Introduction to Mechanics
Projectiles
Max Height

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De Anza College

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Last time

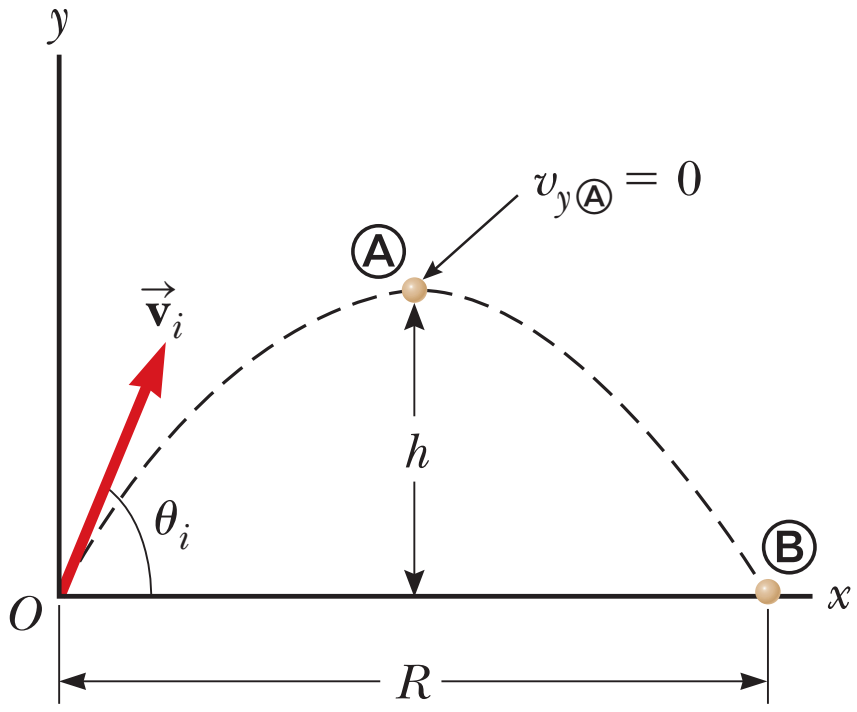
- projectiles launched horizontally
- projectiles launched at an angle

Overview

- max height of a projectile

Height of a Projectile

How can we find the maximum height that a projectile reaches above its launch point?



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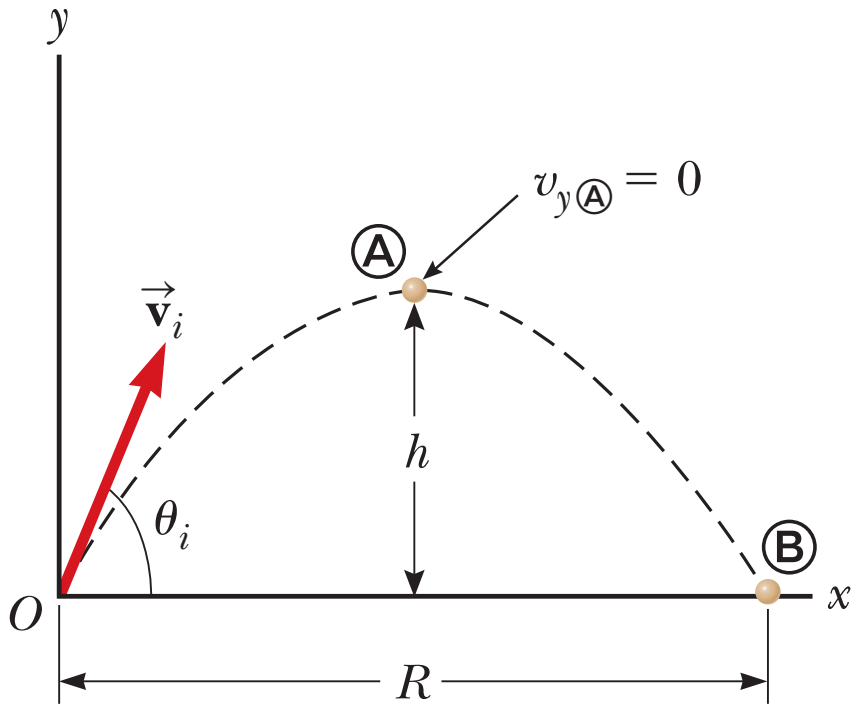
Find the height when $v_y = 0$.

