Ray-tracing

1. **Determining the direction of a ray**: Given a camera positioned at \((-3, 6, 2)\) and a pixel on the viewport/screen at \(\vec{S} = (-3, 2, -1)\), determine the unit vector in the direction of the ray, \(\vec{R}_d\).

2. **Ray-plane intersection**: Say there is a “floor” in the world, represented by a plane with equation \(y = -2\). Where does the ray from (1) intersect this plane? Call this point \(\vec{P}\). How far is \(\vec{P}\) from the camera (i.e. what is \(t\))? **Hint**: find \(t\) first, then \(\vec{P}\).

3. **Visualization**: Draw a picture of this setup from the “right” view. Label all the points. Does this visually agree with your answers from (1) and (2)?
4. **Ray-triangle intersection:** Say a triangle lies on the floor, with coordinates $\vec{A} = (0, -2, -5)$, $\vec{B} = (-3, -2, -4)$, and $\vec{C} = (1, -2, -2)$. Draw a “top” view picture of the floor, labeling $\vec{A}, \vec{B}, \vec{C}$, and $\vec{P}$. Does this ray intersection the triangle?

5. **Barycentric coordinates:** Determine the Barycentric coordinates $(\alpha, \beta, \gamma)$ of $\vec{P}$ in terms of $\vec{A}, \vec{B}$, and $\vec{C}$. Does this confirm your result from (4)?