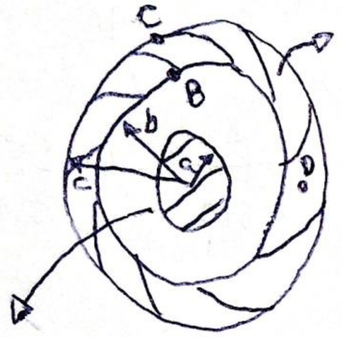
Task 1.1 :

$$Q_a = \int_V \rho\, dV = \int_0^a r \cdot 4\pi r^2 = \pi \left[r^4 \right]_0^a = \pi a^4$$



$$V = \frac{4}{3}\pi r^3$$
$$dV = 4\pi r^2$$

non-conductive sphere $\Big| \rho = r \left(\frac{Q}{m^3}\right)$

1. $\left.\begin{array}{l} 0 = Q_B + Q_c \\ 0 = Q_D = Q_a + Q_B \end{array}\right\}$ $\begin{array}{l} Q_a = Q_C = \pi a^4 \\ Q_a = -Q_B = -\pi a^4 \end{array}$ $\boxed{\begin{array}{l} \sigma_c = \frac{Q_c}{S_c} = \frac{\cancel{\pi} a^4}{4\cancel{\pi} c^2} = \frac{a^4}{4c^2} \\ \sigma_B = \frac{Q_B}{S_B} = \frac{-\cancel{\pi} a^4}{4\cancel{\pi} b^2} = \frac{-a^4}{4b^2} \end{array}}$

2. $\boxed{r < a}$

$$\phi = \oint_V \vec{E}\, d\vec{S} \underset{\vec{E} \parallel \vec{S}}{=} ES = E\, 4\pi r^2 = \frac{Q_{enc}}{\varepsilon_0} \rightarrow E = \frac{\cancel{\pi} r^{\cancel{4}2}}{4\cancel{\pi} \cancel{r^2} \varepsilon_0} \Rightarrow \boxed{\vec{E} = \frac{r^2}{4\varepsilon_0} \left(\frac{N}{C}\right)}$$

$$Q_{enc} = \int_V \rho\, dV = \int_0^r r\, 4\pi r^2 = \pi r^4$$

$\boxed{a < r < b}$

$$\phi = ES = E 4\pi r^2 = \frac{Q_a}{\varepsilon_0} \rightarrow E = \frac{\cancel{\pi} a^4}{4\cancel{\pi} r^2 \varepsilon_0} \rightarrow \boxed{\vec{E} = \frac{a^4}{4 r^2 \varepsilon_0} \left(\frac{N}{C}\right)}$$

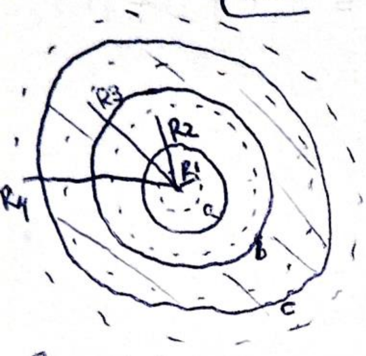
$\boxed{b < r < c}$

$$\phi = 0 \rightarrow \boxed{\vec{E} = 0}$$
$$Q_{enc} = 0$$

$\boxed{c < r}$

$$\phi = ES = E 4\pi r^2 = \frac{Q_a + 0}{\varepsilon_0} \rightarrow E = \frac{\cancel{\pi} a^4}{4\cancel{\pi} r^2} \rightarrow \boxed{\vec{E} = \frac{a^4}{4 r^2 \varepsilon_0} \left(\frac{N}{C}\right)}$$

3. A) $\boxed{\Delta V} = V_{R1} - \cancel{V_\infty}^{\,0} = -\int_\infty^{R1=a/2} \vec{E}\,d\vec{r} = -\int_\infty^{c} \frac{a^4}{4r^2\varepsilon_0}dr - \int_c^{b} 0\,dr - \int_b^{a} \frac{a^4}{4r^2\varepsilon_0}dr - \int_a^{a/2} \frac{r^2}{4\varepsilon_0}dr =$



$$= \frac{a^4}{4\varepsilon_0}\left(\left[\frac{1}{r}\right]_\infty^c + \left[\frac{1}{r}\right]_b^a\right) - \frac{1}{12\varepsilon_0}\left[r^3\right]_a^{a/2} = \frac{a^3(ab+cb-ac)}{4\varepsilon_0 bc} + \frac{7a^3}{96\varepsilon_0} =$$

$$= \boxed{\frac{a^3}{4\varepsilon_0}\left(\frac{ab+cb-ac}{bc} + \frac{7}{24}\right)(V)}$$

$R_1 = a/2$
$R_2 = 2a$
$R_3 = 2b$
$R_4 = 2c$

B) $\boxed{\Delta V} = V_{R1} - V_{R4} = -\int_\infty^{R1=a/2} \vec{E}\,d\vec{r} - \int_\infty^{R4=2c} \vec{E}\,d\vec{r} = \frac{a^3}{4\varepsilon_0}\left(\frac{ab+cb-ac}{bc} + \frac{7}{24}\right) - \int_\infty^{2c} \frac{a^4\,dr}{4r^2\varepsilon_0} =$

$$= \frac{a^3}{4\varepsilon_0}\left(\frac{ab+cb-ac}{bc} + \frac{7}{24} + \frac{a}{2c}\right) = \boxed{\frac{a^3}{4\varepsilon_0}\cdot\frac{36ab+31bc-24ac}{24bc}(V)}$$

C) $\boxed{\Delta V} = V_{R1} - V_{R3} = -\int_\infty^{R1} \vec{E}\,d\vec{r} - \int_\infty^{R3} \vec{E}\,d\vec{r} = \frac{a^3}{4\varepsilon_0}\left(\frac{ab+cb-ac}{bc} + \frac{7}{24}\right) + \underline{\frac{a^4}{4c\varepsilon_0}} =$

$$= \boxed{\frac{a^3}{4\varepsilon_0}\cdot\frac{48ab+31bc-24ac}{24bc}(V)}$$

because From c to R_3 $\Delta V = 0$

D) $\boxed{\Delta V} = V_{R1} - V_{R2} = -\int_\infty^{R1} \vec{E}\,d\vec{r} - \int_\infty^{R2} \vec{E}\,d\vec{r} = -\int_\infty^{R1} \vec{E}\,d\vec{r} + \frac{a^4}{4\varepsilon_0}\left(\left[\frac{1}{r}\right]_\infty^c + \left[\frac{1}{r}\right]_b^{2a}\right) =$

$$= \frac{a^3}{4\varepsilon_0}\left(\frac{24ab+31bc-24ac}{24bc} + \frac{2ab+bc-2ac}{2bc}\right) = \boxed{\frac{a^3}{4\varepsilon_0}\cdot\frac{48ab+43bc-48ac}{24bc}(V)}$$

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