

CONDUCTORS GRIFFITHS §2.5

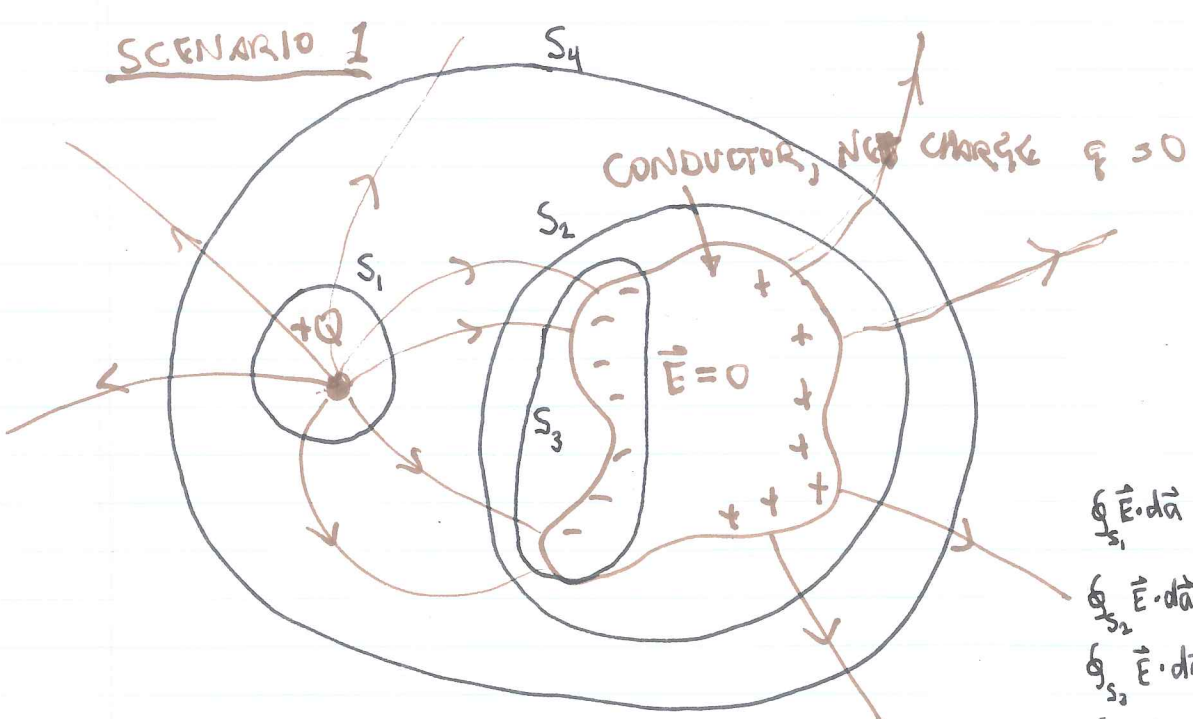
CONDUCTORS (EVEN POOR CONDUCTORS LIKE THE HUMAN BODY) HAVE FREE CHARGES THAT MOVE IN RESPONSE TO ELECTRIC FIELDS. ONCE THOSE CHARGES FIND A STATIC FORCE BALANCE, THEY STOP MOVING. AT THAT POINT, $\vec{E} = 0$.

CONSEQUENTLY, IN ELECTROSTATICS, ALL CONDUCTORS OBEY SOME SIMPLE RULES:

I.E. FIELD ↓ TO SURFACE OF CONDUCTOR

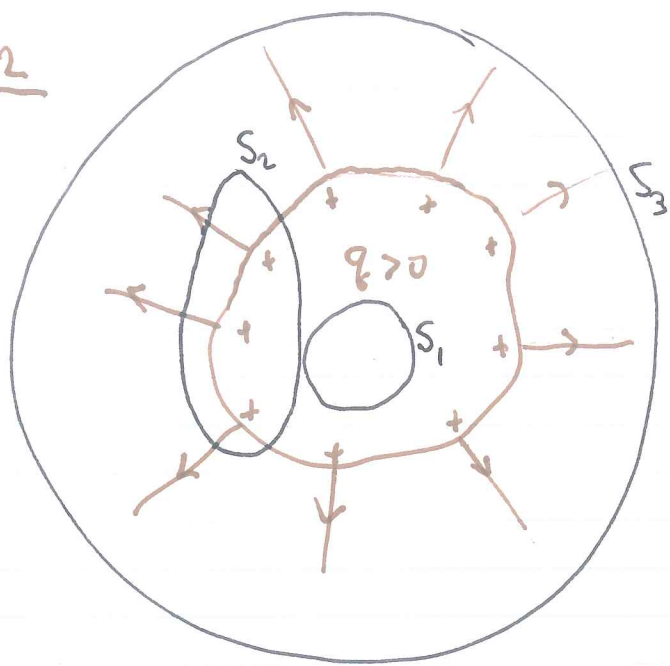
- $\vec{E} = 0$ INSIDE.
 - $\rho = 0$ INSIDE, BECAUSE $\vec{E} = 0 \Rightarrow \nabla \cdot \vec{E} = 0$.
 - $V = \text{CONSTANT}$ (EQUIPOTENTIAL)
 - $\vec{E} \times \hat{n} = 0$; $\vec{E} \cdot \hat{n} = |\vec{E}|$. (USE $\oint \vec{E} \cdot d\vec{l} = 0$ AT BOUNDARY)
 - ANY BUILD-UP OF CHARGE WILL BE ON THE SURFACE ($\sigma \neq 0$).
- THESE RULES HOLD EVEN IF THE CONDUCTOR HAS A NET CHARGE.

SCENARIO 1



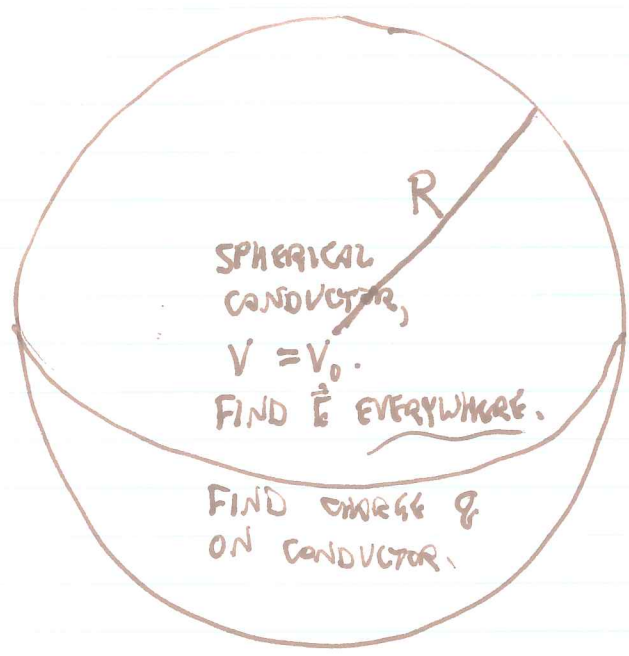
- $\oint_{S_1} \vec{E} \cdot d\vec{a} = ?$
- $\oint_{S_2} \vec{E} \cdot d\vec{a} = ?$
- $\oint_{S_3} \vec{E} \cdot d\vec{a} = ?$ (APPROXIMATE)
- $\oint_{S_4} \vec{E} \cdot d\vec{a} = ?$

SCENARIO 2



- WHAT CAN YOU SAY ABOUT $\oint \vec{E} \cdot d\vec{l}$ ON EACH SURFACE?
- * WHAT (IF ANYTHING) WOULD CHANGE IF WE OPEN UP A CAVITY INSIDE THE CONDUCTOR?

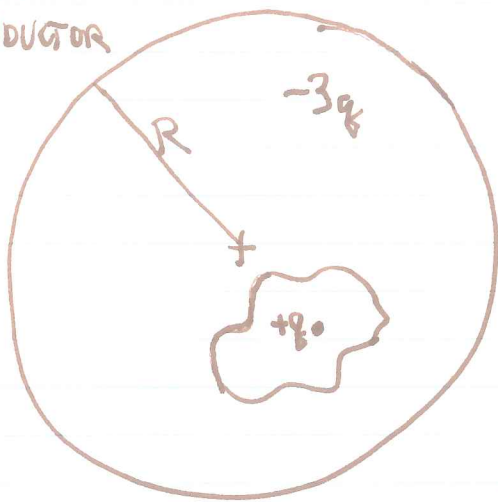
SCENARIO 3



- OPTIONAL:
- (a) USING $\frac{1}{2} \int \rho V d\tau$
 - (b) USING $\frac{1}{2} \epsilon_0 \int E^2 d\tau$

