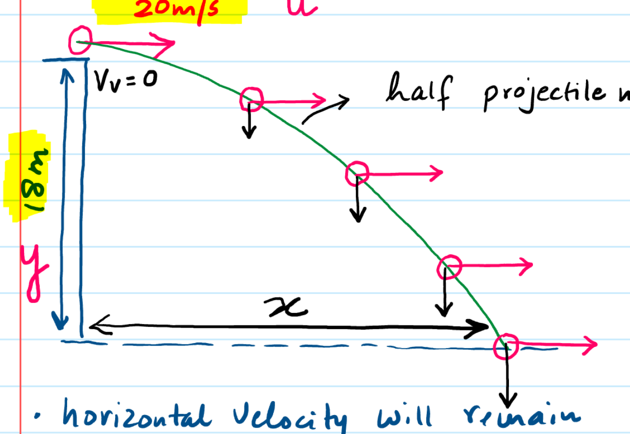
Projectile motion (Theory Continued)

26 October 2020 08:40

Previous class
full projectile motion
In todays class we will discuss
Half projectile motion :-

- A particle is projected **horizontally** from the top of a cliff 18 m high as shown with an initial velocity of 20 m/s

20 m/s u



- horizontal velocity will remain constant throughout (i.e 20 m/s)
- Since it is projected **horizontally** ∴ its **initial vertical velocity** will be **zero**. However as it moves, the vertical velocity starts to increase.

$t = \sqrt{\frac{2y}{g}}$

$x = u \times \sqrt{\frac{2y}{g}}$

(i) Cal time taken (t) to reach the ground. $+\downarrow$ $s = ut + \frac{1}{2}at^2$

$18 = 0 + \frac{1}{2}(9.81)t^2$ ∴ $t = 1.92\,s$

general formula

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

$y = 0 + \frac{1}{2}gt^2$ $\quad t = \sqrt{\frac{2y}{g}}$

(ii) Cal the horizontal distance travelled (x)

$\overset{+}{\rightarrow}$ $d = s \times t$

$x = 20 \times 1.92$

$x = 38.4\,m$

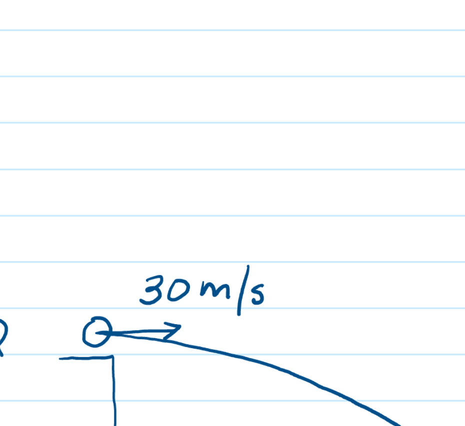
general formula

$\overset{+}{\rightarrow}$ $d = s \times t$

$x = u \times \sqrt{\frac{2y}{g}}$

$x = u\sqrt{\frac{2y}{g}}$

Q



find u = ??

g.f $x = u \times \sqrt{\frac{2y}{g}}$

$25 = u \times \sqrt{\frac{2(10)}{9.81}}$

$u = 17.5\,m/s$

without g. formula

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

$10 = 0 + \frac{1}{2}(9.81)t^2$

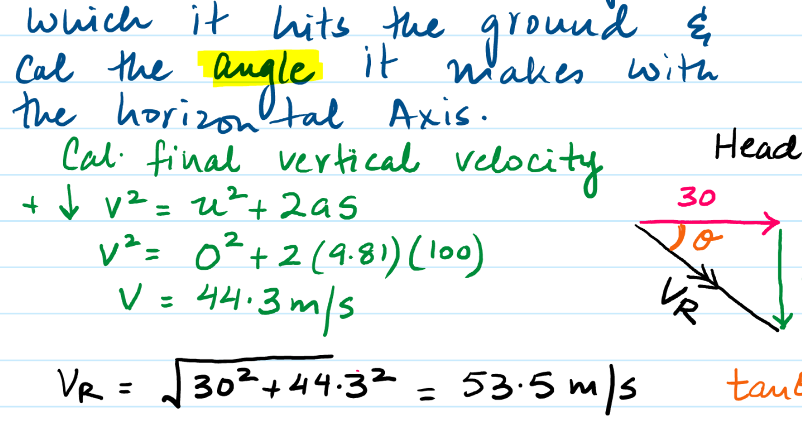
$t = 1.43$

$\overset{+}{\rightarrow}$ $d = s \times t$

$25 = u \times 1.43$

$u = 17.5\,m/s$

Q



(i) find the **resultant** velocity with which it hits the ground & cal the **angle** it makes with the horizontal Axis.

