

Combining forces and drawing force diagrams

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

Friction is the force that makes a sliding block need a steady pull. By dragging a block at constant speed, you use balanced forces to measure friction, and you test how it changes as the block gets heavier.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P5

Aim

To find how the sliding friction force depends on the normal reaction, using the fact that the resultant force is zero when a block slides at constant speed.

Equipment

- Wooden block with a hook or loop of string
- Newton meter (0 to 10 N, resolution 0.1 N)
- Slotted masses of 0.20 kg each
- Flat bench with a smooth surface
- Balance, pencil and graph paper

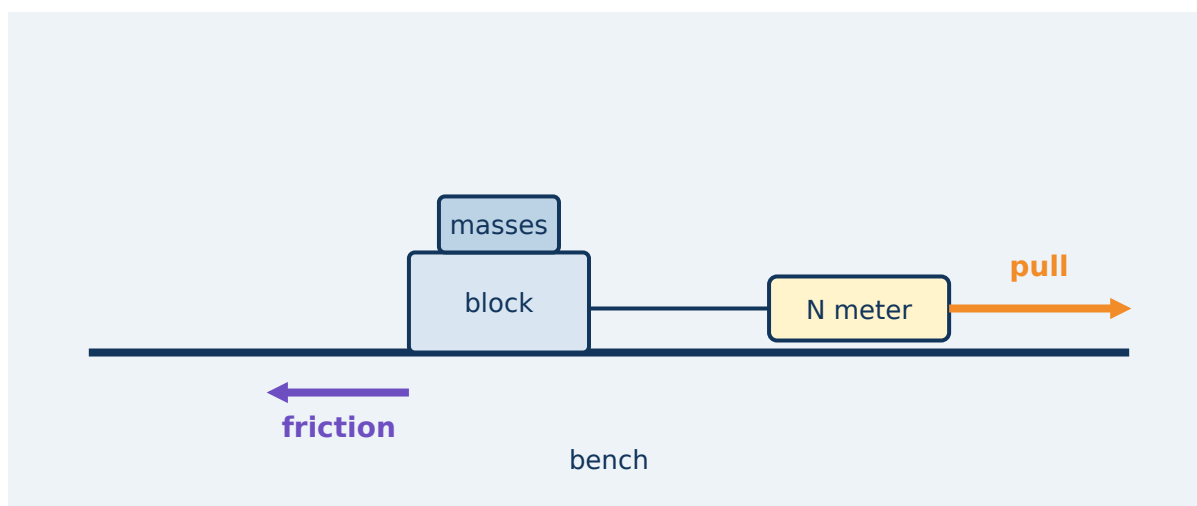
Safety

Safety

Keep your feet clear of the masses. Place a tray or cloth on the floor under the bench edge so that a dropped mass cannot hit feet or break.

Method

1. Weigh the block and note its mass. In this sample the block with its first mass is 0.20 kg in total.
2. Attach the newton meter and pull the block horizontally along the bench at the slowest steady speed you can manage.
3. Read the newton meter while the block moves at constant speed. This reading equals the friction force.
4. Add 0.20 kg to the block, repeat, and continue up to 1.00 kg total. Calculate the weight of the block and masses as $W = m g$ with $g = 9.8 \text{ N/kg}$.



Set-up: pulling a loaded block at constant speed along the bench.

Results

Sample measurements:

Total mass (kg)	Normal reaction R (N)	Pulling force at constant speed (N)
0.20	1.96	0.8
0.40	3.92	1.6
0.60	5.88	2.4
0.80	7.84	3.1
1.00	9.80	4.0

Analysis questions

Question 1 Why the pull equals friction

Explain why the newton meter reading equals the friction force when the block moves at constant speed.

Question 2 Normal reaction

The block rests on a level bench before it is pulled. State the normal reaction for the 0.60 kg total mass and explain how you know.

Question 3 Friction divided by reaction

Calculate friction ÷ normal reaction for each row, to 3 decimal places, and find the mean.

Question 4 Graph

Describe the graph of friction (y-axis) against normal reaction (x-axis) and find its gradient

from the last point.

Question 5 Prediction

Use your mean ratio to predict the friction force for a total mass of 1.20 kg.

Question 6 The 0.80 kg result

The 0.80 kg result gives a lower ratio than the others. Decide whether this is a real difference.

Question 7 Uncertainty in the reading

The newton meter can be read to ± 0.05 N. Calculate the percentage uncertainty in the 0.8 N and the 4.0 N readings.

Question 8 Better friction readings

Propose two changes to the procedure that would give friction values closer to the true ones and with less scatter.