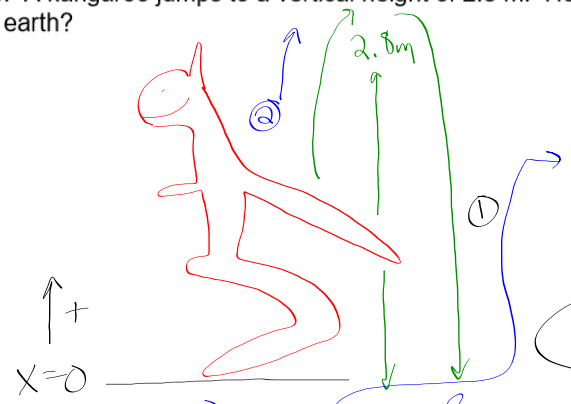
38. A kangaroo jumps to a vertical height of 2.8 m. How long was it in the air before returning to earth?



$x_0 = 0m$
$x = 0$
$v_0 = 7.41 \frac{m}{s}$
$v =$
$a = -9.8 \frac{m}{s^2}$
$t = 1.51s$

$x_0 = 0m$
$x = 2.8m$
$v_0 = 7.41 \frac{m}{s}$
$v = 0 \frac{m}{s}$
$a = -9.8 \frac{m}{s^2}$
$t =$

$v^2 = v_0^2 + 2a(x - x_0)$
$0 = v_0^2 + 2(-9.8)(2.8)$
$v_0 = \sqrt{2(9.8)(2.8)}$
$= 7.41 \frac{m}{s}$

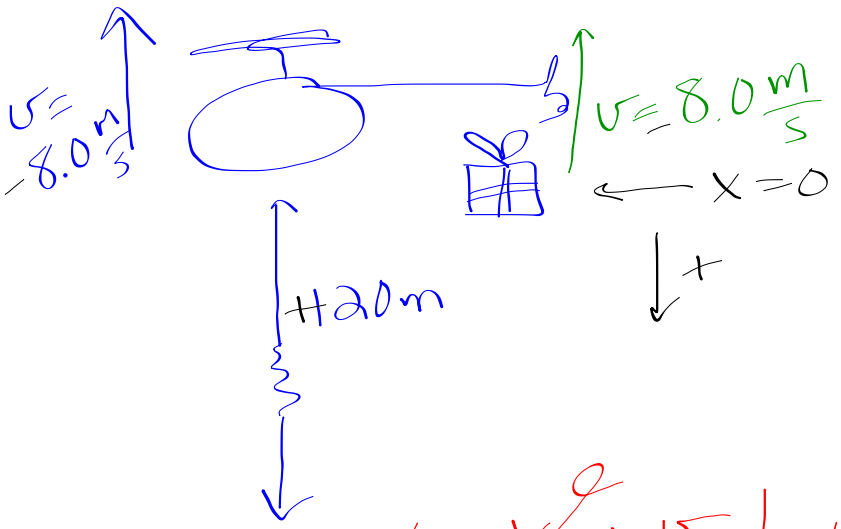
① $x_0 = 0m$
$x = 0$
$v_0 = 7.41 \frac{m}{s}$
$v =$
$a = -9.8 \frac{m}{s^2}$
$t =$

$x = x_0 + v_0 t + \frac{1}{2} a t^2$
$0 = 7.41t - 4.9t^2$
$0 = t(7.41 - 4.9t)$

$t = 0$

$7.41 - 4.9t = 0$
$-4.9t = -7.41$
$t = 1.51s$

39. A helicopter is ascending vertically with a speed of 8.00 m/s; at a height of 120 m above the earth, a package is dropped from a window. How much time does it take for the package to reach the ground?



