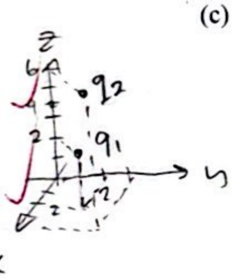
$R_1 = (2,2,2)$

Q1. Charge $q_1 = -6\pi\varepsilon_0$ C is located at point (2 m, 2 m, 2 m) in Cartesian coordinates, and charge q_2 is located at point (3 m, 3 m, 6 m). $R_2 = (3,3,6)$

(a) Draw the locations of the charges in the Cartesian coordinate system. [2] 2

(b) Using Coulomb's law, what should charge q_2 be so that the total electric field $\vec{E}$ at point (0, 0, 4 m) has no x-component? [5] 4

(c) Find the force $\vec{F}$ acting on a third charge $q_3 = 10$ C located the same point (0, 0, 4 m). [3] 1

a) 

b) $E_{1x} = -E_{2x}$ @ $(0,0,4)$ −0.5

$R - R_1 = (0,0,4) - (2,2,2) = (-2,-2,2)$

$R_{1x} = (-2,0,0)$ $|R_{1x}| = 2$

$R - R_2 = (0,0,4) - (3,3,6) = (-3,-3,-2)$

$R_{2x} = (-3,0,0)$ $|R_{2x}| = 3$

$$\frac{1}{4\pi\varepsilon}\left(\frac{q_1(R-R_{1x})}{|R-R_{1x}|^3}\right) = \frac{1}{4\pi\varepsilon}\left(\frac{q_2(R-R_{2x})}{|R-R_{2x}|^3}\right)$$

$$\frac{-6\pi\varepsilon_0(-\hat{x}2)}{2^3} = \frac{q_2(-\hat{x}3)}{3^3}$$

$$q_2 = \frac{-6\pi\varepsilon_0(-\hat{x}2)(3^3)}{2^3(-\hat{x}3)}$$

$$= -\frac{6\pi\varepsilon_0(54)}{24} = -\frac{27}{2}\pi\left(\frac{1}{36\pi}\times 10^{-9}\right) = \frac{-27}{72}\times 10^{-9}$$

−0.5 $= -0.375\times 10^{-9}$ C

c) $$E = \frac{1}{4\pi\varepsilon}\left[\frac{q_1(R-R_1)}{|R-R_1|^3} + \frac{q_2(R-R_2)}{|R-R_2|^3}\right]$$ OK

$$= \frac{1}{4\pi\varepsilon}\left[\frac{-6\pi\varepsilon_0(-\hat{x}2-\hat{y}2+\hat{z}2)}{(2^2+2^2+2^2)^{3/2}} + \left(-\frac{27}{2}\varepsilon_0\right)\frac{(-\hat{x}3-\hat{y}3-\hat{z}2)}{(3^2+3^2+2^2)^{3/2}}\right]$$

$$= \frac{1}{4\pi\varepsilon}\left[\frac{-6\pi\varepsilon_0(-\hat{x}2-\hat{y}2+\hat{z}2)}{(12)^{3/2}} - \frac{27\varepsilon_0(-\hat{x}3-\hat{y}3-\hat{z}2)}{2\,(22)^{3/2}}\right]$$

$$= -\frac{3}{2(12)^{3/2}}(-\hat{x}2-\hat{y}2+\hat{z}2) - \frac{27}{8(22)^{3/2}}(-\hat{x}3-\hat{y}3-\hat{z}2)$$

$F = q_3E$

= ?

−2

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Q2. In a rectangular box defined by the region $0 \le x \le 1$ m, $0 \le y \le 2$ m, $0 \le z \le 3$ m, the electric flux density is given by:

$$\vec{D} = 8x\hat{x} - 3y^2\hat{y} + z^3\hat{z} \quad C/m^2$$

(a) Using the differential form of Gauss' Law, find the volume charge density, ρ_v. [4] 4

(b) Use ρ_v from part (a) to find the total charge Q contained in the box. [6] 2.5

$(8x, -3y^2, z^3)$

a) $Q = \int_v \nabla \cdot D \, dV = \int_v \rho_v \, dV$ $\quad \nabla \cdot D = \rho_v$

