STAEDTLER® No. 937 811E Engineer's Computation Pad

•22 In the 1991 World Track and Field Championships in Tokyo, Mike Powell jumped 8.95 m, breaking by a full 5 cm the 23-year long-jump record set by Bob Beamon. Assume that Powell's speed on takeoff was 9.5 m/s (about equal to that of a sprinter) and that $g = 9.80\ m/s^2$ in Tokyo. How much less was Powell's range than the maximum possible range for a particle launched at the same speed?

THE ANALYSIS FOR THIS PROJECTILE MOTION PROBLEM WAS GIVEN IN PROBLEM #23 WHERE

WE FOUND $R = \text{RANGE} = X_{max} = v_0^2 \sin 2\theta_0 / g$

1ST we find his ANGLE OF PROJECTION i.e. θ_0: THE ANGLE $\vec{v}_0$ makes WRT the HORIZONTAL

$\Rightarrow \sin 2\theta_0 = Rg / v_0^2 = 8.95\,m\,(9.80\,\frac{m}{s^2}) / (9.5\,\frac{m}{s})^2$

$\Rightarrow \theta_0 = 38.2°$, and we REALIZE THAT A GREATER RANGE CAN BE OBTAINED WITH $\theta_0 = 45°$ BECAUSE THEN $R = v_0^2[\sin 90° = 1 = \text{the LARGEST}]/g$ IS A MAXIMUM

IF WE HAD NOT SEEN THIS AS OBVIOUS, THEN WE COULD FIND THE MAIMUM RANGE FROM DIFFERENTIATION:

$\frac{dR}{d\theta_0} = 0$ when R IS MAXIMUM WRT θ_0 — slope = 0 at a MAX

$\frac{dR}{d\theta_0} = \frac{d}{d\theta_0}\left(v_0^2 \sin 2\theta_0 / g\right) = \frac{v_0^2}{g}(\cos 2\theta_0)(2) \stackrel{?}{=} 0$

THIS occurs when $\cos 2\theta_0 \equiv 0 \Rightarrow 2\theta_0 = 90° \Rightarrow \theta_0 = 45°$

Therefore the MAXIMUM RANGE for a given v_0

$R = v_0^2 \sin 2\theta_0 / g = v_0^2 \sin 90° / g = v_0^2 / g$

$= (9.5\,m/s)^2 / 9.80 = 9.21\,m$

WISE UP MIKE & LEARN SOME PHYSICS, LIFE'S HARD WHEN YOUR STUPID!

(ACTUALLY MIKE PROBABLY WAS OPTIMUM, OR CLOSE TO IT, WHEN THE DESIGN OF A HUMAN BODY IS CONSIDERED FOR PRODUCING A v_0, AIR RESISTANCE, AND ALL THE OTHER FACTORS THAT ARE IMPLICITY COMPUTED IN THE BRAIN OF A TRAINED ATHELETE.)