

**Horizontally Launched Projectiles**

1. A rock is thrown horizontally from a cliff at a speed of 16 m/s. The rock falls 120 m before hitting the ground.
  - a. How long does it take to land?
  - b. What is its range? ("Range" means the  $i$  component of the displacement.)
  
2. A rock is thrown horizontally from a cliff at a speed of 22 m/s. The rock falls 180 m before hitting the ground.
  - a. How long does it take to land?
  - b. What is its range?
  - c. What is its velocity, in rectangular coordinates, at 3.0 seconds?
  
3. A baseball is thrown horizontally from a cliff at a speed of 30 m/s. The baseball falls 60 m before hitting the ground.
  - a. What is its range?
  - b. What is its velocity, in rectangular coordinates, at 2.5 seconds?
  - c. What is its velocity, in polar coordinates, at 2.5 seconds?
  
4. A baseball is thrown horizontally from a cliff and falls 100 m to the ground below. The ball's range is 162 m.
  - a. How long was the ball falling?
  - b. What was the ball's initial velocity, in rectangular coordinates?
  - c. What was the ball's final velocity, in rectangular coordinates, just as it reaches the ground?
  - d. What was the ball's final velocity, in polar coordinates, just as it reaches the ground?

5. A pencil rolls off a table and falls to the ground in 0.40 seconds, landing 0.080 m (or 8.0 cm) from the base of the table.
- How tall was the table?
  - What was the pencil's initial velocity, in rectangular coordinates?
  - What was the pencil's displacement, in rectangular coordinates, after falling for 0.30 seconds?

Answers:

1.a. 4.95 (s), b. 79.18 i (m) 2.a. 6.06 (s), b. 133.34 i (m), c. 22 i - 29.4 j (m/s) 3.a. 104.98 i (m), b. 30 i - 24.5 j (m/s), c. 38.73 (m/s) @ 39.24° below the horizon 4.a. 4.52 (s), b. 35.86 i (m/s), c. 35.86 i - 44.30 j (m/s), d. 56.99 (m/s) @ 51.01° below the horizon 5.a. 0.784 m, b. 0.20 i (m/s), c. 0.060 i - 0.44 j (m)