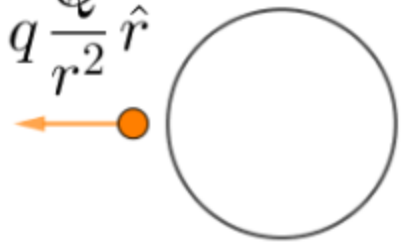
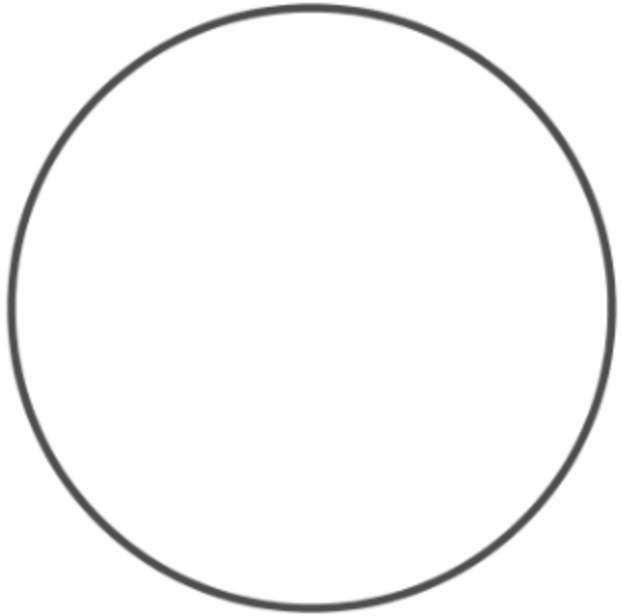
$$\vec{F}_Q = q\frac{Q}{r^2}\hat{r}$$



$Q_{coulomb}$	$g_{gravity}$
$\vec{F}_Q = q\vec{E}_Q$	$\vec{F}_g = mg\hat{y}$
$\vec{E}_Q = \frac{Q}{r^2}\hat{r}$	$\vec{E}_g = g\hat{y}$
$\phi_Q = \frac{Q}{r}$	$\phi_g = gh$
$U_Q = \int_0^\infty E_{(r)}^2 dr = Q\phi$	$U_g = m \cdot gh$

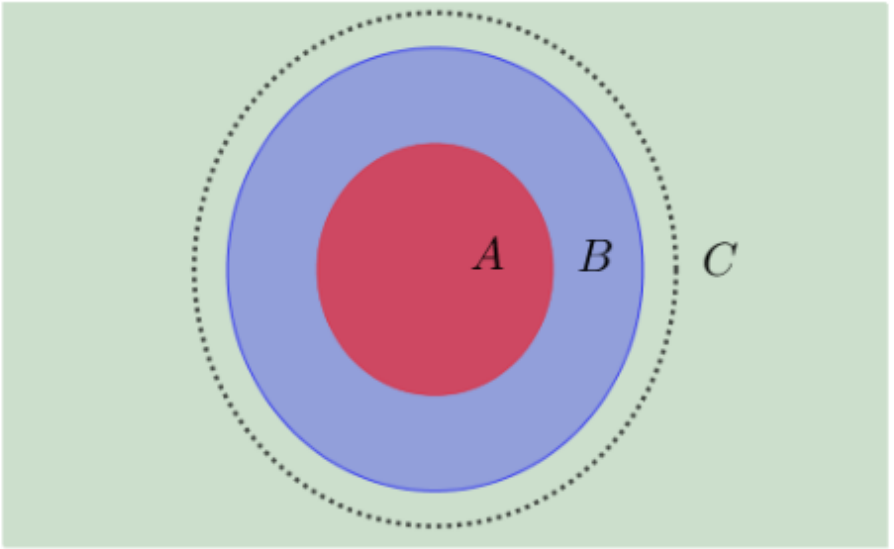


$$\phi_{(r+\epsilon)} = \phi_{(r-\epsilon)}$$

$$\phi_{(r\to\infty)} = 0$$

$$\phi_{ground} = 0$$

$$\phi_{(A)} = \phi_{(B)}$$



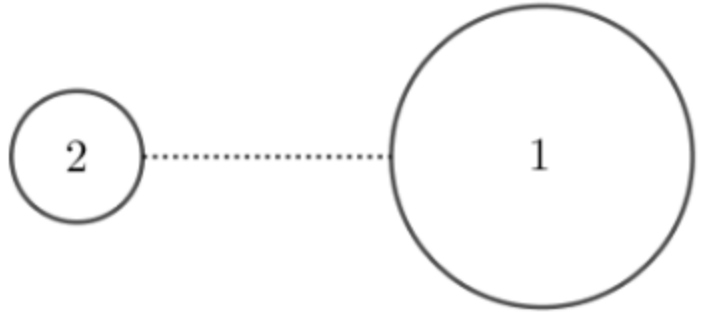
	$E_{(r)}$		$\phi_{(r)}$
A	0	$\underline{C_A}$	$\frac{Q_{AB}}{R_{AB}} + \frac{Q_{BC}}{R_{BC}}$
B	$\frac{Q_{AB}}{r^2}$	$\frac{Q_{AB}}{r} + \underline{C_B}$	$\frac{Q_{AB}}{r} + \frac{Q_{BC}}{R_{BC}}$
C	$\frac{Q_{AB}+Q_{BC}}{r^2}$	$\frac{Q_{AB}+Q_{BC}}{r} + \underline{C_C}$	$\frac{Q_{AB}+Q_{BC}}{r}$

