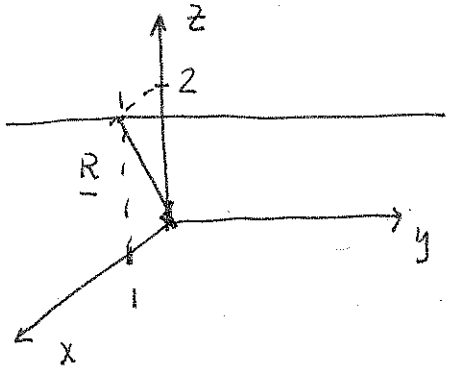
25 points total

Grading. EE1 Quiz 1




1 The co-ordinates of an arbitrary point are $(1, y, 2)$

The vector from this point to the origin at $(0,0,0)$ is

$$\underline{R} = (0-1)\,\underline{a}_x + (0-y)\,\underline{a}_y + (0-2)\,\underline{a}_z$$

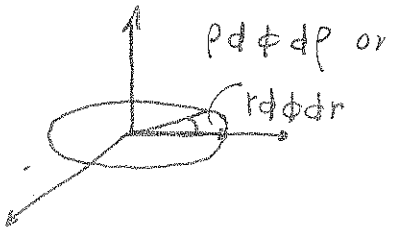
2 $$= -\underline{a}_x - (y)\,\underline{a}_y - 2\,\underline{a}_z.$$

Unit vector $$\underline{a}_R = \frac{\underline{R}}{|\underline{R}|} = \frac{-\underline{a}_x - y\,\underline{a}_y - 2\underline{a}_z}{\sqrt{5+y^2}}.$$ 2

1 2 $$\underline{A}\cdot\underline{B} = |A||B|\cos\theta_{AB} = -4$$

1 $$\underline{A}\times\underline{B} = |\underline{A}||\underline{B}|\sin\theta_{AB} = 0$$

1 $$Q = \int_S \rho_s\, ds$$ ; $\int$ by parts.




3 3 $$Q = \int_0^{2\pi} d\phi \int_0^{a} \rho_{s_0} e^{-r}\, r\,dr$$

3 $$= 2\pi\rho_{s_0}\left[-re^{-r} - e^{-r}\right]_0^a = 2\pi\rho_0\left[1 - e^{-a}(1+a)\right]$$

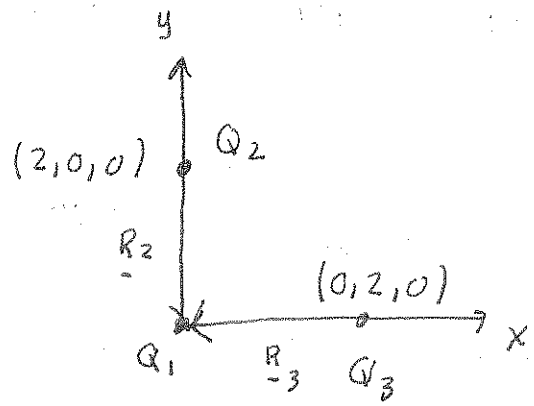
3 for answer

$\int$ by part $\int d(uv) = \int u\,dv + \int v\,du = uv$

let $u = r$, $dv = e^{-r}dr$; $du = dr$, $v = -e^{-r}$

$$\Big| -re^{-r} + \int e^{-r}dr = \int re^{-r}dr \quad \text{/QED.}$$

3 4




Use superposition the electric field due to $Q_2$ and $Q_3$ at the origin is given by.

3 $$\underline{E} = \frac{1}{4\pi\varepsilon_0} 3\times10^{-9} \left[ \frac{-2\underline{a}_x}{(2)^3} - \frac{2\underline{a}_y}{(2)^3} \right]$$

$\varepsilon_0$: $8.854\times10^{-12}$ F/m.

3 $$= 6.74 \left[ -\underline{a}_x - \underline{a}_y \right] \text{ V/m}.$$

This is the force on a unit charge.

Force on 3 nC charge at the origin is therefore

$$\underline{F} = q\underline{E} = 3\times10^{-9} \left[ 6.74 \left( -\underline{a}_x - \underline{a}_y \right) \right] \text{ N}$$

1 $$= 2.02\times10^{-8} \left[ -\underline{a}_x - \underline{a}_y \right] \text{ N}$$

1 $$= 20.2 \left[ -\underline{a}_x - \underline{a}_y \right] \quad \underline{\text{nN}}$$

1

OR

$$\underline{F} = \frac{Q_1 Q_2}{4\pi\varepsilon_0} [\quad]$$

↓

then the same calculation.