c



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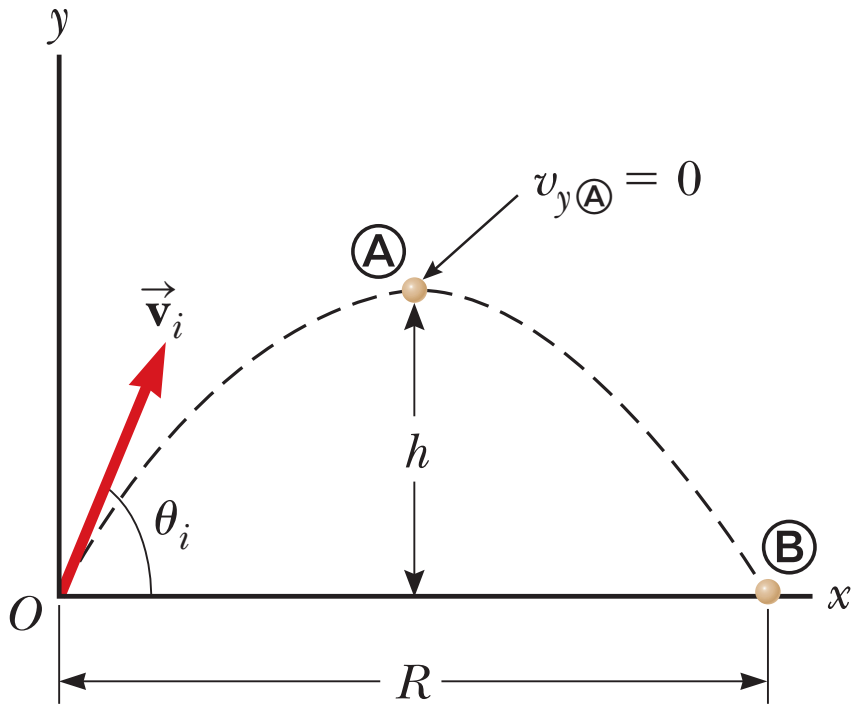
$$v_{fy}^2 = v_{0y}^2 - 2g\Delta y$$



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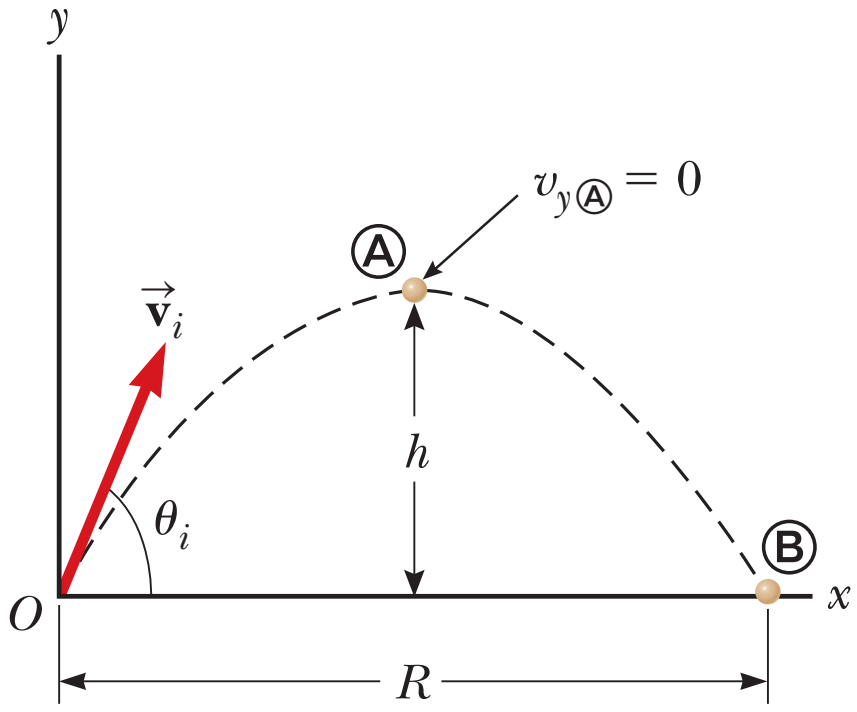

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$$v_{fy}^2 = v_{0y}^2 - 2g\Delta y$$

$$0 = v_{0y}^2 - 2gh$$

$$h = \frac{v_{0y}^2}{2g}$$

In the diagram, $v_{0y} = v_i \sin\theta$.

$$h = \frac{v_0^2 \sin^2\theta}{2g}$$

Max Height of Projectile Example, # 46

A dolphin jumps with an initial velocity of 12.0 m/s at an angle of 40.0° above the horizontal. The dolphin passes through the center of a hoop before returning to the water. If the dolphin is moving horizontally when it goes through the hoop, how high above the water is the center of the hoop?

