Chapter 3 Discussion
2D Kinematics, Vectors

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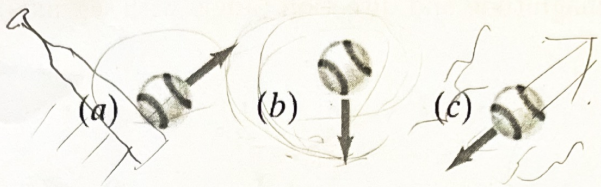
1. A baseball player hits a ball that soars high into the air. After the ball has left the bat, and while it is traveling upward, what is the direction of acceleration? Ignore air resistance. Can you think of what vector quantities the other two arrows might represent?

(b) is the answer



(a) direction can represent when bat is keep pushing ball. so when the player keeps swining to hit the ball futher

(c) can be air resistance when ball is flying exact opposite direction.

2. Vector $\vec{A}$ has components $A_x = 6$ and $A_y = 9$. Vector $\vec{B}$ has components $B_x = 7$ and $B_y = -9$. Vector $\vec{C}$ has components $C_x = 0$, $C_y = -6$.

   (a) Draw these three vectors at the origin of a coordinate plane.

   (b) Determine the components of the following vectors:

   i. $\vec{A} + \vec{B} = \boxed{(13, 0)}$

   ii. $\vec{A} - 2\vec{C} = (6, 9) - 2(0, -6) = \boxed{(6, 21)}$

   iii. $\vec{A} + \vec{B} - \vec{C} = \boxed{(13, 6)}$

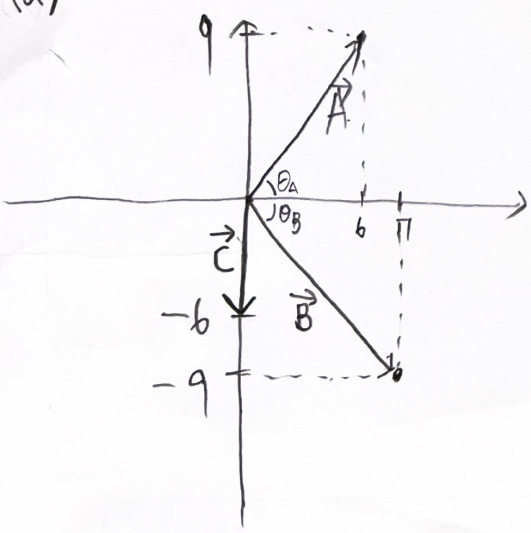
   iv. $\vec{A} + \frac{1}{2}\vec{B} - 3\vec{C} = (6, 9) + \frac{1}{2}(7, -9) - 3(0, -6) = (6 + \frac{7}{2} - 0, 9 - \frac{9}{2} + 18) = \boxed{(\frac{19}{2}, \frac{45}{2})}$

   (c) What are the magnitudes of the three vectors? What is the magnitude of $\vec{A} + \vec{B}$?

   (d) What is $\vec{A} \cdot \vec{B}$? What is $\vec{C} \cdot (\vec{A} + \vec{B})$? $\boxed{\vec{A} \cdot \vec{B} = -38.9}$, $\boxed{\vec{C} \cdot (\vec{A} + \vec{B}) = 0}$

   (e) What is the angle between $\vec{A}$ and $\vec{B}$? Between $\vec{A}$ and $\vec{C}$? angle between $\vec{A}, \vec{B} = 108.4°$; " $\vec{A}, \vec{C} = 146.3°$

(a)



