Key

PHYS 1311: In Class Problems
Chapter 2, Set I
Jan. 18, 2018

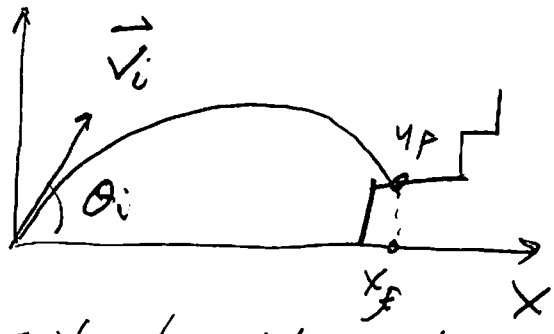
Problem 1. A soccer ball is kicked at an angle of 40.0° with respect to the horizontal with a velocity magnitude of 43.0 m/s, but towards the bleachers. If it hits the bleachers at a height of 6.00 m above the ground determine: (a) the total time of flight, (b) the total horizontal distance from the launch point to where it hit the bleachers, and (c) the final velocity (give in components).

$\vec{V}_i = 43\,m/s \text{ @ } 40° \rightarrow V_{xi} = V_i\cos\theta_i = V_{xf}$

$t_i = 0,\ x_i = 0,\ y_i = 0 \quad V_{yi} = V_i\sin\theta_i$

$y_f = 6.00\,m,\ t_f = ?,\ x_f = ?$

$V_{yf} = ?$



use y-direction kinematics

$y_f = y_i + V_{yi}t_f - \frac{1}{2}gt_f^2$

$y_f = 0 + V_i\sin\theta_i t_f - \frac{1}{2}gt_f^2$

or $t_f^2 - \frac{2V_i\sin\theta_i}{g} + \frac{2y_f}{g} = 0$

quadratic equation

$az^2 + bz + c = 0$

$z = \frac{-b}{2a} \pm \frac{\sqrt{b^2-4ac}}{2a}$

$a = 1,\ b = -2V_i\sin\theta_i/g,\ c = \frac{2y_f}{g}$

$t_f = \frac{V_i\sin\theta_i}{g} \pm \sqrt{\frac{V_i^2\sin^2\theta_i}{g^2} - \frac{2y_f}{g}}$

$= 2.82 \pm 2.594\,s = \boxed{5.41\,s}$

$x_f = V_{xi}t_f = V_i\cos\theta_i t_f$

$= (43)\cos 40°(5.41) = \boxed{178\,m}$

$V_{yf} = V_{yi} - gt_f = V_i\sin\theta_i - gt_f$

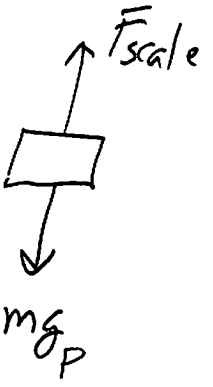
$= (43)\sin 40° - (9.8)(5.41) = -25.3\,m/s$

$\vec{V}_f = \langle 32.94, -25.3, 07\ m/s$

Problem 2. You land your spacecraft on an Earth-like planet and decide to use a scale to weigh a book with a mass of 2.00 kg. When placed on the planet's surface, the scale indicates that the book weighs 40.0 N. (a) Draw a free-body diagram of the book labeling all forces acting on it. (b) Determine the force due to gravity acting on the book. (c) Determine the force due to the scale acting on the book. (d) Find the acceleration due to gravity on the surface of the planet. Give all quantities in 3D vector notation. (This is called a Super Earth. Do you think it would be pleasant to live there?)

(other side)

a) FBD



b) Newton's 2nd Law

$+\uparrow \Sigma F_y = ma_y = 0$ (at rest)

$F_{scale} - mg_p = 0$

$F_{scale} = 40N$

$mg_p = F_{scale} = 40N$

$g_p = \frac{F_{scale}}{m} = \frac{40N}{2.0kg} = 20 m/s^2$

b) $\vec{F_g} = \langle 0, -40.0 \rangle N$

c) $\vec{F}_{scale} = \langle 0, 40.0 \rangle N$

d) $\vec{g}_p = 20 m/s^2$

$g_p \approx g_e \rightarrow$ not pleasant