Spring 2014

PHYS-2010

Lecture 15

Announcements

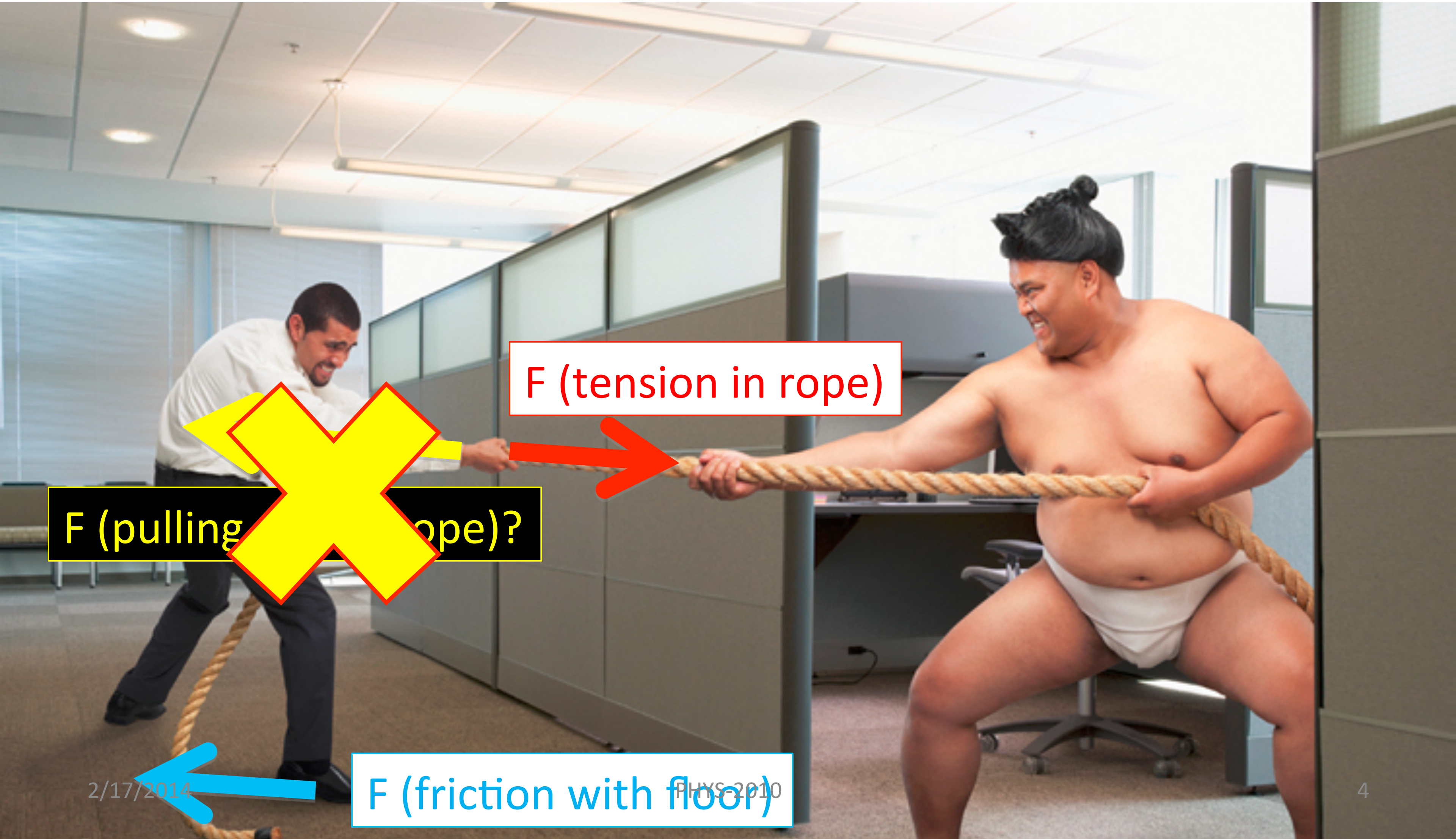
- Read Giancoli Chapter 4 (sections 4.1-4.6).
- **CAPA # 5** is due tomorrow, Tuesday at 11 pm.
- **Written homework # 4** due Friday at 4 pm.
- This week: **Lab # 3 "Projectile Motion"** with a **prelab**.
- Pre-midterm **Study Session** by Prof Pollock tomorrow (Tue, Feb. 18) in G125 (one floor up!), 5-6 pm.

