

# From Quarry to Canal Challenge

## Teachers' Guidance Notes

### Learning Objectives

- To learn about the ways in which stone was transported from the quarries down to the canal
- To learn about gravity and friction and understand how they can affect movement
- To investigate how gravity and friction affect the movement of trucks on an incline
- To develop technical and creative thinking and to employ scientific method

### Resources

- Instruction sheet for inclined plane challenge
- Instruction sheet for the incline model
- Llantysilio Quarry Tramway Fact File
- [Film of the Vivian incline at Dinorwic Slate Quarry](#)
- [A short animation of the same incline](#)

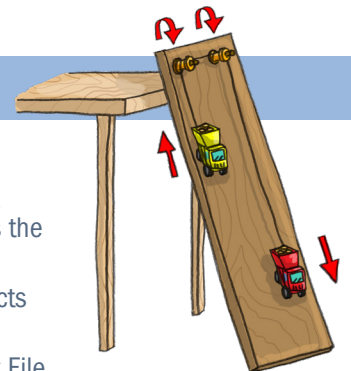
### Activity Instructions

Learners are posed the challenge of trying to find ways of transporting the slate from the quarries down to the canal.

They design an experiment to find out about how increasing the angle of the inclined plane affects the descent of the load. They create a hypothesis before testing their inclines.

As a class, they build a model incline and then investigate how varying the load on the trucks affects their descent.

Watch the films showing working inclines at other quarries and look at the Llantysilio Tramway Fact File.



#### Starter Activity Ideas:



Look at [NLS maps](#) to locate Moel y Faen Quarry and the canal.

How far is it from the canal? What is the terrain like? What height is the quarry above sea level and what height is the canal at Pentrefelin? What difficulties would this have posed?

Discuss ideas for how the slate could have been transported down to the canal before motor vehicles were available.

#### Brief for Learners:



##### Activity 1: Inclined plane experiment

Make an inclined plane using the instructions on the sheet, then experiment to investigate the effect of changing the angle and length of the slope.

Investigate the effect of changing the surface at the bottom of your inclined plane to see the effect of friction.

Discuss: Would an inclined plane be suitable for moving heavy slate trucks? What problems can you envisage? Can you think of any way of solving the problems and making it safer?

##### Activity 2: Build a model quarry incline (class activity)

Watch the films of the Vivian incline at Dinorwic slate quarry.

Build a model quarry incline using the instruction sheet, under the guidance of your teacher.

Test your model using loads of different weights.

#### Further Activity Ideas:



Using the data gathered turn your findings into a graph.

Investigate other inclines in historic quarries and mines around North Wales.

Look up [funicular railways](#) which operate by similar principles.

# Experiment: Understanding how an inclined plane works

## Materials needed:

- Kitchen roll tubes or strips of thick card
- Toy car or marble
- Books to stack
- Measuring tape
- Stopwatch
- Blu-tack
- Adhesive tape
- Scissors



## Instructions:

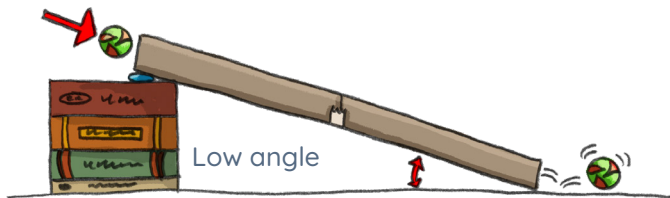
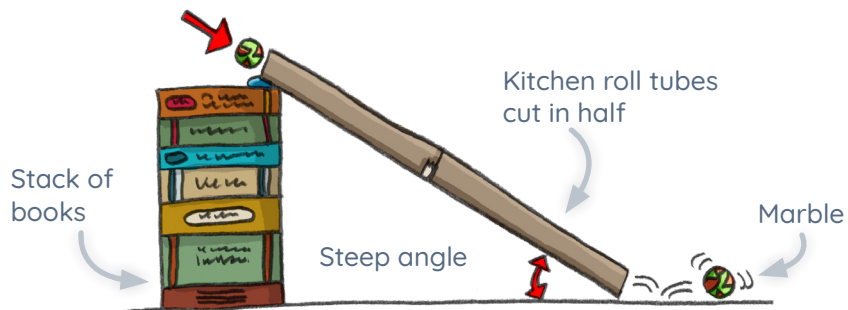


Cut kitchen roll tubes in half lengthways to make a track for the incline. To make a longer incline, use adhesive tape to stick tubes together. Raise one end of the cut tube on a stack of books so that it forms a slope. You may need use blu-tack to secure the end of the tube to the books.

