

MEI

Innovators in
Mathematics
Education



TEXAS
INSTRUMENTS

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**Short, easy practicals
for mechanics**

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Short easy practicals for Mechanics lessons: Newton's Laws

Every Mechanics lessons should have a practical element to this – this can be a full-scale experiment, a short practical or a thought-experiment. This ensures that the theory is linked with experiences of interacting with the physical world.

Newton's laws rephrased

N1: No change in momentum \Leftrightarrow No net force

N2: A net resultant force in a direction \Leftrightarrow change of momentum in a direction

N3: Forces are subjective (I push down with 3N on you means you push up with 3N on me)

N1 covers two situations: a stationary object and one with a constant velocity.

Short easy practicals

- Forces on stationary objects (N1 stationary, N3)
 - Stand up and feel the forces on your feet. What forces are on you?
 - Lift one foot off the floor. What happens to the forces?
 - Push down on a table whilst stood up. What happens to the forces?
 - Stand with one foot in contact with the floor and one on scales or both feet on the scales and pushing down on a table. What is your maximum/minimum "weight" on the scales?
 - How can you make a set of scales show more than your weight? (Push up on the ceiling standing or jump to give an acceleration).
- Net resultant force (N2)
 - Two people push against each other. Who moves?
 - As above but one on wheels/ice/socks on lino.
 - Drop an object. Drop an object whilst walking fast and observe its vertical motion.
- Looking at the force due to the same object in different places (N3)
 - Two people pull either side of a bungee cord. Compare the extension to 2 people pulling on one side with it fixed to a door/wall. How can we get the same extension? (4 people – 2 each end).
 - Attach 2 tables with a bungee cord. Pull the first table using another bungee cord. Which one will stretch more?
- Forces on objects with constant velocity (N1 not stationary)
 - Drop a ball whilst walking fast and observe its horizontal motion.
 - Stand up and imagine you are on a train. What would happen when it accelerates/decelerates/turns? Compare this to when it is not turning or accelerating.

Thought experiments

What would happen if you stood on scales in a lift?

What is the maximum force you can pull down on a nail stuck in the ceiling? How can you make this more than your own weight.

Imagine yourself as the seat on a swing.

Why do sportsmen "follow through"?

What's the best way to abseil?

Short easy practicals for Mechanics: Work, Energy and Power

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What students should know

Work done = Fs , where s is the distance moved in the direction of the force

$$KE = \frac{1}{2}mv^2 \qquad GPE = mgh$$

Power = Fv , the rate of doing work

Many problems can be solved by assuming either:

- mechanical energy is conserved
or
- the change in kinetic energy is equal to the work done due to the resultant force.

Short easy practicals/thought experiments

1. Drop a ball:
 - a. Draw graphs of PE and KE against h on the same axes
 - b. Draw graphs of PE and KE against t on the same axes
2. Lifting yourself through a loft hatch is hard work. This is equivalent to accelerating yourself to what speed?

Is this the same as climbing a flight of stairs?
3. What does it mean to say that one weightlifter is more powerful than another?
4. Slide a washer down a track so that it leaves a table horizontally. What speed should it leave the table and where would you expect it to land? Does it land there?
5. Two cars are level and travelling at 100mph and 70mph respectively. How fast will the first car be going when it reaches the point where the first car stops?
6. If I exert my maximum power on a bicycle why will there be a top speed that I cannot exceed?

Why is “power-to-weight ratio” important for cyclists?
7. Bungee jumping (Mechanics in Action worksheet 22)
8. Loop the loop (Mechanics in Action worksheet 27)