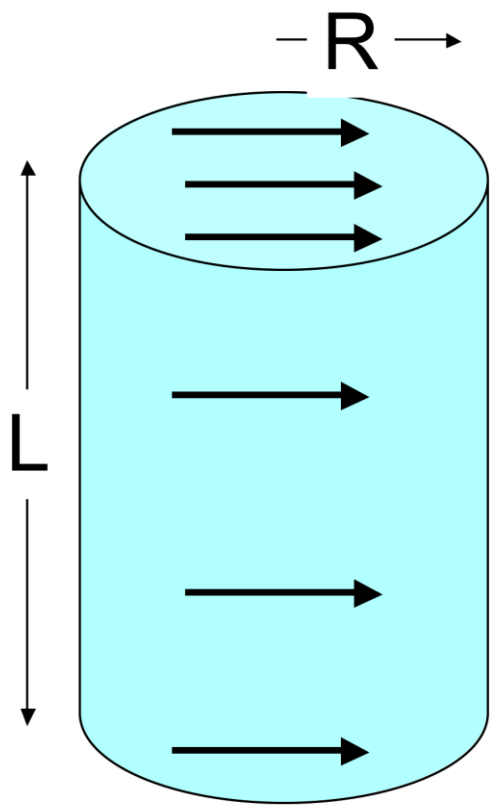
FIELDS FROM MAGNETIZED OBJECTS + BOUND CURRENTS

6.4

A solid cylinder has uniform magnetization **M** throughout the volume in the x direction as shown. What's the magnitude of the total magnetic dipole moment of the cylinder?

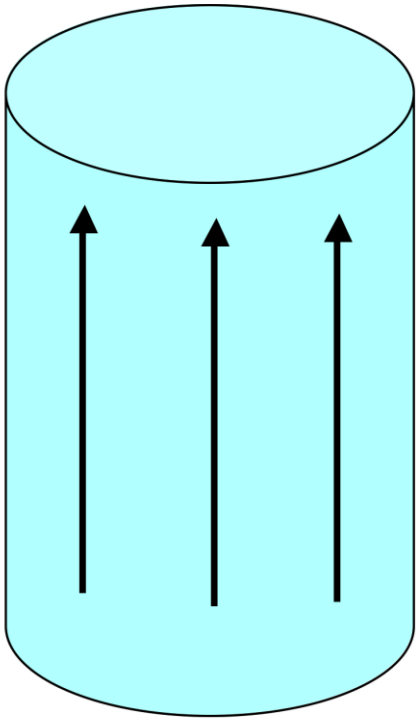
A) $\pi R^2 L M$
B) $2\pi R L M$
C) $2\pi R M$
D) $\pi R^2 M$
E) Something else/ it's complicated!



6.3

A solid cylinder has uniform magnetization **M** throughout the volume in the z direction as shown. Where do bound currents show up?

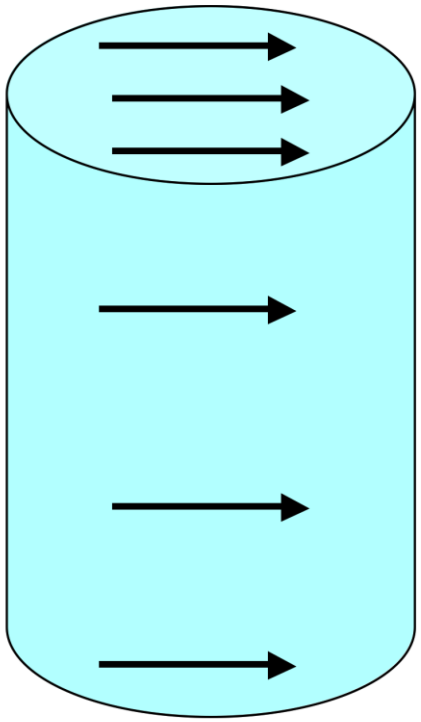
A) Everywhere: throughout the volume and on all surfaces
B) Volume only, not surface
C) Top/bottom surface only
Δ) Side (rounded) surface only
E) All surfaces, but not volume