$x_0 = 0$

$x = 120\ m$

$v_0 = -8.0\ \frac{m}{s}$

$v =$

$a = 9.8\ \frac{m}{s^2}$

$t =$

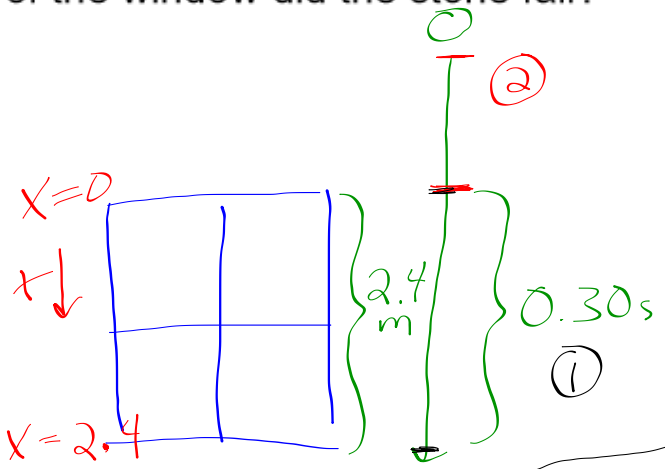
$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$120 = (-8)t + \frac{1}{2}(9.8)t^2$$

$$4.9t^2 - 8t - 120 = 0$$

$t = 5.83\ s$ or $-4.2\ s$

44. A falling stone takes 0.30 s to pass a window 2.4 m high. In other words, as the stone is falling, 0.30 seconds pass AS the stone falls past the window. From what height above the top of the window did the stone fall?



$x_0 = -2.18\,m$
$x = 0$
$v_0 = 0\ \frac{m}{s}$
$v = 6.53\ \frac{m}{s}$
$a = 9.8\ \frac{m}{s^2}$
$t =$

$v^2 = v_0^2 + 2a(x - x_0)$

$x_0 = -\left(\frac{v^2 - v_0^2}{2a}\right)$

$x_0 = -\left(\frac{(6.53^2)}{2(9.8)}\right)$

$= -2.18\,m$

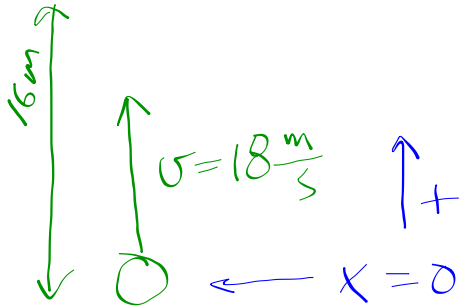
① $x_0 = 0$
$x = 2.4\,m$
$v_0 = 6.53\ \frac{m}{s}$
$v =$
$a = 9.8\ \frac{m}{s^2}$
$t = 0.3\,s$

$x = x_0 + v_0 t + \frac{1}{2}at^2$

$2.4 = v_0(0.3) + \frac{1}{2}(9.8)(0.3)^2$

$v_0 = \frac{2.4 - 4.9(0.3)^2}{0.3} = 6.53\ \frac{m}{s}$

45. A stone is thrown vertically upward with a speed of 18.0 m/s.
    a) How fast is it moving when it reaches a height of 16.0 m?
    b) How long is required to reach this height?
    c) Why are there two answers to (b)?



