Sheet 7

1 Three point charges $Q_1 = 30$ nC , $Q_2 = 150$ nC and $Q_3 = -70$ nC are enclosed by surfaces S. What net flux crosses S ?

$[\boldsymbol{\Psi_{net}} = \boldsymbol{Q_{net}} = \mathbf{110\ nC}]$

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2 A circular disk of 400 cm radius with a charge density $\rho_s = 12 \sin\phi\ \mu C/\text{m}^2$ is enclosed by surface S what net flux crosses S ? Comment.

$[\boldsymbol{\Psi} = \mathbf{0}]$

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3 A 25 µC point charge is located at origin. Calculate the electric flux passing through a portion of a sphere shell with $r = 20$ cm bounded by $\theta = 0 \to \pi$ and $\phi = 0 \to \frac{\pi}{2}$

$$\left[\boldsymbol{\Psi} = \frac{\boldsymbol{Q}}{\mathbf{4}} = \mathbf{6.25\ \mu C}\right]$$

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4 Charge in the form of a plane with density $\rho_s = 40\ \mu\text{C/m}^2$ is located at $z = -0.5$ m . A uniform line charge of $\rho_l = -6\ \mu\text{C/m}$ lies along the y axis . What net flux crosses the surface of the cube 2 m on an edge, cantered at the origin?

$[\boldsymbol{\Psi} = \mathbf{148\ \mu C}]$

5 Two identical uniform line charge lie along the x and y axes with $\rho_l = 20\ \mu\text{C/m}$. Obtain $\overline{D}$ and $\overline{E}$ at (3,3,3) m.

$$\left[\begin{array}{c}\overline{\boldsymbol{D}} = \mathbf{0.5305}(\overline{\boldsymbol{a}}_x + \overline{\boldsymbol{a}}_y + \mathbf{2}\overline{\boldsymbol{a}}_z) \\ \overline{\boldsymbol{E}} = \dfrac{\overline{\boldsymbol{D}}}{\boldsymbol{\epsilon}}\end{array}\right]$$

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6 A uniform line charge of $\rho_l = 3\ \mu\text{C/m}$ lies along the z-axis, and a concentric circular cylinder of radius $a = 2$ m has $\rho_s = (-1.5/4\pi)\ \mu\text{C/m}^2$. Use Gauss' law to find $\overline{D}$ in all regions (i.e. for $0 \le r \le 2$ and $r > 2$).

$$\left[\overline{\boldsymbol{D}} = \begin{cases}\dfrac{\mathbf{0.477}}{\boldsymbol{r}}\ \overline{\boldsymbol{a}}_r\ \mu\text{C/m}^2 & \mathbf{0} \le \boldsymbol{r} \le \mathbf{2} \\ \dfrac{\mathbf{0.239}}{\boldsymbol{r}}\ \overline{\boldsymbol{a}}_r\ \mu\text{C/m}^2 & \boldsymbol{r} > \mathbf{2}\end{cases}\right]$$

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7 A point charge $Q = 2000$ pC is at the origin of spherical coordinates. A concentric distribution of charge at $r = 1$ m has $\rho_s = 40\pi\ \text{pC/m}^2$. What surface charge density on a concentric shell at $r = 2m$ would result in $\overline{D} = 0$ for $r > 2$ m ?

$[\boldsymbol{\rho}_{s2} = -\mathbf{71.2}\ \text{pC/m}^2]$
