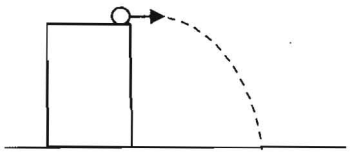
2-D Problem Types
AP Physics B

Name _____
2-3a 3b-4 5-6a 6b-7

1. A ball rolls horizontally off a cliff. If the ball is rolling at 4.2 m/s, and it lands 13m from the base of the cliff, what is the height of the cliff?

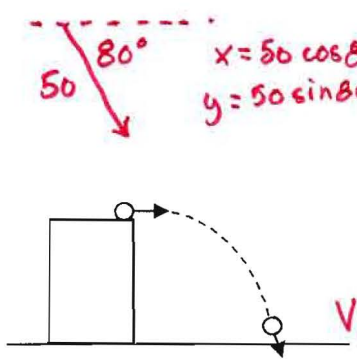


x
$V_x = 4.2\ m/s$
$\Delta x = 13\ m$
$t = ?$
$V_x = \frac{\Delta x}{t}$
$4.2 = \frac{13}{t}$
$t = 3.1\ s$

y
$t = 3.1\ s$
$a = -9.8\ m/s^2$
$V_i = 0$
$\Delta y = ?$

$\Delta y = V_i t + \frac{1}{2} a t^2$
$\Delta y = 0 + \frac{1}{2}(-9.8)(3.1)^2$
$\Delta y = -47.1\ m$
height = 47.1 m
OR 46.9 m

2. After rolling horizontally off of a cliff, a ball lands at a final velocity of 50 m/s at -80°. What is the Δx of the object?



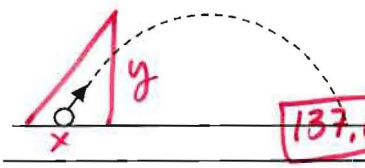
50, 80°
$x = 50\cos 80$
$y = 50\sin 80$

x
$V_x = 50\cos 80$
$V_x = 8.7\ m/s$
$\Delta x = ?$
$t = 5.02\ s$
$V = \frac{\Delta x}{t}$
$\Delta x = 43.6\ m$

y
$V_{fy} = -50\sin 80$
$V_{fy} = -49.24\ m/s$
$a = -9.8\ m/s^2$
$t = ?$
$V_i = 0$

$\frac{V_f - V_i}{t} = a$
$\frac{-49.24 - 0}{t} = -9.8\ m/s^2$
$t = 5.02\ s$

3. A ball is shot at 52 m/s at 43°. Where will the ball be at its highest position? (give both Δy and Δx)



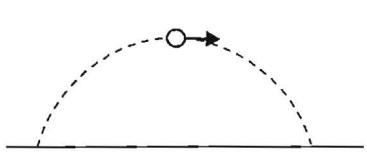
$x = 52\cos 43°$
$y = 52\sin 43°$

x
$V_x = 52\cos 43$
$\Delta x = ?$
$t = 3.69\ s$
$V = \frac{\Delta x}{t} = \frac{\Delta x}{3.69}$
137.6 m OR $\Delta x = 140.3\ m$

y
$V_{iy} = 52\sin 43 = 35.46$
$a = -9.8\ m/s^2$
$t = 3.69\ s$
$V_f = 0$ ← at highest point
$\Delta y = ?$
$\Delta y = 64\ m$

$\frac{V_f - V_i}{t} = a$
$\frac{0 - 52\sin 43}{t} = -9.8$
$\frac{52\sin 43}{9.8} = t$
$t = 3.69\ s$
$V_f^2 = V_i^2 + 2a\Delta x$
$0 = (35.46)^2 + 2(-9.8)\Delta x$

4. A ball shot through the air reaches a maximum height of 23m with a launch angle of 20°. At what speed was the ball shot?

