

**MEI**  
Conference  
**2018**

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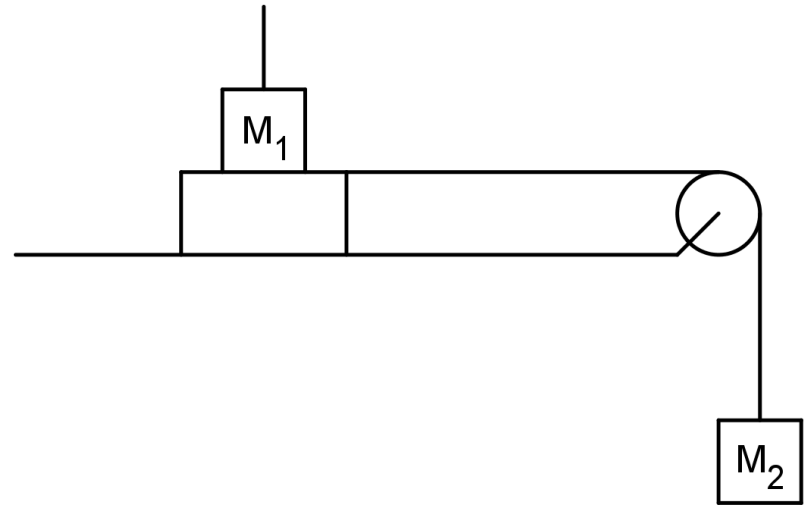
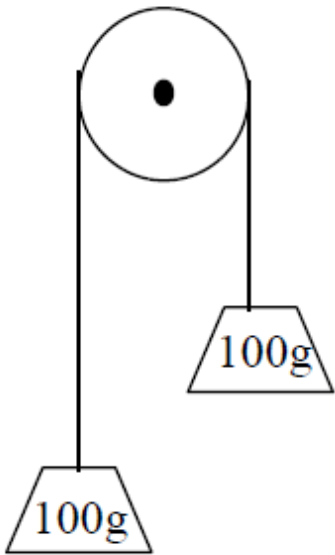
# Forces in two dimensions

*Sue de Pomerai*



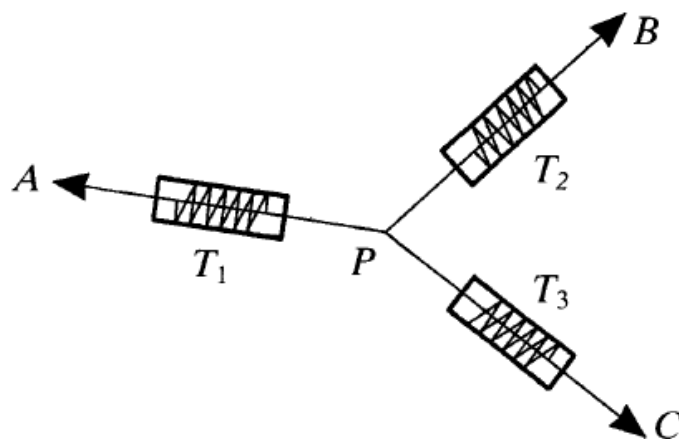
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# 2D or not 2D?



That is the question

# Equilibrium: Resolving Forces



What happens if . . . . .

$T_1 = T_2 = T_3$  ?

$T_1 + T_2 < T_3$  ?