$\int_v \rho_v \, dV = \rho_v \int_0^1 dx \int_0^2 dy \int_0^3 dz = 6\rho_v = Q$

−3

$\cancel{\oint_s D_r \, ds = D_r 22 = Q}$

$\nabla \cdot D = \frac{\partial}{\partial x} 8x + \frac{\partial}{\partial y}(-3y^2) + \frac{\partial}{\partial z} z^3$

$= 8 - 6y + 3z^2 = \rho_v$

C/m^3

$\cancel{D_r 22 = 6\rho_v}$

$\cancel{\frac{\vec{D}}{\hat{R}}(22) = 6\rho_v}$

$\cancel{\rho_v = \frac{22}{6\hat{R}}(8x\hat{x} - 3y^2\hat{y} + z^3\hat{z})}$

$\cancel{\rho_v = \frac{1}{\hat{R}}\left(\frac{88}{3}x\hat{x} - 11y^2\hat{y} + \frac{22}{6}\hat{z}\right)}$

b) $\cancel{Q = 6\rho_v = \frac{1}{\hat{R}}(176x\hat{x} - 66y^2\hat{y} + 22\hat{z})}$

$Q = 6\rho_v = 6(8 - 6y + 3z^2) = 48 - 36y + 18z^2$ C

−0.5

Q1. The potential distribution in a dielectric medium with permittivity $\varepsilon = 9\varepsilon_0$ is given in cylindrical coordinates by

$$V = \frac{1}{r^2} e^{-6z} \cos(\phi) \quad \text{V}$$

$\frac{\partial V_\phi}{\partial \phi} = -\frac{1}{r^2} e^{-6z} \sin\phi$

$\frac{\partial V_z}{\partial z} = -\frac{6}{r^2} e^{-6z} \cos\phi$

(a) Find the electric field $\vec{\mathbf{E}}$ due to this potential distribution. [4]
(b) Evaluate $\vec{\mathbf{E}}$ at point P_1 (r_1, ϕ_1, z_1) = (0.1, 2π, 0.5). [2]
(c) Evaluate the electric flux density $\vec{\mathbf{D}}$ at point P_1. [2]
(d) Evaluate the electric polarization field $\vec{\mathbf{P}}$ at point P_1. [2]

$\frac{\partial V_r}{\partial r}\left(\frac{1}{r^2} e^{-6z} \cos(\phi)\right) = -\frac{3}{r^3} e^{-6z} \cos\phi$

a) $\vec{E} = -\nabla V = -\left(\hat{r}\frac{\partial V}{\partial r} + \hat{\phi}\frac{1}{r}\frac{\partial V}{\partial \phi} + \hat{z}\frac{\partial V}{\partial z}\right)$

$= -\left(\hat{r}\left(-\frac{3}{r^3} e^{-6z} \cos\phi\right) + \hat{\phi}\left(-\frac{1}{r^3} e^{-6z} \sin\phi\right) + \hat{z}\left(-\frac{6}{r^2} e^{-6z} \cos\phi\right)\right)$

$\vec{E} = \hat{r}\frac{\cancel{3}\,2}{r^3} e^{-6z} \cos\phi + \hat{\phi}\frac{1}{r^3} e^{-6z} \sin\phi + \hat{z}\frac{6}{r^2} e^{-6z} \cos\phi$ V/m

$\frac{-1}{2}$

b) $\vec{E}_1 = \hat{r}\frac{3}{(0.1)^3} e^{-6(0.5)} \cos(2\pi) + \hat{\phi}\frac{1}{(0.1)^3} e^{-6(0.5)} \sin(2\pi) + \hat{z}\frac{6}{(0.1)^2} e^{-6(0.5)} \cos(2\pi)$

$= \hat{r}\, 149.36 + \hat{z}\, 29.87$ V/m ✓

$99.8\,\hat{r} + \ldots$

c) $\vec{D}_1 = \varepsilon \vec{E}_1 = (9\varepsilon_0)(149.36, 29.87)$ $\quad \frac{10^{-9}}{36\pi}$

