A thin wire carries a uniform current I. This current produces a magnetic field **B**. Up until now, you've always been told that magnetic fields loop around a current-carrying wire (Figure a. below), but how do you know that there are not other components to the magnetic field? Perhaps the magnetic field has a z-component (Figure b.) or a radial s-component (Figure c.).



Argue for why there shouldn't be a z- or s- component

(a) using the Biot-Savart law (draw on the diagrams to illustrate your argument)

(b) using  $Div\mathbf{B} = 0$  and  $Curl \mathbf{B} = \mu_0 \mathbf{J}$  and the boundary condition  $\mathbf{B} = 0$  at infinity.