Cal. final vertical velocity

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

$v^2 = 0^2 + 2(9.81)(100)$

$v = 44.3\,m/s$

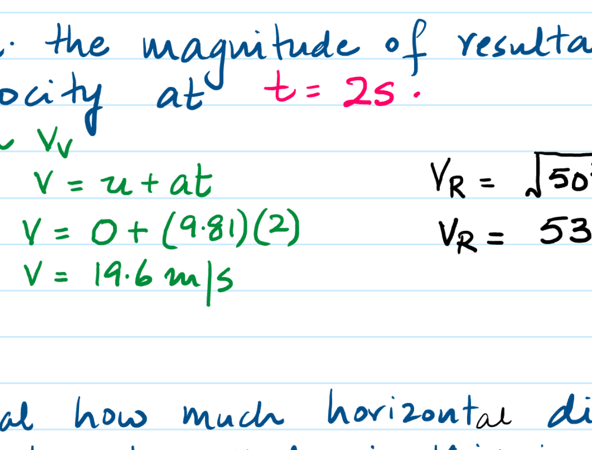
Head to Tail

$V_R = \sqrt{30^2 + 44.3^2} = 53.5\,m/s$

$\tan\theta = \frac{44.3}{30}$

$\theta = 56°$

Q :-



- Cal. the magnitude of resultant velocity at t = 2s.

Cal V_v

$+\downarrow$ $v = u + at$

$v = 0 + (9.81)(2)$

$v = 19.6\,m/s$

$V_R = \sqrt{50^2 + 19.6^2}$

$V_R = 53.7\,m/s$

- Cal how much horizontal distance it has travelled at this instant.

$\overset{+}{\rightarrow}$ $d = s \times t$

$d = 50 \times 2 = 100\,m$

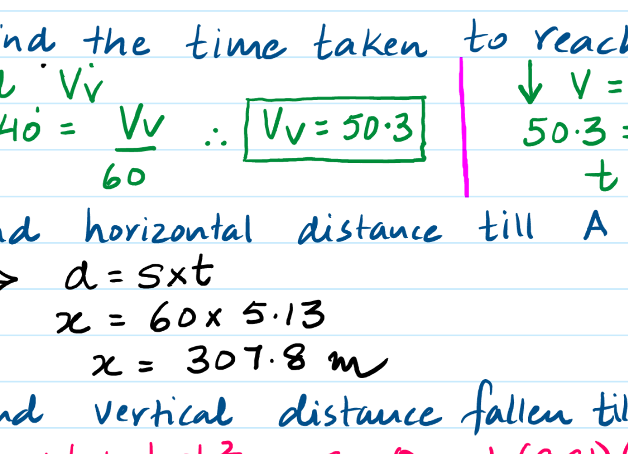
- Cal how much vertical distance has it fallen ?

$+\downarrow$ $s = ut + \frac{1}{2}at^2$, $\quad s = 0 + \frac{1}{2}(9.81)(2)^2 = 19.6\,m$

$+\downarrow$ $v^2 = u^2 + 2as$, $\quad 19.6^2 = 0^2 + 2(9.81)s = 19.6\,m$

g.formula $x = u\sqrt{\frac{2y}{g}}$, $\quad 100 = 50\sqrt{\frac{2y}{9.81}} = 19.6\,m$

