

Simplifying Test Prep

Chapter-12 Atoms Class – XII **Subject – Physics**

- **12.1.** Choose the correct alternative from the clues given at the end of the each statement:
 - a) The size of the atom in Thomson's model is the atomic size in Rutherford's model. (much greater than/no different **from/much less than.**)

 - b) In the ground state of electrons are in stable equilibrium, while in electrons always experience a net force. (Thomson's model/ Rutherford's model.)
 - A classical atom based on is doomed to collapse. **c**) (Thomson's model/ Rutherford's model.)
 - d) An atom has a nearly continuous mass distribution in abut has a highly non-uniform mass distribution in(Thomson's model/ Rutherford's model.)
 - e) The positively charged part of the atom possesses most of the mass in (Rutherford's model/both the models.)

Sol.

- a) No different from
- **b**) Thomson's model; Rutherford's model
- c) Rutherford's model
- **d**) Thomson's model; Rutherford's model
- e) Both the models



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12.2. Suppose you are given a chance to repeat the alpha-particle scattering experiment using a thin sheet of solid hydrogen in place of the gold foil. (Hydrogen is a solid at temperatures below 14 K.) What results do you expect?

Sol.

There would be no large-angle scattering, because the alpha-particle has mass nearly four times than that of the target nuclei. No observable conclusion can be made in this solid hydrogen alpha-particle scattering

experiment.

12.3. What is the shortest wavelength present in the Paschen series of spectral lines?

Sol.

Paschen series is given by

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$\overline{\lambda} = R$	$\overline{3^{2}}$	$-\overline{n^2}$

For shortest wavelength

 $n = \infty$

Substituting and solving

 $\lambda = 820 \text{ nm}$



Simplifying Test Prep 12.4. A difference of 2.3 eV separates two energy levels in an atom. What is the frequency of radiation emitted when the atom make a transition from the upper level to the lower level?

Sol. Given: E = 2.3 eV

We know v = E / h



 $v = E 7 \Pi$ Substitution produces $v = 5.55 \times 10^{14} \text{ Hz}$

12.5. The ground state energy of hydrogen atom is –13.6 eV. What are the kinetic and potential energies of the electron in this state?

Sol.

Given:

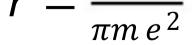
Ground state energy of hydrogen atom

E = -13.6 eV

For ground state, n = 1

Radius for n = 1 is given by formula

$$h^2 \epsilon_o$$





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Substituting the values and solving gives

$$r = 5.29 \text{ x } 10^{-11} \text{ m}$$

Kinetic energy can be calculated by the formula

$$\mathbf{K} = \frac{e^2}{8\pi\epsilon_o r}$$

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

 $\epsilon_o = 8.85 \times 10^{-12}$

Substitution gives



K = 13.6 eV

Now potential energy $U = -e^2 / 4 \pi \epsilon_o r$

Putting values and solving U = -27.2 eV

12.6. A hydrogen atom initially in the ground level absorbs a photon, which excites it to the n = 4 level. Determine the wavelength and frequency of photon.