$x_0 = 0m$

$x = 16m$

$v_0 = 18\frac{m}{s}$

$v = +3.22\frac{m}{s}$

$a = -9.8\frac{m}{s^2}$

$t = 1.5s$ or $2.17s$

$v^2 = v_0^2 + 2a(x - x_0)$

$v = \pm\sqrt{18^2 + 2(-9.8)(16)}$

$v = \pm 3.22\frac{m}{s}$

$x = x_0 + v_0 t + \frac{1}{2}at^2$

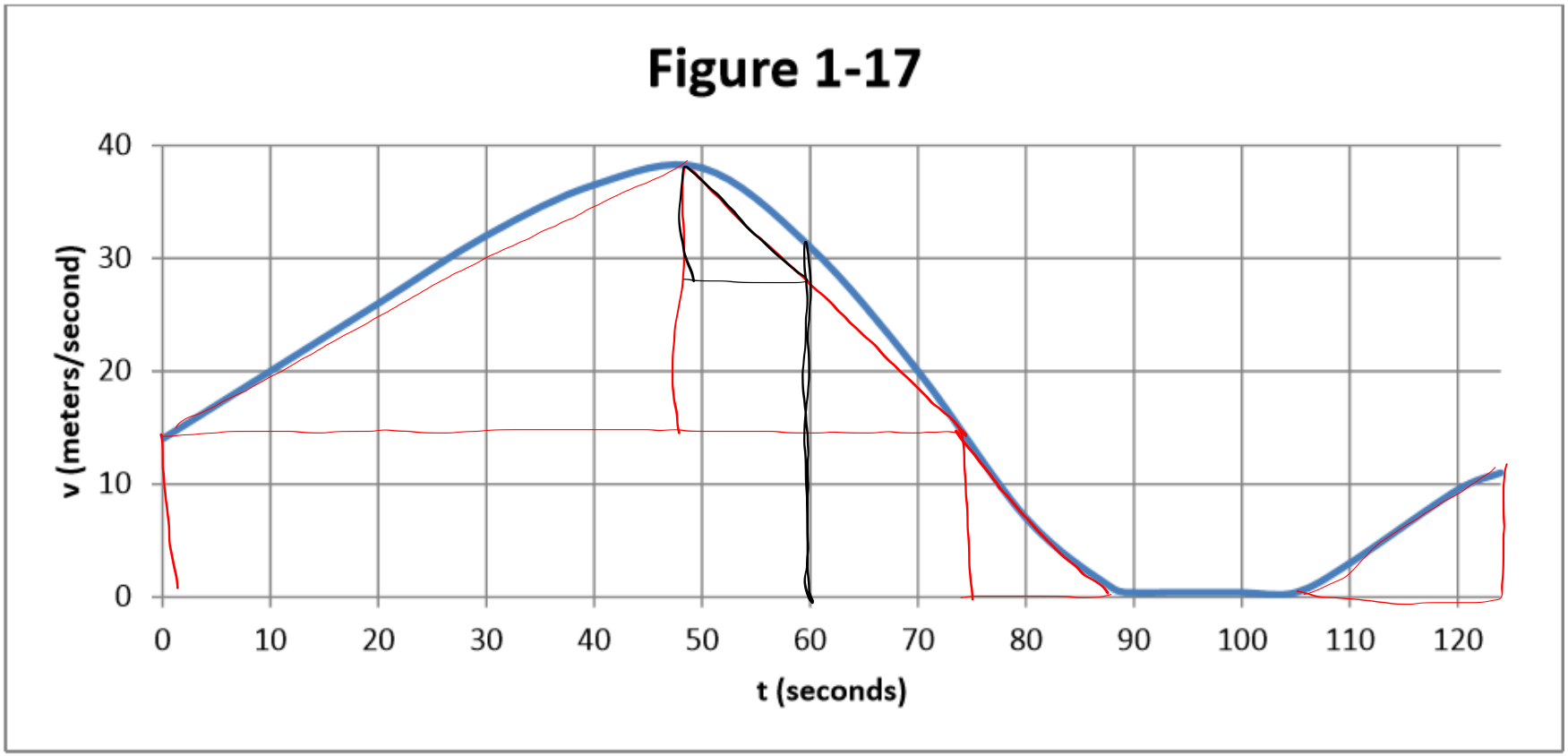
$16 = (18)t + -4.9t^2$

$-4.9t^2 + 18t - 16 = 0$

$t = 1.5$ or 2.17

52. In Figure 1-17, estimate the distance the train traveled during
    a) the first minute.
    b) the second minute.

↳ displacement



Objectives:

Students will understand what a vector is, what types of quantities are vector quantities, and why vectors are useful

Students will understand how to break vectors into components

Students will understand how to add component vectors and resolve into a resultant vector

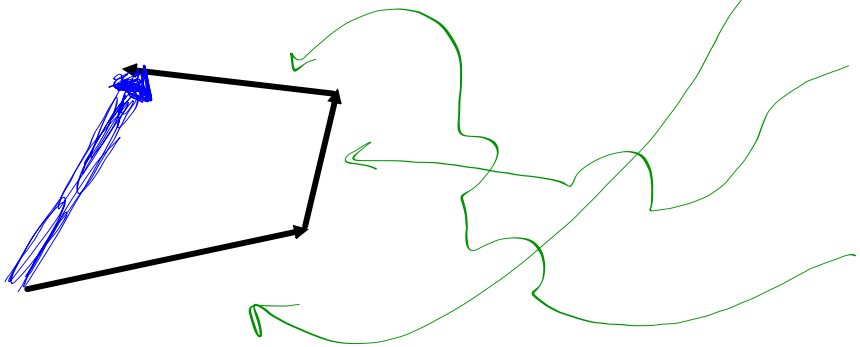
What is a vector?

