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?

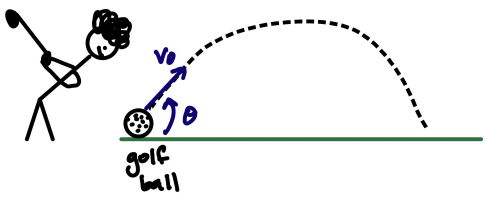

Figure 1: A golfer strikes a ball such that it has an initial speed v_0 and its initial velocity vector $\vec{v}_0$ makes an angle θ with the horizontal.

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.

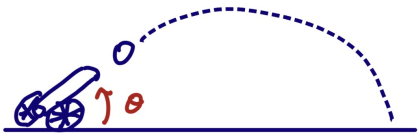

Figure 2: A cannon shoot a cannon ball such that it has an initial speed v_0 and its initial velocity vector $\vec{v}_0$ makes an angle θ with the horizontal.

5. A cannon shoots a ball at an angel 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