A Helium atom has a nuclear charge of Ze, where Z=2. One of the electrons is removed leaving an atom that resembles a Hydrogen atom but with twice the nuclear charge. What are the energy levels in this atom?

The energy levels in the Hydrogen atom are:

\[ E_n = - \frac{me^4}{\varepsilon_0^28n^2h^2} \]

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a) \[ E_n = - \frac{mZe^4}{\varepsilon_0^28n^2h^2} \]

b) \[ E_n = - \frac{mZ^2e^4}{\varepsilon_0^28n^2h^2} \]

c) \[ E_n = - \frac{mZ^4e^4}{\varepsilon_0^28n^2h^2} \]

d) \[ E_n = - \frac{me^4}{\varepsilon_0^28(Zn)^2h^2} \]
An electron that has been accelerated through a voltage $V$ undergoes a large acceleration when it hits the target.

Is there a limit to the wavelength of electromagnetic radiation produced?

a) No

b) There is an upper limit on wavelength

c) There is a lower limit on wavelength
X-rays from a molybdenum target at 35 kV

Wavelength (nm)

Relative intensity

$K_\alpha$

$K_\beta$

Brehmsstrahlung continuum
An electron is in the field of an EM plane wave. The electron is accelerated by the electric field, and therefore emits EM radiation. What would classical theory* predict is the wavelength of the emitted radiation?

a) A shorter wavelength than the plane wave.

b) A longer wavelength than the plane wave.

c) The same wavelength as the plane wave.

* This is called Thomson scattering
A QUANTUM THEORY OF THE SCATTERING OF X-RAYS
BY LIGHT ELEMENTS

By Arthur H. Compton

Fig. 5. The wave-length of scattered γ-rays at different angles with the primary beam, showing an increase at large angles similar to a Doppler effect.

Fig. 7. Comparison of experimental and theoretical intensities of scattered γ-rays.