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CLASS 12 PHYSICS NCERT SOLUTIONS

NCERT Solutions for Class 12 Physics Chapter 12: Atoms – Free PDF Download

Chapter 12 covers atomic structure — Thomson's and Rutherford's atomic models, the alpha-particle scattering experiment, Bohr's model of the hydrogen atom, atomic energy levels, and the origin of spectral lines. As with the previous chapter, the "Additional Exercises" section from older editions has been removed u...

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NCERT Exercise Solutions

12.1 Compare Thomson's model of the atom with Rutherford's model, considering: the size of the atom, the stability of electrons, the nature of the force holding an electron in place, and how mass is distributed within the atom.
Ans: **Size:** both models place the overall atomic size at roughly the same order ($\approx 10^{-10}$m), since this comes from the electron arrangement in either picture. **Stability:** in Thomson's model, an electron displaced from its equilibrium position inside the uniform positive sphere feels a restoring force (like a spring) proportional to its displacement, giving stable equilibrium; in Rutherford's model, an orbiting electron is held in a circular path by Coulomb attraction to the nucleus, but classically an accelerating charge must radiate energy continuously, so a Rutherford atom is **not** stable on classical grounds — a problem only resolved by Bohr's quantisation postulates. **Force:** Thomson's model gives a force proportional to displacement (SHM-like); Rutherford's model gives an inverse-square Coulomb force. **Mass distribution:** Thomson's model spreads the atom's mass almost uniformly through its volume; Rutherford's model concentrates nearly all the mass in a tiny central nucleus, leaving the rest of the atom's volume essentially empty.

12.2 In the alpha-particle scattering experiment, suppose the target gold foil is replaced by an equally thin sheet of solid hydrogen (kept at extremely low temperature). Would the fraction of incident alpha particles bounced back at large angles be similar to, or very different from, the observed gold-foil result? Explain.
Ans: **Very different — essentially no large-angle scattering would be observed.** A hydrogen nucleus (mass$\approx 1.67\times10^{-27}$kg) is lighter than an incident alpha particle (mass$\approx 6.64\times10^{-27}$kg, about 4 times heavier). Large-angle (near-180°) scattering in Rutherford's original experiment happens because the alpha particle rebounds off a gold nucleus far heavier than itself. With a lighter hydrogen target, the situation reverses — like a moving football colliding with a stationary tennis ball — the heavier incident alpha particle simply continues forward with reduced speed, and no significant backscattering can occur regardless of impact parameter.

12.3 The energy difference between two atomic energy levels is 2.3eV. What is the frequency of radiation emitted when an atom transitions from the higher to the lower of these two levels?
Ans: $v=\Delta E/h=2.3/(4.136\times10^{-15})\approx$ $\mathbf{5.56\times10^{14}}$**Hz**.

12.4 The ground state energy of the hydrogen atom is −13.6eV. Find the kinetic and potential energy of the electron in this state.
Ans: In the Bohr model, $KE=-E_{total}=$**13.6eV**, and $PE=2E_{total}=$**−27.2eV** (since total energy is half the potential energy, with kinetic energy equal in magnitude but opposite in sign to the total energy).

12.5 A hydrogen atom's electron makes a transition from n=1 to n=4. Find the wavelength and frequency of the photon absorbed in this transition.
Ans: $\Delta E=E_4-E_1=(-13.6/16)-(-13.6)=$**12.75eV**. $\lambda=hc/\Delta E=1240/12.75\approx$**97.3nm** (far ultraviolet).
$v=c/\lambda\approx 3.08\times10^{19}$Hz.

12.6 Using Bohr's model, calculate (a) the speed of the electron, and (b) the orbital period, for the electron in the n=1, n=2, and n=3 orbits of a hydrogen atom.
Ans: Speed scales as $v_n=v_1/n$ with $v_1\approx 2.2\times10^6$m/s: $\mathbf{v_1=2.2\times10^6}$**m/s**, $\mathbf{v_2=1.1\times10^6}$**m/s**, $\mathbf{v_3\approx 7.33\times10^5}$**m/s**.

Period scales as $T_n=n^3T_1$ with $T_1=2\pi r_1/v_1\approx1.51\times10^{-16}$s: **$T_1\approx1.51\times10^{-16}$s, $T_2\approx1.21\times10^{-15}$s, $T_3\approx4.09\times10^{-15}$s**.

12.7 The radius of the innermost (n=1) electron orbit of a hydrogen atom is 5.3×10^{-11}m. What are the radii of the n=2 and n=3 orbits?
Ans: Using $r_n=n^2r_1$: $r_2=4\times5.3\times10^{-11}\approx$**$2.12\times10^{-10}$m**, $r_3=9\times5.3\times10^{-11}\approx$**$4.77\times10^{-10}$m**.

12.8 A 12.5eV electron beam is used to bombard gaseous hydrogen at room temperature. Which series of wavelengths will be emitted?
Ans: The excitation energy needed to reach level n from the ground state is $13.6(1-1/n^2)$eV: reaching n=3 needs 12.09eV (available), but reaching n=4 needs 12.75eV (not available with only 12.5eV). So hydrogen atoms are excited up to **n=3** at most. The de-excitation that follows emits **both the Lyman series** (transitions ending at n=1: 2→1 and 3→1) **and the Balmer series** (transition 3→2, ending at n=2).

12.9 The Earth revolves around the Sun with an orbital radius of 1.5×10^{11}m, orbital speed 3×10^4m/s, and mass 6.0×10^{24}kg. Treating this like a Bohr-model orbit, find the quantum number that would characterise the Earth's revolution.
Ans: Using Bohr's angular-momentum quantisation $L=mvr=n\hbar$:
$n=mvr/\hbar=(6.0\times10^{24}\times3\times10^4\times1.5\times10^{11})/(1.055\times10^{-34})\approx$**$2.56\times10^{74}$**. This astronomically large quantum number shows why quantisation is utterly unobservable at macroscopic (planetary) scales — matching the correspondence principle between quantum and classical mechanics.

Class 12 Physics Chapter 12 – Notes and Extra Questions

Along with these NCERT Solutions, students can also use the Class 12 Physics Chapter 12 Extra Questions and Class 12 Physics Chapter 12 Revision Notes for quick revision and extra practice.

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