Given: n1 = 1 n2 = 4



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Using the formula

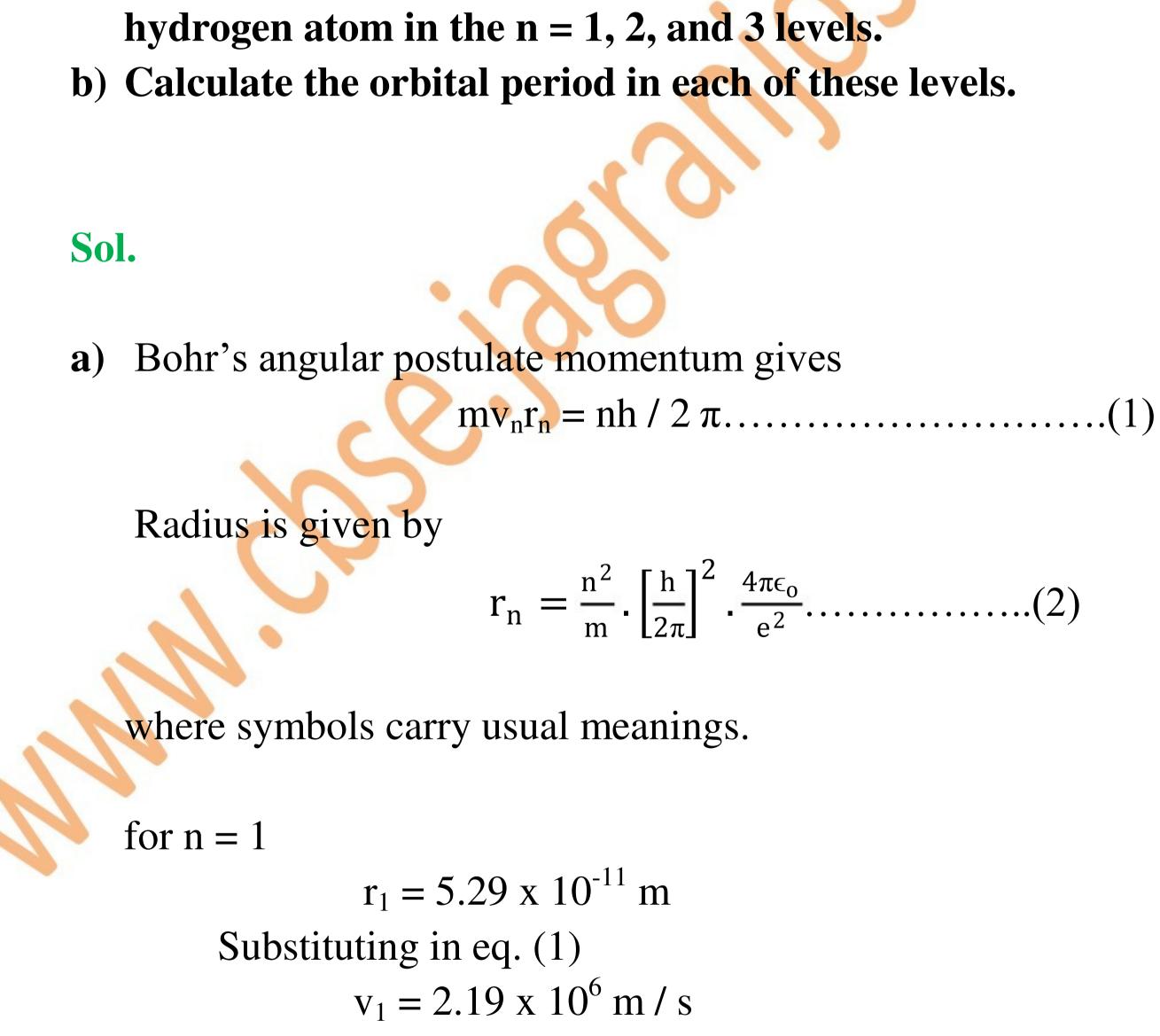
$$\frac{1}{\lambda} = R \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right]$$

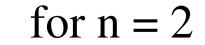
 $\lambda = 9.72 \text{ x } 10^{-8} \text{ m}$ Frequency, $v = c / \lambda = 3.1 \text{ x } 10^{15} \text{ Hz}$



12.7.