A quantity with size & direction
(magnitude)

Why do we use vectors?

Because things like displacement, velocity, acceleration are vectors.
We need rules to do the math.

Vector Addition:

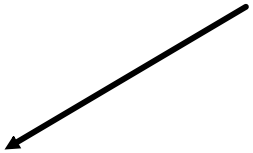


8.24, 14 degrees

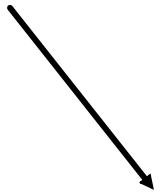
4.12, 76 degrees

6.08, 170.5 degrees

8.06, 209.7 degrees

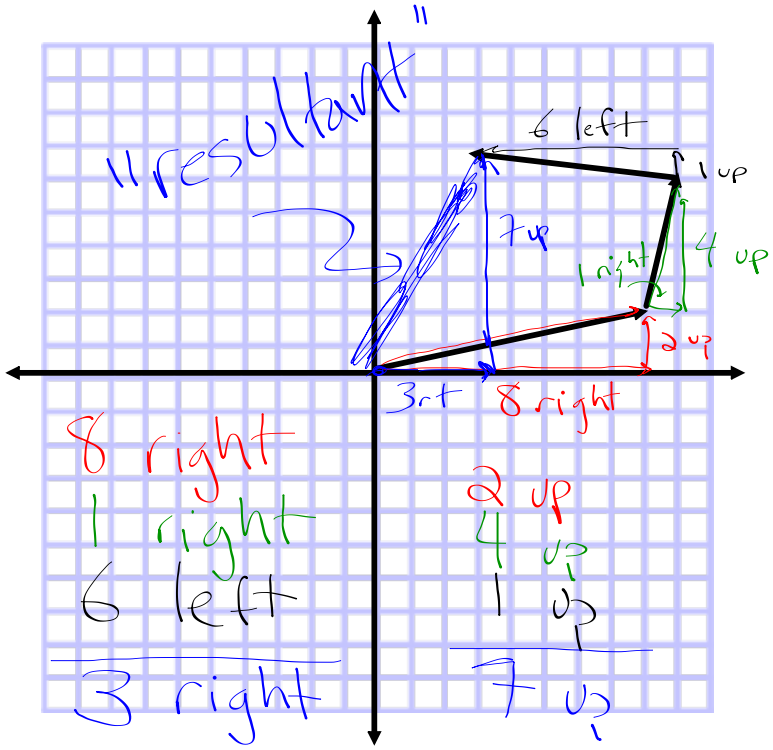


6.4, 308.7 degrees



4.12, 346 degrees

Vector Addition:



8.24, 14 degrees

4.12, 76 degrees

6.08, 170.5 degrees

8.06, 209.7 degrees

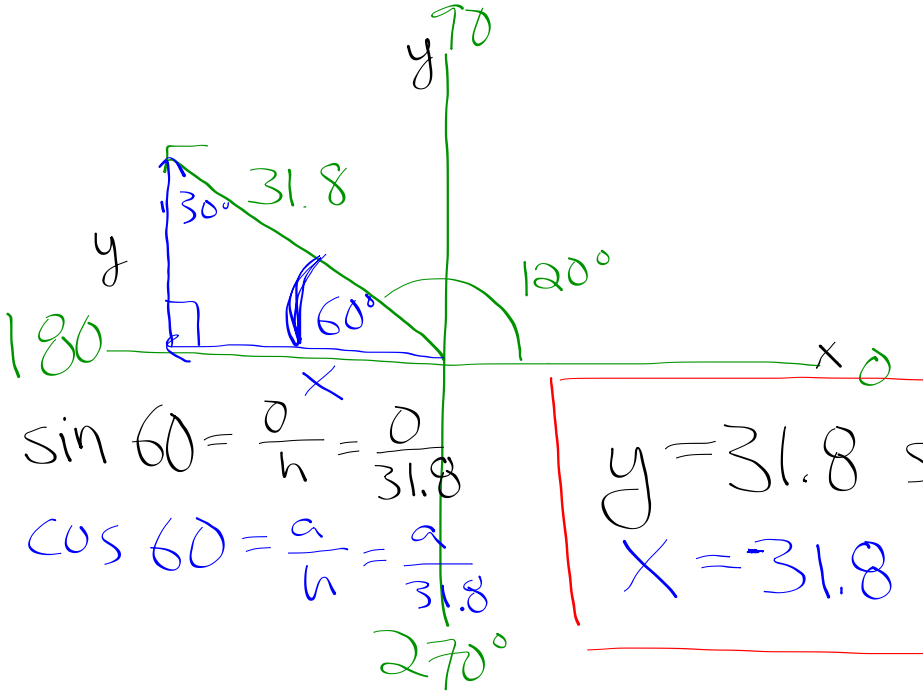
6.4, 308.7 degrees

4.12, 346 degrees

Breaking a vector into perpendicular components:

1. Draw the vector and sketch the components using a cartesian coordinate frame of reference.

2. Use trigonometry to determine the lengths of the component vectors (their direction will determine their sign).



$\sin 60 = \frac{O}{h} = \frac{O}{31.8}$

$\cos 60 = \frac{a}{h} = \frac{a}{31.8}$

$y = 31.8 \sin 60°$

$x = -31.8 \cos 60°$

$y = 27.54$

$x = -15.9$

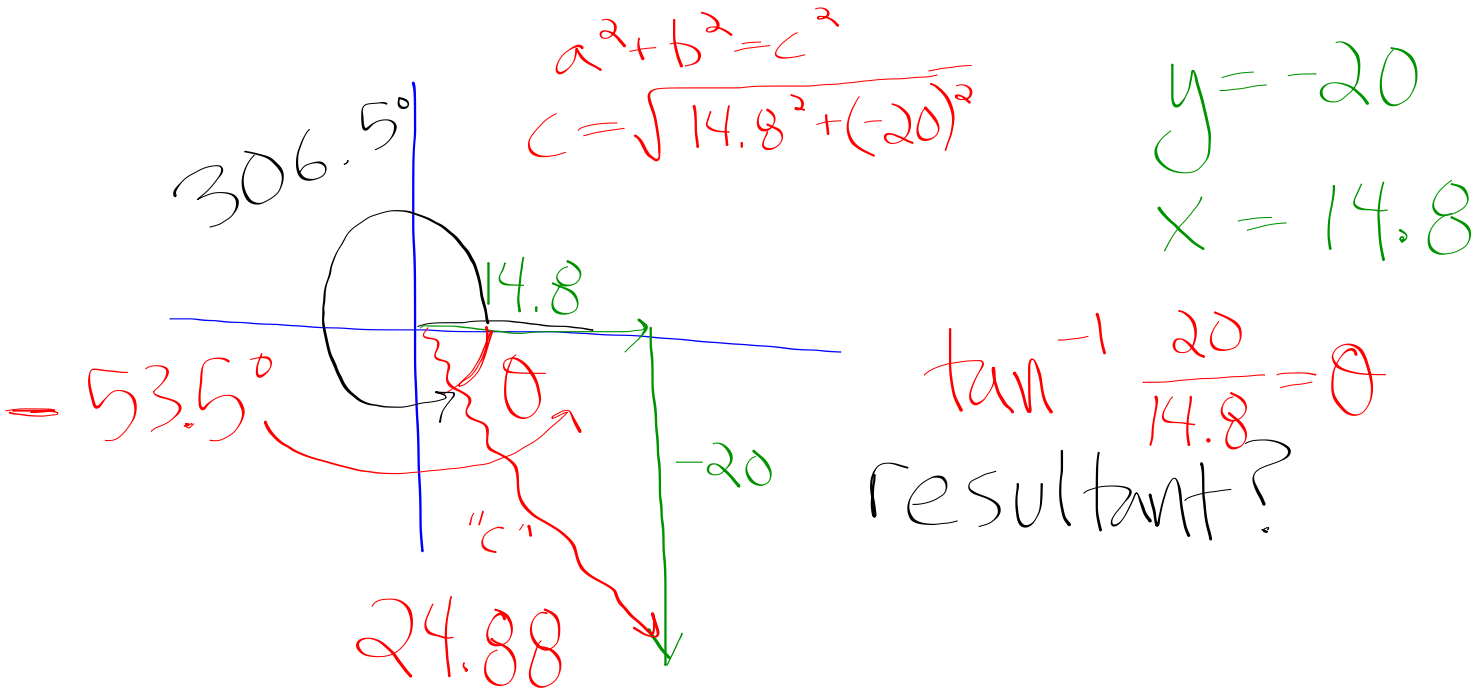
120° 31.8

Resolving component vectors into a resultant:

1. Draw the component vectors and sketch the resultant on a cartesian coordinate plane.

2. Use the pythagorean theorem to find the length of the resultant.

3. Use trigonometry to find the angle of the resultant - and specify what that angle is relative to!

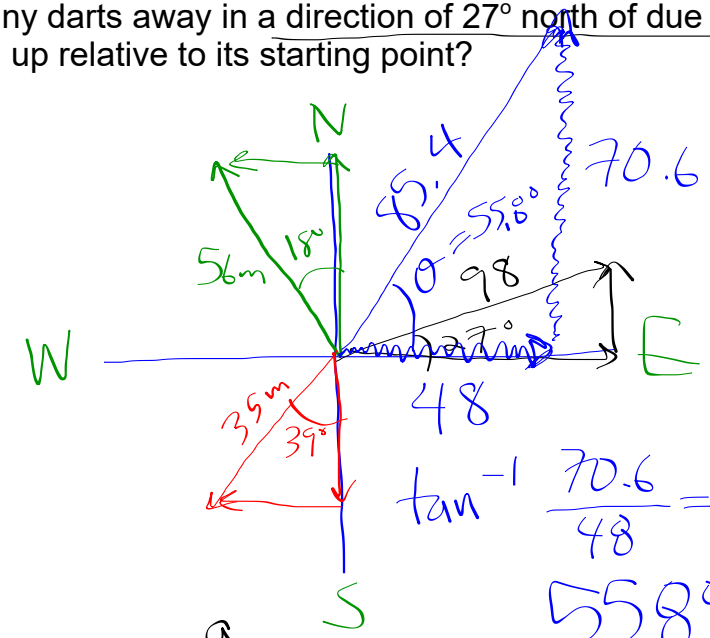


Adding vectors together:

1. For each vector, break into x- and y-components
2. Add all x-components and y-components to find the x- and y-components of the resultant
3. Resolve x- and y-components of the resultant to find its magnitude and direction

EXAMPLE 1: A bionic bunny bounces along a trail and travels 56 meters 18° west of due north. It spies a hawk, gets scared, and bolts in a direction that is 39° west of due south. Unfortunately, after going 35 meters he encounters a burly bear. For the bionic bouncing bunny to avoid the burly bear, the bouncing bunny darts away in a direction of 27° north of due east and runs for 98 meters. Where does the bunny end up relative to its starting point?

EXAMPLE 1: A bionic bunny bounces along a trail and travels 56 meters 18° west of due north. It spies a hawk, gets scared, and bolts in a direction that is 39° west of due south. Unfortunately, after going 35 meters he encounters a burly bear. For the bionic bouncing bunny to avoid the burly bear, the bouncing bunny darts away in a direction of 27° north of due east and runs for 98 meters. Where does the bunny end up relative to its starting point?