FREE-BODY DIAGRAMS

Consider an Everyday Occurrence

Assume you are in a tie with your sumo-wrestler friend.

Draw the free-body diagrams (i.e. forces) acting on you.



Consider an Everyday Occurrence

Draw the free-body diagrams (i.e. forces) acting on you.

Any other forces acting on you?

Clicker Question

Room Frequency BA

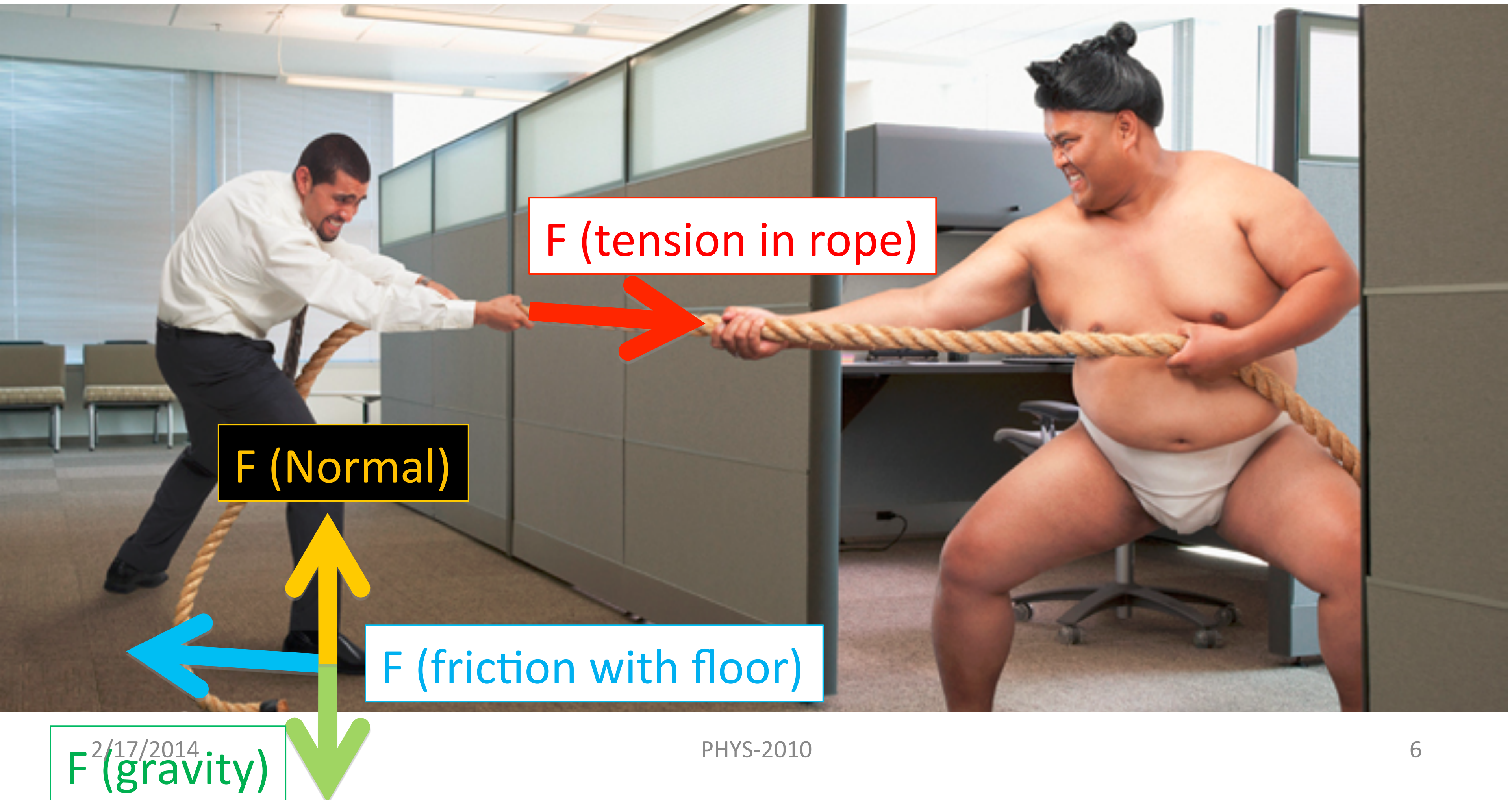
What is the direction of the friction force acting on the *__sumo wrestler’__*s feet?