a) Using the Bohr's model calculate the speed of the electron in a



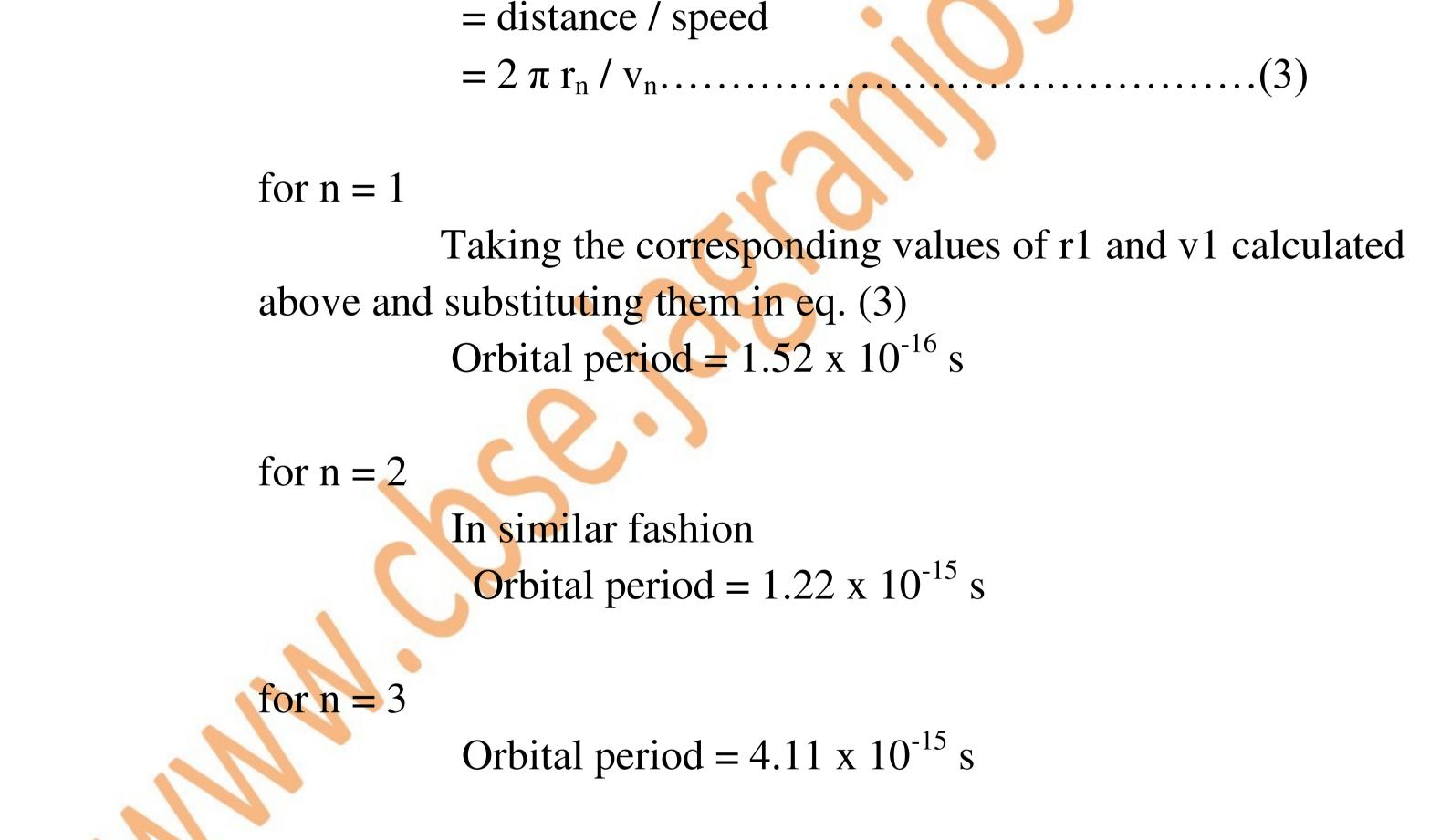




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Calculating radius using eq. (2) $r_2 = 2.12 \text{ x } 10^{-10} \text{ m}$ Putting in eq. (1) $v_2 = 1.09 \text{ x } 10^6 \text{ m / s}$

for n = 3 Calculating radius using eq. (2) $r_3 = 4.78 \times 10^{-10} \text{ m}$ Putting in eq. (1) gives $v_3 = 7.27 \times 10^5 \text{ m / s}$ b) Orbital period can be deduced by the simple relation of = distance / speed



12.8. The radius of the innermost electron orbit of a hydrogen atom is
5.3×10–11 m. What are the radii of the n = 2 and n = 3 orbits?



