PHYS1101 News

- **GRAB A CLICKER AS YOU COME IN**
- **I'll explain what to do with it once the lecture starts**


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interwrite
PRS

Clicker Dry Run

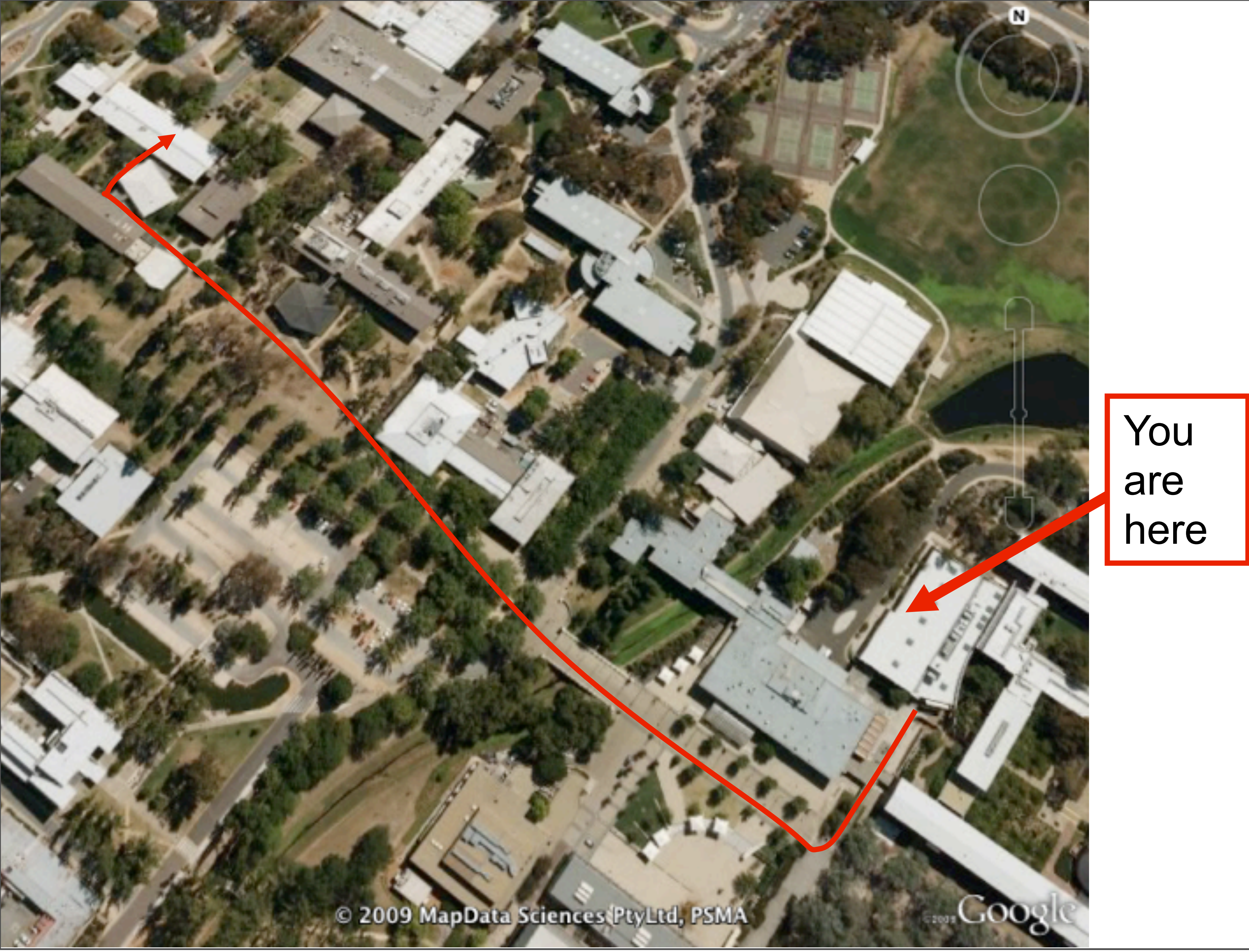
- Clicker marks are for participation only.
- And we won't start counting the marks until next week (so you get a chance to learn the system).
- You can miss up to 20% of lectures without penalty. If you need to miss more (e.g. due to a clash), let me know.

Keep your clickers

- Keep them all semester. Hand them back at the end.
- If you lose yours, there will be a fee to get it replaced.

Tutorials start today

- (labs are not until next week)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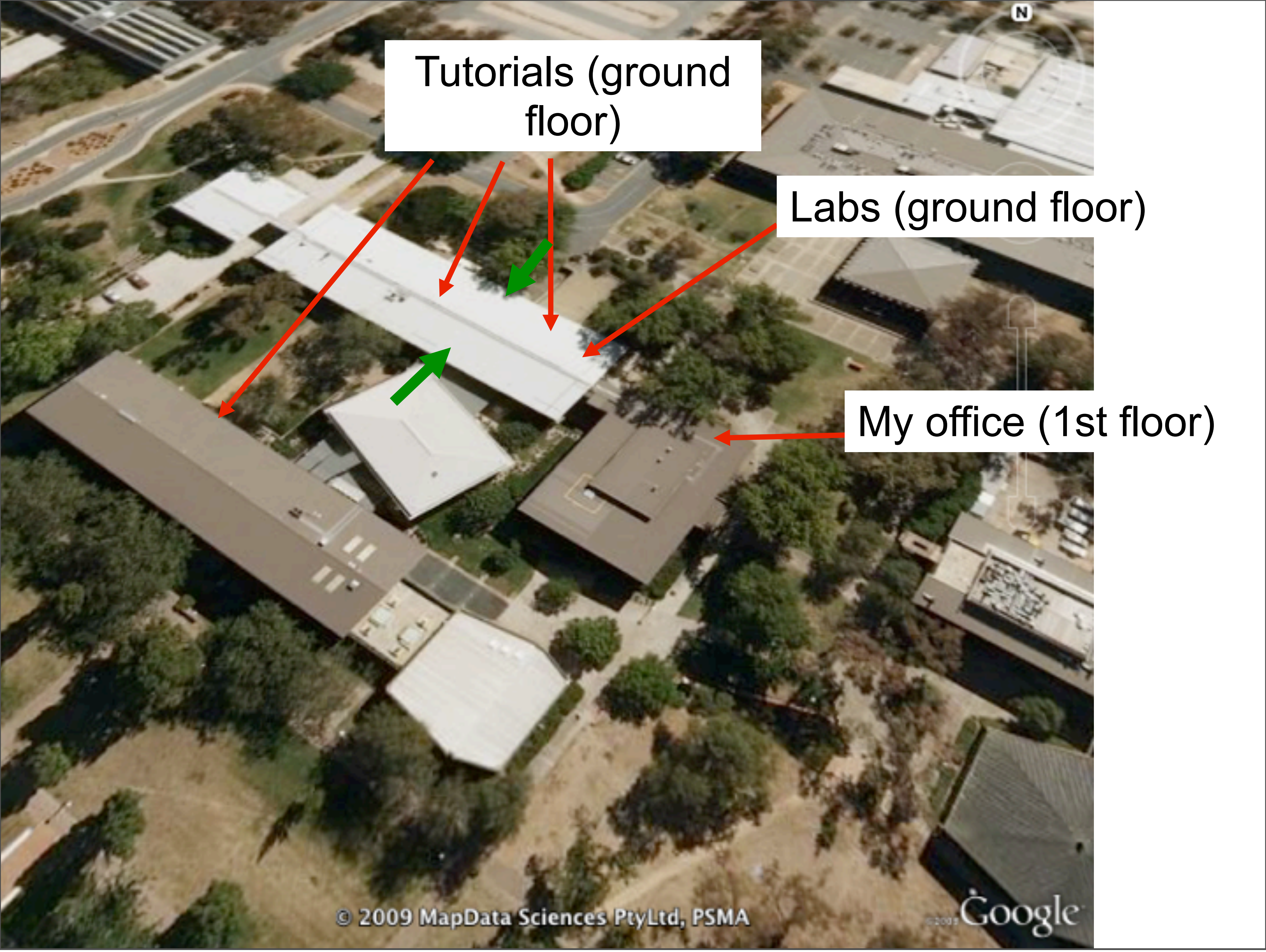