A) Left

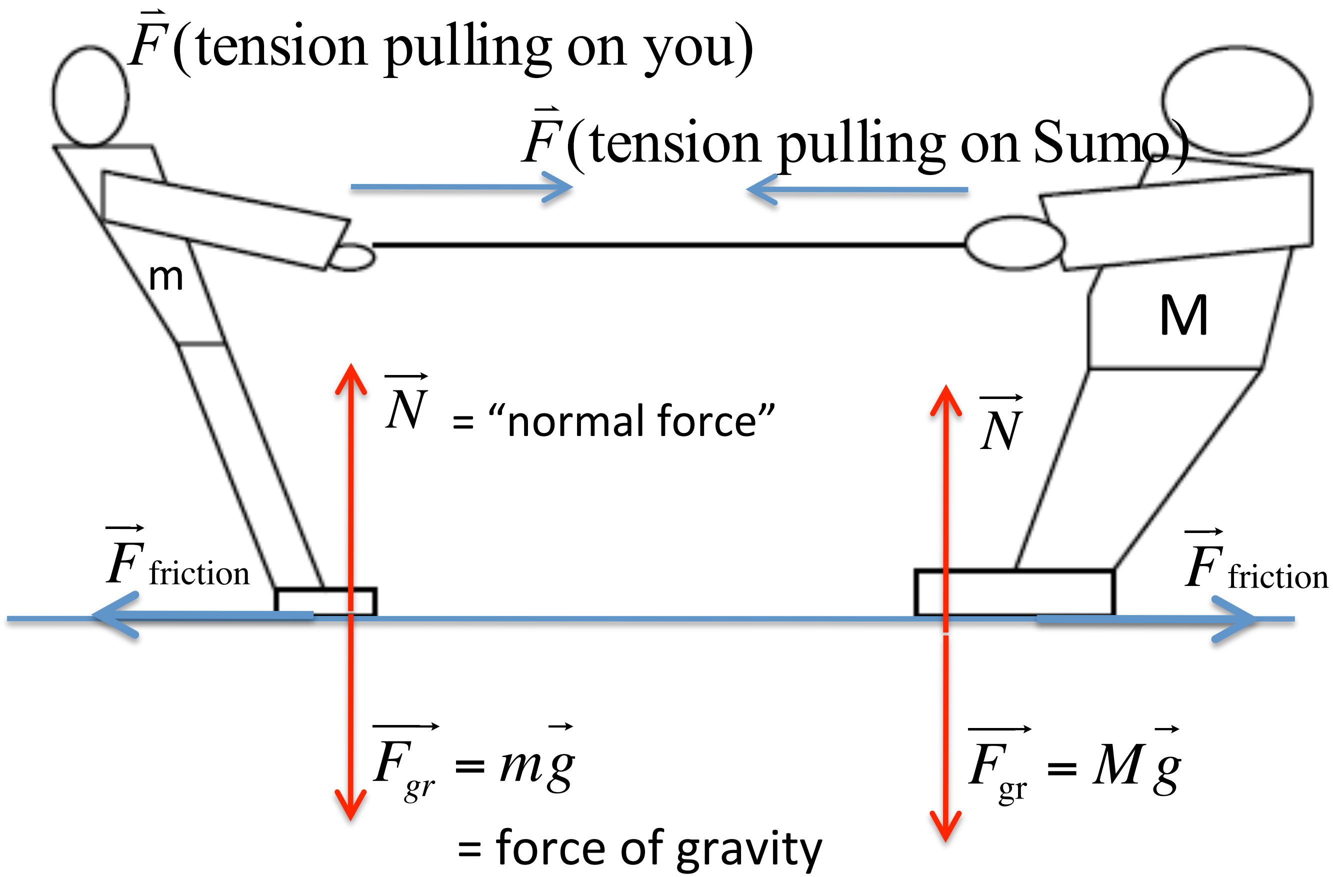
B) Down

C) Right

D) Up



We often draw free-body diagrams schematically

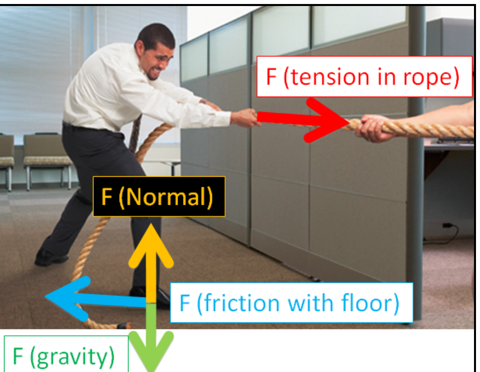


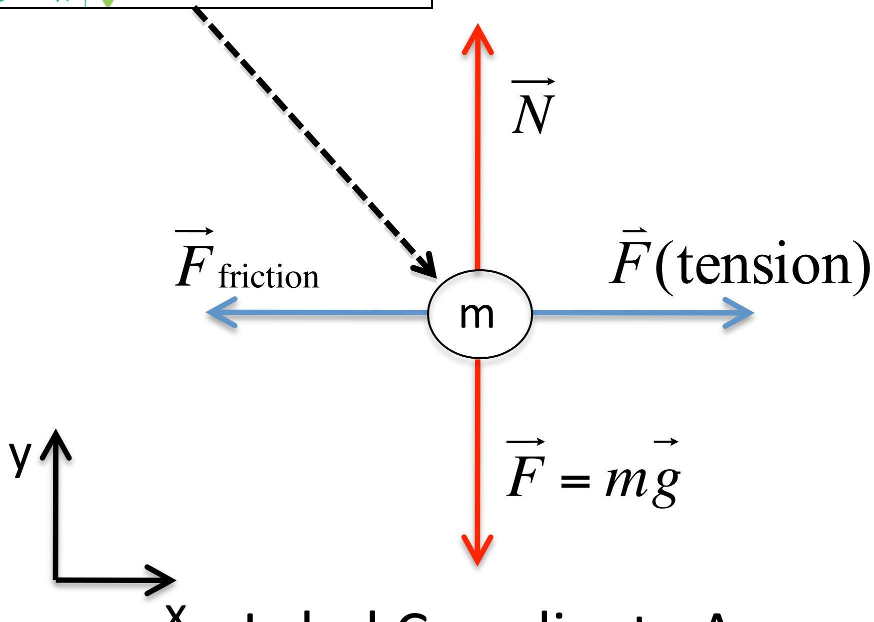
Be very careful to indicate on which object the force is acting (not who does the acting).

Point-Like Objects

We often treat objects as point-like with all forces acting on that point.

Reasonable for rigid (non-deformable) objects and ignoring rotations.





Label Coordinate Axes

