

PHYSICS • CLASS 12

CHAPTER 12

Atoms

NCERT SOLUTIONS



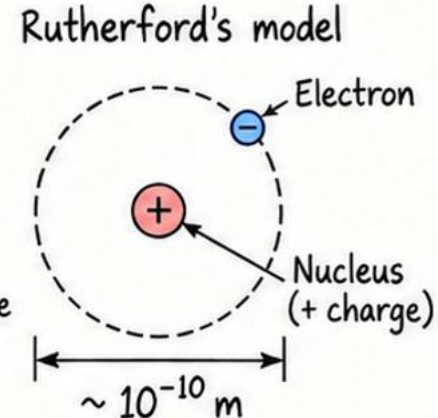
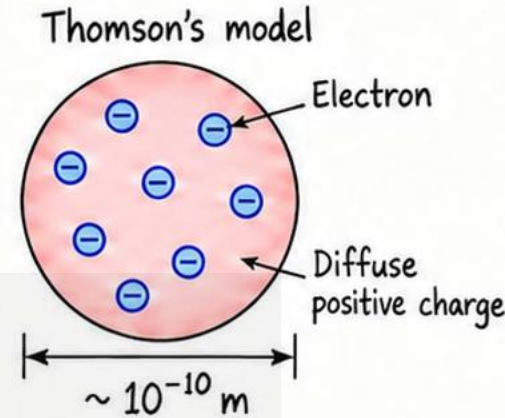
ATOMIC MODELS — EXERCISE 12.1(a-c)

Q. Choose correct alternatives in Exercise 12.1 parts (a), (b), (c).

(a) The size of the atom in Thomson's model is _____ the atomic size in Rutherford's model.

Answer: NO DIFFERENT FROM.

Both models put the atom at approximately 10^{-10} m across.



(b) In the ground state of _____ electrons are in stable equilibrium, while in _____ electrons always experience a net force.

Answer: THOMSON'S MODEL; RUTHERFORD'S MODEL.

Thomson's electrons can be in stable equilibrium in diffuse positive charge;
Rutherford's electron feels an attractive force toward the nucleus.

(c) A classical atom based on _____ is doomed to collapse.

Answer: RUTHERFORD'S MODEL.

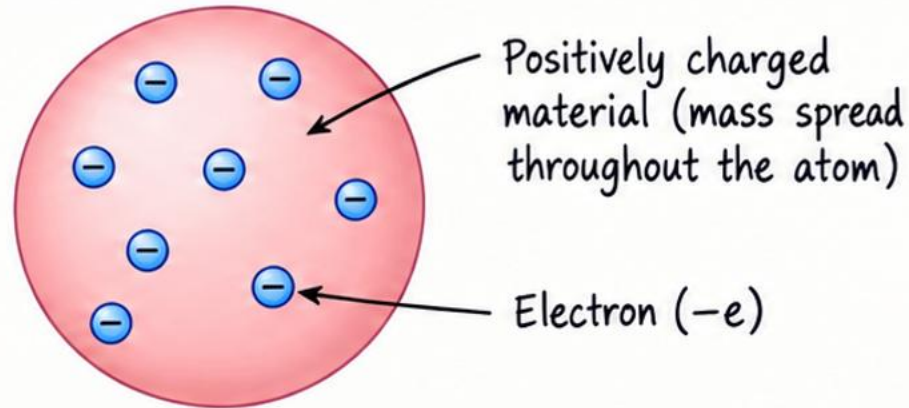
An orbiting charge accelerates and classical theory says it radiates energy.

ATOMIC MASS DISTRIBUTION — EXERCISE 12.1(d-e)

Q. (d) An atom has a nearly continuous mass distribution in _____ but has a highly non-uniform mass distribution in _____.

Answer: THOMSON'S MODEL; RUTHERFORD'S MODEL.

In Thomson's model, the positive mass (charge) is spread throughout the atom, giving a nearly continuous mass distribution. In Rutherford's model, almost all the mass is concentrated in a tiny nucleus, so the mass distribution is highly non-uniform.

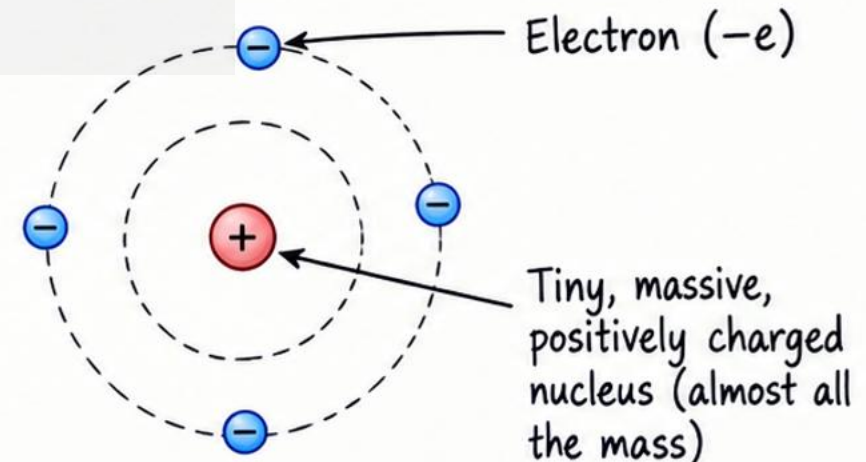


Thomson's model

Q. (e) The positively charged part of the atom possesses most of the mass in _____.

Answer: BOTH THE MODELS.