Tutorials (ground floor)
Labs (ground floor)
My office (1st floor)
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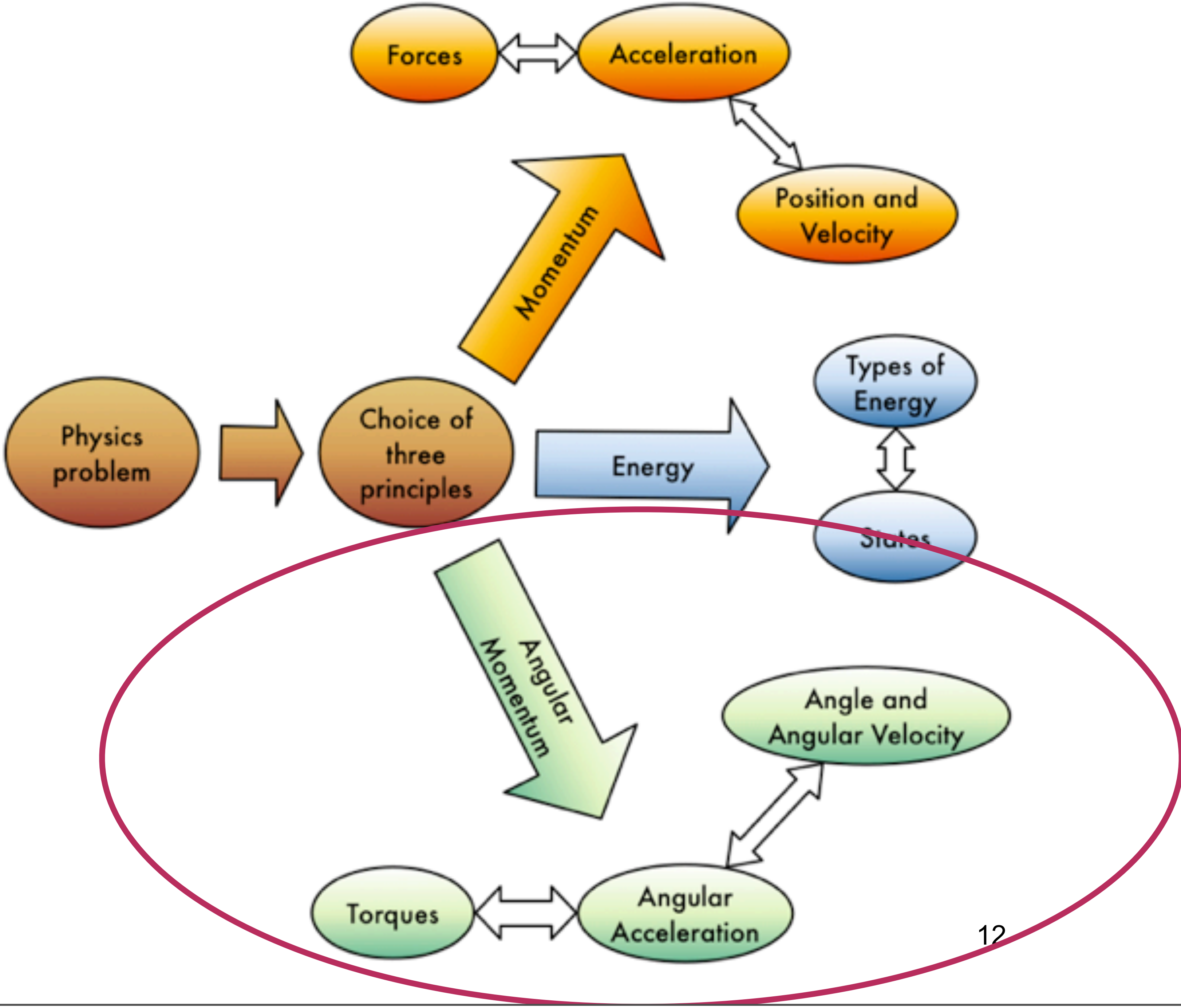
PHYSICS LECTURE

Tutors and Tutorials 2011

Schedule

Tutorial	Tutor	Venue
Monday 11am	Kim, Iain	PSYC G05
Monday 12	Bianca	Tute room
Monday 1pm	Khu	Tute room
Tuesday 10	Michele	Seminar room
Tuesday 11 A	Kim	Seminar room
Tuesday 11 B	Michele	Tutorial room
Tuesday 1	Rose	Seminar room
Wednesday 10 A	Scott	Seminar Room
Wednesday 10am B	Imam	Tutorial room
Wednesday 12	Rajiv	Seminar room
Thursday 9	Danielle	Seminar room
Thursday 10	Prasanga	Seminar room
Friday 10am	Phil, Danielle	PSYC G05
Friday 11am	Kim	Seminar room
Friday 12	Kim	Seminar room
Friday 1pm	Phil	Seminar room

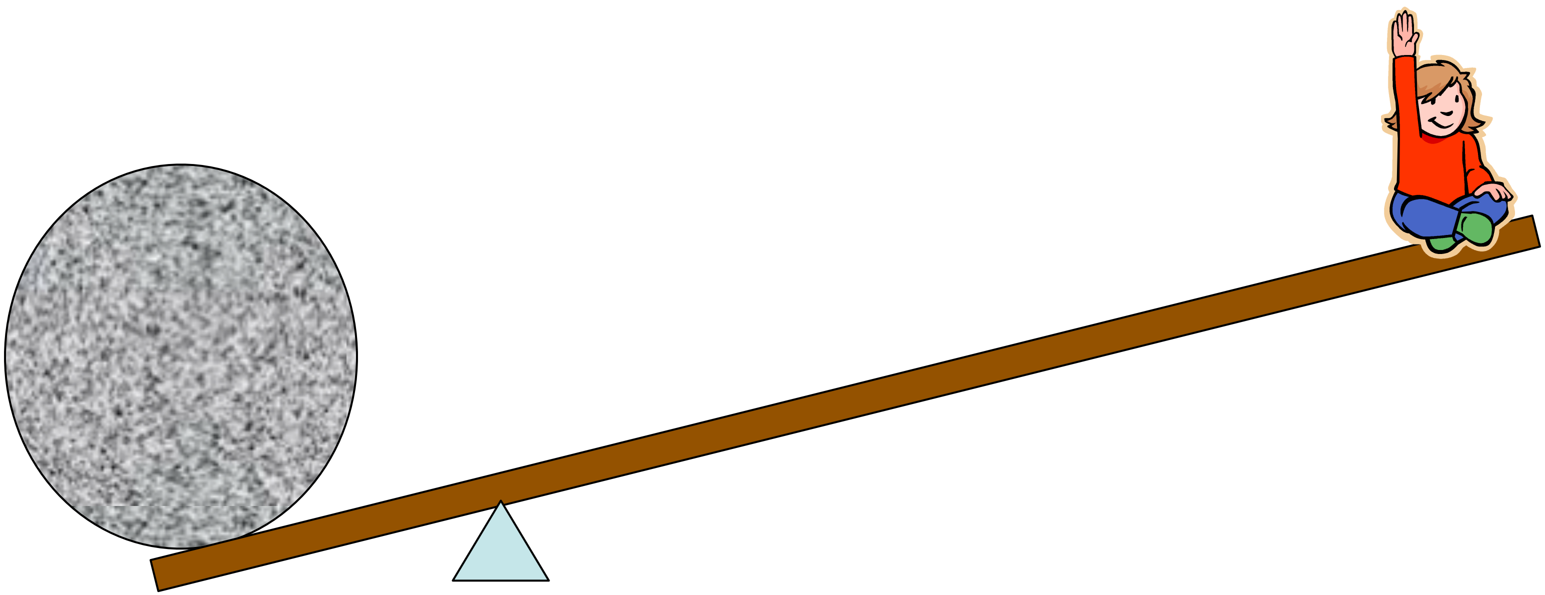

Forces
Acceleration
Position and Velocity
Momentum
Types of Energy
Physics problem
Choice of three principles
Energy
Angular Momentum
Angle and Angular Velocity
Torques
Angular Acceleration

Angular Momentum

- Fundamental Idea: rotating things keep rotating if left to themselves (like the Earth).
- What do you have to do to start something rotating or stop it?

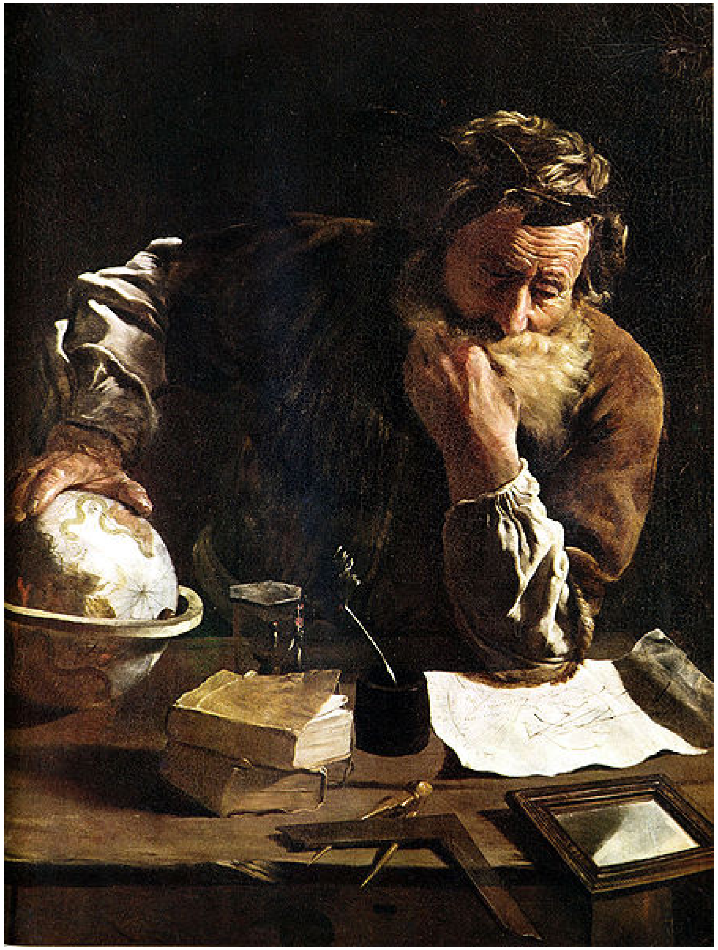
This was discovered several thousand years ago

- With the invention of the lever.



