**P5.**

Represent a vector, **A**, with length 10 pointing 20˚ North of East in unit vector notation.

*ans.* 

**P6.**

Represent a vector, **A**, with length 10 pointing 20˚ West of North in unit vector notation.

*ans.* 

**P7.**

Represent a vector, **A**, with length 10 pointing 20˚ South of West in unit vector notation.

*ans.* 

**P8.**

What is the magnitude and direction of the following vector: ?

*ans.* , and the angle is:  South of West.

**P9.**

What is the magnitude and direction of the following vector: 

*ans.* , and the angle is:  South of East.

**P10.**

Add the following two vectors and find the resultant, **C**’s, magnitude and direction.



*ans.* , and  South of West respectively.

**P11.**

Subtract the two vectors above and find the resultant’s magnitude and direction.

*ans.* , and  North of East respectively.

**P12.**

With respect to the two vectors above, calculate **C** = 2**A**-3**B** and find the resultant’s magnitude and direction.

*ans.* , and  North of East

**P13.**

Solve the following vector equation:

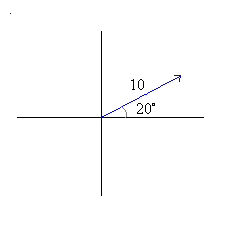


*ans. a = -1/3 , b =-4/3*

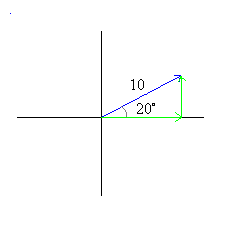
**P5.**

Represent a vector with length 10 pointing 20˚ North of East in unit vector notation.

Graphically, the vector will look like this



Drawing in its components in green,



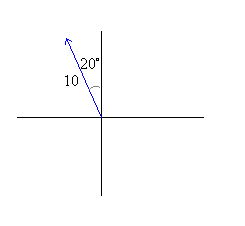
And so breaking it up into its x-y components, we can write it as:



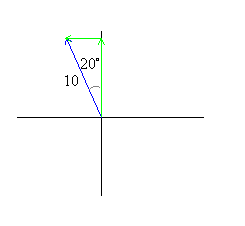
**P6.**

Represent a vector with length 10 pointing 20˚ West of North in unit vector notation.

Graphically, the vector will look like this:



and drawing its components in green,



We can write it as:



**P7.**

Represent a vector with length 10 pointing 20˚ South of West in unit vector notation.

Graphically, the vector will look like this:



and so drawing its components in green,



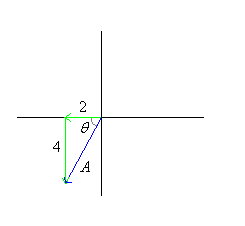
we can write it as:



**P8.**

What is the magnitude and direction of the following vector: ?

Graphically, the vector will look like this (components in green, vector in blue)

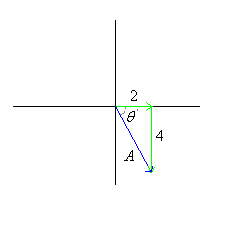


So the magnitude is: , and the angle is:  South of West.

**P9.**

What is the magnitude and direction of the following vector: 

Graphically, the vector will look like this (vector in blue, components in green).



So the magnitude is: , and the angle is:  South of East.

**P10.**

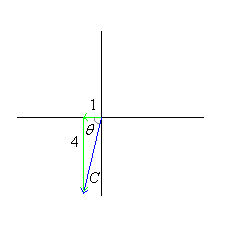
Add the following two vectors and find the resultant’s magnitude and direction.



Adding them gives,



Graphically, the vector will look like this (vector in blue, components in green):



The magnitude and direction are therefore , and  South of West respectively.

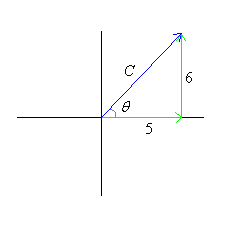
**P11.**

Subtract the two vectors above and find the resultant’s magnitude and direction.

Subtracting them gives,



Graphically, the vector will look like this:



The magnitude and direction are therefore , and  North of East respectively.

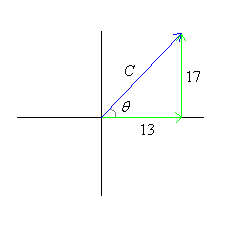
**P12.**

Calculate **C** = 2**A**-3**B** and find the resultant’s magnitude and direction.

Forming the expression we have,



Graphically, the vector will look like this:



The magnitude and direction are therefore , and  North of East respectively.