The marble or toy car will represent the truck full of slate. Place the marble at the top of the slope and release to watch how it travels.

**Create a hypothesis:** How does the angle of the slope affect the distance and speed the marble will travel?

**Experiment:** Release the car/marble and record how far it travelled along the floor after leaving the tube. Then change the angle of the slope by adding or removing books.





# Experiment:

## Understanding how an inclined plane works

### Record your findings:

Record your findings in the table below and compare the results with your hypothesis.



Height of book pile (cms)	Distance the marble / toy car travelled

**How does friction affect the speed of travel?**

Experiment with running the slopes onto different materials such as carpet, smooth wood, grass or gravel.

Predict how the different surfaces will affect the speed and distance the marble /car travels then test your prediction. (If your incline isn't easily moved you can just try rolling your car or a small ball along different surfaces.)

**What conclusions can you draw from your experiments?**

# Making a Quarry Incline Model

## Materials needed:

- 1 x board about 1m long and about 200mm wide.
- 2 x pulley wheels approx 30mm diameter (cotton reels could be used but are less effective).
- 2 x sets of nuts and bolts to attach pulley wheels to the board or round lolly sticks or dowel
- 2 trucks to carry loads - these can be toys or made from LEGO or similar.
- 1m length of thin cord to connect the 2 trucks together.



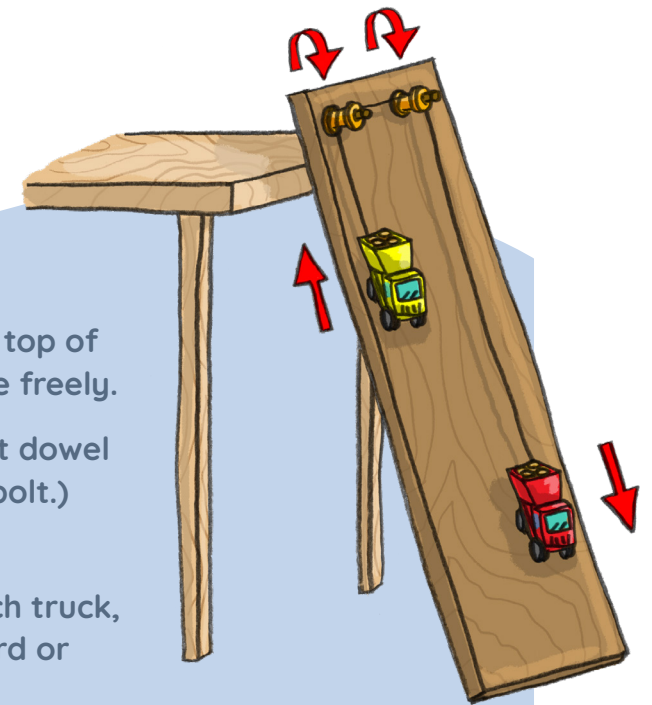
## Method:

1. Attach the pulley wheels near the top of the board, ensuring that they rotate freely.  
(Make holes in the boards and insert dowel or lolly sticks or use a thin nut and bolt.)

2. Attach the cord to one end of each truck, this can be done by knotting the cord or using adhesive if needed.

3. If no "load" holding space is available on the truck then attach a paper cup or similar to each truck. Tilt the cup so that it is vertical when the truck is on the incline. A typical incline angle could be between 45° to 60° from horizontal.

4. Set up the assembly with the board secured at 45° to 60° from the horizontal. This can be done by propping the board on a bench or pile of books and with a block to stop the bottom end slipping away.



# Making a Quarry Incline Model

## Method continued:

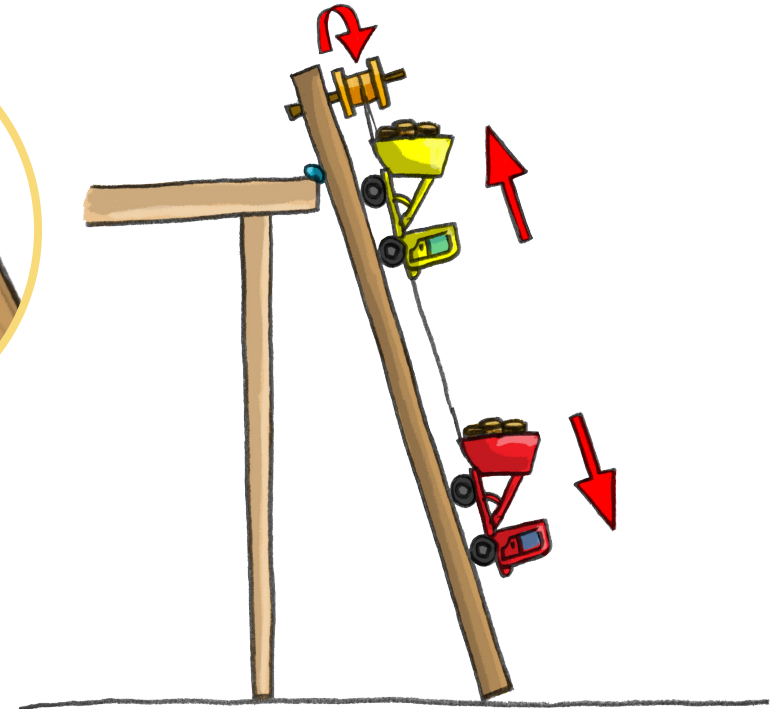
5. Loop the cord over the two pulleys and see if the two empty trucks can be balanced.

