

Office Hours 1

1. **If you didn't finish Activity 1:** Consider the golfer as shown in Fig. 1. Analyze the motion of the ball while in flight.

- (a) Find $\vec{a}(t)$ of the ball
- (b) Find $\vec{v}(t)$ of the ball
- (c) Find $\vec{r}(t)$ of the ball
- (d) Find the time of flight of the ball
- (e) How high above the ground does the ball go?
- (f) How far in the horizontal direction does the ball go?

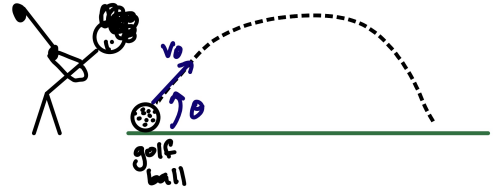


Figure 1: A golfer strikes a ball such that it has an initial speed v_0 and its initial velocity vector \vec{v}_0 makes an angle θ with the horizontal.

2. Prove that if $\vec{v}(t)$ is any vector that depends on time but has *constant magnitude*, then $\dot{\vec{v}}$ is orthogonal to \vec{v} . Also prove the converse, that if $\dot{\vec{v}}(t)$ is orthogonal to $\vec{v}(t)$, then $v(t)$ is constant.

3. **Horizontal Drag** . Let a particle experience a drag force given by:

$$\vec{F}_{\text{drag}} = -v \vec{v} \tag{1}$$

where $\vec{v} = v_x \hat{x}$. Assuming no other forces except drag act on a particle, find its $v_x(t)$ and $x(t)$.

4. Let Object 1 have initial velocity \vec{v} and mass m_1 . Let Object 2 start from rest with mass m_2 . The two objects collide and stick together. Find the final velocity of the system.

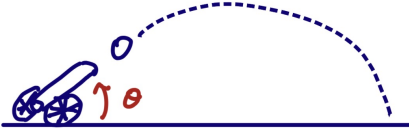


Figure 2: A cannon shoots a cannon ball such that it has an initial speed v_0 and its initial velocity vector \vec{v}_0 makes an angle θ with the horizontal.

5. A cannon shoots a ball at an angle θ above the horizontal, see Fig. 2.
 - (a) Find the ball's position $\vec{r}(t)$ as a function of time.
 - (b) Let $r(t)$ be the ball's distance from the cannon. What is the maximum θ such that $r(t)$ increases throughout the ball's flight?

6. Someone kicks a frictionless puck with initial speed v_0 so that it slides straight up a plank that is inclined at an angle θ above the horizontal.
 - (a) Write down Newton's 2nd law for the puck and solve to give its position as a function of time
 - (b) How long will it take for the puck to return to its starting point?

7. A ball is thrown with initial speed v_0 up an inclined plane. The plane is at an angle ϕ from the horizontal, and the ball is thrown at an angle θ above the plane.
 - (a) Find the ball's position as a function of time
 - (b) Find the distance the ball travels from where it was launched