

Forces, friction and motion on slopes

Physics grades 11-12 (A Level · IB · Class 11-12) · Lab

Name: _____ Date: _____ Class: _____

How rough is a surface? In this lab you tilt a board until a wooden block just starts to slip, and use the angle to calculate the coefficient of static friction without any force meter. You then repeat the test with sandpaper to compare two surfaces.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB A.2

Aim

To measure the coefficient of static friction between a wooden block and a board from the angle at which the block starts to slide, and to compare two surfaces.

Equipment

- Smooth wooden board about 0.60 m long, wooden block
- Strip of sandpaper that can be taped to the board
- Books or a clamp stand to raise the board, metre rule
- Protractor (optional)

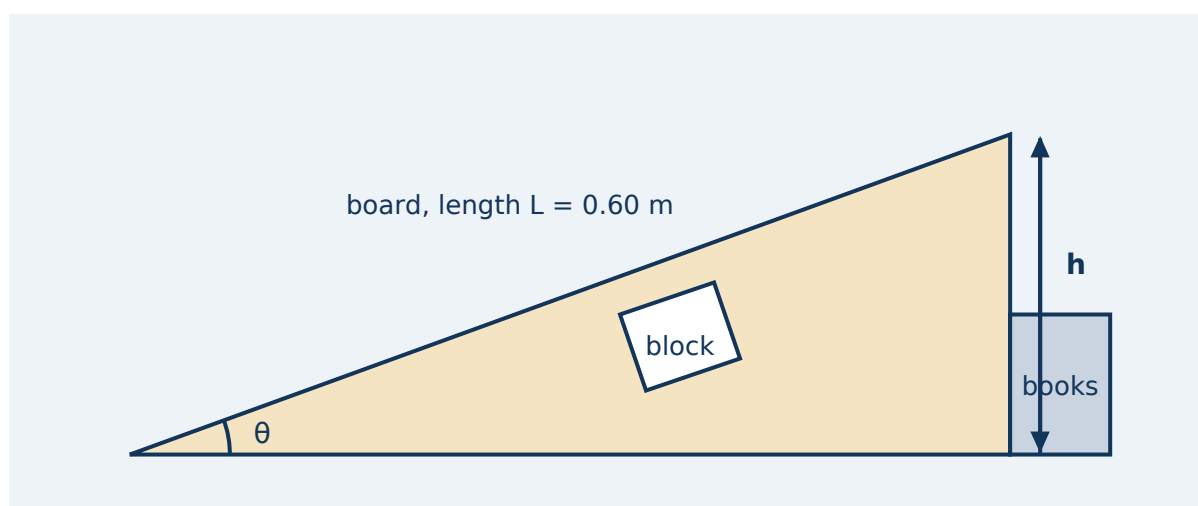
Safety

Safety

Keep fingers clear of the block and the gap between the board and the table when raising the board. Place a soft towel at the bottom so that the block cannot fall on a foot.

Method

1. Place the block at the top part of the flat board and raise one end very slowly.
2. Stop at the moment the block just starts to slide, and measure the height h of the raised end above the table. The board length is $L = 0.60$ m.
3. Repeat five times, putting the block back each time.
4. Tape the sandpaper to the board and repeat the five measurements.
5. Calculate $\sin \theta = h \div L$, then θ and $\mu_s = \tan \theta$ for each surface.



Raising the board until the block slides.

Results

Sample measurements of the height h at the moment of slipping:

Trial	Wood on wood: $h \text{ (m)}$	Wood on sandpaper: $h \text{ (m)}$
1	0.27	0.39
2	0.28	0.41
3	0.26	0.40
4	0.29	0.40
5	0.27	0.40

Analysis questions

Question 1 Mean heights

Calculate the mean height h for each surface and the absolute uncertainty for the wood-on-wood surface using half the range.

Question 2 Angles

Calculate $\sin \theta$ and θ for each surface.

Question 3 Proving the method

Show that $\mu_s = \tan \theta$ at the point of slipping.

Question 4 Coefficients

Calculate μ_s for each surface.

Question 5 Uncertainty

Estimate the uncertainty in μ s for the wood surface from the smallest and largest heights.

Question 6 Sliding down

Once moving, the wood-on-wood kinetic coefficient is 0.40. Calculate the acceleration of the block on a 30° slope.

Question 7 Effect of mass

Explain why putting a second block on top does not change the slipping angle.

Question 8 Improvement

Suggest one improvement to reduce the uncertainty.