[1] Walker, "Physics", page 107.

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Given: $v_0 = 12.0$ m/s, $\theta = 40.0°$
Asked for: max height, h

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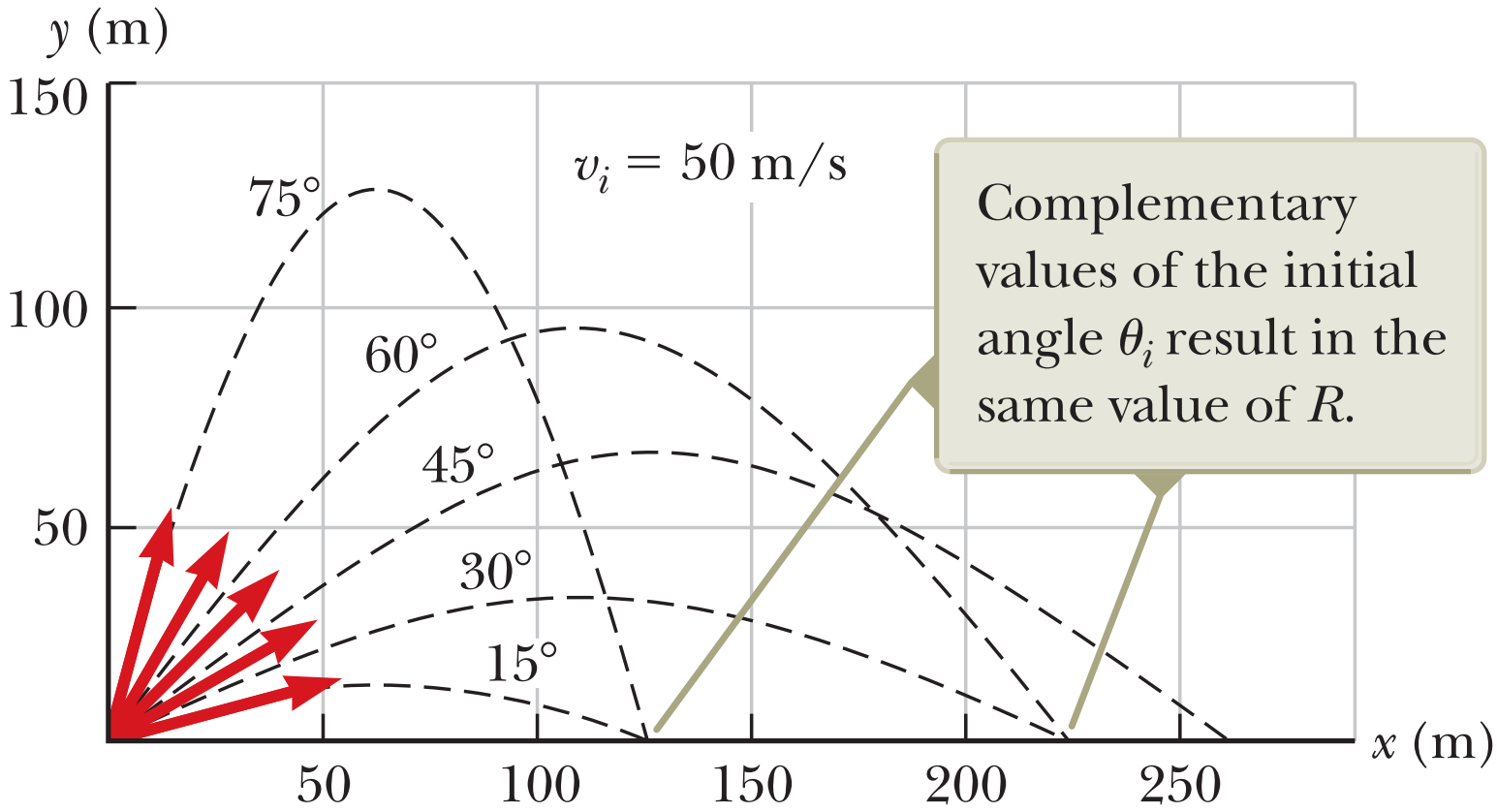
$$\begin{aligned} h &= \frac{(12.0 \text{ m/s})^2 \sin^2(40^\circ)}{2(9.8 \text{ m/s}^2)} \\ &= \underline{3.04 \text{ m}} \end{aligned}$$

Reasonable?: Larger than the hypothesis by 50%, but still same order of magnitude. Dolphins can really jump!

