

Question Number	Answer	Mark
15a	<p>Substitutes values into $E = \left(\frac{e^2}{kh}\right)^2 \left(\frac{m}{8}\right)$ (1)</p> <p>Converts J into eV (1)</p> <p>13.5eV or 13.6 eV (1) 3</p> <p>(MP3 is dependent upon correct working being shown)</p> <p>Example of calculation</p> $E = \frac{(1.60 \times 10^{-19} \text{ C})^4 (9.11 \times 10^{-31} \text{ kg})}{(8.85 \times 10^{-12} \text{ Fm}^{-1})^2 (6.63 \times 10^{-34} \text{ Js})^2 \times 8}$ $E = 2.17 \times 10^{-18} \text{ J}$ $(2.17 \times 10^{-18} \text{ J}) / (1.60 \times 10^{-19} \text{ J eV}^{-1}) = 13.56 \text{ eV}$	
15b	<p>Substitutes values into $r = \frac{h^2 k}{\pi m e^2}$ (1)</p> <p>$r = 5.3 \times 10^{-11} \text{ (m)}$ (1)</p> <p>Use of $\lambda = h/p$ (1)</p> <p>$\lambda = 2.8 \times 10^{-14} \text{ (m)}$ (for neutron) (1)</p> <p>neutron wavelength not similar to size of atom radius, so student is incorrect (1) 5</p> <p>(MP5 is dependent upon awarding all of MP1-4 and there needs to be some comparison of the two values)</p> <p>(allow MP1 and/or MP3 for candidates who substitute the incorrect mass into the equation e.g. mass of neutron where it should be mass of electron in MP1)</p> <p>Example of calculation</p> $r = \frac{h^2 k}{\pi m e^2} = \frac{(6.63 \times 10^{-34} \text{ Js})^2 (8.85 \times 10^{-12})}{\pi (9.11 \times 10^{-31} \text{ kg})(1.60 \times 10^{-19} \text{ C})^2}$ <p>$r = 5.31 \times 10^{-11} \text{ m}$</p> <p>For neutron, $\lambda = h/p = (6.63 \times 10^{-34} \text{ Js}) / (1.67 \times 10^{-27} \text{ kg}) (1.4 \times 10^7 \text{ m s}^{-1})$</p> <p>$= 2.84 \times 10^{-14} \text{ m}$</p>	
Total for question 15		8