Section 6.3 Vectors in the Plane

- A vector **v** is the collection of all directed line segments that are equivalent to a given directed line segment $\overrightarrow{PQ}$.
- You should be able to *geometrically* perform the operations of vector addition and scalar multiplication.
- The component form of the vector with initial point $P = (p_1, p_2)$ and terminal point $Q = (q_1, q_2)$ is

  $\overrightarrow{PQ} = \langle q_1 - p_1, q_2 - p_2 \rangle = \langle v_1, v_2 \rangle = \mathbf{v}$.
- The magnitude of $\mathbf{v} = \langle v_1, v_2 \rangle$ is given by $\|\mathbf{v}\| = \sqrt{v_1^2 + v_2^2}$.
- You should be able to perform the operations of scalar multiplication and vector addition in component form.
- You should know the following properties of vector addition and scalar multiplication.
  - (a) $\mathbf{u} + \mathbf{v} = \mathbf{v} + \mathbf{u}$
  - (b) $(\mathbf{u} + \mathbf{v}) + \mathbf{w} = \mathbf{u} + (\mathbf{v} + \mathbf{w})$
  - (c) $\mathbf{u} + \mathbf{0} = \mathbf{u}$
  - (d) $\mathbf{u} + (-\mathbf{u}) = \mathbf{0}$
  - (e) $c(d\mathbf{u}) = (cd)\mathbf{u}$
  - (f) $(c + d)\mathbf{u} = c\mathbf{u} + d\mathbf{u}$
  - (g) $c(\mathbf{u} + \mathbf{v}) = c\mathbf{u} + c\mathbf{v}$
  - (h) $1(\mathbf{u}) = \mathbf{u}, 0\mathbf{u} = \mathbf{0}$
  - (i) $\|c\mathbf{v}\| = |c|\,\|\mathbf{v}\|$
- A unit vector in the direction of **v** is given by $\mathbf{u} = \dfrac{\mathbf{v}}{\|\mathbf{v}\|}$.
- The standard unit vectors are $\mathbf{i} = \langle 1, 0 \rangle$ and $\mathbf{j} = \langle 0, 1 \rangle$. $\mathbf{v} = \langle v_1, v_2 \rangle$ can be written as $\mathbf{v} = v_1\mathbf{i} + v_2\mathbf{j}$.
- A vector **v** with magnitude $\|\mathbf{v}\|$ and direction θ can be written as $\mathbf{v} = a\mathbf{i} + b\mathbf{j} = \mathbf{v}(\cos\theta)\mathbf{i} + \mathbf{v}(\sin\theta)\mathbf{j}$ where $\tan\theta = b/a$.

Solutions to Odd-Numbered Exercises

1. $\mathbf{v} = \langle 6 - 2, 5 - 4 \rangle = \langle 4, 1 \rangle = \mathbf{v}$

3. Initial point:(0, 0)
Terminal point: (4, 3)
$\mathbf{v} = \langle 4 - 0, 3 - 0 \rangle = \langle 4, 3 \rangle$
$\|\mathbf{v}\| = \sqrt{4^2 + 3^2} = 5$

5. Initial point: (2, 2)
Terminal point: (−1, 4)
$\mathbf{v} = \langle -1 - 2, 4 - 2 \rangle = \langle -3, 2 \rangle$
$\|\mathbf{v}\| = \sqrt{(-3)^2 + 2^2} = \sqrt{13}$

7. Initial point: (3, −2)
Terminal point: (3, 3)
$\mathbf{v} = \langle 3 - 3, 3 - (-2) \rangle = \langle 0, 5 \rangle$
$\|\mathbf{v}\| = 5$

9. Initial point: $\left(\frac{5}{2}, 1\right)$
Terminal point: $\left(-2, -\frac{3}{2}\right)$
$\mathbf{v} = \left\langle -2 - \frac{5}{2}, -\frac{3}{2} - 1 \right\rangle = \left\langle -\frac{9}{2}, -\frac{5}{2} \right\rangle$
$\|\mathbf{v}\| = \sqrt{\left(-\frac{9}{2}\right)^2 + \left(-\frac{5}{2}\right)^2} = \sqrt{\frac{81 + 25}{4}} = \frac{1}{2}\sqrt{106}$

