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Finally, we should check that this works: Putting $u = kH$ and $u = H$ in equation (A) we get:

$$k^2 [H'^2 + H^2] = 2m L_k^{-2} [E_k - a k^\nu H^\nu - b]$$

which gives

$$[H'^2 + H^2] = 2m L_1^{-2} [E_1 - a H^\nu - b]$$

$$L_1^{-2} [E_1 - a H^\nu - b] = k^{-2} L_k^{-2} [E_k - a k^\nu H^\nu - b]$$

Equating coeff of H^ν we get $L_1^{-2} = k^{\nu - 2} L_k^{-2}$ or $\boxed{L_k^2 = L_1^2 k^{\nu-2}}$

Similarly, $\boxed{E_k - b = k^\nu (E_1 - b)}$ This shows how the initial conditions should be adjusted for the various orbits.

Thus, if $u = H(\phi)$ is a solution for E_1 and L_1, $u = k H(\phi)$ is a solution for E_k and L_k. Therefore, there is no restriction on a, ν, and b.