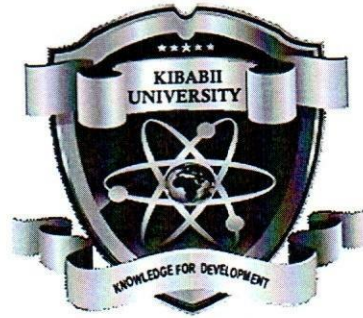


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# KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS  
2021/2022 ACADEMIC YEAR**

**THIRD YEAR FIRST SEMESTER  
MAIN EXAMINATIONS**

**FOR THE DEGREE OF B.ED (SCIENCE) AND BSC (PHYSICS)**

**COURSE CODE:** SPH 316/SPC 314

**COURSE TITLE:** ATOMIC PHYSICS

**DATE:** 25/05/2022

**TIME:** 9:00AM-11:00AM

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**INSTRUCTIONS TO CANDIDATES**

TIME: 2 HOURS

Answer question ONE and any TWO of the remaining

KIBU observes ZERO tolerance to examination cheating

### **QUESTION ONE [30 MARKS]**

- a) Define the following terms: [5 marks]  
Hund's rule, Auger effect, Lamb shift, Lande's interval rule and anomalous Zeeman effect.
- b) Calculate the hyperfine splitting in hydrogen in a ground state. [3 marks]
- c) Obtain an expression of the average speed of an electron in first Bohr orbit of an atom of atomic number  $Z$ . [4 marks]
- d) What is the magnetic moment of an atom in the state  $^3P_0$ ? [3 marks]
- e) Couple a p-state and an s-state via j-j coupling. [4 marks]
- f) What is Lande's g-factor? Find the Lande's g-factor of the state  $^2p_{3/2}$ . [4 marks]
- g) State Moseley's law hence find wavelength  $K_\alpha$  line in cobalt [4 marks]  
[ $Z = 27$  and  $R = 1.097 \times 10^7 m^{-1}$ ]
- h) Compute the separation of the outer lines, two lines of a normal Zeeman pattern for spectral lines of wavelength 612nm in a magnetic field of 10kg. [3 marks]  
[ $1g = 10^{-4}T$ ,  $e = 1.602 \times 10^{-19}C$ ,  $m_e = 9.11 \times 10^{-31}kg$  and  $c = 3.0 \times 10^8 m/s$ ]

### **QUESTION TWO [20 MARKS]**

- a) Describe an experimental arrangement for determining the characteristic lines in an X-ray spectrum. [8 marks]
- b) From measurement of X-ray emission spectra a variety of elements, Moseley was able to assign an atomic number  $Z$  to each of the elements. Explain explicitly how this assignment can be made. [4 marks]
- c) Discrete X-ray lines emitted from a certain target cannot in general be observed as absorption lines in the same material. Explain why, for example, the  $K_\alpha$  lines cannot be observed in the absorption spectra of heavy elements. [4 marks]
- d) Explain the origin of the continuous spectrum of X-ray emitted when a target is bombarded by electrons if given energy. What feature of the spectrum is inconsistent with classical electromagnetic theory? [4 marks]

### **QUESTION THREE [20 MARKS]**

- a) Give main conclusions on the present day atomic model. [14 marks]
- b) Calculate the radius and frequency of an electron in the Bohr's first orbit in hydrogen atom. [6 marks]  
[ $\epsilon_0 = 8.85 \times 10^{-12} F/m$ ,  $m_e = 9.11 \times 10^{-31} kg$ ,  $e = 1.6 \times 10^{-19} C$ ,  
 $h = 6.625 \times 10^{-34} Js$ ]

### **QUESTION FOUR [20 MARKS]**

Explain how the following experiments led to the development of atomic physics.

a) Stern-Gerlach experiment.

[7 marks]

b) Franck-Hertz experiment.

[7 marks]

c) Lamb-Rutherford experiment.

[6 marks]

**QUESTION FIVE [20 MARKS]**

a) Calculate the following: - the magnitude of orbital, spin and total angular momenta and also the angles between  $l$  and  $s$  for  $p$  electron in a one electron atom where  $l = 1$  and  $s = \frac{1}{2}$ .

[14 marks]

b) Find the values of S, L and J in the following states  $1s_0$ ,  $3p_2$  and  $2d_{3/2}$ .

[6 marks]