11. Initial point: $(-3, -5)$

Terminal point: $(5, 1)$

$\mathbf{v} = \langle 5 - (-3), 1 - (-5) \rangle = \langle 8, 6 \rangle$

$\|\mathbf{v}\| = \sqrt{8^2 + 6^2} = \sqrt{100} = 10$

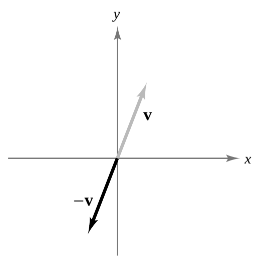
13. Initial point: $(-4.2, 5)$

Terminal point: $(3.7, -12.9)$

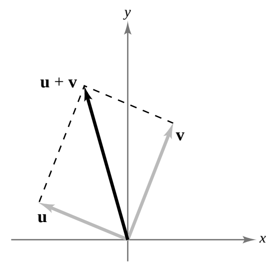
$\mathbf{v} = \langle 3.7, -(-4.2), -12.9 - 5 \rangle = \langle 7.9, -17.9 \rangle$

$\|\mathbf{v}\| = \sqrt{7.9^2 + (-17.9)^2} \approx 19.6$

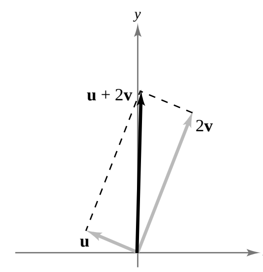
15.



17.



19. $\mathbf{u} + 2\mathbf{v}$



21. $\mathbf{u} = \langle 4, 2 \rangle, \mathbf{v} = \langle 7, 1 \rangle$

(a) $\mathbf{u} + \mathbf{v} = \langle 11, 3 \rangle$

(b) $\mathbf{u} - \mathbf{v} = \langle -3, 1 \rangle$

(c) $2\mathbf{u} - 3\mathbf{v} = \langle 8, 4 \rangle - \langle 21, 3 \rangle = \langle -13, 1 \rangle$

(d) $\mathbf{v} + 4\mathbf{u} = \langle 7, 1 \rangle + \langle 16, 8 \rangle = \langle 23, 9 \rangle$

23. $\mathbf{u} = \langle -5, -2 \rangle, \mathbf{v} = \langle 1, -3 \rangle$

(a) $\mathbf{u} + \mathbf{v} = \langle -4, -5 \rangle$

(b) $\mathbf{u} - \mathbf{v} = \langle -6, 1 \rangle$

(c) $2\mathbf{u} - 3\mathbf{v} = \langle -10, -4 \rangle - \langle 3, -9 \rangle = \langle -13, 5 \rangle$

(d) $\mathbf{v} + 4\mathbf{u} = \langle 1, -3 \rangle + \langle -20, -8 \rangle$
$= \langle -19, -11 \rangle$

25. $\mathbf{u} = \mathbf{i} + \mathbf{j}, \mathbf{v} = 2\mathbf{i} - 3\mathbf{j}$

(a) $\mathbf{u} + \mathbf{v} = 3\mathbf{i} - 2\mathbf{j}$

(b) $\mathbf{u} - \mathbf{v} = -\mathbf{i} + 4\mathbf{j}$

(c) $2\mathbf{u} - 3\mathbf{v} = (2\mathbf{i} + 2\mathbf{j}) - (6\mathbf{i} - 9\mathbf{j})$
$= -4\mathbf{i} + 11\mathbf{j}$

(d) $\mathbf{v} + 4\mathbf{u} = (2\mathbf{i} - 3\mathbf{j}) + (4\mathbf{i} + 4\mathbf{j})$
$= 6\mathbf{i} + \mathbf{j}$

27. $\|\langle 6, 0 \rangle\| = 6$

unit vector $= \frac{1}{6}\langle 6, 0 \rangle = \langle 1, 0 \rangle$

29. $\|\mathbf{v}\| = \|\langle -4, 4 \rangle\| = \sqrt{16 + 16} = 4\sqrt{2}$

unit vector $= \dfrac{1}{4\sqrt{2}}\langle -4, 4 \rangle = \left\langle -\dfrac{1}{\sqrt{2}}, \dfrac{1}{\sqrt{2}} \right\rangle = \left\langle -\dfrac{\sqrt{2}}{2}, \dfrac{\sqrt{2}}{2} \right\rangle$

