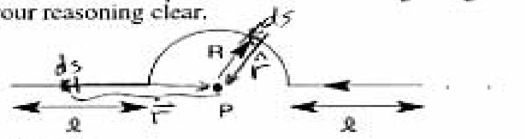
6. (a) Use the Biot-Savart Law to find the magnetic field at the point P for the two long straight wire segments shown in the diagram below. Make your reasoning clear.



$d\vec{s} \times \hat{r} = 0$
because $d\vec{s}$ and $\hat{r}$ are $\parallel$ or antiparallel
so $\sin\theta = \sin 0^\circ$ or $\sin 180^\circ = 0$

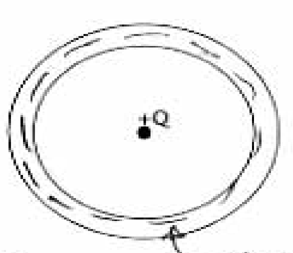
(b) Use the Biot-Savart Law to find the magnetic field for the semi-circular wire segment in the diagram in (a). Make **all** the steps in your reasoning clear.

$d\vec{B} = \frac{\mu_0 I}{4\pi r^2} d\vec{s} \times \hat{r}$ Now $d\vec{s}$ and $\hat{r}$ are $\perp$ so $|d\vec{s} \times \hat{r}| = ds \cdot 1 \cdot \sin 90^\circ = ds$

πR ← half circumference

$$|\vec{B}| = \frac{\mu_0 I}{4\pi R^2} \int_0^{\pi R} ds = \frac{\mu_0 I}{4\pi R^2} \pi R = \frac{\mu_0 I}{4R}$$ out of page

7. A point charge +Q is located at the center of a hollow, uncharged, conducting sphere with inner radius r_1 and outer radius r_2.



(a) How do we know that the electric field inside the metal of the conductor must be zero?

if $\vec{E}$ were not 0, then the e^- in the conductor (free to move) would feel a force and move & it wouldn't be electrostatics

(b) How much charge is located where on the hollow conductor?

$-Q$ uniformly distributed on inner surface and $+Q$ uniformly on outer surface

(c) Explain how we prove your answer to the previous part.

use GL $\oint \vec{E} \cdot \hat{n}\, dA$ over gaussian surface shown $= 0$ since $\vec{E} = 0$ in the metal

$0 = \frac{q_{encl}}{\varepsilon_0} \Rightarrow q_{encl} = 0 = +Q$ @ center + "?" on inner surface → $-Q$ on inner surface

(d) Derive a formula, showing all steps, for the value of the potential V at the inner surface of the conductor. Recall: $E = kQ/r^2$ for $r > r_2$ and $r < r_1$ and $V=0$ at $r \to \infty$.

$$V = -\int_\infty^{r} \vec{E} \cdot d\vec{r} = -\int_\infty^{r_2} \frac{kQ}{r^2} dr - \int_{r_2}^{r_1} 0\, dr$$

$$= -kQ\left(-\frac{1}{r}\right)\Big|_\infty^{r_2} = \frac{kQ}{r_2}$$