$$\underline{C_A} = \frac{Q_{AB}}{R_{AB}} + \underline{C_B} \Rightarrow \underline{C_A} = \frac{Q_{AB}}{R_{AB}} + \frac{Q_{BC}}{R_{BC}}$$

$$\frac{Q_{AB}}{R_{BC}} + \underline{C_B} = \frac{Q_{AB}+Q_{BC}}{R_{BC}} + \underline{C_C} \Rightarrow \underline{C_B} = \frac{Q_{BC}}{R_{BC}}$$

$$\frac{Q_{AB}+Q_{BC}}{\infty} + \underline{C_C} = 0 \Rightarrow \underline{C_C} = 0$$

לאיצנטופ תחת תוקזחום ,וותנ סוידר תולעב תוריפס יתשV–ו 0 .
והיניב תורבוחמ וה חתמה רוקממ וקותינ רחאל.
?תוריפסה לע שדחה לאיצנטופה והמו ,רוביחה רחאל רבע ועטמ המכ



$q_2 = 0 \cdot R_2$

$q_1 = V_1 \cdot R_1$

$q_2^* = \Delta$ $q_1^* = q_1 - \Delta$

$$V_1^* = V_2^* \Rightarrow \frac{q_1^*}{R_1} = \frac{q_2^*}{R_2}$$

$$\frac{q_1 - \Delta}{R_1} = \frac{\Delta}{R_2}$$

$$q_1 R_2 - \Delta \cdot R_2 = \Delta \cdot R_1$$

$$\boldsymbol{\Delta = \frac{R_2}{R_1 + R_2} \cdot q_1 = \frac{R_1 \cdot R_2}{R_1 + R_2} \cdot V_1}$$

$$\boldsymbol{V^* = \frac{R_1}{R_1 + R_2} \cdot V_1}$$

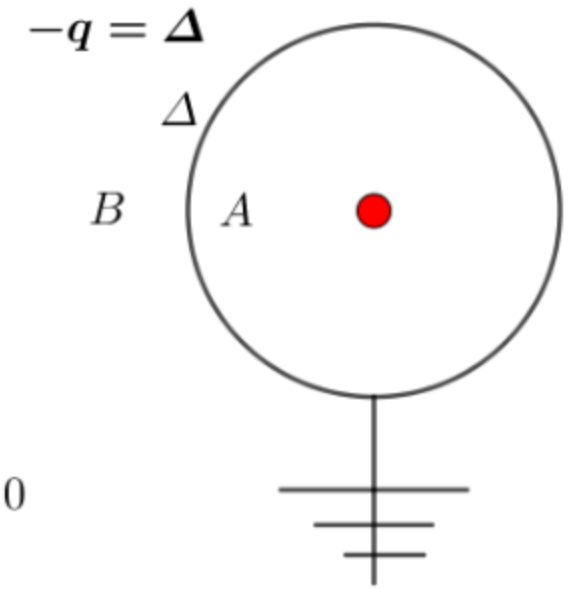
ועטמ וותנף תא אצמ .תקראומ הפילק וביבסמו
לאיצנטופהו ילמשחה הדשה ,הפילקה לע ועטמה

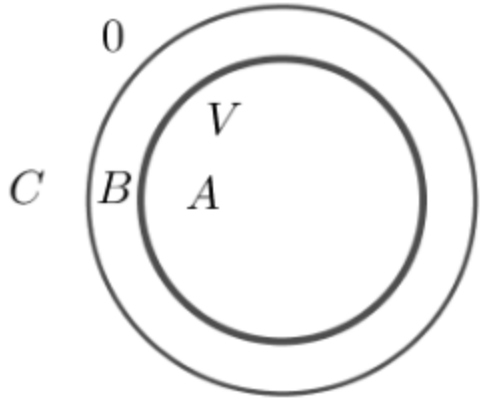
	$E_{(r)}$	$\phi_{(r)}$	
A	$\frac{q}{r^2}$	$\frac{q}{r}+C_A$	$\boldsymbol{\frac{q}{r}-\frac{q}{R_{AB}}}$
B	$\frac{q+\Delta}{r^2}$	$\frac{q+\Delta}{r}+C_B$	$\mathbf{0}$