31. $\|\mathbf{v}\| = \sqrt{(-24)^2 + 7^2} = 25$

unit vector $= \dfrac{1}{25}\langle -24, -7 \rangle = \left\langle -\dfrac{24}{25}, -\dfrac{7}{25} \right\rangle$

33. $\mathbf{u} = \dfrac{1}{\|\mathbf{v}\|}\mathbf{v}$

$= \dfrac{1}{\sqrt{16 + 9}}(4\mathbf{i} - 3\mathbf{j}) = \dfrac{1}{5}(4\mathbf{i} - 3\mathbf{j})$

$= \dfrac{4}{5}\mathbf{i} - \dfrac{3}{5}\mathbf{j}$

35. $\mathbf{u} = \dfrac{1}{2}(2\mathbf{j}) = \mathbf{j}$

37. $5\left(\frac{1}{\|\mathbf{v}\|}\mathbf{v}\right) = 5\left(\frac{1}{\sqrt{3^2 + 3^2}}\langle 3, 3\rangle\right)$

$= 5\left(\frac{1}{3\sqrt{2}}\langle 3, 3\rangle\right)$

$= \left\langle \frac{5}{\sqrt{2}}, \frac{5}{\sqrt{2}} \right\rangle$

$= \left\langle \frac{5\sqrt{2}}{2}, \frac{5\sqrt{2}}{2} \right\rangle$

39. $7\left(\frac{1}{\|\mathbf{v}\|}\mathbf{v}\right) = 7\left(\frac{1}{\sqrt{3^2 + 4^2}}\langle 3, 4\rangle\right)$

$= \frac{7}{5}\langle 3, 4\rangle$

$= \left\langle \frac{21}{5}, \frac{28}{5} \right\rangle$

41. $8\left(\frac{1}{\|\mathbf{v}\|}\mathbf{v}\right) = 8\left(\frac{1}{2}\langle -2, 0\rangle\right)$

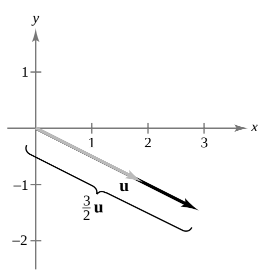
$= 4\langle -2, 0\rangle$

$= \langle -8, 0\rangle = -8\mathbf{i}$

43. $\mathbf{v} = \frac{3}{2}\mathbf{u}$

$= \frac{3}{2}(2\mathbf{i} - \mathbf{j})$

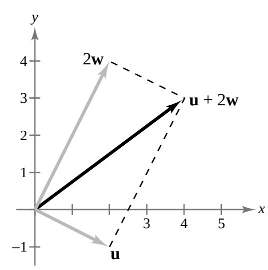
$= 3\mathbf{i} - \frac{3}{2}\mathbf{j} = \langle 3, -\frac{3}{2}\rangle$



45. $\mathbf{v} = \mathbf{u} + 2\mathbf{w}$

$= (2\mathbf{i} - \mathbf{j}) + 2(\mathbf{i} + 2\mathbf{j})$

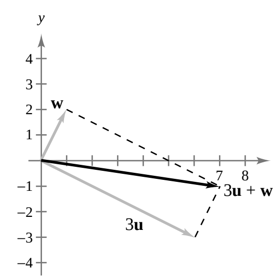
$= 4\mathbf{i} + 3\mathbf{j} = \langle 4, 3\rangle$



47. $\mathbf{v} = (3\mathbf{u} + \mathbf{w})$

$= (6\mathbf{i} - 3\mathbf{j} + \mathbf{i} + 2\mathbf{j})$

$= \langle 7, -1\rangle$



49. $\mathbf{v} = 5(\cos 30°\mathbf{i} + \sin 30\mathbf{j})$

$\|\mathbf{v}\| = 5, \ \theta = 30°$

51. $\mathbf{v} = 6\mathbf{i} - 6\mathbf{j}$

$\|\mathbf{v}\| = \sqrt{6^2 + (-6)^2} = \sqrt{72} = 6\sqrt{2}$

$\tan\theta = \frac{-6}{6} = -1$

Since $\mathbf{v}$ lies in Quadrant IV, $\theta = 315°$.

