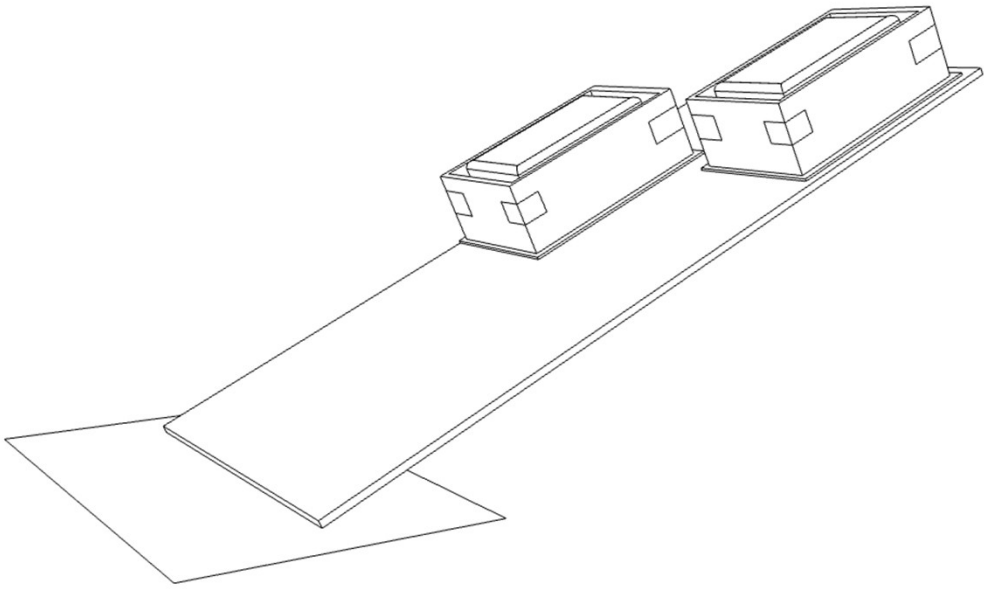
SLIPPERY SLED WORKSHEET



GETTING STARTED

Learn how friction affects the way things slip and slide with the slippery sled activity! The slippery sled activity teaches children how to plan, construct, and carry out an experiment involving an investigation into how objects move across different surfaces. This worksheet has been designed for KS1/2 and 3/4.

The main aim of the investigation is to provide insight into how FRICTION can influence how objects move when in contact with another surface.

The results of the investigation should enable children to comprehend and discuss the importance of selecting different surfaces to reduce or increase friction.

Additionally, the activity provides a platform for children to work in groups, share ideas, and collaborate, which is the most important part of being an engineer.

LEARNING OUTCOMES

KS1/2 Proof-of-concept

- Identify where friction is occurring during the sled experiment.
- Suggest ways to reduce friction to help the sled move more easily.
- Identify which materials increase friction.

KS3/4 Deeper learning activity

- Understand what the coefficient of friction is.
- Define friction as a force that opposes motion between surfaces in contact.
- Identify that different surfaces create different amounts of friction.

VOCABULARY

Surface - The surface is the layers which are touching each other

Force - A force can cause objects to move or stop

Friction - Friction is a type of force which acts between surfaces

Force meter – A piece of equipment used to measure force

Load – The amount of weight carried by an object such as a sled

Lubricant – a substance, usually oil, which is used to control friction

WARM-UP ACTIVITY

5 mins

FUN FRICTION FACT

Sledding is fast **because of a thin layer of water reducing friction!**

When a sled moves over snow, the pressure and friction generate a small amount of heat, melting a thin layer of snow into water. This water layer acts as a lubricant, reducing friction and allowing the sled to glide smoothly.

However, if it's extremely cold, the snow won't melt as easily, increasing friction and making the ride slower!

Can you think of other situations where a **thin layer of water reduces friction?**

Spend 5 minutes discussing and writing down your answers.
Here are a few examples to get you thinking!



MAIN ACTIVITY

Working in groups, your task is to **design and build a small sled** that can carry a load and slide down a ramp. You will attach **different materials to the bottom of your sled** to test how friction affects its motion. The goal is to **select materials that create the most friction**, so your sled stays on the ramp for the longest time as it is gradually tilted. Make sure your design is stable enough to carry the 1kg load without toppling over. The winning team will be the one **whose sled remains on the slope the longest** before it begins to slide!