(c) $|A| = \sqrt{6^2 + 9^2} = 3\sqrt{13}$

$|B| = \sqrt{7^2 + (-9)^2} = \sqrt{130}$

$|C| = 6$

$|\vec{A} + \vec{B}| = 13$

90
+6.3

(d) $\sin\theta_A = \frac{9}{3\sqrt{13}}$, $\theta_A = 56.3°$

$\sin\theta_B = \frac{9}{\sqrt{130}}$, $\theta_B = 52.1°$

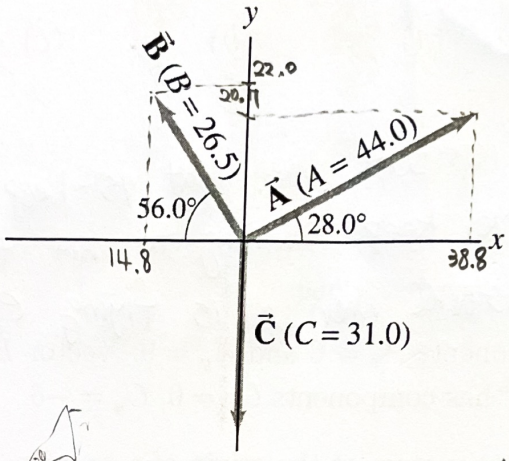
$\vec{A} \cdot \vec{B} = |A||B|\cos\theta = 3\sqrt{13} \times \sqrt{130} \times \cos(108.4°) = \boxed{-38.9}$

3. Three vectors are shown below, and their magnitudes are given in arbitrary units (perhaps these are forces acting on an object). Find the *resultant* (sum) of the vectors and give your answer each of the following forms:

   (a) One of the matrix forms of components. (53.6, 11.7)

   (b) One of the unit vector forms of components. $\left\langle \frac{53.6}{54.86}, \frac{11.7}{54.86} \right\rangle$

   (c) In terms of magnitude and direction (angle with $+x$ axis). $\boxed{54.86, 12.3°}$



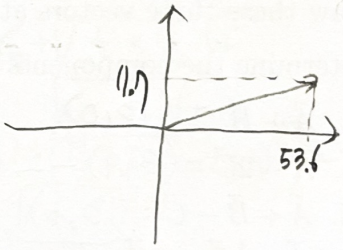
$\vec{A} = (38.8, 20.7)$

$\vec{B} = (14.8, 22.0)$

$\vec{C} = (0, -31.0)$

$\vec{A} + \vec{B} + \vec{C} = (53.6, 11.7)$

$53.6\hat{i} + 11.7\hat{j}$



$|A+B+C| = \sqrt{2872.96 + 136.89}$

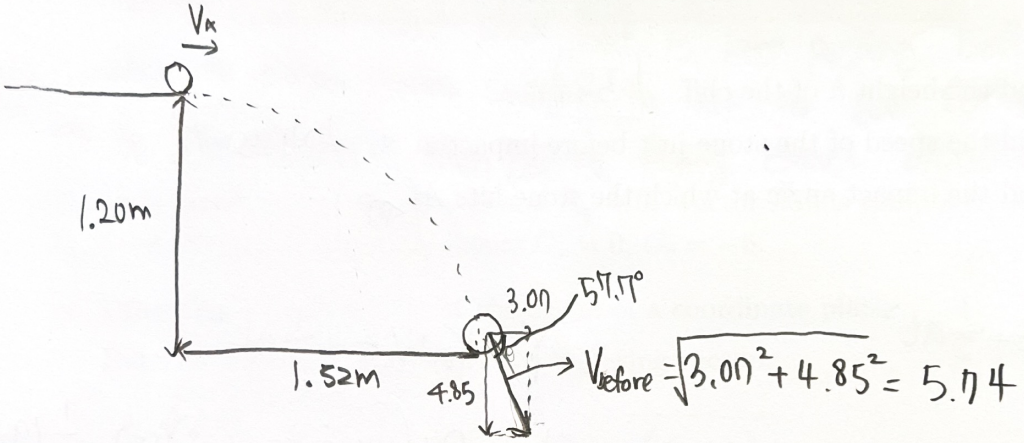
$= \boxed{54.86}$

4. A small ball rolls horizontally off the edge of a tabletop that is 1.20 m high. It strikes the floor at a point 1.52 m horizontally from the table edge.