Effect of changing launch angle

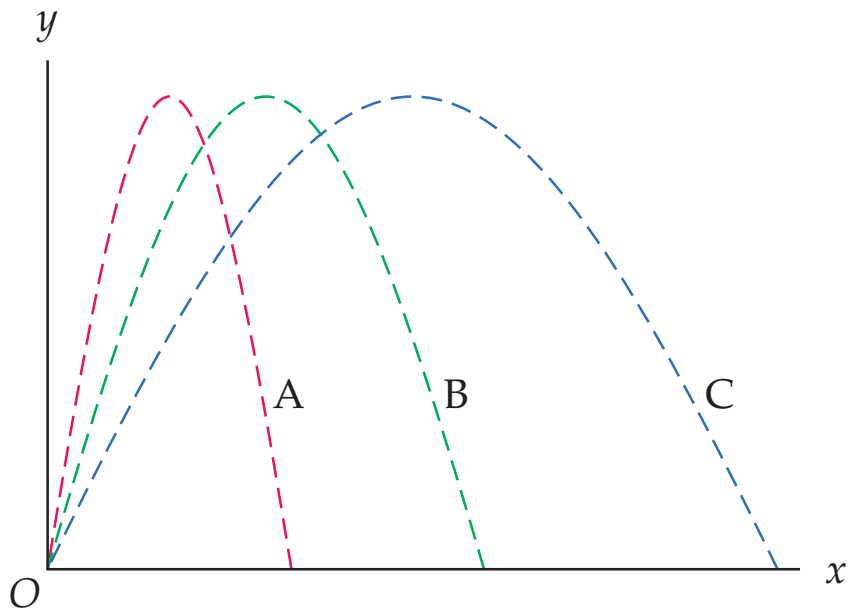
$$h = \frac{v_0^2 \sin^2 \theta}{2g}$$



[1] Figure from Serway & Jewett, 9th ed.

Height and initial speed conceptual question

Three projectiles (A, B, and C) are launched with different initial speeds so that they reach the same maximum height, as shown. List the projectiles in order of increasing initial speed.



(A) A, B, C

(B) C, B, A

(C) B, C, A

(D) all the same

[1]Walker, "Physics", page 106, prob 28.

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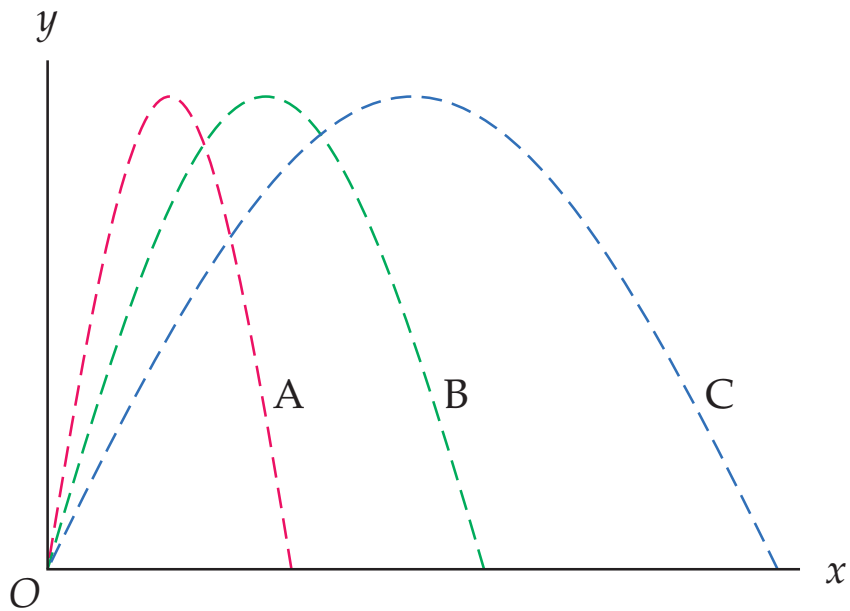