What if:  
 $T_1 : T_2 : T_3 = 3 : 4 : 5$

## N2L in 2D

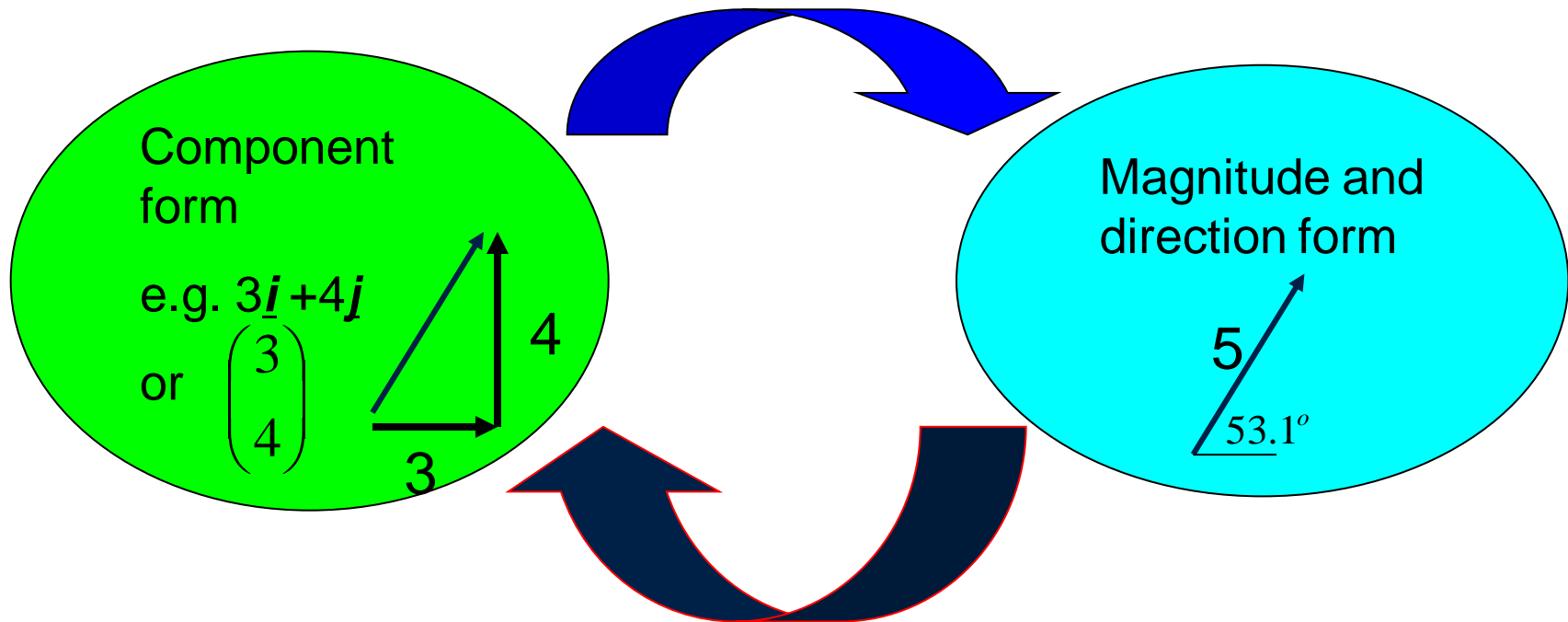
Two forces,  $3i + 2j$  and  $5i - 3j$  act on a particle of mass 10kg

(i) what is the magnitude of the acceleration of the particle?

(ii) What additional force must act on the particle to give it an acceleration of  $2i + j$ ?

