Chapter 23.

Q.2.

(a) Because $\Phi = \frac{q_{enc}}{\varepsilon_0}$ and all 4 surfaces enclose the same charge, all the 4 closed surfaces have identical total flux a=b=c=d.

(b) Since $\Phi = \oint \vec{E} \cdot d\vec{A}$, even though $\vec{E}$ on surfaces b and d does not have identical magnitude everywhere, the total surface areas of the 4 closed surface rank as a < b < c < d, then the average magnitude of $\vec{E}$ should rank as a > b > c > d

Q.5.

Due to symmetry, magnitude of $\vec{E}$ is same everywhere on the cylinder surface for each case. Since the surfaces enclose same amount of total charges and $\Phi = \oint \vec{E} \cdot d\vec{A} = \frac{Q}{\varepsilon_o}$, the magnitude of the three cases are identical. a = b = c

Q.10.

(a) Since $\rho = \frac{Q}{Volume}$, $\rho_a > \rho_b > \rho_c > \rho_d$

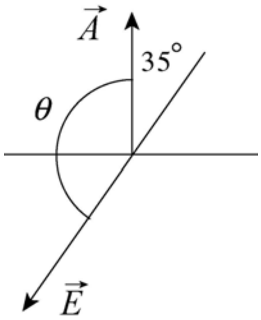
(b) for both cases a and b, the closed Gaussian surface passing position P and centered on the center of spheres will enclose the same amount of charge Q, thus $E_a = E_b$. But for cases c and d, because the total charge are same – Q, and uniformed distributed in the sphere, the large the sphere volume, the smaller the amount of charge enclosed in the Gaussian surface passing P. Therefore $E_c > E_d$.

Thus $E_a = E_b > E_c > E_d$.

P.1.

The vector area $\vec{A}$ and the electric field $\vec{E}$ are shown on the diagram below. The angle θ between them is 180° – 35° = 145°, so the electric flux through the area is

$$\Phi = \vec{E} \cdot \vec{A} = EA\cos\theta = (1800\ \text{N/C})(3.2\times10^{-3}\ \text{m})^2 \cos 145° = -1.5\times10^{-2}\ \text{N}\cdot\text{m}^2/\text{C}.$$



P.5.

The total flux has no dependence on the area of Gaussian surface. Area is only concerned to compute the electric field in symmetry cases.

We use Gauss' law: $\varepsilon_0 \Phi = q$, where Φ is the total flux through the cube surface and q is the net charge inside the cube. Thus,

$$\Phi = \frac{q}{\varepsilon_0} = \frac{1.8\times10^{-6}\ \text{C}}{8.85\times10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2} = 2.0\times10^{5}\ \text{N}\cdot\text{m}^2/\text{C}.$$

P.15.

(a) The charge on the surface of the sphere is the product of the surface charge density σ and the surface area of the sphere (which is $4\pi r^2$, where r is the radius). Thus,

$$q = 4\pi r^2 \sigma = 4\pi \left(\frac{1.2\ \text{m}}{2}\right)^2 (8.1\times10^{-6}\ \text{C/m}^2) = 3.7\times10^{-5}\ \text{C}.$$

(b) We choose a Gaussian surface in the form of a sphere, concentric with the conducting sphere and with a slightly larger radius. The flux is given by Gauss's law:

$$\Phi = \frac{q}{\varepsilon_0} = \frac{3.66\times10^{-5}\ \text{C}}{8.85\times10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2} = 4.1\times10^{6}\ \text{N}\cdot\text{m}^2/\text{C}\ .$$

P.16.

Using Eq. 23-11, the surface charge density is

$$\sigma = E\varepsilon_0 = \left(2.3\times10^{5}\ \text{N/C}\right)\left(8.85\times10^{-12}\text{C}^2/\text{N}\cdot\text{m}^2\right) = 2.0\times10^{-6}\ \text{C/m}^2.$$

P.32.

According to Eq. 23-13 the electric field due to either sheet of charge with surface charge density $\sigma = 1.77\times 10^{-22}$ C/m^2 is perpendicular to the plane of the sheet (pointing *away* from the sheet if the charge is positive) and has magnitude $E = \sigma/2\varepsilon_0$. Using the superposition principle, we conclude:

(a) $E = \sigma/\varepsilon_0 = (1.77 \times 10^{-22})/(8.85 \times 10^{-12}) = 2.00\times10^{-11}$ N/C, pointing in the upward direction, or $\vec{E} = (2.00\times10^{-11}\ \text{N/C})\hat{\text{j}}$.