$= \hat{r}\, \cancel{11.89}\ 7.8 + \hat{z}\, 2.38$ nC/m²

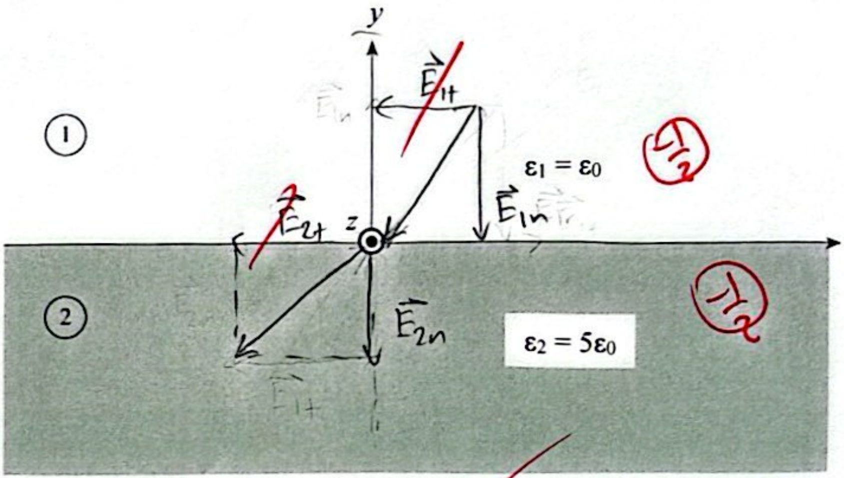
d) $\varepsilon_r = 9 = 1 + \chi_e \quad \chi_e = 9 - 1 = 8$

$\vec{P}_1 = \varepsilon_0 \chi_e \vec{E}_1 = \left(\frac{10^{-9}}{36\pi}\right)(8)(149.36, 29.87)$

$= \hat{r}\, \cancel{10.57}\ 7.0 + \hat{z}\, 2.11$ nC/m²

Q2. The figure below shows the boundary between two dielectric media that extends along the *xz*-plane. Medium 1 above the boundary has a permittivity ε_1, and Medium 2 below the boundary has a permittivity ε_2. The electric field in Medium 1 is given by $\vec{\mathbf{E}}_1 = 10\hat{x} - 6\hat{y} + 8\hat{z}$ V/m.

(a) Find the polarization field in Medium 1, $\vec{\mathbf{P}}_1$. [3]
(b) On the diagram below, draw the normal and tangential components of the electric field in Medium 1, $\vec{\mathbf{E}}_{1n}$ and $\vec{\mathbf{E}}_{1t}$. [1]
(c) Use the electric boundary conditions to find the electric field in Medium 2, $\vec{\mathbf{E}}_2$. [5]
(d) On the diagram below, draw $\vec{\mathbf{E}}_2$ and the normal and tangential components of the electric field in Medium 2, $\vec{\mathbf{E}}_{2n}$ and $\vec{\mathbf{E}}_{2t}$. [1]



a) $\varepsilon_r = 1 = 1 + \chi_e$, $\chi_e = 0$, $\vec{P}_1 = 0$ C/m²

b)

c) $\vec{E}_{1t} = \vec{E}_{2t} = 10\hat{x} + 8\hat{z}$ V/m

$\varepsilon_1 \vec{E}_{1n} = \varepsilon_2 \vec{E}_{2n}$ (no ρ_v)

$\vec{E}_{2n} = \frac{\varepsilon_1}{\varepsilon_2}\vec{E}_{1n} = \frac{\varepsilon_0}{5\varepsilon_0}(-6\hat{y}) = -1.2\hat{y}$ V/m

$\vec{E}_2 = 10\hat{x} - 1.2\hat{y} + 8\hat{z}$ V/m

Q1. A charge with a value of $q = 10$ mC is travelling with a velocity of $\vec{u} = 3\hat{x} - 6\hat{y} + 7\hat{z}$ in both an external electric field and an external magnetic field, given by $\vec{E} = 4xy^2\hat{x} + xz^3\hat{y} - 10yz\hat{z}$ V/m and $\vec{H} = \frac{1}{\mu_0}(2x^2\hat{x} - y^3\hat{y} + 2z^2\hat{z})$ A/m, respectively. At point P (2, 0, 6):

(a) Find the electric force $\vec{F}_e$ acting on the charge. [3]
(b) Find the magnetic force $\vec{F}_m$ acting on the charge. [3]
(c) Find the total electromagnetic force $\vec{F}$ acting on the charge. [2]
(d) Sketch the force $\vec{F}$ in the Cartesian coordinate system. [2]

10

a) $\vec{F}_e = q\vec{E} = (10\times10^{-3}\,C)(4xy^2\hat{x} + xz^3\hat{y} - 10yz\hat{z}\ V/m)$

