# Physics 201 - Lecture 15

→ finish assignment 4

→ more on friction.

→ start assignment 5

(We will go slowly through each problem!)

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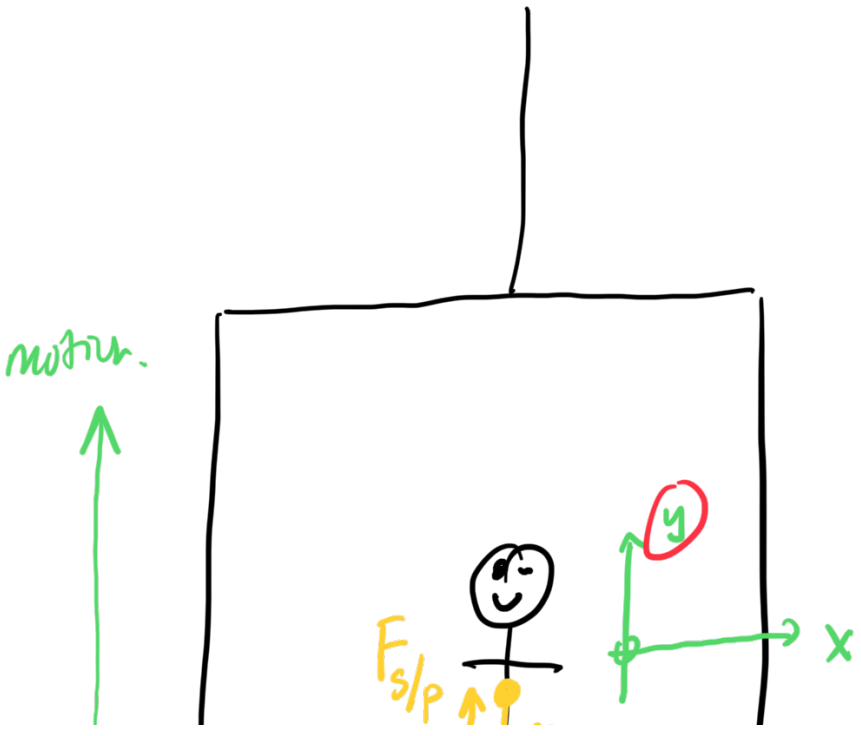
9.




→ Free Body Diagram(s) for the objects of interest.

① gravity
② contact forces ‖ Person.

Man ..

$$\Sigma F_y = m a_y$$

$$\boxed{F_{s/p} - mg = ma_y}$$

a) $a_y = 1.25\ m/s^2$ (+ve because "upwards")

$$F_{s/p} = ma_y + mg$$

$$= (88)(1.25) + (88)(9.8)$$

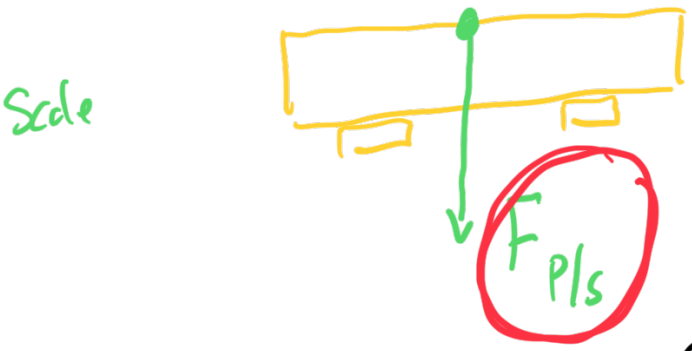
$$= \quad N$$

$= 972$ N

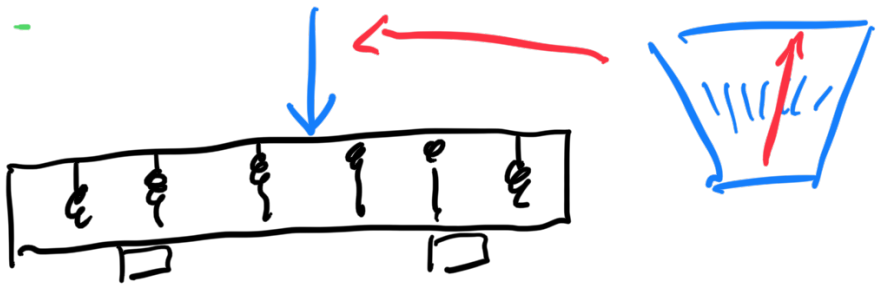
$\vec{F}_{s/p} = 972$ N upwards.

