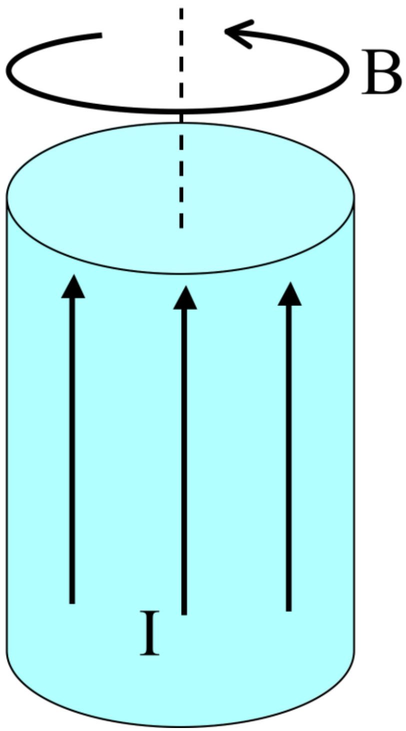
6.8 A very long aluminum (paramagnetic!) rod carries a uniformly distributed current I along the +z direction. We know **B** will be CCW as viewed from above. (Right?)

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) ???

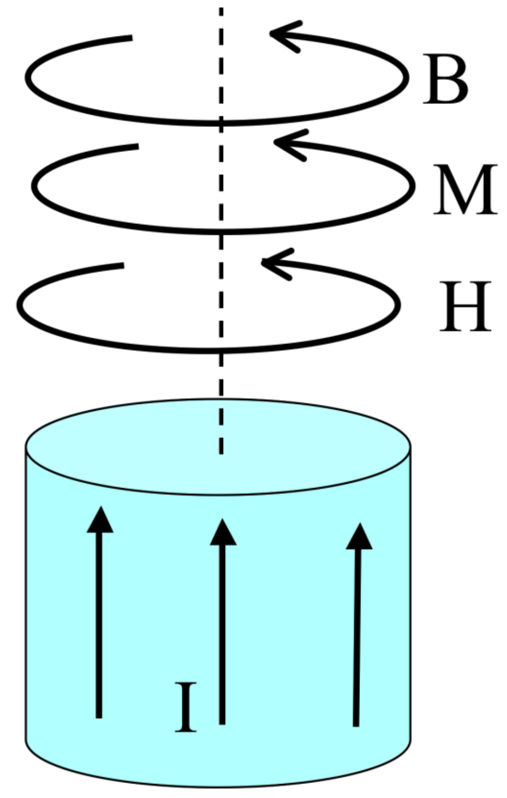
A very long aluminum (paramagnetic!) rod carries a uniformly distributed current I along the +z direction. What is the direction of the bound volume current?

A) $\mathbf{J}_B$ points parallel to I

B) $\mathbf{J}_B$ points anti-parallel to I

C) It's zero!

