2D Kinematics
Projectiles
Relative Motion

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Last Time

- projectiles and principle equations
- height, time of flight, and range of a projectile

Overview

- trajectory equation
- projectile example
- introduced relative motion

Projectiles

Last lecture we derived:

$$\text{max height, } h = \frac{(v_i \sin\theta_i)^2}{2g}$$

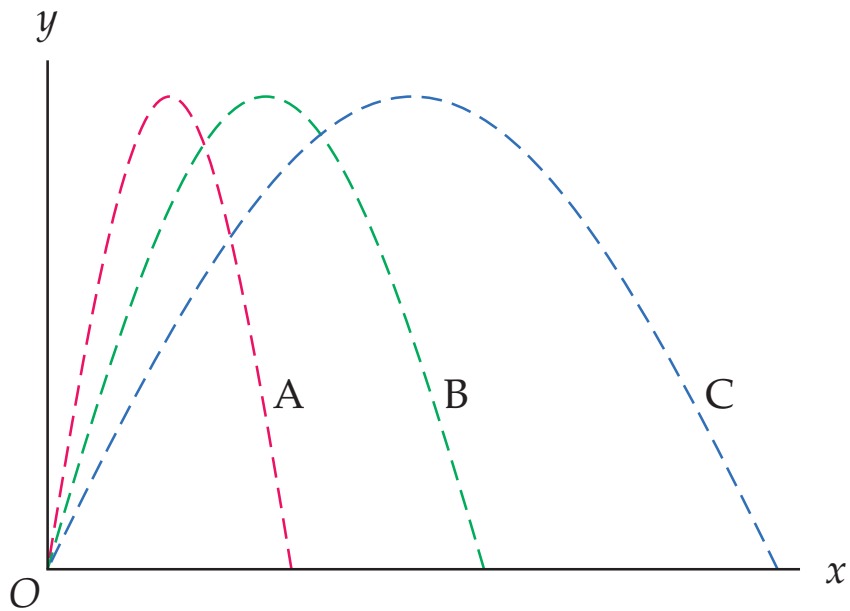
And for cases where the projectile lands at the same height it was launched from:

$$\text{time of flight, } t_{\text{fl}} = \frac{2v_i \sin\theta_i}{g}$$

$$\text{range, } R = \frac{v_i^2 \sin(2\theta_i)}{g}$$

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 time of flight.



(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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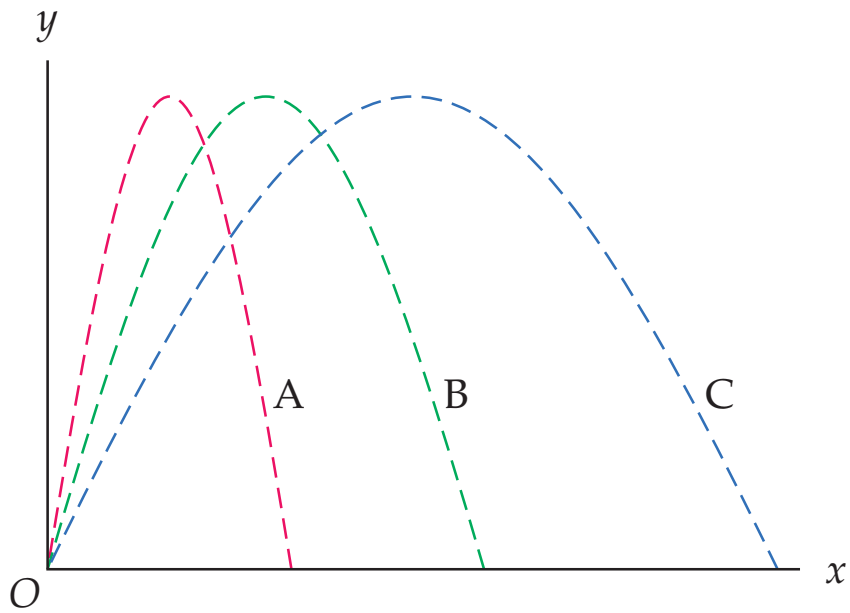

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y-direction:

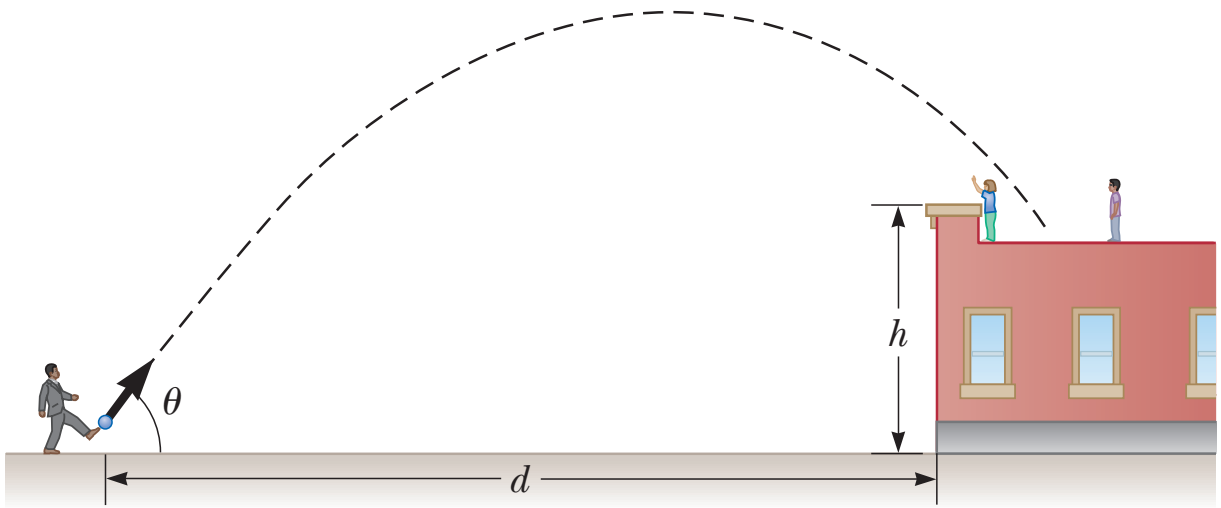
$$y = v_i \sin\theta t - \frac{1}{2} g t^2$$

