Name KEY

Problem 1: (33 Points)

Three vectors $\vec{V}_1 = 4.0\hat{i} - 8.0\hat{j}$, $\vec{V}_2 = \hat{i} + \hat{j}$, and $\vec{V_3} = -3.0\hat{i} + \hat{j}$

Determine the **magnitude and direction** of

(*a*) $\vec{V}_1$,

$|\vec{V}_1| = \sqrt{(4.0)^2 + (-8.0)^2} = 8.95$ units

$\theta = \tan^{-1}\left(\frac{-8.0}{4.0}\right) = -63.43°$

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(*b*) $\vec{V}_2$,

$|\vec{V}_2| = \sqrt{(1.0)^2 + (1.0)^2} = 1.414$ units

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

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(c) $\vec{V_3}$,

$|\vec{V}_3| = \sqrt{(-3.0)^2 + (1.0)^2} = 3.17$ units

$\theta = \tan^{-1}\left(\frac{1.0}{-3.0}\right) = -18.41°$

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(*b*) Determine the **magnitude and direction** of

$\vec{V_1} - 2\vec{V_2} = (4.0\hat{i} - 8.0\hat{j}) - 2(\hat{i} + \hat{j}) = (4.0\hat{i} - 2.0\hat{i}) - 8.0\hat{j} - 2\hat{j}$

$\vec{V}_1 - 2\vec{V}_2 = 2.0\hat{i} - 10\hat{j}$

$|\vec{V}_1 - 2\vec{V}_2| = \sqrt{(2.0)^2 + (-10)^2} = 10.20$ units

$\theta = \tan^{-1}\left(\frac{-10}{2.0}\right) = -78.70°$

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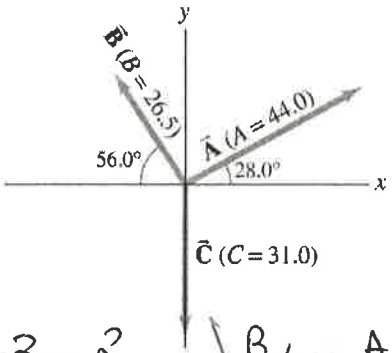
Problem 2: (34 Points)

(II) Three vectors are shown in figure below. Their magnitudes are given in arbitrary units.

(a) determine $\vec{B} - \vec{A}$.



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$\vec{B} - \vec{A} = ?$

$\vec{A}$: $A_x = A\cos\theta = 44\cos 28 = 38.85$ units; $A_y = A\sin\theta = 44\sin 28 = 20.66$ units

$\vec{B}$: $B_x = -B\cos\theta = -26.5\cos 56 = -14.82$ units; $B_y = B\sin\theta = 26.5\sin 5 = 21.97$ units

$\vec{B} - \vec{A}$: $B_x - A_x = -14.82 - 38.84 = -53.67$ units; $B_y - A_x = 21.97 - 20.66 = 1.31$ units

$\vec{B} - \vec{A} = (-53.67\,\hat{i} + 1.31\,\hat{j})$ units

$|\vec{B} - \vec{A}| = \sqrt{(-53.67)^2 + (1.31)^2} = 53.70$ units

$\theta = \tan^{-1}\left(\frac{1.31}{-53.67}\right) = 1.4°$ above $-x$ axis

(b) Determine $\vec{A} - \vec{B}$ without using your answer in (a). Then compare your results and see if they are opposite.

$A_x - B_x = 38.85 - (14.82) = 53.67$ units

$A_y - B_y = 20.66 - 21.97 = -1.31$ units

$|\vec{A} - \vec{B}| = \sqrt{(53.67)^2 + (-1.31)^2} = 53.7°$

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$\theta = \tan^{-1}\left(\frac{-1.31}{53.7}\right) = -1.4$ below $+X$ axis

$\vec{A} - \vec{B} = (53.67\,\hat{i} - 1.31\,\hat{j})$ units

notice that $\vec{A} - \vec{B} = -(\vec{B} - \vec{A})$; same magnitude but direction is different.

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Problem 3: (33 Points)

The position of a ball rolling in a straight line is given by $x = 2.0 - 3.6\,t + 1.1\,t^2$, where x is in meters and t in seconds.

(a) Determine the position of the ball at t = 1.0 s, and 3.0 s.

$x(t=1.0s) = 2.0 - 3.6(1.0s) + 1.1(1.0s)^2 = -0.5m$

$x(t=3.0s) = 2.0 - 3.6(3.0s) + 1.1(3.0s)^2 = 1.1m$

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(b) What is the average velocity over the interval t =1.0s to t =3.0s

$$v_{av} = \frac{\Delta x}{\Delta t} = \frac{x(3.0s) - x(1.0s)}{3.0s - 1.0s} = \frac{1.1m - (-0.5m)}{2.0s} = 0.8m/s$$

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(c) What is its instantaneous velocity at t =2.0s and at t =3.0s

$$v_{inst} = \frac{dx}{dt} = -3.6 + 2.2t$$

$v_{ins}(2.0s) = -3.6 + 2.2(2.0s) = 0.8m/s$

$v_{ins}(3.0s) = -3.6 + 2.2(3.0s) = 3.0m/s$

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