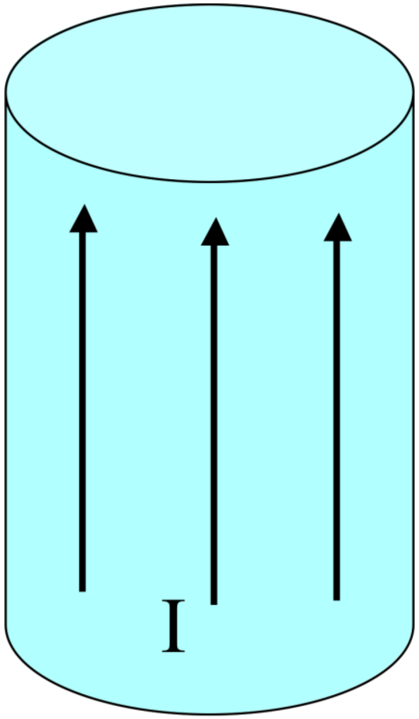
D) Other/not sure



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

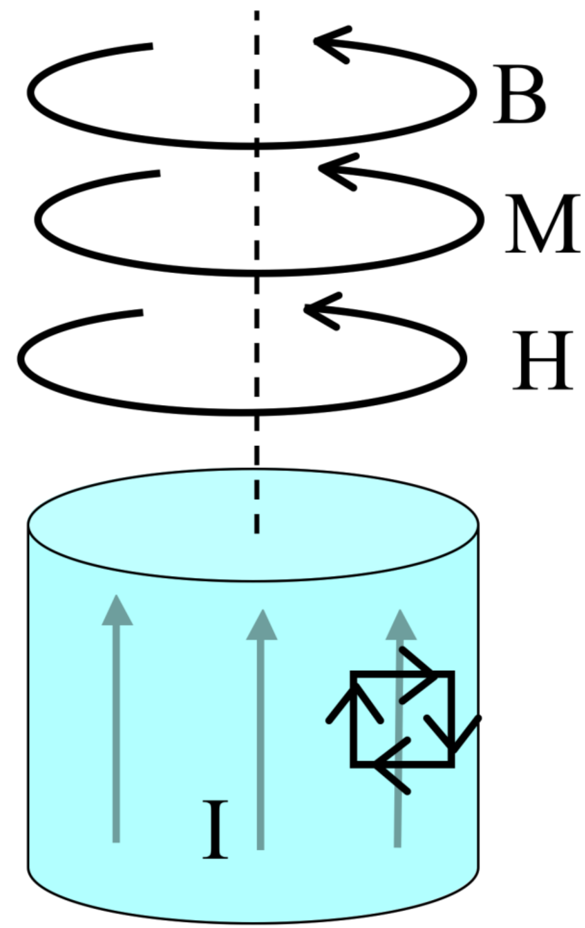


Summary:

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

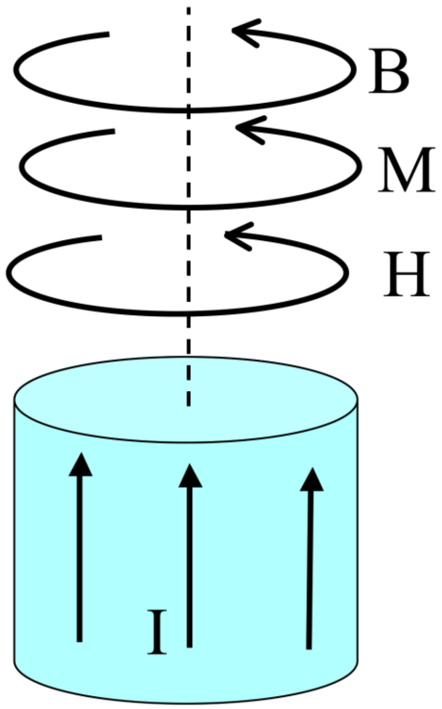
J_B points parallel to I

K_B points anti-parallel to I

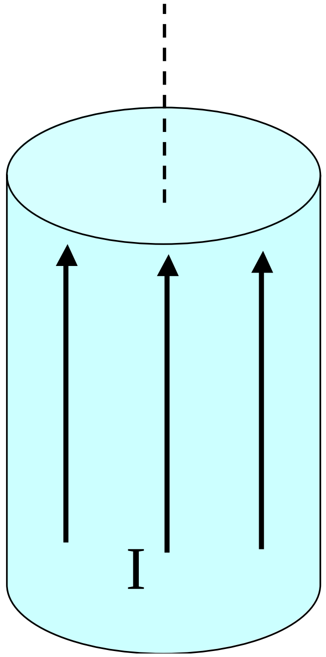


Total bound current vanishes, conservation of charge!

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



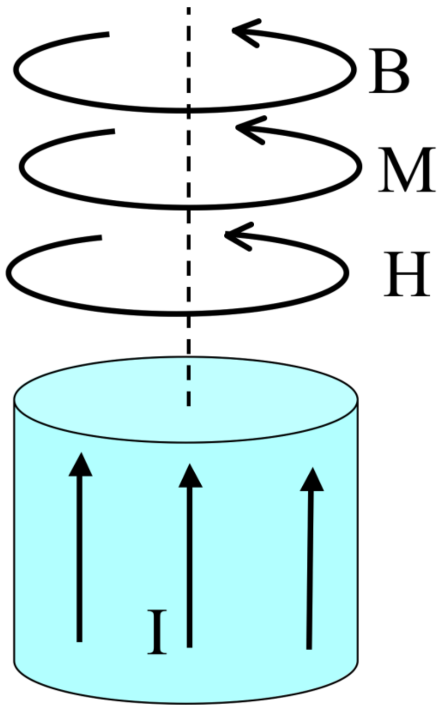
A) All 4 flip
B) 3 of the 4 flip
C) 2 of the 4 flip
D) 1 of them flips
E) None of them flips