6.5

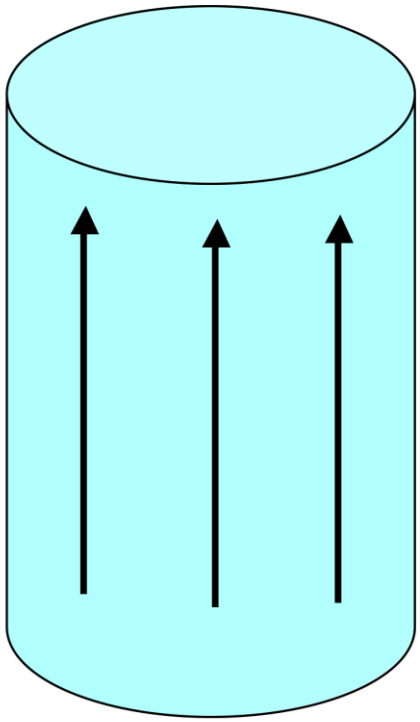
A solid cylinder has uniform magnetization **M** throughout the volume in the x direction as shown. Where do bound currents show up?

A) Top/bottom surface only
B) Side (rounded) surface only
C) Everywhere
D) Top/bottom, and parts of (but not all of) side surface (but not in the volume)
E) Something different/other combination!



To discuss:

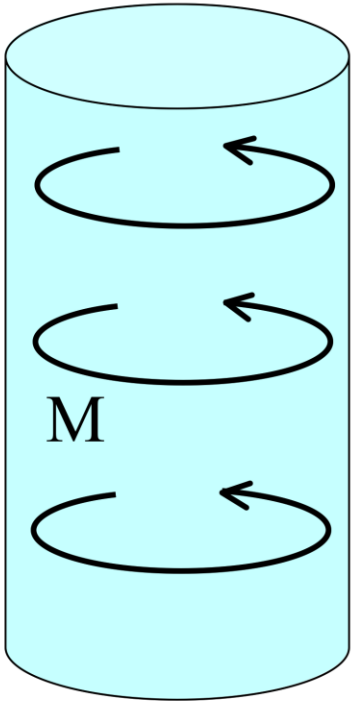
A solid cylinder has uniform magnetization **M** throughout the volume in the z direction as shown. What will the B field look like? (Consider if the cylinder is tall and thin, or short and fat, separately)



6.21

A solid cylinder has uniform magnetization **M** throughout the volume in the φ direction as shown. In which direction does the bound surface current flow on the (curved) sides?

A. There is no bound surface current.
B. The current flows in the $\pm\varphi$ direction.
C. The current flows in the $\pm s$ direction.
D. The current flows in the $\pm z$ direction.
E. The direction is more complicated than the answers B, C, or D.



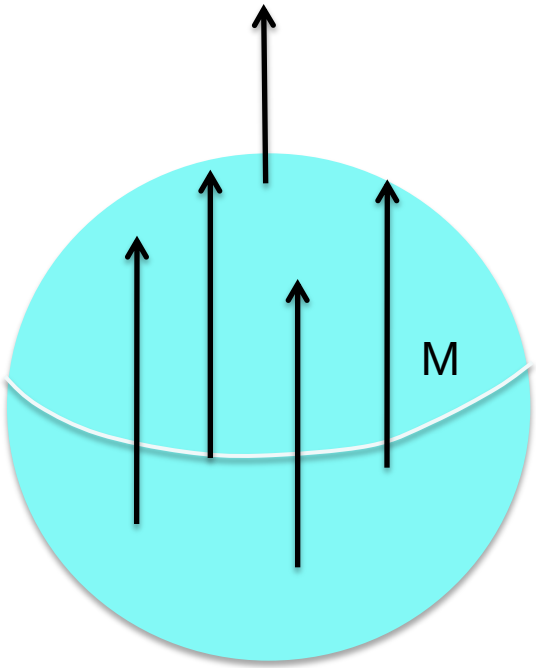
What did you get for the bound current?

A) Fraction of an amp
B) ~ 10 A
C) ~ 1000 A
D) ~ MA
E) Nowhere near (order of magnitude) any of these…

6.6

A sphere has uniform magnetization M in the z direction.

