Coefficient of Friction Lab

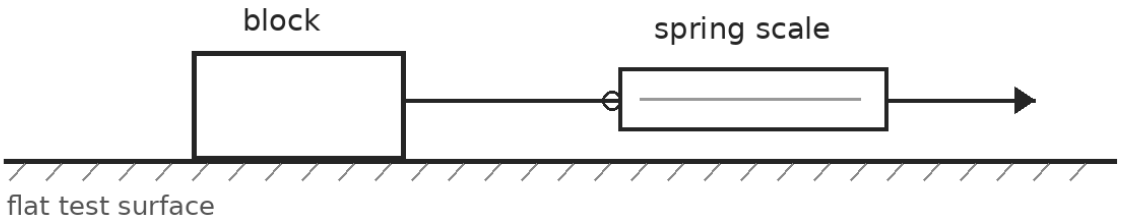
EXPERIMENT 1: MAXIMUM STATIC FRICTION — Data collection

Question: How does the contact material affect the force needed to start a block moving?

Equipment and controlled conditions

Spring scale, balance, five prepared blocks (or four), and one long, level test surface. Label the blocks A–E. Use the same test surface for every experiment; keep contact surfaces clean and dry.

Set-up



Prediction

Which contact material will require the greatest force to begin sliding? Explain briefly.

Procedure

1. Identify the material touching the test surface for each block. Measure each block's total mass, including its attached material.
2. Attach the spring scale to block A. Keep the scale parallel to the surface throughout the pull.
3. Increase the pull slowly and smoothly. Record the largest scale reading immediately before the block starts sliding. Avoid jerking the scale.
4. Repeat for three trials, then repeat for each remaining block. Leave row E empty if only four blocks are available.

Measurements: maximum force just before sliding

Block / contact material	Mass (kg)	Trial 1 (N)	Trial 2 (N)	Trial 3 (N)	Average
A: _____	_____	_____	_____	_____	_____
B: _____	_____	_____	_____	_____	_____
C: _____	_____	_____	_____	_____	_____
D: _____	_____	_____	_____	_____	_____
E: _____	_____	_____	_____	_____	_____

Use each block's measured mass in later calculations. The coefficient belongs to a pair of contacting surfaces, not one material alone.

EXPERIMENT 1: MAXIMUM STATIC FRICTION — Analysis

1. Force diagram

Draw and label every force acting on a block immediately before it begins sliding. Assume the scale is pulled horizontally.

2. Relate the measured force to the coefficient

Immediately before motion, the block has zero acceleration. Use Newton's laws to explain why the measured peak pull equals the maximum static friction force.

Show a full sample calculation for ONE material, including its normal force and coefficient. Use $g = 9.81 \frac{m}{s^2}$.

3. Results for all materials

For each block, average its three peak-force readings, then calculate the coefficient of static friction. Coefficients have no units.

Block / material	Average maximum force (N)	Coefficient of static friction
A: _____	_____	_____
B: _____	_____	_____
C: _____	_____	_____
D: _____	_____	_____
E: _____	_____	_____

4. Interpret

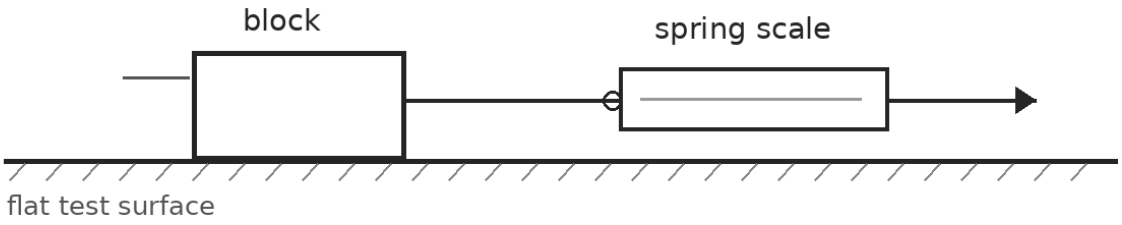
Does static friction always equal its maximum value?

Explain what happens as the pull increases while the block remains at rest.

EXPERIMENT 2: KINETIC FRICTION — Constant-speed data

Question: For the same material pairs, how much horizontal force is needed to keep a block sliding at constant speed?

Set-up



Prediction

For a particular block, will the force needed to maintain constant speed be greater or less than the maximum force needed to begin sliding? Explain your prediction.

