Vectors in Aviation

Standard: N-VM #3: Solve problems involving velocity and other quantities that can be represented by vectors.

Essential Question: How are vectors used in aviation?

**Bearing:** the angle measured clockwise from due north

**METAR reports:**

*Wind is always reported as what direction it is coming FROM*

Ex: Reading Regional Airport/Spaatz Field

METAR KRDG 201554Z 09009KT 10SM CLR 14/01 A3044 RMK AO2 SLP314 T01390011

90° at 9 knots

**Part 1:** Determine the wind direction and speed for each airport below.

METAR KEOS 201554Z 13010KT 10SM FEW250 08/M02 A3053 RMK AO2 SLP337 T00781017

130° at 10 knots

METAR KDFW 201553Z 16011KT 10SM FEW110 BKN160 BKN300 24/13 A3012 RMK AO2 SLP194 T02390128 \$

160° at 11 knots

YMML 201600Z 36017KT CAVOK 12/04 Q1017 NOSIG

360° at 17 knots

**Runways:**

*Runways are always reported as what bearing you are heading towards during landing/takeoff*

Ex: Reading Regional Airport/Spaatz Field

13/31

18/36

**Part 2:** List the runway bearings at each airport above.

<table>
<thead>
<tr>
<th>Boston-Logan</th>
<th>Dallas/Fort Worth</th>
<th>Melbourne, Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>4L/22R</td>
<td>13L/31R</td>
<td>9/27</td>
</tr>
<tr>
<td>4R/22L</td>
<td>13R/31L</td>
<td>16/34</td>
</tr>
<tr>
<td>9/27</td>
<td>17L/35R</td>
<td></td>
</tr>
<tr>
<td>14/32</td>
<td>17R/35L</td>
<td></td>
</tr>
<tr>
<td>15L/33R</td>
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</table>
Landing/Takeoff:

*Under ideal conditions, pilot’s want a direct HEADWIND during landing/takeoff (tailwinds are DANGEROUS)

*Therefore, pilot’s want the wind bearing and runway bearing as close as possible because this minimizes crosswind

Ex: Reading Regional Airport/Spaatz Field

\[
\text{Assumption: desired landing speed of 70 knots}
\]

\[
f = 70^2 + 9^2 - 2(70)(9)\cos 140^
\]

\[
= 5,940
\]

\[
f = 77.11 \text{ knots}
\]

\[
\theta = 4.30
\]

BEARING: \(130 - 4.30 = 125.7^
\]

Part 3: Calculate the magnitude and bearing of the landing plane at each of the previous airports.

1. Boston-Logan

\[
\text{Assumption: runway 14 is too short to safely land}
\]

\[
f = 70^2 + 10^2 - 2(70)(10)\cos 160^
\]

\[
= 6,310
\]

\[
f = 79.47 \text{ knots}
\]

\[
\theta = 2.47^
\]

BEARING: \(150 - 2.47 = 147.53^
\]

2. Dallas/Fort Worth

\[
f = 70^2 + 11^2 - 2(70)(11)\cos 170^
\]

\[
= 6,537.6
\]

\[
f = 80.810 \text{ knots}
\]

\[
\theta = 1.35^
\]

BEARING: \(170 - 1.35 = 168.65^
\]
3. Melbourne, Australia

\[ f^2 = 70^2 + 17^2 - 2(70)(17) \cos 160^\circ \]

\[ f = 7.425 \]

\[ \theta = 3.87^\circ \]

\[ f = 860.17 \text{ knots} \]

\[ \frac{\sin \theta}{17} = \frac{\sin 160^\circ}{860.17} \]

\[ \text{BEARING: } 340^\circ + 3.87^\circ = 343.87^\circ \]

\[ 860.17 \text{ knots bearing } 343.87^\circ \]

Crosswind - Video

*The crosswind component of the wind vector is PERPENDICULAR to the runway

*If the crosswind component is too great for a given airplane, the plane cannot land safely

Ex: Reading Regional Airport/Spaatz Field

\[ \sin 40^\circ = \frac{c}{5} \]

\[ c = 5.79 \text{ knots} \]

Part 4: Calculate the crosswind component at each of the previous airports.

1. Boston-Logan

\[ \sin 20^\circ = \frac{c}{10} \]

\[ c = 3.42 \text{ knots} \]

2. Dallas/Fort Worth

\[ \sin 10^\circ = \frac{c}{11} \]

\[ c = 1.91 \text{ knots} \]

3. Melbourne, Australia

\[ \sin 20^\circ = \frac{c}{17} \]

\[ c = 5.81 \text{ knots} \]