53. $\mathbf{v} = -2\mathbf{i} + 5\mathbf{j}$

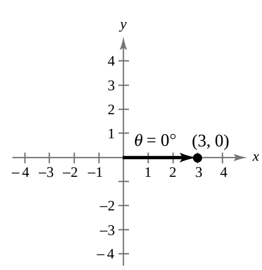
$\|\mathbf{v}\| = \sqrt{(-2)^2 + 5^2} = \sqrt{29}$

$\tan\theta = -\frac{5}{2}$

Since $\mathbf{v}$ lies in Quadrant II,
$\theta \approx 111.8°$.

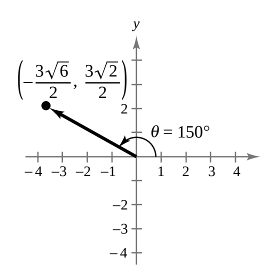
55. $\mathbf{v} = \langle 3\cos 0°, 3\sin 0°\rangle$

$= \langle 3, 0\rangle$



57. $\mathbf{v} = \langle 3\sqrt{2}\cos 150°,$
$3\sqrt{2}\sin 150°\rangle$

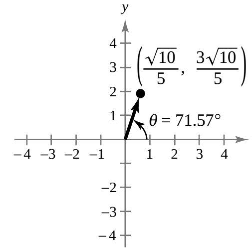
$= \left\langle -\frac{3\sqrt{6}}{2}, \frac{3\sqrt{2}}{2} \right\rangle$



59. $\mathbf{v} = 2\left(\frac{1}{\sqrt{3^2 + 1^2}}\right)(\mathbf{i} + 3\mathbf{j})$

$= \frac{2}{\sqrt{10}}(\mathbf{i} + 3\mathbf{j})$

$= \frac{\sqrt{10}}{5}\mathbf{i} + \frac{3\sqrt{10}}{5}\mathbf{j} = \left\langle \frac{\sqrt{10}}{5}, \frac{3\sqrt{10}}{5} \right\rangle$



61. $\mathbf{u} = \langle 5\cos 60°, 5\sin 60°\rangle = \left\langle \frac{5}{2}, \frac{5\sqrt{3}}{2}\right\rangle$

$\mathbf{v} = \langle 5\cos 90°, 5\sin 90°\rangle = \langle 0, 5\rangle$

$\mathbf{u} + \mathbf{v} = \left\langle \frac{5}{2}, \frac{5\sqrt{3}}{2}\right\rangle + \langle 0, 5\rangle = \left\langle \frac{5}{2}, 5 + \frac{5}{2}\sqrt{3}\right\rangle$

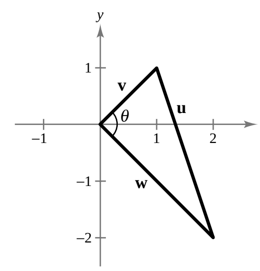
63. $\mathbf{u} = \langle 20\cos 45°, 20\sin 45°\rangle = \langle 10\sqrt{2}, 10\sqrt{2}\rangle$

$\mathbf{v} = \langle 50\cos 150°, 50\sin 150°\rangle = \langle -25\sqrt{3}, 25\rangle$

$\mathbf{u} + \mathbf{v} = \langle 10\sqrt{2} - 25\sqrt{3}, 10\sqrt{2} + 25\rangle$

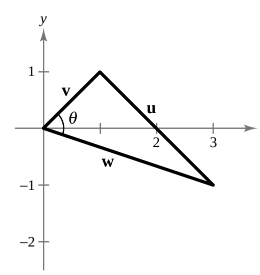
65.

$$\mathbf{v} = \mathbf{i} + \mathbf{j}$$
$$\mathbf{w} = 2(\mathbf{i} - \mathbf{j})$$
$$\mathbf{u} = \mathbf{v} - \mathbf{w} = -\mathbf{i} + 3\mathbf{j}$$
$$\|\mathbf{v}\| = \sqrt{2}$$
$$\|\mathbf{w}\| = 2\sqrt{2}$$
$$\|\mathbf{v} - \mathbf{w}\| = \sqrt{10}$$
$$\cos\alpha = \frac{\|\mathbf{v}\|^2 + \|\mathbf{w}\|^2 - \|\mathbf{v} - \mathbf{w}\|^2}{2\|\mathbf{v}\|\,\|\mathbf{w}\|} = \frac{2 + 8 - 10}{2\sqrt{2} \cdot 2\sqrt{2}} = 0$$
$$\alpha = 90°$$