(A) A, B, C ←

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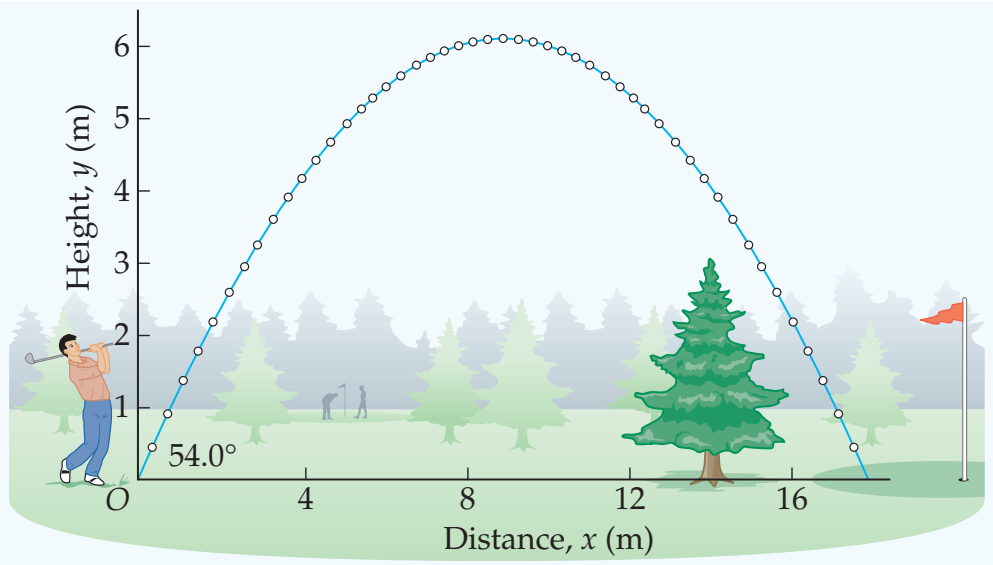
Using the Max Height Equation

In Example 4-5 in the textbook, page 93, a golfer hits a ball over a tree onto the green.



The example asks, "How high was the ball when it passed over the tree?"

If you are given the initial speed and launch angle, can you use the equation

$$h = \frac{v_0^2 \sin^2 \theta}{2g}$$

to answer the question?

(A) Yes

(B) No

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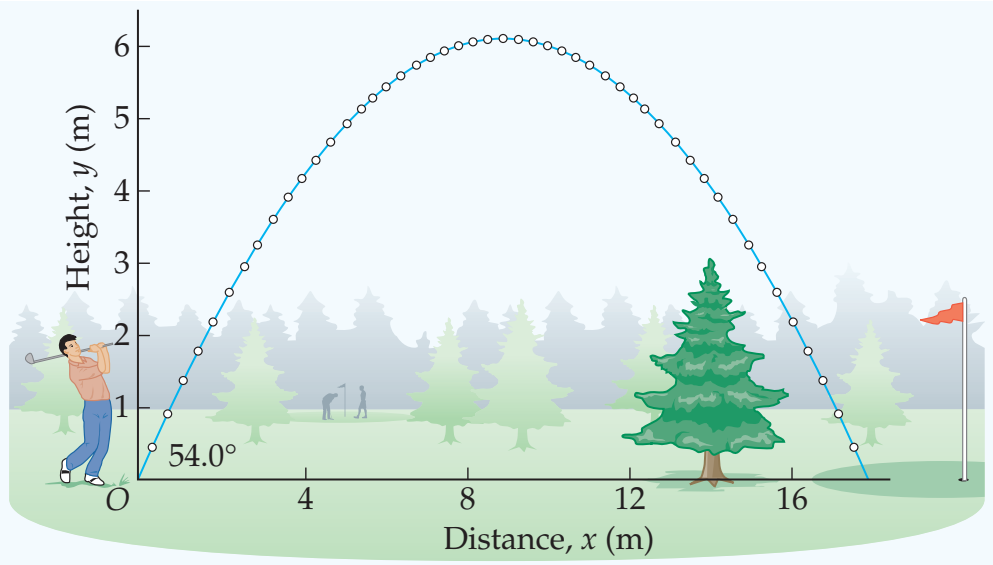

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If you are given the initial speed and launch angle, can you use the equation

