Magnetic Levitation

Part A. Sudden appearance of a magnetic monopole: initial response and subsequent time evolution of the response in the thin film

Initial response

A.1 $(0.4\ \mathrm{pt})$
In the $z \geq 0$ region:

$\vec{B}(\vec{\rho}, z) =$

A.2 $(0.2\ \mathrm{pt})$
In the $z \leq -d$ region:

$\vec{B}(\vec{\rho}, z) =$

A.3 $(0.4\ \mathrm{pt})$
at the $z = 0$ surface:

$\Phi_{\mathrm{B}} =$

at the $z = -d$ surface:

$\Phi_{\mathrm{B}} =$

A.4 $(0.6\ \mathrm{pt})$

$\vec{j}(\vec{\rho}) =$

Subsequent response

A.5 (0.6 pt)
An equation for $B'_z(\rho, z; t)$ near $z \approx 0$:

The equation:

A.6 (0.4 pt)
General form of $B'_z(\rho, z; t)$ near $z \approx 0$:

Form of $B'_z(\rho, z; t) =$

A.7 (0.4 pt)
Show the moving image-monopole picture for $B'_z(\rho, z \approx 0; t)$:

$v_0 =$

Part B. Magnetic force acting on a point-like dipole moving with a constant velocity and at a constant h

A moving monopole

B.1 (0.8 pt)
Positions of the q_m type image monopoles:

Positions of the $-q_\mathrm{m}$ type image monopoles:

B.2 (0.7 pt)
Summation form of $\Phi_+(x,z) =$

Calculate $\Phi_+(x,z) =$

A moving dipole

B.3 (1.5 pt)

$\vec{F} =$

Relation between v_0 and v

B.4 (0.3 pt)

Value of $v_0 =$

B.5 (0.4 pt)
Small v regime:

$v_0(v) =$

Large v regime:

$v_0(v) =$

B.6 (0.3 pt)

$v_\text{c} =$

Part C. Motion of the magnetic dipole when the conducting thin film is superconducting

C.1 $(1.2\ \text{pt})$

$h_0 =$

C.2 $(0.8\ \text{pt})$

$\Omega =$

C.3 $(0.7\ \text{pt})$

Value of $h_0 =$

C.4 $(0.3\ \text{pt})$

Value of $\Omega =$