## Question 32368

One needs to use the laws of conservation of linear momentum and energy.
First one gives:

1) $m_e v = m_e v' + M_H v''$
, where $m_e$ is the mass of electron, $v$ is the initial electron velocity, $v'$ is the final electron velocity, $M_H$ is the mass of hydrogen atom and $v''$ is the velocity of Hydrogen atom after collision. Also, $\frac{M_H}{m_e} = 1837$ (according to given conditions).
Law of conservation of energy gives:
2) $m_e v^2 = m_e v'^2 + M_H v''^2$ .

From equation 1), obtain $v' = v - \frac{M_H}{m_e} v''$ .
Plugging latter expression into 2):
$m_e v^2 = m_e \left(v - \frac{M_H}{m_e} v''\right)^2 + M_H v''^2$ .

Opening brackets in latter expression, obtain $0 = -2 v v'' M_H + \frac{M_H^2}{m_e} v''^2 + M_H v'^2$ . Dividing by $m_e v''$ , get $2v \frac{M_H}{m_e} = v'' \left(\frac{M_H^2}{m_e^2} + \frac{M_H}{m_e}\right)$ , from which obtain connection between $v''$ and $v$ (using $\frac{M_H}{m_e} = 1837$ ): $v'' = \frac{2 \cdot 1837}{\left(1837^2 + 1837\right)} v = 1.09 \cdot 10^{-3} v$ .

The ratio of kinetic energy of the hydrogen atom after the collision to that of the of the electron before the collision is:

$$k = \frac{\frac{M_H v''^2}{2}}{\frac{m_e v^2}{2}} = \frac{M_H v''^2}{m_e v^2} = 1837 \cdot \left(1.09 \cdot 10^{-3}\right)^2 = 0.0022 \quad .$$