

EE 381 Electric and Magnetic Fields Quiz #4 (Fall 2026)Name KEY A**Instructions:** Closed book & notes. Place answers in indicated spaces and show all work for credit.Useful equations: $\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta_{AB}$, $\vec{A} \times \vec{B} = |\vec{A}| |\vec{B}| \sin \theta_{AB} \hat{a}_n$

Given the Cartesian points $A(-4, 3, 8)$, $B(2, -4, 6)$, & $C(3, 6, -6)$ and vectors $\vec{L} = -6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z$, $\vec{M} = 6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z$, & $\vec{N} = 4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z$, all with units of meters, find:

- a) The position vectors locating points
- A
- and
- B

In Cartesian coordinates, the position vector to point (x, y, z) is $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$.

Substituting in the coordinates of the points yields-

$$\vec{r}_A = \underline{-4\hat{a}_x + 3\hat{a}_y + 8\hat{a}_z \text{ (m)}} \quad \vec{r}_B = \underline{2\hat{a}_x - 4\hat{a}_y + 6\hat{a}_z \text{ (m)}}$$

- b) the distance vector
- $\vec{d}_{BA}$
- going from point
- B
- to
- A

$$\vec{r}_B + \vec{d}_{BA} = \vec{r}_A \Rightarrow \vec{d}_{BA} = \vec{r}_A - \vec{r}_B$$

$$\begin{aligned} \vec{d}_{BA} &= (-4\hat{a}_x + 3\hat{a}_y + 8\hat{a}_z) - (2\hat{a}_x - 4\hat{a}_y + 6\hat{a}_z) \\ &= (-4-2)\hat{a}_x + (3+4)\hat{a}_y + (8-6)\hat{a}_z \text{ (m)} \end{aligned}$$

$$\vec{d}_{BA} = \underline{-6\hat{a}_x + 7\hat{a}_y + 2\hat{a}_z \text{ (m)}}$$

- c) the unit vector in the direction of vector
- $\vec{L}$

$$|\vec{L}| = \sqrt{\vec{L} \cdot \vec{L}} = \sqrt{(-6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z) \cdot (-6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z)} = \sqrt{(-4)^2 + 8^2 + (-4)^2} = \sqrt{116}$$

$$\hat{a}_L = \frac{\vec{L}}{|\vec{L}|} = \frac{-6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z}{\sqrt{116}}$$

$$\hat{a}_L = \underline{-0.557\hat{a}_x + 0.743\hat{a}_y - 0.371\hat{a}_z}$$

- d) The smallest angle (in degrees) that vector
- $\vec{L}$
- makes with
- $\vec{M}$

Use scalar product $\vec{L} \cdot \vec{M} = |\vec{L}| |\vec{M}| \cos \theta_{LM}$ where $|\vec{L}| = \sqrt{\vec{L} \cdot \vec{L}} = \sqrt{116}$,

$$|\vec{M}| = \sqrt{\vec{M} \cdot \vec{M}} = \sqrt{(6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z) \cdot (6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z)} = \sqrt{6^2 + (-8)^2 + 12^2} = \sqrt{244}, \text{ and}$$

$$\vec{L} \cdot \vec{M} = (-6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z) \cdot (6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z) = -6(6) + 8(-8) - 4(12) = -148.$$

$$\theta_{LM} = \cos^{-1} \left(\frac{\vec{L} \cdot \vec{M}}{|\vec{L}| |\vec{M}|} \right) = \cos^{-1} \left(\frac{-148}{\sqrt{116} \sqrt{244}} \right) = \cos^{-1}(-0.8797)$$

$$\theta_{LM} = \underline{151.607^\circ}$$

EE 381 Electric and Magnetic Fields Quiz #4 (Fall 2026)Name KEY B**Instructions:** Closed book & notes. Place answers in indicated spaces and show all work for credit.Useful equations: $\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta_{AB}$, $\vec{A} \times \vec{B} = |\vec{A}| |\vec{B}| \sin \theta_{AB} \hat{a}_n$

Given the Cartesian points $A(-4, 3, 8)$, $B(2, -4, 6)$, & $C(3, 6, -6)$ and vectors $\vec{L} = -6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z$, $\vec{M} = 6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z$, & $\vec{N} = 4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z$, all with units of meters, find:

- a) The position vectors locating points
- B
- and
- C

In Cartesian coordinates, the position vector to point (x, y, z) is $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$.

Substituting in the coordinates of the points yields-

$$\vec{r}_B = \underline{2\hat{a}_x - 4\hat{a}_y + 6\hat{a}_z \text{ (m)}} \quad \vec{r}_C = \underline{3\hat{a}_x + 6\hat{a}_y - 6\hat{a}_z \text{ (m)}}$$

- b) the distance vector
- $\vec{d}_{CB}$
- going from point
- C
- to
- B

$$\vec{r}_C + \vec{d}_{CB} = \vec{r}_B \Rightarrow \vec{d}_{CB} = \vec{r}_B - \vec{r}_C$$

$$\begin{aligned} \vec{d}_{CB} &= (2\hat{a}_x - 4\hat{a}_y + 6\hat{a}_z) - (3\hat{a}_x + 6\hat{a}_y - 6\hat{a}_z) \\ &= (2-3)\hat{a}_x + (-4-6)\hat{a}_y + (6+6)\hat{a}_z \text{ (m)} \end{aligned}$$

$$\vec{d}_{CB} = \underline{-\hat{a}_x - 10\hat{a}_y + 12\hat{a}_z \text{ (m)}}$$

