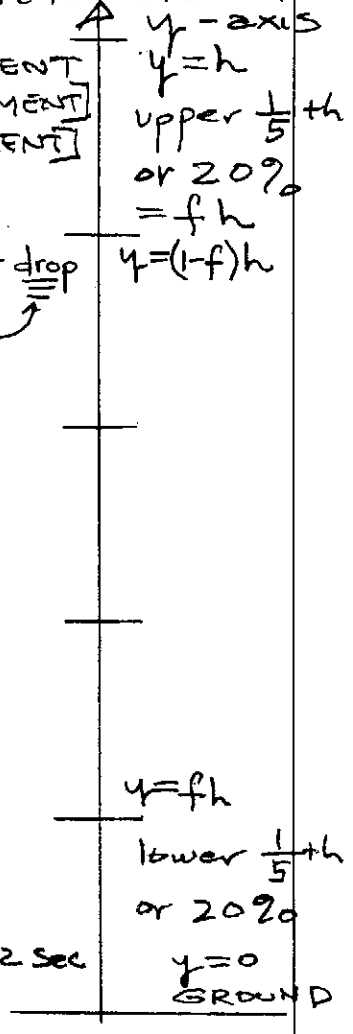
STAEDTLER® No. 937 811E Engineer's Computation Pad

•••64 A basketball player grabbing a rebound jumps 76.0 cm vertically. How much total time (ascent and descent) does the player spend (a) in the top 15.0 cm of this jump and (b) in the bottom 15.0 cm? Do your results explain why such players seem to hang in the air at the top of a jump?

h = HEIGHT OF JUMP = 76.0cm
f = FRACTION OF THE HEIGHT WE ARE INTERESTED IN
ie. $fh = f76.0 = 15.0\text{cm} \Rightarrow$

$$f = \frac{15.0}{76.0} = \frac{1}{5.07} = 0.197 \Rightarrow \sim 20\% \text{ of JUMP}$$

THE JUMP IS SYMMETRIC IN TIME FOR EACH VERTICAL PORTION OF THE TRAJECTORY ie. THE TIME PASSING UP & DOWN THROUGH A VERTICAL SEGMENT IS 2 × [THE TIME TO RISE THROUGH THE SEGMENT] or 2 × [THE TIME TO FALL THROUGH THE SEGMENT]



$\Rightarrow$ TOTAL TIME OF JUMP $= 2t_h$; obtain t_h via

$$h = \tfrac{1}{2} g t_h^2 \Rightarrow t_h = \sqrt{\frac{2h}{g}} = \text{TIME TO FALL or drop DISTANCE } h$$

THIS WORKS BECAUSE v(@ top or $y=h$) $\equiv 0$

TIME TO FALL DISTANCE fh via

$$fh = \tfrac{1}{2} g t_{fh}^2 \Rightarrow t_{fh} = \sqrt{\frac{2fh}{g}}$$

TIME TO FALL DISTANCE $(1-f)h$ via

$$(1-f)h = \tfrac{1}{2} g t_{(1-f)h}^2 \Rightarrow t_{(1-f)h} = \sqrt{\frac{2(1-f)h}{g}}$$

$t_h = 0.394\text{s}$, $t_{fh} = 0.175\text{s}$, $t_{(1-f)h} = 0.353$

a) TIME SPENT IN TOP 15.0cm OF JUMP $= 2t_{fh} = 0.35$ SEC

b) TIME SPENT IN BOTTOM 15.0 cm OF JUMP $= 2(t_h - t_{(1-f)h}) = 2(0.394 - 0.353) = 0.082$ Sec

FRACTION OF TIME SPENT IN THE TOP FRACTION, f, OF JUMP

$$= 2t_{fh} / 2t_h = \sqrt{\frac{2fh}{g}} \Big/ \sqrt{\frac{2h}{g}} = \sqrt{f} = \sqrt{0.197} = 0.444$$

ie. 44.4% of TIME

FRACTION OF TIME SPENT IN THE LOWER FRACTION, f OF JUMP

$$= \frac{2(t_h - t_{(1-f)h})}{2(t_h)} = \frac{\sqrt{\frac{2h}{g}} - \sqrt{\frac{2(1-f)h}{g}}}{\sqrt{2h/g}} = 1 - \sqrt{1-f}$$

$$= 1 - \sqrt{1-0.197} = 1 - 0.896 = 0.104 \Rightarrow 10.4\% \text{ of TIME}$$