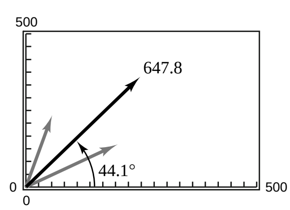


67.

$$\mathbf{v} = \mathbf{i} + \mathbf{j}$$
$$\mathbf{w} = 3\mathbf{i} - \mathbf{j}$$
$$\mathbf{u} = \mathbf{v} - \mathbf{w} = -2\mathbf{i} + 2\mathbf{j}$$
$$\cos\alpha = \frac{\|\mathbf{v}\|^2 + \|\mathbf{w}\|^2 - \|\mathbf{v} - \mathbf{w}\|^2}{2\|\mathbf{v}\|\,\|\mathbf{w}\|} = \frac{2 + 10 - 8}{2\sqrt{2}\,\sqrt{10}} \approx 0.4472$$
$$\alpha = 63.4°$$



69.



$$\mathbf{u} = 400\cos 25°\mathbf{i} + 400\sin 25°\mathbf{j}$$
$$\mathbf{v} = 300\cos 70°\mathbf{i} + 300\sin 70°\mathbf{j}$$
$$\mathbf{u} + \mathbf{v} \approx 465.13\mathbf{i} + 450.96\mathbf{j}$$
$$\|\mathbf{u} + \mathbf{v}\| \approx \sqrt{(465.13)^2 + (450.96)^2} \approx 647.8$$
$$\alpha = \arctan\left(\frac{450.96}{465.13}\right) \approx 44.1°$$

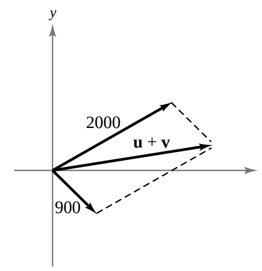
71. Force One: $\mathbf{u} = 45\mathbf{i}$

Force Two: $\mathbf{v} = 60\cos\theta\mathbf{i} + 60\sin\theta\mathbf{j}$

Resultant Force: $\mathbf{u} + \mathbf{v} = (45 + 60\cos\theta)\mathbf{i} + 60\sin\theta\mathbf{j}$

$$\|\mathbf{u} + \mathbf{v}\| = \sqrt{(45 + 60\cos\theta)^2 + (60\sin\theta)^2} = 90$$
$$2025 + 5400\cos\theta + 3600 = 8100$$
$$5400\cos\theta = 2475$$
$$\cos\theta = \frac{2475}{5400} \approx 0.4583$$
$$\theta \approx 62.7°$$

73.
$$\mathbf{u} = (2000\cos 30^\circ)\,\mathbf{i} + (2000\sin 30^\circ\mathbf{j})$$
$$\approx 1732.05\mathbf{i} + 1000\mathbf{j}$$
$$\mathbf{v} = (900\cos(-45^\circ))\mathbf{i} + (900\sin(-45^\circ)\mathbf{j})$$
$$\approx 636.4\mathbf{i} + -636.4\mathbf{j}$$
$$\mathbf{u}+\mathbf{v} \approx 2368.4\mathbf{i} + 363.6\mathbf{j}$$
$$\|\mathbf{u}+\mathbf{v}\| \approx \sqrt{(2368.4)^2 + (363.6)^2} \approx 2396.19$$
$$\tan\theta = \frac{363.6}{2368.4} \approx 0.1535 \implies \theta \approx 8.7^\circ$$



75. Horizontal component of velocity: $70\cos 40^\circ \approx 53.62$ ft/sec
Vertical component of velocity: $70\sin 40^\circ \approx 45.0$ ft/sec

77. Rope $\overrightarrow{AC}$: $\mathbf{u} = 10\mathbf{i} - 24\mathbf{j}$

The vector lies in Quadrant IV and its reference angle is $\arctan\left(\frac{12}{5}\right)$.

