Name: _____ Student ID5_____ Session: T ___

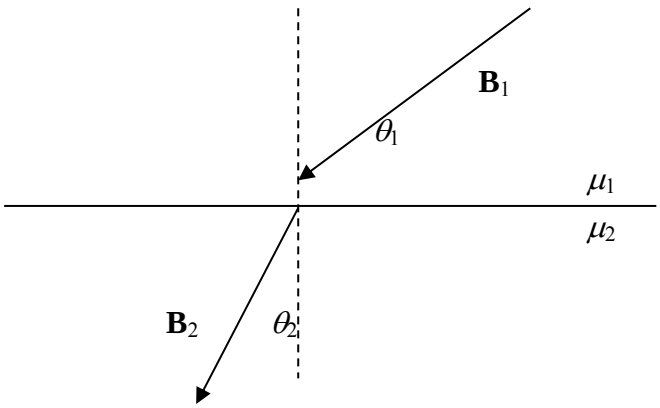
PHYS 3033 - Electricity and Magnetism I

Quiz 9

Time allowed: 15 minutes

20 Nov 2015

Just above and below the interface between two linear magnetic media the directions of the magnetic fields change, as shown in the figure below.



Show that $\tan\theta_2 / \tan\theta_1 = \mu_2 / \mu_1$, assuming there is no free current at the boundary.

Solutions:

It is always true that $\nabla\cdot\mathbf{B}=0$, and if there is no free current, $\nabla\times\mathbf{H}=\mathbf{0}$. The two boundary conditions are

$$\begin{cases}\nabla\cdot\mathbf{B}=0\\ \nabla\times\mathbf{H}=\mathbf{0}\end{cases}\Rightarrow\begin{cases}B_{2\perp}-B_{1\perp}=0\\ H_{2\perp}-H_{1\perp}=0\end{cases}\Rightarrow\begin{cases}B_{1\perp}=B_{2\perp}\\ H_{1\perp}=H_{2\perp}\end{cases}$$

$$\Rightarrow\begin{cases}B_{1\perp}=B_{2\perp}\\ B_{1\perp}/\mu_1=B_{2\perp}/\mu_2\end{cases}\Rightarrow\begin{cases}B_1\cos\theta_1=B_2\cos\theta_2 & ------(1)\\ B_1\sin\theta_1/\mu_1=B_2\sin\theta_2/\mu_2 & ------(2)\end{cases}$$

Divide (2) by (1), hence

$$\frac{B_1\sin\theta_1/\mu_1}{B_1\cos\theta_1}=\frac{B_2\sin\theta_2/\mu_2}{B_2\cos\theta_2}\Rightarrow\frac{\tan\theta_2}{\tan\theta_1}=\frac{\mu_2}{\mu_1}$$

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