$= 40xy^2\hat{x} + 10xz^3\hat{y} - 100yz\hat{z}$ mN $= 4.32\hat{y}$ N

b) $\vec{F}_m = q\vec{u}\times\vec{B}$ $\quad\quad \vec{B} = \mu_0\vec{H} = 2x^2\hat{x} - y^3\hat{y} + 2z^2\hat{z})$

$= (10\times10^{-3}C)(3\hat{x} - 6\hat{y} + 7\hat{z}) \times (2x^2\hat{x} - y^3\hat{y} + 2z^2\hat{z})$

$= (30\hat{x} - 60\hat{y} + 70\hat{z} \times 10^{-3}) \times (2x^2\hat{x} - y^3\hat{y} + 2z^2\hat{z})$

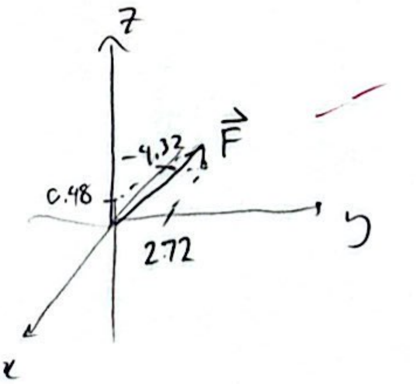
$$\begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 30 & -60 & 70 \\ 2x^2 & -y^3 & 2z^2 \end{vmatrix}$$

$= (-120z^2 + 70y^3)\hat{x} - (60z^2 - 140x^2)\hat{y} + (-30y^3 + 120x^2)\hat{z}$ mN $= -4.32\hat{x} - 1.6\hat{y} + 0.48\hat{z}$ N

c) $\vec{F} = \vec{F}_e + \vec{F}_m = (40xy^2 - 120z^2 + 70y^3)\hat{x} + (10xz^3 - 60z^2 + 140x^2)\hat{y} + (-100yz - 30y^3 + 120x^2)\hat{z}$ mN

$= -4.32\hat{x} + 2.72\hat{y} + 0.48\hat{z}$ N

d)

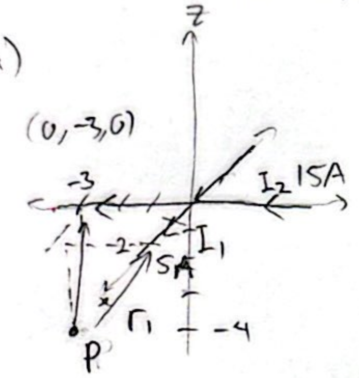


Q2. The x- and y-axes, respectively, carry filamentary currents of 5 A along $\hat{\mathbf{x}}$ and 15 A along $-\hat{\mathbf{y}}$.

(a) Sketch the two filamentary currents in the Cartesian coordinate system. [2] 2

(b) Use the Biot-Savart law to find the total magnetic field $\vec{\mathbf{H}}$ at point (2, −3, −4) m due to both filamentary currents. [8] 7.5

a)



(2,0,0)

x

y

z

y

$r_{p1} = \sqrt{(2-2)^2+(-3-0)^2+(-4-0)^2} = 5\,m$

b) $\vec{B}_1 = \hat{\phi}\dfrac{\mu_0 I_1}{2\pi r_{p1}}$, $\hat{\phi} = \hat{l} \times \hat{r} = \hat{x} \times \left(\dfrac{4\hat{z}+3\hat{y}}{5}\right) = -\dfrac{4}{5}\hat{y} + \dfrac{3}{5}\hat{z}$

$= \dfrac{{}^{2}(4\cancel{\pi}\times10^{-7})(5A)}{\cancel{2}\cancel{\pi}(\cancel{5}m)}\left(-\dfrac{4}{5}\hat{y} + \dfrac{3}{5}\hat{z}\right)$

$= \left(-\dfrac{8}{5}\hat{y} + \dfrac{6}{5}\hat{z}\right)\times10^{-7}$

$r_{p2} = \sqrt{(2-0)^2+(-3-(-3))^2+(-4-0)^2} = \sqrt{20}$

$\vec{B}_2 = \hat{\phi}\dfrac{\mu_0 I_2}{2\pi r_{p2}}$

$\hat{\phi} = \hat{l}\times\hat{r} = (-\hat{y})\times\left(\dfrac{4\hat{z}-2\hat{x}}{\sqrt{20}}\right) = -\dfrac{4}{\sqrt{20}}\hat{x} - \dfrac{2}{\sqrt{20}}\hat{z}$