$$\mathbf{u} = \|\mathbf{u}\|\left[\cos\left(\arctan\tfrac{12}{5}\right)\mathbf{i} - \sin\left(\arctan\tfrac{12}{5}\right)\mathbf{j}\right]$$

Rope $\overrightarrow{BC}$: $\mathbf{v} = -20\mathbf{i} - 24\mathbf{j}$

The vector lies in Quadrant III and its reference angle is $\arctan\left(\frac{6}{5}\right)$.

$$\mathbf{v} = \|\mathbf{v}\|\left[-\cos\left(\arctan\tfrac{6}{5}\right)\mathbf{i} - \sin\left(\arctan\tfrac{6}{5}\right)\mathbf{j}\right]$$

Resultant: $\mathbf{u}+\mathbf{v} = -5000\mathbf{j}$

$$\|\mathbf{u}\|\cos\left(\arctan\tfrac{12}{5}\right) - \|\mathbf{v}\|\cos\left(\arctan\tfrac{6}{5}\right) = 0$$
$$-\|\mathbf{u}\|\sin\left(\arctan\tfrac{12}{5}\right) - \|\mathbf{v}\|\sin\left(\arctan\tfrac{6}{5}\right) = -5000$$

Solving this system of equations yields: $T_{AC} = \|\mathbf{u}\| \approx 3611.1$ pounds
$T_{BC} = \|\mathbf{v}\| \approx 2169.5$ pounds

79. (a) Tow line 1: $\mathbf{u} = \|\mathbf{u}\|(\cos 20^\circ\mathbf{i} + \sin 20^\circ\mathbf{j})$

Tow line 2: $\mathbf{v} = \|\mathbf{u}\|(\cos(-20^\circ)\mathbf{i} + \sin(-20^\circ)\mathbf{j})$

Resultant: $\mathbf{u}+\mathbf{v} = 6000\mathbf{i} = [\|\mathbf{u}\|\cos 20^\circ + \|\mathbf{u}\|\cos(-20^\circ)]\mathbf{i}$

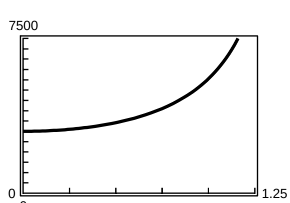
$$\implies 6000 = 2\|\mathbf{u}\|\cos 20^\circ$$
$$\implies \|\mathbf{u}\| \approx 3192.5 \text{ lb}$$

(b) $\mathbf{u}+\mathbf{v} = 6000\mathbf{i} = 2\|\mathbf{u}\|\cos\theta \implies T = \|\mathbf{u}\| = 3000\sec\theta$. Domain: $0^\circ \le \theta <$ ′′°

(c)

θ	10°	20°	30°	40°	50°	60°
T	3046.3	3192.5	3464.1	2916.2	4667.2	6000.0

(d)



(e) The tension increases because the component in the direction of the motion of the barge decreases.

81. Airspeed: $\mathbf{v} = 860(\cos 302°\mathbf{i} + \sin 302°\mathbf{j})$

Groundspeed: $\mathbf{u} = 800(\cos 310°\mathbf{i} + \sin 310°\mathbf{j})$

$\mathbf{w} + \mathbf{v} = \mathbf{u}$

$\mathbf{w} = \mathbf{u} - \mathbf{v} = 800(\cos 310°\mathbf{i} + \sin 310°\mathbf{j}) - 860(\cos 302°\mathbf{i} + \sin 302°\mathbf{j}) \approx 58.50\mathbf{i} + 116.49\mathbf{j}$

$\|\mathbf{w}\| = \sqrt{58.50^2 + 116.49^2} \approx 130.35$ km/hr

$\theta = \arctan\left(\dfrac{116.49}{58.50}\right) \approx 63.3°$

Direction: N 26.7° E

83. (a) $\mathbf{u} = 220\mathbf{i}, \quad \mathbf{v} = 150 \cos 30°\mathbf{i} + 150 \sin 30°\mathbf{j}$

$\mathbf{u} + \mathbf{v} = \left(220 + 75\sqrt{3}\right)\mathbf{i} + 75\mathbf{j}$