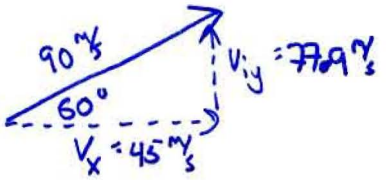


x

y
$V_{iy} = V\sin 20°$
$V_f = 0$
$a = -9.8\ m/s^2$
$\Delta y = 23\ m$

$V_f^2 = V_{iy}^2 + 2(-9.8)23$
$0 = (V\sin 20)^2 + 2(-9.8)23$
$V\sin 20 = \sqrt{2 \cdot 9.8 \cdot 23}$
$V = 62.1\ m/s$

5. A ball is shot at 90m/s at 60°, 20 meters from the edge of a 30 meter tall cliff. Where will the ball land?



x	y
$V_x = 45$ m/s	$V_{iy} = 77.9$ m/s
$\Delta x = ?$	$a = -9.8$ m/s²
$t =$ 15.5 sec	

$\Delta x = V_x t$

$= (45)(15.5)$

697.5 m OVER

30 m UP

* START HERE TO FIND TIME

$\Delta y = 30$ m

FIND TOTAL TIME UP + DOWN

$\Delta y = V_i t + \frac{1}{2} a t^2$

$30 = (77.9)t + \frac{1}{2}(-9.8)t^2$

$0 = -4.9t^2 + 77.9t - 30$

$t = 15.5$ sec

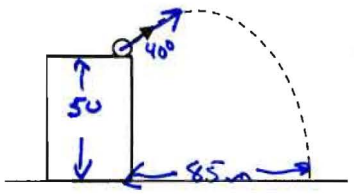
6. A ball is shot a 40 ~~m/s~~ SPEED at an unknown ~~angle~~ VELOCITY off of a 50m cliff. If the ball lands 85m from the base of the cliff, what was the launch ~~angle~~?

SYSTEMS OF EQUATIONS:

START HERE $V_x = \frac{\Delta x}{t}$

$V\cos 30 = \frac{85}{t_{TOT}}$

$t_{TOT} = \frac{85}{V\cos 30}$



x	y
$V_x = V\cos 30$	$V_{iy} = V\sin 40$
$\Delta x = 85$ m	$a = -9.8$ m/s²
$t =$	$\Delta y = -50$ m

~~$V_f = V_i + at$~~

$0 = V\sin 40 + -9.8\, t_{UP}$

t_{TOT}:

$\Delta y = V_i t + \frac{1}{2} a t^2$

~~$-50 = V\sin 40$~~

$-50 = (V\sin 40)\left(\frac{85}{V\cos 30}\right) + \frac{1}{2}(-9.8)\left(\frac{85}{V\cos 30}\right)^2$

$-50 = 71.3 + \frac{-47203}{V^2}$

$-121.3 = \frac{-47203}{V^2}$

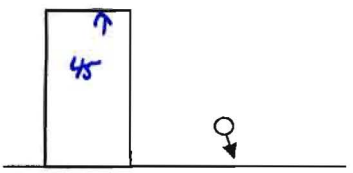
$\sqrt{V^2} = \sqrt{\frac{-47203}{-121.3}}$ = 19.7 m/s

7. A ball was launched from a 45 meter cliff. If the ball spends 1.5 seconds in the air, give two possible launch velocities (give both magnitude and direction).

MAKE UP V_x ... DOES NOT MATTER

MAKE UP ANGLE ... I CHOOSE $-20°$ & $-60°$

CHOOSE ANY ANGLES $0° \to -90°$



x	y
$V_x = V\cos\theta$	$V_{iy} = V\sin\theta$
$\Delta x =$	$\Delta y = -45$ m
$t = 1.5$ sec for	$t = 1.5$ sec for

$\Delta y = V_i t + \frac{1}{2} a t^2$

$-45 = V\sin\theta(1.5) + \frac{1}{2}(-9.8)(1.5)^2$

$-45 = 1.5\, V\sin\theta - 11.025$

$-33.975 = 1.5\, V\sin\theta$

$-22.65 = V\sin\theta$

THIS HAS TO BE THE VERTICAL COMPONENT OF THE VELOCITY TO CAUSE IN 1.5 SEC.

$-20°$: $-22.65 = V\sin(20)$

$V = 66.15$ m/s

$-60°$: $-22.65 = V\sin(-60)$

$V = 26.2$ m/s