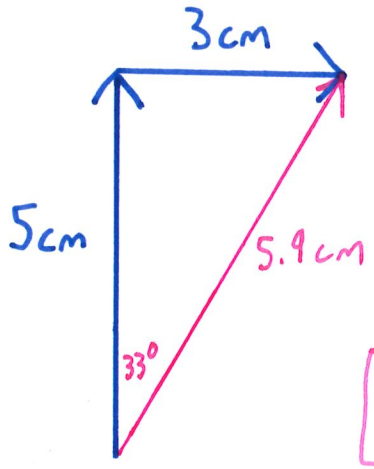
2D Vector Practice

Name:_____

Part 1: Drawing using scale and measurements.

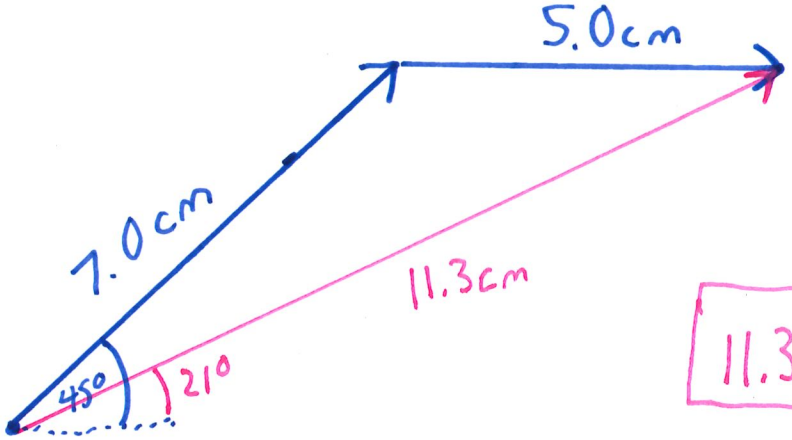
1. Use a ruler and a protractor to draw the following vectors and MEASURE to determine the result of their addition (both magnitude and direction). Give all answers to 2 sig figs.

   a. 5.0 cm North + 3.0 cm East



5.9cm, 33° East of North

   b. 7.0 cm, 45° North of East + 5.0 cm East



11.3cm, 21° North of East

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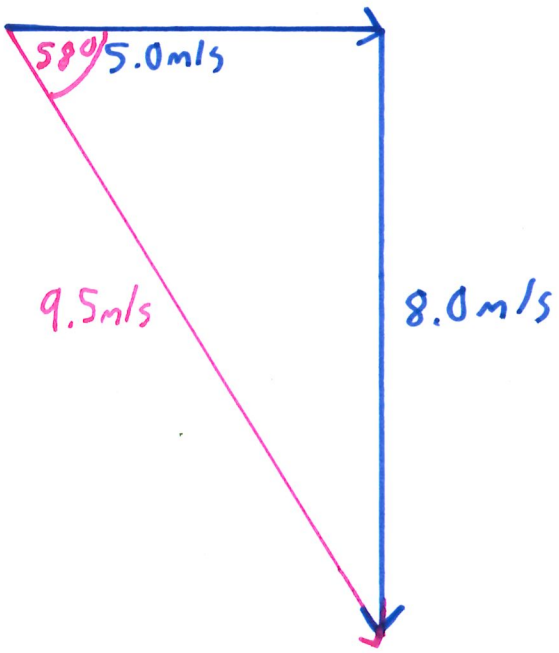
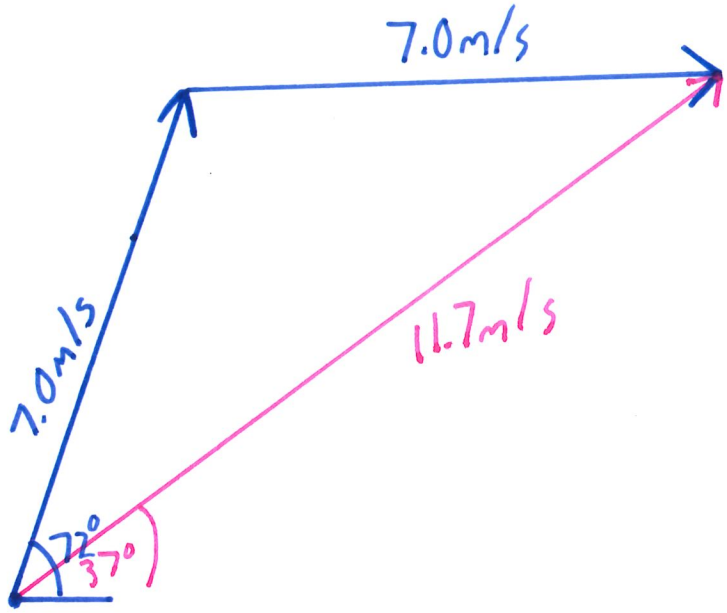
2. Use a scale of 1 m/s = 1 cm to draw and MEASURE to solve each vector addition

a. 5.0 m/s Horizontally + 8.0 m/s Down



9.5m/s, 58° below the horizontal

b. 7.0 m/s, 72° above the horizontal + 7.0 m/s horizontally.

