points & vectors:
- given $P, Q$, find $\overrightarrow{PQ}$
  \[ \overrightarrow{PQ} = \langle x_1-x_0, y_1-y_0, z_1-z_0 \rangle \]
- midpoint: sum components $\overrightarrow{PQ}$ or $\overrightarrow{QP}$
  \[ \text{midpoint} = \left( \frac{x_0+x_1}{2}, \frac{y_0+y_1}{2}, \frac{z_0+z_1}{2} \right) \]

planes & spheres:
1) equation of plane: \[ ax + by + cz = d \]
- doesn't depend on $d$
- e.g. \[ \Pi: x - 2y + 3z = 16 \] perpendicular to \( \langle 1, -2, 3 \rangle \)
- if variable \( (x, y, z) \) not there + coefficient = 0

2) equation for sphere of center \( \langle -7, 0, 3 \rangle \) & radius $R = 9$
- \( (x+7)^2 + (y-0)^2 + (z-3)^2 = 9^2 \)

planes (again):
\[ \{ ax + by + cz = d \} \]
\[ \overrightarrow{PQ} \& \overrightarrow{QP} \in \text{plane } \]
\[ \text{perpendicular vector } \overrightarrow{n} \]
\[ \overrightarrow{n} = \overrightarrow{QP} \times \overrightarrow{QR} \]

vector operations:
\[ \overrightarrow{u} = \langle 1, 2, 0 \rangle \]
\[ \overrightarrow{v} = \langle 0, 0, 1 \rangle \]
- dot product: \( \overrightarrow{u} \cdot \overrightarrow{v} = u_xv_x + u_yv_y + u_zv_z = (1 \cdot 0) + (2 \cdot 0) + (0 \cdot 1) = 0 \)

angle formulas:
\[ \overrightarrow{u} \& \overrightarrow{v} \text{ vectors } \Rightarrow \text{ angle } \theta \]
- \( \theta = \cos^{-1} \left( \frac{\overrightarrow{u} \cdot \overrightarrow{v}}{\overrightarrow{|u|} \overrightarrow{|v|}} \right) \)
- \( \theta = \sin^{-1} \left( \frac{|\overrightarrow{u} \times \overrightarrow{v}|}{\overrightarrow{|u|} \overrightarrow{|v|}} \right) \)

Review Midterm 2 Page 1
review distances

trajectories:
\[ \mathbf{r}(t) = \langle \cos (\theta t), \sin (\theta t), t \rangle \]
\[ \mathbf{r}(0) = \langle 1, 0, 0 \rangle \rightarrow \text{initial position at } t = 0 \]
\[ \mathbf{v}(t) = \mathbf{r}'(t) = \langle -\theta \sin (\theta t), \theta \cos (\theta t), 1 \rangle \rightarrow \text{length at } \theta \rightarrow \text{speed} \]
\[ \mathbf{a}(t) = \mathbf{v}'(t) = \langle -16 \cos (\theta t), -16 \sin (\theta t), 0 \rangle \]

review integrals

\[ \sqrt{0^2 + 0^2} = 0 \]