9 Two metal plates X and Y are contained in an evacuated container and are connected as shown in Fig. 9.1. Monochromatic electromagnetic radiation of blue light is incident on metal plate X.

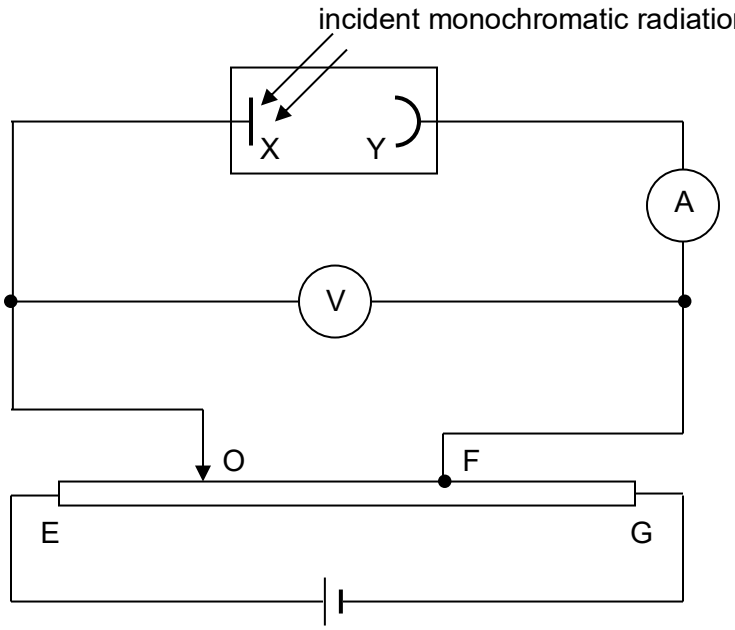

Fig. 9.1

The potential of X with respect to Y is varied by adjusting the position of the sliding contact from E to G. The variation of current *I* recorded at the ammeter with potential *V* of X is given by Fig. 9.2 below.

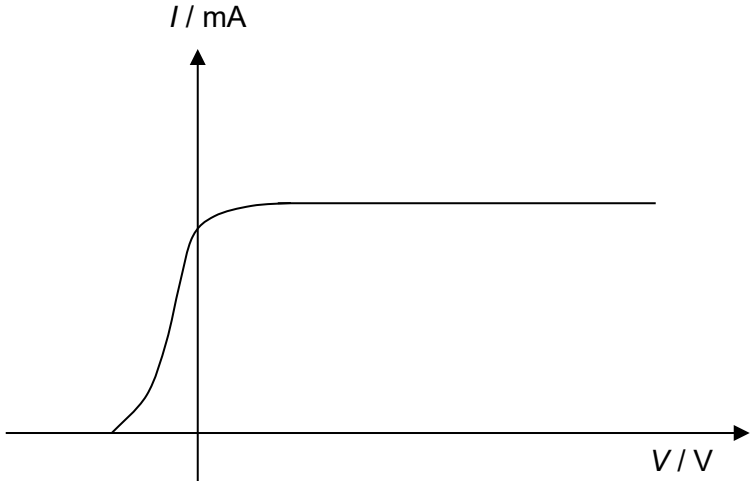

Fig. 9.2

(a) Explain an evidence provided by the photoelectric effect experiment for the failure of the wave theory of light.

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..... [2]

(b) Circle the portion of the graph on Fig. 9.2 that represents the variation of current as the sliding contact moves from F to G.

[1]

(c) Sketch, on Fig. 9.2, the graph when electromagnetic radiation of the same intensity in the ultraviolet region is used instead.

[2]

(d) It is observed that photoelectrons are emitted from plate X when photons of wavelength 520 nm is illuminated on it. The metal plate has a work function of 1.40 eV.

(i) Explain what is meant by *work function*.

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..... [1]

(ii) Determine the maximum speed with which a photoelectron leaves the surface of the plate. Explain your working.

maximum speed = ... m s^{-1} [3]

(iii) Calculate the minimum de Broglie wavelength associated with the photoelectrons that leaves the surface of the plate.

minimum wavelength = ... m [2]

(e) Photoelectrons with a de Broglie wavelength of 17.5 pm is allowed to strike a carbon film as shown in Fig. 9.3. Concentric circles are formed on a screen which is placed 20 cm away. The screen is parallel to the plane of the carbon film.

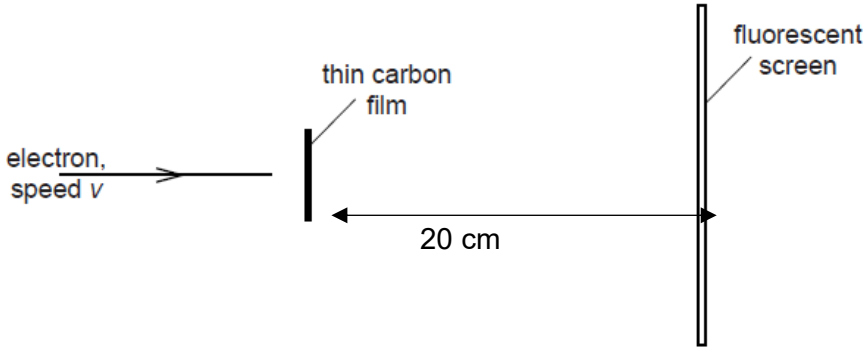

Fig. 9.3

(i) Explain the part played by diffraction in the production of the concentric circles.