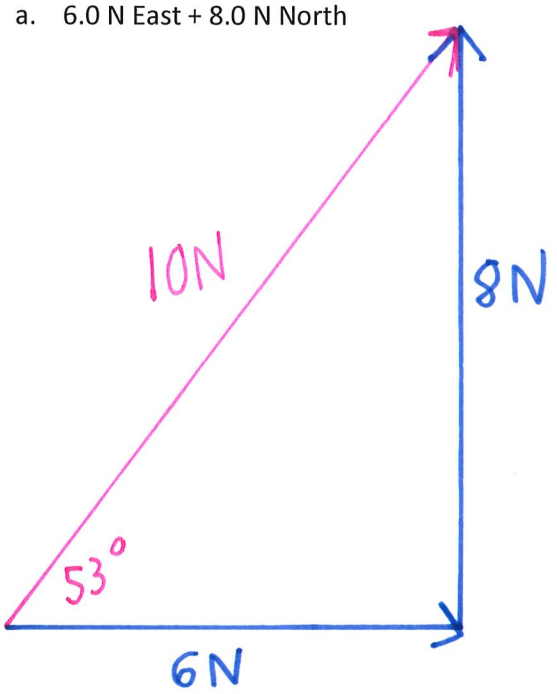


11.7m/s, 37° above the horizontal

2D Vector Practice Name:_____

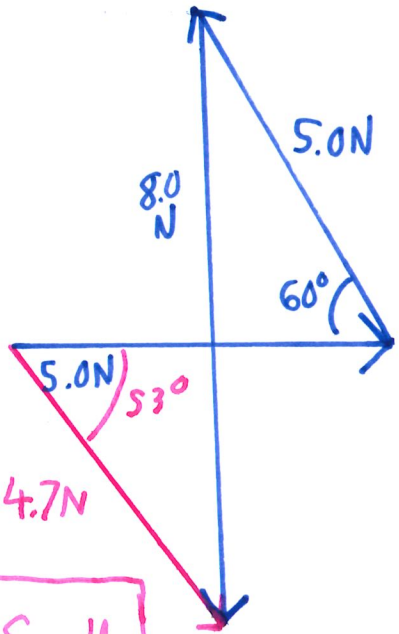
3. Use a scale of 1 N = 1 cm to draw and MEASURE to solve each vector addition

a. 6.0 N East + 8.0 N North



10 N, 53° North of East

b. 5.0 N East + 5.0 N, 60.0° North of West + 8.0 N South



4.7N, 53° South of East

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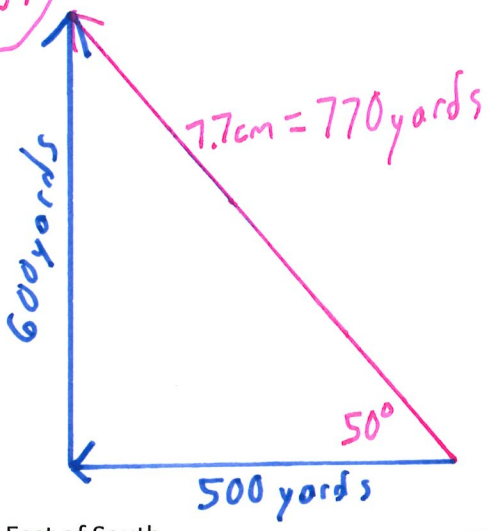
4. Solve each of the following subtractions by drawing scale diagrams:
   a. 500 yards West – 600 yards South

