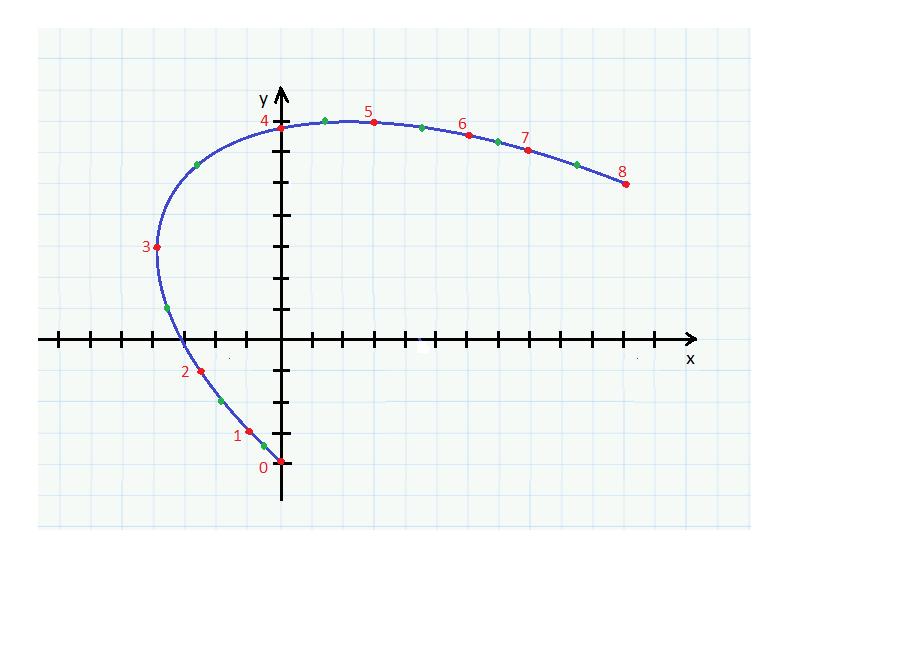
**Assignment 2 Solutions**

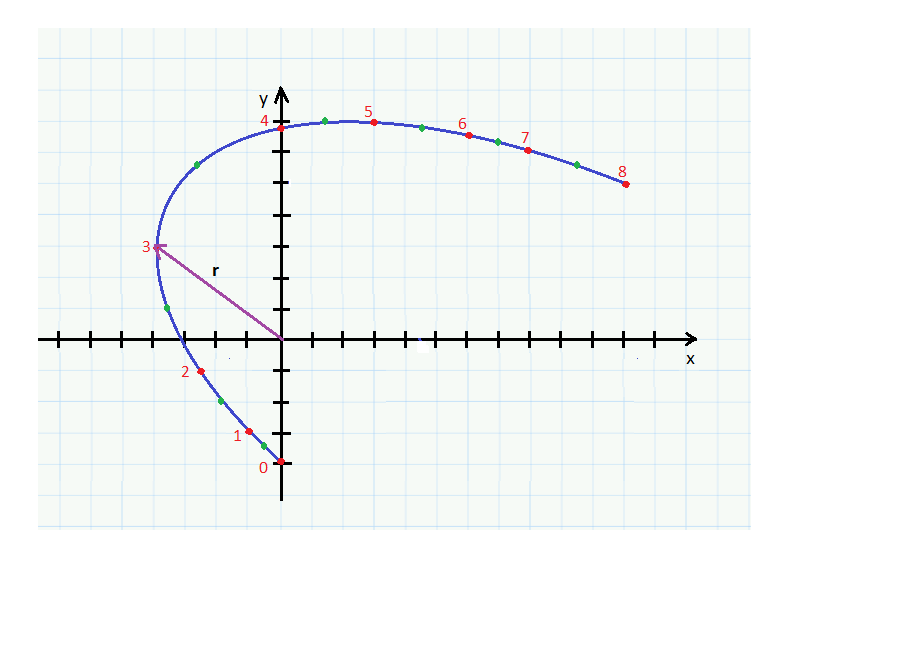
**Problem 1**. A fly’s positions are plotted on an x-y coordinate system (units are meters). The times in red are in seconds, the green dots in between indicate indicate the position at the times directly in between the red ones, i.e., 0.5s, 1.5s, 2.5s, etc.



(a) write down the position vector at time t = 3s in i,j notation. Also calculate the magnitude and direction of the position vector.