$\vec{F}_{p/s} = 972$ N downwards.

$\vec{F}_{s/p} = -\vec{F}_{p/s}$ Newton's 3rd Law




How do scales work?



In "constant velocity" → $a = 0$

b)

$$F_{s/p} - mg = ma_y$$

$$F_{s/p} = mg = 862\,N$$

$\vec{F}_{s/p} = 862\ N$ upwards.

$\vec{F}_{p/s} = \boxed{826\ N}$ downwards.

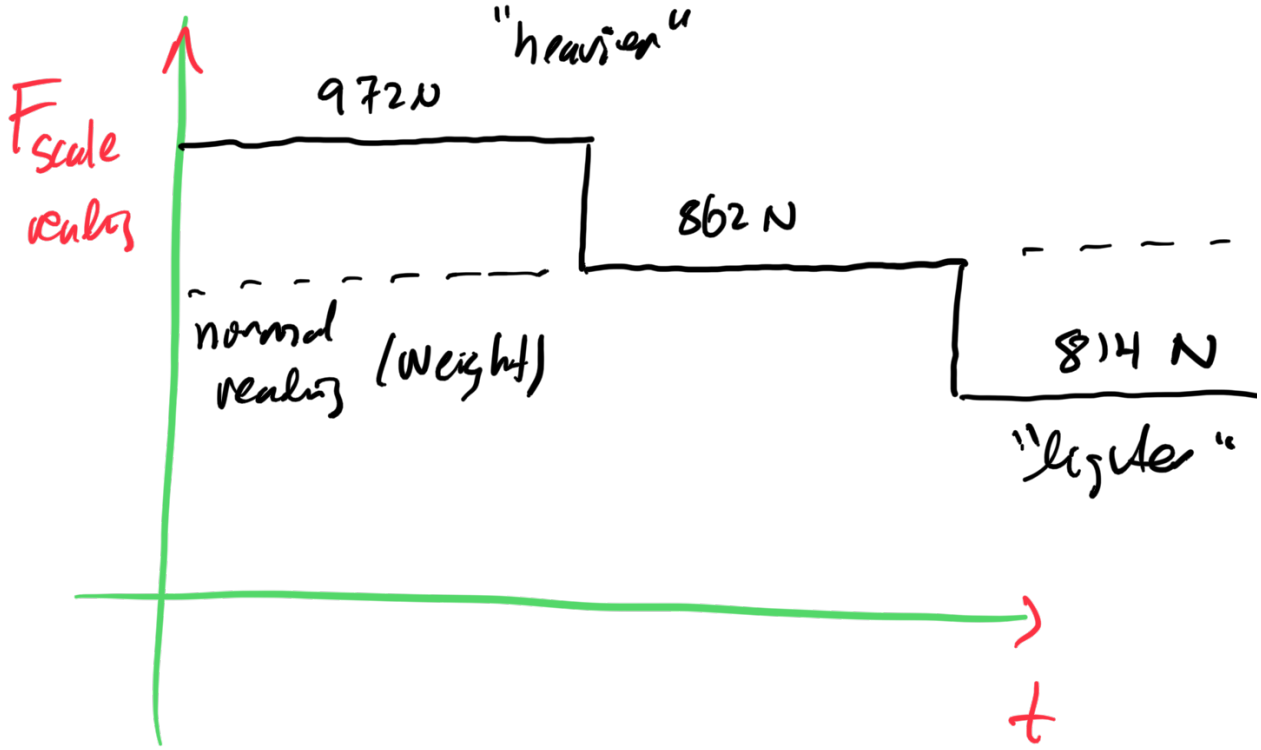
c) $a_y = -0.550\ m/s$

$$F_{s/p} - mg = ma_y$$