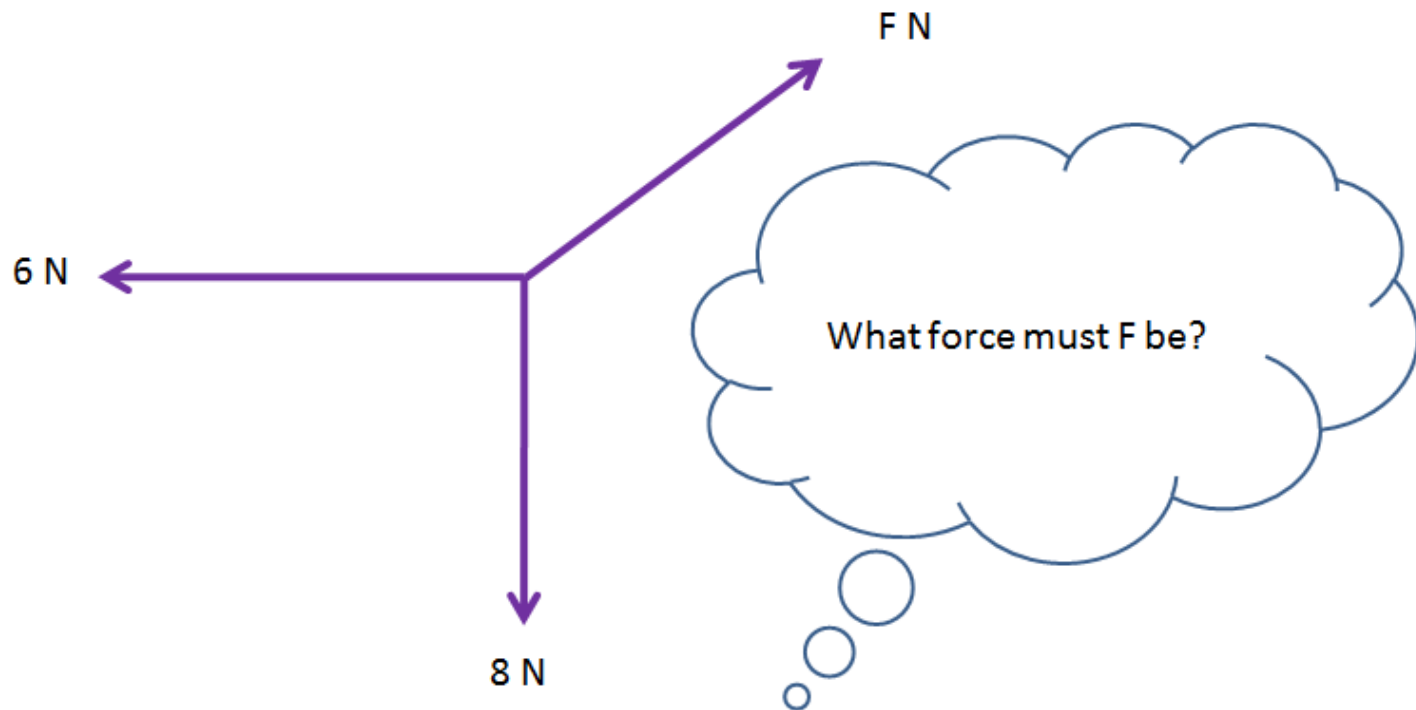
# Resolving Forces

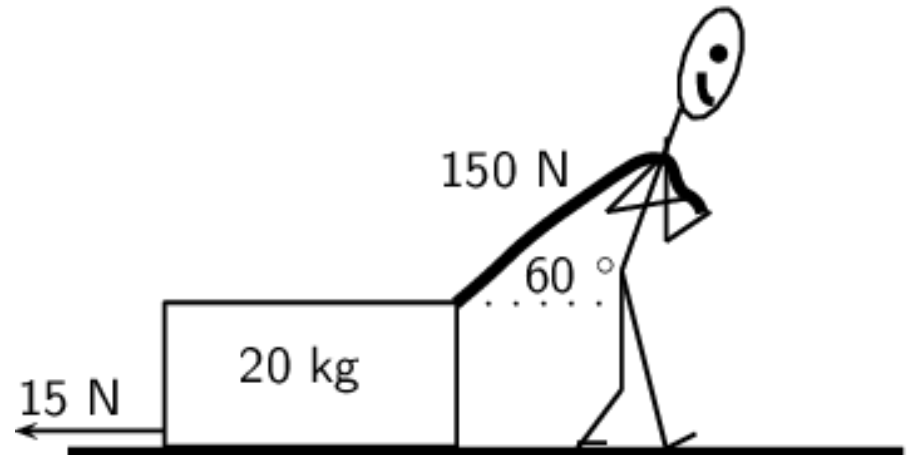
Use Pythagoras' theorem and basic trigonometry



