NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 6
COURSE CODE: MPH602S	**COURSE NAME:** MODERN PHYSICS
SESSION: NOVEMBER 2022	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

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

PERMISSIBLE MATERIALS

Non-programmable Calculators

THIS QUESTION PAPER CONSISTS OF 5 PAGES
(Including this front page)

SECTION A

QUESTION 1 [40]

Multiple choice questions types: Each question in this section carries two marks

1.1 Which of the following representations is correct for an atom X with 28 electrons and 30 neutrons? (2)

a. $^{30}_{28}X$ b. $^{28}_{30}X$ c. $^{58}_{30}X$ d. $^{58}_{28}X$

1.2 The energy associated with the emmited photon when a mercury atom changes from one state to another is 3.3 eV. Calculate the frequency of the photon. (2)

a. 8.0×10^{14}Hz b. 3.1×10^{53}Hz c. 1.3×10^{-15}Hz d. 3.2×10^{-53}Hz

1.3 In the Bohr's model of the atom, 'n' represents what? (2)

a. angular momentum b. spin number c. principal quantum number

d. magnetic quantum number

1.4 One of the following is not an application of photoelectric effect. (2)

a. in burglar alarm b. in solar calculator c. in chromatiser
d. in television camera

1.5 A certain photoelectric surface is illuminated with light of various wavelengths at various stopping potentials if the cut-off or threshold frequency of light is 4.6×10^{14} Hz. Determine the threshold wavelength if the speed of light is given by 3×10^{8} m/s. (2)

a. 1.38×10^{23} m b. 6.5×10^{-7} m c. 1.53×10^{22} m d. 6.4×10^{-6} m

1.6 ..... is a process that involves a photon given electron kinetic energy which causes it to recoil. (2)

a. Photoelectric effect b. Compton Effect c. Pair production
d. Recoil effect

1.7 A certain X-ray photon has energy of 6.2 keV. Calculate its frequency. [Take $h = 6.63 \times 10^{-34}$ Js; $c = 3.0 \times 10^{8}$ m/s; $1eV = 1.6 \times 10^{-19}$ J]. (2)

a. 1.5×10^{18} Hz b. 2.1×10^{-12} Hz c. 2.0×10^{-10} Hz
d. 1.2×10^{-14} Hz

1.8 What is the wavelength of the photon in Question 1.5? (2)

a. 1.4×10^{20} m b. 2.5×10^{22} m c. 1.5×10^{18} m d. 2.0×10^{-10} m

1.9 All the following are example of particle nature of light except ..... (2)

a. Photoelectric effect b. X- ray production c. polarization
d. black body radiation

1.10 There are four quantum numbers used to completely describe the structure of all atoms which includes all the following except ..... (2)

a. continues number b. principal quantum number c. spin quantum number
d. magnetic quantum number

1.11 The spinning direction of two electron must be opposite to one another, it takes the value; (2)

a. $S = \pm 1/3$ b. $S = \pm 1/4$ c. $S = \pm 1/2$ d. $S = \pm 1/5$

1.12 The splitting of a spectral line by a magnetic field is known as; (2)

a. Magnetic diploe moment b. Zeeman effect c. Stern-Gerlach experiment
d. Schrodinger effect

1.13 The actual dimensions of the nucleus present in the atom are called ..... (2)

a. Nuclear density b. Nuclear size c. Nuclear force
d. Nuclear chain size

1.14 A process of formation of heavier and bigger nucleus by the combination of various lighter and smaller nucleus. (2)

a. A nuclear decay b. Nuclear fission c. Nuclear fusion
d. Strong nuclear force

1.15 Suppose an atomic nucleus of element M undergoes positron decay. The equation for this process can be written as. (2)

a. $p \rightarrow n + e^{+} + \nu$
b. $n \rightarrow p + e^{-} + \bar{\nu}$

c. $p \rightarrow n + e^{+} + \bar{\nu}$

d. $n \rightarrow p + e^{-} + \nu$

1.16 A deuterium nucleus and a tritium nucleus fuse together to form a helium nucleus, releasing a particle X in the process, according to the equation

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + X$$

which one of the following correctly identifies X? (2)

a. Electron b. Neutron c. Positron d. Proton

1.17 Who was the Scientist credited as the father of the atomic theory? (2)

a. J.J Thomson b. E. Rutherford c. N. Bohr's d. E. Cloud

1.18 Which of the following is a pair of isotopes? (2)

a. $^{35}_{18}Ar$ and $^{35}_{16}S$ b. $^{35}_{17}Cl$ and $^{37}_{17}Cl$ c. $^{15}_{7}N$ and $^{16}_{8}O$ d. $^{30}_{14}Si$ and $^{30}_{15}P$

1.19 What is the number of neutron in the uranium isotope $^{238}_{92}X$? (2)

a. 92 b. 146 c. 238 d. 330

1.20 The nucleon number and the proton number of a neutral atom of an element are 23 and 11 respectively. How many neutrons are present in the atom? (2)

a. 11 b. 12 c. 23 d. 34

SECTION B

QUESTION 2 **[20]**

2.1 Explain the J.J Thompson' Model of the atom and give two limitation to the model. (9)

2.2 What do you understand by photoelectric effect? (3)

2.3 What is the kinetic energy and speed of an electron ejected from a sodium surface whose work function is $W_o = 2.28$ eV when illuminated by light of wavelength (a) 410 nm, (b) 550 nm? [Take $h = 6.626 \times 10^{-34}$ J; me = 9.1×10^{-31}; 1 eV = 1.6×10^{-19}]. (8)

QUESTION 3 **[20]**

3.1 Explain the ground state of an atom. (2)

3.2 X-ray of wavelength 0.140 nm are scattered from a very thin slice of carbon. What will be the wavelength of X-rays scattered at (a) 0°, (b) 90°, (c) 180°? [Take $h = 6.626 \times 10^{-34}$ J; $m_e = 9.1 \times 10^{-31}$; $c = 3.00 \times 10^{8}$]. (9)

3.3 Determine the wavelength of an electron in meters that has been accelerated through a potential difference of 100 V. (5)

3.4 Calculate the de Broglie wavelength of a 0.20 kg ball moving with a speed of 15 m/s. (4)

QUESTION 4 **[10]**

4.1 Explain the Heisenberg uncertainty principle. (3)

4.2 What is the uncertainty in position, imposed by the uncertainty principle on a 150 g baseball thrown at (93 ± 1) mph = (42 ± 1) m/s? (7)

QUESTION 5 **[10]**

5.1 Explain the half-life of a radionuclide. (3)

5.2 The half-life of radioactive nucleus of $^{226}_{88}Ra$ is about 1.6×10^{3} years.

5.2.1 What is the decay constant (s^{-1}) of $^{226}_{88}Ra$? (7)

END