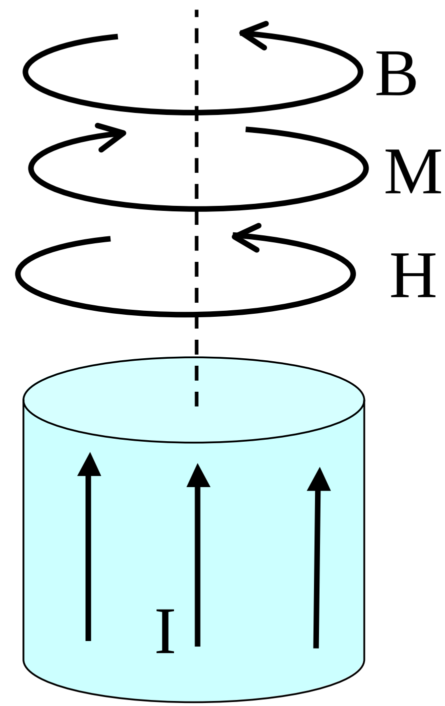
The “para” case

The “dia” case

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



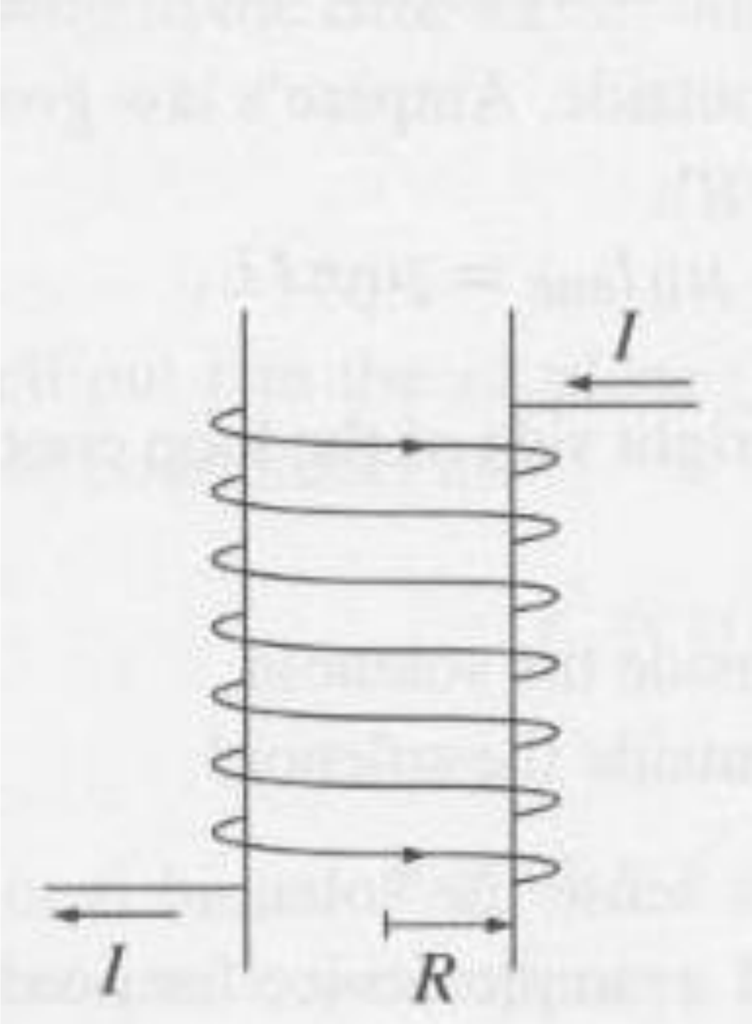
The "para" case

The "dia" case

Inside a hollow solenoid,

$B=B_0=\mu_0 nI$.