Archimedes

- *"Give me a lever long enough and I will move the world!"*
- But he didn't invent it - that was done thousands of years earlier

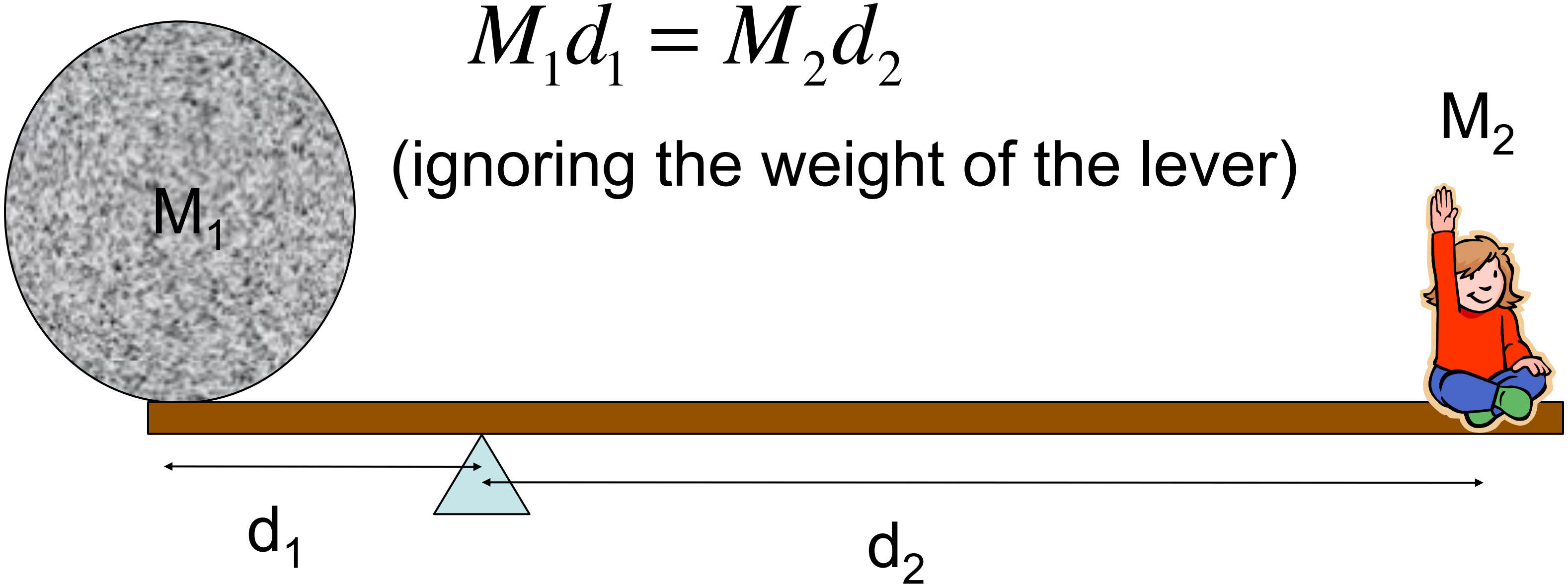


Greek scientists did figure out the balance rule

- To balance two weights, the product of weight times distance from the hinge must be the same.

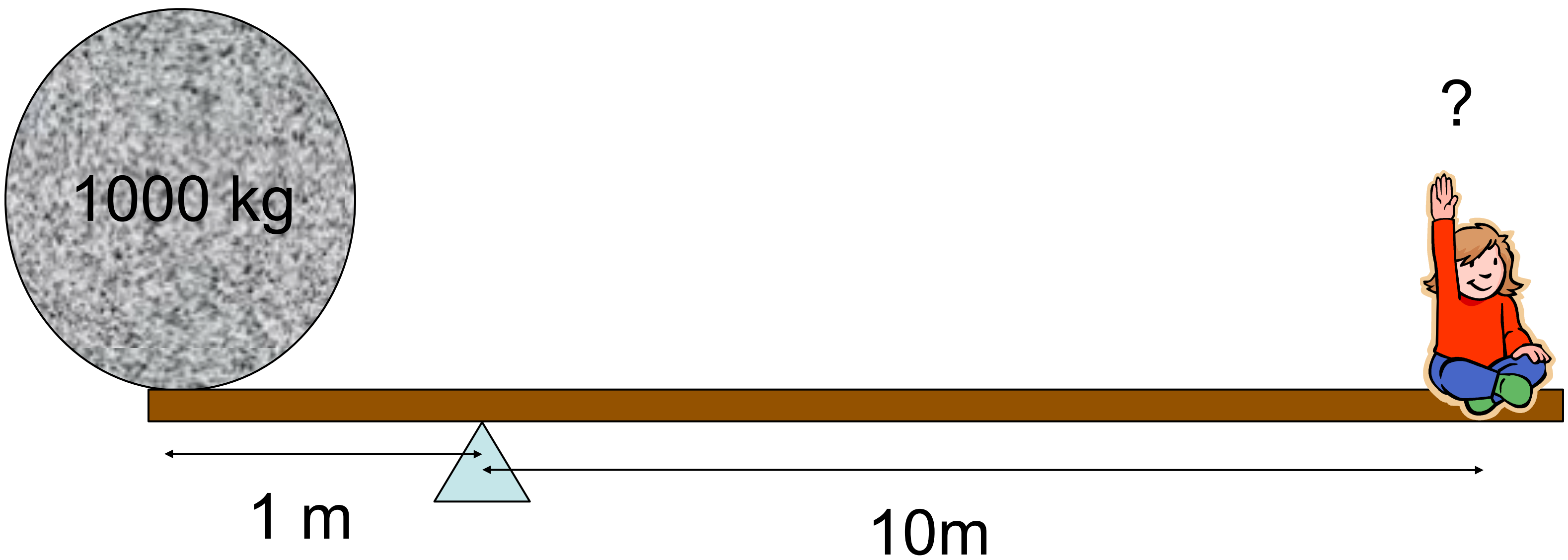
$$M_1 d_1 = M_2 d_2$$

(ignoring the weight of the lever)



Clicker Question

How heavy must the girl be?

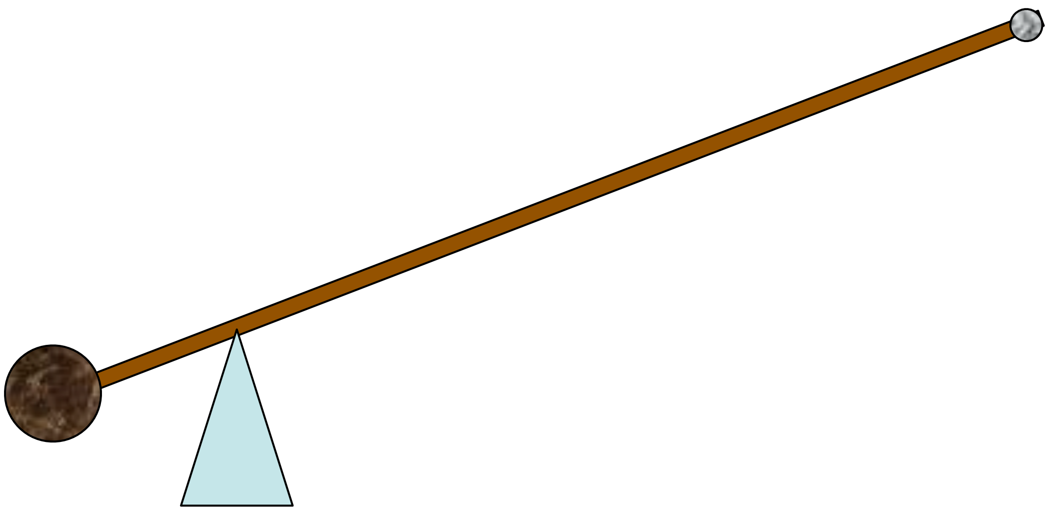


Answer

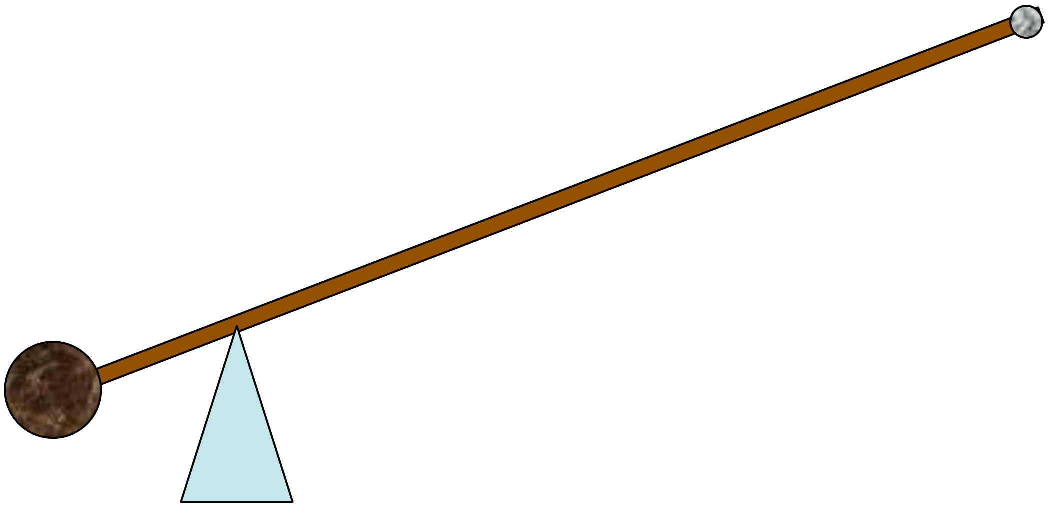
- 100 kg
- Because 1000 times 1 equals 100 times ten

