

D1.1 (a). $\vec{R}_{MN} = N(3, -3, 0) - M(-1, 2, 1) = (4, -5, -1) = 4\hat{a}_x - 5\hat{a}_y - \hat{a}_z$

(b). $\vec{R}_{MP} = P(-2, -3, -4) - M(-1, 2, 1) = (-1, -5, -5)$
 $\vec{R}_{MN} + \vec{R}_{MP} = (4, -5, -1) + (-1, -5, -5) = (3, -10, -6) = 3\hat{a}_x - 10\hat{a}_y - 6\hat{a}_z$

(c). $\vec{r}_M = M(-1, 2, 1) - O(0, 0, 0) = (-1, 2, 1)$, $|\vec{r}_M| = \sqrt{(-1)^2 + (2)^2 + (1)^2} = 2.45$

(d). $\hat{a}_{MP} = \vec{R}_{MP} / |\vec{R}_{MP}|$, $\vec{R}_{MP} = (-1, -5, -5) = -\hat{a}_x - 5\hat{a}_y - 5\hat{a}_z$, $|\vec{R}_{MP}| = \sqrt{(-1)^2 + (-5)^2 + (-5)^2} = 7.1414$
 $\Rightarrow \hat{a}_{MP} = (-\hat{a}_x - 5\hat{a}_y - 5\hat{a}_z) / 7.1414 = -0.14\hat{a}_x - 0.7\hat{a}_y - 0.7\hat{a}_z$

(e). $\vec{r}_P = P(-2, -3, -4) - O(0, 0, 0) = (-2 - 0, -3 - 0, -4 - 0) = (-2, -3, -4)$
 $\Rightarrow 2\vec{r}_P = 2 \times (-2, -3, -4) = (-4, -6, -8)$
 $\vec{r}_N = N(3, -3, 0) - O(0, 0, 0) = (3 - 0, -3 - 0, 0 - 0) = (3, -3, 0)$
 $\Rightarrow 3\vec{r}_N = 3 \times (3, -3, 0) = (9, -9, 0)$
 $\Rightarrow 2\vec{r}_P - 3\vec{r}_N = (-4, -6, -8) - (9, -9, 0) = (-4 - 9, -6 + 9, -8 - 0) = -13\hat{a}_x + 3\hat{a}_y - 8\hat{a}_z$
 $\Rightarrow |2\vec{r}_P - 3\vec{r}_N| = \sqrt{(-13)^2 + (3)^2 + (-8)^2} = \sqrt{242} = 15.56$

D1.2 (a). $S = 125 \{ (x-1)\hat{a}_x + (y-2)\hat{a}_y + (z+1)\hat{a}_z \} / \{ (x-1)^2 + (y-2)^2 + (z+1)^2 \}$, $P(2, 4, 3)$
 $\Rightarrow SP(2,4,3) = 125 \{ (2-1)\hat{a}_x + (4-2)\hat{a}_y + (3+1)\hat{a}_z \} / \{ (2-1)^2 + (4-2)^2 + (3+1)^2 \}$
 $\Rightarrow SP(2,4,3) = 125 \{ \hat{a}_x + 2\hat{a}_y + 4\hat{a}_z \} / \{ (1)^2 + (2)^2 + (4)^2 \} = 125 \{ \hat{a}_x + 2\hat{a}_y + 4\hat{a}_z \} / 21$
 $\Rightarrow SP(2,4,3) = 5.95\hat{a}_x + 11.90\hat{a}_y + 23.8\hat{a}_z$

(b). $\hat{a}_S = SP(2,4,3) / |SP(2,4,3)| = (5.95\hat{a}_x + 11.90\hat{a}_y + 23.8\hat{a}_z) / \sqrt{(5.95)^2 + (11.90)^2 + (23.8)^2}$
 $\Rightarrow \hat{a}_S = 0.218\hat{a}_x + 0.436\hat{a}_y + 0.873\hat{a}_z$

(c). We are given that $|S| = 1$
 $\Rightarrow 125 \left\{ \frac{\sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2}}{\sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2}} \right\} / \{ (x-1)^2 + (y-2)^2 + (z+1)^2 \} = 1$
 $\Rightarrow 125 \left\{ \frac{\sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2}}{\sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2}} \right\} = (x-1)^2 + (y-2)^2 + (z+1)^2$
 $\Rightarrow 125 \left\{ \frac{\sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2}}{\sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2}} \right\} = \sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2} \times \sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2}$
 $\Rightarrow \sqrt{(x-1)^2 + (y-2)^2 + (z+1)^2} = 125$

D1.3 (a). $\vec{R}_{AB} = B(-2, 3, -4) - A(6, -1, 2) = (-2 - 6, 3 + 1, -4 - 2) = (-8, 4, -6) = -8\hat{a}_x + 4\hat{a}_y - 6\hat{a}_z$

(b). $\vec{R}_{AC} = C(-3, 1, 5) - A(6, -1, 2) = (-3 - 6, 1 + 1, 5 - 2) = (-9, 2, 3) = -9\hat{a}_x + 2\hat{a}_y + 3\hat{a}_z$

(c). $\vec{R}_{AB} \cdot \vec{R}_{AC} = |\vec{R}_{AB}| |\vec{R}_{AC}| \cos \theta_{BAC} \Rightarrow \cos \theta_{BAC} = (\vec{R}_{AB} \cdot \vec{R}_{AC}) / (|\vec{R}_{AB}| |\vec{R}_{AC}|)$
 $\Rightarrow \cos \theta_{BAC} = \{ (-8)(-9) + (4)(2) + (-6)(3) \} / \left\{ \sqrt{(-8)^2 + (4)^2 + (-6)^2} \times \sqrt{(-9)^2 + (2)^2 + (3)^2} \right\}$
 $\Rightarrow \cos \theta_{BAC} = 62 / \sqrt{(116)(94)} \Rightarrow \cos \theta_{BAC} = 62 / 104.422 = 0.5937 \Rightarrow \theta_{BAC} = \arccos(0.5937) = 53.6^\circ$

(d). First we need to find the scalar component of \vec{R}_{AB} in the direction of \vec{R}_{AC} , and that scalar component is $|\vec{R}_{AB}| \cos \theta_{BAC} = \vec{R}_{AB} \cdot \vec{R}_{AC} / |\vec{R}_{AC}|$ (from part(c)), then we need to find a unit vector in the direction of \vec{R}_{AC} which is given by $\hat{a}_{R_{AC}} = \vec{R}_{AC} / |\vec{R}_{AC}|$, now multiply these two components to find the vector projection of \vec{R}_{AB} on \vec{R}_{AC}
 $\Rightarrow \left(\vec{R}_{AB} \cdot \vec{R}_{AC} / |\vec{R}_{AC}| \right) \left(\vec{R}_{AC} / |\vec{R}_{AC}| \right)$, we have already calculated all the values present in the last formula in part (c), so using these values we get $\left(62 / \sqrt{94} \right) \left((-9\hat{a}_x + 2\hat{a}_y + 3\hat{a}_z) / \sqrt{94} \right) = -5.94\hat{a}_x + 1.319\hat{a}_y + 1.979\hat{a}_z$

¹This document is prepared in L^AT_EX. (Email: ahmedsa@ieee01@ce80.net.pk)

Drill Problems Solution Of Engineering Electromagnetics Chapter 1

**Thirumalaisamy P.
Velavancorresponding**



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