This process is called **resolving** the vector

# Equilibrium: Resolving Forces

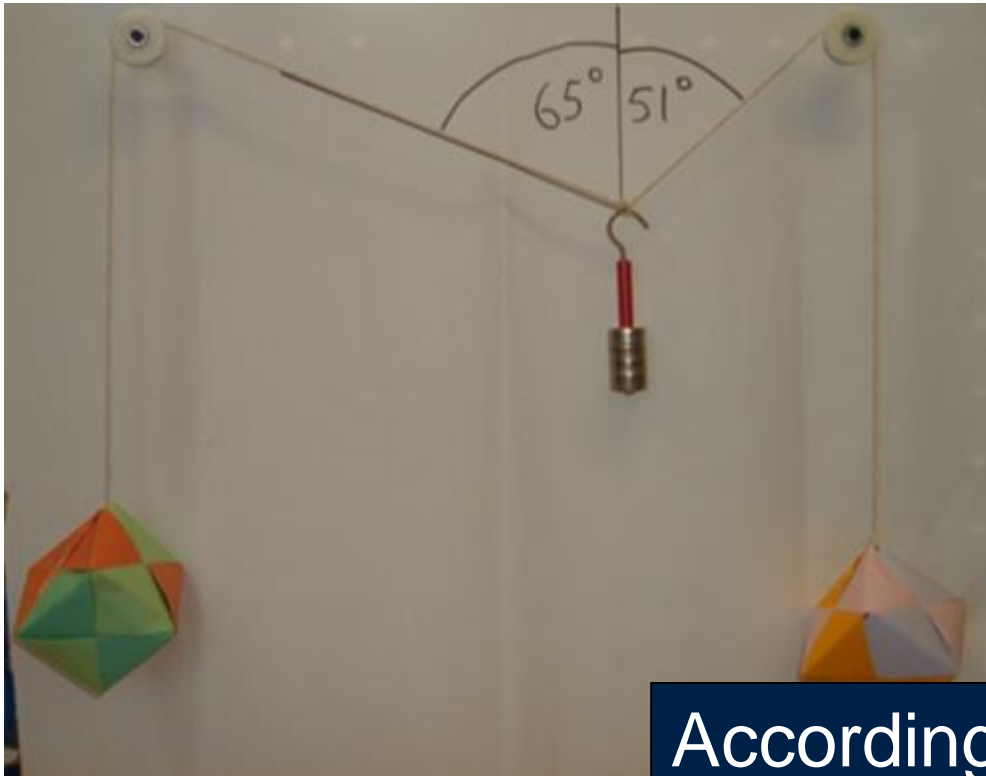




- Pull a chair horizontally with a bungee cord. What does the extension show?
- Now pull the chair at an angle. What happens? Why?



# 3 masses and pulleys



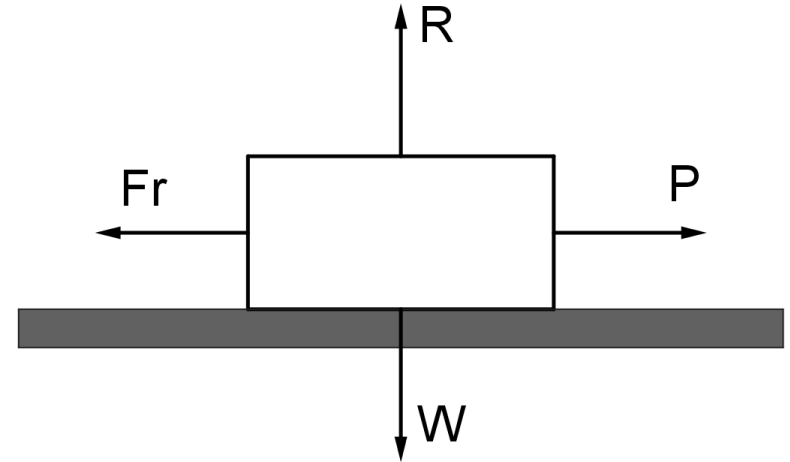
According to my  
kitchen scales he  
weighs 84g

# Friction and the inclined plane



# A model for friction

- A frictional forces oppose motion.
- The magnitude depends on the surfaces in contact.
- It will have a maximum value.