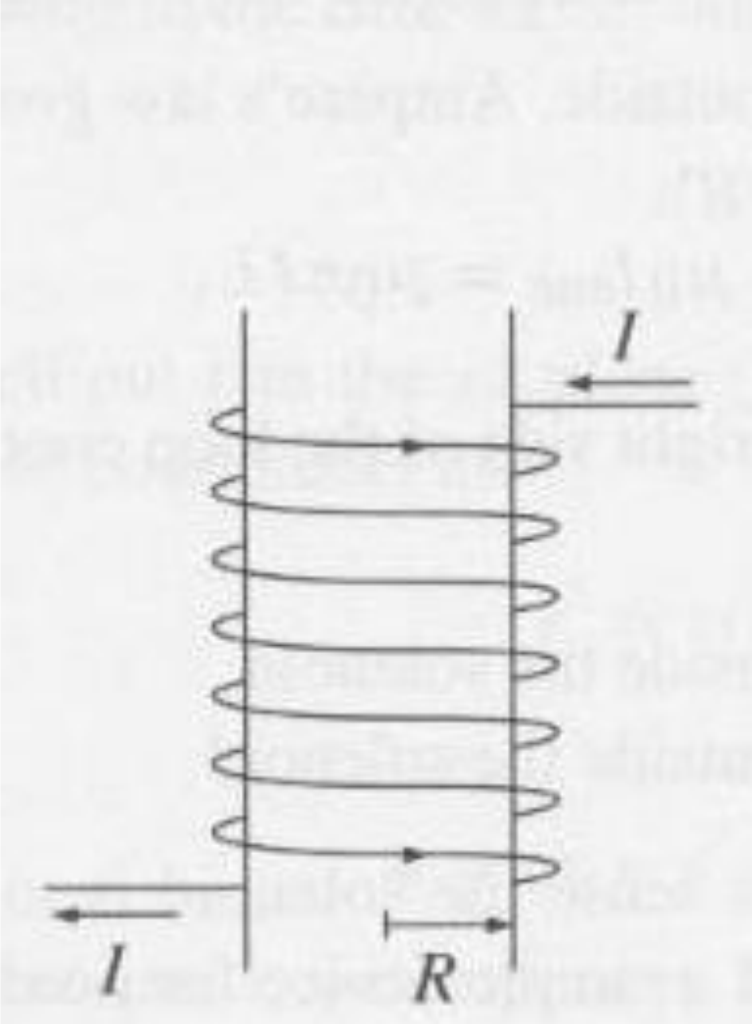
What is the formula for H inside?



Inside a hollow solenoid,

$B=B_0=\mu_0 nI$, (so $H=H_0=nI$)

If the solenoid is filled with a normal paramagnetic material, like aluminum, what is B inside?...



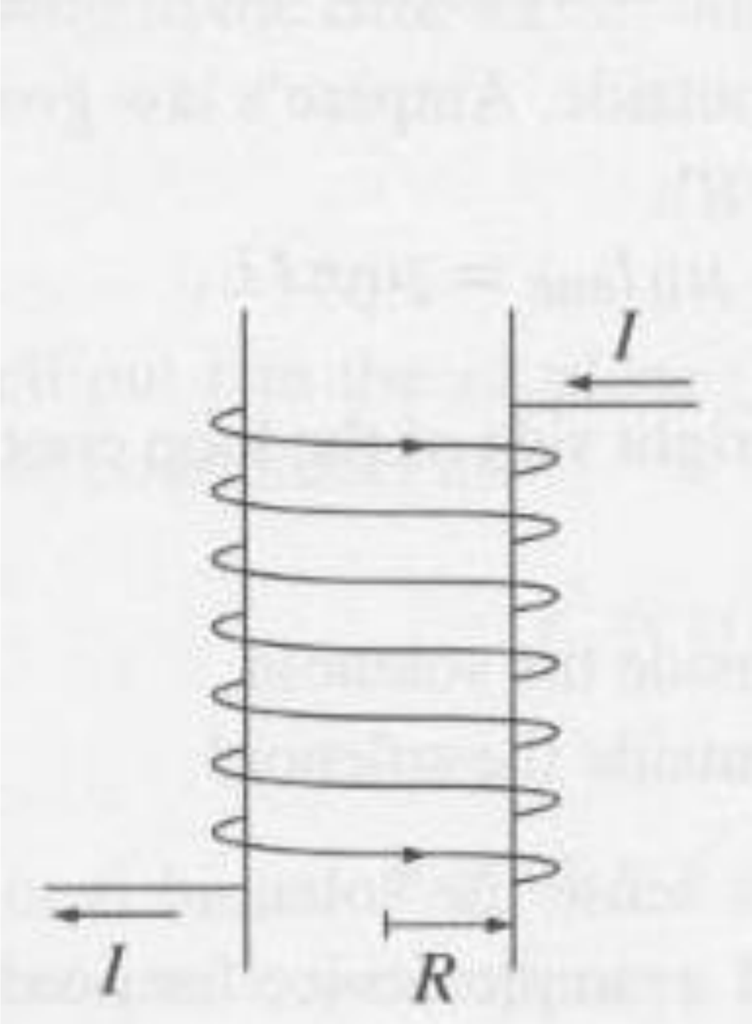
A) Still exactly B_0
B) a little more than B_0
C) a lot more
D) a little less than B_0
E) a lot less than B_0

