15 Niels Bohr developed an early model of the atom where electrons could only exist in fixed orbits around a nucleus.

When an atom is ionised, an electron moves from its orbit around the nucleus to be free of the atom. Bohr derived an expression for the ionisation energy E, in joules, for a hydrogen atom:

$$\left(\frac{e^2}{kh}\right)^2 \times \frac{m}{8}$$

where

m = mass of electron
e = charge of electron
$k = 8.85 \times 10^{-12}\,\text{C V}^{-1}\,\text{m}^{-1}$
h = Planck constant

(a) Calculate E for a hydrogen atom, in eV.

(3)

$E =$ ..... eV

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(b) The Bohr model can also be used to predict an approximate radius for an atom. The equation for the radius r of the hydrogen atom is:

$$r = \frac{h^2 k}{\pi m e^2}$$

where

m = mass of electron

A student suggests that, for a speed of $1.4 \times 10^7\ \text{m s}^{-1}$, neutrons would have a wavelength similar to the radius of a hydrogen atom.

Determine whether the student is correct.

mass of neutron = 1.67×10^{-27} kg

(5)

(Total for Question 15 = 8 marks)

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