Name Solutions **At an Angle Projectile Problems**

Show ALL work including variable identification for full credit

1) A football is kicked to start a game. It reaches a maximum height of 30 m. The horizontal component of its velocity is 20 m/s. What is the hang time?

$d = v_i t + \frac{1}{2} a t^2 \Rightarrow 30 = 0 + \frac{1}{2}(9.8) t^2$

$30 = 4.9 t^2$

$\frac{30}{4.9} = t^2 \Rightarrow \sqrt{\frac{30}{4.9}} = t = 2.5\text{s} + 2.5\text{s} = \boxed{5.0\text{s}}$

DOWN UP

Y → $d = 30\text{m}$, $a = 9.8\text{m/s}^2$ (ON THE WAY DOWN), $v_i = 0\text{m/s}$, $t = ?$

What are the horizontal and vertical components of the velocity at the end of the flight?

X: $V = \boxed{20\frac{\text{m}}{\text{s}}}$ CONSTANT

Y: $v_f = v_i + at$ (DOWN FROM HIGH POINT)

$v_f = 0 + (9.8)(2.5) = \boxed{24.5\text{m/s}}$

What are the horizontal and vertical components of the velocity at the beginning of the flight?

X: $V = 20\frac{\text{m}}{\text{s}}$ CONSTANT

Y: $v_f = v_i + at$ (UP FROM BEGINNING TO HIGH POINT)

$0 = v_i + (-9.8)(2.5) \Rightarrow 0 = v_i - 24.5$

$\boxed{24.5\text{m/s} = v_i}$

What is the range of the football?

X: $d = vt = (20)(5) = \boxed{100\text{m}}$

2) A _____(fill in a noun) was launched from the ground at an angle. Its hang time was 24 s. Its range was 125 m. What was its maximum height?

$d = v_i t + \frac{1}{2} a t^2$

$d = 0 + \frac{1}{2}(9.8)(12)^2$

$d = 4.9(12)^2 = \boxed{706\text{m}}$

Y → $t = 12\text{s}$ (ON THE WAY DOWN), $v_i = 0\text{m/s}$, $a = 9.8\text{m/s}^2$, $d = ?$

What was the vertical component of the final velocity?

Y → $v_f = v_i + at$ (ON THE WAY DOWN)

$v_f = 0 + (9.8)(12)$

$v_f = \boxed{118\frac{\text{m}}{\text{s}}}$

What was the horizontal component of the velocity?

X → $d = 125\text{m}$, $t = 24\text{s}$

$d = vt \Rightarrow 125 = v(24)$

$\frac{125}{24} = v = \boxed{5.2\frac{\text{m}}{\text{s}}}$

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3) A pumpkin is launched with a catapult. It reaches a maximum height of 40 m. The horizontal component of its velocity is 30 m/s. What is the hang time?

Y → $d = 40m$ (ON THE WAY DOWN)
$v_i = 0 \frac{m}{s}$
$a = 9.8 m/s^2$
$t = ?$

$d = v_i t + \frac{1}{2} a t^2 \Rightarrow 40 = 0 + \frac{1}{2}(9.8) t^2$

$40 = 4.9 t^2 \Rightarrow \frac{40}{4.9} = t^2 \Rightarrow \sqrt{\frac{40}{4.9}} = t = 2.9s + 2.9s = \boxed{5.8s}$
(DOWN) (UP)

What are the horizontal and vertical components of the velocity at the end of the flight?

X
$v = \boxed{30 \frac{m}{s}}$
CONSTANT

Y
$t = 2.9s$ (ON THE WAY DOWN)
$a = 9.8 \frac{m}{s^2}$
$v_i = 0 m/s$

$v_f = v_i + at$
$v_f = 0 + (9.8)(2.9) = \boxed{28.4 \frac{m}{s}}$

What are the horizontal and vertical components of the velocity at the beginning of the flight?

X
$v = \boxed{30 \frac{m}{s}}$
CONSTANT

Y
$t = 2.9s$ (ON THE WAY UP TO THE HIGH POINT)
$a = -9.8 m/s^2$
$v_f = 0 m/s$
$v_i = ?$

$v_f = v_i + at$
$0 = v_i + (-9.8)(2.9)$
$0 = v_i + (-28.4) \Rightarrow v_i = \boxed{28.4 m/s}$

What is the range of the pumpkin? Or, in other words, how far away does it get smashed to pieces?

X →
$d = vt$
$d = (30)(5.8) = \boxed{174m}$

4) A snowboarder left the snowy ground at an angle. Their hang time was 8.0 s. Their range was 120 m.

What was it's maximum height?

Y → $t = 4.0s$ (ON THE WAY DOWN)
$a = 9.8 m/s^2$
$v_i = 0 m/s$
$d = ?$

$d = v_i t + \frac{1}{2} a t^2$
$d = 0 + \frac{1}{2}(9.8) t^2$
$d = 4.9(4)^2 = \boxed{78.4m}$

What was the vertical component of the final velocity?

Y →
$v_i = 0 m/s$ (ON THE WAY DOWN FROM HIGH POINT)
$a = 9.8 m/s^2$
$t = 4.0s$
$v_f = ?$

$v_f = v_i + at$
$v_f = 0 + (9.8)(4)$
$\boxed{v_f = 39.2 m/s}$

What was the horizontal component of the velocity?

X →
$d = 120m$
$t = 8s$

$d = vt$
$120 = v(8)$
$\frac{120}{8} = v = \boxed{15 \frac{m}{s}}$

1) 2.5 x2 = 5 s ‹› horizontal 20 m/s vertical 24.5 m/s ‹› horizontal 20 m/s vertical 24.5 m/s ‹› 100 m 2) 706 m ‹› 118 m/s ‹› 5.2 m/s

3) 2.9 x 2 = 5.8 s ‹› horizontal 30 m/s vertical 28.4 m/s ‹› horizontal 30 m/s vertical 28.4 m/s ‹› 174 m 4) 78.4 m ‹› 39.2 m/s ‹› 15 m/s