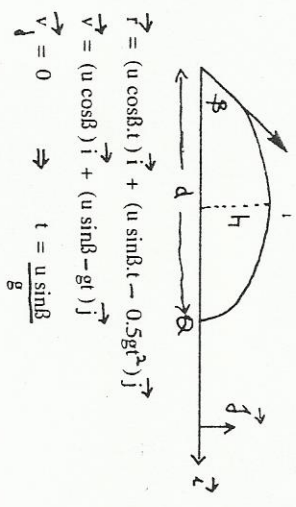


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(a)

At P:



$$\vec{r} = (u \cos \beta t) \vec{i} + (u \sin \beta t - 0.5gt^2) \vec{j}$$

$$\vec{v} = (u \cos \beta) \vec{i} + (u \sin \beta - gt) \vec{j}$$

$$\vec{v}_j = 0 \Rightarrow t = \frac{u \sin \beta}{g}$$

$$h = r_j$$

$$= u \sin \beta \cdot \frac{u \sin \beta}{g} - \frac{0.5g \cdot u^2 \sin^2 \beta}{g^2}$$

$$= \frac{u^2 \sin^2 \beta}{2g}$$

At Q:

$$t = \frac{2u \sin \beta}{g}$$

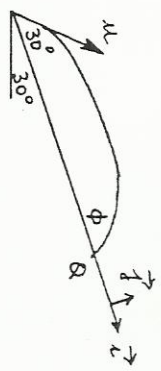
$$d = r_x$$

$$= u \cos \beta \cdot \frac{2u \sin \beta}{g}$$

$$= \frac{2u^2 \sin \beta \cos \beta}{g}$$

$$d = 3h \Rightarrow \frac{2u^2 \sin \beta \cos \beta}{g} = \frac{3u^2 \sin^2 \beta}{2g}$$

$$\Rightarrow \tan \beta = 4/3$$



$$\vec{r} = (u \cos 30 t - 0.5g \sin 30 t^2) \vec{i} + (u \sin 30 t - 0.5g \cos 30 t^2) \vec{j}$$

$$\vec{v} = (u \cos 30 - g \sin 30 t) \vec{i} + (u \sin 30 - g \cos 30 t) \vec{j}$$

$$(iii) \text{ At Q: } \vec{r}_j = 0 \Rightarrow t = \frac{2u \sin 30}{g \cos 30}$$

$$= \frac{2u}{g \sqrt{3}}$$

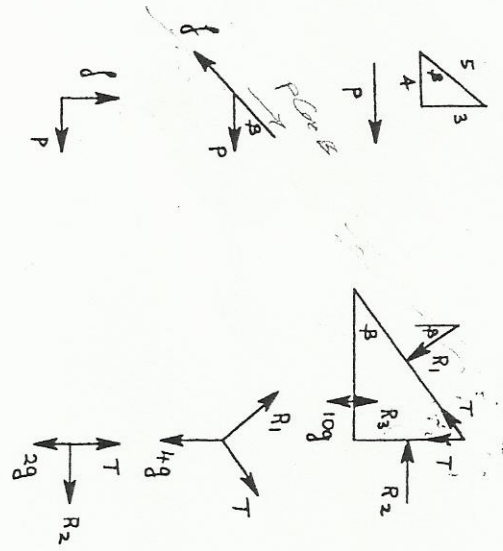
$$\tan \phi = -\frac{v_j}{v_x}$$

$$= -\frac{(u \sin 30 - 2u \sin 30)}{u \cos 30 - g \sin 30 \cdot (2u/g\sqrt{3})}$$

$$\tan \phi = \sqrt{3} \quad \text{or} \quad \phi = 60^\circ$$

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$$(ii) \text{ Wedge: } \text{horiz. } R_1 \sin \beta - R_2 - T \cos \beta = 10p \quad \dots (1)$$

$$4 \text{ kg mass: } 4g \sin \beta - T = 4(f - p \cos \beta) \quad \dots (2)$$

$$2 \text{ kg mass: } \text{horiz. } R_2 = 2p \quad \dots (4)$$

$$\text{vert. } T - 2g = 2f \quad \dots (5)$$

Eliminate f from equations (2) and (5)

$$4g \sin \beta - T = 2T - 4g - 4p \cos \beta$$

$$T = \frac{16p + 32g}{15} \quad \dots (6)$$

Substitute equations (3), (4) and (6) into equation (1)

$$(4g \cos \beta - 4p \sin \beta) \sin \beta - 2p - \frac{(16p + 32g)}{15} \cos \beta = 10p$$

$$p = g/67 \quad \text{or} \quad 0.15$$