Procedure

1. Use the same blocks and the same level test surface as in Experiment 1. Keep the spring scale horizontal.
2. Pull block A until it is sliding at an approximately constant, slow speed. Ignore the higher reading needed to start motion.
3. While the block is sliding steadily, record the scale reading. Do not use readings taken while speeding up or slowing down.
4. Complete three trials for each block. Use the block labels and masses recorded in Experiment 1.
5. Quality check: Repeat any trial in which the block sped up, slowed down, or the scale reading fluctuated substantially.

Measurements: pull during steady sliding

Block / contact material	Trial 1 (N)	Trial 2 (N)	Trial 3 (N)	Average
A: _____	_____	_____	_____	_____
B: _____	_____	_____	_____	_____
C: _____	_____	_____	_____	_____
D: _____	_____	_____	_____	_____
E: _____	_____	_____	_____	_____

PHYSICS 11 | COEFFICIENT OF FRICTION
EXPERIMENT 2: KINETIC FRICTION — Analysis and comparison

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1. Force diagram
Draw and label every force acting on a block while it slides to the right at constant speed.

2. Calculate the coefficient
At constant velocity, $a = 0$ and $\Sigma F_x = 0$.
Explain why the steady scale reading equals the kinetic friction force, then show one complete calculation of the coefficient.

3. Results for all materials
Average the three steady pulling-force readings for each material, then calculate its kinetic coefficient.

Block / material	**Average sliding force (N)**	**Coefficient of kinetic friction**
A: _____	_____	_____
B: _____	_____	_____
C: _____	_____	_____
D: _____	_____	_____
E: _____	_____	_____

4. Compare with Experiment 1
a) For which materials was the maximum static coefficient greater than the kinetic coefficient? Were there any exceptions?

b) A block can move without accelerating. Use the forces in your diagram to explain how this is possible.

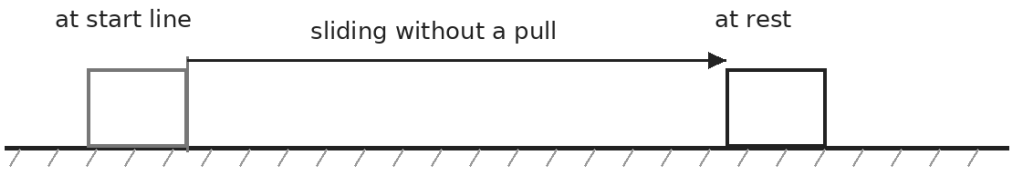
c) Which contact material produced the highest kinetic coefficient? Did the ranking match Experiment 1?

EXPERIMENT 3: KINETIC FRICTION — Sliding-to-rest data

Question: Do different materials produce different decelerations, and does this method agree with Experiment 2?

Equipment and set-up

Use the same level test surface and blocks. You will need a tape measure, start-line marker, and a phone video or stopwatch. Video timing is preferred for short slides.



Procedure

1. Mark a start line. Practice pushing a block briefly BEFORE the line; remove your hand fully before its front edge reaches the line.

2. Start timing when the front edge crosses the line. Stop timing when the block comes to rest. Do not touch the block during the measured slide.

3. Measure the distance from the start line to that same front edge at rest. Record both the distance and the elapsed time.

4. Complete three trials for each contact material. Use a safe initial speed that allows a measurable slide; a short or inconsistent slide should be repeated.

Measurements: motion with no applied force

Record the distance and time for each trial. Calculate the final column after completing the derivation on page 6.

Block	Trial	Distance (m)	Average (m)	Time (s)	Average (s)
A	1				
	2				
	3				
B	1				
	2				
	3				
C	1				
	2				
	3				
D	1				
	2				
	3				
E	1				
	2				
	3				

EXPERIMENT 3: KINETIC FRICTION — Analysis and final synthesis

1. Connect kinematics and dynamics

With final velocity equal to zero. Show how to find the initial speed and acceleration from one trial's distance and time.$d = \frac{(v_I + v_f)}{2} t$; $v_f = v_I + at$;

2. Force diagram and motion

Draw all forces on a block AFTER release, while it is sliding to the right but slowing down.

Use the force diagram to **calculate the kinetic coefficient for all trials on page 5**.

3. Compare both kinetic-friction methods

Block / material	**Acceleration**	**Coefficient of Kinetic Friction**
A: _____	_____	_____
B: _____	_____	_____
C: _____	_____	_____
D: _____	_____	_____
E: _____	_____	_____

4. Explain your findings

a) Which materials produced the greatest and smallest mean kinetic coefficients? Did both methods identify the same materials?

b) Should the two kinetic coefficients for the same contact pair be identical? Explain any important differences using evidence from your measurements.

c) If you added mass to one block without changing its contacting surfaces, how would its frictional force and sliding deceleration change? Support your answer using Newton's Second Law.