PHYS 115

#1] Assuming that the car is a conductor and you are insulated to the metal outside, the lighting will distribute a charge Q over the surface such that ΔV = constant $\rightarrow \vec{E} = 0$ inside. Stepping outside gives a path from car $\rightarrow$ ground $\rightarrow$ you, and very quickly after the strike the charge Q may still be signifigant.

#2]

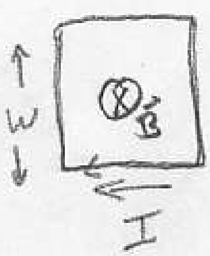
The total length of the wire, $L = 2R + \frac{2\pi R}{2} = R(2+\pi)$

Thus the number of turns per unit length $\delta = N/R(2+\pi)$

$\vec{B} = 0$ outside (approx) as $\int \vec{B} \cdot d\vec{\ell} = 0$

If $\vec{B}$ is appox const. inside

Inside



$$\oint \vec{B} \cdot d\ell = B[\underbrace{L + f(w)}_{\text{small}}] \approx BL = \mu_0 N I$$

$$B = \frac{\mu_0 N I}{R(2+\pi)}$$

#3] Take a sphere of radius r around an amount of mass m (use point mass for simplicity, gauss' law would hold for any mass distribution)

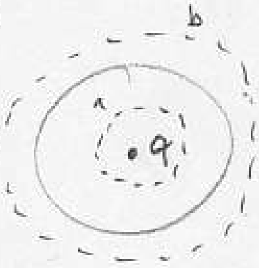
$$\frac{1}{4\pi G} \oint \vec{g} \cdot \hat{n}\, dA = \frac{|\vec{g}|_r}{4\pi G} \oint dA = \frac{g(r)\, r^2}{G} = -m$$

$\vec{g}$ will be constant in magnitude and direction at r

The (-) comes from the fact that mass is always attractive

$$|\vec{g}|_r = g(r) = -\frac{Gm}{r^2}$$

#4]

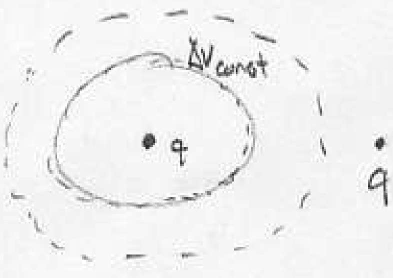


$$\oint_a \vec{E}\cdot d\vec{A} = \frac{q}{\epsilon_0} = E\,4\pi r^2 \qquad \vec{E} = \frac{q}{4\pi\epsilon_0}\frac{1}{r^2}\hat{r}$$

$$\oint_b \vec{E}\cdot d\vec{A} \Rightarrow \vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$

unchanged

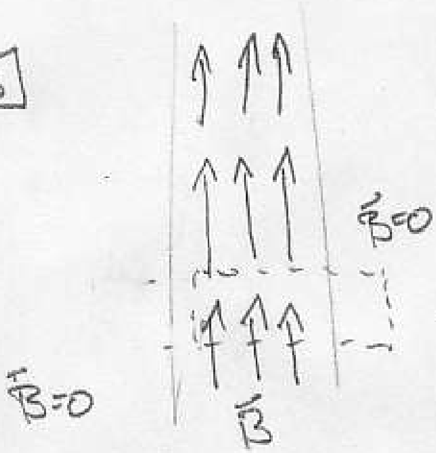
c] no d] yes – the shell would polarize

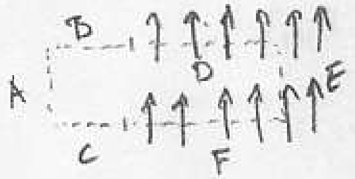


Note that $\oint \vec{E}\cdot d\vec{A}$, $\vec{E}\cdot\hat{n}$ is <u>not</u> constant here

With ΔV = const over the shell the outside charge feels a force, inside does not as $\vec{E} = 0$ inside.

#5]





A, B, C are zero as $\vec{B} = 0$

D, F are zero as $\vec{B}\cdot d\vec{\ell} = 0$

$$\int_E \vec{B}\cdot d\ell \neq 0 = B_0$$

→ take this path

$$\oint \vec{B}\cdot d\vec{\ell} = 0 \quad \text{as } I_{enc} = 0$$

contradiction, thus this can't be a $\vec{B}$ field

#6]

$$\oint \vec{B}\cdot d\ell = B\,2\pi r = \mu_0 I_{enc}$$

$$I_{enc} = I_0 \frac{\int_0^r\int_0^{2\pi} r/a\,(r\,d\theta)\,dr}{\int_0^a\int_0^{2\pi} r/a\,(r\,d\theta)\,dr} = \frac{I_0 \frac{2\pi}{a}\int_0^r r^2\,dr}{\frac{2\pi}{a}\int_0^a r^2\,dr} = I_0\frac{r^3}{a^3}$$

$$B = \frac{\mu_0}{2\pi} I_0 \frac{r^2}{a^3}$$