Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

In a transmission electron microscope (TEM) electrons are accelerated by a potential difference V between a cathode and anode. The de Broglie wavelength λ of the accelerated electrons depends on V.

(a) Identify which of the following represents the relationship between λ and V. Ignore relativistic effects.

Tick (✔) the correct answer in the right−hand column

	✔ **if correct**
$\lambda \propto \sqrt{V}$	
$\lambda \propto V$	
$\lambda \propto \frac{1}{V}$	
$\lambda \propto \frac{1}{\sqrt{V}}$	

(1)

(b) TEMs operate using wavelengths of about 0.1 nm.

Explain why operation at such wavelengths makes the instrument such an important research tool.

_____

_____

_____

_____

(2)

(c) State and explain **two** factors that limit the detail in the image produce by a TEM.

1 _____

_____

_____

_____

2. _____

_____

_____

_____

(4)

(Total 7 marks)

Q33.

Maxwell's theory suggested the existence of electromagnetic waves that travel at a speed of $\sqrt{\frac{1}{\varepsilon_0 \mu_0}}$

Hertz later discovered radio waves and performed experiments to investigate their properties.

The figure below shows a radio wave transmitter and a detector. The wave is transmitted by a dipole aerial. The detector consists of a metal loop connected to a meter.

(a) Explain how the detection of the wave by the loop demonstrates the magnetic nature of the radio waves.

_____

_____

_____

(2)

(b) Explain how the electric nature of the waves emitted by the dipole could be demonstrated.

_____

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_____

(1)

(c) Hertz used an arrangement like that shown in the figure above to determine the speed of radio waves.

Describe how the speed was determined. Go on to discuss how the experiments of Hertz confirmed Maxwell's prediction and the experimental evidence that suggests that light is also an electromagnetic wave.

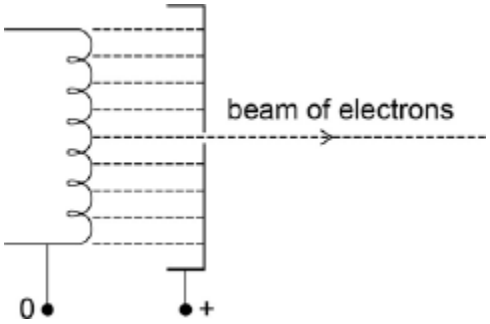
(6)

(Total 9 marks)

Q3.

Figure 1 shows a narrow beam of electrons produced by attracting the electrons emitted from a filament wire, to a positively charged metal plate which has a small hole in it.

Figure 1



(a) Explain why an electric current through the filament wire causes the wire to emit electrons.

(2)

(b) Explain why the filament wire and the metal plates must be in an evacuated tube.

(1)

(c) The potential difference between the filament wire and the metal plate is 4800 V.

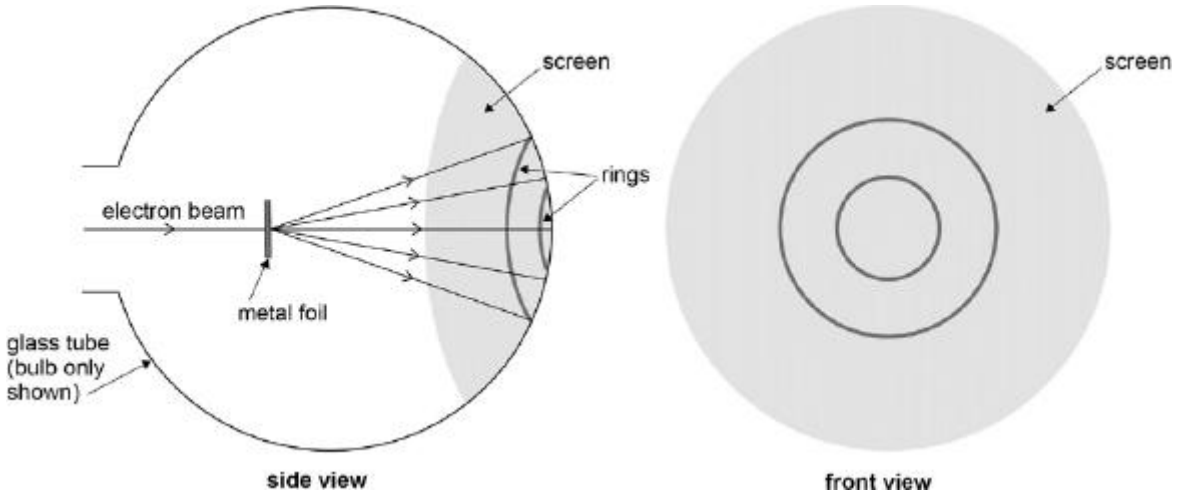
Calculate the de Broglie wavelength of the electrons in the beam.

wavelength = _____ m

(4)

The beam is directed at a thin metal foil between the metal plate and a fluorescent screen at the end of the tube, as shown in **Figure 2**.
The electrons that pass through the metal foil cause a pattern of concentric rings on the screen.

Figure 2



(d) The potential difference between the filament and the metal plate is increased. State and explain the effect this has on the diameter of the rings.

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_____

_____

_____

(3)

(Total 10 marks)