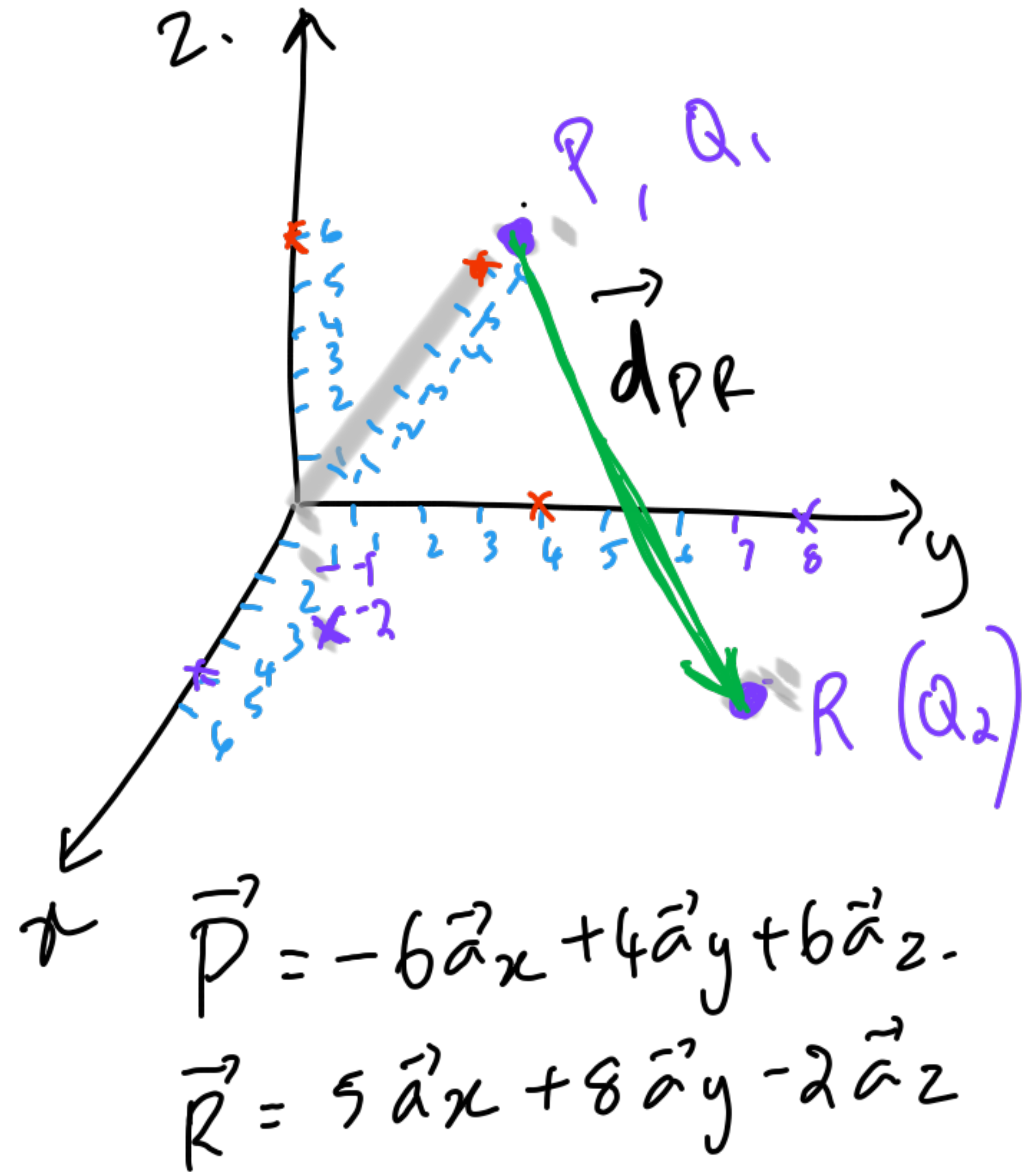


1) A charge $Q_1 = 20 \mu\text{C}$ is located at $P(-6, 4, 6)$ and a charge $Q_2 = -50 \mu\text{C}$ is located at $R(5, 8, -2)$ in a free space. Find the force exerted on Q_2 by Q_1 in vector form. The distance given are in meters.