But one thing eluded the Greeks

- What if the forces were not all in a line?
- For example - a tilted balance…
- Does the same rule apply?



Clicker Question



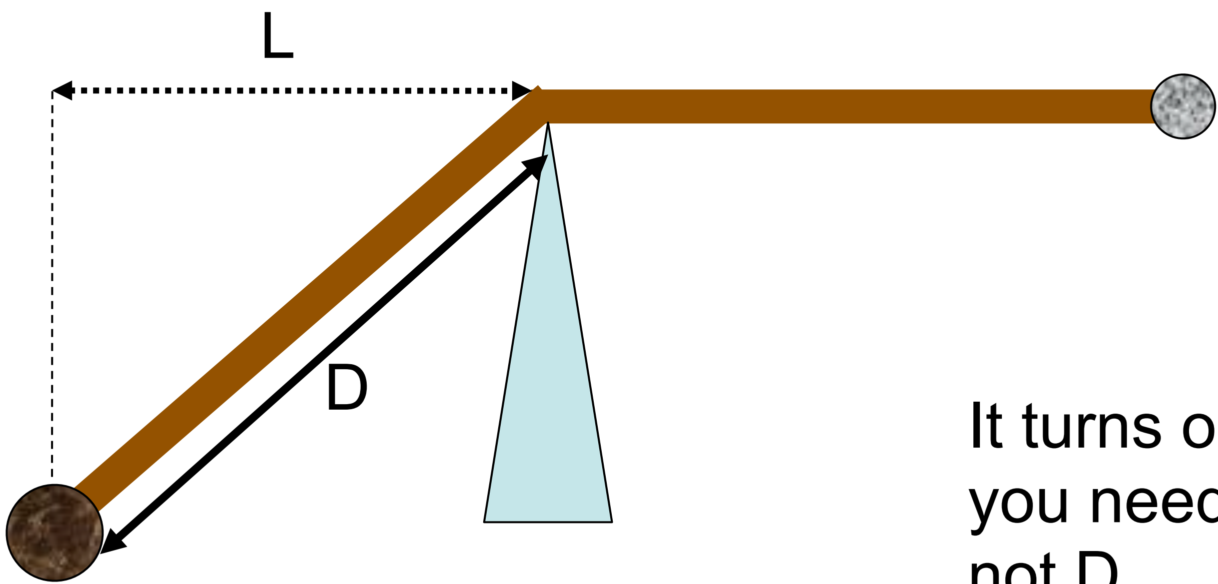
- If you take a balanced lever, and tilt it, what happens?

Answer

- It remains tilted

Or a bent balance?

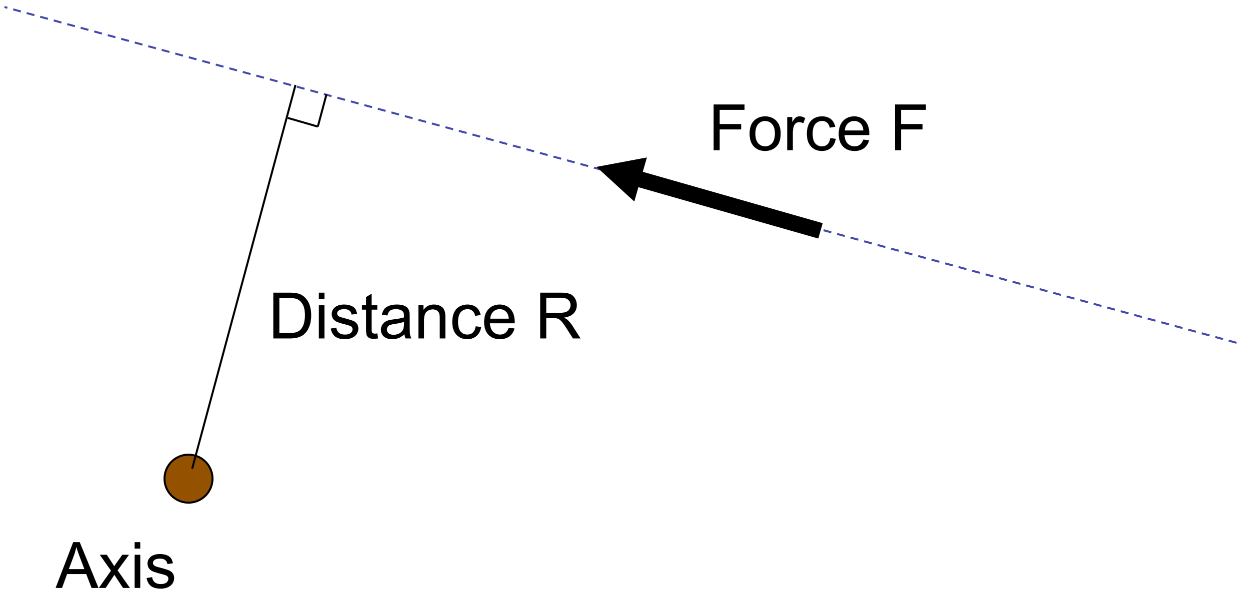
- What distance do you use now - the distance from the hinge D? (no)



It turns out that you need to use L, not D.

Torque

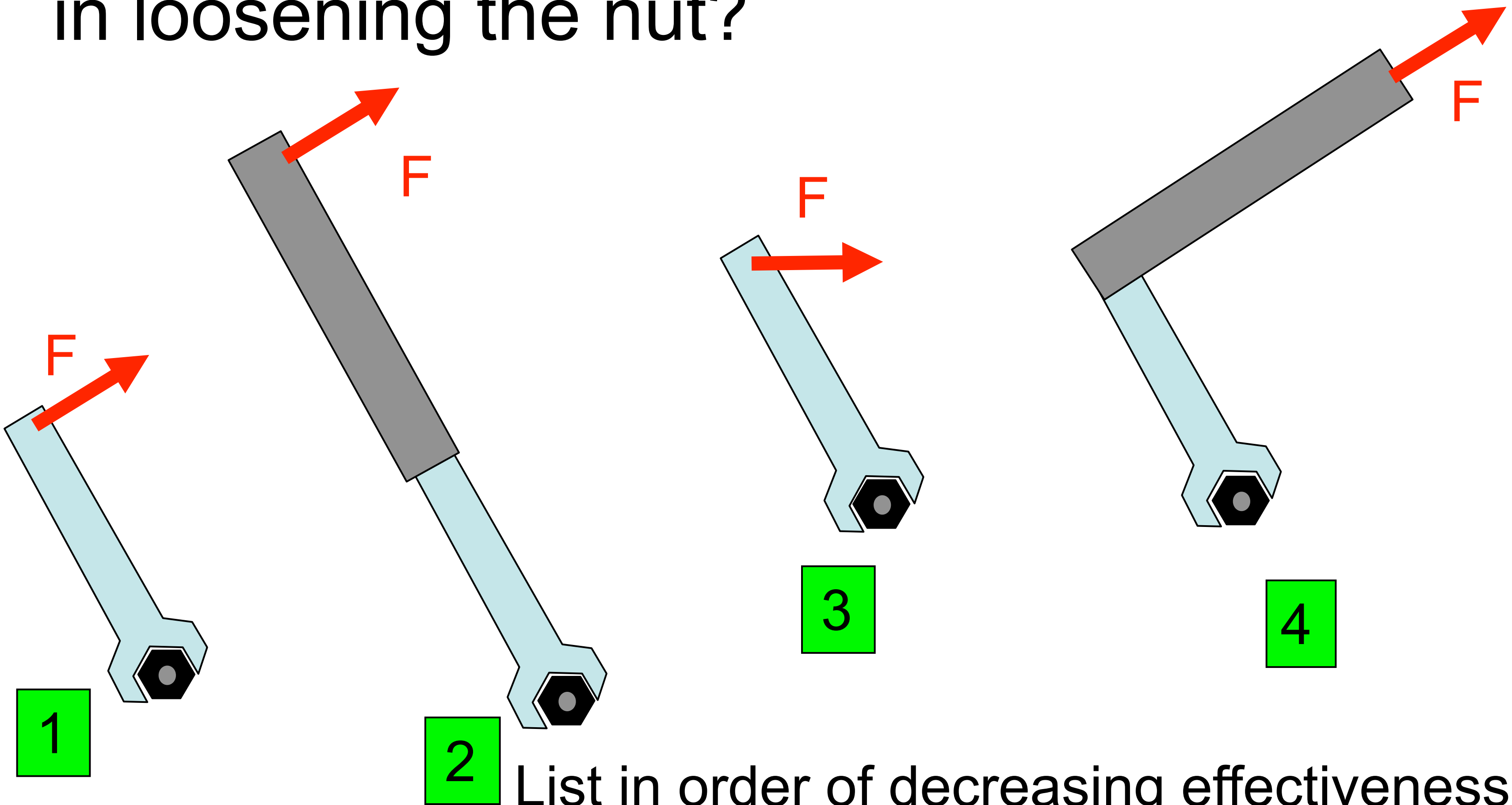
- Isaac Newton (surprise, surprise) worked it out.
- He came up with the concept of "Moment of Force", also known as "Torque".
- A object rotates if the net torque around its axis is zero.
- And what is torque?



