

AUGUST 2023
EBS 357
INTRODUCTORY ATOMIC PHYSICS,
HEAT AND OPTICS
1 HOUR 30 MINUTES

Candidate's Index Number
Signature:

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
SCHOOL OF EDUCATIONAL DEVELOPMENT AND OUTREACH
INSTITUTE OF EDUCATION

COLLEGES OF EDUCATION
FOUR-YEAR BACHELOR OF EDUCATION (B.ED)
THIRD YEAR, END-OF-FIRST SEMESTER EXAMINATION, AUGUST 2023

17TH AUGUST 2023

INTRODUCTORY ATOMIC PHYSICS,
HEAT AND OPTICS

9:30 AM – 11:00 AM

SECTION B
[40 MARKS]

Answer TWO questions only from this Section.

1.

- a. The Rydberg equation is generally expressed as:

$$\frac{1}{\lambda} = RZ^2 \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right); n_i, n_f = 1, 2, 3, \dots \dots n_i > n_f$$

where R is Rydberg constant.

- i. Calculate the wavelength that corresponds to the transition $n_i = 10$ to $n_f = 2$ for hydrogen atom. [6 marks]
- ii. What is the name given to this series? [2 marks]
- iii. where can it be found on the em spectrum? [2 marks]
- b.
- i. State Charles's law. [2 marks]
- ii. Represent this on a PV-diagram. [2 marks]
- c. Both the internal energy U of an ideal gas and its volume V are doubled.
- i. Calculate the new pressure as a result of these changes. [4 marks]
- ii. Comment on your answer. [2 marks]

- 2.
- a. i. Explain the term Ground State of an atom. ✓ [2 marks]
- ii. Calculate the energy of a photon emitted by HeNe laser light radiating at a wavelength of 633 nm. ✓ [4 marks]
- b. i. State **two** characteristics of X-ray. ✓ [2 marks]
- ii. The maximum voltage which a certain X-ray tube can withstand is 95 kV. Calculate the shortest wavelength produced by the tube. [5 marks]
- c. i. Find the wavelength of the electromagnetic radiation that is emitted from an electron which relaxes from $n = 5$ to $n = 1$ in a hydrogen atom. [5 marks]
- ii. What is the name of the resulting spectral series in the transition? [2 marks]
- 3.
- a. i. Explain these processes associated with the production of X-rays: X-ray fluorescence and Bremsstrahlung/braking radiation. [4 marks]
- ii. The maximum voltage which an X-ray tube can withstand is 75kV. Calculate the shortest wavelength produced by the tube. [4 marks]
- b. i. Under what condition is Boyle's law valid? ✓ [2 marks]
- ii. A gas at 100 kPa at 37.0°C fills a flexible container with an initial volume of 2.50 m³. If the temperature is increased to 57.0°C and the pressure increased to 150 kPa, calculate the new volume? ✓ [4 marks]
- c. i. What is interference of light? ✓ [2 marks]
- ii. List **two** differences between interference and diffraction. ✓ [4 marks]
- 4.
- a. Under what condition will an atom absorb radiation? ✓ [2 marks]
- b. The measured frequency of a photon is given as 6.0×10^{15} Hz. Calculate the energy of such a photon. ✓ [5 marks]
- c. i. State the Zeroth law of Thermodynamics. ✓ [2 marks]
- ii. Give **one** practical application where this law is applied and used. [2 marks]
- d. i. Give **two** properties of light. [2 marks]
- ii. Give the full expression for the acronym LASER. [2 marks]
- iii. Light with a wavelength of 511 nm forms a diffraction pattern after passing through a single slit of width 2.50×10^{-6} m. Calculate the angle associated with the second dark fringe above the central bright fringe. [5 marks]

Physical Constants

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$\text{Rydberg constant } R = 1.097 \times 10^7 \text{ m}^{-1}$$

$$\text{Planck's constant } h = 6.62 \times 10^{-34} \text{ Js} = 4.14 \times 10^{-15} \text{ eV}$$

$$E = hf = hc/\lambda$$

$$f = c/\lambda$$

$$y = \frac{m\lambda}{x}$$