$\cos\theta = \frac{a}{h}$

$\tan^{-1}\frac{70.6}{48} = 55.8°$

$c = \sqrt{x^2 + y^2}$

$= \sqrt{48^2 + 70.6^2}$

$= 85.4$

x

$-56 \sin 18 = -17.3$

$-35 \sin 39 = -22$

$98 \cos 27 = 87.3$

$x = 48$

y

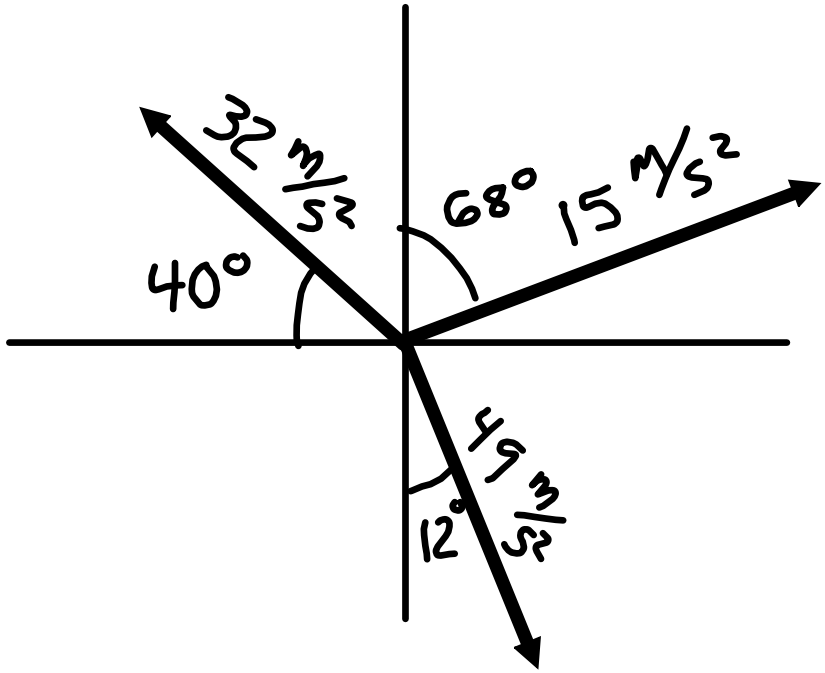
$56 \cos 18 = 53.3$

$-35 \cos 39 = -27.2$

$98 \sin 27 = 44.5$

$y = 70.6$

EXAMPLE 2: A micro meteor experiences the simultaneous accelerations of three different stars as shown. What is the meteor's net acceleration?



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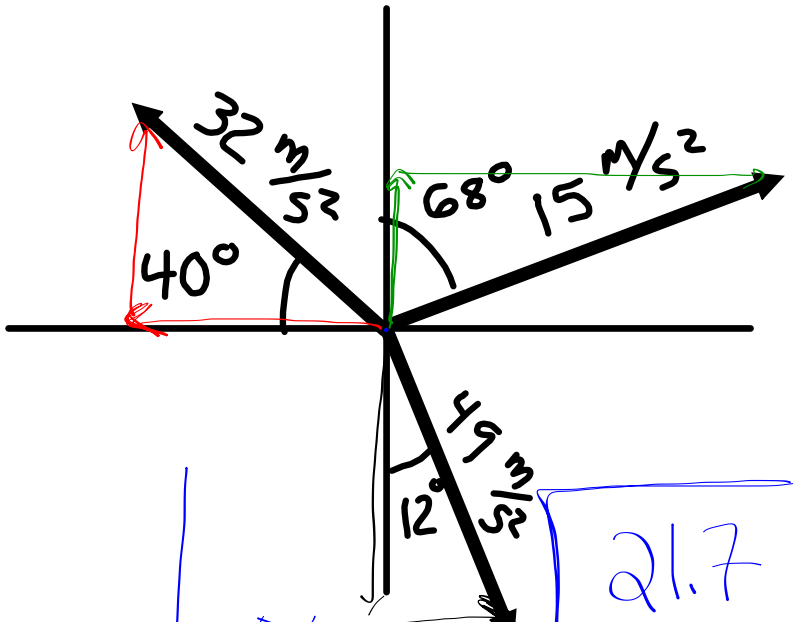


X

$15 \sin 68 = 13.9$

$-32 \cos 40 = -24.5$

$49 \sin 12 = 10.2$

-0.4

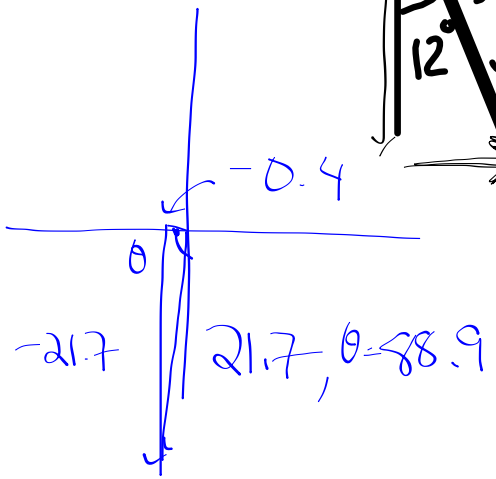
Y

$15 \cos 68 = 5.6$

$32 \sin 40 = 20.6$

$-49 \cos 12 = -47.9$

-21.7



21.7

268.9°