Since you are not moving….

No acceleration in *x* or *y* directions

Net force in *x* must be zero:

$$\vec{F}(\text{friction}) + \vec{F}(\text{tension}) = 0$$

Net force in *y* must be zero:

$$\vec{F}(\text{gravity}) + \vec{F}(\text{Normal}) = 0$$

Physics of the Ultimate Slip-n-Slide

Newton's Laws, Kinematics, Fluids, Friction, Luck?

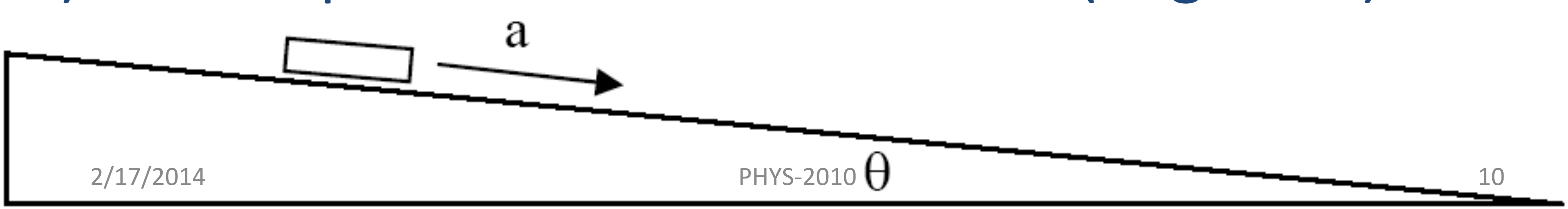
http://www.youtube.com/watch?v=3wAjpMP5eyo

Slip-n-Slide

Part I – going down the slide

Physics approximation….