Inside a hollow solenoid,

$B=B_0=\mu_0 nI$, (so $H=H_0=nI$)

If the solenoid is filled with iron,

what is H inside?...



A) H_0

B) a little more than H_0

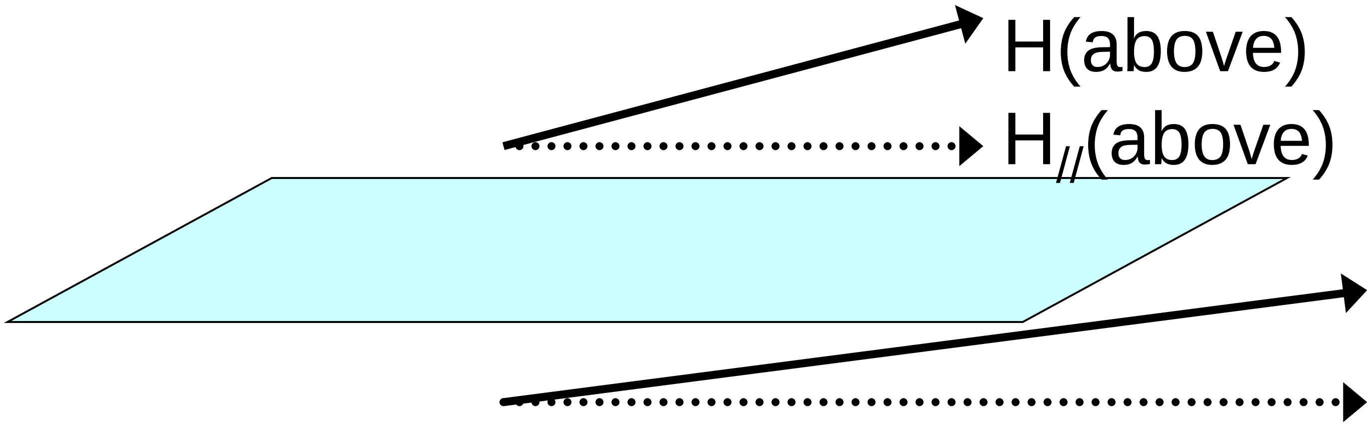
C) a lot more

D) a little less than H_0

E) a lot less than H_0

BOUNDARY VALUE PROBLEMS

I have a boundary sheet, and would like to learn about the change (or continuity!) of H(parallel) across the boundary.



