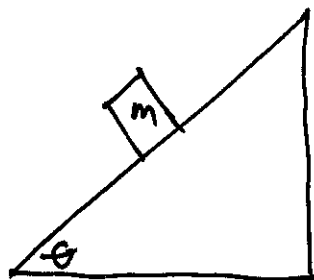


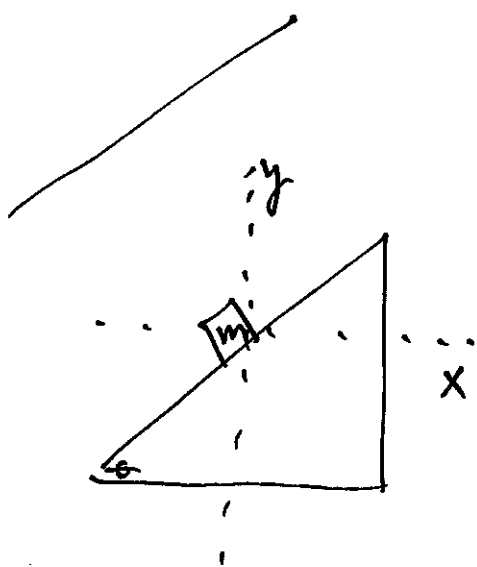
Ⓔ Ramp Problems without Friction



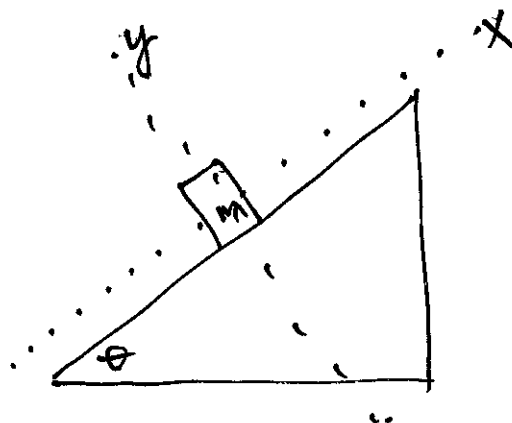
A block of mass m is on a ramp of angle θ .

To correctly analyze this situation we will use a rotated axis to break our forces into components.

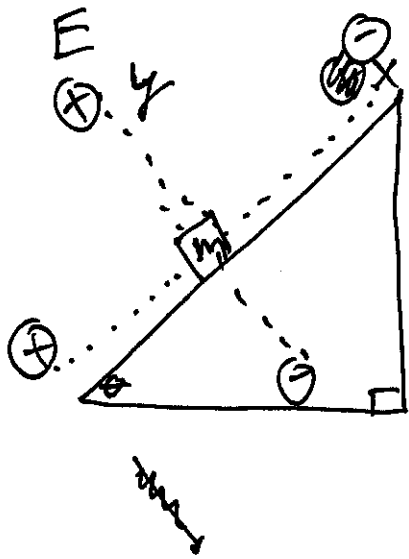
The axes are rotated, so that the x-axis is parallel to the ramp and the y-axis is perpendicular to it.



This is how you typically arrange a coordinate axis



But we will arrange the axes this way instead!



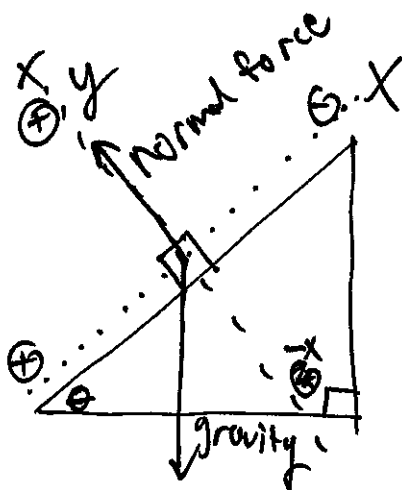
- we have rotated the axes so that the x-axis is now parallel to the ramp, and the y-axis is perpendicular to the ramp.
- (I've also made \hat{x} down the ramp)

In a frictionless ramp, only two forces act on the block.

