

Friction, slopes, pulleys and springs

AP Physics 1 (algebra-based) · Lab answers

The model answers use the sample data. Your readings will differ slightly, but μ_k should come out near 0.3 and μ_s a little larger than μ_k for wood on wood.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 2

Question 1 Normal force

$$N = 1.00 \times 9.81 = 9.81 \text{ N. } F_k \div N = 3.35 \div 9.81 = \mathbf{0.34}.$$

Question 2 Graph of F against N

Gradient = $(3.85 - 1.30) \div (11.77 - 3.92) = 2.55 \div 7.85 = \mathbf{0.32}$. It is the coefficient of kinetic friction, since $F_k = \mu_k N$.

Question 3 Best value of kinetic friction

$$F_k \div N = 0.332, 0.336, 0.331, 0.341, 0.327; \text{ the mean is } \mathbf{0.33}.$$

Question 4 Angle method

On the point of slipping, $mg \sin \theta = \mu_s mg \cos \theta$, so $\tan \theta = \mu_s$. The mean angle is $(19.0 + 20.0 + 18.5 + 19.5 + 20.5) \div 5 = 19.5^\circ$, so $\mu_s = \tan 19.5^\circ = \mathbf{0.35}$.

Question 5 Uncertainty in μ_s

$\tan 18.5^\circ = 0.335$ and $\tan 20.5^\circ = 0.374$. Half the spread is $(0.374 - 0.335) \div 2 = 0.02$, so $\mu_s = \mathbf{0.35 \pm 0.02}$.

Question 6 Comparing coefficients

$\mu_s = 0.35$ is slightly greater than $\mu_k = 0.33$. The surface bonds that must be broken to start the motion are stronger than those continually reformed while sliding, so **μ_s is greater than μ_k** .

Question 7 Improvements

At constant speed the net force is zero, so the balance reading equals the friction force. Improve the lab by dragging at a slow steady speed with a force sensor, and by measuring the mass of the block and the masses with the same balance. The balance reading uncertainty is about **$\pm 0.1 \text{ N}$** .