Am I going to need to know about

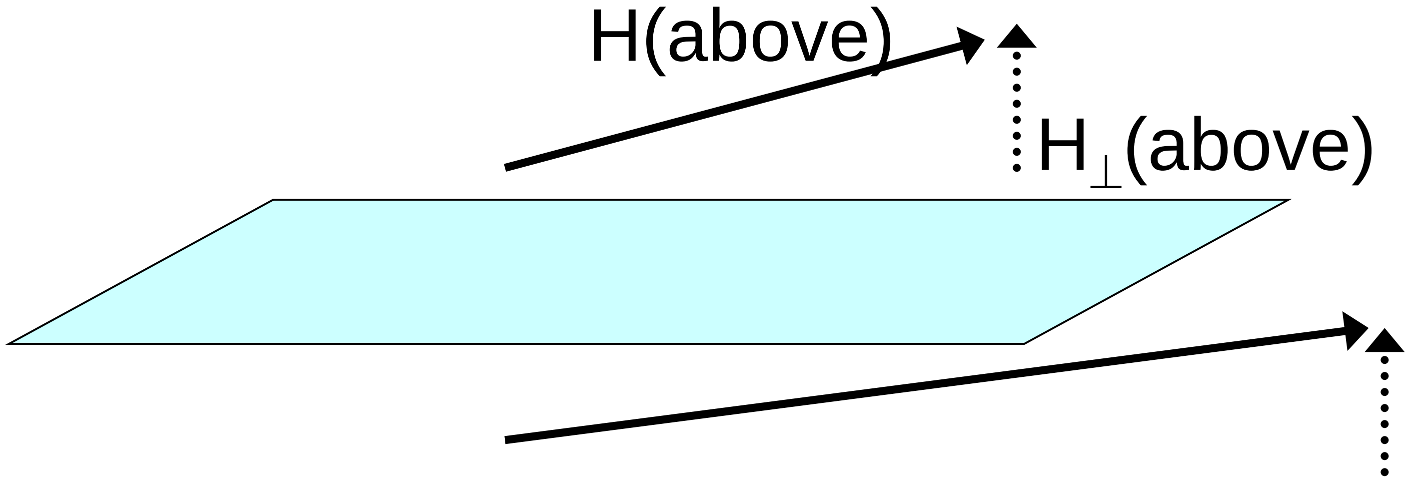
A) $\nabla \times \mathbf{H}$

B) $\nabla \bullet \mathbf{H}$

C) $\nabla \mathbf{H}$

???

I have a boundary sheet, and would like to learn about the change (or continuity!) of H(perp) across the boundary.



Am I going to need to know about

A) $\nabla \times \mathbf{H}$

B) $\nabla \bullet \mathbf{H}$

C) $\nabla \mathbf{H}$

???

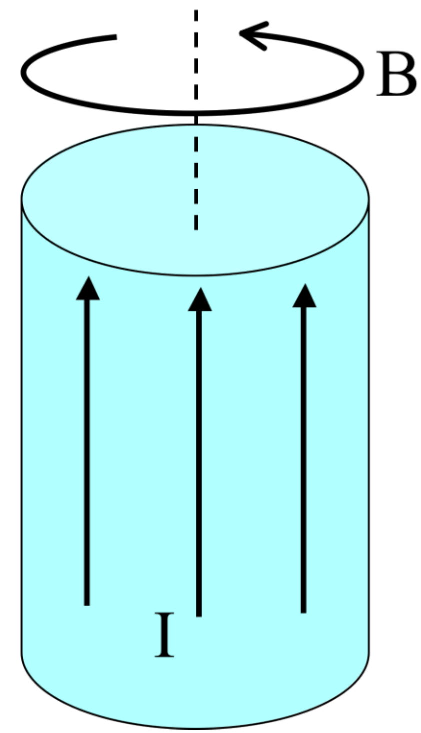
6.8 A very long rod carries a uniformly distributed current I along the +z direction.

Compare the B-field OUTSIDE when the rod is a paramagnet (e.g. Al) to the B-field outside when the rod is a diamagnet (e.g. Cu)

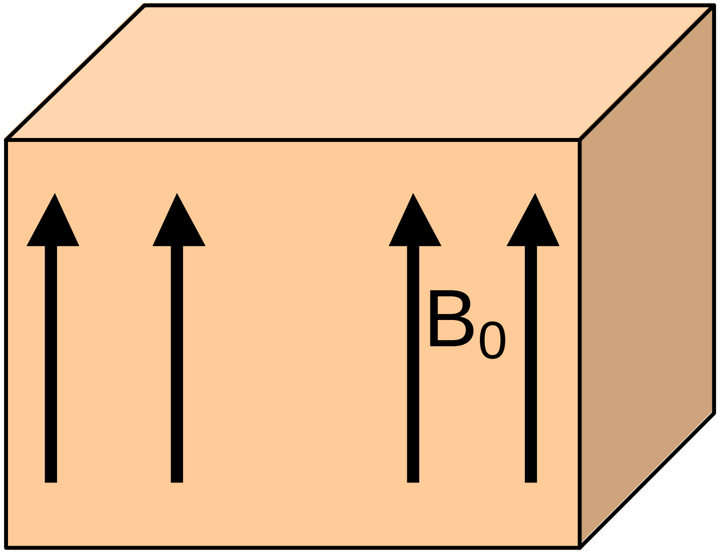
B outside the paramagnetic rod is ..

