SPH3U: Vectors in Two-Dimensions

The main model of motion we have developed so far is motion in a straight line. Now consider two-dimensional motion.

A: Representing a Two-Dimensional Vector

We visually represent vectors by drawing an arrow. We have already done this with displacement and velocity vectors.

1. **Interpret.** What does the length of a displacement vector describe? magnitude / distance

2. **Interpret**. What does the length of a velocity vector describe? magnitude / speed

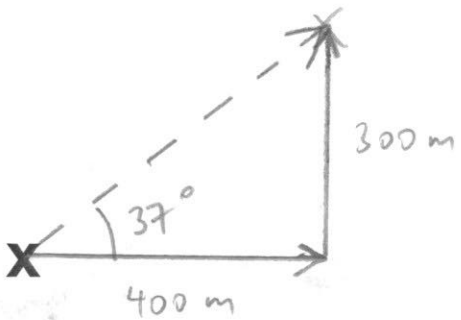
Displacement Vector	Velocity Vector
	
1 cm = 4 m	1 cm = 5 km/h

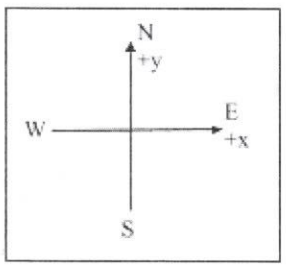
B: Vector Addition aka Treasure Hunt

Suppose you are at a starting location, shown as an **x** below. Someone tells you that you can find a treasure if you walk 400 m [East], then 300 m [North].

Use a ruler to draw the vectors corresponding to those instructions, and mark another **x** where the treasure is buried. You will need to choose an appropriate scale. Remember to put an arrowhead at the end of each vector.

1 cm = 100 m





In order for you to save some time, you could have instead walked a direct line from your starting point to the buried treasure. Using a dotted line, draw a new vector between your starting point and the treasure (this is called the *resultant vector*)

How to write vectors that aren't going either straight up/down/left/right? Imagine a person travels 3.5 m in a direction north and 60° to the west. We will record this as: $\vec{\Delta d} = 3.5\ m\ [N60^{\circ}W]$. The symbol $\vec{\Delta d}$ with an arrow signifies a displacement (a change in the position vector). The number part, 3.5 m, is called the magnitude of the vector, and the direction goes in square brackets.

Use a ruler and a protractor to measure the important characteristics of your resultant vector (both magnitude and direction), and record the resultant vector that would bring you directly from your starting point to the treasure.

500 m [∈ 37° N]

B: Let's Take a Walk

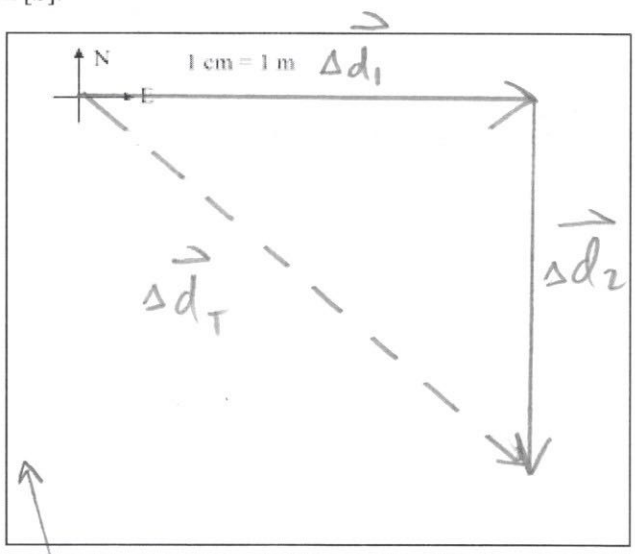
You and a friend take a stroll through a forest. You travel 6 m [E] and then 5 m [S].

1. **Represent.** Draw the two displacement vectors one after the other (tip to tail). *Start your vectors at the centre of the coordinate system.*

2. **Interpret.** After travelling through the two displacements, how far are you from your starting point? In what direction?