$$F_{s/p} = ma_y + mg$$

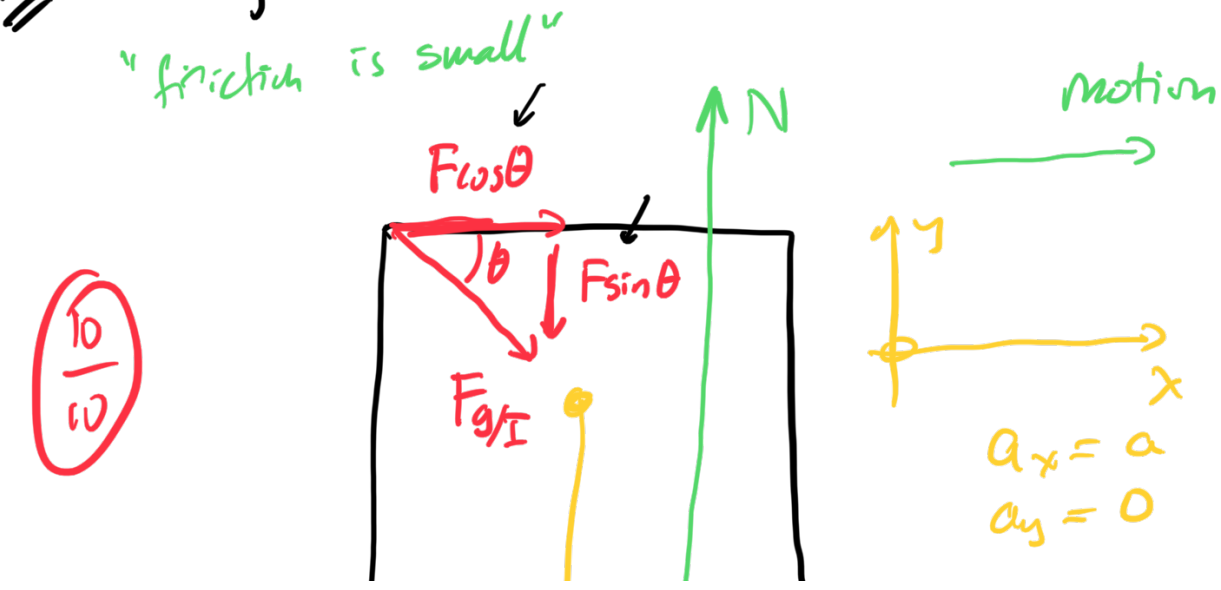
$$= (88)(-0.55) + (88)(9.2$$

$= 814\ N$




10. Object of interest

ICE




1. identify all forces
2. coordinate system
3. resolve into components.

| X | Y |
|---|---|
| $a_x = a$ | $a_y = 0$ |
| $\sum F_x = ma_x$ | $\sum F_y = ma_y = 0$ |
| $F\cos\theta = ma_x$ | $N - mg - F\sin\theta = 0$ |

