

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

A ball is thrown vertically upward. On its way up it passes point A at a speed v . On its way down it passes point B at a speed that is $(3/4)v$. Point B is 4.5 m higher than point A.

(a) What is the speed v ?

(b) What is the distance between point A and the peak height reached by the ball?

Solution:

Assumption: Air resistance is negligible

(a) Use the kinematic equation: $v_2^2 = v_1^2 + 2gd$

both moving upward $\left\{ \begin{array}{l} v_1 = v \text{ (at point A)} \\ v_2 = \frac{3}{4}v \text{ (at point B, because at a given height the downward speed is equal to the upward speed, for free-fall)} \end{array} \right.$ (1-D equation)
 $\uparrow +$ (sign convention)

$$g = -9.8 \text{ m/s}^2$$

$$d = 4.5 \text{ m (displacement between point A and B)}$$

Substitute:

$$\left(\frac{3}{4}v\right)^2 = v^2 - 2(9.8)(4.5)$$

$$v = 14.2 \text{ m/s (answer)}$$

(b) Again, use the kinematic equation:

$$v_1 = v = 14.2 \text{ m/s (at point A)}$$

$$v_3^2 = v_1^2 + 2gd$$

$$v_3 = 0 \text{ (at the peak height location)}$$

$d = ?$ (displacement between point A and the peak height location)

Substitute:

$$0 = (14.2)^2 - 2(9.8)d$$

$$d = 10.3 \text{ m (answer)}$$