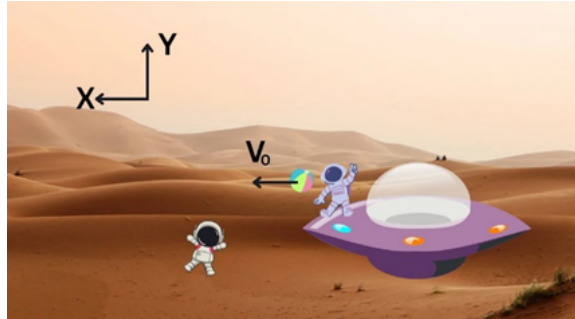


## Mars Astronauts



Finally, the ball was in the air for 6 seconds and landed 5 meters away from the spaceship. Find the velocity  $v_0$  of the ball. Take  $g_{mars} = 4 \text{ m/s}^2$ .

*Using known expressions:*

$$a = \frac{dv}{dt} \Rightarrow dv = a dt \quad (1)$$

$$\int_{v_0}^{v(t)} dv = a \int_0^t dt \quad (2)$$

$$v(t) = at + v_0 \quad (3)$$

$$v = \frac{ds}{dt} \Rightarrow ds = v dt = (v_0 + at) dt \quad (4)$$

$$\int_{s_0}^{s(t)} ds = \int_0^t (v_0 + at) dt \quad (5)$$

$$s(t) = \frac{1}{2} at^2 + v_0 t + s_0 \quad (6)$$

*Given:*

Gravitational acceleration on Mars:  $g_{mars} = 4 \text{ m/s}^2$

Airtime:  $t = 6 \text{ s}$

End position ball:  $x(t_{end}) = 5 \text{ m}$

As can be seen in the image, the positive x-axis is taken to the left. The initial position of the ball is taken to be zero, hence  $s_0 = 0 \text{ m}$ . The acceleration in the horizontal direction is also zero, thus Equation 6 becomes.

$$s(t) = \frac{1}{2} at^2 + v_0 t + s_0 \Rightarrow x(t) = v_0 t \quad (7)$$

Inserting  $t = 6$  s and  $x(6) = 5$  m gives:

$$x(t) = v_0 t \quad \Rightarrow \quad x(6) = v_0 \cdot 6 = 5 \quad \Rightarrow \quad v_0 = \frac{5}{6} \text{ m/s} \quad (8)$$

Thus the initial velocity of the ball was  $v_0 = \frac{5}{6}$  m/s.