

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 $4.9 \times 10^7 \text{ ms}^{-1}$.

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 $4.9 \times 10^7 \text{ ms}^{-1}$ 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]

9 (a) (i) Describe what is meant by wave–particle duality.

.....

.....

..... [2]

(ii) State the relationship between the de Broglie wavelength λ of a particle and its momentum p . State the meaning of any other symbols that you use.

.....

..... [2]

(b) A narrow beam of electrons, all with the same speed, is incident normally on a carbon film. The electrons then move on to a fluorescent screen, as illustrated in Fig. 9.1.

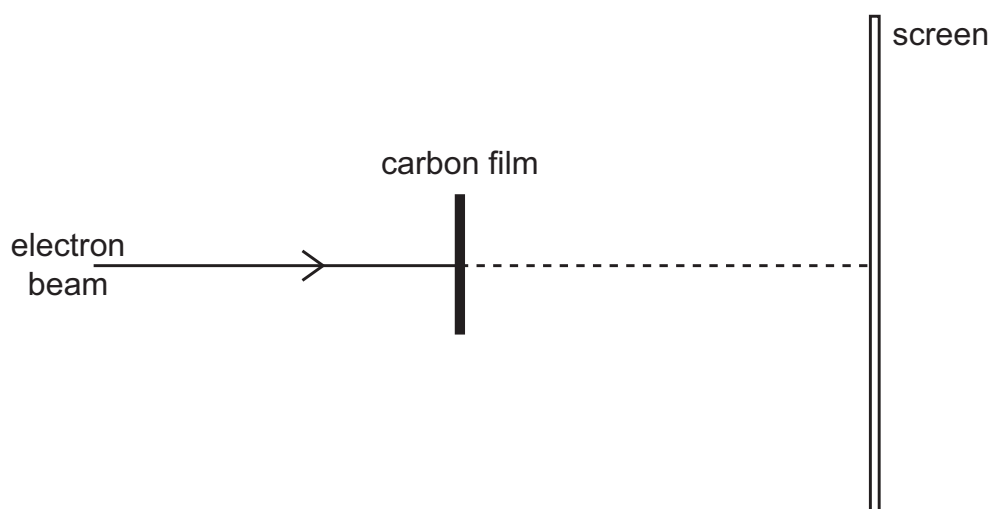


Fig. 9.1

The apparatus is in a vacuum.

The pattern produced on the screen is shown in Fig. 9.2.

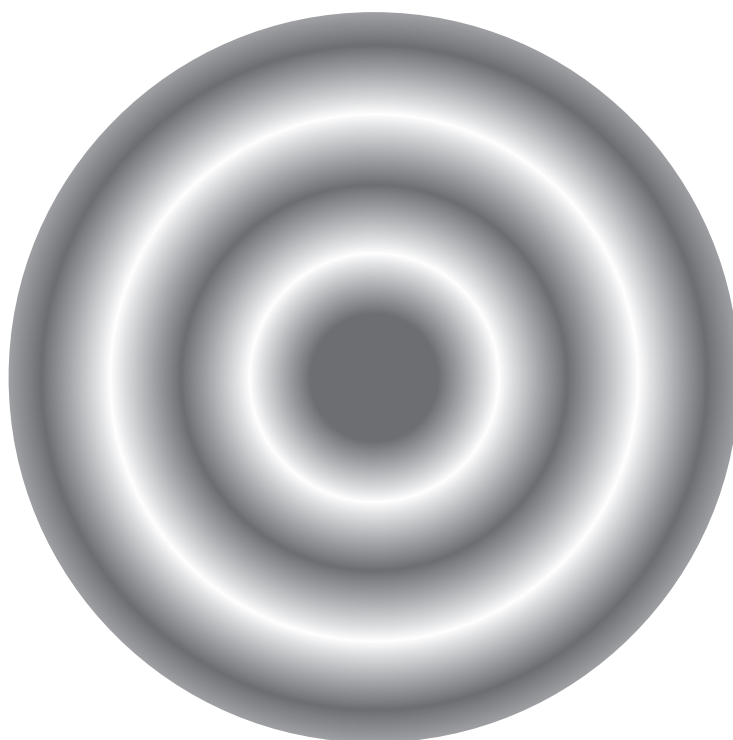


Fig. 9.2 (not to scale)

- (i) Explain why the pattern in Fig. 9.2 provides experimental evidence to indicate a wave nature for the electrons.

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.....

..... [2]

- (ii) The speed of the electrons is increased.

Suggest, with a reason, how this change affects the pattern observed on the screen.

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..... [2]

[Total: 8]