

D:(30 pts) Elevated Projectile Range

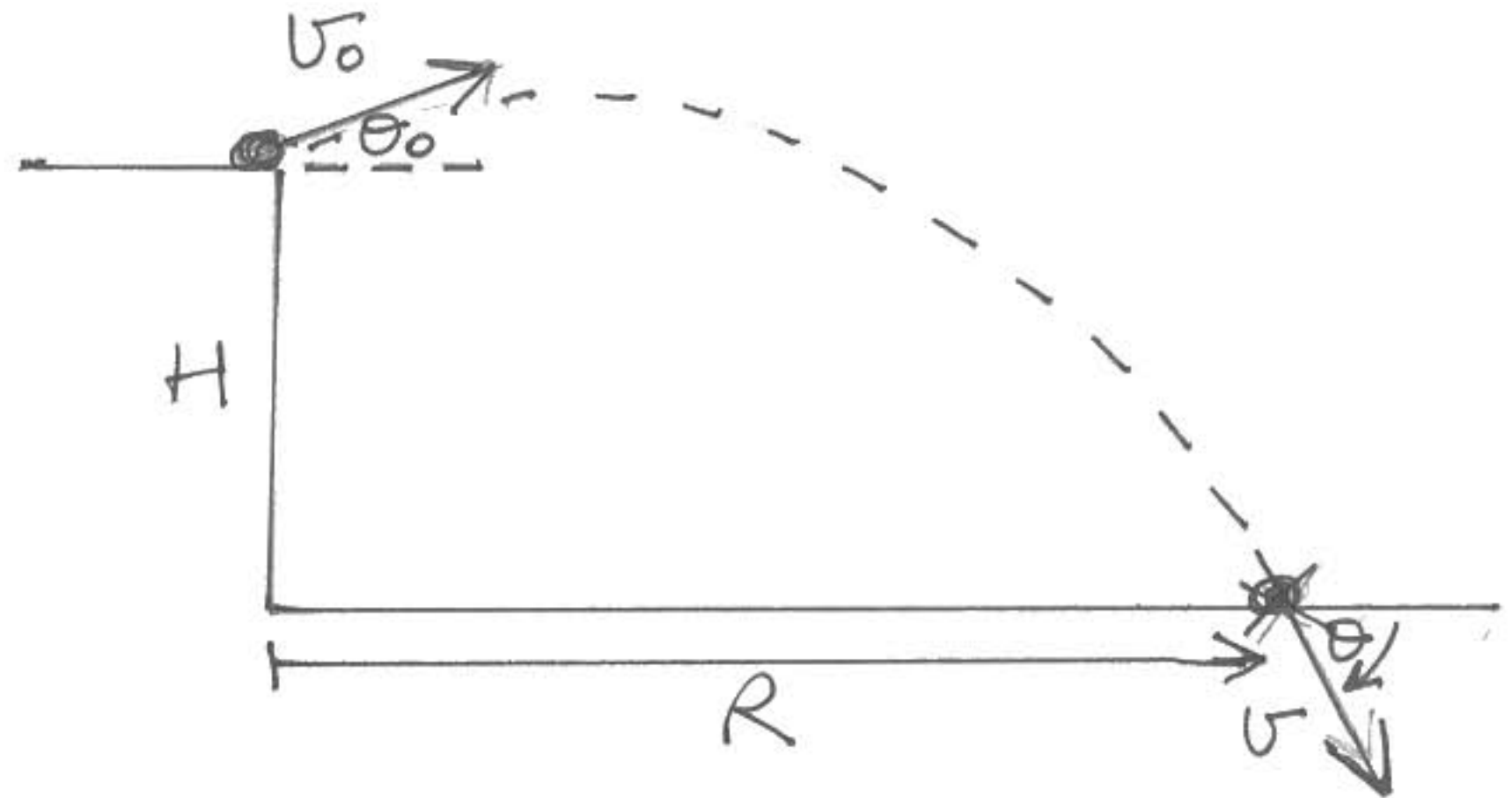
A rock (the projectile) is fired from an elevation of $H = 20\text{m}$, with initial speed $v_0 = 40\text{m/s}$ at an angle $\theta_0 = 30^\circ$. What is rock's time of flight T ? What is the range R of the rock? Consider the moment of impact, i.e. the time T when the rock hits the ground. What is the speed v of the rock at that time? What angle θ does the velocity vector make from the horizontal at that time?