$$\frac{q}{R_{AB}}+C_A=0$$

$$\frac{q+\Delta}{R_{AB}}+0=0$$

$$\frac{q+\Delta}{\infty}+C_B=0$$





		$\vec{E}_{(r)}\hat{r}$	$\phi_{(r)}$	
$0 < r < R_{AB}$	A	0	C_A	$\boldsymbol{q\dfrac{R_{BC}-R_{AB}}{R_{AB}\cdot R_{BC}}=V}$
$R_{AB} < r < R_{BC}$	B	$\dfrac{q}{r^2}$	$\dfrac{q}{r}+C_B$	$\boldsymbol{\dfrac{q}{r}-\dfrac{q}{R_{BC}}}$
$R_{BC} < r < \infty$	C	0	C_C	$\boldsymbol{0}$

$$C_A = \frac{q}{R_{AB}} + C_B \Rightarrow C_A = q(\frac{1}{R_{AB}} - \frac{1}{R_{BC}})$$

$$\frac{q}{R_{BC}} + C_B = C_C \Rightarrow C_B = -\frac{q}{R_{BC}}$$

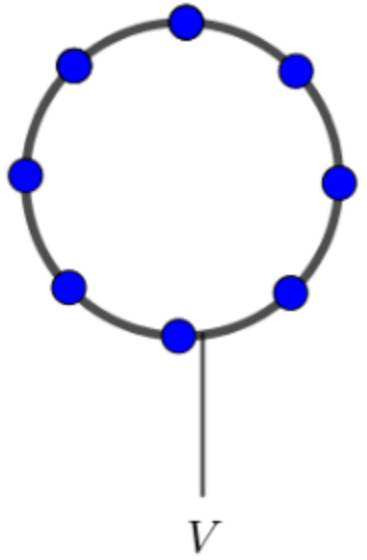
$$C_C = 0$$

סוידר תלעב תירודכ הפילק הנותנR לאיצנטופ תחת תקזחומה V
יפ לדגי רודכה סוידר סא תכרעמה תייגרנא היהת המp
סוידרה יוניש דלהמב לאיצנטופה תחת תקזחום הפילקה סא .א
סוידרה תנטקה ינפל חתמה רוקממ תקתונמ הפילקה סא .ב

		$\vec{E}_{(r)}\hat{r}$	$\phi_{(r)}$
A	$0 < r < R$	0	$\boldsymbol{\frac{q}{R_{AB}} = V}$
B	$R < r < \infty$	$\frac{q}{r^2}$	$V_{(r)} = \frac{R_{AB}}{r} V$

$U = qV$

$$U = R \cdot V^2 = \frac{q^2}{R}$$



$\underline{V^* = V}$ $\qquad$ $\underline{q_* = q}$

$U^* = R^* \cdot V^{*2}$ $\qquad$ $U^* = \frac{q^{*2}}{R^*}$

$W = U^* - U = \boldsymbol{V^2(R^* - R)}$ $\qquad$ $W = U^* - U = \frac{q^2}{R^*} - \frac{q^2}{R} = \boldsymbol{q^2 \frac{R - R^*}{R \cdot R^*}}$

$$V = \frac{Q}{R}$$

$$V_{vol} = \frac{4}{3}\pi R^3$$

$$Q_{10} = 10 \cdot Q_1$$

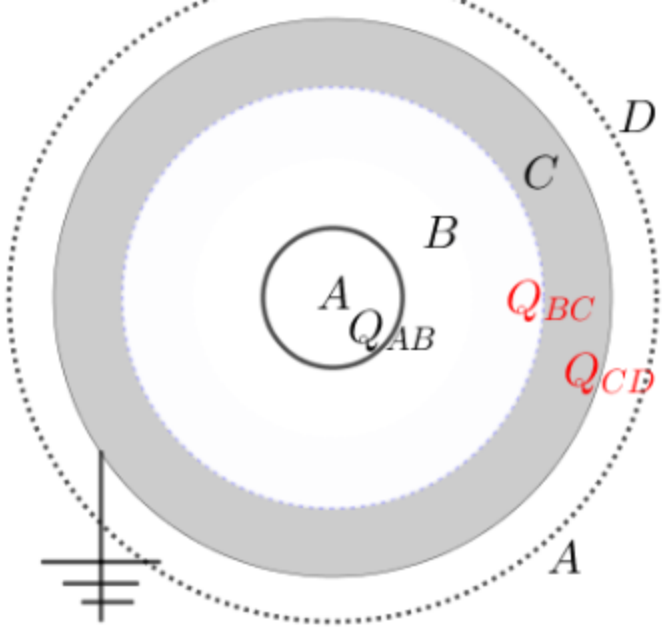
$$R_{10} = 10^{\frac{1}{3}} \cdot R_1$$

$$V_{10} = \frac{Q_{10}}{R_{10}} = \frac{10 \cdot Q_1}{10^{\frac{1}{3}} \cdot R_1} = \frac{10}{10^{\frac{1}{3}}} \cdot \frac{Q_1}{R_1} = \frac{10}{10^{\frac{1}{3}}} \cdot V_1 = 10^{\frac{2}{3}} \cdot V_1$$

