 **[21]**

5.1 State one important idea that Plank used in other to obtain the correct spectral distribution for the blackbody radiation. Write down the Plank spectra distribution law in frequency space. (4)

5.2 Explain the Pauli Exclusion Principle. (2)

5.3 Using Pauli Exclusion Principle determine the quantum numbers for the electrons in the lithium atom (Z = 3) when the atom is in its ground state. (6)

5.4 Show the expression for one-dimensional Schrodinger equation for a particle with a definite energy E. (3)

5.5 Consider the wave function $\psi(x) = A_1 e^{ikx} + A_2 e^{-ikx}$, where k is positive. What is the energy? Is this a valid stationary-state function for a free particle? (6)

END