   (a) How long is the ball in the air? 0.495s

   (b) What is its speed at the instant it leaves the table? 3.07m/s

   (c) What is the ball's *velocity* right before it hits the ground? 5.74m/s, (angle with +x axis) −57.7°



$x = x_0 + V_0 t + \frac{1}{2}at^2$

$1.52 = 0 + V_0 t + 0$

$y = y_0 + V_0 t + \frac{1}{2}at^2$

$0 = 1.20 + 0 - \frac{1}{2}gt^2$

$1.20 = \frac{1}{2}gt^2$

$\sqrt{\frac{2.40}{9.8}} = t$

$0.495s = t$

$1.52 = 0 + V_0\sqrt{\frac{2.40}{9.8}}$

$V_0 = 3.07 m/s$

(c)

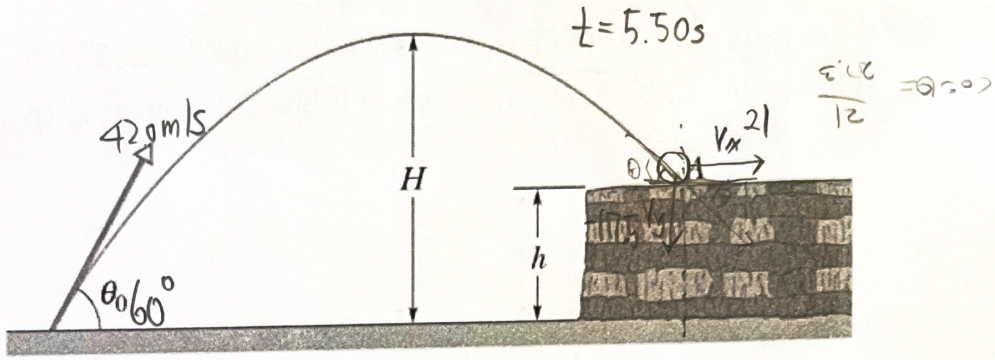
$V_x = V_0 + at$

$V_x = 3.07 m/s$

$V_y = V_0 + at$

$V_y = 0 - 9.8(0.495s) = -4.85 m/s$

5. In the figure, a stone is projected at a cliff of height h with an initial speed of $v_0 = 42.0$ m/s directed at an angle $\theta_0 = 60.0°$ above the horizontal. The stone strikes point A 5.50 s after launching.



(a) Find the height h of the cliff. $\boxed{52}$

(b) Find the speed of the stone just before impact at A. $\boxed{27.3 m/s}$

(c) Find the impact angle at which the stone hits A. $\boxed{40°}$

$X = X_0 + V_0 t + \frac{1}{2}at^2$

$Y = Y_0 + V_0 t + \frac{1}{2}at^2$

$h = 0 + (42.0 \sin 60°)(5.50) - \frac{1}{2}(9.8)(5.50)^2$

$h = 0 + 200 - 148$

$\boxed{h = 52}$

$V_x = V_0 + at$

$V_x = 42 \cos 60 + 0$

$= 21 m/s$

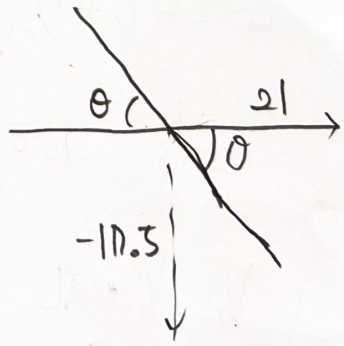
$V_y = V_0 + at$

$V_y = 42 \sin 60 - (9.8)(5.50)$

$V_y = -17.5$

$V_{before} = \sqrt{21^2 + (-17.5)^2} = \boxed{27.3 m/s}$

(c)



$\cos\theta = \frac{21}{27.3} = \boxed{40°}$