Substituting for t gives:

$$y = (\tan\theta)x - \frac{g}{2v_i^2 \cos^2\theta} x^2$$

Projectile Motion Example: #25, page 103

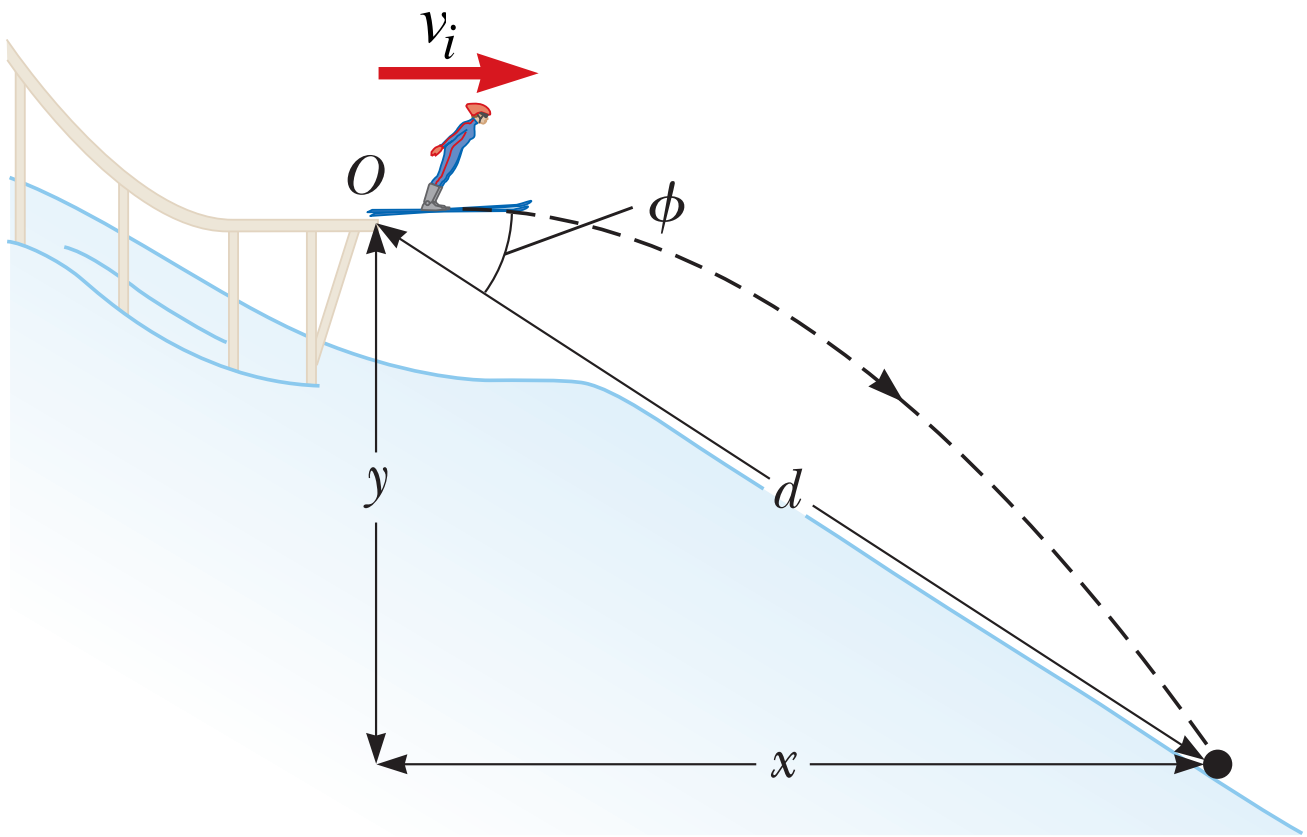
25. A playground is on the flat roof of a city school, 6.00 m above the street below (Fig. P4.25). The vertical wall of the building is $h = 7.00$ m high, forming a 1-m-high railing around the playground. A ball has fallen to the street below, and a passerby returns it by launching it at an angle of $\theta = 53.0°$ above the horizontal at a point $d = 24.0$ m from the base of the building wall. The ball takes 2.20 s to reach a point vertically above the wall. (a) Find the speed at which the ball was launched. (b) Find the vertical distance by which the ball clears the wall. (c) Find the horizontal distance from the wall to the point on the roof where the ball lands.



[1]Serway & Jewett

Projectile Motion Example 4.5

A ski jumper leaves the ski track moving in the horizontal direction with a speed v_i as shown. The landing incline below her falls off at an angle ϕ. Find an expression for d, the distance down the incline where she lands.



[1] Serway & Jewett

Summary

- projectiles
- introduced relative motion

Quiz start of class tomorrow (Friday).

(Uncollected) Homework Serway & Jewett,

- Ch 4, onward from page 104. Problems: 59*

*Fun diversion: OK Go in the Vomit Comet