Projectile Motion Problems

In each of these problems, unless otherwise noted, use $|g| = 10\ m/s^2$*. Ignore air resistance.*

1. A ball rolls off the edge of a table. It has an initial horizontal velocity of 3 m/s and is in the air for 0.75 seconds before hitting the floor.
   a. How high is the table?

   b. How far away from the edge of the table does the ball land?

   c. What are the horizontal and vertical components of the ball's velocity when it lands?

   d. What is the magnitude and direction of the ball's velocity when it lands? Give the angle as the number of degrees below the horizontal.

2. The Coyote is chasing the Road Runner when the Road Runner suddenly stops at the edge of a convenient cliff. The Coyote, traveling with a speed of 15 m/s, does not stop and goes flying off the edge of the cliff, which is 100 meters high.
   a. How long is the Coyote in the air?

   b. Where does the Coyote land?

   c. What are the horizontal and vertical components of the Coyote's velocity when he lands?

   d. What is the magnitude and direction of the Coyote's velocity when he lands? Give the angle as the number of degrees below the horizontal.

3. A car full of bad guys goes off the edge of a cliff. If the cliff was 75 meters high, and the car landed 60 meters away from the edge of the cliff, calculate the following:
   a. The total time the car was in the air.

   b. The initial velocity of the car.

   c. The final velocity of the car just as it hits the ground. (Give the components.)

   d. The final velocity of the car just as it hits the ground. (Give the magnitude and direction.)

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Now these include up and down motion!

4. Mary throws a ball to Suzy, who is standing 25 meters away. Suzy catches the ball from the same height at which it was thrown. If the ball was in the air for 4 seconds, calculate the following:
   a. Horizontal velocity.

   b. Maximum height of the ball.

   c. Initial vertical velocity.

   d. The magnitude and direction of the ball's velocity when caught by Suzy. Give the angle as the number of degrees below the horizontal.

   e. What happens to the components of the velocity and the acceleration as the ball flies through the air?

5. Larry tosses a volleyball to his wife, Lise, who catches it at the same height from which it was tossed. The volleyball travels a horizontal distance of 10 meters, and has a maximum height of 4 meters (above from where it was hit.)
   a. How long was the volleyball in the air?

   b. What was the initial horizontal velocity?

   c. What was the initial vertical velocity?

   d. What was the magnitude and direction of the ball's velocity when caught by Lise. Give the angle as the number of degrees below the horizontal.

   e. What was the acceleration of the volleyball after 1 second? Give the magnitude and direction.

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6. A student tosses an eraser to his friend. The initial velocity of the eraser was 7 m/s at an angle of 50° above the horizontal. The friend catches the eraser at the same level from which it was tossed.
   a. What were the initial components of the eraser's velocity?

   b. How long was the eraser in the air?

   c. How far apart were the two friends?

   d. What was the maximum height of the eraser?

   e. What were the components of the velocity at the top of its flight?

7. A kangaroo is jumping across a field in the outback. The kangaroo jumps with an initial horizontal velocity of 8 m/s and an initial vertical velocity of 5 m/s.
   a. What was the initial velocity of the kangaroo? (Magnitude and direction)

   b. How long was the kangaroo in the air?

   c. What was the maximum height of the kangaroo?

   d. What was the horizontal distance of the kangaroo's jump?

8. An astronaut on the moon tosses a rock with an initial velocity of 3 m/s at an angle of 35° above the horizontal. The acceleration due to gravity on the moon is 1.7 m/s^2.
   a. What are the components of the initial velocity?

   b. How long was the rock "in the air?'

   c. What was the maximum height of the rock?

   d. What was the horizontal distance traveled by the rock?

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Answers:

1. a) 2.81 m
   b) 2.25 m
   c) $v_x = 3$ m/s & $v_y = 7.5$ m/s down
   d) $v = 8.1$ m/s at an angle of 68.2° below the horizontal

2. a) 4.47 s
   b) 67.1 m from the base of the cliff
   c) $v_x = 15$ m/s & $v_y = 44.7$ m/s down
   d) $v = 47.2$ m/s at an angle of 71.5° below the horizontal

3. a) 3.87 s
   b) $v_x = 15.5$ m/s & $v_y = 0$ m/s
   c) $v_x = 15.5$ m/s & $v_y = 38.7$ m/s down
   d) $v = 41.7$ m/s at an angle of 68.2° below the horizontal

4. a) 6.25 m/s
   b) 20 m
   c) 20 m/s up
   d) $v = 21$ m/s at an angle of 72.7° below the horizontal
   e) v_x = constant = 6.25 m/s & acceleration = constant = 10 m/s^2 down & v_y starts positive 20 m/s (up) decreases to 0 m/s at top and continues to decrease to -20 m/s (down) when finally caught

5. a) 1.79 s
   b) 5.6 m/s
   c) 8.9 m/s up
   d) $v = 10.5$ m/s at an angle of 57.8° below the horizontal
   e) acceleration = gravity = 10 m/s^2 down

6. a) $v_x = 4.5$ m/s & $v_y = 5.36$ m/s up
   b) 1.07 s
   c) 4.82 m
   d) 1.44 m
   e) $v_x = 4.5$ m/s & $v_y = 0$ m/s

7. a) $v = 9.43$ m/s at an angle of 32° above the horizontal
   b) 1.0 s
   c) 1.25 m
   d) 8 m

8. a) $v_x = 2.46$ m/s & $v_y = 1.72$ m/s up
   b) 2.02 s
   c) 0.87 m
   d) 4.97 m