Homework 1

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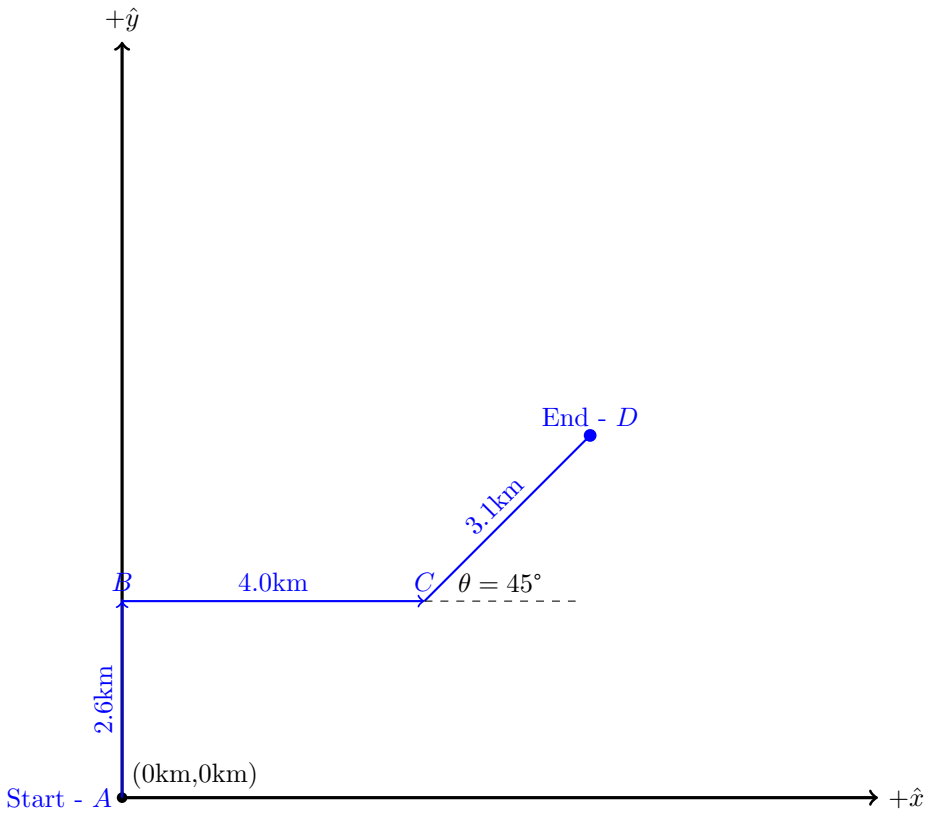
Units and Vectors

1 Book

1.1 1.21



Variables:

$$\begin{aligned}
\overrightarrow{AB} &= ((0)\hat{x} + (2.6)\hat{y})\,\text{km} \\
\overrightarrow{BC} &= ((4.0)\hat{x} + (0)\hat{y})\,\text{km} \\
\overrightarrow{CD} &= 3.1\text{km} \\
\theta &= 45^\circ \\
\overrightarrow{CD}_x &= ? \\
\overrightarrow{CD}_y &= ? \\
\overrightarrow{AD} &= ?
\end{aligned}$$

Finding components of $\overrightarrow{CD}$:

$$\begin{aligned}
\cos(\theta) &= \frac{\overrightarrow{CD}_x}{\text{hyp.}} \\
\overrightarrow{CD}_x &= \text{hyp.} \cdot \cos(\theta) \\
&= 3.1\text{km} \cdot \cos(45^\circ) \\
&= 2.2\text{km} \\
\sin(\theta) &= \frac{\overrightarrow{CD}_y}{\text{hyp.}} \\
\overrightarrow{CD}_y &= \text{hyp.} \cdot \sin(\theta) \\
&= 3.1\text{km} \cdot \sin(45^\circ) \\
&= 2.2\text{km}
\end{aligned}$$

$$\overrightarrow{CD} = \left((2.2)\hat{i} + (2.2)\hat{j}\right)\,\text{km}$$

Finding the vector $\overrightarrow{AD}$:

$$\begin{aligned}
\overrightarrow{AD} &= \overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CD} \\
&= \left(\overrightarrow{AB}_x + \overrightarrow{BC}_x + \overrightarrow{CD}_x\right)\hat{i} + \left(\overrightarrow{AB}_y + \overrightarrow{BC}_y + \overrightarrow{CD}_y\right)\hat{j} \\
&= \left(0\hat{i} + 4.0\hat{i} + 2.2\hat{i}\right)\,\text{km} + \left(2.6\hat{j} + 0\hat{j} + 2.2\hat{j}\right)\,\text{km} \\
&= \left(6.6\hat{i} + 4.8\hat{j}\right)\,\text{km}
\end{aligned}$$

Finding magnitude of $\overrightarrow{AD}$:

$$\begin{aligned}
\|\overrightarrow{AD}\| &= \sqrt{(AD_x)^2 + (AD_y)^2} \\
&= \sqrt{(6.6\text{km})^2 + (4.8\text{km})^2} \\
&= 8.16\text{km}
\end{aligned}$$

Finding direction of $\overrightarrow{AD}$:

$$\begin{aligned}\tan(\theta) &= \frac{\text{opp.}}{\text{adj.}} \\ \theta &= \arctan\left(\frac{\text{opp.}}{\text{adj.}}\right) \\ &= \arctan\left(\frac{4.8\text{km}}{2.2\text{km}}\right) \\ &= 65.38^\circ \text{ N of E}\end{aligned}$$

Solution:

Magnitude: 8.16km
Direction: 65.38° N of E

2 Lab Manuel

2.1 172

a) Prove that $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$

b) Show that $\vec{A} \cdot \vec{B}$ can be interpreted either as $\vec{B}$ times the component of $\vec{A}$ in the direction of $\vec{B}$, or as $\vec{A}$ times the component of $\vec{B}$ in the direction of $\vec{A}$.

c) Calculate the dot product of the two vectors, $\vec{A} \cdot \vec{B}$, given below: (No units)

1) $\vec{A} = 20$ along the +X axis, $\vec{B} = 15$ at 37° above the +X axis.

2) $\vec{A} = 6$ at 20° above the +X axis, $\vec{B} = 10$ at 70° above the +X axis.

3) $\vec{A} = 3$ along the +X axis, $\vec{B} = 4$ along the +X axis.

4) $\vec{A} = 4$ along the +X axis, $\vec{B} = 4$ along the -X axis.

5) $\vec{A} = 0.3$ along the +X axis, $\vec{B} = 0.5$ at 135° to $\vec{A}$

6) $\vec{A} = 12$ along the +X axis, $\vec{B} = 7$ along the +Y axis.

a)

$$\begin{aligned}\vec{A} \cdot \vec{B} &= \vec{B} \cdot \vec{A} \\ \vec{A}_x\vec{B}_x + \vec{A}_y\vec{B}_y &= \vec{B}_x\vec{A}_x + \vec{B}_y\vec{A}_y\end{aligned}$$

Which can be rewritten as

$$\boxed{\vec{A}_x\vec{B}_x + \vec{A}_y\vec{B}_y = \vec{A}_x\vec{B}_x + \vec{A}_y\vec{B}_y}$$

b)
Begin by finding "the component of $\vec{A}$ in the direction of $\vec{B}$"

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

2.2 173 (b)

2.3 174

2.4 184