EXERCISE

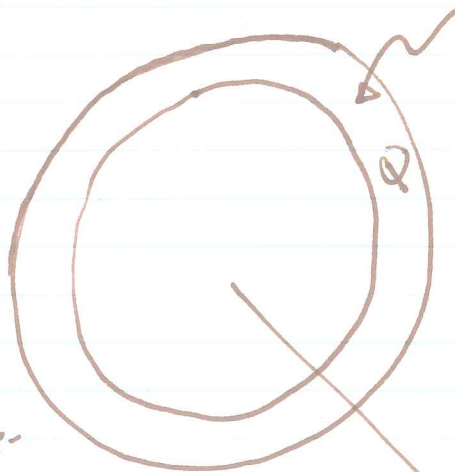
- SPHERICAL CONDUCTOR,
- IRREGULAR CAVITY
- $+q$ IN CAVITY
- $-3q$ ON CONDUCTOR



- SKETCH THE SURFACE CHARGES & FIELD LINES.
- FIND THE TOTAL CHARGE (q_{total}) ON THE INSIDE SURFACE OF THE CAVITY
- FIND THE CHARGE ON THE OUTSIDE SURFACE OF THE SPHERE
- FIND \vec{E} FOR $r > R$.

SCENARIO 4

$+q$



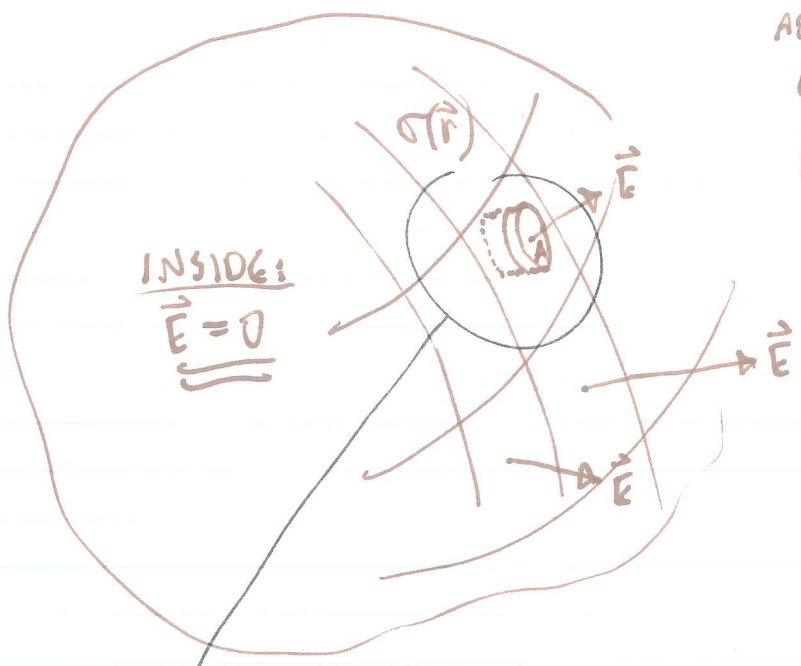
CONDUCTING SHELL,
ANY SHAPE,
CHARGE Q

* IS THERE ANYTHING WE CAN DO FROM OUTSIDE TO CREATE A FIELD INSIDE?

WHAT IS THE FIELD INSIDE?

DISCUSS FARADAY CAGE CONCEPT

THE SURFACE OF A CONDUCTOR HAS CHARGE DENSITY $\sigma(\vec{r})$, VARYING OVER THE SURFACE.



ASSUME $\vec{E}(\vec{r}) = E(\vec{r}) \hat{n}$

$\oint \vec{E} \cdot d\vec{a} = E(\vec{r}) A$

$Q_{ENC} = \sigma A$

$\vec{E}(\vec{r}) = \frac{\sigma(\vec{r}) \hat{n}}{\epsilon_0}$

THE TRICK IS TO ASSUME A GAUSSIAN "PILLBOX" WITH AREA A SMALL ENOUGH THAT $\sigma = \text{CONST.}$ OVER THAT AREA, AND ALSO THE SURFACE IS FLAT SO $\hat{n} = \text{CONST.}$ AND $\vec{E} = \text{CONST.}$