$= \dfrac{{}^{2}(4\cancel{\pi}\times10^{-7})(15A)}{\cancel{2}\cancel{\pi}\sqrt{20}}\left(-\dfrac{4}{\sqrt{20}}\hat{x} - \dfrac{2}{\sqrt{20}}\hat{z}\right)$

−0.5

$= (-6\hat{x} - 3\hat{z})\times10^{-7}$

~~2.5~~

$\vec{B} = \vec{B}_1 + \vec{B}_2 = \left(-6\hat{x} - \dfrac{8}{5}\hat{y} - \dfrac{9}{5}\hat{z}\right)\times10^{-7}$ / $4\pi\times10^{-7}$

$\vec{H} = \dfrac{\vec{B}}{\mu_0} = -\dfrac{3}{2\pi}\hat{x} - \dfrac{2}{5\pi}\hat{y} - \dfrac{9}{20\pi}\hat{z}$ A/m

$= -0.477\hat{x} - 0.127\hat{y} - 0.143\hat{z}$ A/m

Q1. A wire extending along $0 < x < 20$ m has a linear charge density of $\rho_l = \mathbf{50x^3}$ μC/m.

(a) Find the total charge, Q, on the line. [2]

(b) Draw the wire in the Cartesian coordinate system, and draw vectorially the electric field distribution around the wire. [1]

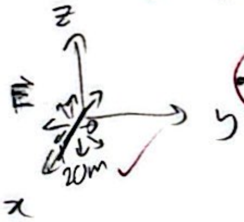
(c) Using Coulomb's law, find the electric field $\vec{E}$ at point (0, 0, 100 km) in Cartesian coordinates. [4] !

(d) Find the force $\vec{F}$ acting on a point charge $q_l = 5$ C located the same point (0, 0, 100 km). [2]

(e) Draw the vector force $\vec{F}$ on the diagram from part (b). [1]

a) $Q = \int_l \rho_l d\vec{l} = \int_{x=0}^{20} 50x^3 \times 10^{-9}\, dx = 50\,\frac{x^4}{4} \times 10^{-9}\,C\Big|_0^{20} = 2\,mC$ ✗ $-\frac{1}{2}$

b)



$\vec{F}$ ✗ -1

$R = (x, 0, 0) - (0, 0, 1M) = (x, 0, -1M)$

c) $\vec{E} = \frac{1}{4\pi\varepsilon}\int_{l'} \hat{R}' \frac{\rho_l dl}{R'^2} = \frac{1}{4\pi\varepsilon}\int_{x=0}^{20} \hat{R}' \frac{50x^3}{(1M)^2}\, dx = \frac{50 \times 10^{-9}}{4\pi\varepsilon (1M)^2}\left[\frac{x^4}{4}\Big|_0^{20}\right]\hat{R}$

$= \frac{(50 \times 10^{-9})(40000)}{4\pi(\frac{10^{-9}}{36\pi})(1M)^2}\hat{R} = \frac{(50)(9)(40000)}{(1M)^2}\hat{R}$

$= \hat{R}\, 18\, \mu V/m$ ✗ $-\frac{1}{2}$

$\hat{R}$?

-1

d) $\vec{F} = q\vec{E} = (5C)(18 \times 10^{-6}\, V/m) = \hat{R}\, 90\, \mu N$

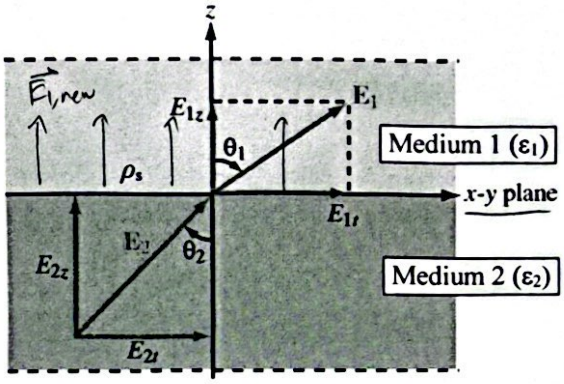
OK.