Soln. $Q_1 = 20 \times 10^{-6} \text{ C}$ $\xrightarrow{P}$
 $Q_2 = -50 \times 10^{-6} \text{ C}$ $\xrightarrow{R}$



$$\begin{aligned}
 \vec{d}_{PR} &= \vec{R} - \vec{P} \\
 &= (5 - (-6))\vec{a}_x + (8 - 4)\vec{a}_y + (-2 - 6)\vec{a}_z \\
 &= 11\vec{a}_x + 4\vec{a}_y - 8\vec{a}_z
 \end{aligned}$$

$$|\vec{d}_{PR}| = \sqrt{(11)^2 + (4)^2 + (-8)^2}$$

$$|\vec{d}_{PR}| = 14.18$$

$$\vec{a}_{PR} = \frac{\vec{d}_{PR}}{|\vec{d}_{PR}|} = \frac{11\vec{a}_x + 4\vec{a}_y - 8\vec{a}_z}{14.18}$$

$$\vec{a}_{PR} = 0.776\vec{a}_x + 0.28\vec{a}_y - 0.56\vec{a}_z$$

$$\vec{F} = \frac{Q_1 Q_2}{4\pi\epsilon_0 d_{PR}^2} \vec{a}_{PR}$$

$$\vec{F} = \frac{20 \times 10^{-6} \times (-50) \times 10^{-6}}{4\pi \times 8.854 \times 10^{-12} \times (14.18)^2} \vec{a}_{PR}$$

