Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

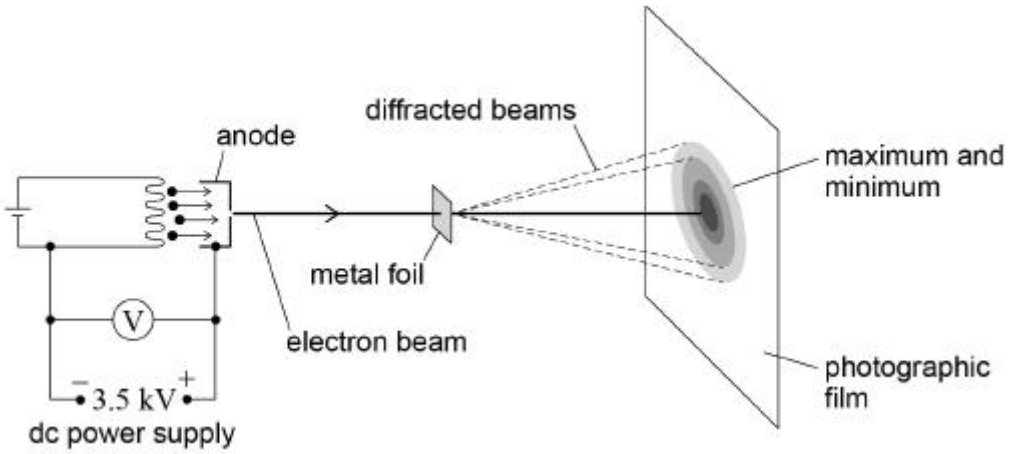
Q1.

Figure 1 shows part of the apparatus used to investigate electron diffraction.

Electrons were accelerated through a potential difference to form a beam which was then incident on a thin metal foil.

Regions of maximum and minimum intensity formed on a photographic film behind the foil.

Figure 1



(a) State de Broglie's hypothesis.

_____

_____

_____

_____

(2)

(b) The voltmeter in **Figure 1** shows a reading of 3.5 kV.

Determine whether this voltmeter reading is consistent with a de Broglie wavelength for the electrons in the beam of about 0.02 nm.

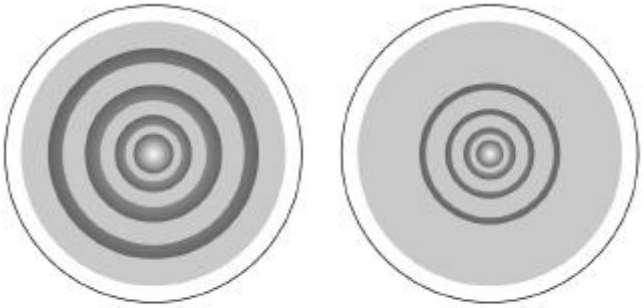
_____

_____

(2)

(c) The experiment is repeated using a similar arrangement to that shown in **Figure 1**. **Figure 2** shows the diffraction patterns from the two experiments.

Figure 2



first experiment second experiment

State and explain **two** independent changes that could be made to the arrangement in **Figure 1** to produce the result shown for the second experiment in **Figure 2**.

First change _____

_____

_____

_____

_____

_____

Second change _____

_____

_____

_____

_____

_____

(4)

(Total 8 marks)

Q2.

The table shows data of speed v and kinetic energy E_k for electrons from a modern version of the Bertozzi experiment.

v / 10^8 m s^{-1}	E_k / MeV
2.60	0.5
2.73	0.7
2.88	1.3

2.96	2.6
2.99	5.8

(a) Classical mechanics predicts that $E_k \propto v^2$.

Deduce whether the data in the table above are consistent with this prediction.

(2)

(b) Discuss how Einstein's theory of special relativity explains the data in the table.

(4)

(c) Calculate, in J, the kinetic energy of one electron travelling at a speed of 0.95c.

kinetic energy = _____ J

(3)

(Total 9 marks)