Which formula is correct for this surface current?



A) $\mathrm{M}\ \sin q\ \hat{q}$

B) $\mathrm{M}\ \sin q\ \hat{j}$

C) $\mathrm{M}\ \cos q\ \hat{q}$

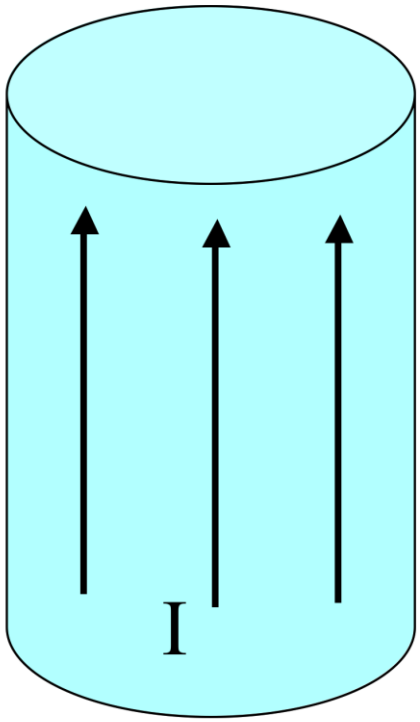
D) $\mathrm{M} \cos q\ \hat{j}$

E) None of these!

6.9 A very long aluminum (paramagnetic!) rod carries a uniformly distributed current I along the +z direction.

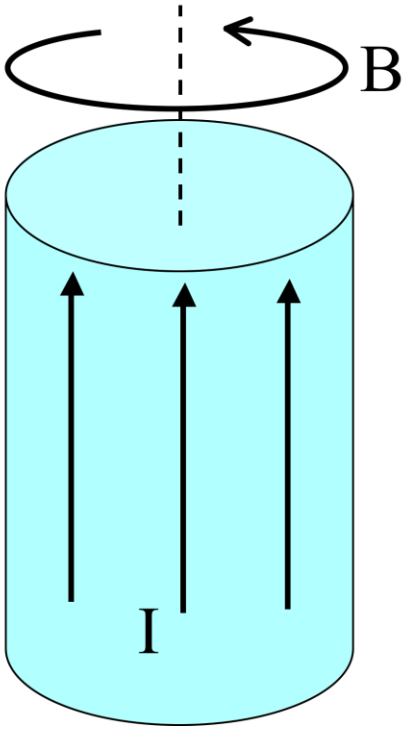
What is the direction of the bound volume current?

A) $\mathbf{J_B}$ points parallel to I
B) $\mathbf{J_B}$ points anti-parallel to I
C) It's zero!
D) Other/not sure



6.8 A very long aluminum (paramagnetic!) rod carries a uniformly distributed current I along the +z direction. We know **B** will be CCW as viewed from above. (Right?)

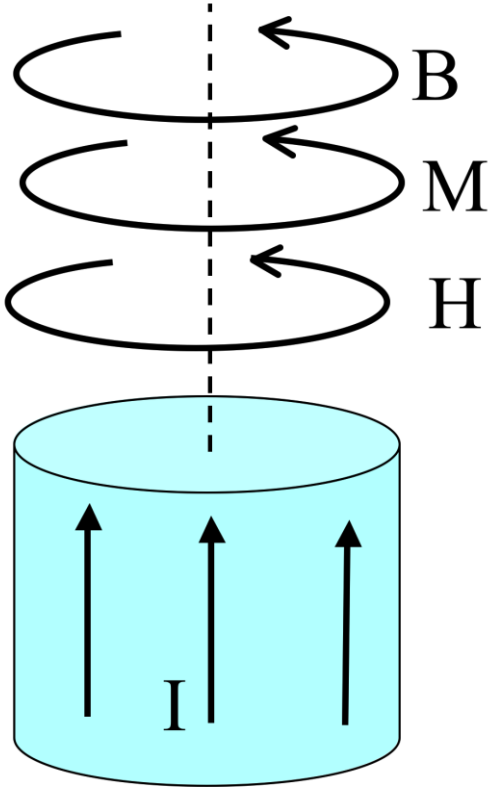
What about **H** and **M** inside the cylinder?



