

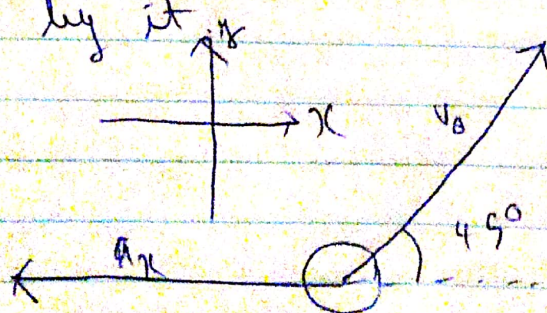
PHYS-230 LAB

LAB QUIZ #2

The Dardanelles gun was a cannon used by the Ottomans during the Siege of Constantinople (1453 AD). It had the longest range of any weapon of its time, capable of firing cannonballs at 124 m/s . The cannon was fired from the ground at an angle of 45° above the horizontal and the ground was completely flat.

We model the effect of air resistance on the cannonball along the horizontal axis as creating an acceleration $a_x = -0.12t \text{ m/s}^2$ (see diagram below), where t is the time measured from the gun firing. Constantinople's knights want to charge against the Dardanelles gun, at a constant galloping speed of 14 m/s , directly towards it. The gun's operator wants to fire the cannon and impact the knights, to prevent them from reaching the gun. Determine:

- The range of the Dardanelles gun.
- The distance the knights must be from the gun when the cannonball is fired if they are to be hit by it.



Ans. (A) Time of flight will remain as before :-

$$T = \frac{2u \sin \theta}{g} = \frac{2 \times 125 \times \sin 45^\circ}{\frac{9.8}{4.9}}$$

$$T = \underline{\underline{18.045}}$$

Now, in horizontal direction :-

$$\frac{dv}{dt} = -(0.12)t$$

$$\Rightarrow \int_{v_0 \cos 45^\circ}^{v_x} dv = -0.12 \int_0^t t dt$$

$$\Rightarrow v_x - v_0 \cos 45^\circ = -0.12 \left(\frac{t^2}{2} \right)$$

$$\Rightarrow v_x = \frac{125}{\sqrt{2}} - (0.06)t^2$$

$$\Rightarrow \frac{dx}{dt} = 88.39 - (0.06)t^2 \quad \text{--- (1)}$$

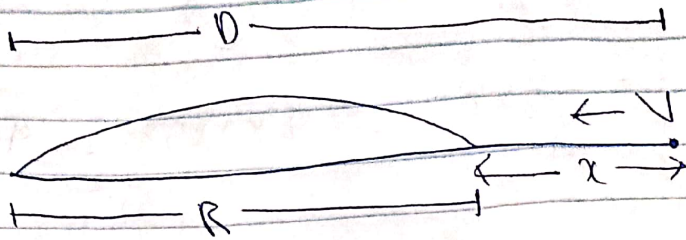
$$\Rightarrow \int_0^R dx = \int_0^T (88.39) dt - \int_0^T (0.06)t^2 dt$$

$$\Rightarrow R = (88.39) \times (18.04) - \frac{(0.06) \times (18.04)^3}{3}$$

$$R = \underline{\underline{1477.1 \text{ m}}}$$

\therefore Range of the Scudamelles Gun = 1477.1 m

(b)



$$x = VT$$
$$= (14 \times 18.04) \text{ m}$$

$$x = \underline{\underline{252.56 \text{ m}}}$$

$$\therefore \text{Distance, } D = x + R$$
$$= 1477.1 + 252.56$$
$$= \underline{\underline{1729.7 \text{ m}}}$$

Distance the knights must be from the gun when the cannonball is fired, if they are to be hit by it = 1729.7 m

(3)