$$F \leq \mu R$$

Friction  
force

Coefficient of  
friction

Reaction  
force

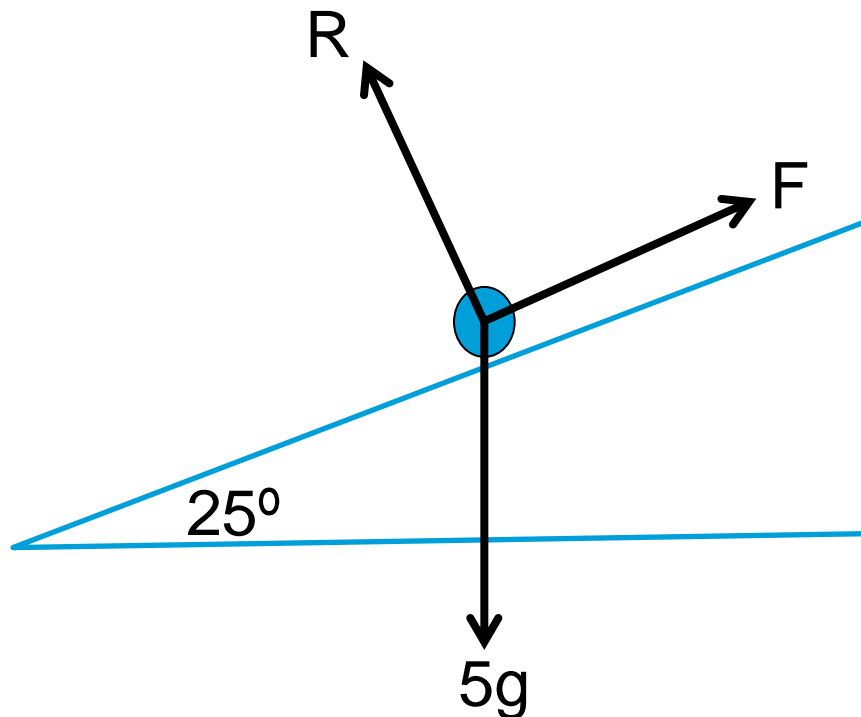
# Example coefficients of friction

Surfaces		$\mu$
Ice	Steel	0.03
Wood - waxed	Dry snow	0.04
Wood - waxed	Wet snow	0.1
Tire, wet	Road, wet	0.2
Car tire	Grass	0.35
Wood	Brick	0.6
Skin	Metals	0.9
Tire, dry	Road, dry	
Rubber	Rubber	
Platinum	Platinum	

Students sometimes have the misconception that the coefficient of friction is always less than 1

# Resolving Forces on an Inclined Plane

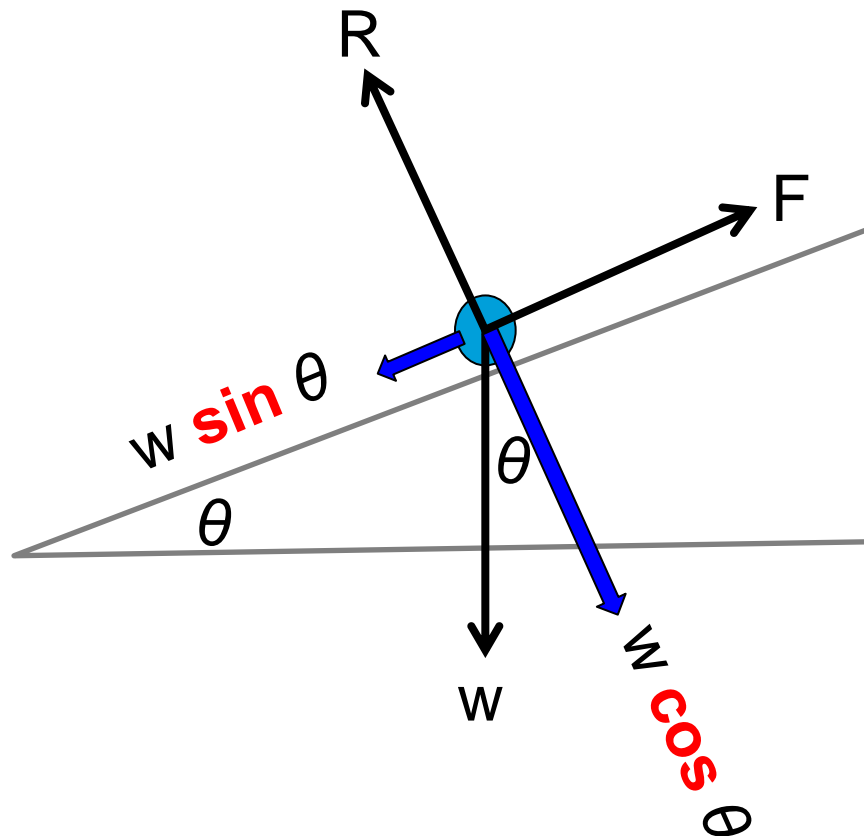
Resolve the forces parallel and perpendicular to the plane to find  $R$  and  $F$  when the particle of mass  $5\text{kg}$  is in equilibrium.