Q2. The figure below shows the boundary between two dielectric media that extends along the *x-y* plane. Medium 1 above the boundary has a permittivity ε_1, and Medium 2 below the boundary has a permittivity ε_2. The electric field in Medium 2 is given by $\vec{E}_2 = -10\hat{x} + 5\hat{y} + 20\hat{z}$ V/m, the surface charge density on the boundary is $\rho_s = 8\varepsilon_0$ C/m², and the relative permittivities of the two media are $\varepsilon_{r1} = 2$ and $\varepsilon_{r2} = 10$.

(a) Use the electric boundary conditions to find the electric field in Medium 1, $\vec{E}_1$. [4]

(b) Medium 2 is now replaced with a perfect conductor. Thus, now the boundary is between Medium 1, a dielectric with permittivity ε_1, and Medium 2, a perfect conductor. The surface charge density on the boundary remains at $\rho_s = 8\varepsilon_0$ C/m². Find the new electric field in Medium 1, $\vec{E}_{1,new}$. Sketch $\vec{E}_{1,new}$ in the figure below. [4]

(c) For the scenario of part (b) above, calculate the energy densities for both Medium 1 and Medium 2. You can leave your answers in terms of ε_0. [2]



$\varepsilon_1 = 2\varepsilon_0$

$\varepsilon_2 = 10\varepsilon_0$

→ perfect conduct

a) $\vec{E}_{1t} = \vec{E}_{2t} = -10\hat{x} + 5\hat{y}$

$\varepsilon_1 \vec{E}_{1n} - \varepsilon_2 \vec{E}_{2n} = \rho_s$

$\vec{E}_{1n} = \frac{\rho_s + \varepsilon_2 \vec{E}_{2n}}{\varepsilon_1} = \frac{8\varepsilon_0}{2\varepsilon_0} + \frac{10\varepsilon_0}{2\varepsilon_0}(20\hat{z}) = \cancel{100\hat{z} + 4}$

$(100+4)\hat{z}$

$\vec{E}_1 = -10\hat{x} + 5\hat{y} + 100\hat{z} + 4$ V/m

$-\frac{1}{2}$

b) $\vec{E}_{1t,new} = \vec{E}_{2t} = 0$

$\varepsilon_1 \vec{E}_{1n,new} = \rho_s$

$\vec{E}_{1n,new} = \frac{\rho_s}{\varepsilon_1} = \frac{8\varepsilon_0}{2\varepsilon_0} = 4$

$\vec{E}_{1,new} = 4$ V/m $\hat{z}$

c) $w_e = \frac{1}{2}\varepsilon|\vec{E}|^2$

$w_{e1} = \frac{1}{2}(2\varepsilon_0)|4|^2 = 16\varepsilon_0$ J/m³

$w_{e2} = \frac{1}{2}\varepsilon(0)^2 = 0$ J/m³

Q3. The potential distribution in free space is given in spherical coordinates by:

$$V = \frac{1}{R^3}\cos\phi \sin\theta \quad \text{V}$$

$$\frac{\partial V}{\partial R} = -\frac{3}{R^4}\cos\phi\sin\theta$$

$$\frac{\partial V}{\partial \theta} = \frac{1}{R^3}\cos\phi\cos\theta$$

$$\frac{\partial V}{\partial \phi} = -\frac{1}{R^3}\sin\phi\sin\theta$$

(a) Find the electric field $\vec{E}$ due to this potential distribution. [6] 6

(b) Evaluate $\vec{E}$ at point P_1 $(R_1, \theta_1, \phi_1) = (1, \pi/4, \pi/4)$. [1] 1

(c) Find the electric flux density $\vec{D}$. [2] 2

(d) Evaluate $\vec{D}$ at point P_1 $(R_1, \theta_1, \phi_1) = (1, \pi/4, \pi/4)$. [1] 0.5

a) $\vec{E} = -\nabla V = -\left(\hat{R}\frac{\partial V}{\partial R} + \hat{\theta}\frac{1}{R}\frac{\partial V}{\partial \theta} + \hat{\phi}\frac{1}{R\sin\theta}\frac{\partial V}{\partial \phi}\right)$

$= -\left(\hat{R} -\frac{3}{R^4}\cos\phi\sin\theta + \hat{\theta}\frac{1}{R^4}\cos\phi\cos\theta + \hat{\phi} -\frac{1}{R^4}\sin\phi\right)$