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..... [3]

Fig. 9.4 shows a scaled diagram of the concentric rings formed on the screen.

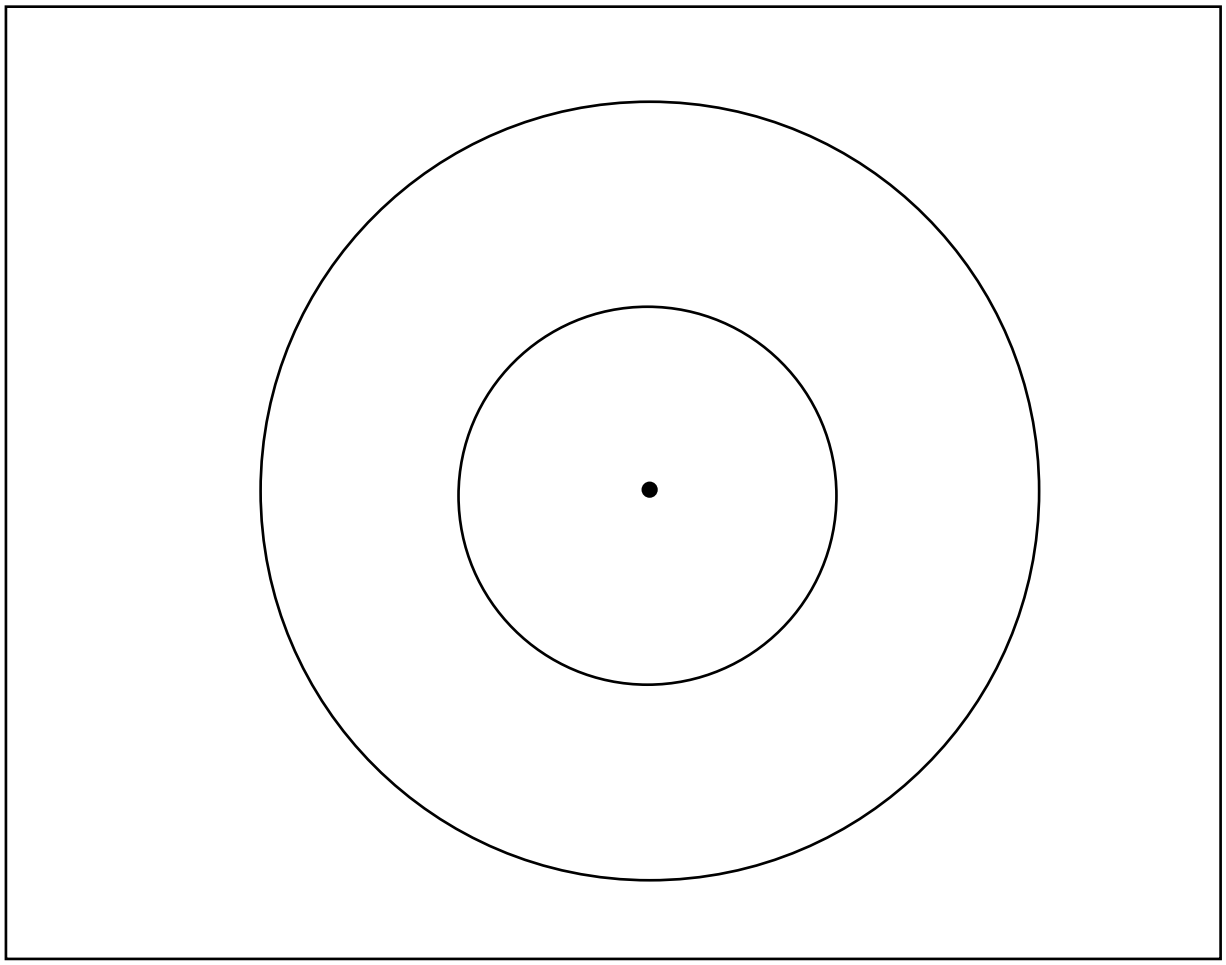

Fig. 9.4

(ii) Show that the spacing between the carbon atoms is 140 pm. Explain your working clearly.

[3]

(iii) Metal plate X is replaced with another of lower work function

1. Sketch, on Fig. 9.4, the ring representing the first order maxima. [1]

2. Explain your answer to **(iii)1**.

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..... [2]

[Total: 20]

End of Paper