Electrons are much lighter than the positively charged material in either historical model, so the positively charged part of the atom possesses most of the mass in both models.



Rutherford's model

HYDROGEN FOIL SCATTERING – EXERCISE 12.2

Q. What would happen if Rutherford's alpha-particle scattering experiment used a thin sheet of SOLID HYDROGEN instead of gold foil? The source notes hydrogen solidifies below 14 K.

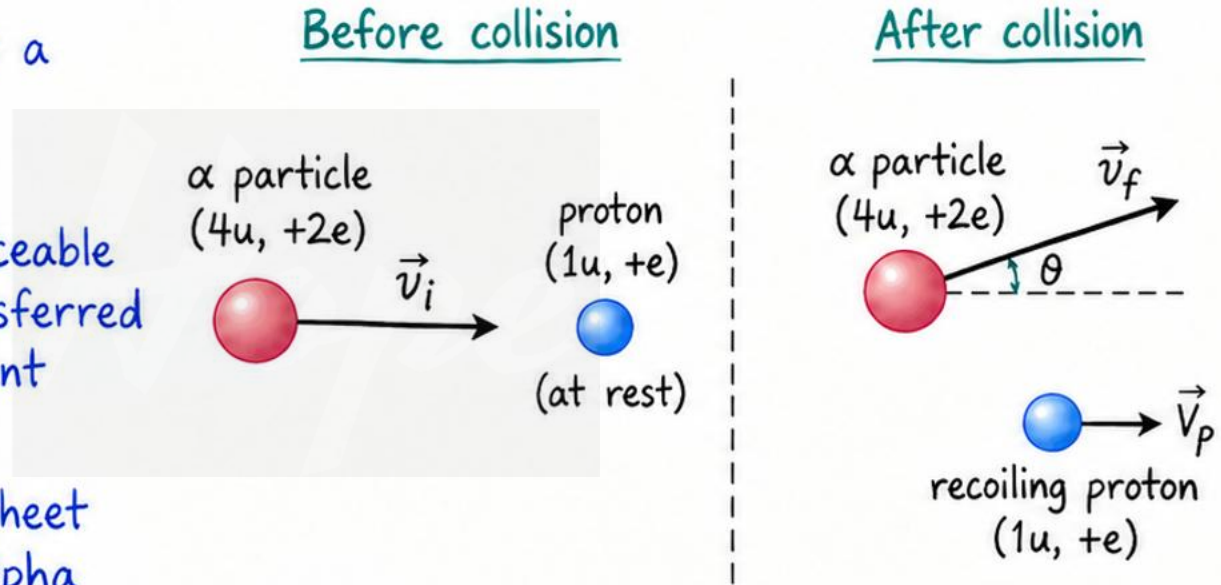
Answer:

An alpha particle (mass about $4u$, charge $+2e$) meets a proton (about $1u$, $+e$), much lighter and less strongly charged than a gold nucleus.

Because the target proton is light, in a collision a noticeable fraction of the alpha particle's momentum can be transferred to the proton, so the proton can recoil with a significant forward speed.

Most alpha particles pass through the thin hydrogen sheet with little or no deflection. In a single collision the alpha particle is deflected only modestly, since the electrostatic repulsion from a proton is weaker than from a heavy gold nucleus.

The pronounced large-angle or backward scattering of alpha particles, which occurs with heavy gold nuclei, is not expected from a thin sheet of solid hydrogen.



ATOMIC ENERGIES — EXERCISES 12.3–12.4

Q.12.3 Two atomic levels differ in energy by $\Delta E = 2.3 \text{ eV}$. Find the frequency of the radiation emitted when the atom makes a transition from the upper to the lower level.

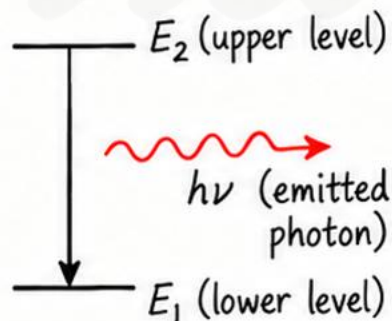
Answer:

When the atom makes a transition from the upper to the lower level, it emits a photon of energy equal to the difference in the two levels.

$$\Delta E = h\nu$$

$$\begin{aligned}\Delta E &= 2.3 \text{ eV} = 2.3(1.602 \times 10^{-19}) \text{ J} \\ &= 3.685 \times 10^{-19} \text{ J}\end{aligned}$$

$$\begin{aligned}\nu &= \frac{\Delta E}{h} = \frac{3.685 \times 10^{-19}}{6.63 \times 10^{-34}} \\ &= 5.56 \times 10^{14} \text{ Hz}\end{aligned}$$



Q.12.4 The total energy of the electron in the ground state of the hydrogen atom is -13.6 eV . What are the kinetic and potential energies of the electron in this state?

Answer:

For an electron in a Coulomb orbit, the potential energy is related to the kinetic energy as

$$U = -2K$$

The total energy is

$$E = K + U = -K$$

Given $E = -13.6 \text{ eV}$, hence

$$K = -E = +13.6 \text{ eV}$$

Then

$$U = -2K = -2(13.6 \text{ eV}) = -27.2 \text{ eV}$$



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