Electrostatics – Problems 11, 34, 57

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11. Positive particle with charge 6[nC] $\rightarrow \mathrm{p}^{6+}$, positive particle with charge 5[nC] $\rightarrow \mathrm{p}^{5+}$, negative particle with charge -3[nC] $\rightarrow \mathrm{e}^{3-}$ (1)

$$\begin{aligned}
F_{\mathrm{e}^{3-}\text{ on }\mathrm{p}^{5+}} &= k\frac{|(5\cdot 10^{-9})(-3\cdot 10^{-9})|}{.1^2} \\
&= 1.35\cdot 10^{-5}[\mathrm{N}_{\mathrm{down}}] \\
F_{\mathrm{e}^{6+}\text{ on }\mathrm{p}^{5+}} &= k\frac{|(5\cdot 10^{-9})(6\cdot 10^{-9})|}{.3^2} \\
&= 3\cdot 10^{-6}[\mathrm{N}_{\mathrm{left}}] \\
||F_{\text{on }\mathrm{p}^{5+}}|| &= \sqrt{(1.35\cdot 10^{-5})^2+(3\cdot 10^{-6})^2} \\
&= 1.38\cdot 10^{-5}[\mathrm{N}] \\
\angle \mathrm{p}^{5+} &= \tan^{-1}\left(\frac{3\cdot 10^{-6}}{1.35\cdot 10^{-5}}\right) \\
&= 12.53^\circ \text{ (left of } 270^\circ \text{ line)} \\
\angle_f &= 270-12.53 = 257.47^\circ \\
F_{\text{on }\mathrm{p}^{5+}} &= 1.38\cdot 10^{-5}[\mathrm{N}] \text{ at } 257.47^\circ
\end{aligned} \tag{1}$$

34. (a) (2)

$$\begin{aligned}
q_1 &= -6 \\
q_2 &= 18 \\
\frac{q1}{q2} &= -\frac{1}{3}
\end{aligned} \tag{2}$$

(b) (3)

q_1 has a negative sign because the electric field is going into it
q_2 has a positive sign because the electric field is leaving it (3)

57. Field by particle with charge 3[nC] $\rightarrow E_{\mathrm{p}^{3+}}$, Field by particle with charge 5[nC] $\rightarrow E_{\mathrm{p}^{5+}}$, Field by particle with charge -4[nC] $\rightarrow E_{\mathrm{e}^{4-}}$ (4)

$$
\begin{aligned}
E_{\mathrm{p}^{3+}} &= k\frac{3\cdot 10^{-9}}{1.2^2} \\
&= 18.72\left[\frac{\mathrm{N}}{\mathrm{C}}\ \text{right}\right] \\
E_{\mathrm{p}^{5+}} &= k\frac{5\cdot 10^{-9}}{2^2} \\
&= 11.23\left[\frac{\mathrm{N}}{\mathrm{C}}\ \text{right}\right] \\
E_{\mathrm{e}^{4-}} &= k\frac{4\cdot 10^{-9}}{2.5^2} \\
&= 5.75\left[\frac{\mathrm{N}}{\mathrm{C}}\ \text{left}\right] \\
18.72 + 11.23 - 5.75 &= 24.2\left[\frac{\mathrm{N}}{\mathrm{C}}\ \text{right}\right]
\end{aligned}
\tag{4}
$$