PHYSICS 12

MANIPULATING VARIABLES

Notes:

1. **What effect does the doubling of initial velocity have on the maximum height of a projectile?**

A $v_{i_A} = v_{i_A}$

$$h_{max} = \frac{v_{fy}^2 - v_{iy}^2}{2a_y}$$

$$= \frac{0 - (v_{i_A} \sin\theta)^2}{2a_y}$$

$$h_{max_A} = \frac{-(v_{i_A} \sin\theta)^2}{2a_y}$$

B $v_{i_B} = 2v_{i_A}$

$$h_{max_B} = \frac{v_{fy}^2 - v_{iy}^2}{2a_y}$$

$$= \frac{0^2 - (2v_{i_A} \sin\theta)^2}{2a_y}$$

$$= \frac{0^2 - 4(v_{i_A} \sin\theta)^2}{2a_y}$$

$$h_{max_B} = 4 \cdot h_{max_A}$$

2. **What effect does the quadrupling of initial velocity have on the time needed to reach the maximum height?**

A $v_{i_A} = v_{i_A}$

$$t_{h_{max}} = \frac{v_{fy} - v_{iy}}{a_y}$$

$$= \frac{0 - v_{i_A} \sin\theta}{a_y}$$

$$t_{h_{max_A}} = \frac{-v_{i_A} \sin\theta}{a_y}$$

B $v_{i_B} = 4v_{i_A}$

$$t_{h_{max_B}} = \frac{v_{fy} - v_{iy}}{a_y}$$

$$= \frac{0 - 4v_{i_A} \sin\theta}{a_y}$$

$$= 4 \cdot \frac{-v_{i_A} \sin\theta}{a_y}$$

$$t_{h_{max_B}} = 4 \cdot t_{h_{max_A}}$$

3. How is the time spent in the air affected when the vertical displacement of a free-falling object is tripled?

A

$$d_{yA} = d_{yA}$$

$$t_{ff_A} = \sqrt{\frac{2 d_{yA}}{a_y}}$$

Z

$$d_{y_B} = 3 d_{yA}$$

$$t_{ff_B} = \sqrt{\frac{2 d_{yB}}{a_y}}$$

$$= \sqrt{\frac{2 \cdot 3 d_{yA}}{a_y}}$$

$$= \sqrt{3} \cdot \sqrt{\frac{2 d_{yA}}{a_y}}$$

$$= \sqrt{3} \cdot t_{ff_A}$$

4. How does final velocity of a projectile change if it maximum height is increased by a factor of 8?

A

$$h_{max_A} = h_{max_A} = d_{yA}$$

$$v_{fy}^2 = v_{iy}^2 + 2 a_y d_y$$

$$v_{fy_A} = \sqrt{2 a_y d_{yA}}$$

B

$$h_{max_B} = 8 h_{max_A} = 8 d_{yA}$$

$$v_{fy} = \sqrt{2 a_y d_{yB}}$$

$$= \sqrt{2 a_y 8 d_{yA}}$$

$$= \sqrt{8} \cdot \sqrt{2 a_y d_{yA}}$$

$$v_{fy_B} = \sqrt{8}\, v_{fy_A}$$