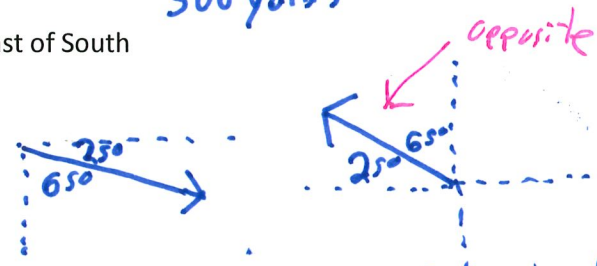
1 cm = 100 yds

500 yards West + 600 yards North

770 yards, 50° North of West



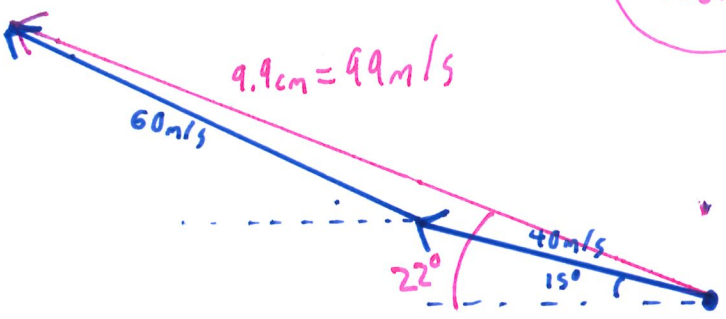
   b. 40 m/s, 15° North of West – 60 m/s 65° East of South



40 m/s, 15° North of West + 60 m/s, 25° North of West

1 cm = 10 m/s

99 m/s, 22° North of West



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Part 2: Using PhET simulation

Use the link on the Google Classroom, or https://phet.colorado.edu/sims/html/vector-addition/latest/vector-addition_en.html. Then select "Explore 2D"

5.

$\lvert\vec{a}\rvert$	18.0	θ	56.3	a_x	10.0	a_y	15.0

What do each of the numbers shown here represent? Fill in with the terms:

Horizontal Component, Vertical Component, Angle, and **Magnitude**

$|\vec{a}|$ represents magnitude

θ represents the angle

a_x represents the x-component of vector

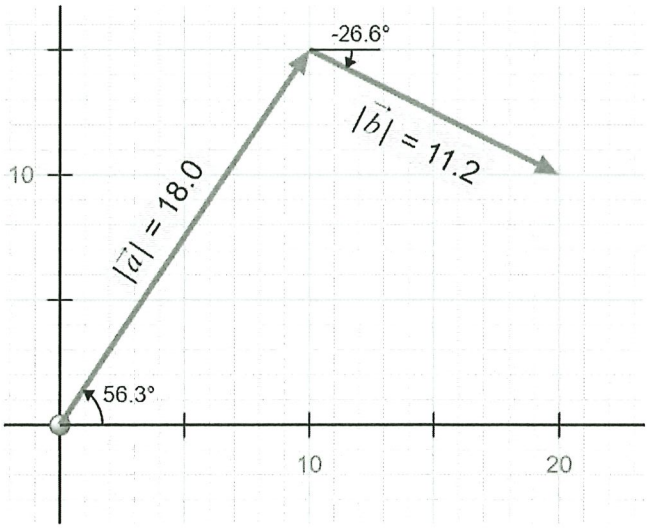
a_y represents the y-component of vector

6. What could the following addition of vectors represent:

A: 18.0 m/s, at 56.3° above the horizontal + 11.2 m/s, at 26.6° below the horizontal ✓

B: 18.0 N, at 56.3° North of East + 11.2 N 26.6° South of East ✓

C: 11.2 kilometres, 26.6° down from straight across plus 18.0 kilometres, 56.3° up from straight across.



D: All of the above

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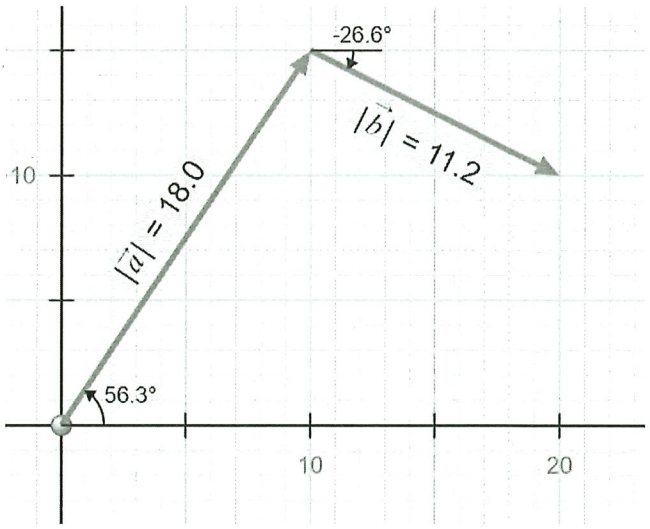
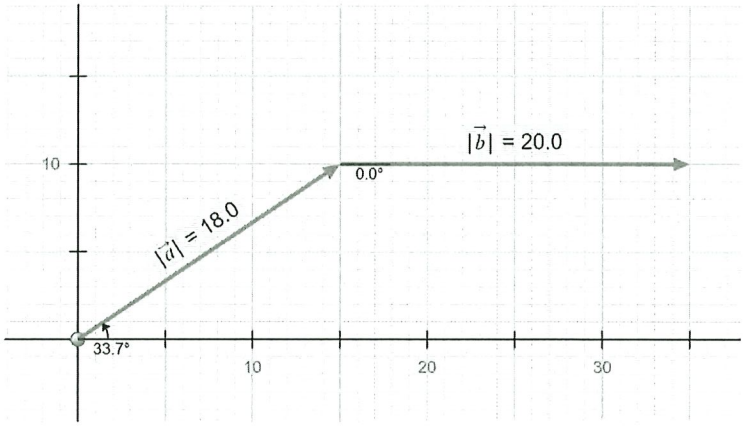
7. Draw the two vectors shown and turn on the "Sum", then drag the resultant vector so it connects the start of vector ***a*** to the end of vector ***b***. What is the magnitude and direction of the sum?