- Torque is F times R.
- Where R is measured along a line from the axis perpendicular to the force.

Wrench question

- You are using a spanner and trying to loosen a rusty nut. Which of the arrangements shown in most effective in loosening the nut?



List in order of decreasing effectiveness

Answer

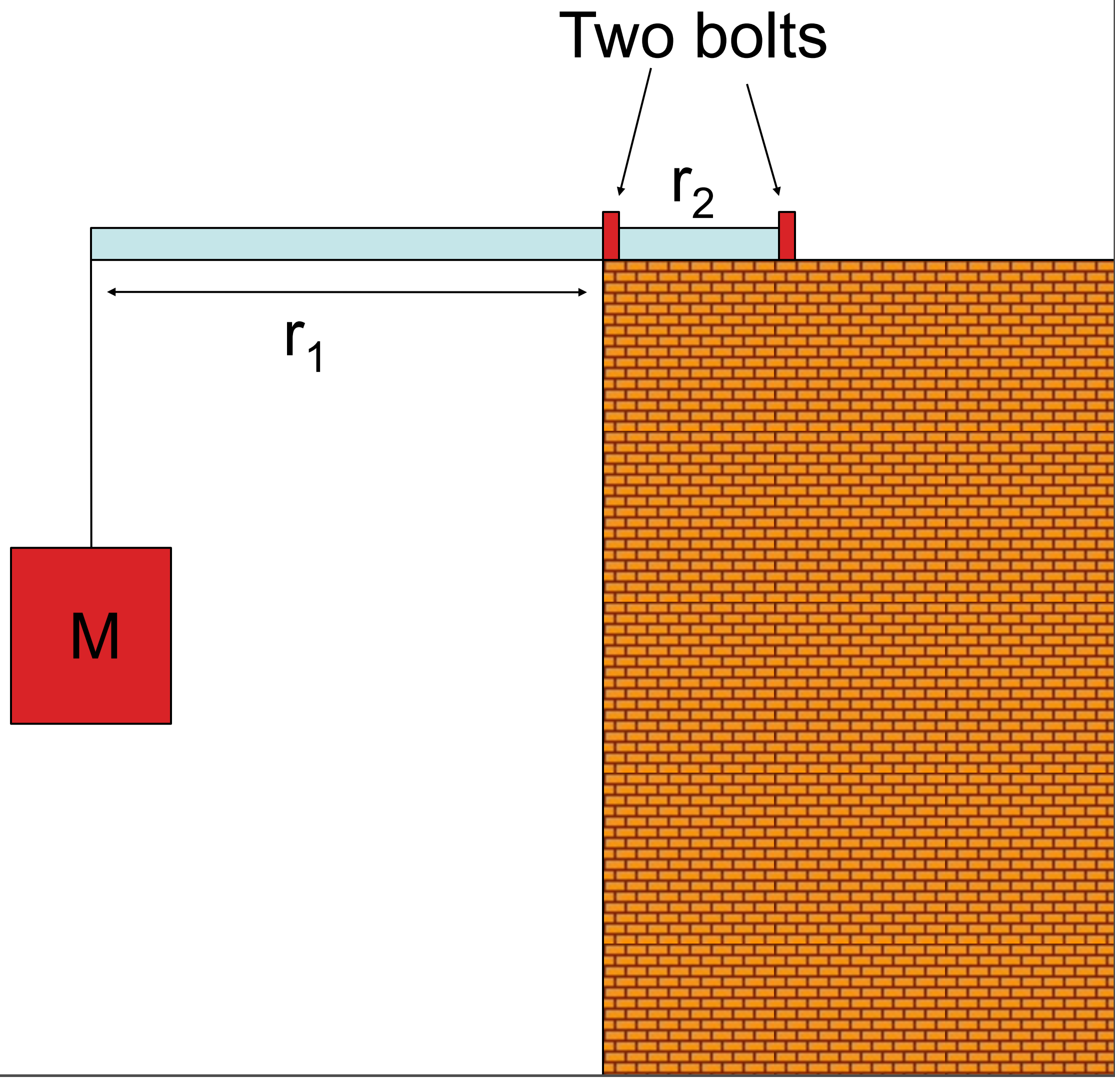
- 2 is best
- 1 and 4 are equal
- 3 is worst.
- In all cases the force is equal, so you need only compare the “moment arm” or how far a line through the force vector passes at its closest to the axis.

Statics

- We now have all the tools we need for the complete study of “Statics” - things that don’t move.
- From our knowledge of Newton’s laws - all the forces on a given object or system must (vector) sum to zero.
- From our knowledge of torques, the torques on any given object (around any possible axis) must add up to zero.

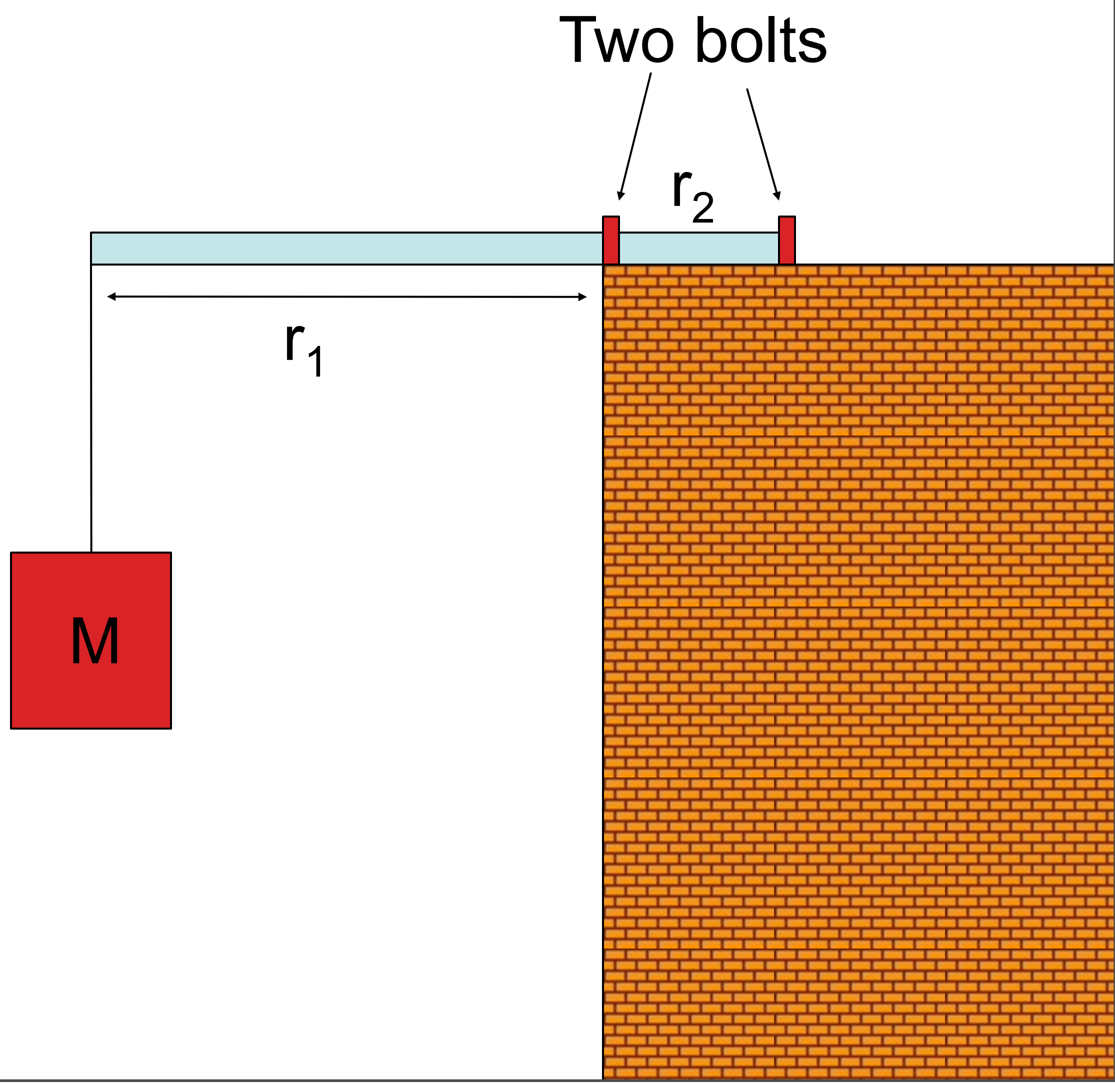
For example

- Let's say you want to attach a light-weight beam to the roof of a building, from which a heavy sign will be hung.

