

Projectile motion (Theory Continued)

26 October 2020 08:40

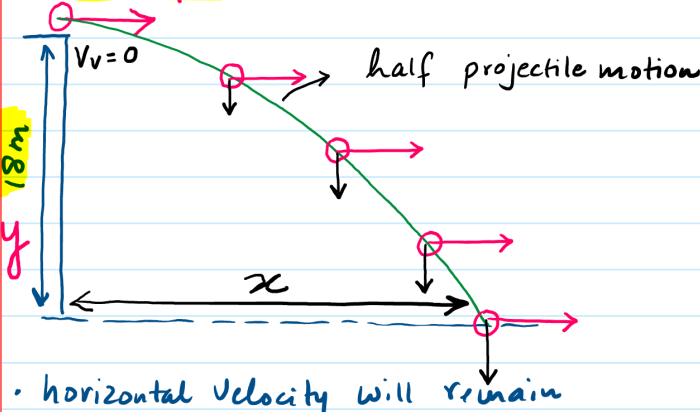
Previous class

full projectile motion

In today's class we will discuss

Half projectile motion :

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



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

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

$$18 = 0 + \frac{1}{2}(9.8)t^2 \therefore t = 1.92s$$

general formula

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

$$y = 0 + \frac{1}{2}gt^2$$

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

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

(ii) Cal the horizontal distance travelled (x)