mag = 22.4, 26.6°

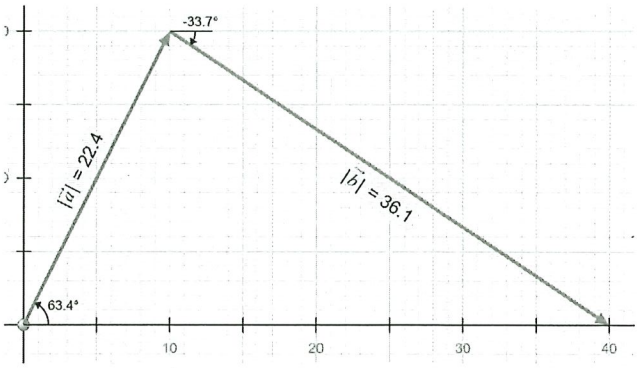
8. Use the simulation to determine the magnitude and direction of the sum of the vector addition shown:



mag = 36.4

θ = 15.9°

9. Use the simulation to determine the magnitude and direction of the sum of the vector addition shown:



mag = 40.0

θ = 0°

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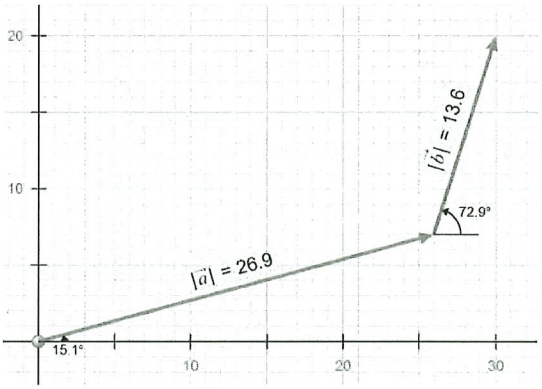
10.

a. What addition is shown in the diagram?



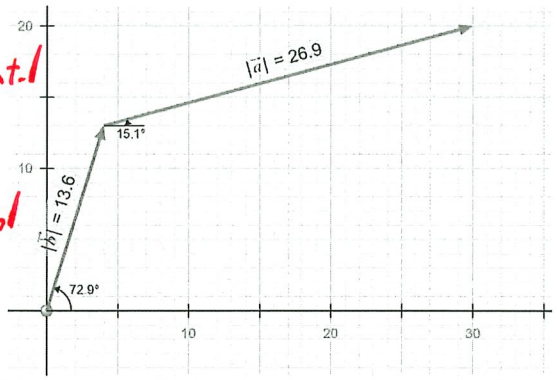
26.9, 15.1° above horizontal
+
13.6, 72.9° above horizontal

b. What is the sum of that addition?

36.1, 33.7° above horizontal

11.

a. What addition is shown in the diagram?



13.6, 72.9° above horizontal
+
26.9, 15.1° above horizontal

b. What is the sum of that addition?

36.1, 33.7° above horizontal

c. Does the order of addition matter in vector addition?

No, answers to 10b and 11b are the same

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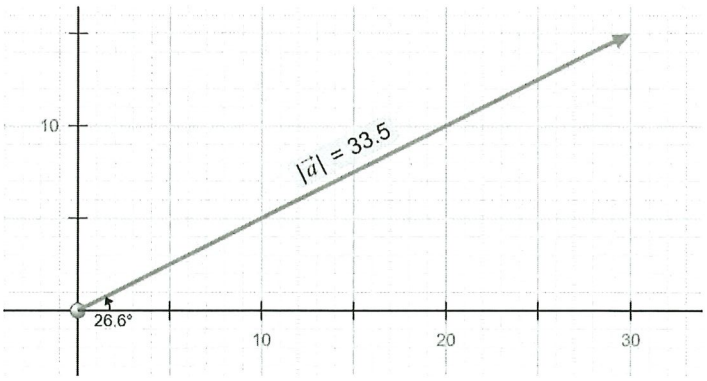
~~10~~ 1. Use the simulation to determine the horizontal and vertical components of the vector shown:



$a_x = 30.0$

$a_y = 15.0$

13

~~12~~ 2. Use the simulation to determine the result of adding 29.2 Newtons at 31° above the horizontal plus 11.2 Newtons at 63.4° above the horizontal. Your answer should have both angle and magnitude.