A) Slightly smaller than…
B) The same as…
C) Slightly larger than…

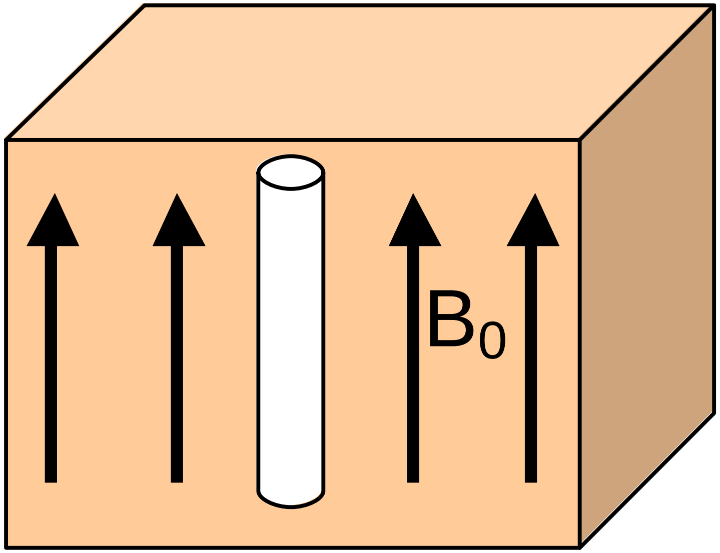
B outside the diamagnetic rod



A large chunk of paramagnetic material (χ_m>0) has a uniform field B_0 throughout its bulk, and thus a uniform H_0=??



A large chunk of paramagnetic material ($\chi_m > 0$) has a uniform field B_0 throughout its bulk, and thus a uniform $H_0 = B_0/\mu = B_0 / \mu_0(1+\chi_M)$ We then cut out a cylindrical hole (very skinny, very tall!)



What is M at the center of that hole?

A) $\chi_M H_0$

B) little more than $\chi_M H_0$

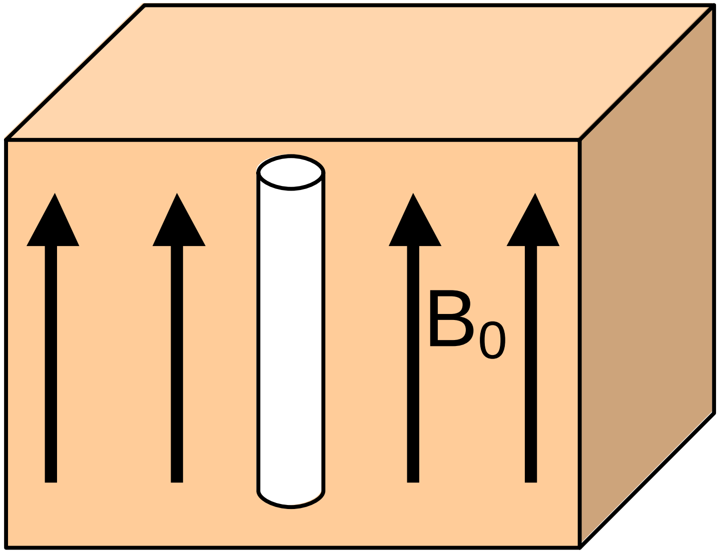
C) Little less than $\chi_M H_0$

D) Zero

E) ??? (it depends/not sure)

6.10

A large chunk of paramagnetic material (χ_m>0) has a uniform field B0 throughout its interior. We cut out a cylindrical hole (very skinny, very tall!)

