Projectile How to apply Eq. of motion in a Projectile motion

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$v = u + at$

$v^2 = u^2 + 2as$

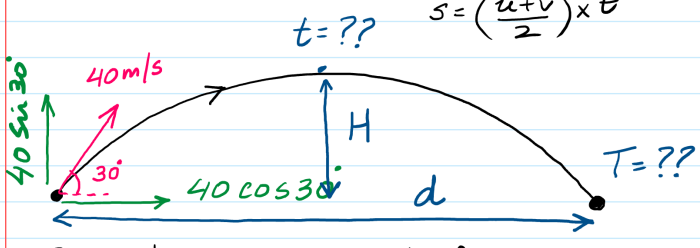
$s = ut + \frac{1}{2}at^2$

$s = \left(\frac{u+v}{2}\right) \times t$

$s = \bar{v}t \quad | \quad v = v + at$

$v^2 = v^2 + 2as$

$s = \frac{1}{2}vt + \frac{1}{2}at^2$



- Initial horizontal component of velocity.
  $= 40 \cos 30 = 34.6$ m/s
- Initial vertical component of velocity.
  $= 40 \sin 30 = 20$ m/s
- Cal max height reached (H)

$+\uparrow$ $u = 20$ $v = 0$ $a = -9.81$ $s = ??$

$v^2 = u^2 + 2as$

$0^2 = 20^2 + 2(-9.81)s$ $\quad s = 20.4$ m.

- Cal time taken (t) to reach max height.

$+\uparrow$ $u = 20$ $v = 0$ $a = -9.81$ $s = 20.4$ $t = ??$

$v = u + at$ ✓ OR $s = ut + \frac{1}{2}at^2$

$0 = 20 + (-9.81)t$

$t = 2.04$ s

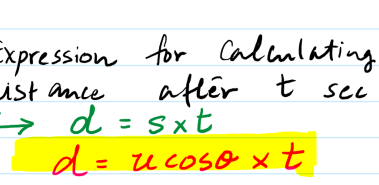
- Cal the total time (T) for entire journey. $T = 2 \times t = 2 \times 2.04 = 4.08$ s.
- Cal the total horizontal distance (d) covered by projectile.

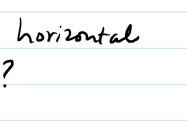
$\xrightarrow{+}$ $d = s \times t$ OR $\xrightarrow{+}$ $s = ut + \frac{1}{2}at^2$

$d = 34.6 \times 4.08$ $\quad s = 34.6 \times 4.08$

$d = 141$ m $\quad s = 141$ m

- Cal. the "resultant" velocity at $t = 1.5$ s ?





- V_H remains constant throughout $V_H = 34.6$ m/s
- find V_V at 1.5 sec

$+\uparrow$ $u = 20$ $V_V = ??$ $a = -9.81$ $t = 1.5$s

$+\uparrow$ $v = u + at$

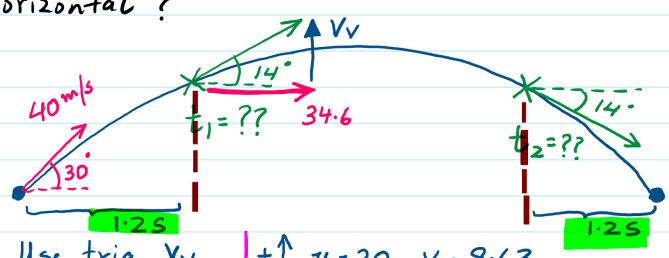
$V = 20 + (-9.81)(1.5)$

$V_V = 5.3$ m/s

$V_R = \sqrt{34.6^2 + 5.3^2}$

$V_R = 35$ m/s

- Cal. the 2 times t_1 & t_2 when ball makes an angle of 14° with the horizontal ?