$\uparrow \theta$

$N = mg + F\sin\theta$

$$F = \frac{ma_x}{\cos\theta}$$

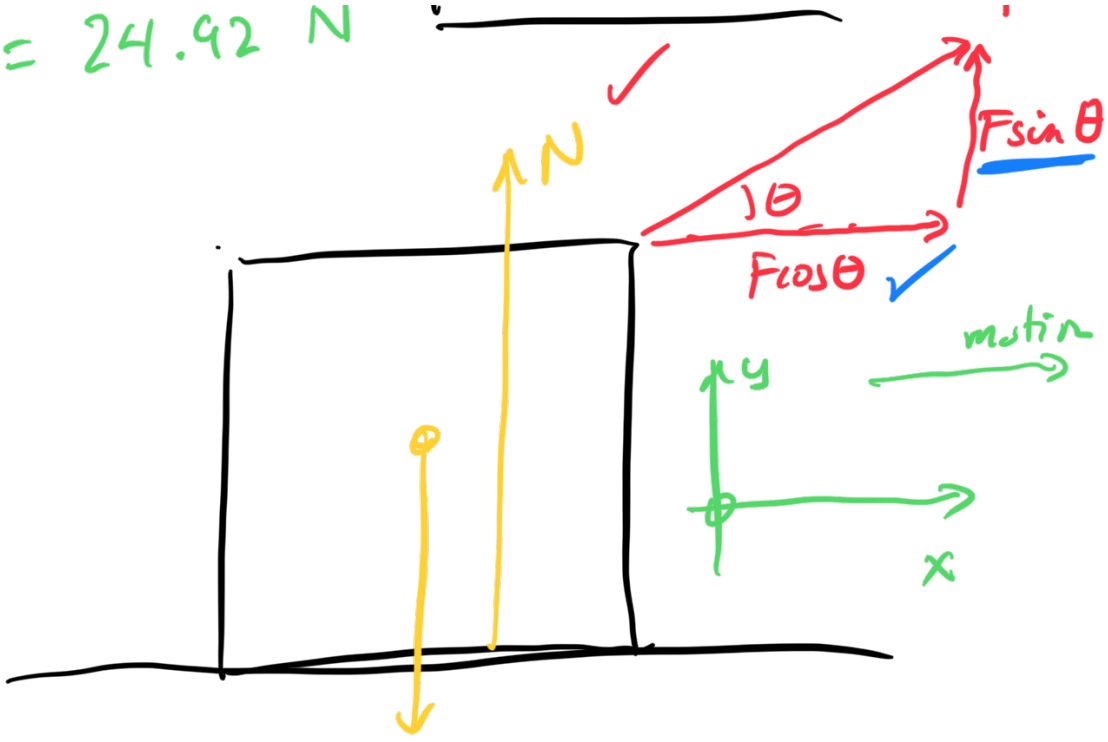
$$= \frac{(40)(.550)}{\cos(28^\circ)}$$

$$= (40)(9.8) + (24.92)\sin(28$$

$N = 404\ N$

F

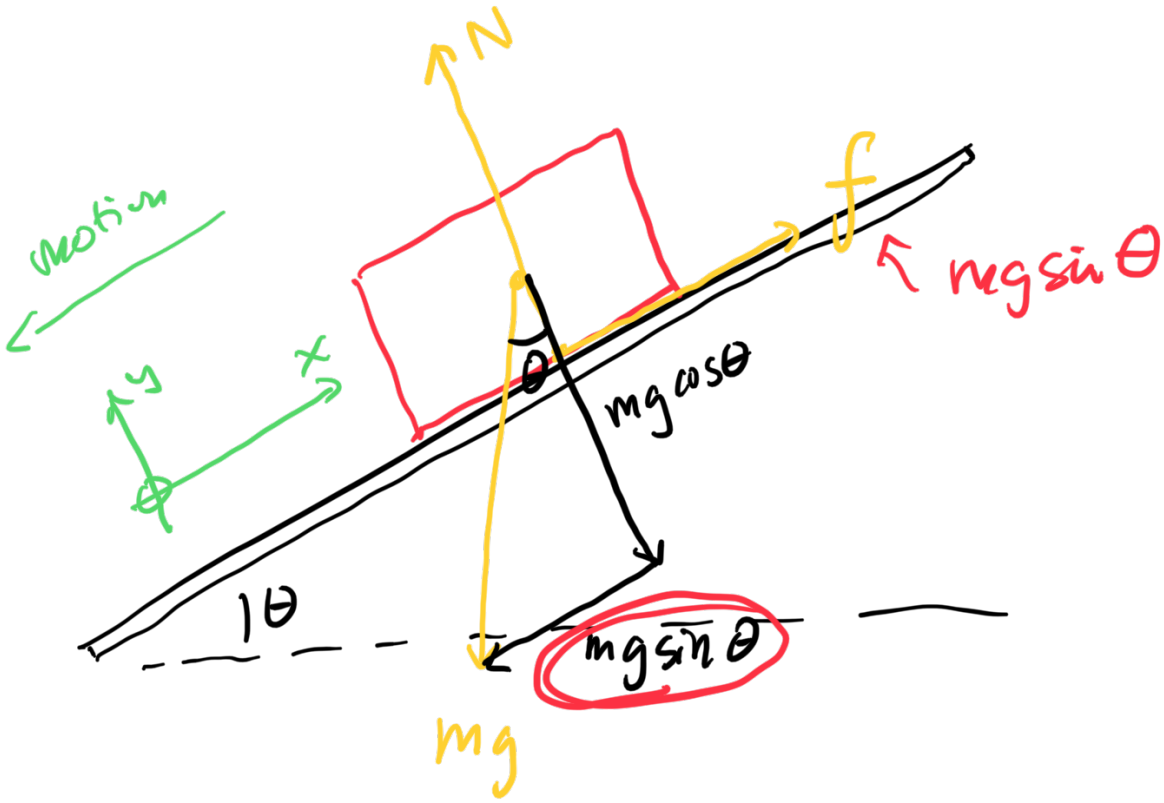
$= 24.92$ N




| X | Y |
| --- | --- |
| $F\cos\theta = ma_x$ | $N - mg + F\sin\theta = 0$ |
| $F = 24.92\,N$ | $N = mg - F\sin\theta$ |
| | $= (40)(9.8) - (24.92)\sin 28$ |
| | $= 380\,N$ |

Friction → energy losses

→ $$$




| X | Y |
| --- | --- |
| $\Sigma F_x = ma_x$ | $\Sigma F_y = ma_y = 0$ |
| $f - mg\sin\theta = ma_x$ | $N - mg\cos\theta = 0$ |
| | $N = mg\cos\theta$ |

coefficient of

friction.

Definition of friction: $f = \mu N$

$$f = \mu m g \cos\theta$$

$$\mu m g \cos\theta - m g \sin\theta = m a_x$$

$$a_x = \mu g \cos\theta - g \sin\theta$$

$$\Rightarrow \boxed{a_x = g(\mu \cos\theta - \sin\theta)}$$

TWO REGIMES:

Static

Kinetic

object is slidi

- object is not moving relative to the surface.

- object is moving relative to the surface.