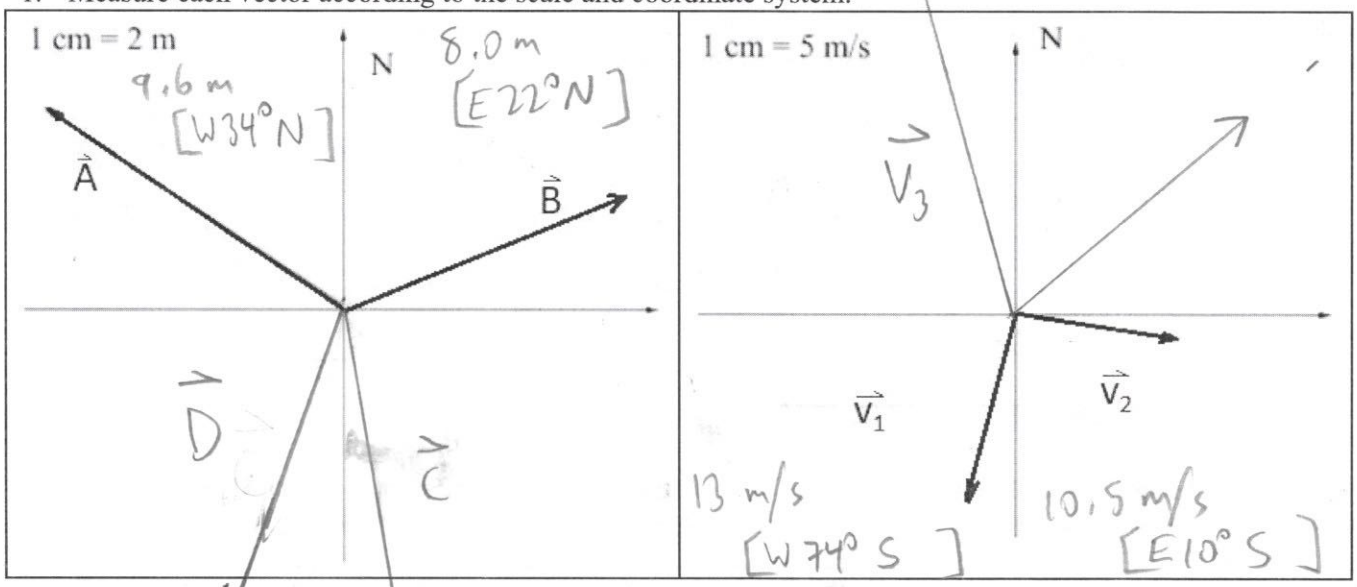
   ~ 7.7 cm [E 40° S]

3. **Represent.** Draw a single vector arrow which represents the total displacement for your friend's entire trip. Label the three vectors in your diagram as $\vec{\Delta d}_1$, $\vec{\Delta d}_2$ and $\vec{\Delta d}_T$



SPH3U: Vector Practice

1. Measure each vector according to the scale and coordinate system.



2. Draw each vector to scale on the space above, each starting at the origin of the coordinate system.

$\vec{C}$ =12 m [S 10° E]

$\vec{D}$ =9 m [W 70° S]

$\vec{V}_3$ = 35 m/s [N 15°W]

$\vec{V}_4$ = 20 m/s [E 40° N]

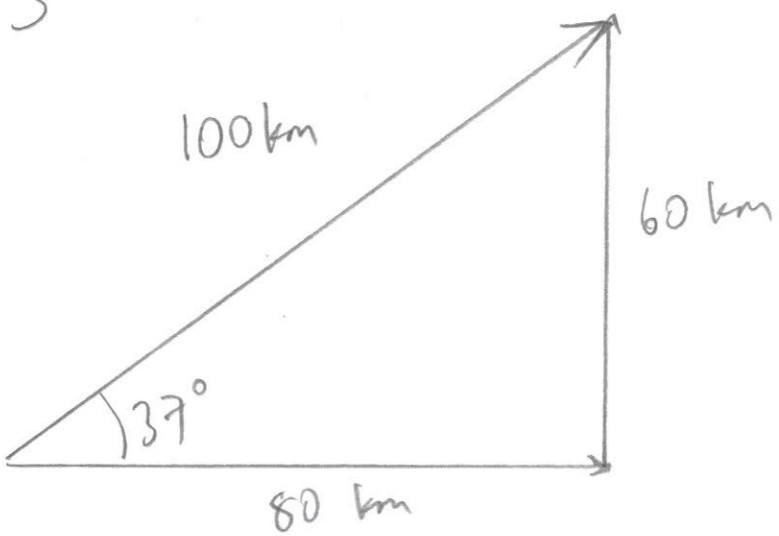
3. Add the two displacement vectors together tip-to-tail. Find the total distance, displacement average speed and average velocity if the whole trip took 2.0 hours. Use the scale 1 cm = 10 km.

   a) 80 km [W] & 60 km [N]

   d) 40 km [E] & 30 km [S50°W]

2 D Vectors

#3



100 km [E 37° N]

Total distance
60 + 80 = 140 km

Total displacement
100 km

Average speed
140 ÷ 2 = 70 km/h

Average velocity
100 ÷ 2 = 50 km/h

#4

[W 13° S]

Total distance
30 + 40 = 70 km

Total displacement
68 km

Avg speed
70 ÷ 2 = 35 km/h

Avg. vel
68 ÷ 2 = 34 km/h