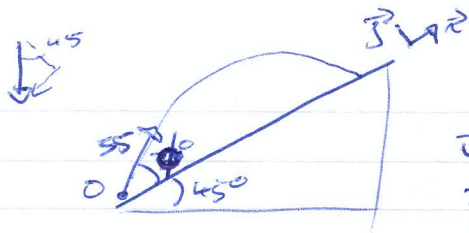


H. 1976 Q2 Proj



$$\vec{u} = 35 \cos \phi \vec{i} + 35 \sin \phi \vec{j}$$

$$\vec{g} = -\frac{g}{\sqrt{2}} \vec{i} - \frac{g}{\sqrt{2}} \vec{j}$$

$$\vec{v}(t) = \left( 35 \cos \phi - \frac{g}{\sqrt{2}} t \right) \vec{i} + \left( 35 \sin \phi - \frac{g}{\sqrt{2}} t \right) \vec{j}$$

$$\vec{r}(t) = \left( 35 \cos \phi t - \frac{g}{2\sqrt{2}} t^2 \right) \vec{i} + \left( 35 \sin \phi t - \frac{g}{2\sqrt{2}} t^2 \right) \vec{j}$$

Steepest horizontally:

Need  $T$ :

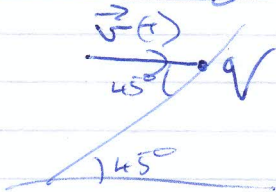
$$(\vec{r}(t))_j = 0$$

$$35 \sin \phi t - \frac{g}{2\sqrt{2}} t^2 = 0$$

$$\Rightarrow t = 0 \text{ and } 35 \sin \phi - \frac{g}{2\sqrt{2}} t = 0$$

$$\Rightarrow T = \frac{70\sqrt{2} \sin \phi}{g}$$

Steepest horizontally:



$$\tan 45^\circ = \frac{|\vec{v}(t)_j|}{|\vec{v}(t)_i|}$$

$$1 = \frac{35 \sin \phi - \frac{g}{\sqrt{2}} T}{35 \cos \phi - \frac{g}{\sqrt{2}} T}$$

$$1 = \frac{35 \sin \phi - \frac{g}{\sqrt{2}} \left( \frac{70\sqrt{2} \sin \phi}{g} \right)}{35 \cos \phi - \frac{g}{\sqrt{2}} \left( \frac{70\sqrt{2} \sin \phi}{g} \right)}$$

$$1 = \frac{35 \sin \phi - 70 \sin \phi}{35 \cos \phi - 70 \sin \phi}$$

$$\Rightarrow 35 \cos \phi - 70 \sin \phi = -35 \sin \phi$$

$$\Rightarrow 35 \cos \phi - 70 \sin \phi = 35 \sin \phi$$

$$\Rightarrow 35 \cos \phi = 105 \sin \phi$$

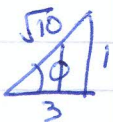
$$\Rightarrow \frac{35}{105} = \tan \phi$$

$$\Rightarrow \frac{1}{3} = \tan \phi \Rightarrow \boxed{\phi = 3}$$

Calculate  $|oq|$  (Range):

$$T = \frac{70\sqrt{2} \sin \phi}{g} = \frac{70\sqrt{2}}{g \sqrt{10}}$$

$$= \frac{70\sqrt{2}}{g \sqrt{10}}$$



$$\sin \phi = \frac{1}{\sqrt{10}}$$

$$\cos \phi = \frac{3}{\sqrt{10}}$$

$$\Rightarrow |oq|_{\text{range}} = 35 \cos \phi T - \frac{g}{2\sqrt{2}} T^2 = 35 \frac{3}{\sqrt{10}} \left( \frac{70\sqrt{2}}{g \sqrt{10}} \right) - \frac{g}{2\sqrt{2}} \frac{70\sqrt{2}}{g \sqrt{10}} \frac{70\sqrt{2}}{g \sqrt{10}}$$

$$= 106.066 - 35.355$$

$$= 70.710661$$