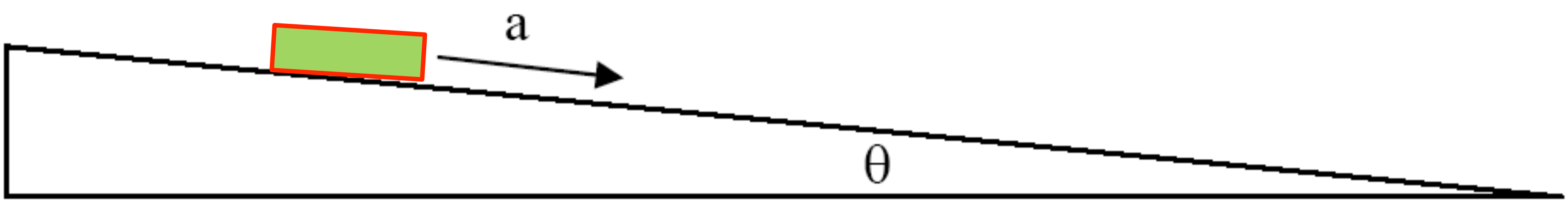
1) You are a small rectangular box (that we will treat as a point-like object anyway).
2) The slope of the slide is constant (angle = θ)



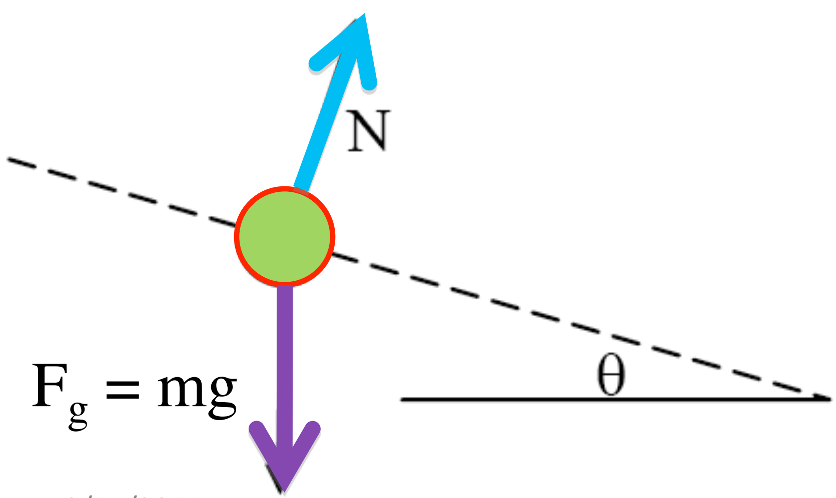
How large a net force will you feel down the slope?

What is the acceleration down the slope?

How fast will you be going after traveling down the slope for some time *t*?



