Section 1.3

Two Dimensional Motion :

We have looked at 1D motion, now we need to expand into 2D.

For example, let us say that a dog escapes from its owner and takes off running 5 m [N] and then hangs a right and runs 12 m [E].

a) What is the total distance traveled by the dog ?

b) What is the dog's displacement from its owner?

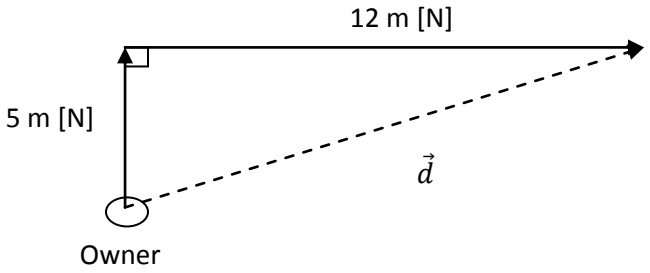
Sol'n a)

Distance traveled is not impacted by direction of travel. So we simply add the distances ran.

d = 5 + 12 = 17 m

Sol'n b)

Displacement is impacted by direction of travel. So let's look at what happened.



2D motion leads to the creation of a Pythagorean triangle. So let's use Pythagorean theorem to determine the unknown displacement.

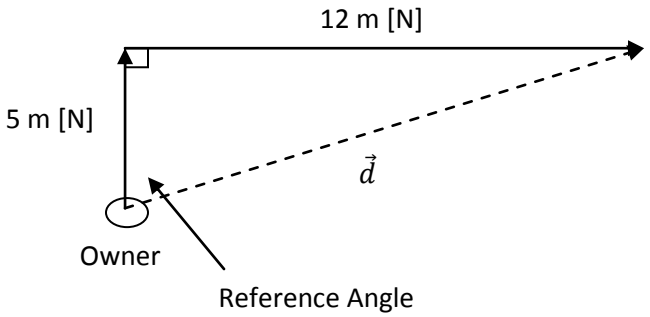
$d = \sqrt{5^2 + 12^2}$

$d = \sqrt{169}$

$d = 13\ m$

But because the motion is not along one of the major axis, we need to determine the reference angle as well. ** Note ** you cannot just say NE -- this applies only when the reference angle is a perfect 45°. In other words, the legs of the triangle must be exactly the same.

To determine the reference angle we make use of trigonometry.



$$Tan\ A = \frac{opp}{adj}$$

$$Tan\ A = \frac{12\ ^{East}}{5\ _{North}}$$

$$A = tan^{-1}\left(\frac{12}{5}\right)$$

$A = 67.4°$ E of N

So, putting our two pieces together we get $\vec{d}$ = 13 m [67.4° E of N]

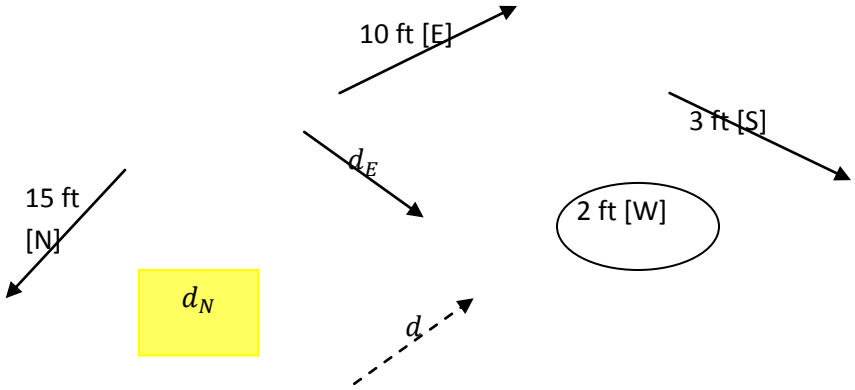
What if there are more than 2 motions in the question?

For example:

> Let's say Dora the Explorer gets side swiped by a jeep and is stumbling around a parking lot. If she staggers 15 feet North of the collision point, then 10 feet to the East, followed by 3 feet to the South and then 2 feet to the west. Where should Boots the monkey put the mattress to cushion her fall?

Sol'n

Let's start with a quick diagram.



Remember, we only care about where we started and where we finished. Let's make the Pythagorean triangle. The boxed sides are all that we need, so let's determine the unknown side lengths.

d_N = 15 - 3 = 12 ft [N]

d_E = 10 - 2 = 10 ft [E]

Find the displacement start to finish.

$$d = \sqrt{12^2 + 10^2}$$

$$d = \sqrt{244}$$

$$d = 15.62\ ft$$

Find the reference angle

$$Tan\ A = \frac{opp}{adj}$$

$$Tan\ A = \frac{10\ ^{East}}{12\ _{North}}$$

$$A = tan^{-1}\left(\frac{10}{12}\right)$$

$A = 39.8°$ E of N

So, putting our two pieces together we get $\vec{d}$ = 15.62 m [39.8° E of N]

Assigned questions - Two dimensional problem generated by class.