(b) $E = 0$;

(c) and, $E = \sigma/\varepsilon_0$, pointing down, or $\vec{E} = -(2.00\times10^{-11}\ \text{N/C})\hat{\text{j}}$.

Chapter 24 -1.

Q.3.

Because $\boldsymbol{V} = \frac{\boldsymbol{kq}}{\boldsymbol{r}}$ and all charges have the same r, the origin potential $\boldsymbol{V} = \sum \boldsymbol{V_i}$:

a: $\boldsymbol{V} = \frac{\boldsymbol{k}}{\boldsymbol{r}}[(+2\boldsymbol{q}) + (-9\boldsymbol{q})] = -7\boldsymbol{q} \cdot \frac{\boldsymbol{k}}{\boldsymbol{r}}$

c: $\boldsymbol{V} = \frac{\boldsymbol{k}}{\boldsymbol{r}}[(-2\boldsymbol{q}) + (-2\boldsymbol{q}) + (-\boldsymbol{q}) + (-2\boldsymbol{q})] = -7\boldsymbol{q} \cdot \frac{\boldsymbol{k}}{\boldsymbol{r}}$

b: $\boldsymbol{V} = \frac{\boldsymbol{k}}{\boldsymbol{r}}(-3\boldsymbol{q}) + (-2\boldsymbol{q}) = -5\boldsymbol{q} \cdot \frac{\boldsymbol{k}}{\boldsymbol{r}}$

d: $\boldsymbol{V} = \frac{\boldsymbol{k}}{\boldsymbol{r}}[(+2\boldsymbol{q}) + (-4\boldsymbol{q}) + (+2\boldsymbol{q}) + (-7\boldsymbol{q})] = -7\boldsymbol{q} \cdot \frac{\boldsymbol{k}}{\boldsymbol{r}}$

$V_b > Va = V_c = V_{d.}$

Q.6.

(a) $\boldsymbol{V_p} = \frac{\boldsymbol{kQ}}{\boldsymbol{R}}$

(b) $\boldsymbol{V_p} = \int_{0^\circ}^{40^\circ} \frac{\boldsymbol{kdQ}}{\boldsymbol{R}} = \frac{\boldsymbol{k}}{\boldsymbol{R}} \int_{0^\circ}^{40^\circ} \boldsymbol{dQ} = \frac{\boldsymbol{kQ}}{\boldsymbol{R}}$

(c) $\boldsymbol{V_p} = \int_{0^\circ}^{360^\circ} \frac{\boldsymbol{kdQ}}{\boldsymbol{R}} = \frac{\boldsymbol{k}}{\boldsymbol{R}} \int_{0^\circ}^{360^\circ} \boldsymbol{dQ} = \frac{\boldsymbol{kQ}}{\boldsymbol{R}}$

(d) then a = b =c.

Q.8.

(a) $|E_x| = \frac{dV}{dx}$, so : $E_2 > E_4 > E_1 = E_3 = E_5$.

(b) $\boldsymbol{E_x} = -\frac{\boldsymbol{dV}}{\boldsymbol{dx}}$, when V increase along x, E points toward –x; when V decrease along x, E points toward +x. Therefore E_2 toward –x, E_4 toward +x directions.

P.1.

(a) $q = \int i dt = i \cdot t = 90A \cdot \frac{60\min}{h} \cdot \frac{60s}{\min} = 90A \cdot 3600s = 3.2 \cdot 10^5 C$

(b) $U = qV = 3.2 \cdot 10^5 C \cdot 12V = 3.888 \times 10^5 J$

P.4.

The electric field does positive work to move –e charge from A to B, which means the electron loses its potential energy ∇U= -e ∇V <0. Therefore ∇V>0, the potential actually increases from A to B. Therefore we can figure out $V_A < V_B$, also $V_C = V_B$

(a) $V_B - V_A = \left|\frac{\nabla U_{BA}}{e}\right| = \frac{3.94 \cdot 10^{-19} J}{1.6 \times 10^{-19} C} = 2.46V$

(b) $V_C - V_A = (V_C - V_B) + (V_B - V_A) = 0 + 2.46V = 2.46V$

(c) $V_C - V_B = 0V$ (same potential)