

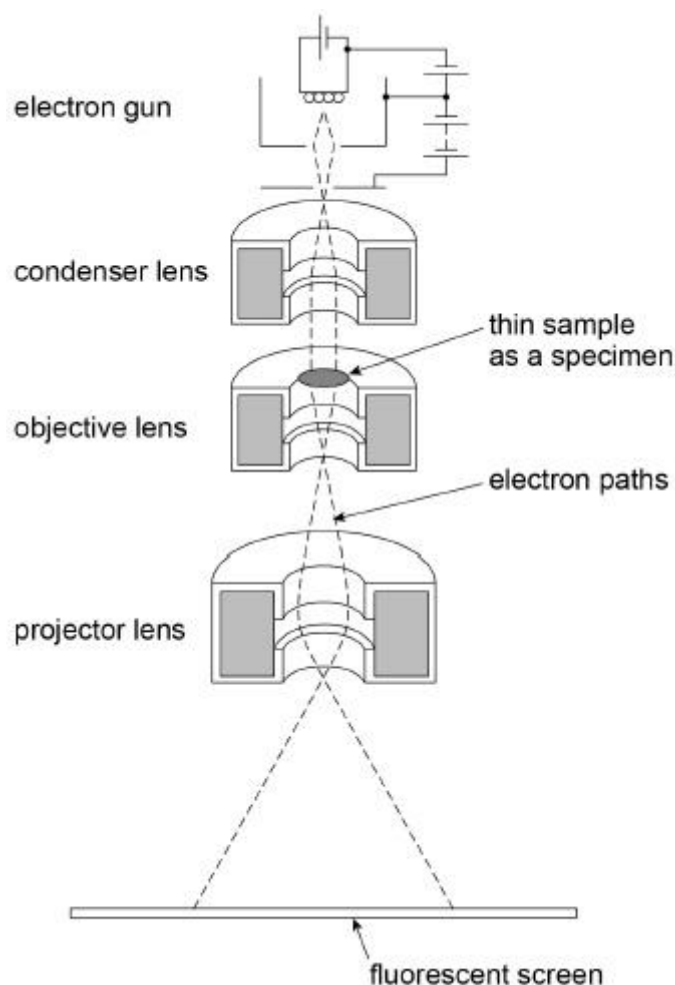
Name of the Student: _____

Max. Marks : 19 Marks

Time :19 Minutes

Q1.

The diagram shows the main parts of a transmission electron microscope (TEM).



- (a) What is the process by which electrons are produced in an electron gun?
Tick (✓) the correct box.

Beta particle emission

☐

Electron diffraction

☐

Photoelectric effect

☐

(1)

- (b) The electrons in a particular TEM have a kinetic energy of 4.1×10^{-16} J. Relativistic effects are negligible for this electron energy.

Suggest, with a calculation, whether the images of individual atoms can, in principle, be resolved in this TEM.

(3)

- (c) A typical TEM can accelerate electrons to very high speeds and form high resolution images.

Explain:

- the process of image formation, and
- the factors that affect the quality of, and the level of detail in, the image.

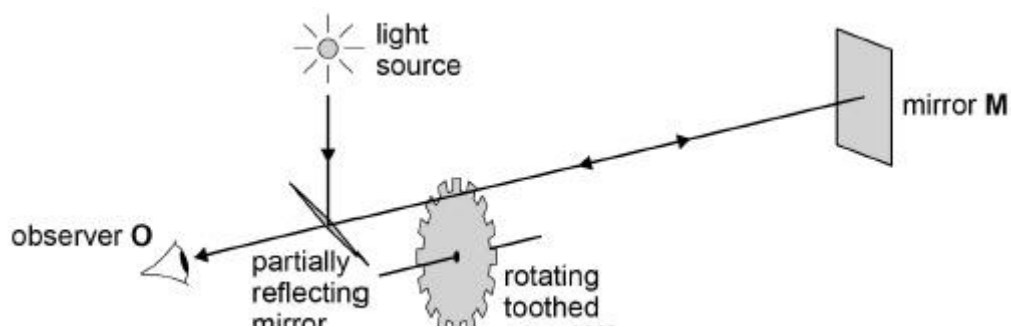
[illegible]

(6)

(Total 10 marks)

Q2.

The diagram shows the apparatus Fizeau used to determine the speed of light.



The following observations are made.

- A When the speed of rotation is low the observer sees the light returning after reflection by the mirror **M**.
- B When the speed of the wheel is slowly increased the observer continues to see the light until the wheel reaches a certain speed. At this speed the observer cannot see the light.
- (a) Explain these observations.

Observation A

Observation B

(2)

- (b) The table shows data from Fizeau's experiment at the instant when observation B is made.

d , distance from M to W	8.6 km
f , number of wheel revolutions per second	12
n , number of teeth in the wheel	720

It can be shown that the speed of light c is given by the equation

$$c = 4dnf$$

Discuss whether the data in the table are consistent with the present accepted value for the speed of light.

(2)

- (c) The speed of the wheel is further increased.

Deduce the value of f when the observer would next be unable to see light returning from the mirror.

(2)

- (d) Explain how the nature of light is implied by Maxwell's theory of electromagnetic waves and Fizeau's result.

(3)

(Total 9 marks)