Suppose potential energy between electron and proton at separation r is given by $U = k \ln r$, where k is a constant. For such a hypothetical hydrogen atom, the radius of n^{th} Bohr orbit is given by:

(A) $\frac{nh}{2\pi\sqrt{mk}}$ (B) $\frac{nh}{\pi\sqrt{2mk}}$

(C) $\frac{n\hbar}{2\pi\sqrt{mk}}$ (D) $\frac{n\hbar}{\pi\sqrt{2mk}}$

Solution

$$F = -\frac{dU}{dr} = -\frac{k}{r}$$

$$\therefore \frac{mv^2}{r} = \frac{k}{r}$$

$$\therefore mv = \sqrt{mk}$$

Also, $mvr = n\frac{h}{2\pi}$

$$\therefore r\sqrt{mk} = n\frac{h}{2\pi}$$

$$\therefore r = \frac{nh}{2\pi\sqrt{mk}}$$

Hence, (A)