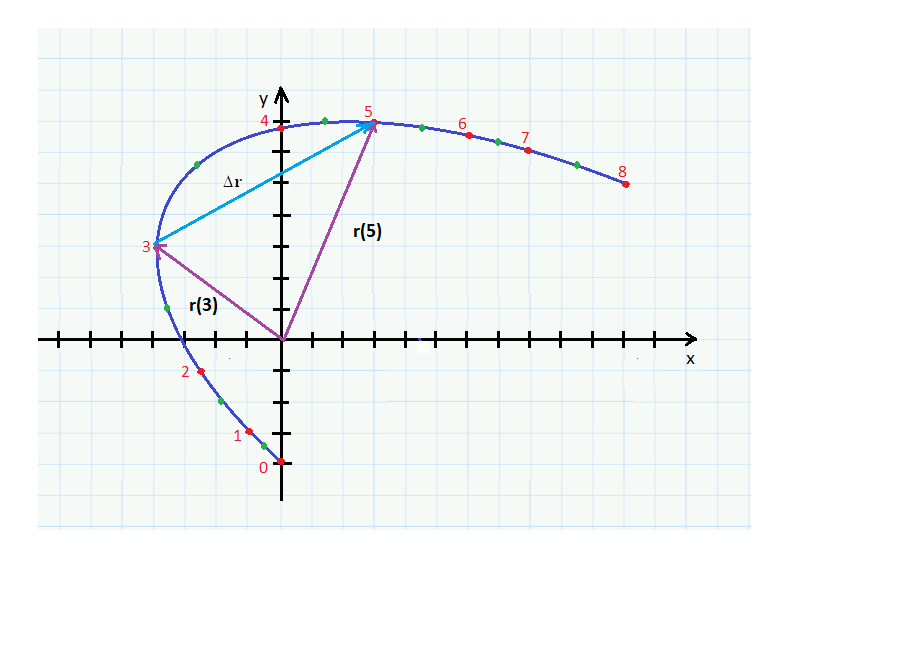
**r** is illustrated below:



(b) write down the displacement vector between times t = 3s and t = 5s in i,j notation. And calculate its magnitude and direction.



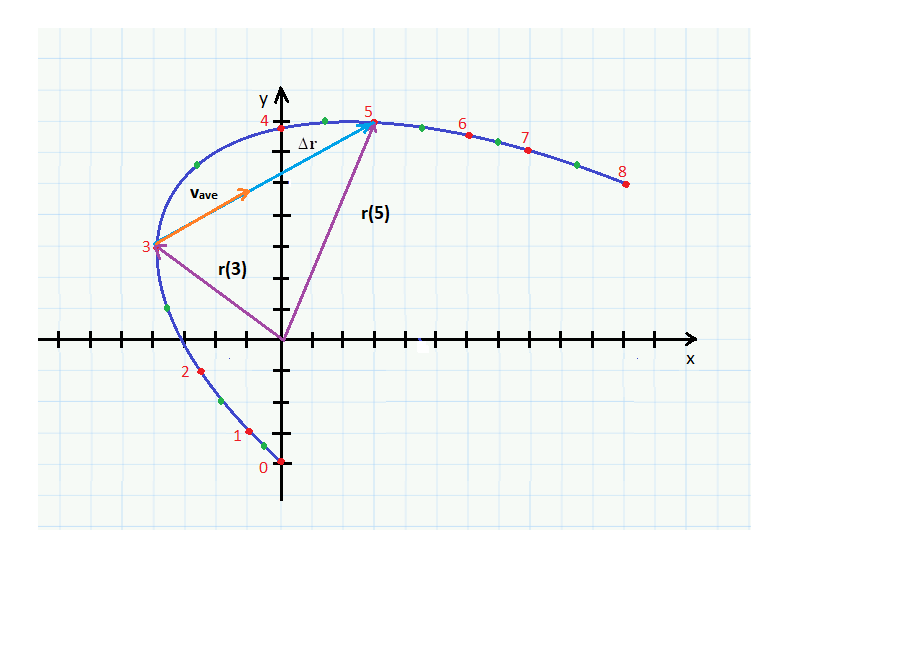
**r**(5), **r**(3), and Δr are illustrated below:



(c) write down the average velocity vector between times t = 3s and t = 5s in i,j notation. And calculate its magnitude and direction.