**P13.**

Solve the following vector equation:



Simplifying we have,



Now in order for this to be true, we must have the x components of both vectors equal, and also the y components of both vectors equal. Therefore we must have,



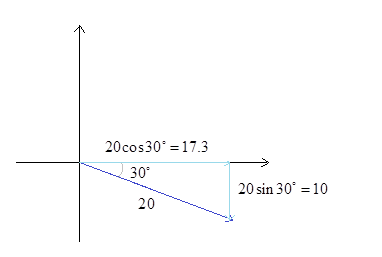
Solving the first equation gives,



Plugging that into the second and solving for b gives,

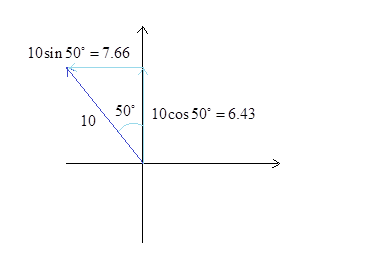


1. Draw a picture of the velocity vector **v** = 20m/s, 30° S of E. And then write it in mathematical notation, i.e., in the form **v** = (vx, vy). Your arrow doesn’t have to be set to a particular scale.



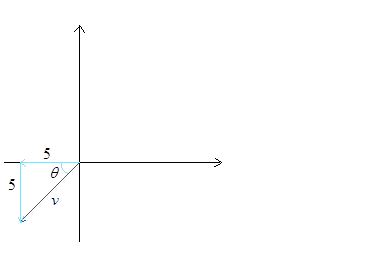
In mathematical notation it would look like **v** = (17.3, -10).

2. Draw a picture of the force vector **F** = 10 N, 50° W of N. And then write it in mathematical notation, i.e. in the form **F** = (Fx, Fy). Your arrow doesn’t have to be set to a particular scale.



In mathematical notation we’d have **F** = (-7.66, 6.43).

3. Determine the magnitude and direction of the following velocity vector **v** = (-5,-5). Be sure to specify cardinal directions of the angle you obtain.

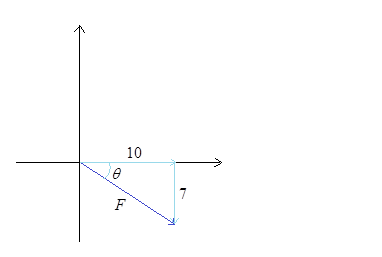


The magnitude and angle θ are given below:



4. Determine the magnitude and direction of the following force vector **F** = (10,-7). Again, be sure to specify the cardinal directions of the angle you obtain.

Picture is shown below:

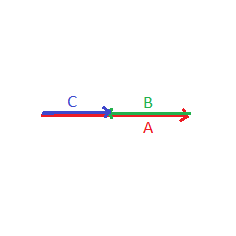


and magnitude/direction are:

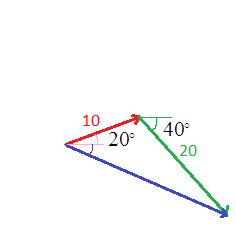


**Question 1.** Suppose vectors **A**, **B**, and **C**, are related via: **C** = **A** + **B**. Under what circumstance would it be true that the magnitudes are related via C = A – B? Draw a diagram illustrating your answer, please?

If B is pointed opposite the direction of A.



**Question 2**. A butterfly butterflies 5m @ 20° North of East, and then 10m @ 40° South of East. What is the magnitude and direction of the butterfly’s displacement?



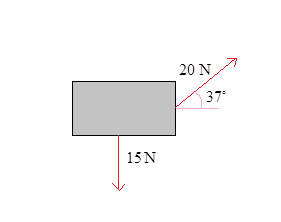
Let **A** and **B** be the first and second displacements respectively. Then



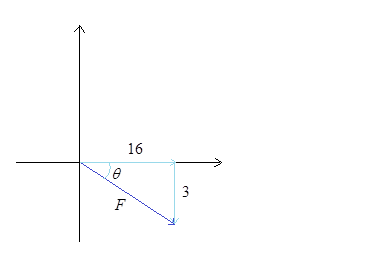
And so the net displacement is:



5. Suppose two people exert the following forces on a box. What is the net force’s magnitude and direction?



Breaking the two forces into their components, as above we have **F**1 = (20cos37, 20sin37) = (16,12). And **F**2 is given by (0,-15). Adding the two together we get **F** = **F**1 + **F**2 = (16,12) + (0,-15) = (16,-3). The magnitude and direction of this vector is obtained from the picture below:



and so



**Question 1.** A velocity vector pointing 50° above the positive x-axis has a y component vy = 20m/s. What is vx?

We can say tan(50) = vy/vx → vx = vy/tan(50) = 20/tan(50) = 16.8 m/s.

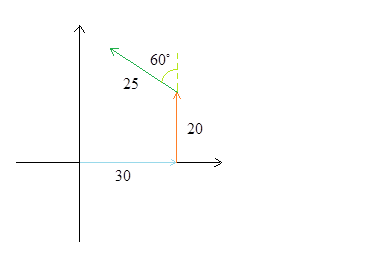
**Question 2**. A pilot of a small plane encounters shifting winds. He flies 20km @ 30° north of east, and then 40km due north. From this point he flies an additional distance in an unknown direction, finding himself 70km directly north of his original starting point. What was the magnitude and direction of his third displacement?

