8 **(a)** State what is meant by the de Broglie wavelength.

.....

..... [1]

(b) Calculate the de Broglie wavelength of an electron moving at a speed of $4.9 \times 10^7\,\text{m s}^{-1}$.

wavelength = ... m [2]

(c) State **one** similarity and **one** difference between an electron and a positron.

similarity: .....

.....

difference: .....

.....
[2]

(d) An electron moving at a speed of $4.9 \times 10^7\,\text{m s}^{-1}$ collides with a positron that is travelling at the same speed in the opposite direction. As a result of the collision, two gamma-ray photons are produced.

(i) State the name of this type of reaction.

..... [1]

(ii) State what happens to the electron and to the positron.

.....

.....

..... [2]

(iii) Explain why two gamma-ray photons are produced, rather than just one.

.....

..... [1]

(iv) Show that the kinetic energy of the electron before the collision is $1.1 \times 10^{-15}\,\text{J}$.

[1]

(v) Use the information in **(d)(iv)** to determine, to three significant figures, the wavelength associated with the gamma radiation emitted in the collision.

wavelength = ... m [3]

[Total: 13]