- Gravity and - Normal Force

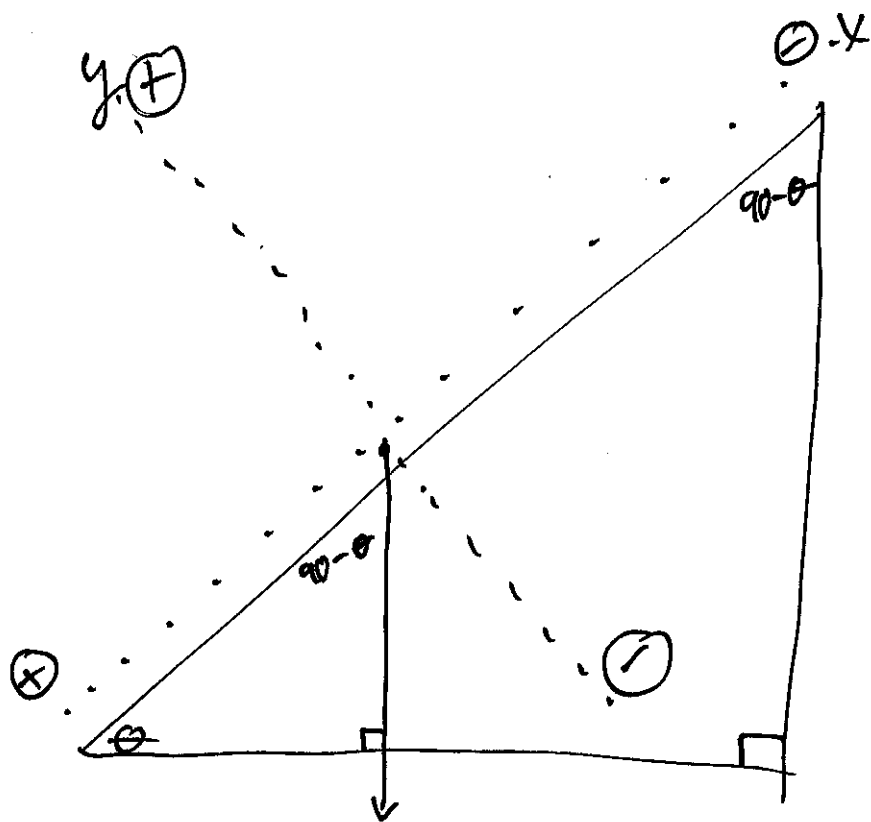
- Gravity always acts directly down

- Normal Force always acts perpendicular to the surface



* This means

- Normal Force acts in the \hat{y} direction, and does not need to be broken into components.
- Gravity must be broken into components!



How do we find the direction of gravity in our new coordinate system?

- From the diagram above,
and using the principle that the sum of the angles of a triangle is 180° ,

we can see the direction of gravity is
 $90 - \theta$ below the \oplus axis.

In which θ is the angle of incline of the ramp.

⑤

Magnitudes of forces

- Gravity always has direction directly down

and magnitude given by
 $F_g = mg$

- The normal force always has direction perpendicular to the surface, and it is a constraint force.

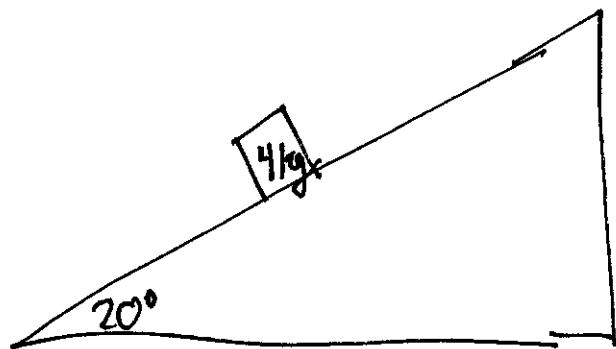
In this case, the normal force acts to keep the block on the ramp.

The normal force will adapt to whatever magnitude is necessary such that

$$\sum F_y = 0.$$

The sum of all y-components of forces is equal to zero.

E.1



- A block with a mass of 4 kg is on a ^{frictionless} ramp with an angle of incline of 20° .

- Ⓐ Set up ~~the~~ a coordinate axis based on the ~~any~~ direction of the ramp.
- Ⓑ Draw a free-body diagram including only two forces.
- Ⓒ Break gravity into components, and ~~draw these~~ fill out the following table:

X-Forces

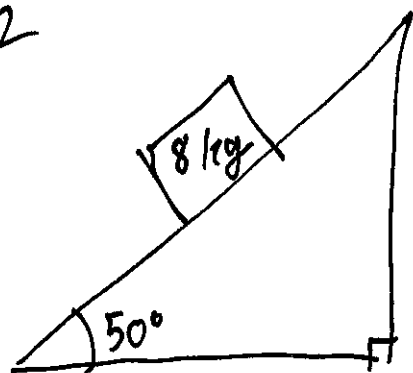
Force	Magnitude + sign

Y-Forces

Force	Magnitude + sign

- Ⓓ Determine ΣF_x and the acceleration of the block.

E.2



- A block with a mass of 8 kg is on a frictionless ramp with an angle of incline of 20° .

- Set up a coordinate axis based on the surface of the ramp.
- Draw a free-body diagram including only two forces.
- Break gravity into components and fill out the following tables:

X-forces	
Force	Magnitude + sign

Y-forces	
Force	Magnitude + sign

- Determine $\sum F_x$ and determine the acceleration of the block a_x .