Projectile Motion

Kinematics · 8 questions · step-by-step answers at the end

Name: Date: Score: / 8

USEFUL EQUATIONS

$x = v_0 \cos\theta \cdot t$ $y = h + v_0 \sin\theta \cdot t - \tfrac{1}{2}gt^2$ $v_y = v_0 \sin\theta - gt$ $H = (v_0 \sin\theta)^2 / 2g$

$R = v_0^2 \sin 2\theta / g$

Questions

Show your working in the space under each question.

1. A ball is launched at 20 m/s and 30° above level ground. Find the time of flight, the range and the maximum height.

2. A ball rolls off a 20 m high cliff with a horizontal speed of 8.0 m/s. Find (a) the time in the air, (b) how far from the base of the cliff it lands, and (c) its speed just before landing.

3. If a projectile's launch speed doubles (same angle, level ground), what happens to its range?

4. Two balls are launched at the same speed, at 25° and 65°. Which lands farther away (level ground)?

5. A ball is thrown horizontally off a cliff. If its throwing speed doubles, what happens to its time of flight and horizontal distance?

6. A package is dropped from a plane flying horizontally at 60 m/s, 180 m up. How far ahead of the drop point does it land?

7. What is the acceleration of a projectile at the top of its path?

8. At what point in a projectile's flight is its speed smallest?

Step-by-step answers

Projectile Motion

1. v_{y0} = 10 m/s, so T = 2(10)/9.8 = **2.04 s**; R = (17.3)(2.04) = **35.3 m**; H = 10^2/19.6 = **5.1 m**.

2. 1. Vertical motion starts with v_{y0} = 0: 20 = ½(9.8)t^2 → t = √(40/9.8) = **2.02 s**.
2. Horizontal: $x = v_x t$ = (8.0)(2.02) = **16.2 m**.
3. Just before landing: $v_y = gt$ = (9.8)(2.02) = 19.8 m/s (downward), and v_x = 8.0 m/s.
4. Speed = √(8.0^2 + 19.8^2) = **21.4 m/s**.

Answer: (a) 2.0 s (b) 16 m (c) 21 m/s

3. R ∝ v_0^2, so it becomes **4 times** as large.

4. They land at the **same** place, because sin 50° = sin 130°. The 65° ball stays in the air longer.

5. The time is **unchanged**, because it is set by the height alone. The distance **doubles**.

6. t = √(2·180/9.8) = 6.06 s, so x = 60 × 6.06 ≈ **364 m**.

7. **g, straight down**. Only the vertical velocity is zero there.

8. At the **top**, where v_y = 0. The speed there equals v_x, which is not zero.