$\|\mathbf{u} + \mathbf{v}\| = \sqrt{\left(220 + 75\sqrt{3}\right)^2 + 75^2} \approx 357.85$ newtons

$\tan \theta = \dfrac{75}{220 + 75\sqrt{3}} \implies \theta \approx 12.1°$

(b) $\mathbf{u} + \mathbf{v} = 220\mathbf{i} + (150 \cos \theta\mathbf{i} + 150 \sin \theta\mathbf{j})$

$M = \|\mathbf{u} + \mathbf{v}\| = \sqrt{(220^2 + 150^2(\cos^2 \theta + \sin^2 \theta) + 2(220)(150) \cos \theta}$

$= \sqrt{70{,}900 + 66{,}000 \cos \theta}$

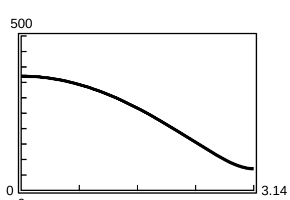
$= 10\sqrt{709 + 660 \cos \theta}$

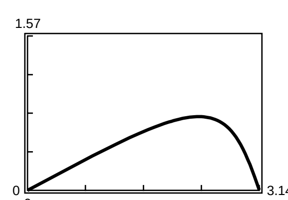
$\alpha = \arctan\left(\dfrac{15 \sin \theta}{22 + 15 \cos \theta}\right)$

(c)

θ	0°	30°	60°	90°	120°	150°	180°
M	370.0	357.9	322.3	266.3	194.7	117.2	70.0
α	0°	12.1°	23.8°	34.3°	41.9°	39.8°	0°

(d)





(e) For increasing θ the two vectors tend to work against each other resulting in a decrease in the magnitude of the resultant.

85. True. See page 444

87. True. In fact, $a = b = 0$.

89. (a) The angle between them is 0°.

(b) The angle between them is 180°.

(c) No. At most it can be equal to the sum when the angle between them is 0°.

91. Let $\mathbf{v} = (\cos \theta)\mathbf{i} + (\sin \theta)\mathbf{j}$

$\|\mathbf{v}\| = \sqrt{\cos^2 \theta + \sin^2 \theta} = \sqrt{1} = 1$

Therefore, $\mathbf{v}$ is a unit vector for any value of θ.

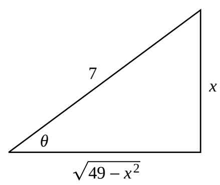
93. $\mathbf{u} = \langle 5 - 1, 2 - 6 \rangle = \langle 4, -4 \rangle$

$\mathbf{v} = \langle 9 - 4, 4 - 5 \rangle = \langle 5, -1 \rangle$

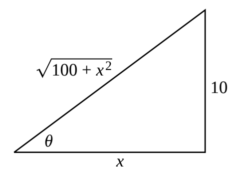
$\mathbf{u} - \mathbf{v} = \langle -1, -3 \rangle$

$\mathbf{v} - \mathbf{u} = \langle 1, 3 \rangle$

95. $\sin\theta = \dfrac{x}{7} \implies \sqrt{49 - x^2} = 7\cos\theta$



97. $\cot\theta = \dfrac{x}{10} \implies \sqrt{x^2 + 100} = 10 \cdot \csc\theta$

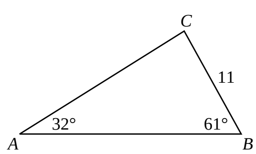


99. Given: $A = 32°, a = 11, B = 61°$

$C = 180° - 32° - 61° = 87°$

$b = \dfrac{a}{\sin A}(\sin B) = \dfrac{11}{\sin 32°}(\sin 61°) \approx 18.16$

$c = \dfrac{a}{\sin A}(\sin C) = \dfrac{11}{\sin 32°}(\sin 87°) \approx 20.73$



101. Given: $a = 12, b = 15, c = 24$

$\cos A = \dfrac{b^2 + c^2 - a^2}{2bc} = \dfrac{15^2 + 24^2 - 12^2}{2(15)(24)} = 0.9125 \implies A \approx 24.1°$

$\sin B = \dfrac{b \sin A}{a} \approx 0.5104 \implies B \approx 30.7°$

$C = 180° - 24.1° - 30.7° = 125.2°$