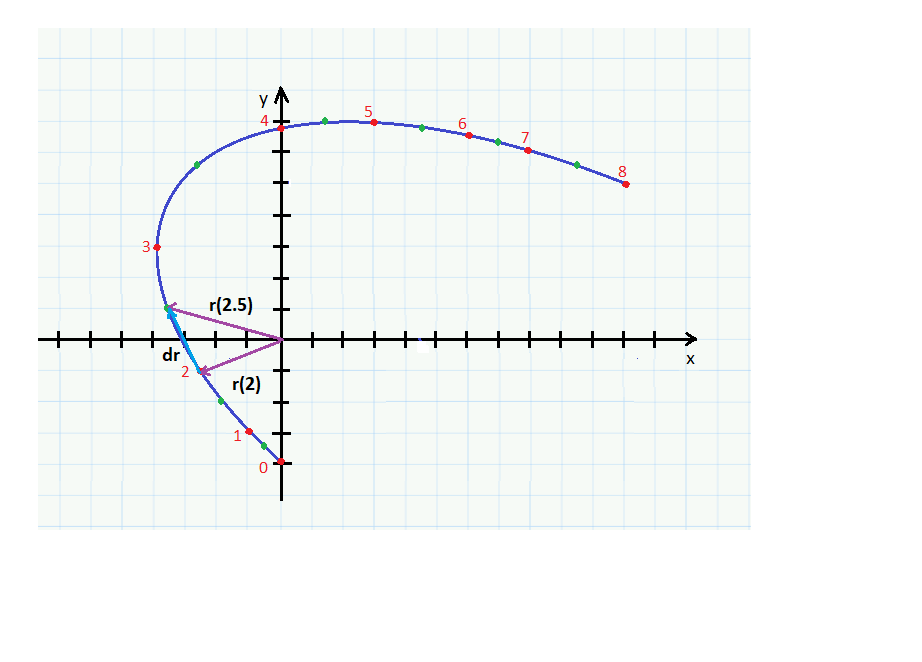
**r**(5), **r**(3), Δ**r**, and **v**ave. are illustrated below:



(d) estimate the instantaneous velocity vector at time t = 2s in i,j notation. And calculate its magnitude and direction.



**r**(2.5) and **r**(2), and d**r** are illustrated below,



(f) estimate the average acceleration vector between t = 2s and t = 5s in i,j notation. And calculate its magnitude and direction.

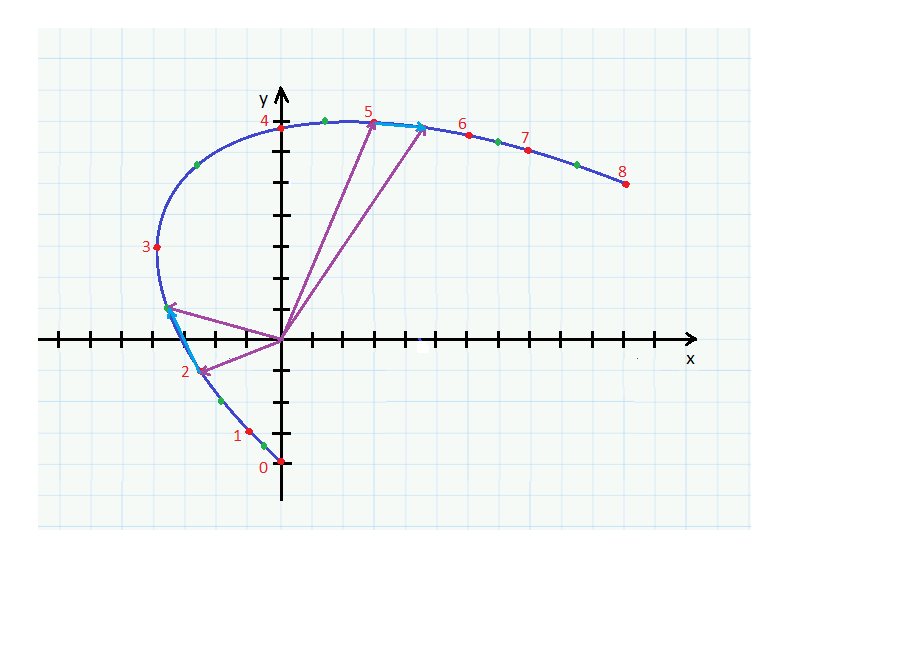
We have **v**(2) = -2**i**+4**j**, but we need **v**(5) as well. This is:



And so,



The **r**’s and d**r**’s are illustrated below:



(g) estimate the instantaneous acceleration vector at time t = 2s in i,j notation. And calculate its magnitude and direction.

