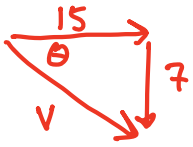
ABRHS PHYSICS (H) NAME: KEY

Vector Problems

1. A bird has a velocity of 15**i** – 7**j** m/s. What is its speed and direction?

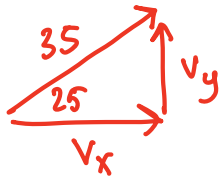


$V^2 = 15^2 + 7^2$ $\quad \tan\theta = \frac{7}{15}$ $\quad \theta = 25°$

$V = 16.6$ m/s

So Direction $= -25°$ or $335°$

2. A tennis ball hits a wall with a velocity of 35 m/s at an angle of 25° above the horizontal. What is its velocity in component form?



$V_x = 35 \cos 25 = 31.7$

$V_y = 35 \sin 25 = 14.8$

$\vec{V} = 31.7\hat{i} + 14.8\hat{j}$

3. The initial position of a dancer is –6**i** + 12**j**. The dancer travels for 15 seconds, and has a final position of 4**i** + 18**j**.
   a. What was the displacement vector? (Worded another way, what was the change in position?)

$\vec{r}_i = -6\hat{i} + 12\hat{j}$

$\vec{r}_f = 4\hat{i} + 18\hat{j}$

$t = 15$ s

$\Delta\vec{r} = \vec{r}_f - \vec{r}_i$

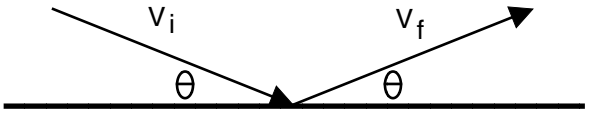
$= (4\hat{i} + 18\hat{j}) - (-6\hat{i} + 12\hat{j})$

$\Delta\vec{r} = 10\hat{i} + 6\hat{j}$ m

   b. What was the average velocity of the dancer?

$\vec{V}_{ave} = \frac{\Delta\vec{r}}{t} = \frac{10\hat{i} + 6\hat{j}}{15} = 0.67\hat{i} + 0.4\hat{j}$ m/s

4. A pool ball bounces off the side of the pool table as shown. If $v_i = v_f = 5$ m/s and $\theta_i = \theta_f = 30°$,



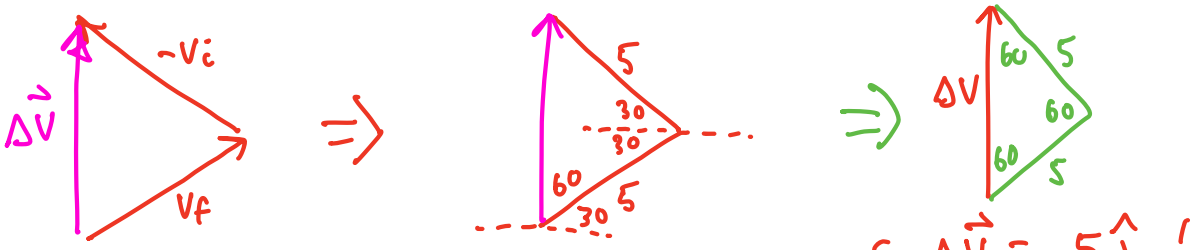
   a. In unit-vector form, what is the change in velocity of the pool ball?

$\vec{V}_i = 5\cos 30\hat{i} - 5\sin 30\hat{j}$

$V_f = 5\cos 30\hat{i} + 5\sin 30\hat{j}$

$\Delta\vec{V} = \vec{V}_f - \vec{V}_i = (4.33 - 4.33)\hat{i} + (2.5 - (-2.5))\hat{j} = 0\hat{i} + 5\hat{j}$ m/s

   b. Draw a vector diagram showing Δ**v**.



So $\Delta\vec{V} = 5\hat{j}$!

Vector Problems

5. Another pool ball hits the side of the table. Its final velocity is 4 m/s at an angle of 25°, as shown in the diagram above. If its change in velocity was –1**i** +4**j** m/s, what was the ball's initial velocity?

