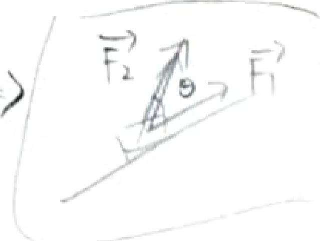
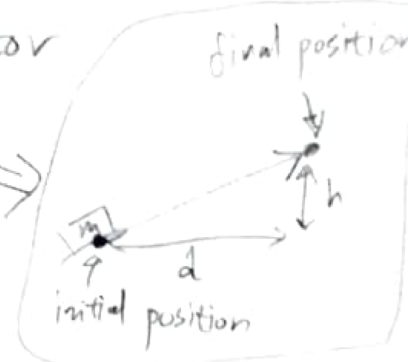
Q 4.1

net force ⇔



$$\text{Work} = \vec{F}_{net} \cdot \vec{d}$$

← displacement vector



$$= \left[\left(\vec{F_1} + \vec{F_2} \right) \cdot \vec{d} \right] (J)$$

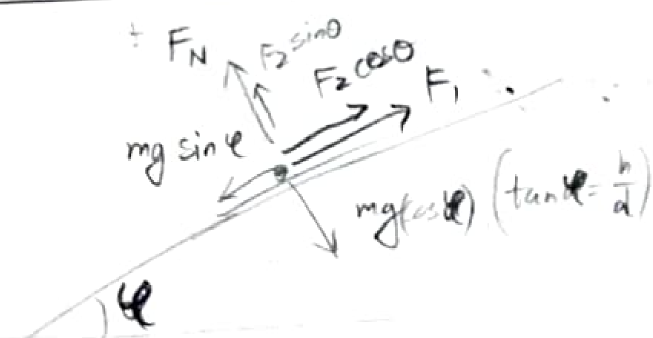
$$= \left[\vec{F_1} \cdot \vec{d} + \vec{F_2} \cdot \vec{d} \right] (J)$$

$$= \left[|\vec{F_1}||\vec{d}| + |\vec{F_2}||\vec{d}| \cos\theta \right] (J) \text{ where } |\vec{d}| = \sqrt{d^2 + h^2}$$

$$= \left[|\vec{d}| \left(|\vec{F_1}| + |\vec{F_2}| \cos\theta \right) \right] (J) = \sqrt{d^2+h^2} \left(F_1 + F_2 \cos\theta \right) J$$

Answer: $(F_1 + F_2 \cos\theta)\sqrt{d^2+h^2}$ J.

Q 4.2



⟨Free-body Diagram⟩

Since there is no friction and a linear motion from bottom to top of the ramp, we do know the net force will be pulled to the surface of the motion. Thus, we assume

$$F_N + F_2 \sin\theta = mg \cos\varphi \quad \text{(vertical components)}$$

For horizontal components, we know the net force will be

$$F_1 + F_2 \cos\theta - mg \sin\varphi \quad (\text{direction}: \nearrow)$$

and acceleration will be $\frac{F_1}{m} + \frac{F_2}{m}\cos\theta - g\sin\varphi$

According to the kinematics formula, we know

$$2as = (V_f^2 - V_i^2)$$

Thus, we know it starts ~~at~~ rest, $V_i = 0$.

$$2as = V^2$$

Therefore, we have the following equation

$$V = \sqrt{2as}$$

Here, s is given "$\sqrt{d^2+h^2}$" and a is gained "$\frac{F_1}{m} + \frac{F_2}{m}\cos\theta - g\frac{h}{\sqrt{d^2+h^2}}$". Thus,

$$V = \sqrt{2 \cdot \left(\frac{F_1}{m} + \frac{F_2}{m}\cos\theta - g\frac{h}{\sqrt{d^2+h^2}}\right) \cdot \sqrt{d^2+h^2}}$$

$$= \sqrt{\frac{2F_1}{m}\sqrt{d^2+h^2} + \frac{2F_2}{m}\cos\theta \cdot \sqrt{d^2+h^2} - 2gh}$$

Answer:

$$\boxed{V = \sqrt{\frac{2F_1}{m}\sqrt{d^2+h^2} + \frac{2F_2}{m}\cos\theta\sqrt{d^2+h^2} - 2gh}}$$