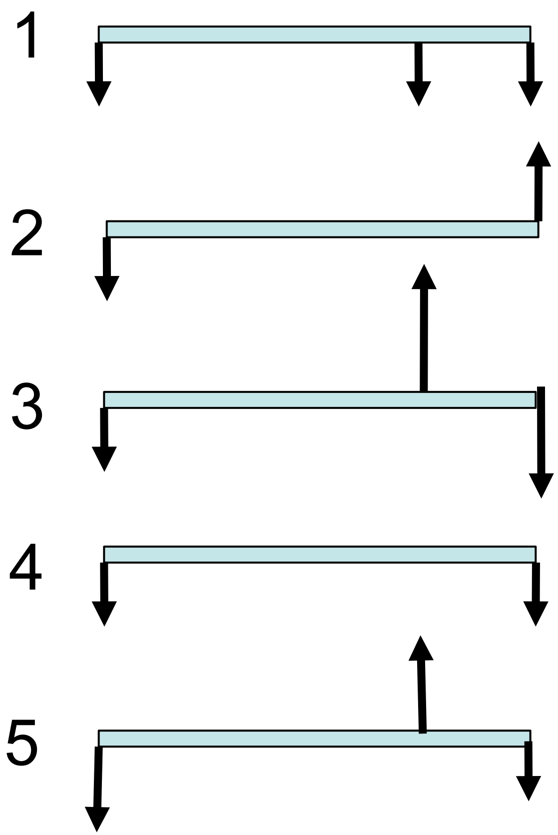


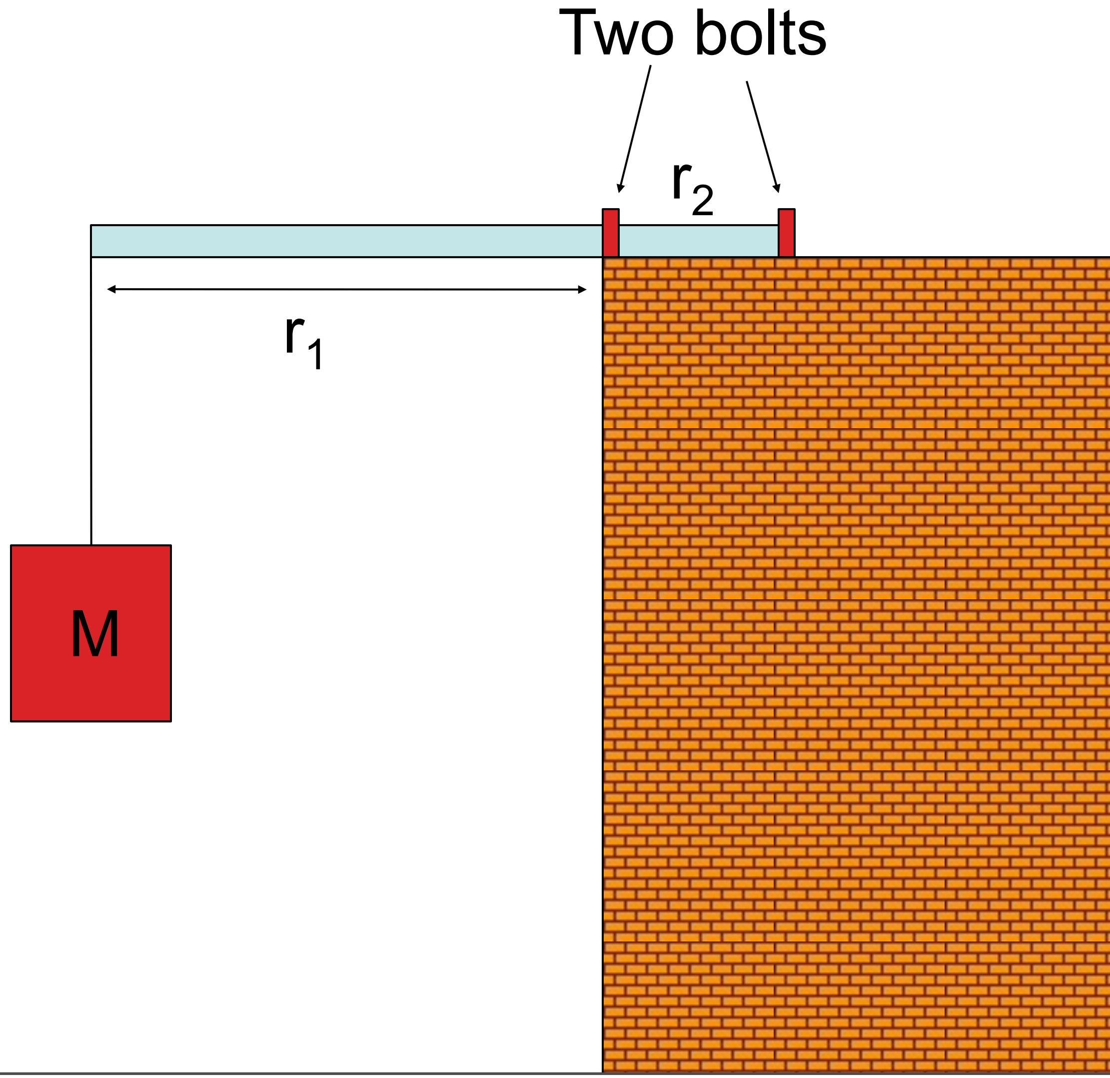
Use your intuition

- Three forces act on the beam - one from the weight and one at each bolt.
- Sketch the relative sizes and directions of them.
- (remember - the forces *acting on the beam)*



