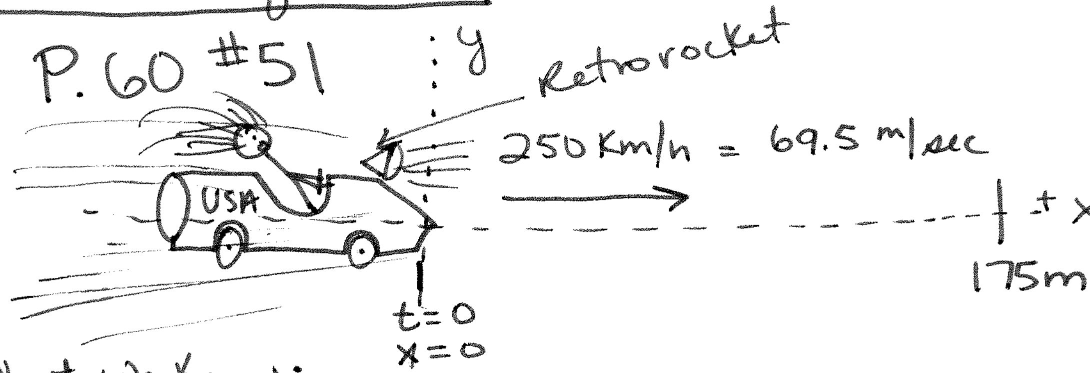
AP Review

Quadratic Equations

P. 60 #51



What We Know:

$V_0 = 69.5 \, m/s$

$a = -8.25 \, m/s^2$ (he hits the retro rocket @ t=0 x=0)

What We want to Know:

when will he hit 175m from x=0 t=0?

Think about it:

He's going to reach 175m TWICE! Why? 1st time he'll pass it. Then The retrorockets will bring him back (if he were braking @ $-8.25 m/s^2$ he'll only pass it once. But since it's a retrorocket, it Keeps acc. @ $-8.25 m/s^2$)

Solve:

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

$$175m = (69.5 m/s)t + \frac{1}{2}(-8.25 m/s^2) t^2$$

Re-arrange to resemble Quadratic

$$(4.125 m/s^2)t^2 - (69.5 m/s)t - 175m = 0$$

Solve quadratic: $t = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$t = 3.08$ sec and 13.8 sec

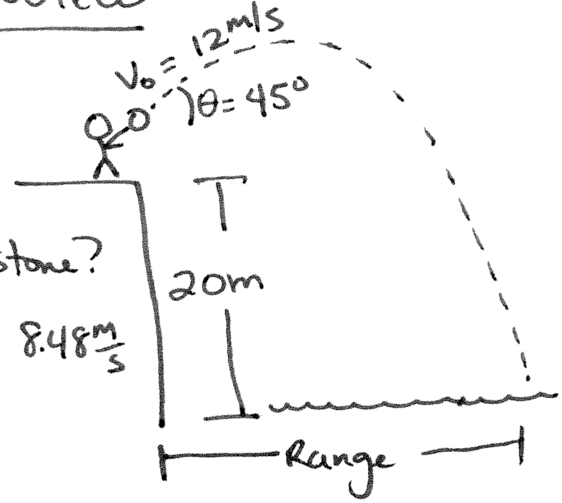
↑ 1st pass

↑ catch you on The re-bound! ☺

AP Review

Projectile Motion:

P. 96 # 83



ⓐ What is The range of the stone?

1. Find V_{ox} : $V_{ox} = (12\,m/s)\cos 45 = 8.48\,\frac{m}{s}$

2. Find time rock is in The air

$$y = V_{oy}t + \frac{1}{2}at^2$$

y component of motion $= (12\,m/s)\sin 45 = 8.48\,m/s$

$-20m$
negative because its going down

$$-20m = {}^{+}8.48\,m/s\,t + \frac{1}{2}(-9.8\,m/s^2)t^2$$

going down · going up · acc is going down

Re-arrange for quadratic: $4.9t^2 - 8.48\,m/s\,t - 20m = 0$

solve quadratic : $t = \boxed{+3.06\,sec}$ and $-1.33\,sec$

behind him

3. V_{ox} is unchanged in flight

$$d = V_{ox}\cdot t = (8.48\,m/s)(3.06\,sec) = \boxed{25.95\,m}$$

ⓑ How fast does rock hit water? at The Water, all ~~KE has~~ Potential Energy has become Kinetic Energy.