# Resolving Forces on an Inclined Plane

The weight  $5g$  N can be resolved into 2 components:

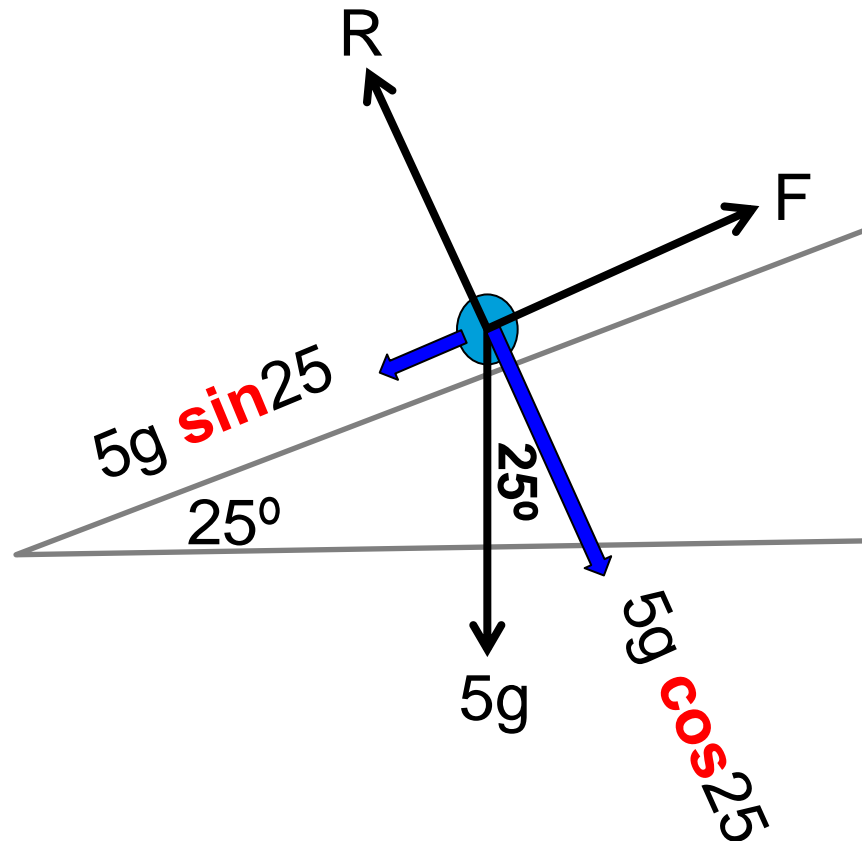
- Perpendicular to plane  $w \cos \theta$
- Parallel to the plane  $w \sin \theta$



# Resolving Forces on an Inclined Plane

The weight  $5g$  N can be resolved into 2 components:

- Perpendicular to plane  $5g \cos 25$
- Parallel to the plane  $5g \sin 25$

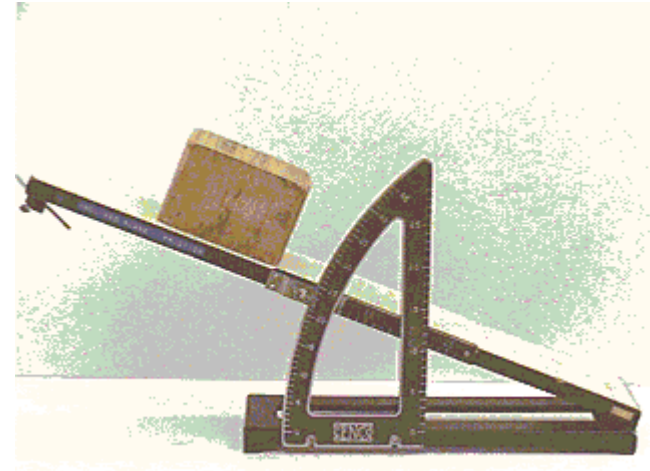


# Experiments

- finding  $\mu$

Change the angle of the plane until the block just moves

The mass of block is 145g



- How much does bagpuss weigh?

According to my kitchen scales he weighs 84g





# PD videos

- <http://furthermaths.org.uk/pd-videos-mechanics>

## Videos

- Exploring kinematic graphs
- Using physical phenomena: Classroom session
- Using physical phenomena: Student reflections
- Identifying forces
- Making a mathematical model

## Exploring kinematic graphs



## Questions for reflection

- What are the key misconceptions that students might have?
- How can graphical representations help to develop students' understanding?
- How can you use dynamic graphing software to deepen understanding of kinematics?

# About MEI

- Registered charity committed to improving mathematics education
- Independent UK curriculum development body
- We offer continuing professional development courses, provide specialist tuition for students and work with employers to enhance mathematical skills in the workplace
- We also pioneer the development of innovative teaching and learning resources