SET 4

Data:

$E_H = -13.6$ Ev ; $c = 3\times10^8$ ms^{-1} ; $me = 9.1\times10^{-31}$kg

$e = -1.6\times10^{-19}$ coulomb ; $h = 6.625\times10^{-34}$ j.s ; $c = 3\times10^8$ m/s

Exercise 1: De Broglie's Law

What is, in nanometer, the wavelength associated with each of the following material systems?

a)A car of mass 1 quintal (100 kg) moving at a speed of 90 km/h.

b) A rifle bullet of mass 3 g fired at a speed of 400 m/s.

c) An electron with a kinetic energy of 56 eV.

d) A tritium nucleus moving at a speed of 10^5 m/s.

Comment and conclude.

Exercise 2: Heisenberg's Uncertainty Principle

Heisenberg's principle shows that it is impossible to measure precisely both the **position** and the **momentum** of a microscopic particle.

1/ Considering a **ball** of mass **1 g** moving in a straight line, calculate the **uncertainty in its velocity** if its **position can be measured to within 1 nm**.

2/ What is the **uncertainty in the velocity** of an **electron** moving in a straight line if its **position is known to within 1 Å**?

3/ What is the **theoretical minimum uncertainty** in the **position** of a **vehicle** moving at **50 km/h ± 1 km/h**, with a mass of **500 kg**?

4/ If the **velocity of an electron** is known to within **±1 m/s**, what is the **uncertainty in its position**?

Comment and conclude.

Exercise 3: Quantum Numbers

1/ Give the **name** of each quantum number that characterizes an electron in a given energy state and then in a given orbital.

2/ In a **table**, give all the **quantum values** for the electron successively occupying the **first four energy levels**.

3/ Using the relationships between the three quantum numbers *n*, *l*, and *m*, determine the **degree of degeneracy** of the first three energy levels and explain **how it varies with n**.

Exercise 4

1/ How many quantum numbers are needed to define:

a/ energy level

b/ sub-energy level

c/ atomic orbital

d/ electron in an atom

Determine which of the following combinations correspond to **possible quantum states**, and justify your choice:

a/ n = 2 ; l = 1 ; m = 0 ; s = +1/2

b/ n = 3 ; l = 3 ; m = 1 ; s = –1/2

c/ n = 2 ; l = –2 ; m = 0 ; s = –1/2

d/ n = 3 ; l = 2 ; m = –3 ; s = +1/2

e/ n = 6 ; l = 4 ; m = –4 ; s = +1/2

f/ n = 2 ; l = 1 ; m = 0 ; s = +3/2