Assignment: Atomic Structure

Topic: Radius, Velocity, and Energy of Electron in the n^{th} Orbit

Total Questions: 15 Time: 30 Minutes Marks: 60 (4 marks each)

Instructions

- Each question carries 4 marks. There is no negative marking.
- Choose the **correct** option for each question.
- Use the following constants where required:
  - Bohr radius, $a_0 = 0.529$ Å $= 52.9$ pm
  - Ground state energy of H-atom, $E_1 = -13.6$ eV
  - Ground state velocity of H-atom, $v_1 = 2.19 \times 10^6$ m/s
  - 1 eV $= 1.6 \times 10^{-19}$ J
  - Speed of light, $c = 3 \times 10^8$ m/s

Part A: NEET Previous Year Pattern Questions

Q1. In the Bohr model of the hydrogen atom, let R, v and E represent the radius of the orbit, the speed of electron and the total energy of the electron respectively. Which of the following quantity is proportional to the quantum number n?

(a) R/E

(b) E/v

(c) RE

(d) vR

Q2. The energy and radius of first Bohr orbit of He^+ and Li^{2+} are [Given $R_H = 2.18 \times 10^{-18}$ J, $a_0 = 52.9$ pm]

(a) $E_n(Li^{2+}) = -19.62 \times 10^{-18}$ J; $r_n(Li^{2+}) = 17.6$ pm
$E_n(He^+) = -8.72 \times 10^{-18}$ J; $r_n(He^+) = 26.4$ pm

(b) $E_n(Li^{2+}) = -8.72 \times 10^{-18}$ J; $r_n(Li^{2+}) = 26.4$ pm
$E_n(He^+) = -19.62 \times 10^{-18}$ J; $r_n(He^+) = 17.6$ pm

(c) $E_n(Li^{2+}) = -19.62 \times 10^{-16}$ J; $r_n(Li^{2+}) = 17.6$ pm
$E_n(He^+) = -8.72 \times 10^{-16}$ J; $r_n(He^+) = 26.4$ pm

(d) $E_n(Li^{2+}) = -8.72 \times 10^{-16}$ J; $r_n(Li^{2+}) = 17.6$ pm
$E_n(He^+) = -19.62 \times 10^{-16}$ J; $r_n(He^+) = 17.6$ pm

Q3. The ratio of the speed of the electrons in the ground state of hydrogen to the speed of light in vacuum is:

(a) 1/2

(b) 2/137

(c) 1/137

(d) 1/237

Q4. How fast does light travel in vacuum as compared to the velocity of an electron in Bohr's first orbit of hydrogen atom?

(a) 13.7 times

(b) 67 times

(c) 137 times

(d) 97 times

Q5. What is Bohr's radius of the 4^{th} orbit of He^{+} in Å?

(a) 5.23 Å

(b) 3.23 Å

(c) 6.23 Å

(d) 4.23 Å

Part B: Radius of the n^{th} Orbit

Q6. If the radius of the 1^{st} orbit of hydrogen is 5.29×10^{-11} m, then the radius of the 2^{nd} orbit of hydrogen is _____ $\times 10^{-11}$ m.

(a) 10.58

(b) 2.645

(c) 21.16

(d) 27.98

Q7. The radius of the second Bohr orbit for hydrogen atom is:

(a) 1.06 Å

(b) 0.53 Å

(c) 2.12 Å

(d) 4.23 Å

Q8. What is the radius of 1^{st} orbit of He^{+} atom?

(a) 0.1058 nm

(b) 0.2156 nm

(c) 0.00529 nm

(d) 0.02645 nm

Part C: Velocity of the Electron in the n^{th} Orbit

Q9. The velocity of an electron in the first orbit of hydrogen atom is 2.19×10^6 m/s. What is the velocity of the electron in the third orbit?

(a) 7.3×10^5 m/s

(b) 2.19×10^6 m/s

(c) 6.57×10^6 m/s

(d) 1.46×10^6 m/s

Q10. For a hydrogen-like ion with atomic number $Z = 3$, the velocity of the electron in the first orbit will be:

(a) 2.19×10^6 m/s

(b) 6.57×10^6 m/s

(c) 1.095×10^6 m/s

(d) 4.38×10^6 m/s

Q11. If the velocity of an electron in the second orbit of a hydrogen-like atom is 1.1×10^6 m/s, the value of Z for that atom is:

(a) 1

(b) 2

(c) 3

(d) 4

Part D: Energy of the Electron in the n^{th} Orbit

Q12. The energy of a hydrogen atom in the ground state is -13.6 eV. The energy of a He^+ ion in the first excited state will be:

(a) -6.8 eV

(b) -13.6 eV

(c) -27.2 eV

(d) -54.4 eV

Q13. The energy of radiation emitted when an electron falls from $n = 3$ to $n = 2$ level in a hydrogen atom will be: ($R_H = 2.18 \times 10^{-18}$ J atom^{-1})

(a) 0.3×10^{-18} J atom^{-1}

(b) 3×10^{-18} J atom^{-1}

(c) 0.03×10^{-18} J atom^{-1}

(d) 3×10^{-17} J atom^{-1}

Q14. In a hypothetical Bohr hydrogen, the mass of the electron is doubled. What will be the energy E_0 and the radius r_0 of the first orbit? (a_0 is the Bohr radius)

(a) $E_0 = -27.2$ eV; $r_0 = a_0/2$

(b) $E_0 = -27.2$ eV; $r_0 = a_0$

(c) $E_0 = -13.6$ eV; $r_0 = a_0/2$

(d) $E_0 = -13.6$ eV; $r_0 = a_0$

Q15. If the atom ${}_{100}\mathrm{Fm}^{257}$ follows the Bohr model and the radius of ${}_{100}\mathrm{Fm}^{257}$ is n times the Bohr radius, then the value of n is:

(a) 100

(b) 200

(c) 4

(d) 14

Best of Luck!