$$\Delta KE = \Delta U$$

$$\frac{1}{2}\cancel{m}v^2 - \frac{1}{2}\cancel{m}v_o^2 = \cancel{m}gh$$

$$v^2 - v_o^2 = 2gh$$

$$v^2 = 2gh + v_o^2$$

(or) $v^2 = v_o^2 + 2gy$

$v^2 = (12\,m/s)^2 + 2(-9.8\,\frac{m}{s^2})(-20\,m)$

$v = \sqrt{2gh + v_o^2}$

$v = 23.15\,m/s$

Great Formula to memorize → $v = \sqrt{2gh + v_o^2}$

$V_o = 12\,m/s$ NOT $8.48\,m/s$

(usually, $V_o = 0\,m/s$, but if it doesn't, you need to take That into account)

$$V = \sqrt{2(9.8\,\frac{m}{s^2})(20) + (12)^2}$$

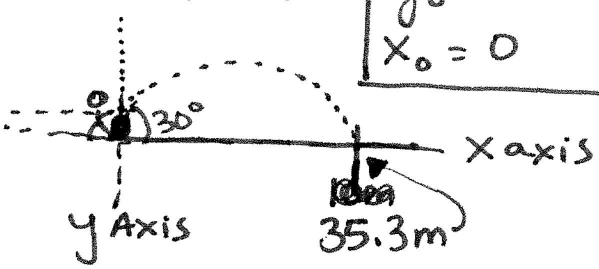
$$\boxed{V = 23.15\,m/s}$$

This is always true, but if you drop The rock off The bridge, $V_o = 0\,m/s$ so $V = \sqrt{2gh + 0}$

AP Physics Review

Projectiles Summary

Scenario #1 : $\boxed{y_0 = 0 \quad y = 0 \quad V_0 = 20\,m/s \\ x_0 = 0 \quad x = 10m \quad \theta = 30^\circ}$ What We Know



What we can find out:

- $V_{oy} = 20\,m/s \sin 30 = 10\,m/s$
- $V_{ox} = 20\,m/s \cos 30 = 17.32\,m/s$
- V_{oy} @ Top $= 0\,m/s$ so, $V_y^2 = V_{oy}^2 + 2gy$

$$0^2 = (10\,m/s)^2 + 2(-9.8\tfrac{m}{s^2})y$$

$$\boxed{y = 5.10m}$$
max altitude

- V_{ox} never changes!
- Ball is <u>always</u> accelerating at $9.8\,m/s$ toward earth even when it has no V_y direction.
- Time to get to apex:

$$V_y = V_{oy} + a_y t$$

at apex → $0\,m/s = (10\,m/s) + (-9.8\,m/s^2)t$

$$t = 1.02\text{ sec}$$

- Time of total flight $= 2(1.02\text{sec}) = 2.04\text{sec}$
- Distance downrange:

$$D = V_{ox} t = (17.32\,m/s)(2.04\text{sec})$$

$$D_x = 35.3m$$

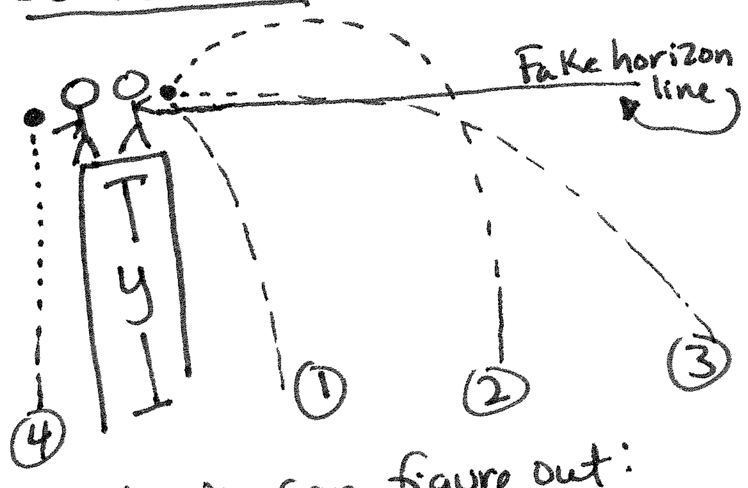
Or! $\text{Range} = \dfrac{V_0^2 \sin 2\theta}{g} = \dfrac{(20\,m/s)^2 \sin 60}{9.8} = 35.3m$

formula <u>only</u> works when $y_0 = y$

AP Physics Review

Projectile Summary

Scenario #2



What We Know

1. Thrown straight down @ 10 m/s
2. Thrown at angle 50° @ 10 m/s
3. Thrown horizontally @ 10 m/s
4. dropped straight down @ 0 m/s