Before you start spend about 10 minutes discussing and planning your sled design.

Think carefully about the following points:

- Which materials are likely to create the most friction?
- How might the shape and size of your sled affect how it grips the ramp?
- Can you test your design before putting it to the real test?

MATERIALS

 A4 card / box	 Sandpaper	 Paper	 icing sugar
 Tape	 Roll of Velcro	 1kg bag of rice	 Force meter

METHOD

30 mins

EXPERIMENTAL PROCEDURE

1. Build your sled
2. Add surfaces to the bottom of your sled
3. Add the load to your sled and weigh it
4. Perform a pull test using the force meter
5. Place your sled at the top of the ramp and gradually tilt the ramp until the sled slides
6. Record the height of the ramp at which the sled slides
7. Repeat the test with icing sugar on the ramp

TIPS / HINTS

- Ask the teacher for help building your sled if you're stuck
- Make sure your sled can fit the bag of rice / load inside
- Use a force meter to and some string to drag your sled on a flat surface before you test it on the slope

RESULTS

10 mins

ACTIVITY ONE – PULL TEST

With your sled now build, firstly weigh your sled and record the mass. If you don't have scales, assume it's the weight of the bag of rice (1000g). Attach your force meter to the sled using some string and pull your sled, then record the force.

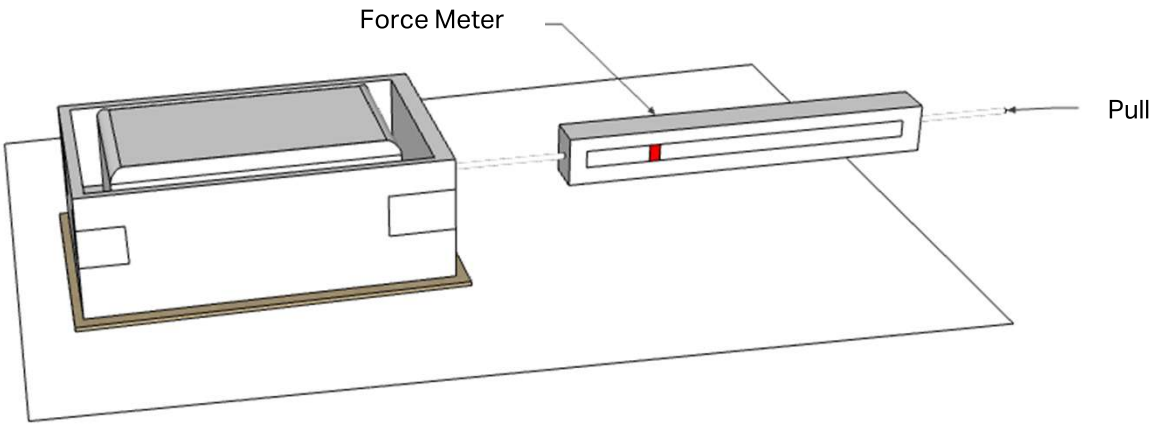


Table 1: Results of the pull test

Group No.	Surface(s) used	Pull force (N)	Mass (g)
1			
2			
3			
4			
5			

RESULTS

10 mins

ACTIVITY TWO – SLOPE TEST

You're now ready to test your sled on a ramp. This can be done in two ways. You can test different sleds against each other on the ramp, gradually increasing the angle of the slope, until the last one standing wins. Or you can place individual sleds on the ramp and measure the height at which the sled slides. Rate the sleds in order of sliding or measured height.