39.1 N, ~~63.4~~ 39.8° above the horizontal

14

~~13~~ 3. Use the simulation to determine the result of adding 18 m/s, 33.7° North of East + 11.2 m/s, 26.6° South of East + 19.0 m/s North.

34.7 m/s, 43.8° North of East

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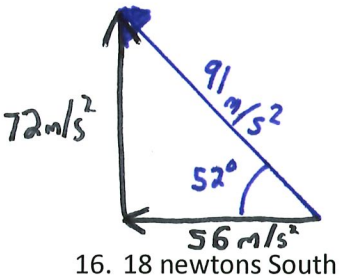
Part 3: Adding and subtracting vectors at right angles using trigonometry.

Draw a diagram, and using right angle trigonometry and the Pythagorean theorem to determine the solution to the following:

$\sin\theta = \frac{Opposite}{Hypotenuse}$ $\cos\theta = \frac{Adjacent}{Hypotenuse}$ $\tan\theta = \frac{Opposite}{Adjacent}$

15. 56 m/s^2 West + 72 m/s^2 North.



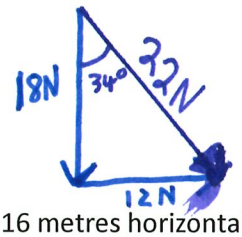
Magnitude: $\sqrt{72^2 + 56^2} = 91 m/s^2$

Angle: $\tan^{-1}\left(\frac{72}{56}\right) = 52°$

91 m/s², 52° North of West

16. 18 newtons South – 12 newtons West

18N South + 12 N East

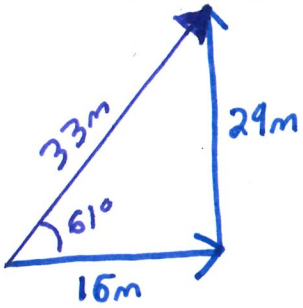


Magnitude: $\sqrt{18^2 + 12^2} = 22N$

Angle: $\tan^{-1}\left(\frac{12}{18}\right) = 34°$

22N, 34° East of South

17. 16 metres horizontally + 29 metres vertically



Magnitude: $\sqrt{16^2 + 29^2} = 33m$

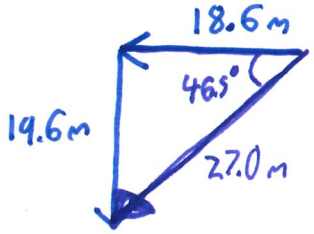
Angle: $\tan^{-1}\left(\frac{29}{16}\right) = 61°$

