

Combining forces and drawing force diagrams

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

The model answers use the sample table. Your own values will differ a little, but friction should be roughly proportional to the normal reaction, giving a straight line through the origin.

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

Question 1 Why the pull equals friction

At constant velocity the resultant force on the block is zero. The pull forward is therefore balanced by an equal friction force backwards, so the **reading equals the friction**.

Question 2 Normal reaction

The block is at rest vertically, so the reaction equals the weight: $R = m g = 0.60 \times 9.8 = \mathbf{5.88 \text{ N}}$.

Question 3 Friction divided by reaction

$0.8 \div 1.96 = \mathbf{0.408}$; $1.6 \div 3.92 = \mathbf{0.408}$; $2.4 \div 5.88 = \mathbf{0.408}$; $3.1 \div 7.84 = \mathbf{0.395}$; $4.0 \div 9.80 = \mathbf{0.408}$. Mean = $2.028 \div 5 = \mathbf{0.406}$.

Question 4 Graph

The points lie on a straight line through the origin, so friction is **directly proportional** to the normal reaction. Gradient = $4.0 \div 9.80 = \mathbf{0.41}$.

Question 5 Prediction

$R = 1.20 \times 9.8 = 11.76 \text{ N}$. Friction = $0.406 \times 11.76 = 4.77$, so about **4.8 N**.

Question 6 The 0.80 kg result

The expected friction is $0.406 \times 7.84 = 3.18 \text{ N}$, so a reading of 3.1 N differs by about 0.1 N. That equals the resolution of the newton meter, so it is **not a real difference**.

Question 7 Uncertainty in the reading

0.8 N: $0.05 \div 0.8 \times 100 = \mathbf{6.3 \%}$. 4.0 N: $0.05 \div 4.0 \times 100 = \mathbf{1.3 \%}$.

Question 8 Better friction readings

1. Repeat each reading three times and average, to reduce random error caused by uneven pulling.
2. Use a data-logging force sensor, or a newton meter with finer divisions, and pull with a motor at steady speed to lower the **uncertainty**.