A) Both are CCW
B) Both are CW
C) **H** is CCW, but **M** is CW
D) **H** is CW, **M** is CCW
E) ???

A very long aluminum (paramagnetic!) rod carries a uniformly distributed current I along the +z direction. What is the direction of the bound volume current?

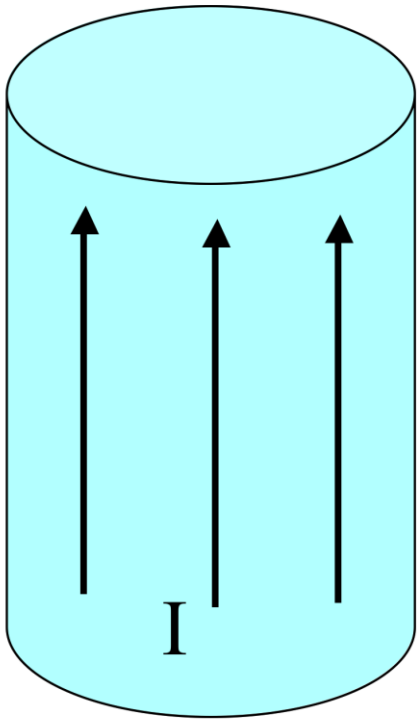
A) $\mathbf{J_B}$ points parallel to I
B) $\mathbf{J_B}$ points anti-parallel to I
C) It's zero!
D)Other/not sure



6.9 b A very long aluminum (paramagnetic!) rod carries a uniformly distributed current I along the +z direction.

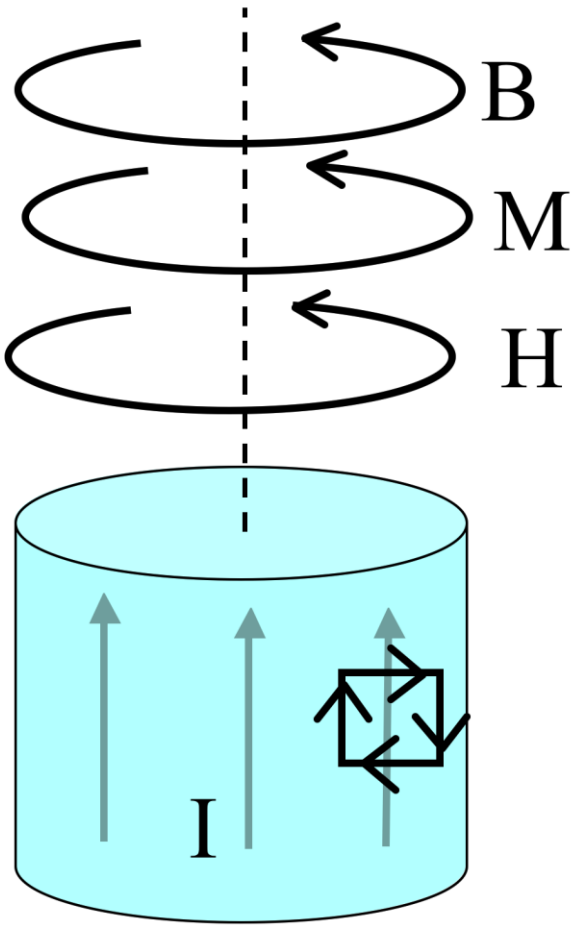
What is the direction of the bound **surface** current?

A) $\mathbf{K_B}$ points parallel to I
B) $\mathbf{K_B}$ points anti-parallel to I
C) Other/not sure



Summary:

A very long aluminum (paramagnetic!) rod carries a uniformly distributed current I along the +z direction.



