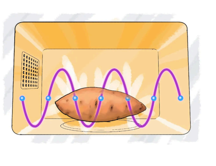
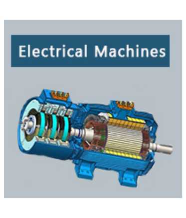
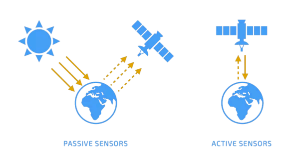
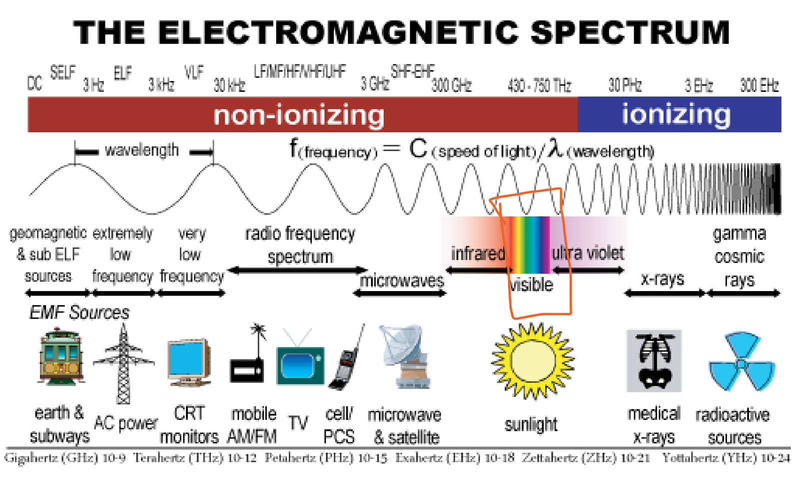
Electromagnetics: lecture 1 (intro)



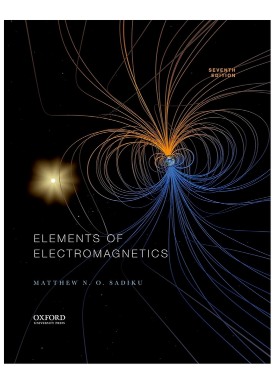






Text book:

Sadiku, Elements of Electromagnetics 7th edition



course structure:

- Vector analysis — chapter 1, 2 and 3
- Electrostatics — chapters 4 , 5 and 6
- Magnetostatics — chapters 9 and 10
- applications — chapters 11, 12, and 13

scalars and vectors:

- scalar: a quantitiy that can be represented completely by one value
- vector: a quantitiy that is represented by a set of values

- Field: a function that specify a particular quantity everywhere
  - Electric filed
  - Magnetic filed

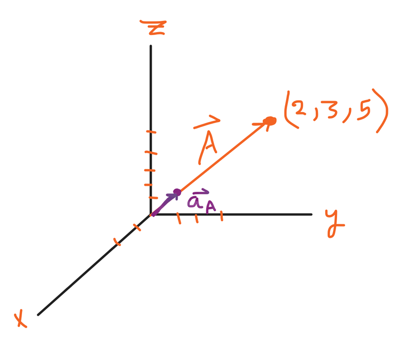
scalar or vector?

- time — scalar
- velocity — vector
- speed — scalar
- distance — scalar
- force — vector
- temprature — scalar

- electric field intencity — vector
- electric potential — scalar

Unit vector

$\mathbf{A}$ $\vec{A}$ — vector A — scalar



magnitude $|\vec{A}| \longrightarrow$ scalar

$$\vec{a}_A = \frac{\vec{A}}{|\vec{A}|}$$

$$\vec{A} = |\vec{A}|\,\vec{a}_A$$

$$|\vec{a}_A| = 1$$

$$\vec{A} = (2, 3, 5)$$

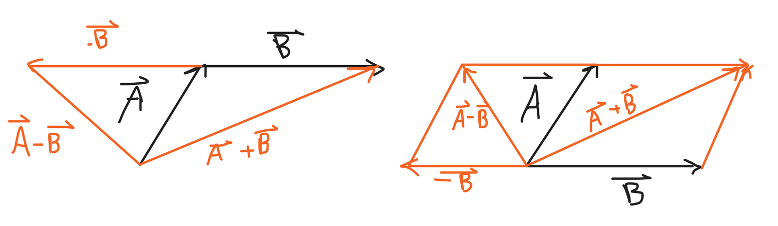
$$\vec{A} = 2\vec{a}_x + 3\vec{a}_y + 5\vec{a}_z$$

$$\vec{A} = (A_x, A_y, A_z)$$

$$\vec{A} = A_x\vec{a}_x + A_y\vec{a}_y + A_z\vec{a}_z$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$\vec{a}_A = \frac{\vec{A}}{|\vec{A}|} = \frac{A_x\vec{a}_x + A_y\vec{a}_y + A_z\vec{a}_z}{\sqrt{A_x^2 + A_y^2 + A_z^2}}$$



$$\vec{A} = (A_x, A_y, A_z) \qquad \vec{A}+\vec{B} = (A_x+B_x, A_y+B_y, A_z+B_z)$$

$$\vec{B} = (B_x, B_y, B_z) \qquad \vec{A}-\vec{B} = (A_x-B_x, A_y-B_y, A_z-B_z)$$

