Jan. 7, 2020



This is a 1-D problem involving Free-Fall acceleration.

A girl is standing in an elevator moving upward at 5 m/s. She places a launch toy on the floor of the elevator, which then launches a ball straight up at 5.5 m/s relative to the elevator. The girl catches the ball 1.0 s later. At the instant the ball is caught the floor of the elevator is 32 m above the ground.

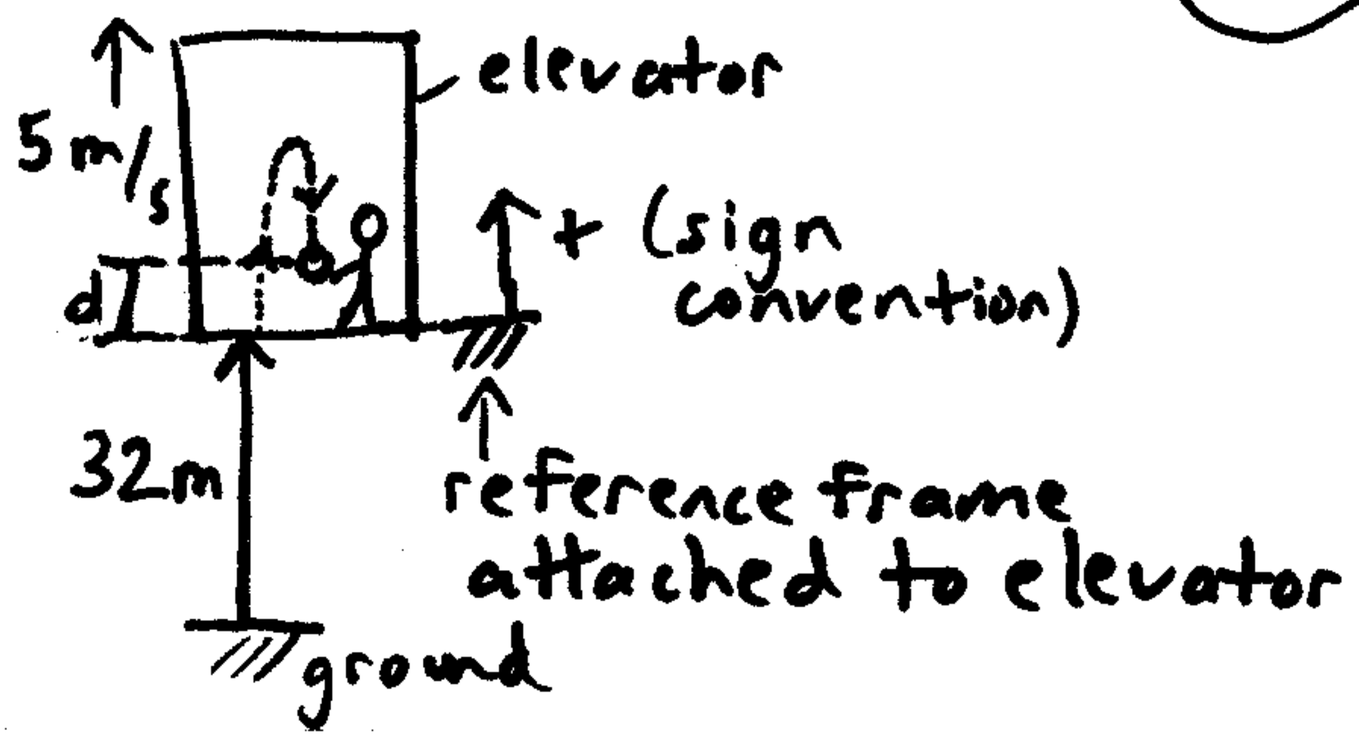
(a) What is the height of the ball above the ground at the instant it is caught?

(b) What is the height of the elevator floor above the ground at the instant the ball is launched?

Solution:

(a) To analyze the motion of the ball relative to the elevator we can attach the reference frame to the elevator, to simplify the calculations.

this can be done because the elevator is moving at constant velocity



Use the Kinematic equation:

$$d = v_1 t + \frac{1}{2} g t^2$$

$d$ = ? (displacement of ball relative to elevator floor)

($d$ when it is caught) $v_1 = 5.5\ m/s$ (initial speed of ball)

$t = 1.0\ s$ (airborne time of ball before it is caught)

$g = -9.8\ m/s^2$

Substitute:

$$d = 5.5(1.0) - \frac{1}{2}(9.8)(1.0)^2$$

$$d = 0.6\ m$$

At the instant the ball is caught it is $0.6m + 32m = 32.6\ m$, above the ground. (answer)

(b) Between the time the ball is launched and when it is caught the elevator moves a distance of $5 \times 1.0 = 5\ m$, relative to the ground. Therefore the elevator floor is 5m lower in height than when the ball is caught, which is $32m - 5m = 27\ m$ (answer)