5.1 Cartesian Vectors Worksheet with solutions

This document was composed and formatted by Annie Bernatchez.

The course material originated from www.jensenmath.ca

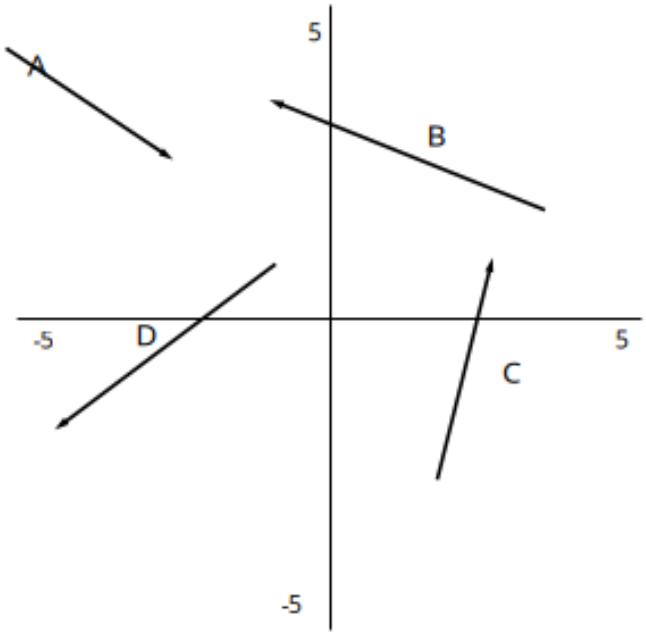
1) Express each vector in terms of the unit vectors $\vec{i}$ and $\vec{j}$.

a) $[-2, 0]$	b) $[0, 3]$	c) $[3, 2]$	d) $[-1, 6]$
$= -2\vec{i}$	$= 3\vec{j}$	$= 3\vec{i} + 2\vec{j}$	$= -\vec{i} + 6\vec{j}$

2) Express each vector as a position vector $[a, b]$.

a) $3\vec{i} + 2\vec{j}$	b) $4\vec{j}$	c) $-7\vec{i} + 3\vec{j}$	d) $-9\vec{i}$
$= [3, 2]$	$= [0, 4]$	$= [-7, 3]$	$= [-9, 0]$

3) Write the coordinates of each Cartesian vector and determine the magnitude.



$\vec{A} = [-3-(-6), 3-5]$ $\vec{A} = [3, -2]$ $\lvert\vec{A}\rvert = \sqrt{(3)^2 + (-2)^2} = \sqrt{13}$	$\vec{B} = [-1-4, 4-2]$ $\vec{B} = [-5, 2]$ $\lvert\vec{B}\rvert = \sqrt{(-5)^2 + (2)^2} = \sqrt{29}$
$\vec{C} = [3-2, 1-(-3)]$ $\vec{C} = [1, 4]$ $\lvert\vec{C}\rvert = \sqrt{(1)^2 + (4)^2} = \sqrt{17}$	$\vec{D} = [-5-(-1), -2-1]$ $\vec{D} = [-4, -3]$ $\lvert\vec{D}\rvert = \sqrt{(-4)^2 + (-3)^2} = \sqrt{25} = 5$

4) Given the vector $\vec{v} = [2, -5]$.

a) State the vertical and horizontal vector components of $\vec{v}$.

Horizontal: $v_x = 2$

Vertical: $v_y = -5$

b) Find two vectors that are collinear with $\vec{v}$.

$2\vec{v} = [2(2), 2(-5)] = [4, -10]$

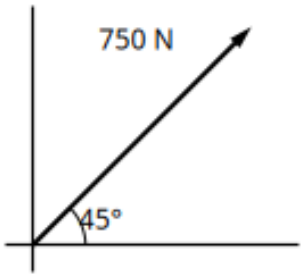
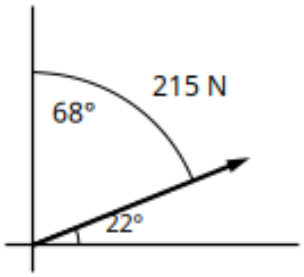
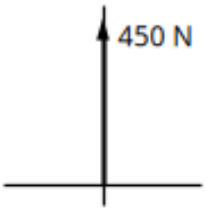
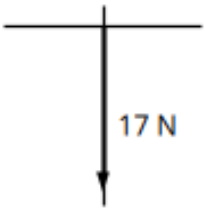
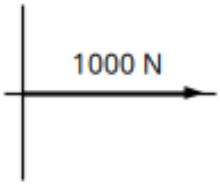
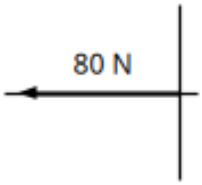
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$3\vec{v} = [3(2),\ 3(-5)] = [6,\ -15]$

5) If $\vec{u} = [-3,\ 5]$ and $\vec{v} = [2,\ 9]$.

