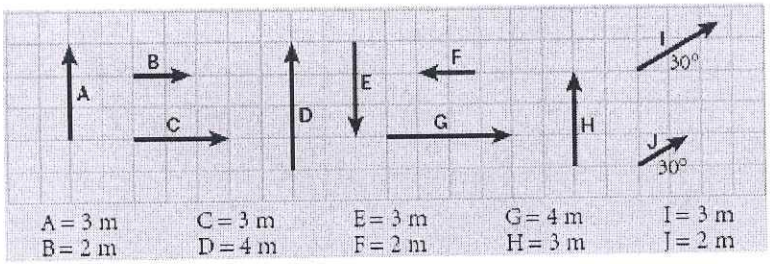
PROBLEMS and SOLUTIONS on VECTORS 1.3 Problem Set 1

1. Use the following vectors to answer the questions.



a. Which vectors have the same magnitude? A, C, E, H, I

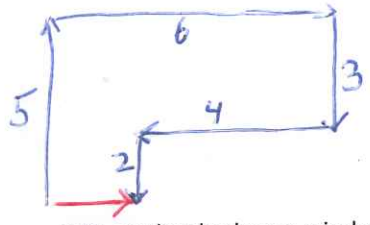
b. Which vectors have the same direction? A, D, H / B, C, G / I, J

c. Which arrows, if any, represent the same vector? A and H

2. What is the minimum number of vectors with *unequal* magnitudes whose vector sum can be zero?
   a. two (b.) three c. four d. five e. six

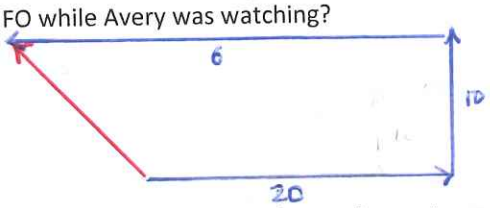
3. What is the minimum number of vectors with *equal* magnitudes whose vector sum can be zero?
   (a.) two b. three c. four d. five e. six

3. Lynn is driving home from work and finds that there is road construction being done on her favorite route, so she must take a detour. Lynn travels 5 km north, 6 km east, 3 km south, 4 km west, and 2 km south. a) Draw a vector diagram of the situation. b) What is her **displacement (how far and in what direction she moved)**
   c) What total distance has Lynn covered? distance = 21 km (Scalar)



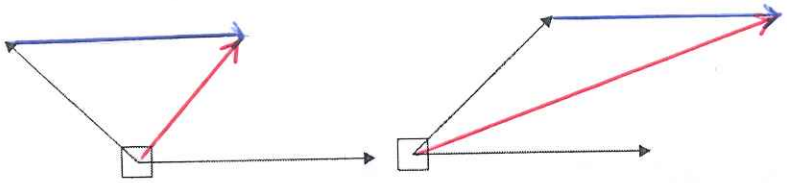
displacement = 2 km East

4. Avery sees a UFO out her bedroom window and calls to report it to the police. She says, "The UFO moved 20.0 m east, 10.0 m north, and 30.0 m west before it disappeared." What was the displacement (how far and in what direction are they from original position) of the UFO while Avery was watching?



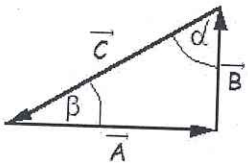
R = 14.1 m, 135°

5. A body is acted upon by the two forces shown. In each case draw the one force whose effect on the body is the same as the two together. Always add head to tail



6. What is the angle between the vectors $\vec{A}$ and $-\vec{A}$ when they are drawn from a common origin?
   a. 0° b. 90° (c.) 180° d. 270° e. 360°

7. Which expression is *false* concerning the vectors shown in the sketch?



a. $\vec{C} = \vec{A} + \vec{B}$

b. $\vec{C} + \vec{A} = -\vec{B}$

c. $\vec{A} + \vec{B} + \vec{C} = 0$

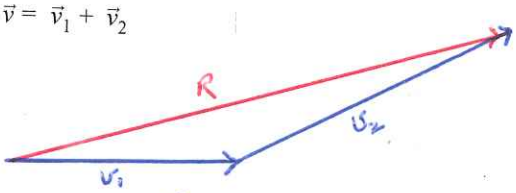
d. $C < A + B$

e. $A^2 + B^2 = C^2$

Solve problems graphically:

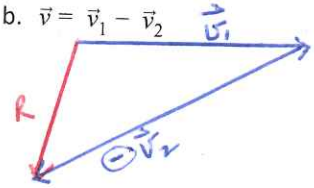
8. $\vec{v}_1 = 3m/s,\ E$ *and* $\vec{v}_2 = 4m/s, 30^0$

a. $\vec{v} = \vec{v}_1 + \vec{v}_2$



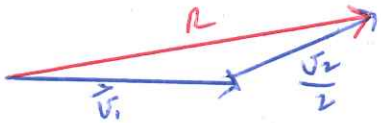
$\vec{R} \approx 7 \frac{m}{s}$

b. $\vec{v} = \vec{v}_1 - \vec{v}_2$



$R \approx 1.9\ m/s$

c. $\vec{v} = 2\vec{v}_1 + \frac{1}{2}\vec{v}_2$

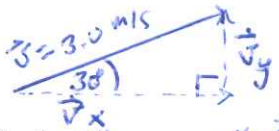


$R \approx 4.8 \frac{m}{s}$

Solve problems numerically (analytically), but first sketch the problem.

9. Sketch and calculate the vertical and horizontal components of the following vectors:

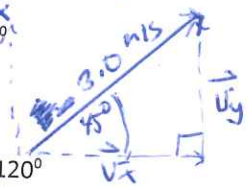
a. $\vec{v}$ = 3.0 m/s, 30°



$v_x = (3.0)\cos(30^\circ) = +2.6\ m/s$

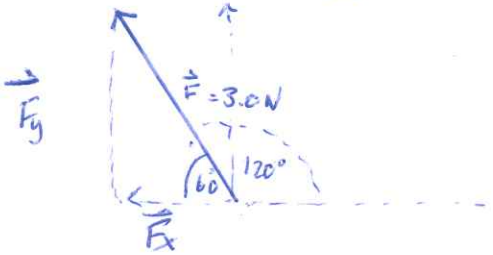
$v_y = (3.0)\sin(30^\circ) = +1.5\ m/s$

b. $\vec{v}$ = 3m/s, 45°



$v_x = (3.0)\cos(45^\circ) = 2.1 \frac{m}{s} = v_y$

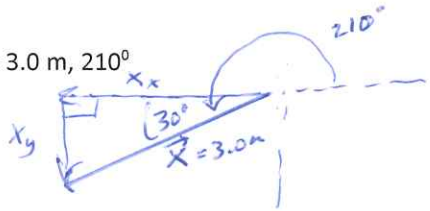
c. $\vec{F}$ = = 3.0 N, 120°



$F_x = (3.0)\cos(60^\circ) = -1.5\ m/s$

$F_y = (3.0)\sin(60^\circ) = +2.6\ m/s$

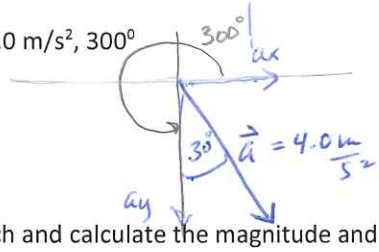
d. $\vec{x}$ = 3.0 m, 210°



$X_x = (3.0)\cos(30°) = -2.6\ \frac{m}{s}$

$X_y = (3.0)\sin(30°) = -1.5\ m/s$

e. $\vec{a}$ = 4.0 m/s², 300°

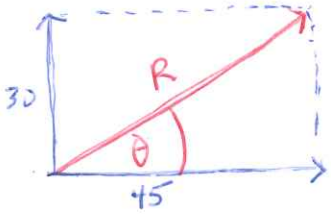


$a_x = (4.0)\sin(30°) = 2.0\ m/s^2$

$a_y = (4.0)\cos(30°) = 3.5\ m/s^2$

10. Sketch and calculate the magnitude and direction of the vectors that has following horizontal and vertical components:

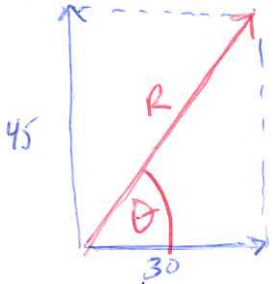
a. v_x = 45 m/s , v_y = 30. m/s



$R = \sqrt{(45)^2+(30)^2} = 54\ \frac{m}{s}$

$\theta = \tan^{-1}\left(\frac{30}{45}\right) = 34°$

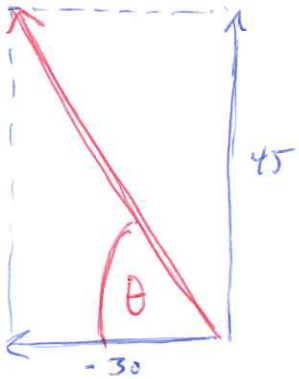
b. v_x = 30. m/s , v_y = 45 m/s



$R = 54\ \frac{m}{s}$

$\theta = 90 - 34 = 56°$

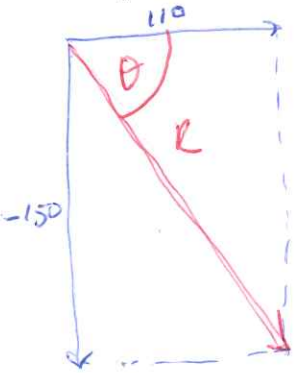
c. v_x = - 30. m/s , v_y = 45 m/s



$R = 54\ \frac{m}{s}$

θ = 56° above -x, or 127°

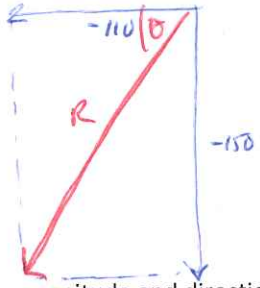
d. F_x = 110. N, F_y = - 150. N



$R = \sqrt{(110)^2+(150)^2} = 186\ N$

$\theta = \tan^{-1}\left(\frac{150}{110}\right) = 54°$ below +x or 306°

e. $F_x = -110.\ m/s^2$, $F_y = -150.\ m/s^2$



$R = 186\ N$

$\theta = 54°$ below $-x$ or $234°$

12. Find the magnitude and direction of the vectors with components:

(a) $A_x = -4.0$ cm, $A_y = -4.0$ cm $A = 5.7\ cm, 225°$

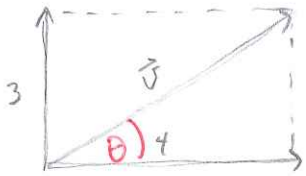
(b) $A_x = 124$ km, $A_y = -158$ km $A = 201\ km, -51.9°$ or $308.1°$

(c) $A_x = 0$, $A_y = -5.0$ m $A = 5.0\ m, 90°$

(d) $A_x = 8\ N$, $A_y = 0$. $A = 8\ N, 0°$

13. $\vec{v}_1 = 3m/s,\ N$ *and* $\vec{v}_2 = 4m/s, E$ Calculate magnitude and direction of the vector $\vec{v}$ if:

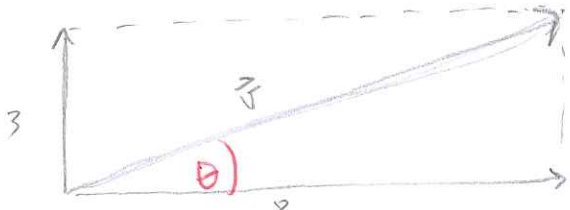
a. $\vec{v} = \vec{v}_1 + \vec{v}_2$



$\vec{v} = \sqrt{3^2 + 4^2} = 5\ m/s$

$\theta = \tan^{-1}\left(\frac{3}{4}\right) = 37°$ N of E

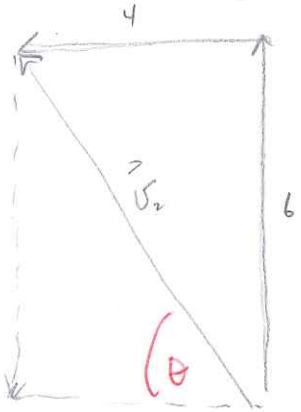
b. $\vec{v} = \vec{v}_1 + 2\vec{v}_2$



$\vec{v} = \sqrt{8^2 + 3^2} = 8.5\ m/s$

$\theta = \tan^{-1}\left(\frac{3}{8}\right) = 21°$ N of E

c. $\vec{v} = 2\vec{v}_1 - \vec{v}_2 = 2\vec{v}_1 + (-)\vec{v}_2$

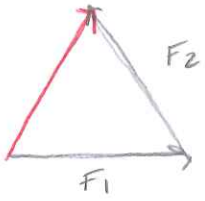


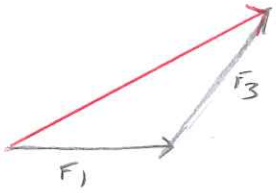
$\vec{v} = \sqrt{4^2 + 6^2} = 7.2\ \frac{m}{s}$

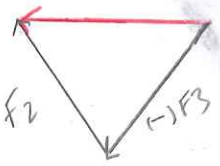
$\theta = \tan^{-1}\left(\frac{6}{4}\right) = 56°$ N of W