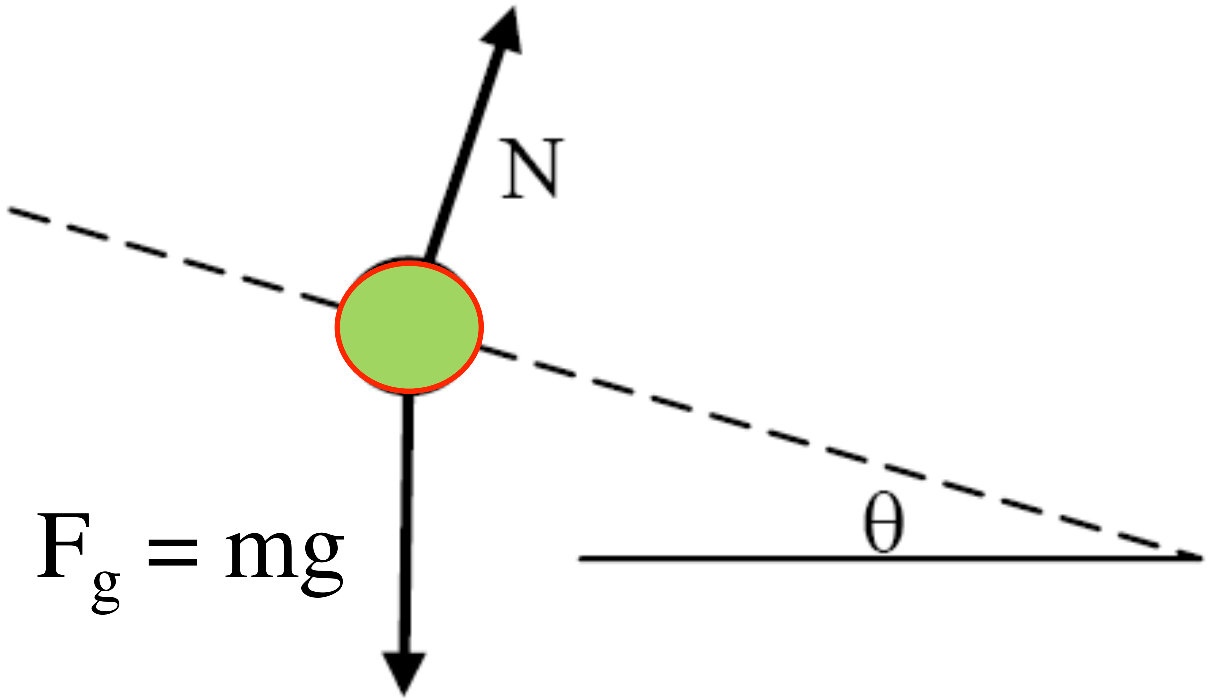
Step 1: Draw a free-body diagram

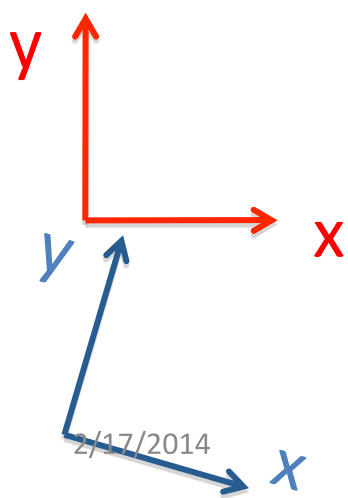


Note: "Normal Force" is always **perpendicular** (i.e. normal) to the surface of contact.

In this case, it is ***not*** in the opposite direction to the gravitational force.

Step 2: Choose a coordinate system



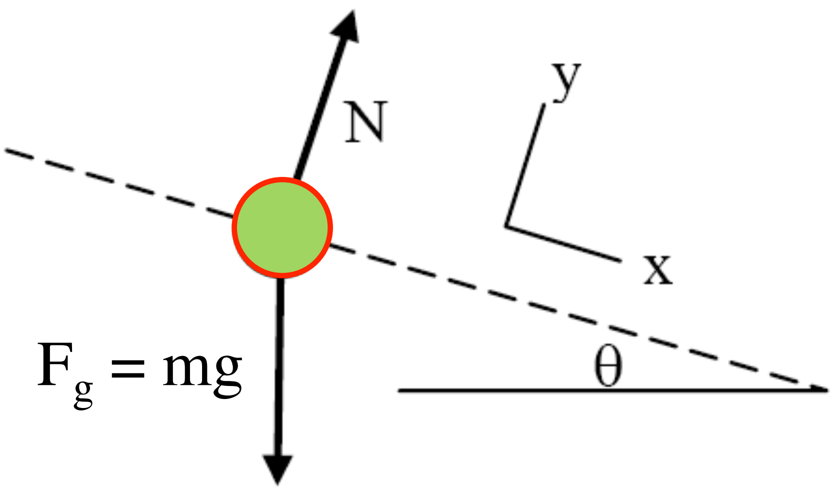


We could choose our "usual" axes…
However, we know that we will have motion in both the *x* and *y* directions.

If we pick these rotated axes, we know that the acceleration along *y* must be zero.

