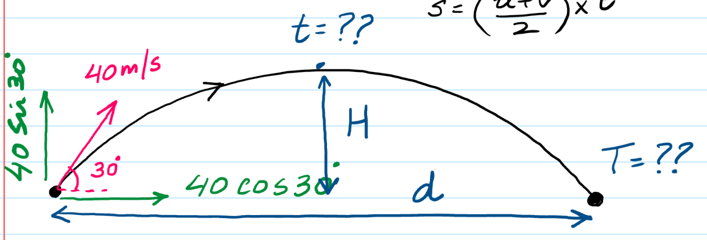
Projectile 22 October 2020 08:58

How to apply Eq. of motion in a Projectile motion

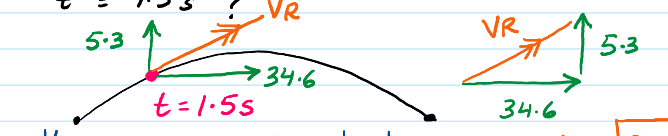
$v = u + at$
$v^2 = u^2 + 2as$
$s = ut + \frac{1}{2}at^2$
$s = \left(\frac{u+v}{2}\right) \times t$

$s = \bar{v}t \quad \Big| \quad v = u + at$
$v^2 = u^2 + 2as$
$s = \frac{1}{2}vt + \frac{1}{2}at^2$



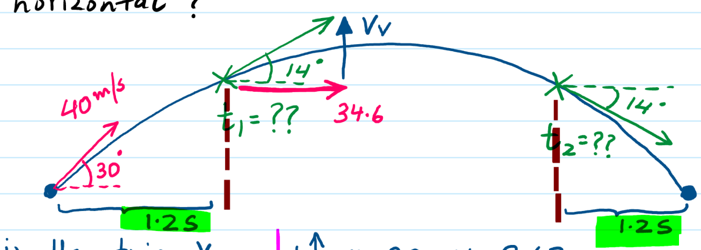

- Initial horizontal component of velocity.
  $= 40\cos 30 = 34.6\ m/s$
- Initial vertical component of velocity.
  $= 40 \sin 30 = 20\ m/s$
- Cal max height reached (H)
  $+\uparrow$ $u = 20$ $v = 0$ $a = -9.81$ $s = ??$
  $v^2 = u^2 + 2as$
  $0^2 = 20^2 + 2(-9.81)s$ $s = 20.4m.$
- Cal time taken (t) to reach max height.
  $+\uparrow$ $u = 20$ $v = 0$ $a = -9.81$ $s = 20.4$ $t = ??$
  $v = u + at$ ✓ OR $s = ut + \frac{1}{2}at^2$
  $0 = 20 + (-9.81)t$
  $t = 2.04s$
- Cal the total time (T) for entire journey $T = 2 \times t = 2 \times 2.04 = 4.08s.$
- Cal the total horizontal distance (d) covered by projectile.
  $\xrightarrow{+}$ $d = s \times t$ OR $\xrightarrow{+}$ $s = ut + \cancel{\frac{1}{2}at^2}$
  $d = 34.6 \times 4.08$
  $d = 141\ m$ $s = 34.6 \times 4.08$
  $s = 141\ m$

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




$V_R = \sqrt{34.6^2 + 5.3^2}$
$V_R = 35\ m/s$

- $V_H$ remains constant throughout $V_H = 34.6\ m/s$
- find $V_V$ at 1.5 sec
  $+\uparrow$ $u = 20$ $V_V = ??$ $a = -9.81$ $t = 1.5s$
  $+\uparrow$ $v = u + at$
  $V = 20 + (-9.81)(1.5)$
  $V_V = 5.3\ m/s$
- Cal. the 2 times $t_1$ & $t_2$ when ball makes an angle of 14° with the horizontal?

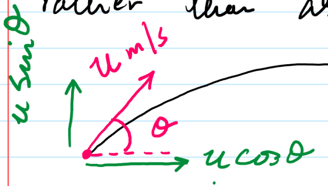



(i) Use trig $V_V$
$\tan 14° = \frac{V_V}{34.6}$
$V_V = 8.63\ m/s$

$+\uparrow$ $u = 20$ $v = 8.63$
$a = -9.81$ $t = t_1$
$+\uparrow$ $v = u + at$
$8.63 = 20 + (-9.81)t_1$
$t_1 = 1.2s$

$t_2 = 4.08 - 1.2s = 2.88s$

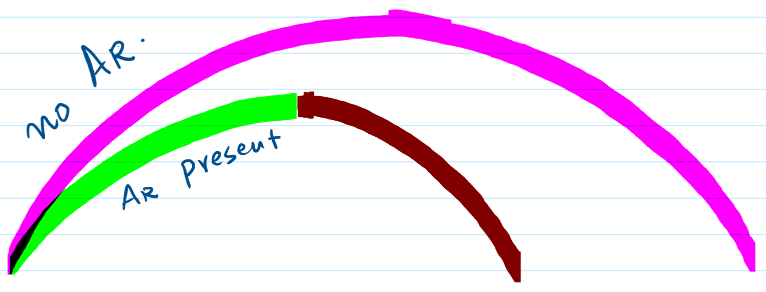
Example Question using Variables rather than absolute numbers.




- 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 for 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).
$0 = 60\sin 50 - 9.81t$
$t = 4.7s$

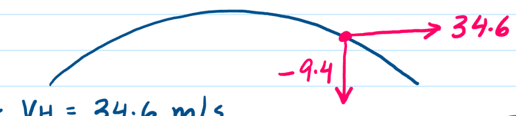
(ii) $T = 2 \times t = 2 \times 4.7$
$= 9.4s$

(iii) total horizontal distance
$\xrightarrow{+}$ $d = s \times t$
$d = (60\cos 50°) \times 9.4$
$d = 362.5m$

(iv) max # of cars.
$\frac{362.5}{5} = 72.5 \approx 72$ cars

Side note.

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




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

$+\uparrow$ $v = u + at$
$V = 20 + (-9.81)(3)$
$V = -9.4\ m/s$

$V_R = \sqrt{(-9.4)^2 + (34.6)^2}$
$V_R = 36\ m/s.$