Problem Set 2

Free Fall and Projectile Motion

October 8, 2019

g=9.8m/s^2, ignore air resistance for all problems.

1. $\star$ A ball is dropped from rest at a height of 50m. How long does the ball take to reach the ground, and what is its velocity when it reaches the ground?

   $a =$

   $v_i =$

   $v_f =$

   $h_i =$

   $h_f =$

2. $\star$ A projectile is launched at 30° with an initial velocity of 10m/s. What is

   a) the horizontal range of the projectile?

   b) The maximum height of the projectile?

3. $\star$ A marble is rolled off of the edge of a ramp with a velocity of 10 m/s at 40°. If the edge of the ramp is 12 m above the ground what is the

   a) time it takes for the marble to hit the ground?

   b) horizontal displacement of the marble?

   c) highest point in altitude of the marble?

4. $\star\star$ A person drops a rock from a bridge, and he hears the sound of a splash 2.5 seconds later. How high is the bridge? The speed of sound is 340 m/s.

5. ⋆⋆ A watermelon is launched from the top of a hill with an initial velocity vector that makes an angle of 45 degrees with the horizontal. The projectile lands at a point that is 10 m vertically below the launch point and 300 m horizontally away from the launch point. Determine the initial speed of the watermelon.

6. ⋆⋆ A sponge is launched vertically upwards from a cannon at 50 m/s. If a plane is moving at 150 m/s in the positive x direction and starts at position $x_0 = 0$, at what x would you need to position the cannon for the sponge to hit the plane

   a) on the way up?

   b) on the way down?

7. ⋆⋆⋆ Two baseballs are thrown off the same cliff, but at different times. The second baseball is thrown 4 seconds after the first one. If the height of the cliff is 200 m, when will the baseballs be 6 m apart?

8. ⋆⋆⋆ An airplane has a speed of 290 km/h and is diving at an angle of $\theta = 30$ degrees below the horizontal when the pilot releases a radar decoy. The horizontal distance between the release point and the point where the decoy strikes the ground is d= 700 m.

   a) How long is the decoy in the air?

   b) How high was the release point?

9. ⋆ ⋆ ⋆ A ball is shot from the ground into the air. At a height of 9.1m, its velocity is $\mathbf{v} = (\mathbf{7.6}\hat{\mathbf{i}} + \mathbf{6.1}\hat{\mathbf{j}})\mathbf{m/s}$.

   a) To what maximum height does the ball rise?

   b) What total horizontal distance does the ball travel?

   What are the c) magnitude and d) angle (below the horizontal) of the ball's velocity just before it hits the ground?