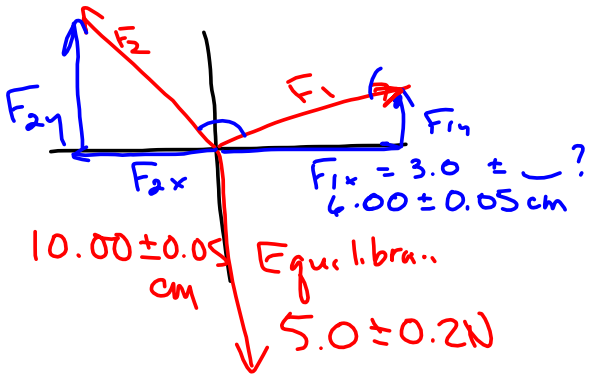
A Note on Scale

Scale 2cm : 1N

2.0 ± ___ cm/N



$$\text{Scale} = \frac{10.00 \pm 0.05\ \text{cm}}{5.0 \pm 0.2\ \text{N}}$$

$$= 2.00 \pm 0.08\ \frac{\text{cm}}{\text{N}}$$

$\delta F_{x_1} = ?$

$$F_{x_1} = \frac{6.00 \pm 0.05\ \text{cm}}{2.00 \pm 0.08\ \text{cm/N}}$$

$$= 3.0 \pm 0.1\ \text{N}$$

$$\frac{\delta Q}{|Q|} = \sqrt{\left(\frac{\delta a}{a}\right)^2 + \left(\frac{\delta b}{b}\right)^2}$$

$$\frac{\delta Q}{2\ \text{cm/N}} = \sqrt{\left(\frac{0.05}{10.00}\right)^2 + \left(\frac{0.2}{5.0}\right)^2}$$

$$= 0.041$$

$$\delta Q = 0.08\ \text{cm/N}$$

Compare

1) Are they experimentally equal?

6.5 ± 0.2N vs 6.7 ± 0.2N

subtract 0.2 ± 0.3 N

(-0.1, 0.4)

zero in range

If yes, say so.

If no ... ±2

2) Calculate % diff

$$\%\ \text{diff} = \left|\frac{\text{Value 1} - \text{Value}}{\text{theoretical, best or smallest value}}\right| \times 100$$

no ± in % diff calc. → $\frac{6.7\text{N} - 6.2\text{N}}{6.2\text{N}} \times 100\%$

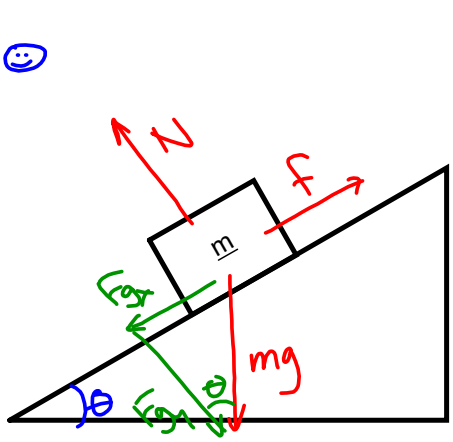
Homework: Questions?

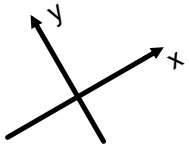
Inclined Planes

Recall that for solving inclined plane problems that it is useful to tilt our typical x-y axis

$v_i = 0$

μ





2 Possibilities

1) It slides downhill

2) It remains at rest.

$F_{gx} = mg\sin\theta$

$N = F_{gy} = mg\cos\theta$

$f = \mu N$

$= \mu mg\cos\theta$

Case 1: $F_{gx} > f$

$\Sigma F = F_{gx} - f = ma$

$mg\sin\theta - \mu mg\cos\theta = ma$

$mg(\sin\theta - \mu\cos\theta) = ma$

$a = g(\sin\theta - \mu\cos\theta)$

independent of m.

$a > 0$ when $\frac{\sin\theta}{\cos\theta} > \frac{\mu\cos\theta}{\cos\theta}$

$\tan\theta > \mu$

Case 2: $F_{gx} = f$

$f_{max} = \mu N$

Is $mg\sin\theta = \mu mg\cos\theta$?

No.

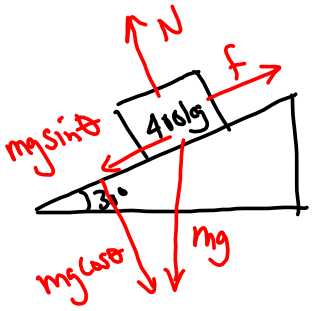
$f = mg\sin\theta \leq \mu mg\cos\theta$

This is true when

$\tan\theta \leq \mu$

Example

A piano (m=400 kg) is initially at rest on a ramp with an incline of 30°. The coefficient of friction between the wheels of the piano and the ramp is 0.10. If left on its own, what will be its acceleration? What force would be needed to push it uphill at a constant speed?



Is $mg\sin\theta > f_{max}$

$F_{gx} = mg\sin\theta = (400\,kg)(9.807\,m/s^2)(\sin 30°)$

$= 1960\,N$

$f_{max} = \mu N = \mu mg\cos\theta$

$= (0.10)(400)(9.807)\cos 30°$

$= 339\,N$

$\Sigma F = F_{gx} - f = ma$

$1960N - 339N = 400kg\ a$

$a = 4.05\,m/s^2$ downhill.

If pushing uphill (with a force F), friction flips ☺

$\Sigma F = F - (F_{gx} + f) = ma$

$F = F_{gx} + f = 1960 + 339\,N = 2299\,N$

Homework: Questions #1-5 from worksheet. (First 2 are just review if you need it).

Read the tutorial and watch the video on free body diagrams if you need a refresher:

https://www.aplusphysics.com/courses/honors/dynamics/FBD.html