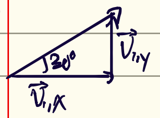
Projectile motion

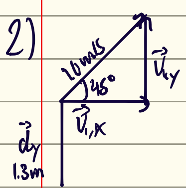
1)



$\vec{V}_{1,y} = 15\sin 30^\circ$ m/s [up]
$\vec{a} = -9.81$ m/s^2 [up]
$\vec{d}_y = 0$ m
$\vec{d}_y = \vec{V}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$0 = (15\sin 30^\circ)\Delta t - 4.905\Delta t^2$
$0 = \Delta t(15\sin 30^\circ - 4.905\Delta t)$
$\Delta t = \frac{15\sin 30^\circ}{4.905}$
$= 1.53$ s

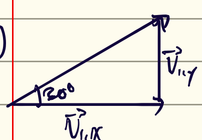
$\vec{V}_{1,x} = 15\cos 30^\circ$ m/s [F]
$\Delta t = 1.53$ s
$\vec{d}_x = \vec{V}_{1,x}\Delta t$
$= (15\cos 30^\circ)(1.53\text{s})$
$= 19.86$ m [F]

2)



$\vec{V}_{1,y} = 10\cos 45^\circ$ m/s [up]
$\vec{a} = -9.81$ m/s^2 [up]
$\vec{d}_y = -1.3$ m [up]
$\vec{d}_y = \vec{V}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$-1.3 = 10\cos 45\Delta t - 4.905\Delta t^2$
$0 = -4.905\Delta t^2 + 10\cos 45 + 1.3$
$\Delta t = \frac{-10\cos 45 \pm \sqrt{(10\cos 45)^2 - 4(-4.905)(1.3)}}{2(-4.905)}$
⋮
$\Delta t = 1.61$ s
$\vec{V}_{1,x} = 10\cos 45^\circ$ m/s [F]
$\Delta t = 1.61$
$\vec{d}_x = (\vec{V}_{1,x})(\Delta t)$
$= 11.38$ m [F]

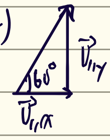
3)



$\vec{V}_{1,x} = 12\cos 30^\circ$ m/s [F]
$\vec{d}_x = 9$ m [F]
$\Delta t = \frac{d_x}{V_{1,x}}$
$= \frac{9}{12\cos 30^\circ}$
$= 0.866$ s

$\vec{V}_{1,y} = 12\sin 30^\circ$ m/s [up]
$\vec{a} = -9.81$ m/s^2 [up]
$\Delta t = 0.866$ s
$\vec{d}_y = \vec{V}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$= (12\sin 30^\circ)(0.866) - 4.905(0.866)^2$
$= 1.52$ m [up]

4)

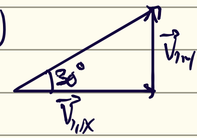


$\vec{V}_{1,y} = 8\sin 60^\circ$ m/s [up]
$\vec{a} = -9.81$ m/s^2
$\vec{d}_y = 1$ m [up]
$\vec{d}_y = \vec{V}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$1 = (8\sin 60^\circ)\Delta t - 4.905\Delta t^2$
$-4.905\Delta t^2 + 8\sin 60^\circ\Delta t - 1 = 0$
⋮
$\Delta t = 0.163$ s or $\Delta t = 1.249$ s

$\vec{V}_{1,x} = 8\cos 60^\circ$ m/s [F]
$\vec{d}_x = \vec{V}_{1,x} \cdot \Delta t$
$= (8\cos 60^\circ)(0.163\text{s})$
$= 0.65$ m [F]

$\vec{V}_{1,x} = 8\cos 60^\circ$ m/s [F]
$\vec{d}_x = \vec{V}_{1,x} \cdot \Delta t$
$= (8\cos 60^\circ)(1.249\text{s})$
$= 5.00$ m [F]

5)

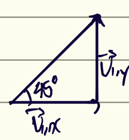


$\vec{V}_{1,y} = V\sin 30^\circ$ m/s [up]
$\vec{a} = -9.81$ m/s^2 [up]
$\vec{d}_y = 0$
$\vec{d}_y = \vec{V}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$0 = \Delta t(V\sin 30^\circ - 4.905\Delta t)$
$V\sin 30^\circ - 4.905\Delta t = 0$
① $\Delta t = \frac{V\sin 30}{4.905}$

$\vec{V}_{1,x} = V\cos 30^\circ$ m/s [F]
$\vec{d}_x = 20$ m [F]
$\Delta t = \frac{d_x}{V_{1,x}}$
$= \frac{20}{V\cos 30^\circ}$ ②

