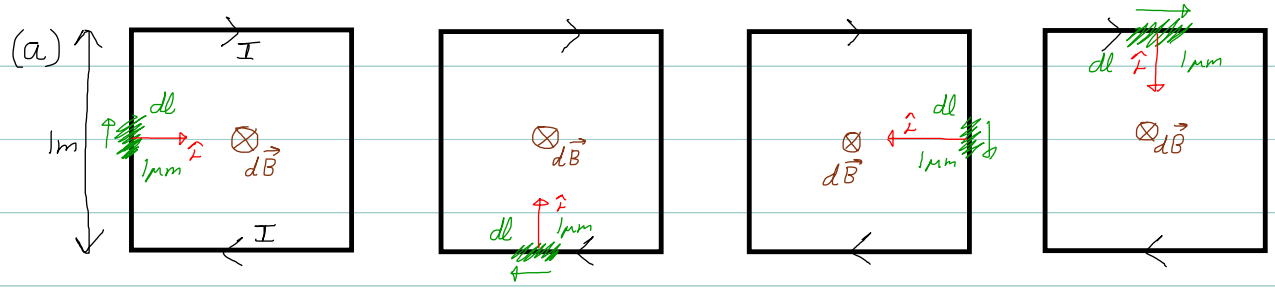
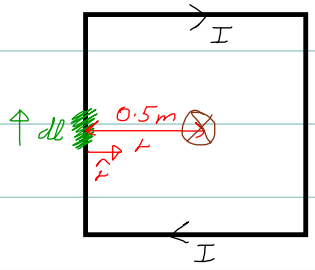
AN EXACTLY SQUARE WIRE LOOP OF AREA $1\ m^2$ HAS A CLOCKWISE CURRENT OF 1.0 A RUNNING THROUGH IT. (a) FOR 1 mm (i.e. FOR A 1 mm SECTION OF THE WIRE) AT EACH OF THE 4 MIDPOINTS ALONG THE SIDES OF THE LOOP SKETCH THE MAGNETIC FIELD DIRECTION AT THE CENTER OF THE LOOP (b) CALCULATE THE MAGNETIC FIELD AT THE CENTER OF THE LOOP DUE TO THESE SAME 4 MIDPOINTS (c) WHAT IS THE TOTAL MAGNETIC FIELD AT THE CENTER OF THE LOOP DUE TO THE 4 MIDPOINTS?

(a)



$d\vec{B} = \frac{\mu_0}{4\pi}\frac{I d\vec{l} \times \hat{r}}{r^2}$ (BIOT-SAVART LAW) SO THE DIRECTION OF $d\vec{B}$ IS GIVEN BY $d\vec{l} \times \hat{r}$ AND THE RIGHT-HAND RULE SHOWS THAT THIS IS INWARDS. ALTERNATIVELY, IF YOU CURL THE FINGERS OF YOUR RIGHT HAND IN THE DIRECTION OF THE CURRENT, YOUR THUMB POINTS IN THE DIRECTION OF THE B-FIELD (INWARDS)

(b)



THE BIOT-SAVART LAW STATES $d\vec{B} = \frac{\mu_0}{4\pi}\frac{I d\vec{l} \times \hat{r}}{r^2} = \frac{\mu_0}{4\pi}\frac{I dl \sin\theta}{r^2}$

WHERE $d\vec{l} \times \hat{r} = |dl||\hat{r}|\sin\theta$, θ IS THE ANGLE BETWEEN $d\vec{l}$ AND $\hat{r}$ AND THE MAGNITUDE OF THE UNIT VECTOR $\hat{r}$ IS ONE.

NOTE THAT THE ANGLE BETWEEN $d\vec{l}$ AND $\hat{r}$ IS 90^0, SO $dB = \frac{\mu_0}{4\pi}\frac{I dl}{r^2}\sin 90^0 = \frac{\mu_0}{4\pi}\frac{I dl}{r^2}$

SUBSTITUTING IN NUMBERS, $d\vec{B} = \frac{4\pi \times 10^{-7}}{4\pi}\frac{(1.0)(10^{-6})}{0.5^2} = 4 \times 10^{-13}\ T$ INWARDS (WHERE EVERYTHING IS KEPT IN SI UNITS)

SIMILARLY, THE RESULT WILL BE IDENTICAL FOR EACH OF THE 4 MIDPOINTS

(c) AS THE RESULT IS IDENTICAL FOR EACH OF THE 4 MIDPOINTS, $\vec{B}_{TOTAL} = 4.(4 \times 10^{-13}) = 1.6 \times 10^{-12}\ T$ (ALSO INTO THE SCREEN/PAGE)