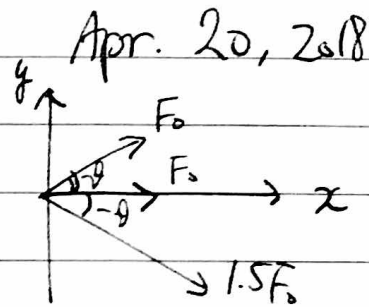


# 1. PHYQA Discussion 3



1.

$$1) F_x = F_0 + F_0 \cos \theta + 1.5 F_0 \cos(-\theta)$$

$$= F_0 (1 + 2.5 \cos \theta),$$

$$F_y = F_0 \sin \theta + 1.5 F_0 \sin(-\theta)$$

$$= -0.5 F_0 \sin \theta.$$

$$\Rightarrow F := \|F\| = \sqrt{F \cdot F}$$

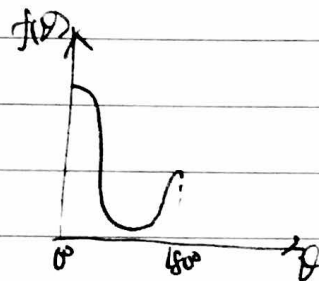
$$= \sqrt{F_x^2 + F_y^2}$$

$$= F_0 \sqrt{(1 + 2.5 \cos \theta)^2 + (-0.5 \sin \theta)^2}$$

$$= \frac{F_0}{2} \sqrt{(2 + 5 \cos \theta)^2 + \sin^2 \theta}$$

$$= \frac{F_0}{2} \sqrt{24 \cos^2 \theta + 20 \cos \theta + 5}$$

$\leftarrow f(\theta)$



$$\forall \theta, f(\theta) \neq 0 \quad \therefore F \neq 0.$$

$$f'(\theta) = -48 \cos \theta \sin \theta - 20 \sin \theta$$

$$= -4 \sin \theta (12 \cos \theta + 5) = 0$$

$$\therefore \sin \theta = 0 \quad \text{or} \quad \cos \theta = -\frac{5}{12}$$

$$\Leftrightarrow \theta = \underbrace{0^\circ, 180^\circ}_{\text{local maxima}}, \quad \underbrace{\arccos\left(-\frac{5}{12}\right)}_{\text{minimum}} \approx 114.6^\circ$$

2.

$$ii) F = ma$$

$$\Rightarrow m = \frac{F}{a} = \frac{F_0}{2a} \sqrt{24 \cos^2 \theta + 20 \cos \theta + 5}$$

$$\approx 1.411 \text{ [kg]}.$$

$$\vartheta_a \equiv \arctan\left(\frac{a_y}{a_x}\right) = \arctan\left(\frac{m a_y}{m a_x}\right)$$

$$= \arctan\left(\frac{F_y}{F_x}\right)$$

$$= \arctan\left(\frac{-0.5 \sin \theta}{1 + 2.5 \cos \theta}\right)$$

$$\approx -4.516^\circ. \quad (\text{measured from the direction of the second force.})$$