6 **(a)** The wave properties of electrons can be demonstrated using electron diffraction. The arrangement used includes a parallel beam of electrons accelerated by a potential difference in a glass envelope as shown in Fig. 6.1. A graphite film is placed perpendicularly to the path of the electron beam.

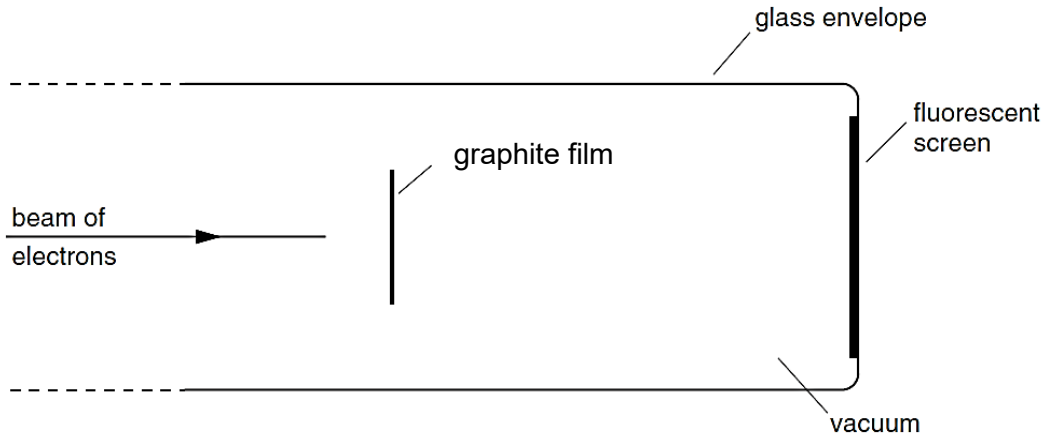

Fig. 6.1

The electrons incident on a fluorescent screen create a pattern consisting of bright and dark rings, as shown in Fig. 6.2.

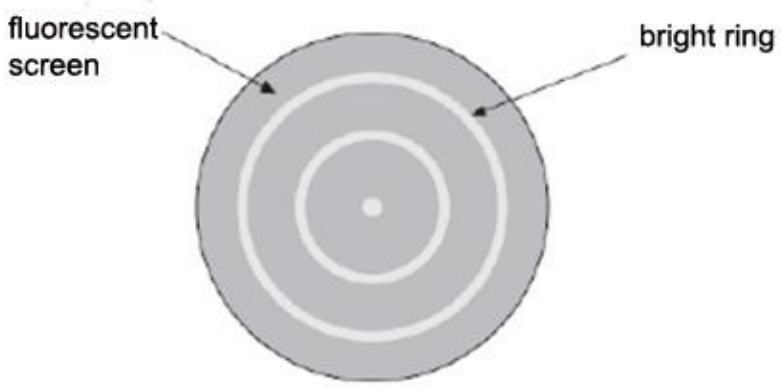

Fig. 6.2

(i) Identify two key features in Fig. 6.2 and explain how they provide evidence for the wave nature of electrons.

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..... [2]

(ii) Electrons of mass *m* are accelerated in a vacuum through a potential difference *V* of 250 V.

1. Show that the associated wavelength λ of the electrons can be expressed as

$$\lambda = \frac{h}{\sqrt{2meV}}.$$

[2]

2. Hence, calculate the wavelength λ of the electrons.

λ = ... m [2]

(iii) Describe and explain how the observed pattern in Fig. 6.2 changes as the potential difference V is increased.

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..... [2]

(b) The wave properties of matter do not seem to affect us noticeably in everyday life.

When a 80 kg man walks in a straight line at 2.0 m s^{-1} and passes through a doorway of width 1.2 m, he is not obviously deflected from his path.

Show, using Heisenberg's Uncertainty Principle and some appropriate workings, that the deflection of the man is negligible. You may take the width of the doorway as the uncertainty in position of the man.

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..... [2]

[Total: 10]

Section B

Answer **one** question from this Section in the spaces provided.