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Subject	E-m-F
Assignment	02
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3(a) The value of E at $P(\rho = 2, \phi = 40, z = 3)$ - - - - - for move a $20 \mu C$ charged a distance of $6 \mu m$.

Ans The direction of a_ρ: incremental work is given by $dW = -qE \cdot dL$, where in this case, $dL = d\rho a_\rho = 6 \times 10^{-6} a_\rho$ Thus

$$dW = -(20 \times 10^{-6} C)(100 V/M)(6 \times 10^{-6} M) = -12 \times 10^{-9} J$$

$$\Rightarrow -12 nJ$$

- The direction of a_ϕ: In this case $dL = 2 d\phi 2\phi = 6 \times 10^{-6} a_\phi$ & so

$$dW = -(20 \times 10^{-6})(300)(6 \times 10^{-6}) = 2.4 \times 10^{-8} J = 24 nJ$$

- The direction of a_z: Here $dL = dz a_z = 6 \times 10^{-6} a_z$

$$dW = -(20 \times 10^{-6})(300)(6 \times 10^{-6}) = -3.6 \times 10^{-8} J = 36 nJ$$

- The direction of E: Here, $dL = 6 \times 10^{-6} a_E$,

$$a_E = \frac{100 a_\rho - 200 a_\phi + 300 a_z}{(100^2 + 200^2 + 300^2)^{1/2}}$$

$$\Rightarrow 0.267 a_\rho - 0.535 a_\phi + 0.8082 a_z$$

Thus

$$dW = -(20 \times 10^{-6})[100 a_\rho - 200 a_\phi + 300 a_z] \cdot [0.267 a_\rho - 0.535 a_\phi + 0.802 a_z] \times (6 \times 10^{-6})$$

$$\Rightarrow -44.9 nJ$$

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the direction of $G = 2a_x - 3a_y + 4a_z$: in this Case, $dL = 6 \times 10^{-6} a_G$

$$a_G = \frac{2a_x - 3a_y + 4a_z}{[2^2 + 3^2 + 4^2]^{1/2}} = 0.371a_x - 0.557a_y + 0.743a_z$$

Now

$$dW = -(20 \times 10^{-6})[100a_\rho - 200a_\phi + 300a_z] \cdot [0.371a_x - 0.557a_y + 0.743a_z](6 \times 10^{-6})$$

$$\Rightarrow -(20 \times 10^{-6})[37.1(a_\rho \cdot a_x) - 55.7(a_\rho \cdot a_y) - 74.2(a_\phi \cdot a_x) + 111.4(a_\phi \cdot a_y) + 222.9](6 \times 10^{-6})$$

Where at P, $(a_\rho \cdot a_x) = (a_\phi \cdot a_y) = \cos(40) = 0.766$

$(a_\rho \cdot a_y) = \sin(40) = 0.643$, & $(a_\phi \cdot a_x)$

$\Rightarrow -\sin(40^\circ) = -0.643$

Subtituting these resultion

$$dw = -(20 \times 10^{-6})[28.4 - 35.8 + 47.7 + 85.3 + 222.9](6 \times 10^{-6}) = -41.8\,nJ$$

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Q2 let $E = 400a_x - 300a_y + 500a_z$ ----

---- distance 1mm in the direction specified by.

(a) $a_x + a_y + a_z$ lale lalrite

$$dW = -qE \cdot dL$$

$$= -4(400a_x - 300a_y + 500a_z) \cdot \frac{a_x + a_y + a_z}{\sqrt{3}} (10^{-3})$$

$$= \frac{-(4 \times 10^{-3})}{\sqrt{3}} (400 - 300 + 500) = \boxed{-1.39\ j}$$

(b) $-2a_x + 3a_y - a_z$. The computation is similar that of part a, but we change the direction.

$$dW = -qE \cdot dL$$

$$\Rightarrow -4(400a_x - 300a_y + 500a_z) \cdot \frac{(-2a_x + 3a_y - a_z)}{\sqrt{14}} (10^{-3})$$

$$\Rightarrow \frac{-(4 \times 10^{-3})}{\sqrt{14}} (-800 - 900 - 500) = \boxed{2.35\ j}$$

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Q13 IF $E = 120\, a_\rho$ V/m Find the incremental -- -------- - Charge a distance of 2mm form.

(A)

P(1,2,3) toward Q(2,1,4) The vector along this direction will be Q - P = (1,-1,1) form Which $a_{PQ} = [a_x - a_y + a_z]/\sqrt{3}$ We now write

$$dW = -qE \cdot dL$$

$$= -(50 \times 10^{-6}) \left[120 a_\rho \cdot \frac{a_x - a_y + a_z}{\sqrt{3}}\right] (2 \times 10^{-3})$$

$$= -(50 \times 10^{-6})(120)\left[(a_\rho \cdot a_x) - (a_\rho \cdot a_y)\right] \frac{1}{\sqrt{3}} (2 \times 10^{-3})$$

At P, $\phi = \tan^{-1}(2/1) = 63.4$. Thus $(a_\rho \cdot a_x) = \cos(63.4) = 0.447$ & $(a_\rho \cdot a_y) = \sin(63.4) = 0.894$ substituting these we obtain $dW = 3.1\,\mu J$.

(B) Q(2,1,4) toward P(1,2,3). A little through in order here. Note that the field has only a radial component & does not depend ϕ or z. Note Also that P & Q are the same radius ($\sqrt{5}$) from z-axis. But different ϕ & z coordinates. Two point at the same

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z location and problem would not change. then moving along a straight line Between P & Q would involve moving along a chord of a circle whose radius $\sqrt{5}$. Halfway along this line point of symmetry in field (make a sekch to see this).

This means that when starting from either Point the intial force will be same. Thus the answer $dW = 31\ \mu J$ as Part a. This is also found by going through the same procedure as part a, but with the direction (role of P & Q) reversed.

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Q_4

Compute the value of G - -
- - - - - - - using the Path.

(A)

Striaght line of segments $A(1,-1,2)$ to $B(1,1,2)$ to $P(2,1,2)$ In general we have.

$$\int_A^P G.dL = \int_A^P 2y\,dx$$

The change of x occurs when moving Between B & P during which $Y=1$ Thus

$$\int_A^P G.dL = \int_B^P 2y\,dx = \int_1^2 2(1)\,dx = \boxed{2}$$

(B)

Straigh line segment $A(1,-1,2)$ $C(2,-1,2)$ to $P(2,1,2)$. In case the change in x occur when moving from A to C, during which $Y = -1$. Thus

$$\int_A^P G.dL = \int_A^C 2y\,dx = \int_1^2 2(-1)\,dx = \boxed{-2}$$

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Q_5 For $G = 3xy^3 a_x + 2z a_y$. Now things - - -
- - - - - - in that path does matter.

(A) Straight line $Y = x-1$, $z = 1$ we obtain

$$\int G \cdot dL = \int_2^4 3xy^2\,dx + \int_1^3 2z\,dy = \int_2^4 3x(x-1)^2\,dx + \int_1^3 2(1)\,dy = \boxed{90}$$

(B) Parabola $6y = x^2 + 2$, $z = 1$ we obtain

$$\int G \cdot dL = \int_2^4 3xy^2\,dx + \int_1^3 2z\,dy$$

$$\Rightarrow \int_2^4 \frac{1}{12} x(x^2+2)^2\,dx + \int_1^3 2(1)\,dy = \boxed{82}$$

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