電磁気学II演習　解答　No.1

1.求める電荷を q [C] とすると

$$F = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{r^2}$$

$$160 = 9\times10^9 \times \frac{q^2}{\left(30\times10^{-2}\right)^2}$$

$$q^2 = 16\times10^{-10}$$

$$\therefore q = \pm4\times10^{-5}\ [\mathrm{C}] = \pm40\ [\mu\mathrm{C}]$$

2.b球がa球に、c球がa球に及ぼす力をそれぞれ $F_{b\to a}$、 $F_{c\to a}$ とする。

$$F_{b\to a} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q^2}{r_{ba}^2} = 9\times10^9\times\frac{\left(2\times10^{-6}\right)^2}{0.3^2} = 0.4\ [\mathrm{N}]$$

$$F_{c\to a} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q^2}{r_{ca}^2} = 9\times10^9\times\frac{\left(2\times10^{-6}\right)^2}{0.3^2} = 0.4\ [\mathrm{N}]$$

a球に働く力は $F_{b\to a}$、 $F_{c\to a}$ の合力

$$F = F_{b\to a}\cdot\cos30^\circ + F_{c\to a}\cdot\cos30^\circ = 2\times0.4\times\frac{\sqrt{3}}{2} \approx 0.69\ [\mathrm{N}]$$

3.

$$\vec{\mathrm{A}}\cdot\vec{\mathrm{B}} = -10+18-8 = 0$$

$$\vec{\mathrm{A}}\times\vec{\mathrm{B}} = \begin{vmatrix} \mathrm{i} & \mathrm{j} & \mathrm{k} \\ 2 & 3 & 4 \\ -5 & 6 & -2 \end{vmatrix} = \left(-6-24\right)i+\left(-20+4\right)j+\left(12+15\right)k = \left(-30,-16,27\right)$$

$\vec{\mathrm{A}}\cdot\vec{\mathrm{B}} = 0$ よりAとBのなす角は90°

4. x成分は

$$\begin{aligned}\left(\vec{A}\times\left(\vec{B}\times\vec{C}\right)\right)_x &= A_y\left(\vec{B}\times\vec{C}\right)_z - A_z\left(\vec{B}\times\vec{C}\right)_y \\ &= A_y\left(B_xC_y - B_yC_x\right) - A_z\left(B_zC_x - B_xC_z\right) \\ &= \left(A_yC_y + A_zC_z\right)B_x - \left(A_yB_y + A_zB_z\right)C_x \\ &= \left(A_xC_x + A_yC_y + A_zC_z\right)B_x - \left(A_xB_x + A_yB_y + A_zB_z\right)C_x \\ &= \left(\vec{A}\cdot\vec{C}\right)B_x - \left(\vec{A}\cdot\vec{B}\right)C_x\end{aligned}$$

同様にして

$$\left(\vec{A}\times\left(\vec{B}\times\vec{C}\right)\right)_y = \left(\vec{A}\cdot\vec{C}\right)B_y - \left(\vec{A}\cdot\vec{B}\right)C_y$$

$$\left(\vec{A}\times\left(\vec{B}\times\vec{C}\right)\right)_z = \left(\vec{A}\cdot\vec{C}\right)B_z - \left(\vec{A}\cdot\vec{B}\right)C_z$$

$$\therefore\left(\vec{A}\times\left(\vec{B}\times\vec{C}\right)\right) = \left(\vec{A}\cdot\vec{C}\right)\vec{B} - \left(\vec{A}\cdot\vec{B}\right)\vec{C}$$