Question #55092, Physics / Mechanics | Kinematics | Dynamics |

A ball thrown down from a balcony lands in 0.7 s on the ground at a speed of 23 m/s. Find:

a) the initial speed;

b) the height from which it was thrown;

c) the time to land if it were thrown up from the balcony with the same initial speed.

Answer:

The speed of the ball on the ground is defined by the equation:

$v = v_0 + gt$, where t – the time of fly and v_0 – the initial speed.

Thus,

a) $v_0 = v - gt = 23\ m\ s^{-1} - [9.8\ m\ s^{-2} \times 0.7\ s] = 16.14\ m/s$

b) The height equals:

$h = v_0t + 0.5gt^2 = 16.14\ m\ s^{-1} \times 0.7\ s + 0.5\ [9.8\ m\ s^{-2} \times 0.49\ s^2] = 11.298\ m + 2.401\ m = 13.7\ m$

c) If the ball goes up it travels unless its speed becomes zero:
$v = v_0 + gt_1 = 0$, t_1 – the time of fly in the opposite direction to the ground.
Therefore, $t_1 = \frac{v0}{g} = \frac{23}{9.8}\ s = 2.35\ s$

The ball travels the following distance:
$h_1 = v_0t - 0.5gt_1^2 = 23\ m\ s^{-1} \times 2.35\ s - 0.5\ [9.8\ m\ s^{-2} \times 5.5225\ s^2] = 27\ m$

After this the ball falls down with zero initial speed being of h (27 m + 13.7 m) over the ground.
The time of this free fall is found using the equation:
$h = 0.5gt_2^2$.

Thus, $t_2 = (\frac{h}{0.5g})^{0.5} = (\frac{40.7}{0.5 \times 9.8})^{0.5} = 2.88\ s$

Finally, the total time of fly is:

$t = t_1 + t_2 = 2.35\ s + 2.88\ s = 5.23\ s$