33m, 61° up from right

18. 6.2 metres West + 19.2 metres South – 12.4 metres East

6.2m W – 12.4m East = 6.2m W + 12.4m W = 18.6m West

18.6m West + 19.2m South



Magnitude: $\sqrt{19.6^2 + 18.6^2} = 27.0m$

Angle: $\tan^{-1}\left(\frac{19.6}{18.6}\right) = 46.5°$

27.0m, 46.5° South of West

~~**Part 4: Using components to add and subtract vectors**~~

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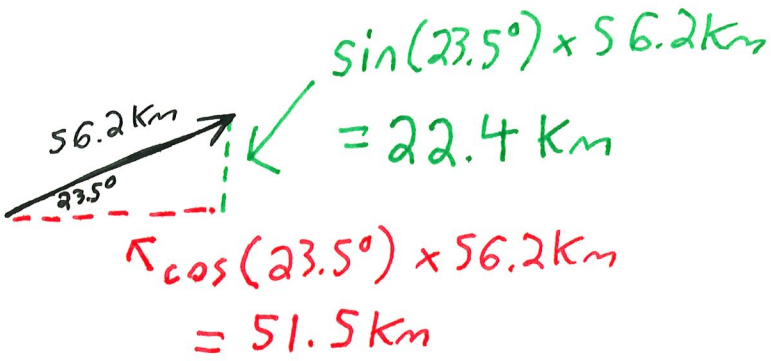
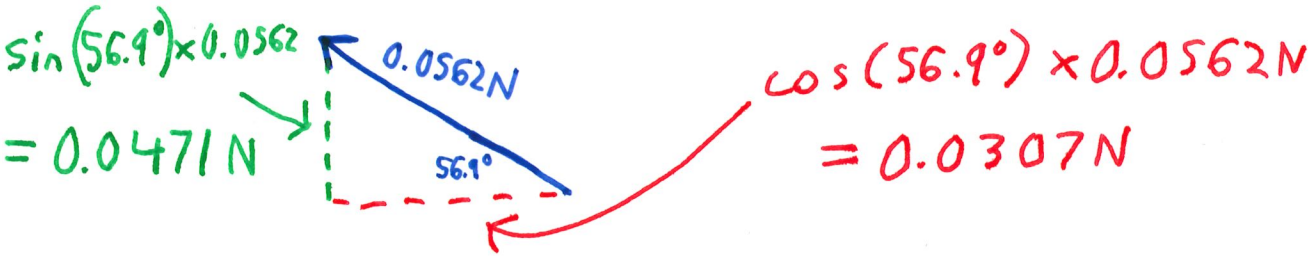
Part 4: Using components to add and subtract vectors

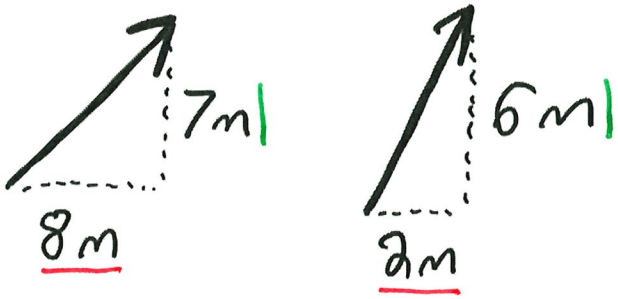
19. Use trigonometry to determine the components of the following vectors:
    a. 56.2 km, at 23.5° above the horizontal



    b. 0.0562 Newtons, at 56.9° North of West



20. Two vectors and their components are shown.



    a. Determine the sum of the horizontal components.

8m + 2m = 10m

    b. Determine the sum of the ~~horizontal~~ vertical components.

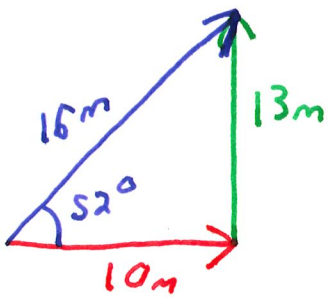
7m + 6m = 13m

    c. Determine result of adding the two vectors, this should be a vector with magnitude and direction.

$\sqrt{10^2 + 13^2}$

$= 16m$

$\tan^{-1}\left(\frac{13m}{10m}\right) = 52°$



16m, 52° North of East

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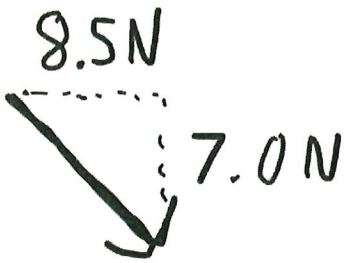
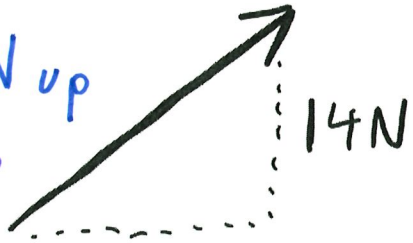
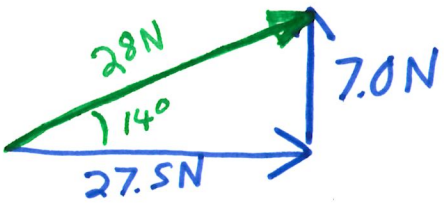
21. Determine the result of adding the two vectors shown.



Horizontal components : 8.5N + 19N
= 27.5N

Vertical components : -7.0N + 14N = 7.0N up
↑ since it is going down

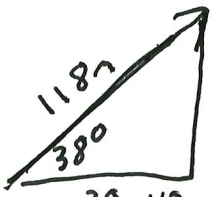




$\tan^{-1}\left(\frac{7.0N}{27.5N}\right) = 14°$ 19N $\sqrt{27.5^2 + 7.0^2} = 28N$

28N, 14° above horizontal

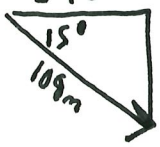
22. Determine the components for each of the following vectors, and then use the components to determine the resultant vector.