Step 3: Write down the equations

$$\Sigma F_x = m\,a_x\ ,\ \Sigma F_y = m\,a_y$$



Problem:

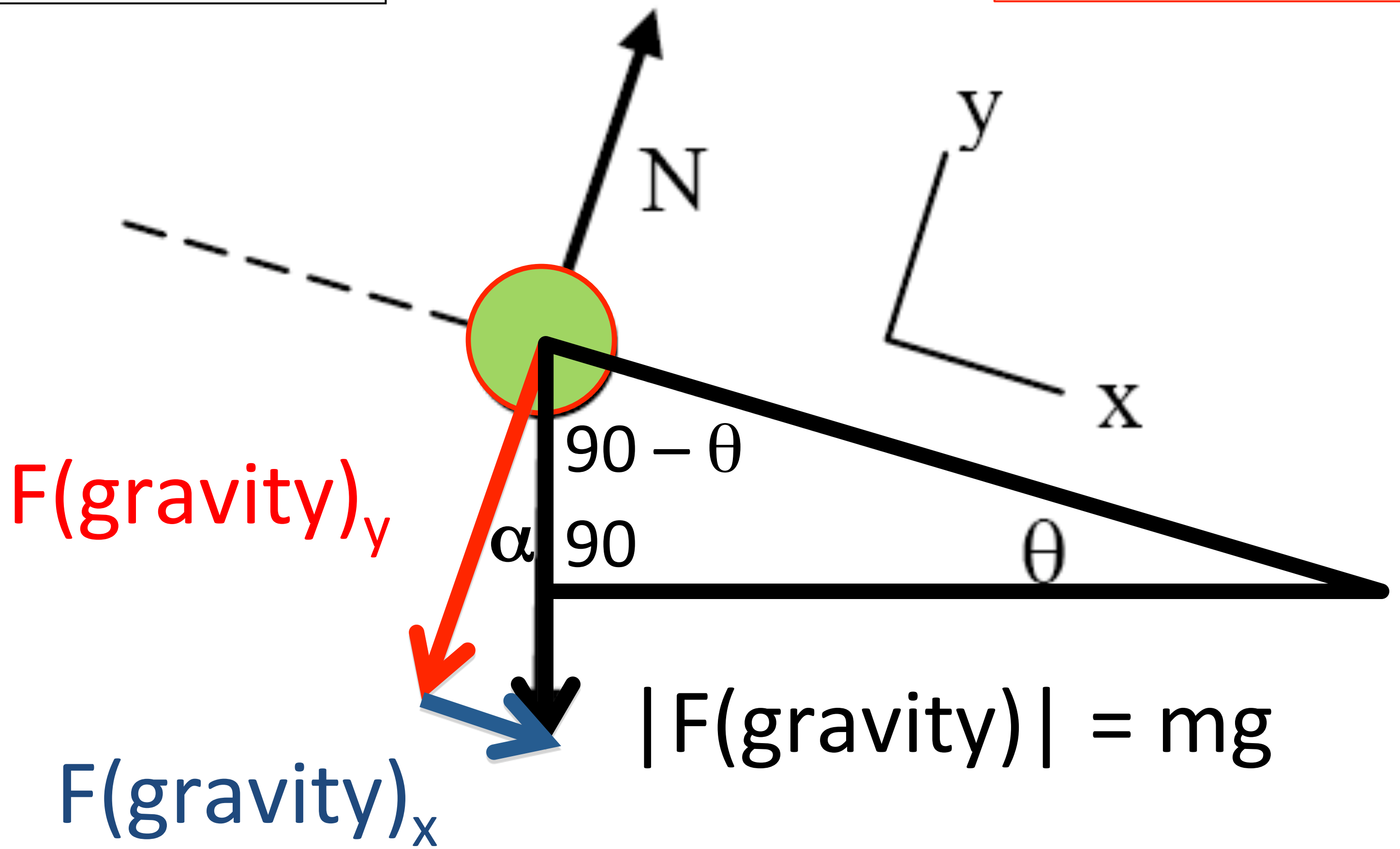
F_g doesn't point in a coordinate direction.

Must break it into its

x- and *y*-components.

Clicker Question

Room Frequency BA



What is the angle α labeled above?