$$\vec{A}+\vec{B} = \vec{B}+\vec{A}$$

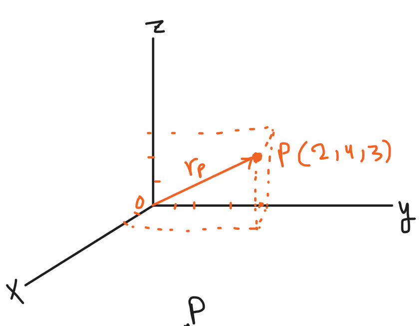
$$\vec{A}+(\vec{B}+\vec{C}) = (\vec{A}+\vec{B})+\vec{C}$$

$$k(\vec{A}+\vec{B}) = k\vec{A} + k\vec{B}$$

Position vector r_p

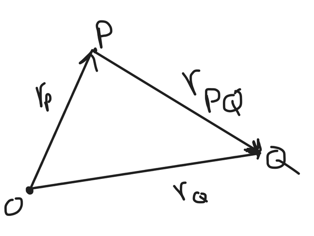
radius vector

$$r_p = OP = 2\vec{a}_x + 4\vec{a}_y + 3\vec{a}_z$$



$$r_{PQ} = r_Q - r_P$$

$$= (x_Q - x_P)\vec{a}_x + (y_Q - y_P)\vec{a}_y + (z_Q - z_P)\vec{a}_z$$



$\vec{A}$ $\mathbf{A}$

EXAMPLE 1.1 If $\mathbf{A} = 10\mathbf{a}_x - 4\mathbf{a}_y + 6\mathbf{a}_z$ and $\mathbf{B} = 2\mathbf{a}_x + \mathbf{a}_y$, find: (a) the component of $\mathbf{A}$ along $\mathbf{a}_y$, (b) the magnitude of $3\mathbf{A} - \mathbf{B}$, (c) a unit vector along $\mathbf{A} + 2\mathbf{B}$.

$$\vec{A} = 10\vec{a}_x - 4\vec{a}_y + 6\vec{a}_z = (A_x, A_y, A_z) \quad \text{a) } A_y = -4$$

$$\vec{B} = 2\vec{a}_x + \vec{a}_y + 0\vec{a}_z$$

b) $3\vec{A} = 30\vec{a}_x - 12\vec{a}_y + 18\vec{a}_z$

$$3\vec{A} - \vec{B} = 28\vec{a}_x - 13\vec{a}_y + 18\vec{a}_z$$

$$|3\vec{A} - \vec{B}| = \sqrt{(28)^2 + (-13)^2 + (18)^2} = 35.74$$

c) $\vec{A} + 2\vec{B} = 14\vec{a}_x - 2\vec{a}_y + 6\vec{a}_z$ $\quad \vec{a}_{\vec{A}+2\vec{B}} = \frac{\vec{A}+2\vec{B}}{|\vec{A}+2\vec{B}|}$ ✓

$$|\vec{A}+2\vec{B}| = \sqrt{(14)^2 + (-2)^2 + (6)^2} =$$

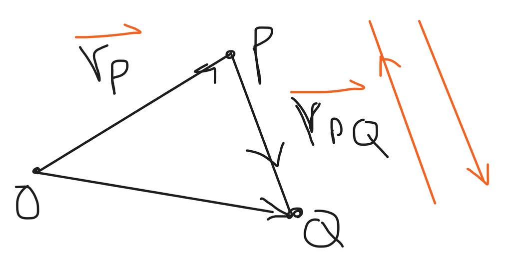
$$\vec{a}_{\vec{A}+2\vec{B}} = \frac{14\vec{a}_x - 2\vec{a}_y + 6\vec{a}_z}{\sqrt{(14)^2 + (-2)^2 + (6)^2}} = 0.9113\vec{a}_x - 0.1302\vec{a}_y + 0.3906\vec{a}_z$$

$$|\vec{a}_{\vec{A}+2\vec{B}}| \simeq 1$$

EXAMPLE 1.2 Points P and Q are located at (0, 2, 4) and (−3, 1, 5). Calculate

(a) The position vector P
(b) The distance vector from P to Q
(c) The distance between P and Q
(d) A vector parallel to PQ with magntude of 10

$P(0, 2, 4) \qquad Q(-3, 1, 5)$



a) $\vec{r}_p = OP = P - O = P = 2\vec{a}_y + 4\vec{a}_z$

b) $\vec{r}_{PQ} = \vec{r}_Q - \vec{r}_P = -3\vec{a}_x - \vec{a}_y + \vec{a}_z$

c) $d = |\vec{r}_{PQ}| = \sqrt{(-3)^2 + (-1)^2 + (1)^2} = \sqrt{11} = 3.317$

d) $\vec{a}_{r_{PQ}} = \frac{\vec{r}_{PQ}}{|\vec{r}_{PQ}|} = \frac{-3\vec{a}_x - \vec{a}_y + \vec{a}_z}{3.317} =$

$$C = 10\,\vec{a}_{r_{PQ}} = 10 * \frac{-3\vec{a}_x - \vec{a}_y + \vec{a}_z}{3.317}$$

$$= \pm(-9.045\,\vec{a}_x - 3.015\,\vec{a}_y + 3.015\vec{a}_z)$$