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From the previous question

$$r_n = \frac{n^2}{m} \cdot \left[\frac{h}{2\pi}\right]^2 \cdot \frac{4\pi\epsilon_o}{e^2}$$

Therefore

for
$$n = 2$$

 $r_2 = 2.12 \times 10^{-10} \text{ m}$
for $n = 3$
 $r_3 = 4.78 \times 10^{-10} \text{ m}$

12.9. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. What series of wavelengths will be emitted?

Sol.

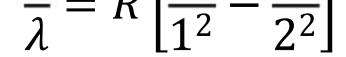
From the formula $E_n = -13.6 / n^2 eV$ For n = 3 to n = 1 $E_3 - E_1 = 12.09 eV \approx 12.5 eV$

This energy difference includes Lyman and Balmer series. At room temperature, most of the hydrogen atoms are in ground state. So n = 1, and the energy difference indicates the final n to be 2 or 3.

Lyman series

for n = 2

$$\frac{1}{R} = R \left[\frac{1}{R} - \frac{1}{R} \right]$$



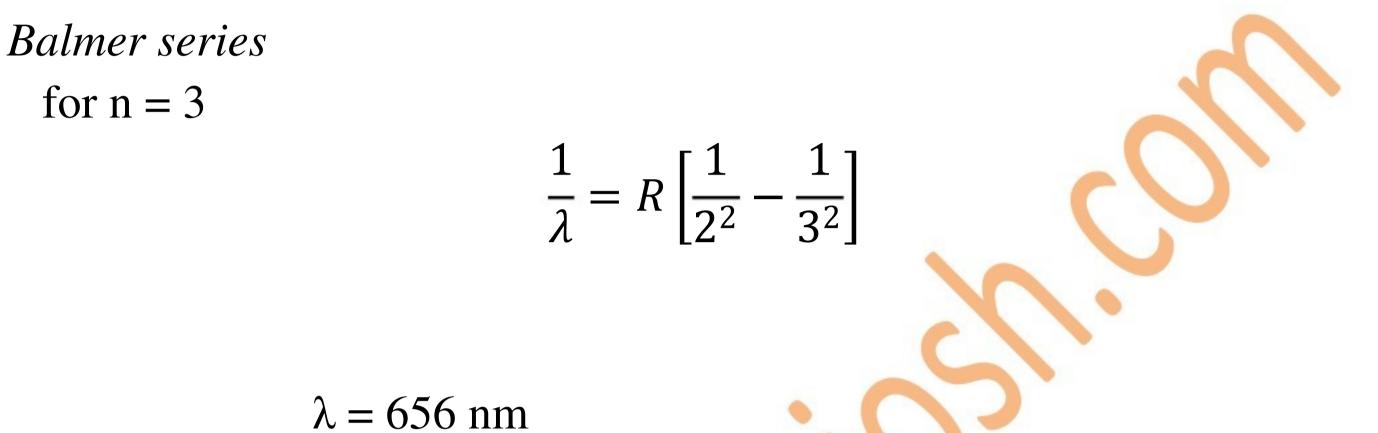


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 $\lambda = 122 \text{ nm}$

for n = 3

 $\lambda = 103 \text{ nm}$



12.10.In accordance with the Bohr's model, find the quantum number that characterises the earth's revolution around the sun in an orbit of radius 1.5 × 1011 m with orbital speed 3 × 104 m/s. (Mass of earth = 6.0 × 1024 kg.)

Sol.

Given: $r = 1.5 \times 10^{11} m$ v = 30000 m / s $m = 6 \times 10^{24} \text{ kg}$

Using the expression mvr = nh / 2π

Substituting and solving

$$n = 2.56 \times 10^{74}$$