Force directions



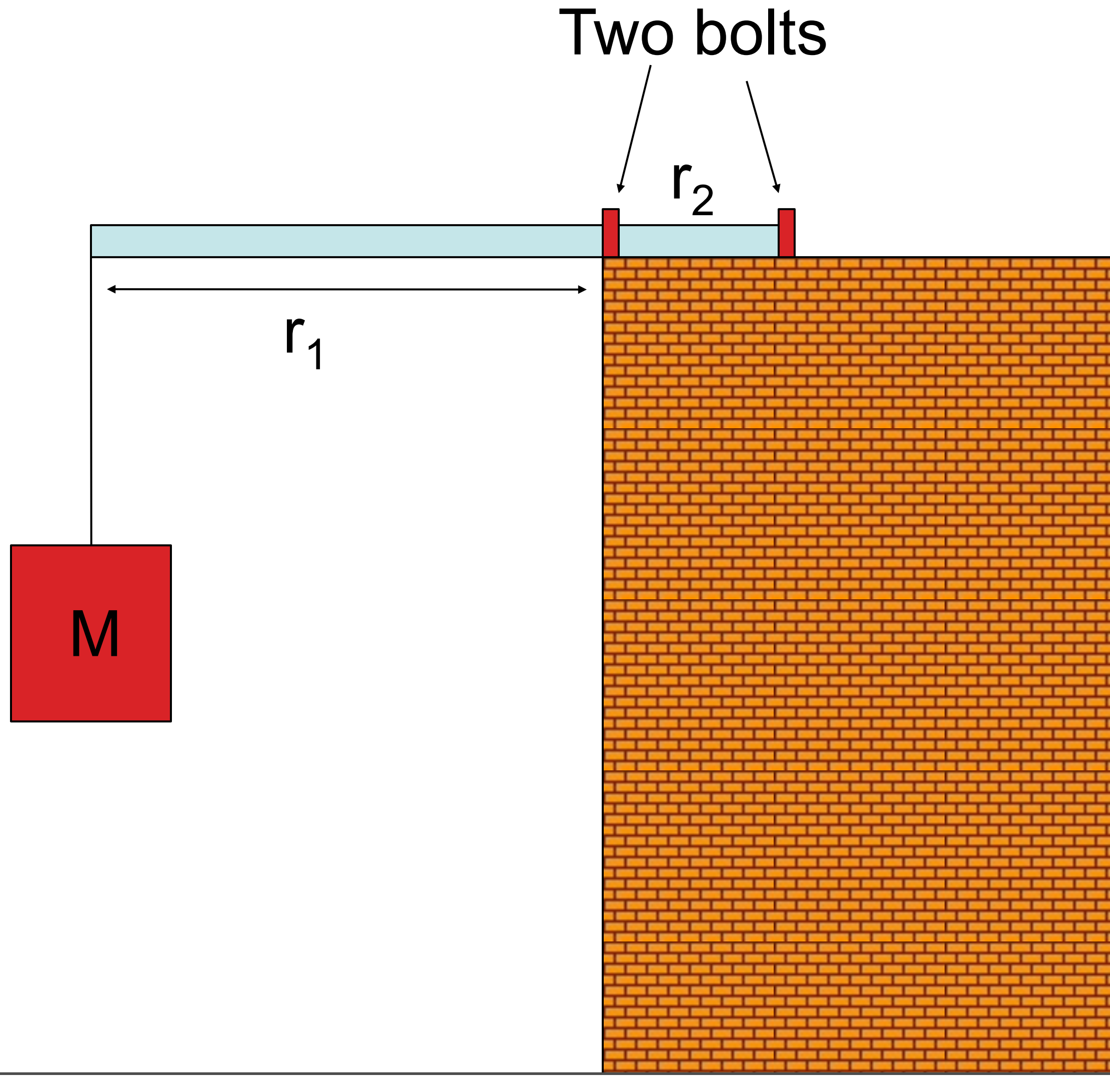


Answer

- Correct answer is 3

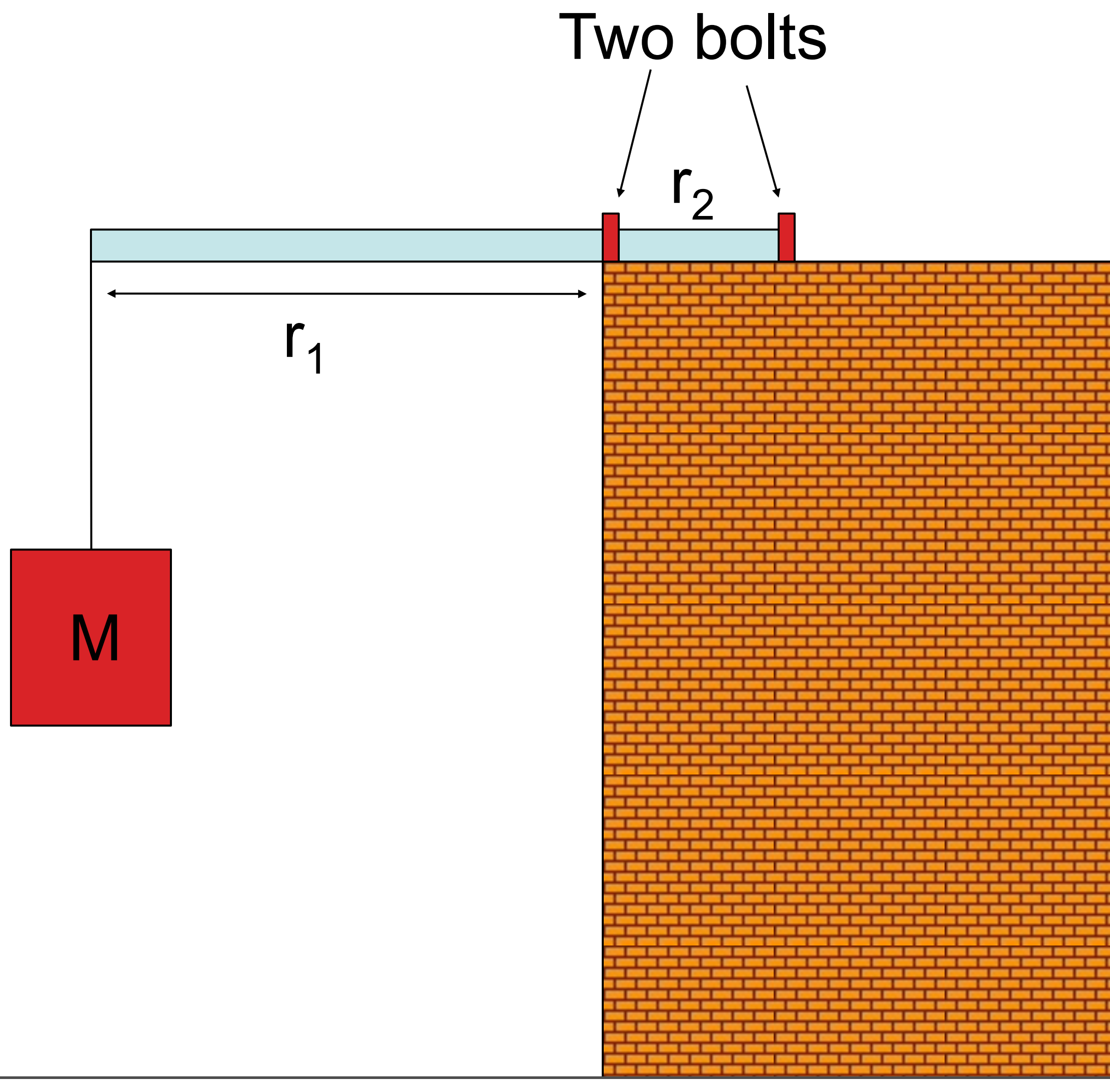
Use two principles - momentum and angular momentum

- The forces on the beam must sum to zero or it would accelerate (momentum)
- The torques on the beam (around any hinge) must sum to zero or it would rotate (angular momentum).



Which direction?

- The weight applies a downward force.
- So the net force from the bolts must be upwards to compensate.
- But if the force from both was upwards, there would be a net torque and the beam would rotate.
- The only solution is to have an upward force from the bolt at the building edge, and a smaller downward force from the other bolt.

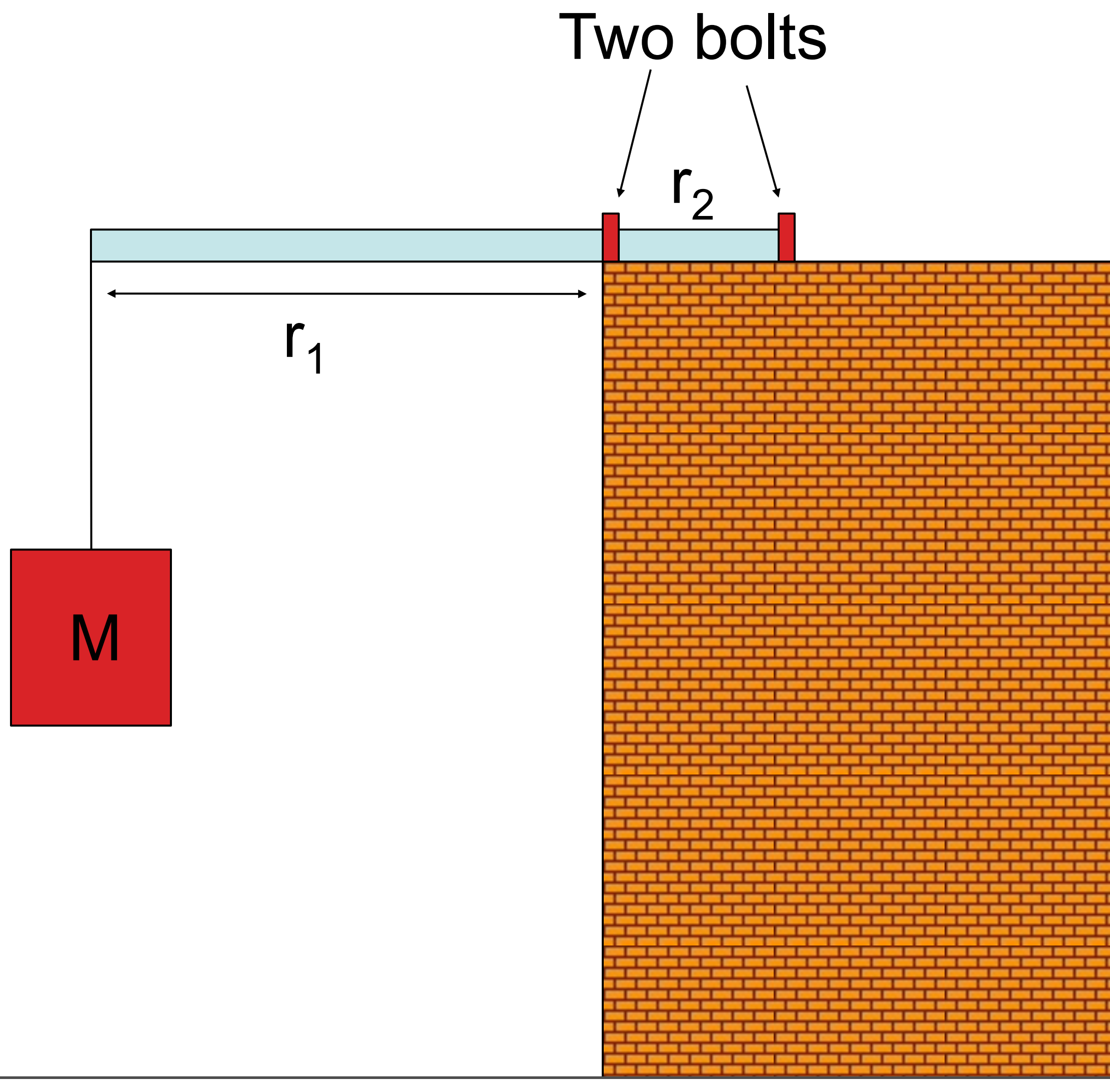


Does this agree with your common sense?

