Projectile Motion

Q2- A gun shoots bullets that leave the muzzle at 207 m/s. If a bullet is to hit a target 159.9 m away at the level of the muzzle, the gun must be aimed at a point above the target. (Neglect air resistance.)

How far above the target is this point if the angle the gun makes is less than 45^{o}.

Let the angle of projection be θ then as the horizontal range is given by

$$R = \frac{v_0^2 \sin 2\theta}{g}$$

gives $159.9 = 207^2 \sin(2\theta)/ 9.8$

Or $\sin(2\theta) = 0.03657$

gives $2\theta = 2.0958^0$

And $\theta = 1.05^0$

As the gun aimed at this angle then the height of aiming is given by (as in previous problem)

$$\tan\theta = h/R$$

Or $0.01829 = h/159.9$

Or $h = 2.9$ m

How far above the target is this point if the angle the gun makes is greater than 45^0

As we know that $\sin\theta = \sin(180^0 - \theta)$ for the same value the other angle of projection is given by

$$\sin(2\theta) = 180^0 - 2.0958^0$$

Or $2\theta = 177.9^0$

Or $\theta = 88.95^0$

And hence $\tan\theta = H/R$ will give

$$H = R^* \tan\theta = 159.9*54.6766 = 8741.839 \text{ m}$$
$$H = 8741.8 \text{ m}$$