•(12pts) $T =$ _____

•(6pts) $R =$ _____

•(6pts) $v =$ _____

•(6pts) $\theta[\text{degrees}] =$ _____



D:(30 pts) Elevated Projectile Range

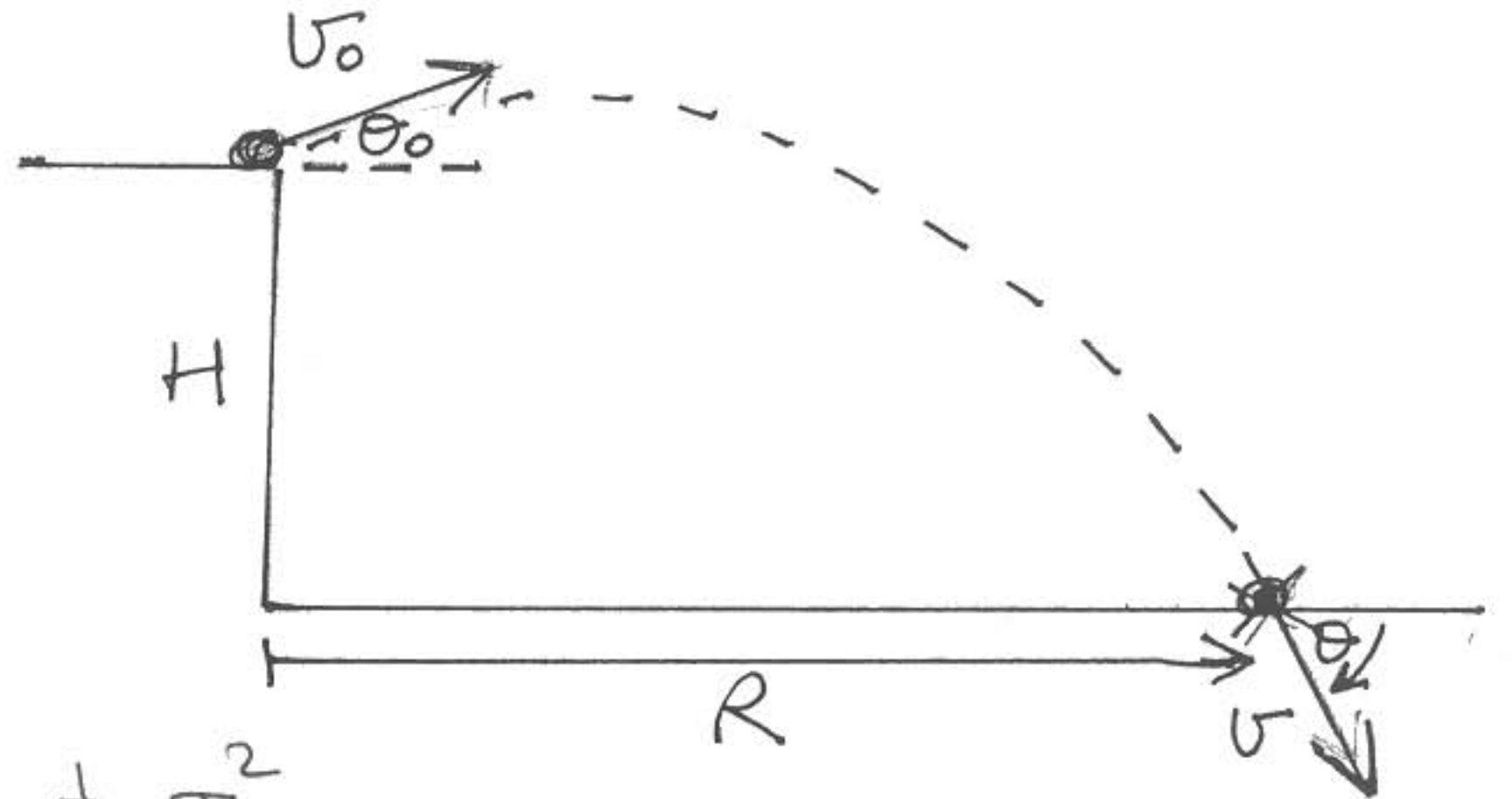
A rock (the projectile) is fired from an elevation of $H = 20\text{m}$ with initial speed $v_0 = 40\text{m/s}$ at an angle $\theta_0 = 30^\circ$. What is rock's time of flight T ? What is the range R of the rock? Consider the moment of impact, i.e. the time T when the rock hits the ground. What is the speed v of the rock at that time? What angle θ does the velocity vector make from the horizontal at that time?

•(12pts) $T = \underline{4.91\text{ s}}$

•(6pts) $R = \underline{170\text{ m}}$

•(6pts) $v = \underline{44.6\text{ m/s}}$

•(6pts) $\theta[\text{degrees}] = \underline{39.1^\circ}$



◦ Find T :

$$0 = H + v_0 \sin \theta_0 \cdot T - \frac{1}{2} g T^2$$

$$\left(\frac{g}{2}\right) T^2 + (-v_0 \sin \theta_0) \cdot T + (-H) = 0$$

$$T = \frac{1}{g} \left\{ v_0 \sin \theta_0 \pm \sqrt{(-v_0 \sin \theta_0)^2 - 4 \left(\frac{g}{2}\right)(-H)} \right\}, \oplus \text{ sign}$$

$$= \left(\frac{v_0 \sin \theta_0}{g}\right) + \sqrt{\left(\frac{v_0 \sin \theta_0}{g}\right)^2 + \frac{2H}{g}} = \underline{4.91250\text{ s}}$$

◦ Range: $R = v_0 \cos \theta_0 \cdot T = \underline{170.174\text{ m}}$

◦ Find \vec{v} :

$$v_x = v_0 \cos \theta_0 = \underline{34.6410\text{ m/s}}$$

$$v_y = v_0 \sin \theta_0 - gT = \underline{-28.1425\text{ m/s}}$$

$$\Rightarrow v = \sqrt{v_x^2 + v_y^2} = \underline{44.6318\text{ m/s}}$$

$$\tan \theta = |v_y / v_x| = 0.812404$$

$$\theta = \underline{-39.0906^\circ}$$