$$\boldsymbol{V_{10} = 10^{\frac{2}{3}} \cdot V_1}$$

$$V_{1000} = 1000^{\frac{2}{3}} \cdot V_1$$

$$V_{1000} = 100 \cdot V_1$$



$$Q_{BC} = -Q_{AB}$$

$$Q_{CD} = 0$$

$$\Delta_g = Q_{BC} + Q_{CD}$$

$$U = Q_{AB}\left(\frac{Q_{AB}}{R_{AB}} - \frac{Q_{AB}}{R_{BC}}\right)$$

	$E_{(r)}$	$\phi_{(r)}$
A	0	C_A
B	$\frac{Q_{AB}}{r^2}$	$\frac{Q_{AB}}{r} + C_B$
C	$\frac{Q_{AB} + Q_{BC}}{r^2} = 0$	$C_C = 0$
D	$\frac{Q_{AB} + Q_{BC} + Q_{CD}}{r^2}$	$\frac{Q_{CD}}{r} + C_D$

$$C_A = \frac{Q_{AB}}{R_{AB}} + C_B \Rightarrow C_A = \frac{Q_{AB}}{R_{AB}} - \frac{Q_{AB}}{R_{BC}}$$

$$\frac{Q_{AB}}{R_{BC}} + C_B = C_C \Rightarrow C_B = -\frac{Q_{AB}}{R_{BC}}$$

$$C_C = \frac{Q_{CD}}{R_{CD}} + C_D \Rightarrow Q_{CD} = 0$$

$$\frac{Q_{CD}}{\infty} + C_D = 0 \Rightarrow C_D = 0$$

	$E_{(r)}$	$\phi_{(r)}$
A	$?/\frac{Q}{r^2}$	$?/C_A$
B	0	$0 = C_B$
C	$\frac{Q_{BC}}{r^2}$	$\frac{Q_{BC}}{r} + C_C$
D	0	$V = C_D$
E	$\frac{Q_{DE}}{r^2}$	$\frac{Q_{DE}}{r} + C_E$

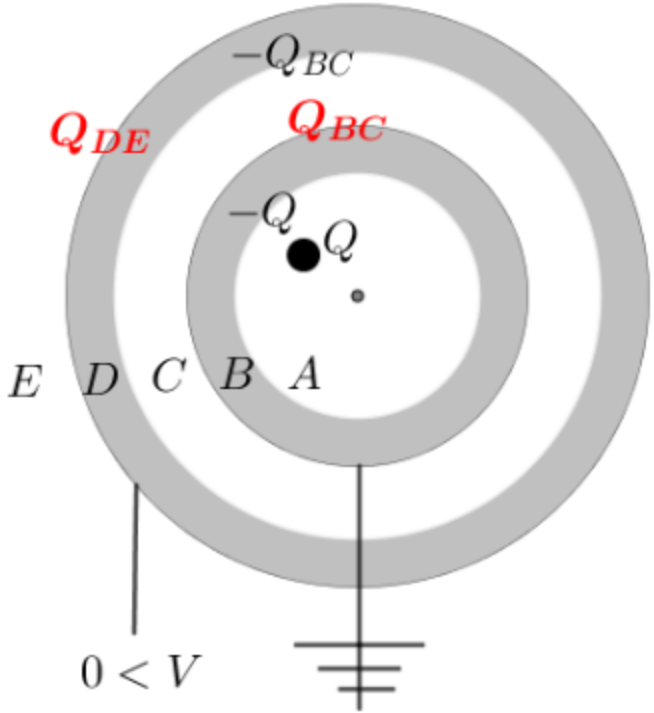
$$0 = \frac{Q_{BC}}{R_{BC}} - \frac{Q_{BC}}{R_{CD}} + V$$

$$C_B = \frac{Q_{BC}}{R_{BC}} - \frac{Q_{BC}}{R_{CD}} + \frac{Q_{DE}}{R_{DE}}$$

$$\frac{Q_{BC}}{R_{CD}} + C_C = \frac{Q_{DE}}{R_{DE}}$$

$$C_D = \frac{Q_{DE}}{R_{DE}}$$

$$\frac{Q_{DE}}{\infty} + C_E = 0$$



$$\boldsymbol{Q_{DE} = V \cdot R_{DE}}$$

$$\boldsymbol{Q_{BC} = V \cdot \frac{R_{BC} \cdot R_{CD}}{R_{BC} - R_{CD}}}$$