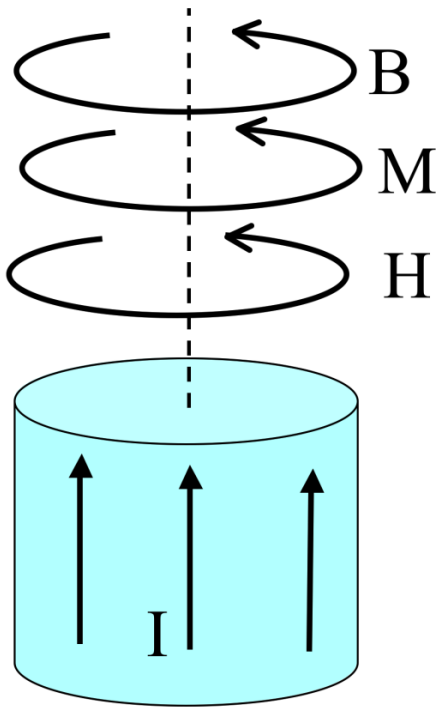
$\mathbf{J_B}$ points parallel to I

$\mathbf{K_B}$ points anti-parallel to I

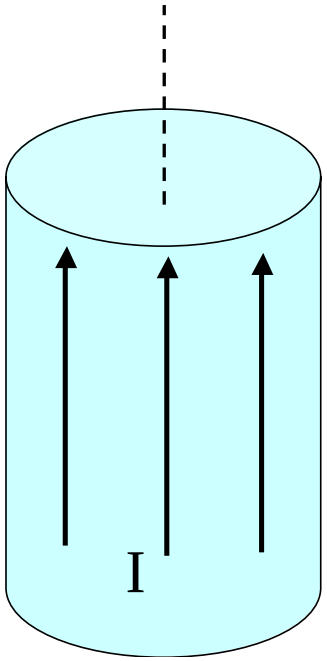
Total bound current vanishes, conservation of charge!

6.8

What if that long rod (the wire) was made of copper (diamagnetic!) instead. Of B, M, H, and J_bound, which ones "flip sign"?



A) All 4 flip
B) 3 of the 4 flip
C) 2 of the 4 flip
D) 1 of them flips
E) None of them flips

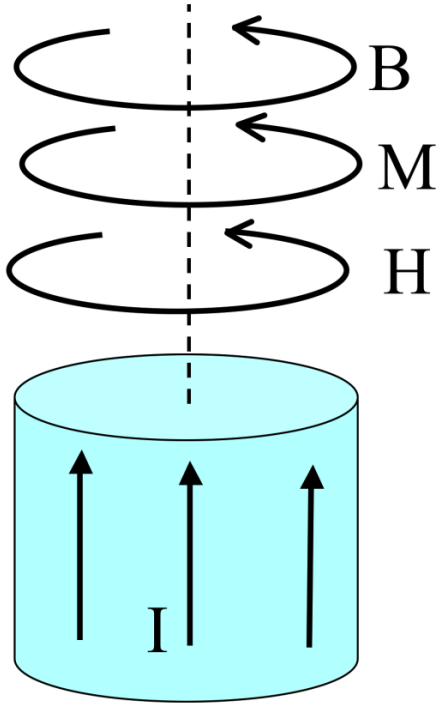


The "para" case

The "dia" case

6.8

What if that long rod (the wire) was made of copper (diamagnetic!) instead. Of B, M, H, and J_bound, which ones "flip sign"?



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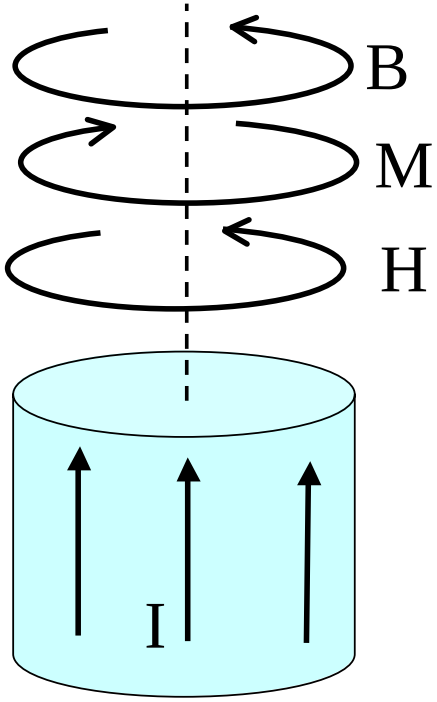

The "para" case

The "dia" case