Q :-



Q At "A" ball makes 40° with the horizontal

- Find the time taken to reach A

find V_v

$\tan 40° = \frac{V_v}{60}$ ∴ $V_v = 50.3$

$\downarrow$ $v = u + at$

$50.3 = 0 + (9.81)t$

$t = 5.13\,s.$

- Find horizontal distance till A

$\rightarrow$ $d = s \times t$

$x = 60 \times 5.13$

$x = 307.8\,m$

- Find vertical distance fallen till A

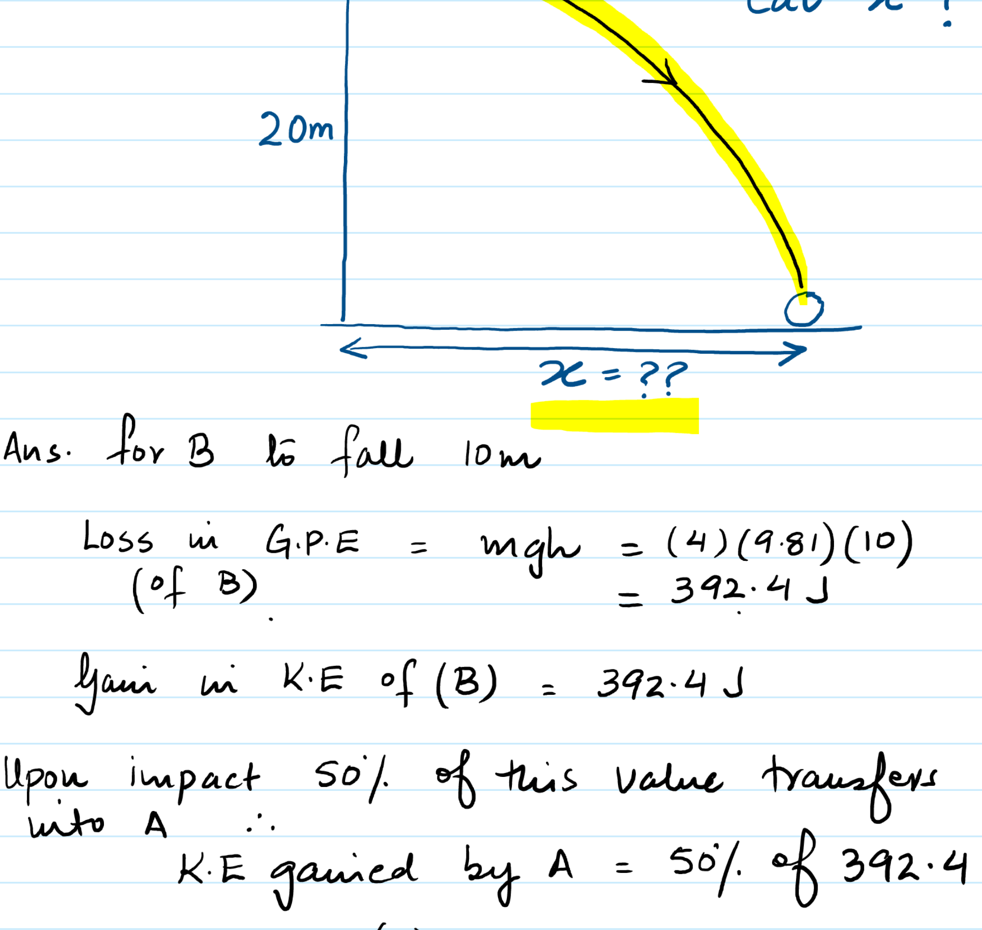
$+\downarrow$ $s = ut + \frac{1}{2}at^2$; $s = 0 + \frac{1}{2}(9.81)(5.13)^2 = 129.1\,m$

$+\downarrow$ $v^2 = u^2 + 2as$; $50.3^2 = 0^2 + 2(9.81)(s) = 129.1\,m$

general formula $x = u\sqrt{\frac{2y}{g}}$

$307.8 = 60\sqrt{\frac{2(y)}{9.81}} = 129.1\,m$

Q



If B transfers 50% of its energy to A upon impact. Cal x ?

Ans. for B to fall 10m

Loss in G.P.E (of B) = mgh = (4)(9.81)(10)
= 392.4 J

Gain in K.E of (B) = 392.4 J

Upon impact 50% of this value transfers into A ∴

K.E gained by A = 50% of 392.4

K.E (A) = 196.2 J

$\frac{1}{2}mv^2 = 196.2$ $\quad m = 2\,Kg$

$v = 14\,m/s$

without g. formula

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

$20 = 0 + \frac{1}{2}(9.81)t^2$

$t = 2.02\,s$

$\overset{+}{\rightarrow}$ $d = s \times t$

$x = 14 \times 2.02$

$x = 28.3\,m$

with g. formula

$x = u \times \sqrt{\frac{2y}{g}}$

$x = 14 \times \sqrt{\frac{2(20)}{9.81}}$

$x = 28.3\,m$