sin38 x 118m
= 72.65m

cos38 x 118
= 92.99m

cos15 x 108m
= 104.32m



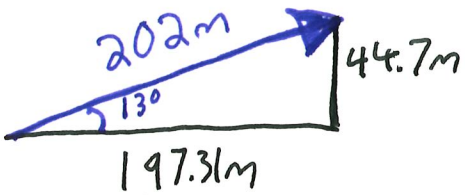
sin15° x 108
= 27.95m

Horizontal components
92.99m + 104.32m = 197.31m

Vertical components
72.65m − 27.95m = 44.7m

$\sqrt{197.31^2 + 44.7^2} = 202m$

$\tan^{-1}\left(\frac{44.7m}{197.31m}\right) = 13°$



202m, 13° above horizontal

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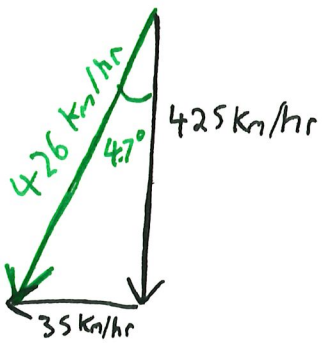
Part 5: Solving Problems

23. A plane is flying due South. A 35 km/hr wind blows due West. The plane flies with a velocity of 425 km/hr. What is the actual speed and direction the plane is flying?



$\tan^{-1}\left(\frac{35}{425}\right) = 4.7°$

$\sqrt{425^2 + 35^2}$

$= 426\ km/hr$

426 km/hr, 4.7° West of South

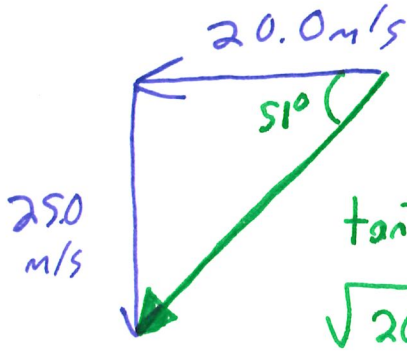
24. What is the acceleration of a car that turns from travelling 25.0 m/s North to travelling 20.0 m/s West? $a = \frac{\Delta v}{t} = \frac{v_f - v_i}{t}$

$V_f = 20.0\ m/s$ West

$V_i = 25.0\ m/s$ North

$V_f - V_i \rightarrow 20.0\ m/s$ West $- 25\ m/s$ North

$= 20.0\ m/s$ West $+ 25\ m/s$ South



$\tan^{-1}\left(\frac{25}{20}\right) = 51°$

$\sqrt{20^2 + 25^2} = 32.0\ m/s$

$a = \frac{V_f - V_i}{t} = \frac{32.0\ m/s,\ 51°\ South\ of\ West}{3.0\ sec}$

$= (10.7\ m/s^2,\ 51°\ South\ of\ West)$

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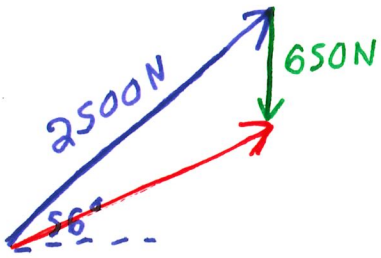
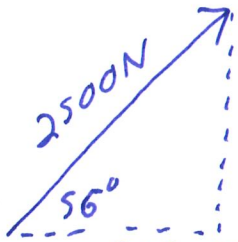
25. A rocket is pointed at an angle of 56° above the horizontal and the engines output 2500 N of force, gravity pulls the rocket straight downwards with a force of 650 N. What is the net force acting on the rocket?