14. if $\vec{F}_1$ = 6 N, 0°; $\vec{F}_2$ = 6 N, 120°; $\vec{F}_3$ = 6 N, 60°, find $\vec{F}$ (magnitude F and direction)

a. $\vec{F} = \vec{F}_1 + \vec{F}_2$ b. $\vec{F} = \vec{F}_1 + \vec{F}_3$ c. $\vec{F} = -\vec{F}_3 + \vec{F}_2$







15. Add three vectors: $\vec{F}_1 = (40N, 0^0)$ $\vec{F}_2 = (30N, 180^0)$ $\vec{F}_3 = (50N, 90^0)$

Find resultant force $\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$

16. Two vectors $\vec{A}$ and $\vec{B}$ are added together to form a vector $\vec{C}$. The relationship between the magnitudes of the vectors is given by $A + B = C$. Which one of the following statements concerning these vectors is true?

a. $\vec{A}$ and $\vec{B}$ must be displacements.
b. $\vec{A}$ and $\vec{B}$ must have equal lengths.
c. $\vec{A}$ and $\vec{B}$ must point in opposite directions.
d. $\vec{A}$ and $\vec{B}$ must point in the same direction.
e. $\vec{A}$ and $\vec{B}$ must be at right angles to each other.

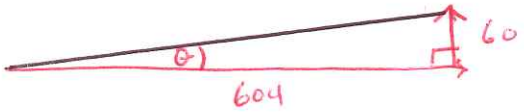
17. A person walks 5.0 km east, followed by 3.0 km north and then another 4.0 km east. Where does he end up?

18. $\vec{a} = (1, 2)$, $\vec{b} = (1, -1)$. Find the magnitude of $\vec{a}$ and $\vec{b}$ and magnitude of $\vec{a} + \vec{b}$.

$a = 2.2$
$b = \sqrt{2}$

$\vec{a} + \vec{b} = (2, 1)$ So magnitude = 2.2

19. Find vector $\vec{F}_1 + \vec{F}_2$ (magnitude and direction) if $\vec{F}_1 = (8N \text{ @ } 138^\circ)$ and $\vec{F}_2 = (12N \text{ @ } 28^\circ)$.



20. A jet moving at 500.0 km/h due east moves into a region where the wind is blowing at 120.0 km/h in a direction 30.0° north of east. What is the new velocity and direction of the aircraft relative to the ground?

a. 607 km/h, 5.67° north of east
b. 620.0 km/h, 7.10° north of east
c. 550.0 km/h, 6.22° north of east
d. 588 km/h, 4.87° north of east

Vector	X-component	y-component
jet	500	0
wind	$120 \cdot \cos(30°)$	$120 \cdot \sin(30°)$
Resultant	604	60

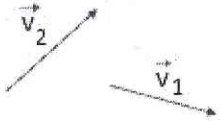
$R = 607 \frac{km}{h}$

$\theta = 5.67°$ N of E

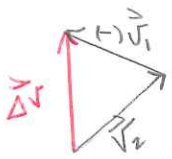
21. A boat is able to move through still water at 20 m/s. It makes a round trip to a town 3.0 km downstream. If the river flows at 5 m/s, the time required for this round trip is:

a. 120 s b. 150 s c. 200 s d. 300 s e. 320 s

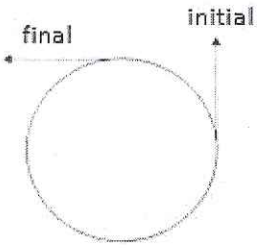
22. In physics we are often interested in finding the *change* in a vector. For example, consider a body whose velocity changes from $\vec{v}_1$ to $\vec{v}_2$. Find vector representing the change in the velocity $\Delta\vec{v} = \vec{v}_2 - \vec{v}_1$.



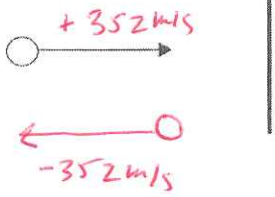
$= \vec{v}_2 + (-)\vec{v}_1$



23. Figure shows the velocity vector of a particle moving in a circle with speed 10 m/s at two separate points. The velocity vector is tangential to the circle. Find the vector representing the *change* in the velocity vector.



24. A molecule with a velocity of 352 m/s collides with a wall as shown and bounces back with the same speed.
(a) What is the change in the molecule's velocity?
(b) What is the change in the speed?



(a) $\Delta V = V_f - V_i = -352 - 352 = -704$ m/s

or 704 $\frac{m}{s}$ (away from wall)

(b) Δ speed = 0

25. A body moves in a circle of radius 3 m with a constant speed of 6.0 m/s. The velocity vector is at all times tangent to the circle. The body starts at A and proceeds to B and then C. Find the change in the velocity vector between A and B and between B and C.