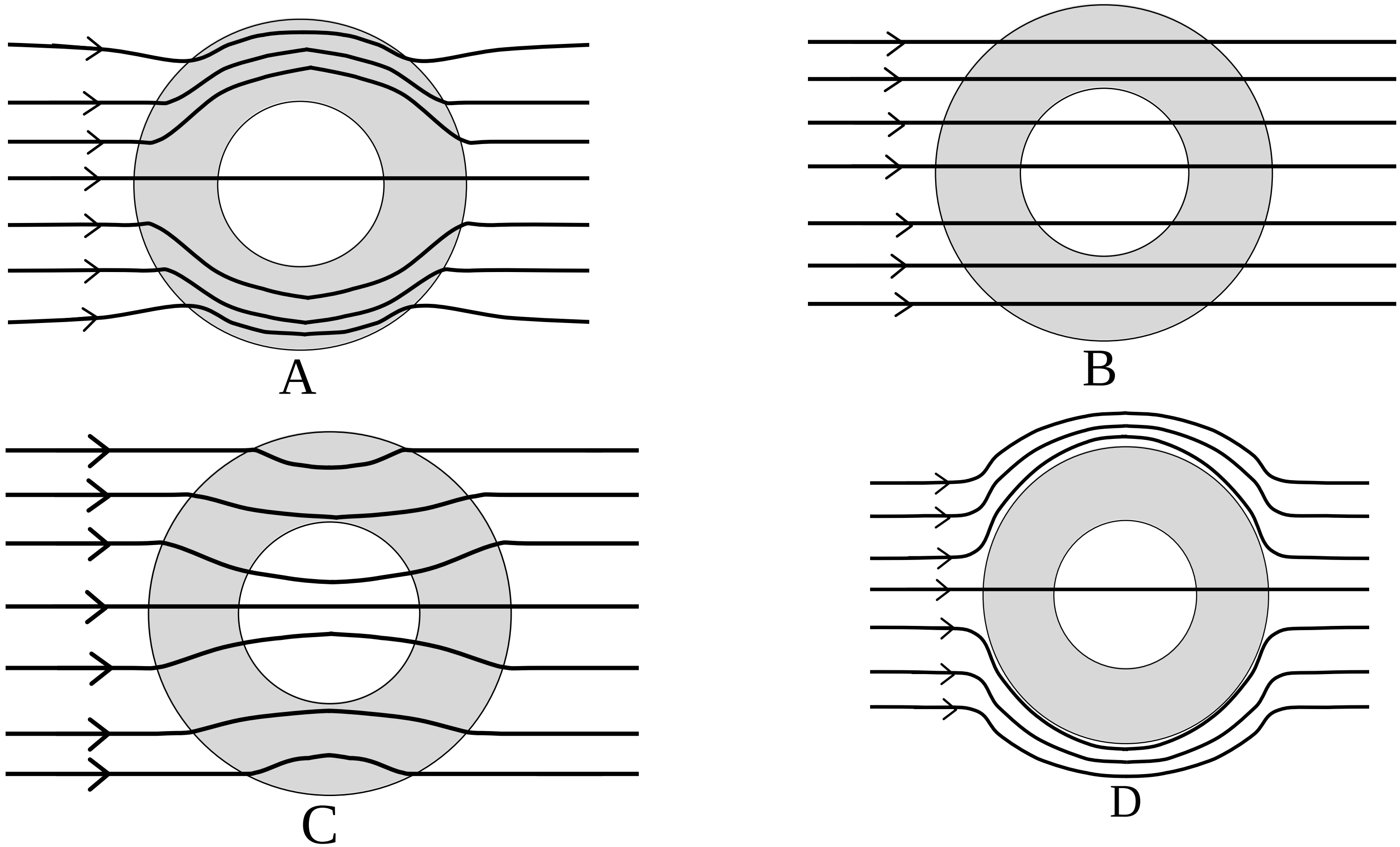


What is B at the center of that hole?

A) B_0 B) more than B_0 C) less than B_0

D) ??

A sphere (with a spherical cavity inside it) is made of a material with *very* large positive χ_m.
It is placed in a region of uniform B field.
Which figure best shows the resulting B field lines?



E) None of these can be even remotely correct

Mu-metal (75% nickel, 15% iron, plus copper and molybdenum) acts as a *sort* of “magnetic shield”...
(there is no perfect “Faraday cage” effect for magnetism - why not)