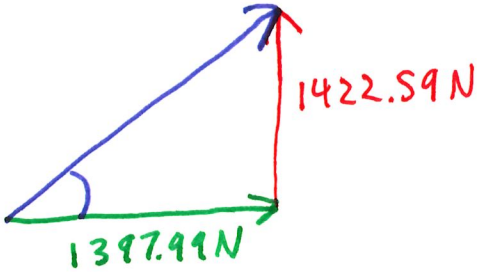


$\sin(56°) \times 2500N$
$= 2072.59N$

$\cos(56) \times 2500N$
$= 1397.99N$

Total horizontal force is $1397.99N$

Total vertical force
$2072.59N - 650N$
$= 1422.59N$



$\sqrt{1397.99^2 N + 1422.59^2 N}$
$= 1994.53N$

$\tan^{-1}\left(\frac{1422.59N}{1397.99N}\right) = 45°$

$2.0 \times 10^3 N$, 45° above horizontal

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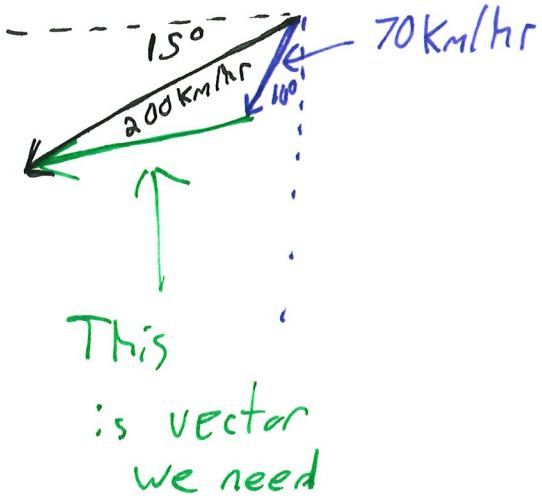
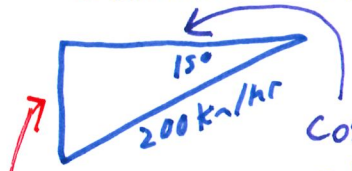
26. A pilot wishes to reach a city 400.0 km away in a direction of 15° S of W in two hours. If there is a wind of 70 km/h blowing at 10° W of S. What must be the heading and air speed of the plane?

Resultant velocity must be $\frac{400.0\text{ km}}{2\text{ hrs}} = 200\text{ km/hr}$, 15° S of W



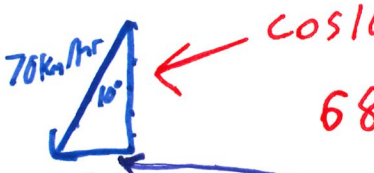
Consider Components:



$\cos 15 \times 200 = 193.18\text{ km/hr}$

$\sin 15° = \frac{Opp}{200}$

51.76 km/hr



$\cos 10° \times 70\text{ km/hr}$

68.94 km/hr

$\sin 10° \times 70\text{ km/hr}$

12.16 km/hr

We Know $68.94\text{ km/hr} + V_y = 51.76\text{ km/hr}$ $V_y = 17.18\text{ km/hr}$ North

and $12.16\text{ km/hr} + V_x = 193.18\text{ km/hr}$ $V_x = 181.02\text{ km/h}$ West

$\sqrt{181.02^2 + 17.18^2} = 182\text{ km/hr}$

$\tan^{-1}\left(\frac{17.18}{181.02}\right) = 5.4°$

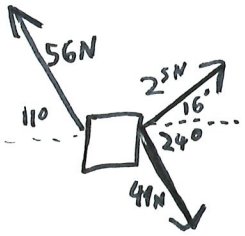
182 km/hr, 5.4° North of West

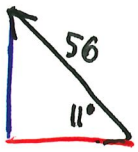
2D Vector Practice

Name:_____

27. Three forces act on a 5.0 kg block. There is a 25 N force at 16° North of East, a 49 N force at ~~34°~~ 34° South of East and a 56 N force acting at 11° North of West.

a. What is the net force acting on the block?



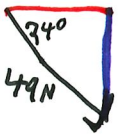


$\cos 11 \times 56 = -54.97\text{N}$

$\sin 11 \times 56 = 10.69\text{N}$

$\cos 16° \times 25 = 24.03\text{N}$

$\sin 16 \times 25 = 6.89\text{N}$



$\cos 34° \times 49\text{N} = 40.62\text{N}$

$\sin 34 \times 49\text{N} = -27.4\text{N}$

Total vertical

$10.69\text{N} + 6.89\text{N} - 27.4\text{N} = -9.82\text{N}$

9.82N down

Total horizontal

$-54.97\text{N} + 24.03\text{N} + 40.62\text{N}$

9.68N East

$\sqrt{9.68^2 + 9.82^2} = 13.79$

$\tan^{-1}\left(\frac{9.82}{9.68}\right) = 45°$

14N, 45° South of East

b. What is the acceleration of the block ($F_{net} = ma$)

$$a = \frac{F_{net}}{m} = \frac{13.79\text{N}, 45° \text{ South of East}}{5.0\text{kg}} = 2.758\ \frac{\text{m}}{\text{s}^2}, 45° \text{ South of East}$$

c. What will be the displacement of the block after travelling for 5.0 seconds?

34.475

$d = v_0 t + \frac{1}{2}at^2 \rightarrow d = \text{m}, 45° \text{ South of East}$

d. What will be the kinetic energy of the block after it has been travelling for 5.0 seconds?

13.79 m/s

$v_f = v_0 + at \rightarrow v_f =$

$E_K = \frac{1}{2}mv^2 = 475\text{J}$