Q- What is the wavelength of an electron of energy (a) 20 eV (b) 200 eV (c) 2.0 keV

(a) The kinetic energy of the electron is 20 eV = $20*1.6*10^{-19}$ J = $3.2*10^{-18}$ J
Thus the velocity of electron is given by

$$K = \frac{1}{2}mv^2$$

Or $$v = \sqrt{\frac{2*KE}{m}} = \sqrt{\frac{2*3.2*10^{-18}}{9.11*10^{-31}}} = 2.65*10^6 \text{ m/s}$$

(This velocity is 0.0088c hence non relativistic approach)

The de Broglie wavelength of the electron at this speed is given by

$$\lambda_1 = \frac{h}{p} = \frac{h}{mv} = \frac{6.63*10^{-34}}{9.11*10^{-31}*2.65*10^6} = 2.75*10^{-10} \text{ m} = \mathbf{0.275\ nm}.$$

(b) The kinetic energy of the electron is 200 eV = $200*1.6*10^{-19}$ J = $3.2*10^{-17}$ J

Thus the velocity of electron is given by

$$KE = \frac{1}{2}mv^2$$

Or $$v = \sqrt{\frac{2*KE}{m}} = \sqrt{\frac{2*3.2*10^{-17}}{9.11*10^{-31}}} = 8.38*10^6 \text{ m/s}$$

(This velocity is 0.028c hence non relativistic approach)

The de Broglie wavelength of the electron at this speed is given by

$$\lambda_2 = \frac{h}{p} = \frac{h}{mv} = \frac{6.63*10^{-34}}{9.11*10^{-31}*8.38*10^6} = 8.68*10^{-11} \text{ m} = \mathbf{0.0868\ nm}.$$

(c) The kinetic energy of the electron is 2000 eV = $2000*1.6*10^{-19}$ J = $3.2*10^{-16}$ J
Thus the velocity of electron is given by

$$KE = \frac{1}{2}mv^2$$

Or $$v = \sqrt{\frac{2*KE}{m}} = \sqrt{\frac{2*3.2*10^{-16}}{9.11*10^{-31}}} = 2.65*10^7 \text{ m/s}$$

(This velocity is 0.088c hence non relativistic approach)

The de Broglie wavelength of the electron at this speed is given by

$$\lambda_2 = \frac{h}{p} = \frac{h}{mv} = \frac{6.63*10^{-34}}{9.11*10^{-31}*2.65*10^7} = 2.75*10^{-11} \text{ m} = \mathbf{0.0275\ nm}.$$