Assignment 1 (Due Friday October 9, 2020 @ 11:59 PM)

Chloe Ma - 101122600133
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Part 1: Physics Problem

1. Over a completely flat surface a **thermal detonator (Star Wars)** is thrown by a wookiee (a member of the rebel alliance) towards a group of imperial stormtroopers. The thermal detonator always leaves the wookiee's hand with a speed of 95m/s and the thermal detonator has a mass of 2.2Kg.
   a) Suppose that the Stormtroopers are 485m away. What is the correct **angle** for the wookiee to throw the thermal detonator so that it reaches the Stormtroopers. (10 Marks)
   b) What is the **maximum distance** the thermal detonator could travel? (10 Marks)
   c) Include a **short document (report)** that includes a **diagram** that illustrates the problem and your solution. Ensure you include appropriate labels and **show your work** (10 Marks)

a) Let x represent horizontal distance
Let y represent vertical distance
Let v represent velocity
Let t represent time
Let g represent gravity of $-9.8\ m/s^2$

y direction

$v_1 = 95\sin\theta$
$v_2 = ?$
$a = -9.8\ m/s^2$
$\Delta d = 0\ m$ (completely flat surface)
$\Delta t = t$

x direction

$v_x = 95\cos\theta$
$\Delta d_x = 485\ m$
$\Delta t = t$

$v = \frac{\Delta d}{\Delta t}$
$95\cos\theta = \frac{485}{t}$
$t = \frac{485}{95\cos\theta}$

$\Delta d = vt + \frac{1}{2}at^2$
$0 = 95\sin\theta t - 4.9t^2$
$0 = 95\sin\theta\left(\frac{485}{95\cos\theta}\right) - 4.9\left(\frac{485}{95\cos\theta}\right)^2$ ← Replace t
$0 = 485\tan\theta - \left(\frac{4.9\cdot 485^2}{95^2\cos^2\theta}\right)$ ← Simplify
$0 = 485\tan\theta - \frac{127.7121884}{\cos^2\theta}$ ← $\frac{1}{\cos^2\theta} = \sec^2\theta$
$0 = 485\tan\theta - 127.7121884\sec^2\theta$ ← $\sec^2\theta = 1+\tan^2\theta$
$0 = 485\tan\theta - 127.7121884(1+\tan^2\theta)$ ← expand equation
$0 = -127.7121884\tan^2\theta + 485\tan\theta - 127.7121884$ ← quadratic equation

Quadratic Equation

$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$x = \frac{-485 \pm \sqrt{(-485)^2 - 4(-127.7121884)(-127.7121884)}}{2(-127.7121884)}$

$x = \frac{-485 \pm \sqrt{169983.3877}}{-255.4243768}$

$x_1 = \frac{-485 + 412.2904167}{-255.4243768}$ $\quad x_2 = \frac{-485 - 412.2904167}{-255.4243768}$

$x_1 = 0.28466188$ $\quad x_2 = 3.512939634$

Finding the Angle

$\tan\theta = 0.28466188,\ 3.512939634$
$\therefore \theta_1 = \tan^{-1}(0.28466188) = 15.88963283^\circ$
$\theta_2 = \tan^{-1}(3.512939634) = 74.11058191^\circ$

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b) Let R represent range

Let v represent velocity

Let g represent gravity of $-9.8\ m/s^2$

$$R = \frac{V_0^2 \sin 2\theta_0}{g}$$ ← The maximum range occurs at $\theta_0 = 45°$

$$R = \frac{(95)^2 \sin(2 \cdot 45)}{|-9.8|}$$

$$R = \frac{9025 \sin 90}{9.8}$$ ← $\sin(90) = 1$

$$R = \frac{9025\,(1)}{9.8}$$

$$R \approx 920.9\ m$$

∴ The maximum distance the thermal detonator could travel is approximately 920.9 m

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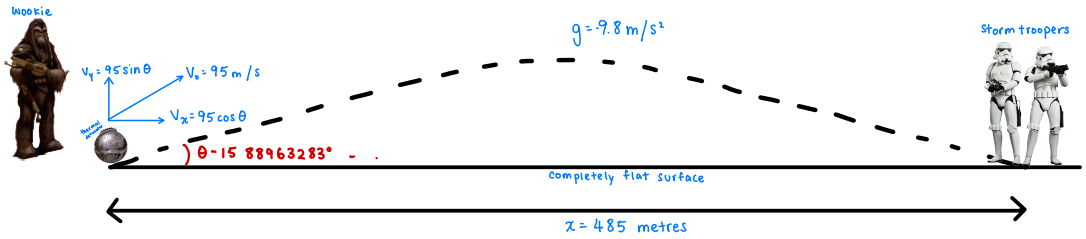
c) Scenario 1 : $\theta_1 = \tan^{-1}(0.28466188) = 15.88963283°$



c) Scenario 2 : $\theta_2 = \tan^{-1}(3.512939634) = 74.11058191°$