The displacement vectors are: **d**1 = (20cos(30°), 20sin(30°)) = (17.3, 10), **d**2 = (0,40), **d**3 = ?, and the net displacement is **d** = (0, 70). We have **d**1 + **d**2 + **d**3 = **d** → **d**3 = **d** – **d**1 – **d**2 = (0, 70) – (17.3,10) – (0,40) = (0-17.3-0, 70-10-40) = (-17.3,20). And so the magnitude and direction of **d**3 is:



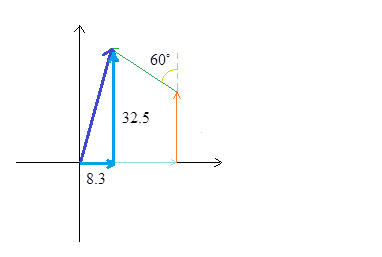
6. You obtain a secret copy of Alexander the Great’s battle plan. Suppose he plans to march his army East for 30 miles, then North for 20 miles, and then finally 25 miles in direction 60° W of N. Draw a picture of his path, and then mathematically determine what single displacement vector you could make to meet him there, starting from the same point he did. Give this vector’s magnitude and direction.

A picture of the movements is given below:



The first displacement can be written **d**1 = (30,0). The second as **d**2 = (0,20). And the third as

**d**3 = (-25sin60, 25cos60) = (-21.7, 12.5). Adding these together gives the net displacement vector **d** = **d**1 + **d**2 + **d**3 = (30,0) + (0,20) + (-21.7,12.5) = (8.3,32.5). Drawing the net displacement vector below, on the same graph just to evince its relationship to the other three vectors, we have:

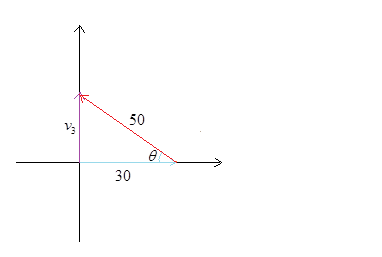


The magnitude and direction of this vector is:



7. Here’s a harder one. Suppose you’re in a car traveling 30mph E. If you can throw a baseball with speed 50mph, in what direction (to the left of vertical) would you have to throw the ball to make it actually travel straight up? What will be its overall speed then?

The velocity of the ball is the sum of two velocity vectors **v**1 = 30mph E, and **v**2 = 50mph @ unknown θ. And the result should be **v**3 = unknown magnitude N. We can represent this geometrically like this:

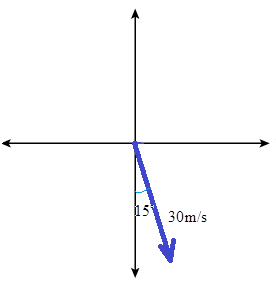


And so we can see that



Well actually I asked for the angle w/r to the vertical, and so this would 90 – 53 = 37° W of vertical.

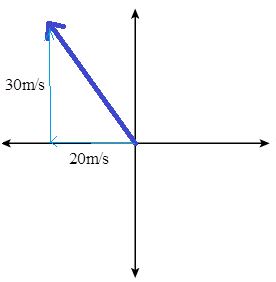
**Problem 1**. A car is moving with speed **v** = 30m/s, 15◦ E of S. Draw this vector in the space below, and write out its algebraic representation.



Vector representation is:



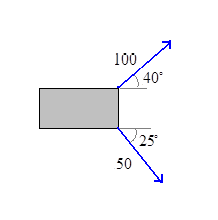
**Problem 2**. A car’s velocity is given as **v** = -20m/s **i** + 30m/s **j**. Draw this vector below, and determine its magnitude and direction. Specify the direction with the angle measured counterclockwise from the positive x-axis.



Magnitude and direction are:



**Problem 3**. Suppose I pull on a car with a force **F**1 = 100 lbs. directed 40 degrees N of E, while another person pulls on a car with a force **F**2 = 50 lbs. directed 25 degrees S of E. What is the magnitude and direction of the net (i.e. total) force?



First we break the vectors into components and then add:



Adding gives:



Magnitude and direction is:



**Problem 4**

Let **A** = 5**i** – 8**j**, and **B** = – 2**i** – 10**j**. (a) What is the algebraic representation of **A** – 3**B**. (b) What is its magnitude and direction?

(a) Algebraic representation is given by:



(b) magnitude and direction is:



**Problem 5**

Let **A** = – 3**i** + 4**j** – 5**k**, and **B** = 12**i** + 2**k**. (a) Determine **A**∙**B**. (b) Determine **A**×**B**.

(a) Well let’s see.



(b) and,



**Problem 6**

Let **A** = (3t2 + 2)**i** + **j** – (1/t)**k**. (a) Determine d**A**/dt. (b) Determine 

(a) we have:



(b) we have:



**2.** Let **A** = (3t2 + 2)**i** + **j** – cos(t)**k**. Determine d**A**/dt.

It is d**A**/dt = 6t**i +** sin(t)**k**

**Problem 7**

Let **A** = 2a**i** – (3b + 7)**j**, and **B** = -(a+b)**i** + 12**j**. Determine a and b such that **A** – 2**B** = 0.

We have:

