Answer on Question #40942, Physics, Mechanics | Kinematics | Dynamics

a) A dentistry student is running with a constant acceleration until she reached a max speed of 5m/s. If she suddenly sees a wall 20 m in front of her, how long will it take her to come to a complete stop just before she reaches the wall, what was her acceleration?

b) If the same student decided to check what is behind the wall by stepping 5 meters back and throwing a rock so that just clears the 2-m high wall. What should be the initial velocity (magnitude and direction) by which she must throw the rock, so that it just clears the wall at its max height of trajectory?

Solution:

a)

The two kinematic equations that describe the student's motion are:

$$d = \frac{v_i + v_f}{2} t$$

$$v_f = v_i + at$$

The symbol d stands for the displacement of the student. The symbol t stands for the time for which the student moved to stop. The symbol v stands for the velocity of the student; a subscript of i after the v (as in v_i) indicates that the velocity value is the initial velocity value and a subscript of f (as in v_f) indicates that the velocity value is the final velocity value. The symbol a stands for the acceleration.

Given:

$v_i = 5\ m/s,$

$v_f = 0,$

$d = 20\ m,$

$t = ?$

$a = ?$

From above equation

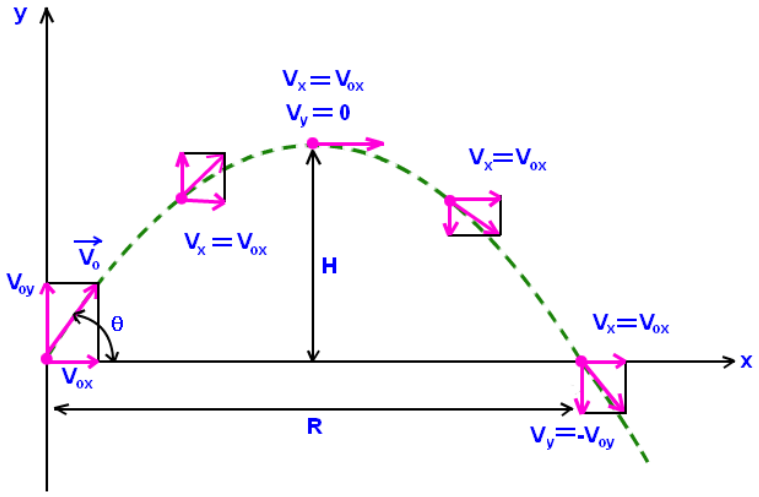
$$t = \frac{2d}{v_i + v_f} = \frac{2 \cdot 20}{5} = 8\ \text{s}$$

The acceleration is

$$a = \frac{v_f - v_i}{t} = \frac{-5}{8} = -0.625\ \text{m/s}^2$$

b)

A projectile is some object thrown in air or space. The Curved path along which the projectile travels is what is known as trajectory.



Equations related to trajectory motion (projectile motion) are given by

$$\text{Maximum height reached, } H = \frac{v_0^2 \sin^2\theta}{2g}$$

$$\text{Horizontal range, } R = \frac{v_0^2 \sin 2\theta}{g}$$

where V_o is the initial Velocity.

Given:

$H = 2\ m,$

$\frac{R}{2} = 5\ m$

$v_0 = ?$

$\theta = ?$

From equations above we obtain

$$\frac{R}{H} = \frac{v_0^2 \sin 2\theta}{g} \cdot \frac{2g}{v_0^2 \sin^2\theta} = \frac{2\sin 2\theta}{\sin^2\theta} = \frac{2\sin\theta\cos\theta}{\sin^2\theta} = \frac{2}{\tan\theta}$$

Thus,

$$\tan\theta = \frac{2H}{R} = \frac{2}{5} = 0.4$$

$$\theta = \tan^{-1} 0.4 = 21.8°$$

From first equation

$$v_0 = \frac{\sqrt{2gH}}{\sin\theta} = \frac{\sqrt{2 \cdot 9.81 \cdot 2}}{\sin 21.8°} = 16.87\ m/s$$

Answer. a) $t = 8$ s, $a = -0.625$ m/s^2;

b) $v_0 = 16.87$ m/s, $\theta = 21.8°$ above the horizont.