Question #82206, Physics / Mechanics | Relativity

A rocket is launched at an angle of 53° above the horizontal with an initial speed of 75 m/s, as shown in Figure 3-31. It moves for 23 s along its initial line of motion with an acceleration of 20 m/s2. At this time its engines fail and the rocket proceeds to move as a free body.

a) What is the rocket's maximum altitude?

(b) What is the rocket's total time of flight?

(c) What is the rocket's horizontal range?

Solution

a)

$$h_0 = \left(v_0 t + \frac{1}{2}at^2\right)\sin\theta = \left((75)(23) + \frac{1}{2}(20)(23)^2\right)\sin 53 = 5602\ m.$$

$$v = v_0 + at = (75) + 20(23) = 535\frac{m}{s}.$$

$$h = h_0 + \frac{v^2}{2g}(\sin\theta)^2$$

$$h = 5602 + \frac{535^2}{2(9.8)}(\sin 53)^2 = 15000\ m = 15\ km.$$

b)

$$T = t + t_1$$

$$-h = vt_1\sin\theta - \frac{1}{2}gt_1^2$$

$$-15000 = 535t_1\sin 53 - \frac{1}{2}9.8t_1^2$$

$$t_1 = 114\ s.$$

$$T = 23 + 114 = 137\ s.$$

c)

$$D = D_0 + vt_1\cos\theta$$

$$D_0 = \left(v_0 t + \frac{1}{2}at^2\right)\cos\theta$$

$$D = \left(v_0 t + \frac{1}{2}at^2 + vt_1\right)\cos\theta = \left((75)(23) + \frac{1}{2}(20)(23)^2 + 535(137)\right)\cos 53 = 48000\ m = 48\ km.$$