$$\vec{F} = -0.0447 \vec{a}_{PR}$$

$$\vec{F} = -0.0447 (0.776 \vec{a}_x + 0.28 \vec{a}_y - 0.56 \vec{a}_z)$$

$$\vec{F} = (-0.035 \vec{a}_x - 0.013 \vec{a}_y + 0.025 \vec{a}_z) \text{ N}$$

$$|F| = \frac{Q_1 Q_2}{4\pi \epsilon_0 d^2}$$

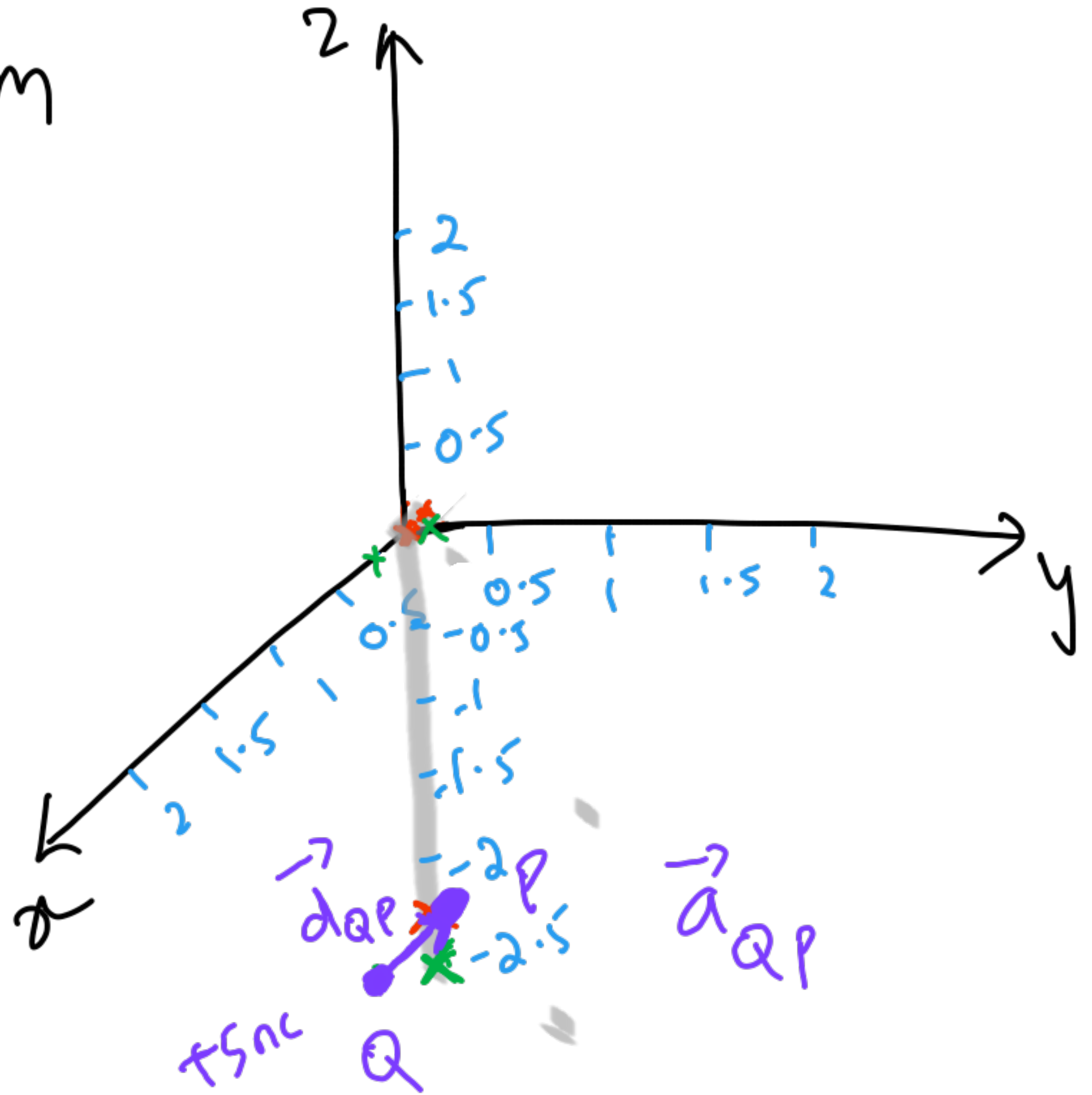
$$\vec{F} = \frac{Q_1 Q_2}{4\pi \epsilon_0 d^2} \vec{a}$$

2) Determine the electric field intensity vector at $P(-0.2, 0, -2.3)\text{m}$ due to a point charge at $+5\text{nC}$ at $Q(0.2, 0.1, -2.5)\text{m}$ in air.

Soln $\vec{E} = ?$

$$\vec{P} = -0.2\vec{a}_x + 0\vec{a}_y - 2.3\vec{a}_z$$

$$\vec{Q} = 0.2\vec{a}_x + 0.1\vec{a}_y - 2.5\vec{a}_z$$



$$\vec{d}_{QP} = \vec{P} - \vec{Q}$$

$$\vec{d}_{QP} = (-0.2 - 0.2)\vec{a}_x + (0 - 0.1)\vec{a}_y + (-2.3 - (-2.5))\vec{a}_z$$

$$\vec{d}_{QP} = -0.4\vec{a}_x - 0.1\vec{a}_y + 0.2\vec{a}_z$$

$$|\vec{d}_{QP}| = \sqrt{(-0.4)^2 + (-0.1)^2 + (0.2)^2}$$

$$|\vec{d}_{QP}| = 0.46$$

$$\vec{a}_{QP} = \frac{\vec{d}_{QP}}{|\vec{d}_{QP}|} = \frac{-0.4\vec{a}_x - 0.1\vec{a}_y + 0.2\vec{a}_z}{0.46}$$

$$\vec{a}_{QP} = -0.88\vec{a}_x - 0.22\vec{a}_y + 0.43\vec{a}_z$$

$$\vec{E} = \frac{Q}{4\pi\epsilon_0 d_{QP}^2} \vec{a}_{QP}$$

$$= \frac{5 \times 10^{-9}}{4\pi \times 8.854 \times 10^{-12} \times (0.46)^2} \vec{a}_{QP}$$

$$= 214 \left(-0.88\vec{a}_x - 0.22\vec{a}_y + 0.43\vec{a}_z \right)$$

$$\vec{F} = (-187 \vec{a}_x - 46 \vec{a}_y + 93 \vec{a}_z) \text{ N/C}$$