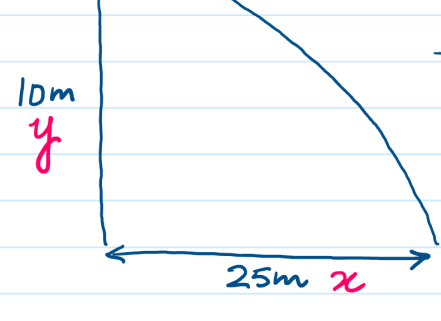
$$d = s \times t$$

$$x = 20 \times 1.92$$

$$x = 38.4m$$

general formula $d = s \times t$
 $x = u \times \sqrt{\frac{2y}{g}}$

Q. $u = ??$ (find)



find $u = ??$

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

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

$$u = 17.5 \text{ m/s}$$

without g formula

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

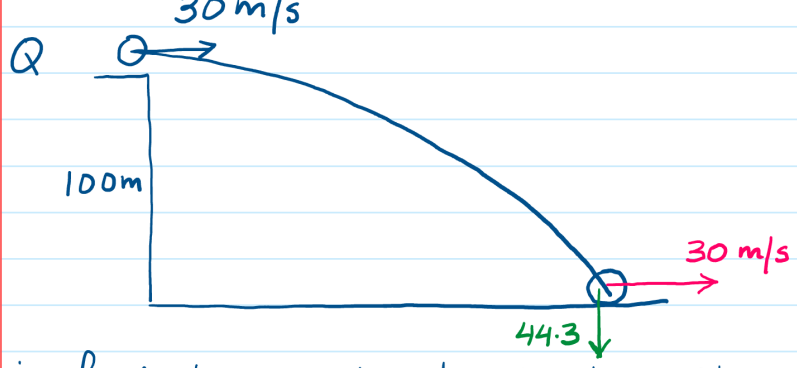
$$10 = 0 + \frac{1}{2}(9.8)t^2$$

$$t = 1.43$$

$$d = s \times t$$

$$25 = u \times 1.43$$

$$u = 17.5 \text{ m/s}$$



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

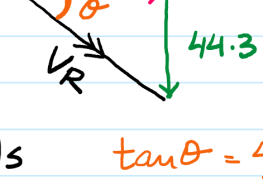
Cal final vertical velocity

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

$$v^2 = 0^2 + 2(9.8)(100)$$

$$v = 44.3 \text{ m/s}$$

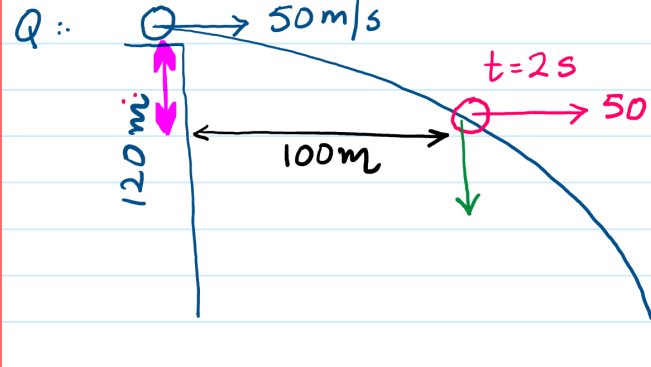
Head to Tail



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

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

$$\theta = 56^\circ$$



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

Cal V_v

$$v = u + at$$

$$v = 0 + (9.8)(2)$$

$$v = 19.6 \text{ m/s}$$

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

$$V_R = 53.7 \text{ m/s}$$

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

$$d = s \times t$$

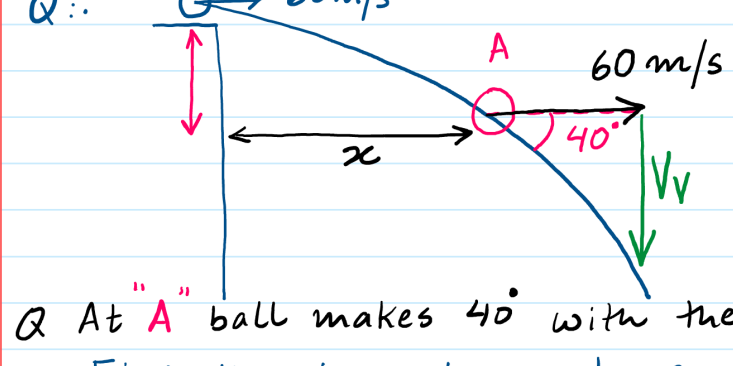
$$d = 50 \times 2 = 100m$$

Cal how much vertical distance has it fallen?

$$s = ut + \frac{1}{2}at^2, \quad s = 0 + \frac{1}{2}(9.8)(2)^2 = 19.6m$$

$$v^2 = u^2 + 2as, \quad 19.6^2 = 0^2 + 2(9.8)s = 19.6m$$

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



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

Find the time taken to reach A

find V_v

$$\tan 40^\circ = \frac{V_v}{60} \therefore V_v = 50.3$$

$$v = u + at$$

$$50.3 = 0 + (9.8)t$$

$$t = 5.13s$$

Find horizontal distance till A

$$d = s \times t$$

$$x = 60 \times 5.13$$

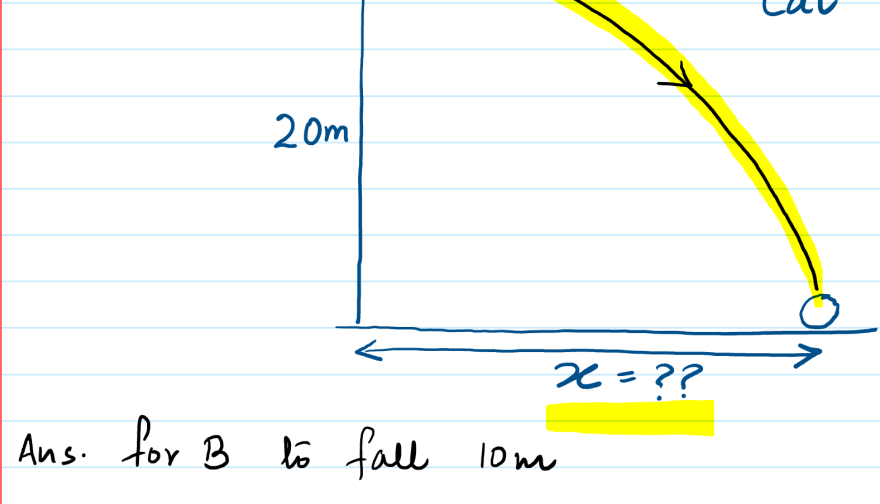
$$x = 307.8m$$

Find vertical distance fallen till A

$$s = ut + \frac{1}{2}at^2; \quad s = 0 + \frac{1}{2}(9.8)(5.13)^2 = 129.1m$$

$$v^2 = u^2 + 2as; \quad 50.3^2 = 0^2 + 2(9.8)(s) = 129.1m$$

general formula $x = u \sqrt{\frac{2y}{g}}$
 $307.8 = 60 \sqrt{\frac{2(y)}{9.81}} = 129.1m$



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

Ans. for B to fall 10m

$$\text{Loss in G.P.E of B} = mgh = (4)(9.8)(10) = 392.4J$$

$$\text{Gain in K.E of B} = 392.4J$$

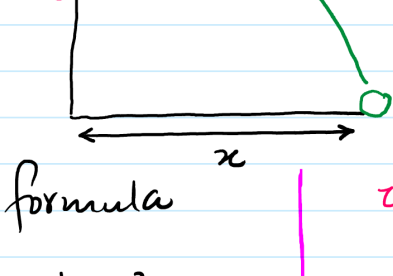
Upon impact 50% of this value transfers into A

$$\text{K.E gained by A} = 50\% \text{ of } 392.4$$

$$\text{K.E (A)} = 196.2J$$

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

$$v = 14 \text{ m/s}$$



without g formula

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

$$20 = 0 + \frac{1}{2}(9.8)t^2$$

$$t = 2.02s$$

$$d = s \times t$$

$$x = 14 \times 2.02$$

$$x = 28.3m$$

with g formula

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

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

$$x = 28.3m$$