

ENGINEERING ELECTROMAGNETICS by William H. Hayt, Jr.
FIFTH EDITION (ANSWER TO ODD-NUMBERED QUESTIONS)

CHAPTER 1 VECTOR ANALYSIS
PROBLEMS

1. Let each of the vectors $\vec{A} = 5\vec{a}_x - \vec{a}_y + 3\vec{a}_z$, $\vec{B} = -2\vec{a}_x + 2\vec{a}_y + 4\vec{a}_z$, and $\vec{C} = 3\vec{a}_x - 9\vec{a}_y$ extend outward from the origin of a cartesian coordinate system to points A, B, and C, respectively. Find a unit vector directed from point A toward (a) the origin, (b) point B, (c) a point equidistant from B and C on the line BC. (d) Find the length of the perimeter of the triangle ABC.

$$\begin{aligned} \text{a) } \vec{R}_{AO} &= \vec{a}_0 - \vec{A} \\ &= 0 - (5\vec{a}_x - \vec{a}_y + 3\vec{a}_z) \\ \vec{R}_{AO} &= -5\vec{a}_x + \vec{a}_y - 3\vec{a}_z \\ |\vec{R}_{AO}| &= \sqrt{(-5)^2 + (1)^2 + (-3)^2} \\ |\vec{R}_{AO}| &= \sqrt{35} \\ \hat{a}_{AO} &= \frac{-5\vec{a}_x + \vec{a}_y - 3\vec{a}_z}{\sqrt{35}} \end{aligned}$$

$$\begin{aligned} \text{b) } \vec{R}_{AB} &= \vec{B} - \vec{A} \\ &= -2\vec{a}_x + 2\vec{a}_y + 4\vec{a}_z - (5\vec{a}_x - \vec{a}_y + 3\vec{a}_z) \\ \vec{R}_{AB} &= -7\vec{a}_x + 3\vec{a}_y + \vec{a}_z \\ |\vec{R}_{AB}| &= \sqrt{(-7)^2 + (3)^2 + (1)^2} \\ |\vec{R}_{AB}| &= \sqrt{59} \\ \hat{a}_{AB} &= \frac{-7\vec{a}_x + 3\vec{a}_y + \vec{a}_z}{\sqrt{59}} \end{aligned}$$

$$\text{c) } \hat{a}_{AO} = -0.495\vec{a}_x + 0.161\vec{a}_y - 0.507\vec{a}_z$$

$$\text{d) } \hat{a}_{AB} = -0.492\vec{a}_x + 0.342\vec{a}_y + 0.150\vec{a}_z$$

$$\begin{aligned} \text{c) } \vec{R}_{BC} &= \frac{\vec{B} + \vec{C}}{2} \\ &= \frac{-2\vec{a}_x + 2\vec{a}_y + 4\vec{a}_z + 3\vec{a}_x - 9\vec{a}_y}{2} \\ &= \frac{-2\vec{a}_x + 5\vec{a}_y + 4\vec{a}_z}{2} \\ \vec{R}_{BC} &= -\vec{a}_x + \frac{5}{2}\vec{a}_y + 2\vec{a}_z \\ \vec{R}_{BC} &= \vec{R}_{CB} - \vec{B} \\ &= -\vec{a}_x + \frac{5}{2}\vec{a}_y - (-2\vec{a}_x + 2\vec{a}_y + 4\vec{a}_z) \\ &= -\vec{a}_x + \frac{5}{2}\vec{a}_y - 3\vec{a}_z \\ |\vec{R}_{BC}| &= \sqrt{(-1)^2 + (\frac{5}{2})^2 + (-3)^2} \\ |\vec{R}_{BC}| &= \frac{\sqrt{35}}{2} \\ \hat{a}_{BC} &= \frac{\vec{R}_{BC}}{|\vec{R}_{BC}|} \\ &= \frac{-\vec{a}_x + \frac{5}{2}\vec{a}_y - 3\vec{a}_z}{\frac{\sqrt{35}}{2}} \end{aligned}$$

$$\begin{aligned} \text{d) } \vec{R}_{AC} &= \vec{C} - \vec{A} \\ &= 3\vec{a}_x - 9\vec{a}_y - (5\vec{a}_x - \vec{a}_y + 3\vec{a}_z) \\ \vec{R}_{AC} &= -2\vec{a}_x - 8\vec{a}_y - 3\vec{a}_z \\ |\vec{R}_{AC}| &= \sqrt{(-2)^2 + (-8)^2 + (-3)^2} \\ |\vec{R}_{AC}| &= \sqrt{89} \\ \vec{R}_{AC} &= \vec{C} - \vec{B} \\ &= 3\vec{a}_x - 9\vec{a}_y - (-2\vec{a}_x + 2\vec{a}_y + 4\vec{a}_z) \\ \vec{R}_{AC} &= 5\vec{a}_x - 11\vec{a}_y - 4\vec{a}_z \\ |\vec{R}_{AC}| &= \sqrt{(5)^2 + (-11)^2 + (-4)^2} \\ |\vec{R}_{AC}| &= \sqrt{146} \end{aligned}$$

$$\begin{aligned} \vec{R}_{AC} &= \vec{A} - \vec{C} \\ &= 5\vec{a}_x - \vec{a}_y + 3\vec{a}_z - (3\vec{a}_x - 9\vec{a}_y) \\ &= 2\vec{a}_x + 8\vec{a}_y + 3\vec{a}_z \\ |\vec{R}_{AC}| &= \sqrt{(2)^2 + (8)^2 + (3)^2} \\ |\vec{R}_{AC}| &= \sqrt{90} \end{aligned}$$

$$\begin{aligned} P_{\Delta} &= |\vec{R}_{AB}| + |\vec{R}_{BC}| + |\vec{R}_{AC}| \\ &= \sqrt{59} + \sqrt{35} + \sqrt{90} \end{aligned}$$

$$\text{c) } \hat{a}_{BC} = -0.745\vec{a}_x + 0.464\vec{a}_y - 0.294\vec{a}_z$$

$$\text{d) } P_{\Delta} = 25.5 \text{ units}$$

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Lauren Gardner



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