- c) the unit vector in the direction of vector
- $\vec{M}$

$$|\vec{M}| = \sqrt{\vec{M} \cdot \vec{M}} = \sqrt{(6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z) \cdot (6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z)} = \sqrt{6^2 + (-8)^2 + 12^2} = \sqrt{244}$$

$$\hat{a}_M = \frac{\vec{M}}{|\vec{M}|} = \frac{6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z}{\sqrt{244}}$$

$$\hat{a}_M = \underline{0.384\hat{a}_x - 0.512\hat{a}_y + 0.768\hat{a}_z}$$

- d) The smallest angle (in degrees) that vector
- $\vec{M}$
- makes with
- $\vec{N}$

Use scalar product $\vec{M} \cdot \vec{N} = |\vec{M}| |\vec{N}| \cos \theta_{MN}$ where $|\vec{M}| = \sqrt{\vec{M} \cdot \vec{M}} = \sqrt{244}$,

$$|\vec{N}| = \sqrt{\vec{N} \cdot \vec{N}} = \sqrt{(4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z) \cdot (4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z)} = \sqrt{4^2 + 8^2 + 2^2} = \sqrt{84}, \text{ and}$$

$$\vec{M} \cdot \vec{N} = (6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z) \cdot (4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z) = 6(4) - 8(8) + 12(2) = -16.$$

$$\theta_{MN} = \cos^{-1} \left(\frac{\vec{M} \cdot \vec{N}}{|\vec{M}| |\vec{N}|} \right) = \cos^{-1} \left(\frac{-16}{\sqrt{244} \sqrt{84}} \right) = \cos^{-1}(-0.11176)$$

$$\theta_{MN} = \underline{96.417^\circ}$$

EE 381 Electric and Magnetic Fields Quiz #4 (Fall 2026)Name KEY C**Instructions:** Closed book & notes. Place answers in indicated spaces and show all work for credit.Useful equations: $\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta_{AB}$, $\vec{A} \times \vec{B} = |\vec{A}| |\vec{B}| \sin \theta_{AB} \hat{a}_n$

Given the Cartesian points $A(-4, 3, 8)$, $B(2, -4, 6)$, & $C(3, 6, -6)$ and vectors $\vec{L} = -6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z$, $\vec{M} = 6\hat{a}_x - 8\hat{a}_y + 12\hat{a}_z$, & $\vec{N} = 4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z$, all with units of meters, find:

- a) The position vectors locating points
- A
- and
- C

In Cartesian coordinates, the position vector to point (x, y, z) is $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$.

Substituting in the coordinates of the points yields-

$$\vec{r}_A = \underline{-4\hat{a}_x + 3\hat{a}_y + 8\hat{a}_z \text{ (m)}} \quad \vec{r}_C = \underline{3\hat{a}_x + 6\hat{a}_y - 6\hat{a}_z \text{ (m)}}$$

- b) the distance vector
- $\vec{d}_{CA}$
- going from point
- C
- to
- A

$$\vec{r}_C + \vec{d}_{CA} = \vec{r}_A \Rightarrow \vec{d}_{CA} = \vec{r}_A - \vec{r}_C$$

$$\begin{aligned} \vec{d}_{CA} &= (-4\hat{a}_x + 3\hat{a}_y + 8\hat{a}_z) - (3\hat{a}_x + 6\hat{a}_y - 6\hat{a}_z) \\ &= (-4-3)\hat{a}_x + (3-6)\hat{a}_y + (8+6)\hat{a}_z \text{ (m)} \end{aligned}$$

$$\vec{d}_{CA} = \underline{-7\hat{a}_x - 3\hat{a}_y + 14\hat{a}_z \text{ (m)}}$$

- c) the unit vector in the direction of vector
- $\vec{N}$

$$|\vec{N}| = \sqrt{\vec{N} \cdot \vec{N}} = \sqrt{(4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z) \cdot (4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z)} = \sqrt{4^2 + 8^2 + 2^2} = \sqrt{84}$$

$$\hat{a}_N = \frac{\vec{N}}{|\vec{N}|} = \frac{4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z}{\sqrt{84}}$$

$$\hat{a}_N = \underline{0.436\hat{a}_x + 0.873\hat{a}_y + 0.218\hat{a}_z}$$

- d) The smallest angle (in degrees) that vector
- $\vec{L}$
- makes with
- $\vec{N}$

Use scalar product $\vec{L} \cdot \vec{N} = |\vec{L}| |\vec{N}| \cos \theta_{LN}$ where $|\vec{N}| = \sqrt{\vec{N} \cdot \vec{N}} = \sqrt{84}$,

$$|\vec{L}| = \sqrt{\vec{L} \cdot \vec{L}} = \sqrt{(-6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z) \cdot (-6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z)} = \sqrt{(-4)^2 + 8^2 + (-4)^2} = \sqrt{116}, \text{ and}$$

$$\vec{L} \cdot \vec{N} = (-6\hat{a}_x + 8\hat{a}_y - 4\hat{a}_z) \cdot (4\hat{a}_x + 8\hat{a}_y + 2\hat{a}_z) = -6(4) + 8(8) - 4(2) = 32.$$

$$\theta_{LN} = \cos^{-1} \left(\frac{\vec{L} \cdot \vec{N}}{|\vec{L}| |\vec{N}|} \right) = \cos^{-1} \left(\frac{32}{\sqrt{116} \sqrt{84}} \right) = \cos^{-1}(0.32417)$$

$$\theta_{LN} = \underline{71.084^\circ}$$