# ELIZADE UNIVERSITY

# ILARA-MOKIN

# ONDO STATE

**FACULTY: Basic and Applied Sciences**
**DEPARTMENT: Physical and Chemical Sciences**
**FIRST SEMESTER EXAMINATIONS**
**2016/2017 ACADEMIC SESSION**

**COURSE CODE: PHY 201**

**COURSE TITLE: Elementary Modern Physics**

**DURATION: 2 HRS**

**HOD's SIGNATURE**

**TOTAL MARKS: 60**

**Matriculation Number:** _____

**INSTRUCTIONS:**

1. Write your matriculation number in the space provided above and also on the cover page of the exam booklet.
2. This question paper consists of 3 pages with printing on both sides.
3. Answer all questions in the exam booklet provided.
4. At the end of this examination, place the question paper inside the exam booklet.
5. Attempt any 3 out of the 5 questions

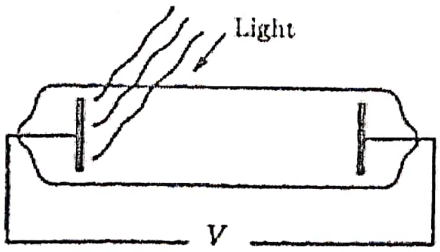
## QUESTION ONE

(a) Write briefly on the following:
   (i) Michelson-Morley experiment (ii) Einstein's postulates of special relativity (iii) Proper time interval

(b) A stick of proper length $\ell_0$ sits at rest in the frame $\Sigma$, lying in the x-y plane at an angle of $\theta = \tan^{-1}\left(\frac{3}{4}\right)$ with the x-axis. A frame $\Sigma'$ moves with velocity $\vec{v} = v\hat{x}$ with respect to the frame $\Sigma$. In the frame $\Sigma'$, the stick is angled at $45^0$ with respect to the x'-axis.
   (i) What is v?
   (ii) What is the length of the rod as measured in frame $\Sigma'$?

## QUESTION TWO

(a) Consider two light beams of different intensities $I_1$ and $I_2$ (such that $I_2 > I_1$) incident on the photoelectric circuit shown below:




Plot schematically, on the given blank graphs, (1) the photocurrent (i.e. number of ejected electrons per unit time) as a function of applied voltage and (2) the maximum kinetic energy of the photoelectrons as a function of frequency for each beam. Label as many features as you can.

(b) In a photoelectric effect experiment on a certain metal, it is observed that incident light of wavelength 413nm causes electrons to be ejected from the metal's surface with a maximum kinetic energy of $3.2 \times 10^{-19}$J. What is the longest wavelength of light that will eject electrons from this metal?

## QUESTION THREE

(a) Briefly explain the following:
   (i) Black body radiation (ii) Wien's displacement law (iii) Planck's radiation law

(b) In a Compton's scattering event, the scattered photon was found to have energy of 120 keV, and the recoil electron was given a kinetic energy of 40 keV.
   (i) What was the scattering angle $\theta$ for the 120 keV
   (ii) What angle $\phi$ does the path of the scattered electron make with the direction of the incident photon?

## QUESTION FOUR

(a) Consider a hydrogenic atom consisting of a single electron around a uranium nucleus (Z = 92)

(i) What will be the energy in eV and the radius in nm of the first Bohr orbit for this atom?

(ii) Consider this hydrogenic atom initially in an n = 10 excited state, from which it de-excites to the n = 1 state by emitting electromagnetic radiation. What would be the weight change of the atom due to emitting this radiation, including its sign (increase or decrease)?

(b) Balance coulombic force and acceleration and use the result of part (a) to derive the speed of the electron in the first Bohr orbit around this atom, using a non-relativistic approach. Based on your answer, is non-relativistic approach adequate?

## QUESTION FIVE

Alpha Centauri, a nearby star in our galaxy, is 4.3 light years away. This means as measured by a person on earth, it would take light 4.3 years to reach this star. A rocket leaves for Alpha Centauri at a speed of v = 0.95c relative to the earth. Assume the Earth and Alpha Centauri are stationary with respect to one another. According to the astronauts,

(a) How much did they age (in years) during their journey?

(b) How far (in km) did they travel?