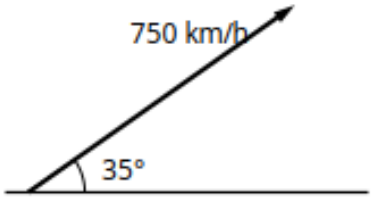
a) $\vec{u} + \vec{v}$ $= [-3 + 2,\ 5 + 9]$ $= [-1,\ 14]$	b) $\hat{u}$ $= \frac{1}{\lvert\vec{u}\rvert}\vec{u} = \frac{1}{\sqrt{34}}[-3,\ 5]$ $= \left[\frac{-3}{\sqrt{34}},\ \frac{5}{\sqrt{34}}\right]$	c) $-3\vec{u} + 4\vec{v}$ $= -3[-3,\ 5] + 4[2,\ 9]$ $= [9,\ -15] + [8,\ 36]$ $= [17,\ 21]$
d) $7\vec{u} + 6\vec{i} - 8\vec{j} - 3\vec{v}$ $= 7(-3\vec{i} + 5\vec{j}) + 6\vec{i} - 8\vec{j} - 3(2\vec{i} + 9\vec{j})$ $= -21\vec{i} + 35\vec{j} + 6\vec{i} - 8\vec{j} - 6\vec{i} - 27\vec{j}$ $= -21\vec{i} + 0\vec{j} = [-21,\ 0]$	e) $\lvert\vec{v}\rvert$ $= \sqrt{(2)^2 + (9)^2}$ $= \sqrt{85}$	f) $\lvert -3\vec{u} - 2\vec{v}\rvert$ $-3\vec{u} - 2\vec{v} = -3[-3,\ 5] - 2[2,\ 9]$ $= [9,\ -15] - [4,\ 18] = [5,\ -33]$ $\lvert -3\vec{u} - 2\vec{v}\rvert = \sqrt{(5)^2 + (-33)^2} = \sqrt{1114}$

6) Write each force as a Cartesian vector.

a) 750 N applied 45° to the horizontal 	b) 215 N applied 68° to the vertical 
$\vec{F} = [750\cos 45,\ 750\sin 45]$	$\vec{F} = [215\cos 22,\ 215\sin 22]$
c) 450 N applied upwards 	d) 17 N applied downwards 
$\vec{F} = [0,\ 450]$	$\vec{F} = [0,\ -17]$
e) 1000 N east 	f) 80 N west 
$\vec{F} = [1000,\ 0]$	$\vec{F} = [-80,\ 0]$

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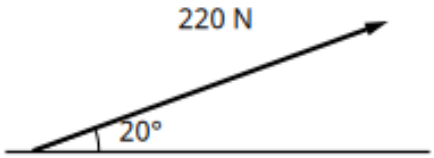
7) An aircraft is travelling at 750 km per hour at an angle of 35° to the level ground below. Find the force in component form as a Cartesian vector.



$\vec{F} = [750\cos 35,\ 750\sin 35]$

$\vec{F} \cong [614.36,\ 430.18]$

8) A mom is pulling a sled exerting a force of 220 N along a rope that makes an angle of 20° to the horizontal. Write this force in component form as a Cartesian vector.