A) α = 90 degrees

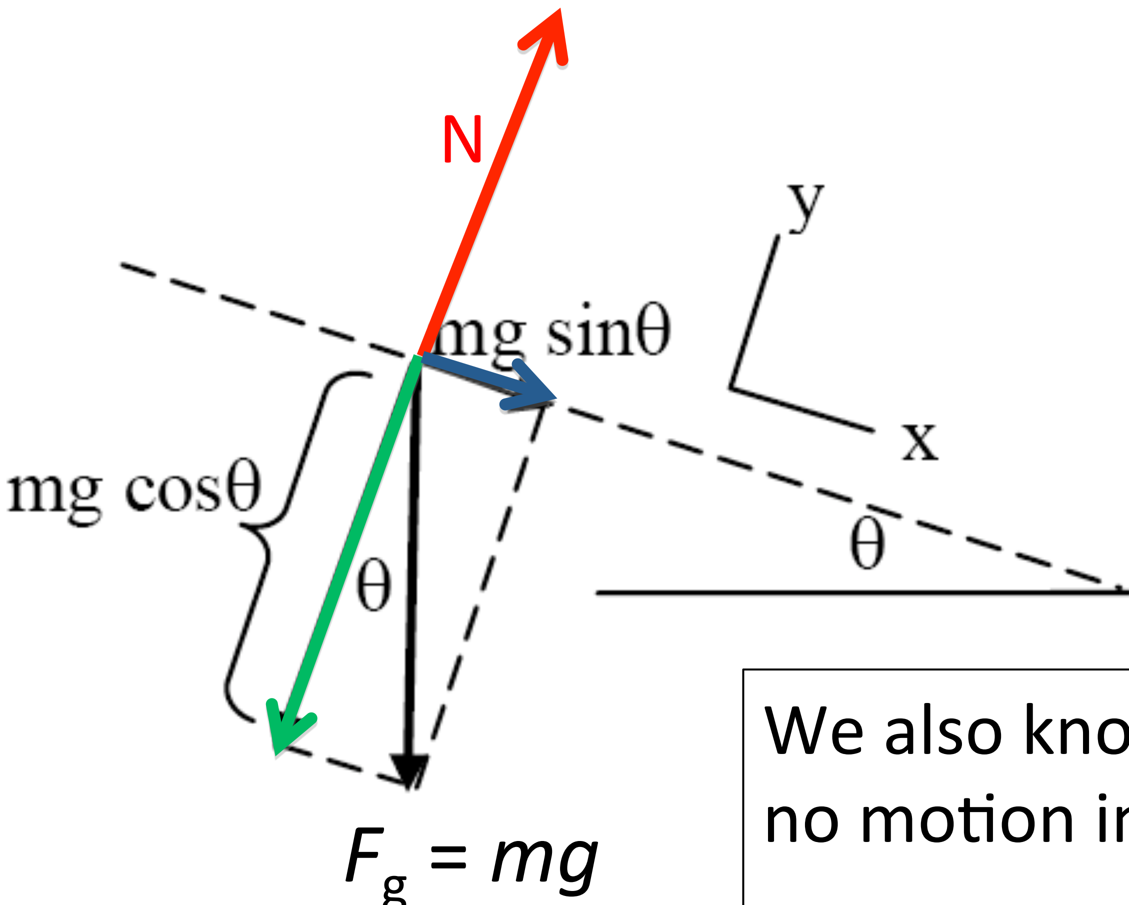
B) α = θ

C) α = 90 – θ

D) Cannot be determined

Step 3: Write down the equations

$$\Sigma F_x = m\, a_x\ ,\ \Sigma F_y = m\, a_y$$



$$F_x = mg \sin(\theta)$$

$$F_y = N - mg \cos(\theta)$$

We also know that $a_y = 0$, there is no motion in that direction.

$$F_y = ma_y = 0 = N - mg \cos(\theta)$$

Step 4: Solve the Equations

$$F_x = ma_x = mg\sin(\theta)$$

$$a_x = g\sin(\theta)$$

As expected, maximum acceleration if straight down (θ=90 degrees), a_x = g.

$$F_y = ma_y = N - mg\cos(\theta)$$

$$a_y = \frac{N}{m} - g\cos(\theta) = 0$$

$$N = mg\cos(\theta)$$

Recall *x*-*y* definition