(i) Use trig V_V

$\tan 14° = \frac{V_V}{34.6}$

$V_V = 8.63$ m/s

$+\uparrow$ $u = 20$ $v = 8.63$ $a = -9.81$ $t = t_1$

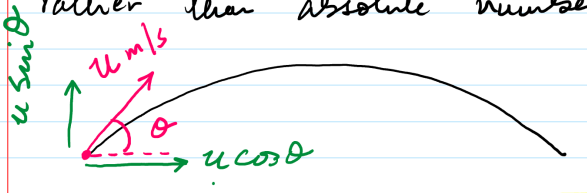
$+\uparrow$ $v = u + at$

$8.63 = 20 + (-9.81)t_1$

$t_1 = 1.2$ s

$t_2 = 4.08 - 1.2$s $= 2.88$s

Example Question using Variables rather than absolute numbers.



- Initial horizontal velocity = $u\cos\theta$
- Initial vertical velocity = $u\sin\theta$
- Expression for vertical velocity after t sec

$+\uparrow$ $v = u + at$

$v = u\sin\theta + (-g)t$

$v = u\sin\theta - gt$

- Expression fo horizontal velocity after t sec

$u\cos\theta$

- Expression for calculating horizontal distance after t sec ?

$\xrightarrow{+}$ $d = s \times t$

$d = u\cos\theta \times t$

- Expression for calculating vertical distance after t sec.

$+\uparrow$ $s = ut + \frac{1}{2}at^2$

$s = (u\sin\theta)t + \frac{1}{2}(-g)t^2$

$s = u\sin\theta \cdot t - \frac{1}{2}gt^2$

- Expression for time taken (t) to reach max height.

$+\uparrow$ $v = u + at$

$0 = u\sin\theta + (-g)t$

$t = \frac{u\sin\theta}{g}$

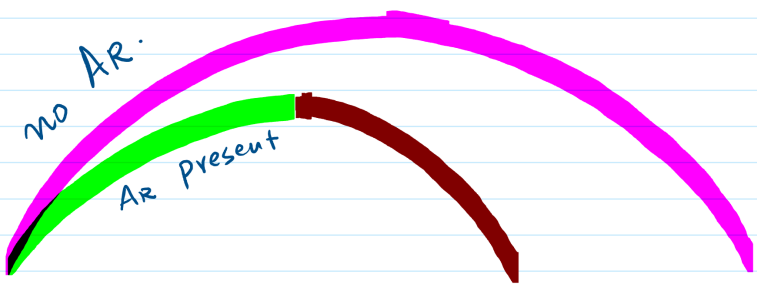
- Expression for total time (T) for the journey.

$T = 2 \times t$

$T = \frac{2u\sin\theta}{g}$

Note: Above expressions / general formula used in mcqs.

How to construct path of projectile if air resistance is present



(i) due to AR

- vertical height will reduce.
- horizontal range / distance will reduce.
- since AR is present ∴ horizontal component of velocity will keep decreasing ∴ dist covered in 2nd half (brown) will be less than dist covered in the first half (green) ∴ path NOT symmetrical.

Side note:

Cal. max # of blocks which can be crossed by the car in the given diagram?

(i) $\uparrow$ $v = u + at$ (t to reach highest pt).

$0 = 60\sin 50 - 9.81t$

$t = 4.7$s

(ii) $T = 2 \times t = 2 \times 4.7$

$= 9.4$s

(iii) total horizontal distance

$\xrightarrow{+}$ $d = s \times t$

$d = (60\cos 50) \times 9.4$

$d = 362.5$ m

(iv) max # of cars.

$\frac{362.5}{5} = 72.5 \approx 72$ cars

side note.

Q:. Cal V_R at $t = 3$ sec

- $V_H = 34.6$ m/s
- Find V_V at $t = 3$s

$+\uparrow$ $v = u + at$

$V = 20 + (-9.81)(3)$

$V = -9.4$ m/s

$V_R = \sqrt{(-9.4)^2 + (34.6)^2}$

$V_R = 36$ m/s.