6. Put a “load” in one truck, such as marbles, pebbles, coins, or sand. 2p coins work well as they are a good weight, flat, and not messy.



7. Let go of the upper truck and watch what happens.

8. Vary the load weight to see how it affects the speed of descent. Does it make it faster or slower?



### Teacher's note:

If the two trucks are of equal weight the forces are balanced and the trucks shouldn't move. If one is heavier then gravitational force causes it to move down the slope. The weight of the loaded truck pulls up the lower truck.



# Fact File: Llantysilio Slate Quarries

In the 1800s there were three working slate quarries on the Llantysilio hillsides. The canal provided the means to transport the slate cheaply to the growing English towns and cities but was some distance from the quarries and at a much lower level.



Cutting slabs in the mill

At first, horse and carts were used to transport the slate but, in 1852, a 7.5km tramway was built. This linked the quarries to Pentrefelin Mill beside the canal, where the **slate was cut into slabs** before being loaded onto canal boats.

Horses pulled the laden trucks along the rails on the flat sections of the tramway. The smooth rails minimised friction so the heavy trucks could be pulled easily and smoothly.



Horses pulled the trucks on the flat sections

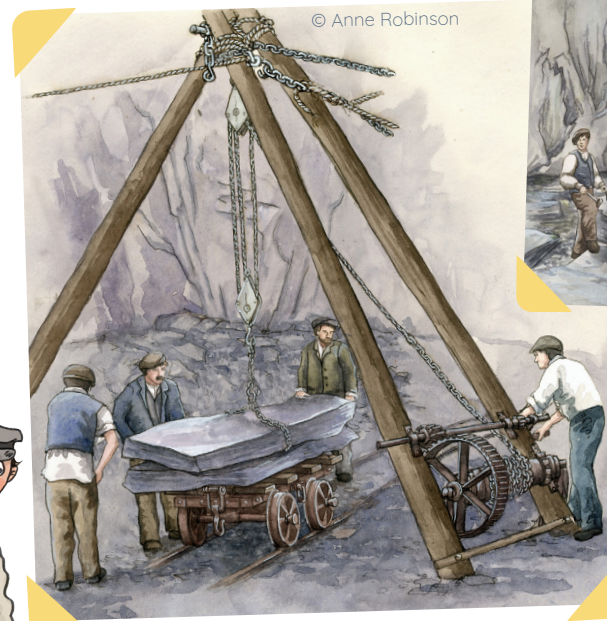


# Fact File: Llantysilio Slate Quarries

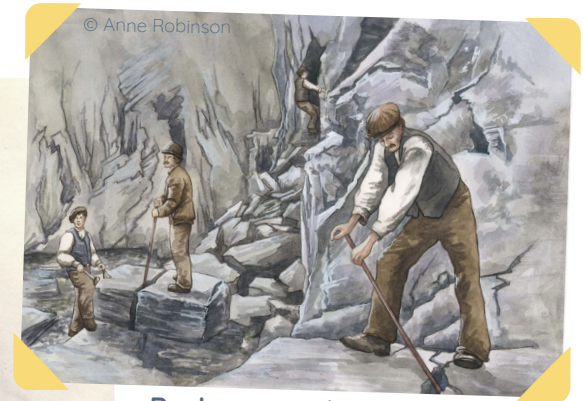
On the steeper slope a long **incline** was built and the trucks descended by gravity. To ensure the heavy trucks could be moved in a safe controlled way, they were attached to a **strong metal cable** that was wound round a large drum.



Trucks were attached to metal rope wound round a drum to go down the steep incline



Hoisting slabs onto a truck



Rockman working at quarry face



Loading slates onto a canal boat

The weight of a loaded truck descending was used to pull up an empty truck that was attached to the other end of the metal cable. The cable was slowly unwound allowing the trucks to move. A brakeman controlled the speed using a brake lever that was connected to the drum.