- Imagine standing on the roof holding the beam with your two hands.
- Which hand would be pushing down and which pulling up?

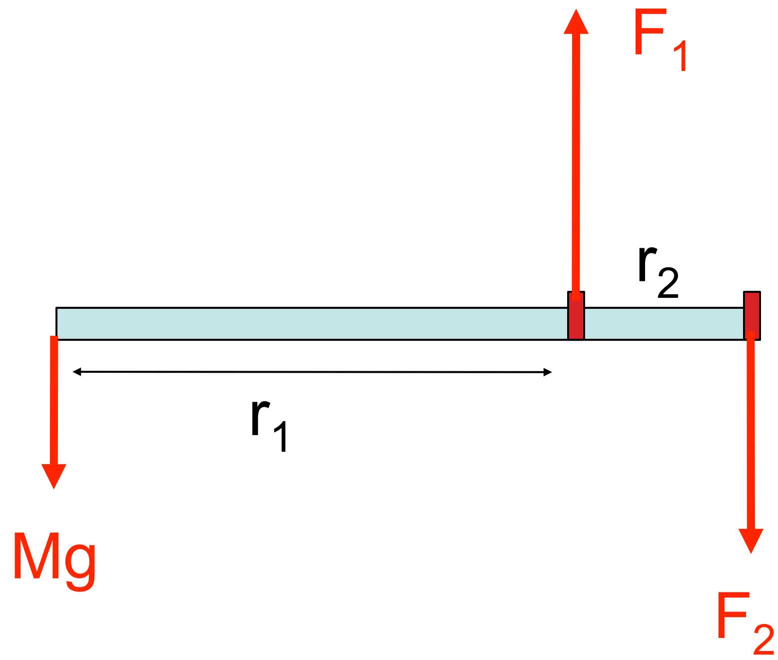
How big are the forces?

- Take the beam as our system.
- Draw (as usual) a diagram



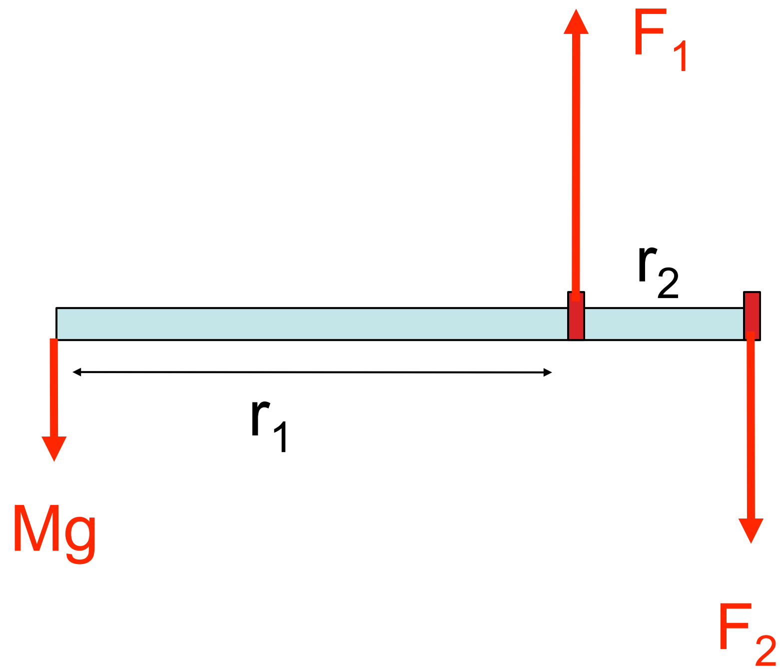
How big are the forces?

- Take the beam as our system.
- For all "statics" problems like this - write down the net force and the net torque equations.
- Both must be zero.
- Net force upwards is $F_1 - F_2 - Mg = 0$



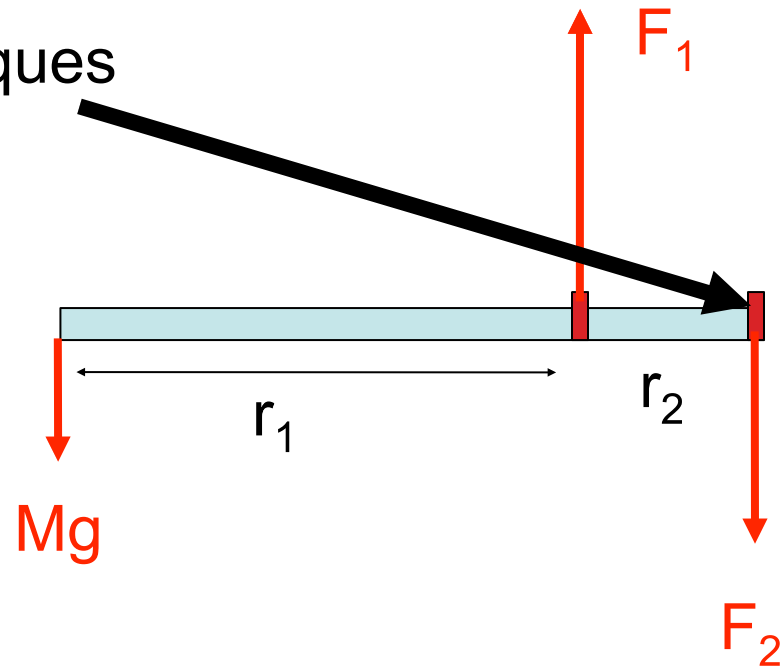
Now balance torques

- About where shall we measure torques?
- It doesn't matter - the answer will be the same regardless.
- But a clever choice will make the maths easier.
- Hint - if there is some force you don't want to work out, pick a hinge on that force..



To work out F_1…

- Measure torques around here



$F_1 r_2 - M g (r_1+r_2) = 0$

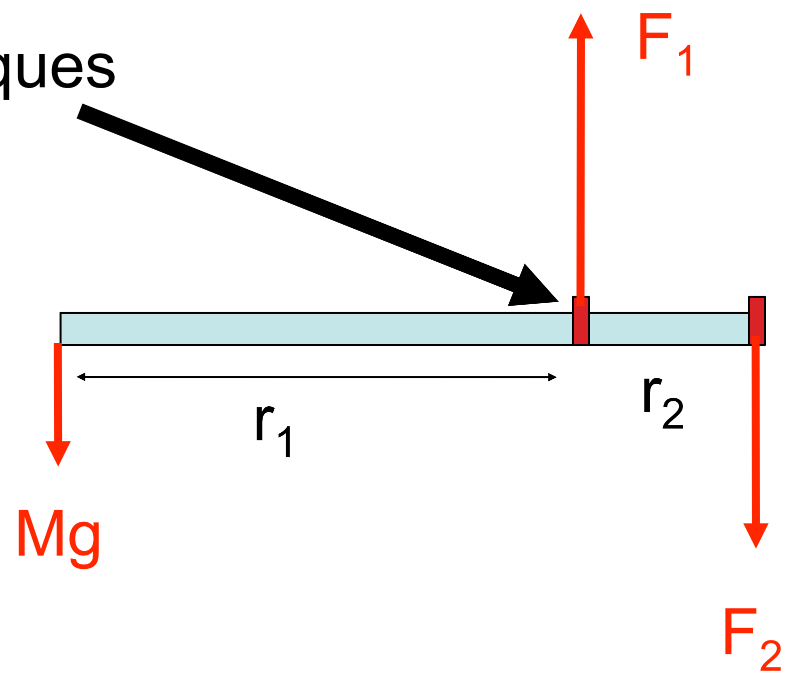
Rearrange…

$F_1 r_2 = M g (r_1+r_2)$

$$F_1 = \frac{Mg(r_1 + r_2)}{r_2}$$

To work out F_2…

- Measure torques around here



$F_2\, r_2 - M\, g\, r_1 = 0$

Rearrange…

$F_2\, r_2 = M\, g\, r_1$

$$F_2 = \frac{Mgr_1}{r_2}$$

Check

$$F_1 - F_2 = \frac{Mg(r_1 + r_2)}{r_2} - \frac{Mgr_1}{r_2} = Mg\left(\frac{r_1 + r_2}{r_2} - \frac{r_1}{r_2}\right) = Mg$$

So the net force really is zero…

Solve anything!

- Any static situation can be solved this way!
- Forces on any object must balance.
- Torques (about any axis you like) on any object must balance.
- This will give you enough equations to solve simultaneously to solve almost any problem.

Crazy structures…

- Just balance forces and torques for each object.
- You may end up with a LOT of simultaneous equations in various unknowns.