QUESTION :

Prove the bohr radius for hg and find its quantized energy levels by using modern physics

Answer

Bohr's radius = 0.538×10^{-10}m

Explanation

Centripetal force :
$F = mv^2/r$
Electrostatic force :
$F = 1/4\pi\varepsilon * ze^2/r$

In a hydrogen atom,
Electrostatic force = Centrifugal force
$mv^2/r = 1/4\pi\varepsilon * ze^2/r$
$v^2 = 1/4\pi\varepsilon * ze^2/mr$ -> eq1

From Bohr's quantum equation,
$L = mvr = nh'$-> eq2
Where $h' = h/2\pi$

Get v from eq2,
$v = nh'/mr$

Then substitute v from eq1,
$1/4\pi\varepsilon * ze^2/mr = (nh'/mr)^2$; get the radius , r
$r = 4\pi\varepsilon (nh')^2/ mze^2$ -> eq3
As $4\pi\varepsilon = 1.9 \times 10^9$
And $h' = h/2\pi$; $h = 6.625 \times 10^{-34}$

The radius of Hydrogen Atom has ;
n = 1
$m = 9.11 \times 10^{-31}$kg,
z = 1
$e = 1.609 \times 10^{-19}$ C
Substitute this values in the Bohr's radius formula; eq3

$r = 4\pi\varepsilon (nh')^2/ mze^2$
$= (1.9 \times 10^9(1)^2(6.625 \times 10^{-34}/2\pi)^2)/(9.11 \times 10^{-31})(1)(1.609 \times 10^{-19})$
$r = \underline{0.538 \times 10^{-10}m}$