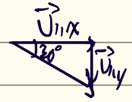
Equate ① and ②:
$\frac{V\sin 30}{4.905} = \frac{20}{V\cos 30^\circ}$
$V^2\sin 30\cos 30 = 98.1$
$V^2 = 226.55$
$V = 15.05$ m/s
∴ it was kicked at 15.05 m/s [30° above the horizontal]

6)

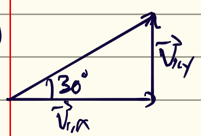


$\vec{V}_{1,x} = 25\cos 45^\circ$ m/s [F]
$\vec{d}_x = 30$ m [F]
$\Delta t = \frac{d_x}{V_{1,x}}$
$= \frac{30}{25\cos 45^\circ}$
$= 1.697$ s

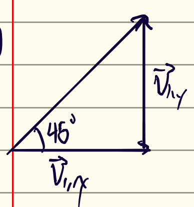
$\vec{V}_{1,y} = 25\sin 45^\circ$ m/s [up]
$\vec{a} = -9.81$ m/s^2 [up]
$\Delta t = 1.697$ s
$\vec{d}_y = \vec{V}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$= (25\sin 45^\circ)(1.697\text{s}) + \frac{1}{2}(-9.81)(1.697)^2$
$= 15.87$ m [up]
∵ $\vec{d}_y > 3$ m [up],
∴ a field goal will be made.

7) 

$\vec{v}_{1,y} = 6\sin 30$ m/s [down]
$\vec{a} = 9.81$ m/s^2 [down]
$\vec{d}_y = 8$m [down]
$\vec{d}_y = \vec{v}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$8 = 6\sin 30\Delta t + 4.905\Delta t^2$
$4.905\Delta t^2 + 6\sin 30\Delta t - 8 = 0$
⋮
$\Delta t = 1.007$s
$\vec{v}_{1,x} = 6\cos 30°$ m/s [F]
$\vec{d}_x = \vec{v}_{1,x}\Delta t$
$= (6\cos 30°)(1.007)$
$= 5.23$ m [F]

8) 

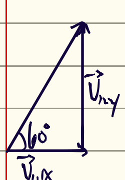
$\vec{v}_{1,x} = 20\cos 30°$ m/s [F]
$\vec{d}_x = 12$ m [F]
$\Delta t = \frac{d_x}{\vec{v}_{1,x}}$
$= \frac{12}{20\cos 30}$
$= 0.693$s
$\vec{v}_{1,y} = 20\sin 30°$ m/s [F]
$\vec{a} = -9.81$ m/s^2 [up]
$\Delta t = 0.693$s
$\vec{d}_y = \vec{v}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$= (20\sin 30°)(0.693s) + \frac{1}{2}(-9.81)(0.693)^2$
$= 4.57$ m [up]

9) 

$\vec{v}_{1,y} = 9\sin 45°$ m/s [up]
$\vec{a} = -9.81$ m/s^2 [up]
$\vec{d}_y = 1.5$ m [up]
$\vec{d}_y = \vec{v}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$1.5 = (9\sin 45)\Delta t - 4.905\Delta t^2$
$-4.905\Delta t^2 + 9\sin 45\Delta t - 1.5 = 0$
⋮
$\Delta t = 0.31$s or $\Delta t = 0.988$s

$\vec{v}_{1,x} = 9\cos 45°$ m/s [F]
$\vec{d}_x = \vec{v}_{1,x}\Delta t$
$= (9\cos 45°)(0.31)$
$= 1.97$m [F]

$\vec{v}_{1,x} = 9\cos 45°$ m/s [F]
$\vec{d}_x = \vec{v}_{1,x}\Delta t$
$= (9\cos 45)(0.988)$
$= 6.29$m [F].

10) 

$\vec{v}_{1,y} = 20\sin 60°$ m/s [up]
$\vec{a} = -9.81$ m/s^2
$\vec{d}_y = 0$
$\vec{d}_y = \vec{v}_{1,y}\Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$0 = \Delta t(20\sin 60° - 4.905\Delta t)$
$20\sin 60° - 4.905\Delta t = 0$
$\Delta t = \frac{20\sin 60}{4.905}$
$= 3.53$s

$\vec{v}_{1,x} = 20\cos 60°$ m/s [F]
$\Delta t = 3.53$s
$\vec{d}_x = \vec{v}_{1,x} \cdot \Delta t$
$= (20\cos 60°)(3.53s)$
$= 35.3$m [F]

$\because \vec{d}_x < 40$m [F],
$\therefore$ the ball ends up in a bond