So $\vec{V}_f = 4\cos 25\,\hat{i} + 4\sin 25\,\hat{j}$

$\vec{V}_f = 3.6\,\hat{i} + 1.7\,\hat{j}$

$\Delta\vec{V} = -1\hat{i} + 4\hat{j}$

$\Delta\vec{V} = \vec{V}_f - \vec{V}_i$

$(-1\hat{i} + 4\hat{j}) = (3.6\hat{i} + 1.7\hat{j}) - \vec{V}_i$

$\vec{V}_i = 4.6\,\hat{i} - 2.3\,\hat{j}$ m/s

6. A plane is flying due north at 100 m/s. It makes a nice smooth turn, ending with a final velocity of 100 m/s due east.
   a. What was its change in velocity?

$\vec{V}_i = 100\,\hat{j}$

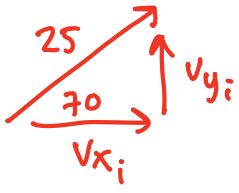
$\vec{V}_f = 100\,\hat{i}$

$\Delta\vec{V} = \vec{V}_f - \vec{V}_i = 100\,\hat{i} - 100\,\hat{j}$ m/s

   b. If the turn took 30 seconds, what was the average acceleration of the plane?

$\vec{a}_{ave} = \frac{\vec{V}_f - \vec{V}_i}{t} = \frac{100\hat{i} - 100\hat{j}}{30} = 3.3\,\hat{i} - 3.3\,\hat{j}$ m/s²

7. A soccer ball is kicked with an initial velocity of 25 m/s at an angle of 70° above the horizontal.
   a. What is its initial velocity in component form?



$V_{x_i} = 25\cos 70 = 8.6$

$V_{y_i} = 25\sin 70 = 23.5$

$\vec{V}_i = 8.6\,\hat{i} + 23.5\,\hat{j}$ m/s

   b. If it undergoes a constant acceleration of 0**i** – 10**j** m/s² for 3 seconds, what is its final velocity?

$\vec{a} = 0\hat{i} - 10\hat{j}$ m/s²

$t = 3$ s

$\vec{V}_f = \vec{a}t + \vec{V}_i$

$= (0\hat{i} - 10\hat{j})(3) + (8.6\hat{i} + 23.5\hat{j})$

$= 8.6\,\hat{i} + -6.5\,\hat{j}$ m/s

8. If in question 4, the ball was in contact with the side of the table for only 0.05 seconds, what was the average acceleration of the ball?

From #4

$\Delta\vec{V} = 0\hat{i} + 5\hat{j}$

$t = 0.05$ s

$\vec{a}_{ave} = \frac{\Delta\vec{V}}{t} = \frac{0\hat{i} + 5\hat{j}}{0.05}$

$= 0\,\hat{i} + 100\,\hat{j}$ m/s²

Vector Problems

9. The position as a function of time for a mouse is given by $\mathbf{r}(t) = (3t)\mathbf{i} + (0.5t^2)\mathbf{j}$.
   a. At time t = 3, where is the mouse?

$\vec{r}(3) = (3 \cdot 3)\hat{i} + (\frac{1}{2} \cdot 3^2)\hat{j} = 9\hat{i} + 4.5\hat{j}$ m

   b. What is the function that would represent the velocity of the mouse?

$\vec{v} = \frac{d\vec{r}}{dt} = 3\hat{i} + (1t)\hat{j}$

   c. What is the function that would represent the acceleration of the mouse?

$\vec{a} = \frac{d\vec{v}}{dt} = 0\hat{i} + 1\hat{j}$

Answers:

1) 16.6 m/s @–25°
*2) 31.7**i** + 14.8**j** m/s*
*3 a) 10**i** + 6**j** m*
*b) 0.67**i** + 0.4**j** m/s*
*4 a) 0**i** + 5**j** m/s*
*5) 4.63**i** – 2.31**j** m/s*
*6 a) 100**i** – 100**j** m*
*b) 3.3**i** – 3.3**j** m/s²*
*7 a) 8.55**i** + 23.49**j** m/s*
*b) 8.55**i** – 6.51**j** m/s*
*8) 0**i** + 100**j** m/s²*
*9 a) 9**i** + 4.5**j** m*
*b) **v**(t) = 3i + t**j***
*c) **a**(t) = 0**i** + 1**j***