$= \hat{R}\frac{3}{R^4}\cos\phi\sin\theta - \hat{\theta}\frac{1}{R^4}\cos\phi\cos\theta + \hat{\phi}\frac{1}{R^4}\sin\phi$

b) $\vec{E} = \hat{R}\frac{3}{1^4}\cos(\frac{\pi}{4})\sin(\frac{\pi}{4}) - \hat{\theta}\frac{1}{(1)^4}\cos(\frac{\pi}{4})\cos(\frac{\pi}{4}) + \hat{\phi}\frac{1}{1^4}\sin(\frac{\pi}{4})$

$= \hat{R}\,3(\frac{1}{\sqrt{2}})(\frac{1}{\sqrt{2}}) - \hat{\theta}(\frac{1}{\sqrt{2}})(\frac{1}{\sqrt{2}}) + \hat{\phi}\frac{1}{\sqrt{2}}$

$= \hat{R}\frac{3}{2} - \hat{\theta}\frac{1}{2} + \hat{\phi}\frac{1}{\sqrt{2}}$ V/m $= \hat{R}1.5 - \hat{\theta}0.5 + \hat{\phi}0.707$ V/m

c) $\vec{D} = \varepsilon_0\vec{E} = \hat{R}\frac{1}{12\pi R^4}\cos\phi\sin\theta - \hat{\theta}\frac{1}{36\pi R^4}\cos\phi\cos\theta + \hat{\phi}\frac{1}{36\pi R^4}\sin\phi$ nC/m

0.5

d) $\vec{D} = \varepsilon_0\vec{E} = (\frac{10^{-9}}{36\pi})\vec{E} = \hat{R}0.1326 - \hat{\theta}0.0442 + \hat{\phi}0.0625$ pC/m²

−0.5

c)

Q4. Two conducting plates are located at $z = 0$ and $z = d = 500$ mm, as shown in the figure below. The zero-voltage reference is at $z = z_1 = 200$ mm, and the electric field is given by

$$\vec{E} = 120\pi\hat{z} \qquad \text{V/m}$$

(a) Using Laplace's equation, calculate the voltage on the top conductor, $V(z = d)$. [5] 3.5

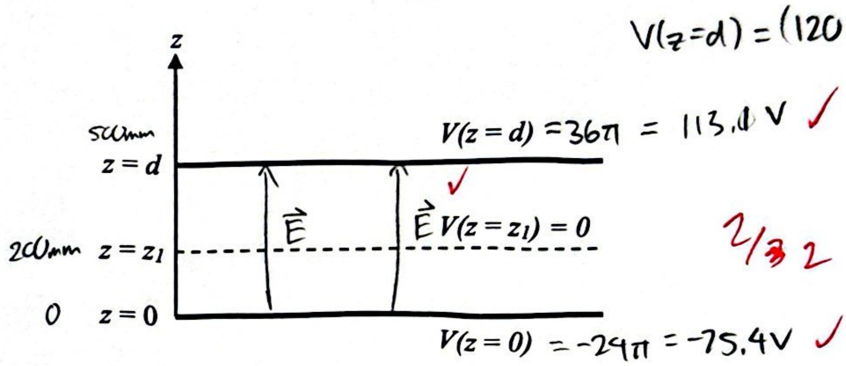
(b) Calculate the voltage on the bottom conductor, $V(z = 0)$. [3] 3

(c) On the diagram below, write down the values for $V(z = d)$ and $V(z = 0)$ and sketch the electric fields between the two conducting plates [2]. 2

½.

$V(z=d) = (120\pi)(0.3) = 36\pi$

no units.



a) $\nabla^2 V = 0$

$$\frac{dV}{dz} = \int \frac{d^2V}{dz^2}\,dz = \int 0\,dz = A$$

$V(z=z_1) = 0\text{V}$

$$V = \int \frac{dV}{dz}\,dz = \int A\,dz = Az + B \checkmark$$

$$\left.\begin{aligned} V(z=d) &= 36\pi = A(0.5) + B \\ V(z=z_1) &= 0 = A(0.2) + B \end{aligned}\right\}$$

$36\pi = 0.3A$

$A = 120\pi$ ½

$B = 36\pi - (120\pi)(0.5)$

$= -24\pi$ ½

$V = 120\pi z - 24\pi$ ✓

b) $V(z=0) = 120\pi(0) - 24\pi$

$= -24\pi = -75.4\text{ V}$ 3/3

c)

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