

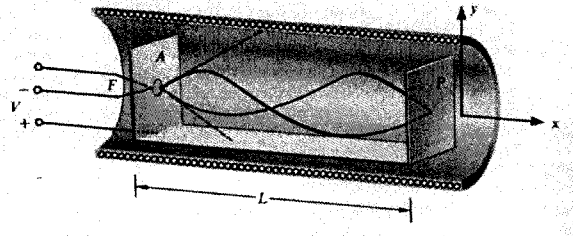
The max. points to be gained are indicated at the end of each question.

1. Explain briefly the following (8 p):

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|---------------------|------------------------------------|
| a) Geometric optics | e) Control loop |
| b) Abbé criterion | f) Electric force microscopy |
| c) Eyepiece | g) Projection printing |
| d) Field emission | h) Extreme ultraviolet lithography |

2. The magnetic lens in electron microscopy. Basic construction and aberration mechanisms. (4p)

3. Pictured is a long solenoid with a uniform axial magnetic field of intensity B . Through a small hole in the screen A electrons, that have been accelerated with the voltage V , enter with a velocity with components in both x- and y-directions, but so that one may approximate their kinetic energy, eV , solely by the x-component v_x ($eV = mv_x^2/2$).



The electron beam converges at point P, a distance L from the screen A. Derive an expression for L . (6)

4. The main components in a Scanning Probe Microscope (SPM). Discuss briefly all the main parts and principles of operation that make up the SPM and that are common to both STM and AFM. Discuss also briefly what then makes the difference between the STM and the AFM. (6p)

5. Calculate the mechanical eigenfrequency for axial oscillation for a tube scanner with the following parameters:

Outer radius D_o : 10 mm

Inner radius D_i : 8 mm

Length L : 40 mm

Young's modulus Y : 100 Gpa (1 Pa = 1 N/m²)

Density ρ : 5 g/cm³

If the scanner is moving a tip that images with a resolution of 10 nm in the plane of the sample surface, what is the absolute upper limit for the velocity of the tip ? (6)

Possibly useful equations: $\omega = \frac{eB}{m}$, $\omega_0 = \sqrt{\frac{k}{m}}$