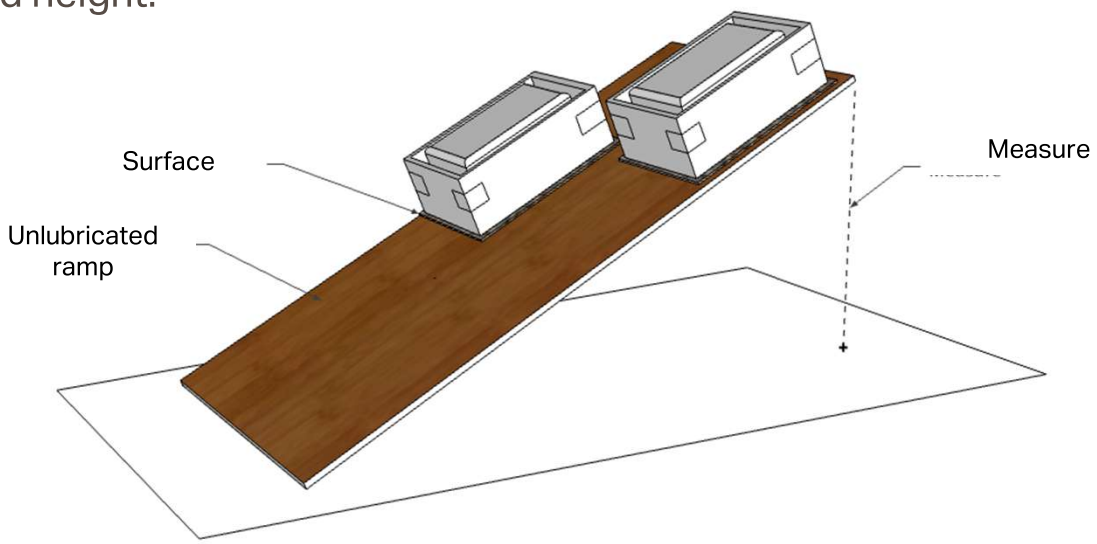


Table 2: Results of the unlubricated ramp test

Group No.	Surface(s) used	Order of sliding height (1-5) / measured height (cm)
1		
2		
3		
4		
5		

RESULTS

10 mins

ACTIVITY THREE – SLOPE TEST WITH LUBRICATION

To simulate the lubricating effect of snow, add icing sugar to the ramp and repeat the slope test as described in activity two.

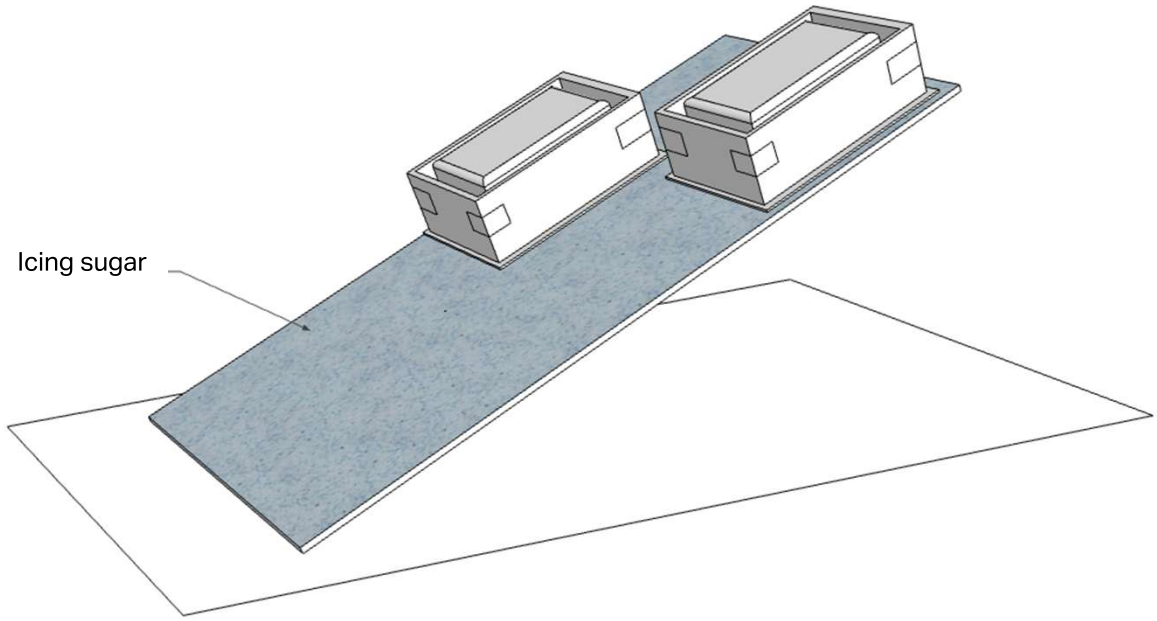


Table 3: Results of the lubricated ramp test

Group No.	Surface(s) used	Order of sliding height (1-5) / measured height (cm)
1		
2		
3		
4		
5		

DEEPER LEARNING (KS3/4)

10-20 mins

STRETCH ACTIVITY

The **coefficient of friction** is the ratio of the friction force between two surfaces to the normal force pressing them together. It helps us understand how easily surfaces slide, stick, or roll against each other.