$$a_x = 0$$

$$0 = g(\underbrace{\mu\cos\theta - \sin\theta}_{=0})$$

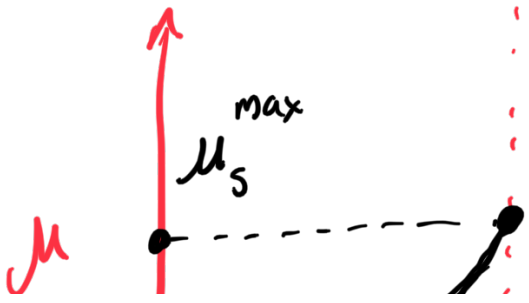
$$\mu\cos\theta - \sin\theta = 0$$

$$\mu\cos\theta = \sin\theta$$

$$\mu = \frac{\sin\theta}{\cos\theta}$$

$$\boxed{\mu = \tan\theta}$$ ☺

$$\mu_s^{max} = \tan(\theta_{max})$$

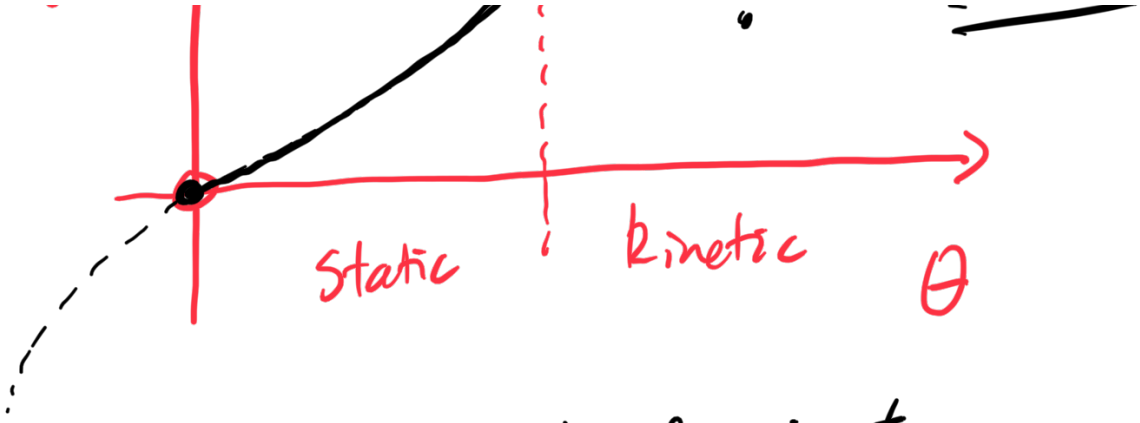



$$f = \mu mg\cos\theta$$

$$= \tan\theta \cdot mg\cos\theta$$

$$= \frac{\sin\theta}{\cancel{\cos\theta}} \cdot mg\cancel{\cos\theta}$$

$$? = mg\sin\theta$$




← measured by experiment.

$\mu_s^{max}$ ≡ max. coefficient of static friction.

↑ surface just gets overwhelmed 😐

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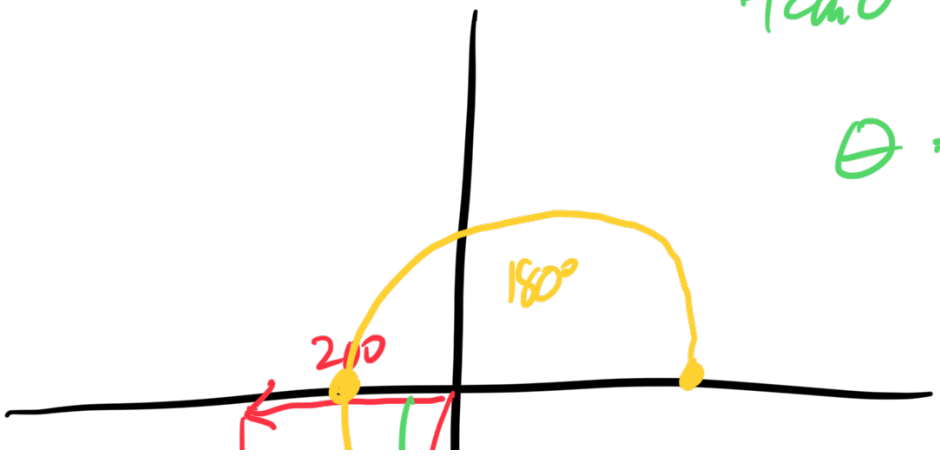
Q2:

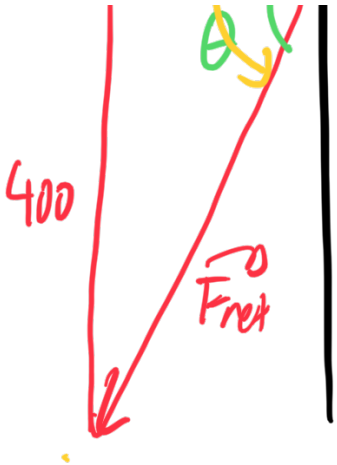
a) $\vec{F}_{net} = -200\hat{i} - 400\hat{j}$

$\tan\theta = \frac{O}{a} = \frac{400}{200}$

$\theta = 63.43°$

b)






$\phi = 180° + 63.43$

$= 243.43°$