What we can figure out:

- Ball ③ + ④ hit at exactly same time.
- Ball ③ goes farthest.
- If there were no cliff, ball ② would go farthest (see fake horizon line above to see what I mean)
- Ball ① hits first, ball ② hits last
- Ball ①, ②, ③ all hit ground @ same speed (regardless of angle thrown.) Why? $V^2 = V_0^2 + 2gy$ ← 10 m/s

  $V = \sqrt{2gh + V_0^2}$
- Ball ④ hits ground at $V = \sqrt{2gh + 0}$
- Time of each balls flight:

  ③ = ④ = $y = V_{oy}t + \frac{1}{2}at^2$ (solve for t)

  $-y = 0 + \frac{1}{2}(-9.8\,m/s^2)t^2$ (quadratic)

  ① $-y = -10\,m/s\,t + \frac{1}{2}(-9.8\,m/s^2)t^2$ (quadratic)

  ② $-y = (10\sin 50)t + \frac{1}{2}(-9.8\,m/s^2)t^2$ (quadratic)

y = height of ball to ground (use negative value)

AP Review

Kinematic / Energy Formulas

$V_y^2 = V_{0y}^2 + 2gy$ (or you could use "a" for "g" or "x" for "y")

quadratic $\rightarrow$ $X = V_{0x}t + \frac{1}{2}a_x t^2$ (or you could use "y")

$V_x = V_{0x} + a_x t$ (or you could use "y")

Total <u>Energy</u> has units of Joules (N·m) So does <u>Work</u>

$E_{Total} = Work = KE + U$

$KE_{max} = U_{max}$

$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$

$V = \sqrt{2gh}$

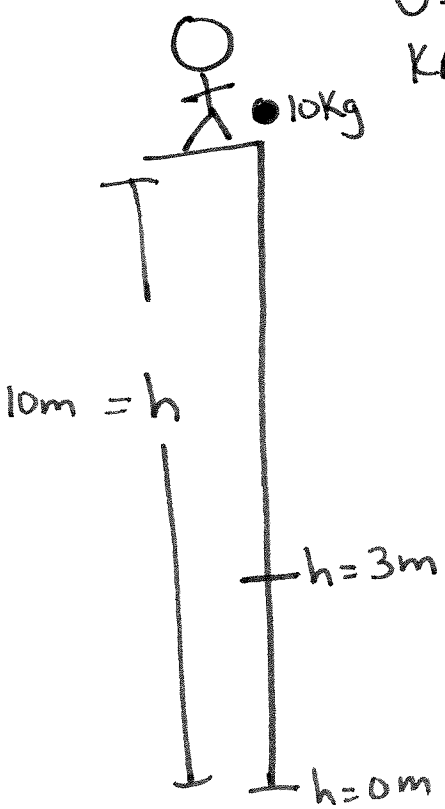
$V_0 = 0 \, m/s$

← Same Thing →

$\Delta KE = \Delta U$

$\frac{1}{2}\cancel{m}v^2 - \frac{1}{2}\cancel{m}V_0^2 = \cancel{m}gh - \cancel{m}gh_0$

$V = \sqrt{2gh + V_0^2}$



$U = mgh = (10kg)(10 m/s^2)(10m) = 1000J$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(10kg)(0 m/s^2) = 0J$

no initial Velocity

$U = mgh = (10 Kg)(10 m/s^2)(3m) = 300J$

$KE = 1000J - 300J = 700J$

$700J = \frac{1}{2}mv^2 = \frac{1}{2}(10kg)v^2$

$\boxed{V_{@3m} = 11.83 \, m/s}$ or $V = \sqrt{2gh}$ ← Where $h = (10m - 3m)$

$KE = 1000J = \frac{1}{2}mv^2 = \frac{1}{2}(10Kg)v^2$

$\boxed{V = 14.14 \, m/s}$ or $V = \sqrt{2gh}$
$= \sqrt{2(10)(10)}$
$= 14.14 \, m/s$