2-d Motion Example

Example

1. **Read the problem.**
   The brakes go out on Mr. Rodriguez's car and he drives off a cliff at 35 m/s. If the cliff is 50.0 m high, how far away will the car land?

2. **Diagram/illustrate. INCLUDE COORDINATE SYSTEM.**

3. **List given information and unknowns. Make a chart!**

	X	Y
d_i	0.00m	50.0m
d_f	____	0 m
v_i	35 m/s	0 m/s
v_f	35 m/s	___
a	0 m/s^2	-9.80 m/s^2
t		

4. **Break down given information in to components (X and Y). If given an angle determine the x component by multiplying by cosine of the angle (measured from the +x axis) and the y component by multiplying by the sine of the angle (measured from the +x axis).**
   No angles in this problem.

5. **Solve one dimension for time. (look for equation and use known information)**

$$d_y = v_{iy} t + ½ a_y t^2$$

$$t = \frac{-v_{iy} \pm \sqrt{v_{iy}^{\ 2} - 4\left(\frac{1}{2}a_y\right)\left(-d_y\right)}}{2\left(\frac{1}{2}a_y\right)}$$

$$t = \frac{-0 \pm \sqrt{0^2 - 4\left(\frac{1}{2}(-9.8)\right)\left(-(-50)\right)}}{2\left(\frac{1}{2}(-9.8)\right)}$$

$$t = \frac{-\sqrt{-4(-4.9)(50)}}{-9.8}$$

t =3.2 s

6. Solve other dimension for unknown.

$d_x = v_{ix}\, t + ½\, a_x t^2$

$d_x = (35\ m/s)\ (3.2\ s) + ½\ 0\ m/s^2\ (3.2\ s)^2$

$d_x = 110\ m$

7. **Combine components (if necessary) for final answer. (The magnitude will use Pythagorean theorem and the angle will use inverse tangent of the y component divided by the x component)**

Not necessary for this problem.

$$v = \sqrt{{v_x}^2 + {v_y}^2}$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$ ....+180 if v_x is negative

2-d Motion Example

Example

1. **Read the problem.**
   Mr. Rucker foolishly drives his motorcycle off a 25 degree ramp at 35 m/s on top of a 50.0 m cliff. Calculate Mr. Rucker's velocity when he crashes.

2. **Diagram/illustrate. INCLUDE COORDINATE SYSTEM.**

3. **List given information and unknowns. Make a chart!**

	X	**Y**
d_i	0.00m	50.0m
d_f		0 m
v_i		
v_f	___	___
a	0 m/s^2	-9.80 m/s^2
t		

   v_i=35 m/s @ 25 degrees

4. **Break down given information in to components (X and Y). If given an angle determine the x component by multiplying by cosine of the angle (measured from the +x axis) and the y component by multiplying by the sine of the angle (measured from the +x axis).**

   $v_{ix} = v_i \cos \theta$
   $v_{ix} = 35\ m/s \cos(25)$
   $v_{ix} = 32\ m/s$

   $v_{iy} = v_i \sin \theta$
   $v_{iy} = 35\ m/s \sin(25)$
   $v_{iy} = 15\ m/s$

	X	Y
d_i	0.00m	50.0m
d_f		0 m
v_i	**32 m/s**	**15 m/s**
v_f	___	___
a	0 m/s^2	-9.80 m/s^2
t		

5. **Solve one dimension for time. (look for equation and use known information)**

$$d_y = v_{iy} t + \tfrac{1}{2} a_y t^2$$

$$t = \frac{-v_{iy} \pm \sqrt{v_{iy}^{2} - 4\left(\frac{1}{2}a_y\right)(-d_y)}}{2\left(\frac{1}{2}a_y\right)}$$

$$t = \frac{-15 \pm \sqrt{15^2 - 4\left(\frac{1}{2}(-9.8)\right)(-(-50))}}{2\left(\frac{1}{2}(-9.8)\right)}$$

$$t = \frac{-15 \pm \sqrt{225 + 4(4.9)(50)}}{-9.8}$$

$$t = \frac{-15 \pm \sqrt{1205}}{-9.8}$$

t =5.1 s

	X	Y
d_i	0.00m	50.0m
d_f		0 m
v_i	32 m/s	15 m/s
v_f	32 m/s	___
a	0 m/s²	-9.80 m/s²
t	**5.1 s**	

6. Solve for unknown.

$v_{fy} = v_{iy} + a_y t$

v_{fy} =15 m/s + -9.8 m/s^2 (5.1 s)

v_{fy} = -35 m/s

	X	Y
d_i	0.00m	50.0m
d_f		0 m
v_i	32 m/s	15 m/s
v_f	32 m/s	-35 m/s
a	0 m/s^2	-9.80 m/s^2
t	**5.1 s**	

7. **Combine components (if necessary) for final answer. (The magnitude will use Pythagorean theorem and the angle will use inverse tangent of the y component divided by the x component)**

$$v = \sqrt{v_x^{\ 2} + v_y^{\ 2}}$$

$$v = \sqrt{(32m/s)^2 + (-35m/s)^2}$$

$$v = 47m/s$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$ ....+180 if v_x is negative

$$\theta = \tan^{-1}\left(\frac{-35m/s}{32m/s}\right)$$

$$\theta = -48^\circ$$