3. Two–dimensional motion: I (Projectile motion)

Note: this worksheet is too long by design. You will generally not finish each worksheet during your DL session; we hope to leave you some problems to practice on for exams. We will, however, revisit some of the Questions and Problems below in your next session.

In this handout, vectors will be denoted by boldface letters. For example, **V** denotes a vector. The *magnitude* of **V**, which is a number, will be denoted by V.

Questions

1. A projectile is fired with initial speed v_o at an angle θ_o above the horizontal. Visualize this projectile at the instant when it reaches the top of its trajectory.

   (a) At this instant, what is the speed of the projectile?

   (b) At this instant, what is the acceleration of the projectile?

   (c) At this instant, how does the direction of the acceleration compare to the direction of the velocity?

2. Consider the two football trajectories shown. (Ignore air resistance.)

   (a) Is the flight time of *A* greater than, less than, or equal to the flight time of *B*? Explain.

   (b) Is the vertical component of launch velocity of *A* greater than, less than, or equal to that of *B*? Explain.

   (c) Is the horizontal component of launch velocity of *A* greater than, less than, or equal to that of *B*? Explain.

   (d) Is the launch speed of *A* greater than, less than, or equal to that of *B*? Explain.

3. Identical guns fire identical bullets horizontally at the same speed and from the same height above level planes, one on the earth and one on the moon. (Neglect air resistance on the earth.) Decide whether the following statements are true or false, and explain with a sentence for each.

   (i) The horizontal distance traveled by the bullet is greater on the moon.

   (ii) The flight time is less for the bullet on the earth.

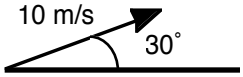
   (iii) The velocities of the bullets at impact are the same.

Problems

1. A ball moves with a velocity $\mathbf{v}_i = 21$ m/s to the right. The ball strikes a wall and bounces back with a velocity $\mathbf{v}_f = 15$ m/s to the left.

   (a) Sketch the vectors $\mathbf{v}_i$, $\mathbf{v}_f$, and $\Delta\mathbf{v} = \mathbf{v}_f - \mathbf{v}_i$.
   (b) What is the magnitude and direction of the change in velocity $\Delta\mathbf{v}$?
   (c) What is the change in speed Δv?

2. A projectile is fired into the air with an intial speed of 10 m/s at an angle of 30˚ to the horizontal. Find the components of the initial speed in the x– and y–directions; that is, find v_{ox} and v_{oy} so that you may write $v_o = v_{ox}\mathbf{i} + v_{oy}\mathbf{j}$.



3. An object just about to strike the ground is measured to have components of velocity of 5 m/s in the x–direction, and 10 m/s in the y–direction.

   (a) What is the speed of the object at this instant?
   (b) What angle does its velocity vector make with the horizontal?