$\vec{F} = [220\cos 20,\ 220\sin 20]$

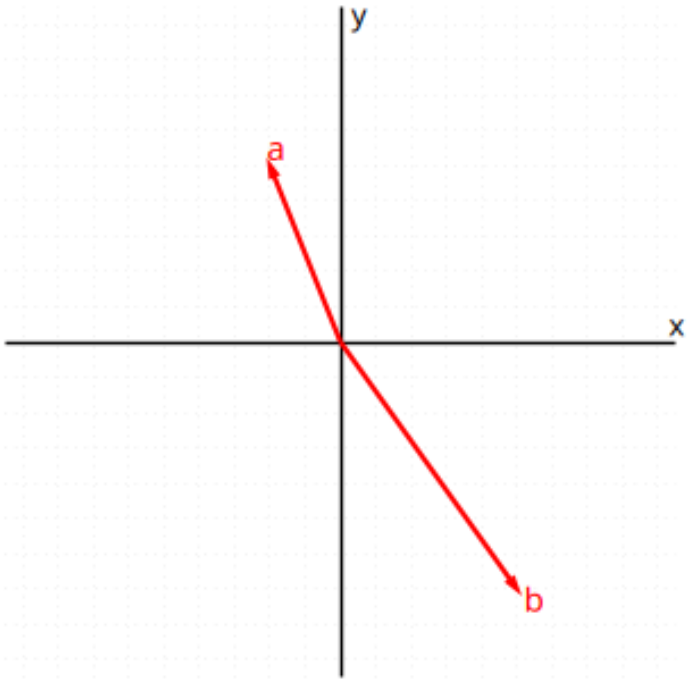
$\vec{F} \cong [206.73,\ 75.24]$

9) Let $\vec{a} = [-2,\ 5]$ and $\vec{b} = [5,\ -7]$.

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9) Let $\vec{a} = [-2, 5]$ and $\vec{b} = [5, -7]$.

a) Plot the two vectors.



b) Which is greater: $|\vec{a} + \vec{b}|$ or $|\vec{a}| + |\vec{b}|$?

$\vec{a} + \vec{b} = [-2 + 5, 5 + (-7)] = [3, -2]$

$|\vec{a} + \vec{b}| = \sqrt{13}$

$|\vec{a}| + |\vec{b}| = \sqrt{29} + \sqrt{74}$

$|\vec{a}| + |\vec{b}| > |\vec{a} + \vec{b}|$

10) Given the points $P(-6, 1)$, $Q(-2, -1)$, and $R(-3, 4)$, find…

a) $\overrightarrow{QP}$	b) $\lvert\overrightarrow{RP}\rvert$	c) perimeter of $\triangle PQR$
$\overrightarrow{QP} = [-6 - (-2), 1 - (-1)]$ $\overrightarrow{QP} = [-4, 2]$	$\lvert\overrightarrow{RP}\rvert = \sqrt{[-6 - (-3)]^2 + (1 - 4)^2}$ $= \sqrt{(-3)^2 + (-3)^2} = \sqrt{18}$ $\lvert\overrightarrow{RP}\rvert = 3\sqrt{2}$	$\lvert\overrightarrow{QP}\rvert = \sqrt{(-4)^2 + (2)^2} = \sqrt{20} = 2\sqrt{5}$ $\lvert\overrightarrow{QR}\rvert = \sqrt{(-1)^2 + (5)^2} = \sqrt{26}$ Perimeter $= 3\sqrt{2} + 2\sqrt{5} + \sqrt{26} \cong 13.8$ units

11) Which vector is NOT collinear with $\vec{a} = [6, -4]$?

$\vec{b} = [3, -2]$, $\vec{c} = [-6, -4]$, $\vec{d} = [-6, 4]$, or $\vec{e} = [-9, 6]$

$\frac{a_x}{b_x} = \frac{a_y}{b_y} : \frac{6}{3} = \frac{-4}{-2} \Rightarrow 2 = 2, \ \vec{a} = 2\vec{b}$

$\frac{a_x}{c_x} = \frac{a_y}{c_y} : \frac{6}{-6} = \frac{-4}{-4} \Rightarrow -1 \neq 1, \ \vec{a}$ and $\vec{c}$ are NOT collinear

$\frac{a_x}{d_x} = \frac{a_y}{d_y} : \frac{6}{-6} = \frac{-4}{4} \Rightarrow -1 = -1, \ \vec{a} = -\vec{d}$

$\frac{a_x}{e_x} = \frac{a_y}{e_y} : \frac{6}{-9} = \frac{-4}{6} \Rightarrow -\frac{2}{3} = -\frac{2}{3}, \ \vec{a} = -\frac{2}{3}\vec{e}$

$\vec{c}$ is NOT collinear with $\vec{a}$.

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