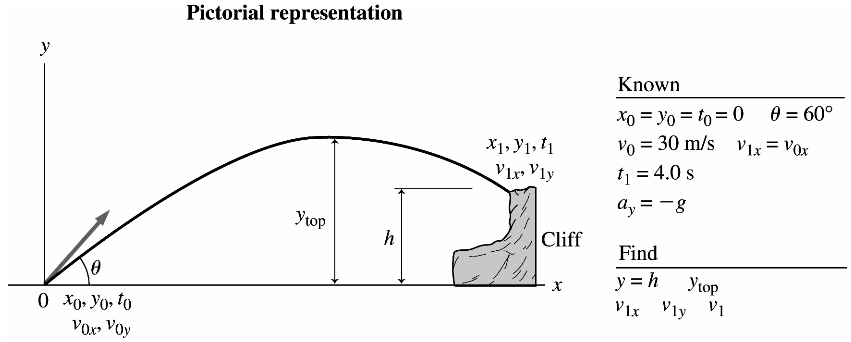
4.45. Model: The particle model for the ball and the constant-acceleration equations of motion are assumed.
Visualize:



Solve: **(a)** Using $y_1 = y_0 + v_{0y}(t_1 - t_0) + \frac{1}{2}a_y(t_1 - t_0)^2$,

$$h = 0\text{ m} + (30\text{ m/s})\sin 60°(4\text{ s} - 0\text{ s}) + \tfrac{1}{2}(-9.8\text{ m/s}^2)(4\text{ s} - 0\text{ s})^2 = 25.5\text{ m}$$

The height of the cliff is 26 m.
(b) Using $(v_y^2)_{top} = v_y^2 + 2a_y(y_{top} - y_0)$,

$$0\text{ m}^2/\text{s}^2 = (v_0 \sin\theta)^2 + 2(-g)(y_{top}) \Rightarrow y_{top} = \frac{(v_0 \sin\theta)^2}{2g} = \frac{[(30\text{ m/s})\sin 60°]^2}{2(9.8\text{ m/s}^2)} = 34.4\text{ m}$$

The maximum height of the ball is 34 m.
(c) The x and y components are

$$v_{1y} = v_{0y} + a_y(t_1 - t_0) = v_0 \sin\theta - gt_1 = (30\text{ m/s})\sin 60° - (9.8\text{ m/s}^2)\times(4.0\text{ s}) = -13.22\text{ m/s}$$

$$v_{1x} = v_{0y} = v_0 \cos 60° = (30\text{ m/s})\cos 60° = 15.0\text{ m/s}$$

$$\Rightarrow v_1 = \sqrt{v_{1x}^2 + v_{1y}^2} = 20.0\text{ m/s}$$

The impact speed is 20 m/s.
Assess: Compared to a maximum height of 34.4 m, a height of 25.5 for the cliff is reasonable.