Your task in the deeper learning activity is to measure the **static** coefficient of friction using the pull force test and **make predictions as to which angle the sled will begin to slide.** Then, compare your predictions with your measurements.

Measure the static coefficient of friction in the **pull force test for the unlubricated and lubricated conditions by rearranging the following equation:**

$$\mathrm{F(friction\ force)} = \mu_s\mathrm{(coefficient\ of\ static\ friction)} * \mathrm{F_N(normal\ force)}$$

The normal force acting on the sled is given by:

$$F_N = W\cos(\theta)$$

The object will begin to slide when the downslope gravitational force equals the maximum static friction force:

$$W\sin(\theta) = \mu_s W\cos(\theta)$$

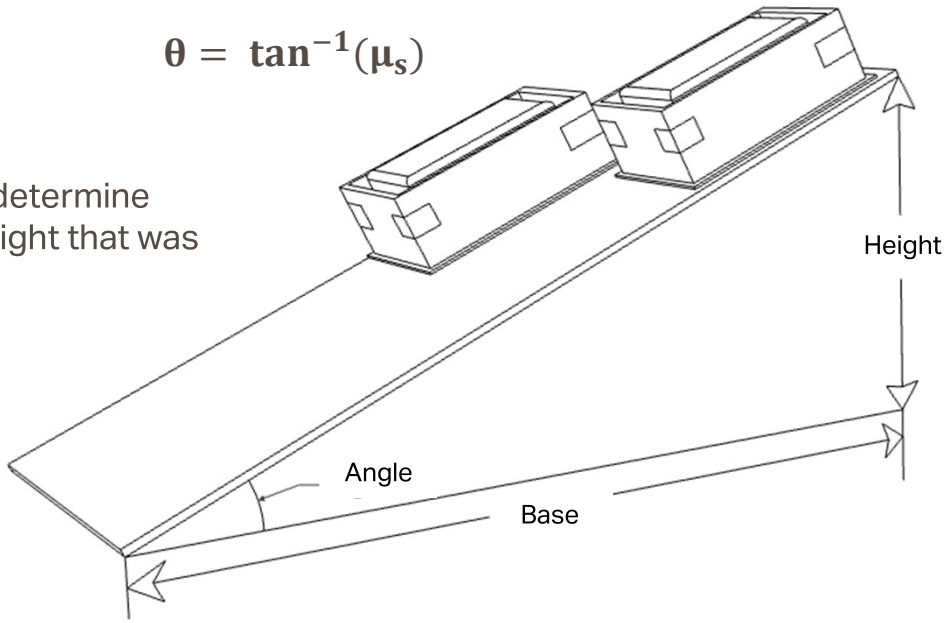
Solving for the angle θ gives:

$$\tan(\theta) = \mu_s$$

$$\boldsymbol{\theta = \tan^{-1}(\mu_s)}$$

Notes:

- Use trigonometry to determine the angle from the height that was measured



RESULTS

10-20 mins

STRETCH ACTIVITY

Table 4: Results of the unlubricated ramp test

Group No.	Surface(s) used	Static friction coefficient	Calculated angle (rad)	Measured angle (rad)
1				
2				
3				
4				
5				

Table 5: Results of the lubricated ramp test

Group No.	Surface(s) used	Static friction coefficient, μ_s	Calculated angle (rad)	Measured angle (rad)
1				
2				
3				
4				
5				

PROOF OF CONCEPT QUIZ

5-10 mins

What is friction?

Name the forces acting on the sled.

Where did friction occur in the test?

What materials prevent the sled from sliding easier?

Does icing sugar reduce friction? Can you explain why?

Why does tilting the ramp cause the sled to slide?

DEEPER LEARNING QUIZ

5-10 mins

Why is determining the coefficient of friction useful in engineering?

What condition needs to occur before the sled begins to slide?

How could you improve the accuracy of the experiment?

What variables are difficult to control in the experiment?

Can you think of reasons why the calculated angle may differ from the measured angle?

Do your results support the hypothesis that '*applying icing sugar to a contact surface reduces the coefficient of friction*'. Justify your answer with an explanation of the underlying mechanism.