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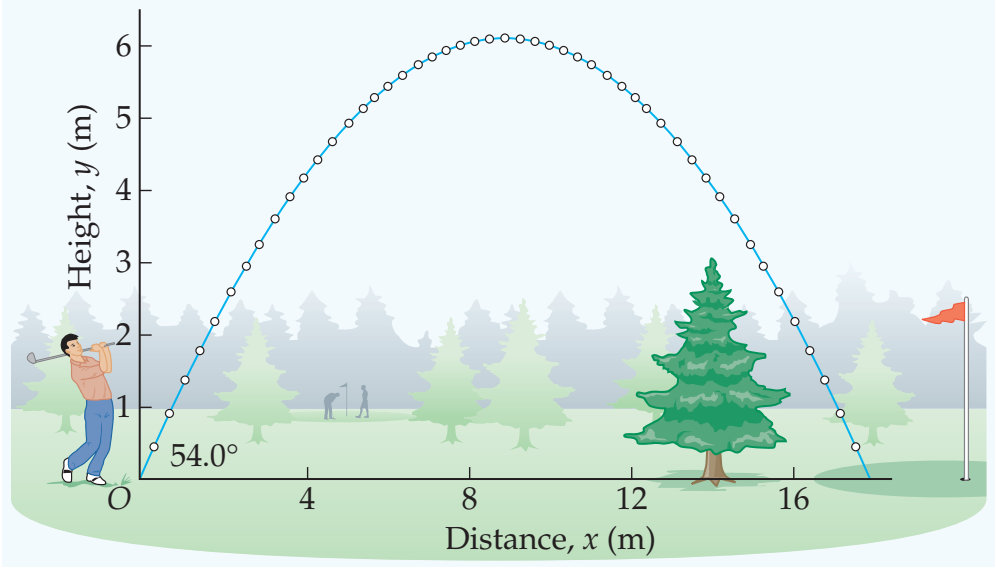
to answer the question?

(A) Yes

(B) No ← it is not at the max height

Not Using the Max Height Equation

"How high was the ball when it passed over the tree?" Suppose $v_0 = 13.5$ m/s, $\theta = 54.0°$ and tree is 14.0 m from golfer. How can we find the answer?



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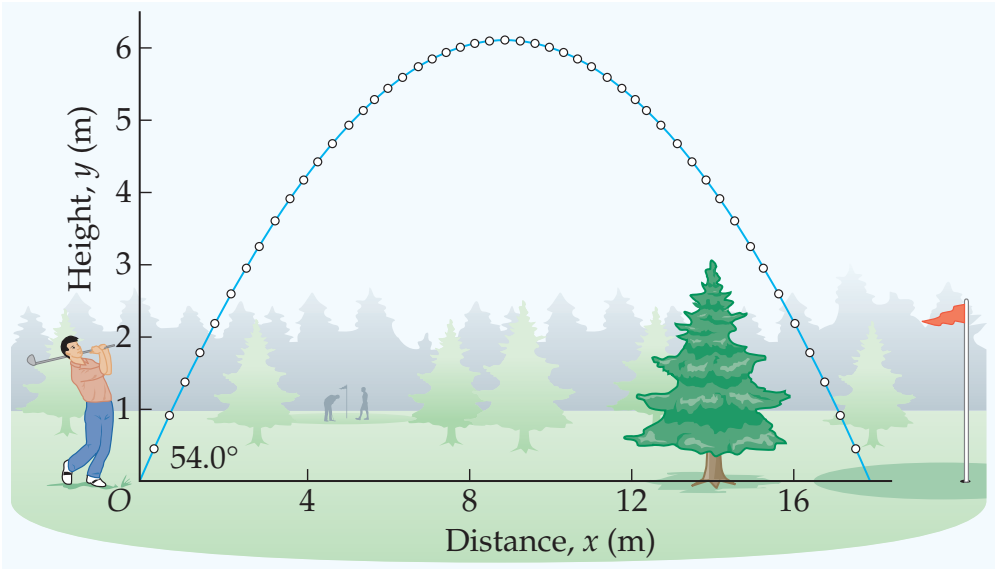

Go back to the kinematics expressions!

$$\Delta y = v_{0y} t - \frac{1}{2} g t^2$$

We can find the height if we know the time the ball was over the tree.

Summary

- max height of projectiles

Test 2 Monday, Feb 24 (TBC).

Homework

Walker Physics:

- Ch 4, onward from page 100. Problems: 51, 52[1]

[1] Ans: (a) 849 m/s, (b) less than.