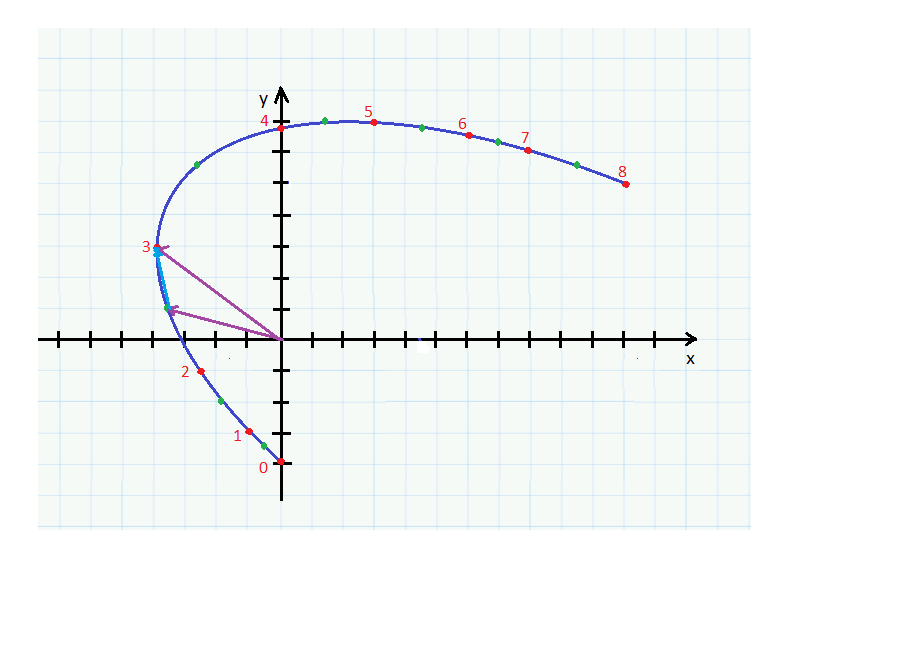
We have **v**(2) = -2**i**+4**j**, but not **v**(2.5). This is:



And so,

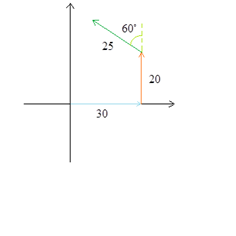


**v**(2.5) is illustrated below:

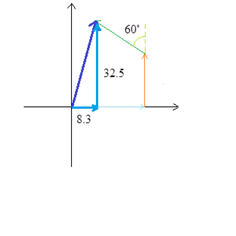


**Problem 2**. You obtain a secret copy of Alexander the Great’s battle plan. Suppose he plans to march his army East for 30 miles, then North for 20 miles, and then finally 25 miles in direction 60° W of N. Draw a picture of his path, and then mathematically determine what single displacement vector (in i,j notation) you could make to meet him there, starting from the same point he did. Give this vector’s magnitude and direction.

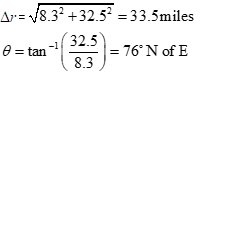
A picture of the movements is given below:



The first displacement can be written Δ**r**1 = 30**i**+0**j**. The second as Δ**r**2 = 0**i**+20**j**. And the third as Δ**r**3 = -25sin60**i**+25cos60**j** = -21.7**i** +12.5**j**. Adding these together gives the net displacement vector Δ**r** = Δ**r**1 + Δ**r**2 + Δ**r**3 = (30**i**+0**j**) + (0**i**+20**j**) + (-21.7**i**+12.5**j**) = (8.3**i**+32.5**j**). 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:



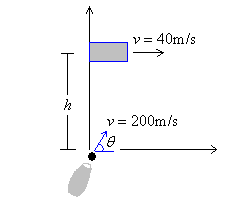
**Problem 3**. Suppose Tim and Percy start at the same spot. Tim goes to the left 2m and north 3m. Percy on the other hand runs to the right 10m, and then south 3m. How far and in what direction should Tim throw the football so that Percy will catch it?

The displacement vector of the ball is:



**Problem 4**. A really fast tank is traveling to the right at speed 40m/s, at initial position 500m on the y-axis. Just as the tank crosses the y-axis, you fire a projectile (muzzle velocity v = 200m/s) from the origin at angle θ to hit the tank. At what angle θ should you aim the gun? And how long will it take for the projectile to hit?

We have



We use the x and y equations for the position of the projectile. Note that we assume ax = ay = 0. So then…



Setting the two equal,



**Problem 5.** Suppose you’re flying you’re flying your personal plane at 200mph. Let’s consider the effect of various headwinds. Suppose…

(a) You’re flying 200mph East in a 50mph West wind. What is your speed?

Well,



(b) Now suppose the headwind is 60° North of West. Specify your net velocity in i,j notation. And calculate its magnitude and direction.



Which has a magnitude and direction:



(c) Consider the same headwind as in part b, and suppose you still fly at 200mph. What direction should you fly in order to proceed due North? And what would be your speed?

Now our v is unknown, but we know that:

