Maths in Action at Combe Mill

Exploring maths skills in real-life situations in the fields of science, engineering and technology.

Name: ....

Developed for Year 5 and 6
- Miss Hodge- Combe C of E Primary School

Permission given for this workbook to be used for school activities at Combe Mill delivered by the education team of Combe Mill Society

Minor editorial corrections made by Tony Simmons - March 2015

Each of the challenges in this booklet are based on the science, engineering, maths and technology that takes place in a workplace such as Combe Mill.

The challenges are designed to allow you to use your maths skills of + - x and ÷ and your understanding of fractions, decimals, angles, measurements, negative numbers and ratios.

I look forward to seeing you **apply** these skills to real-life problems, selecting the appropriate calculation.

Each challenge is broken down into parts.

A) Warm Up

B) Medium

C) Harder

D) Challenging

I don't expect you to manage them all at the Mill. C and D challenges may require more thinking and calculation back at school and over the holidays.

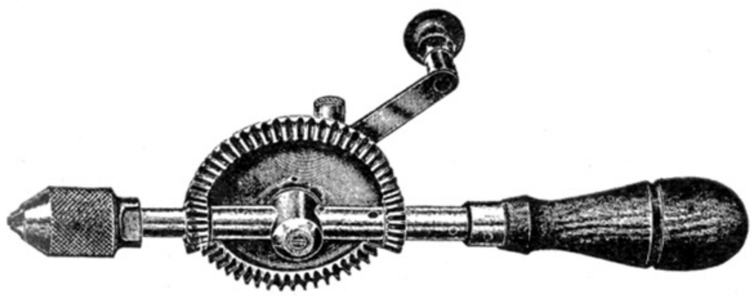
Good Luck!

Hand-drill Challenges

Look carefully at the hand-drill.

It is a simple mechanism with only 2 cogs. It is designed to have a drill piece in the end to drill holes, often in wood.

You wouldn't want to have to turn the handle 100 times to make the drill piece rotate 100 times. The cogs are in place to make it easier, but how much easier…?



A. Place a tiny piece of Blutac™ on a tooth of the smaller cog.

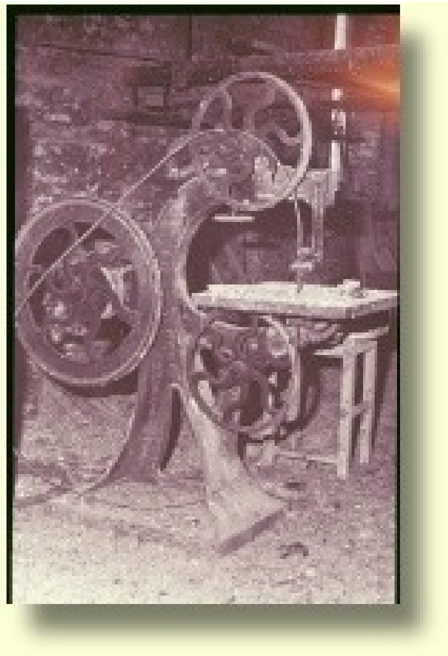
Count **approximately** how many times the drill piece would turn (the same as the small cog) in one full turn of the handle.

B. Imagine a hand-drill with a large cog that has 60 teeth and small cog that has 20 teeth.
Every time you rotate the handle on a large cog in one full circle**, how many times will the smaller cog spin**?

C. Imagine a hand-drill with an even bigger 'large' cog and an even smaller 'small' cog. If the larger cog had 60 teeth and the smaller cog had 12 teeth, **how many times would the drill piece rotate** if you spun the handle 8 times?

D. Imagine that to drill through a piece of wood when building a desk, a carpenter must apply a certain pressure and have the drill piece rotate 400 times.

If the large cog has 60 teeth and the small cog has 12 teeth, **how many times must they rotate the handle?**



Band Saw Challenges

Look carefully at the band saw.

It is an amazing versatile machine that can be run by 3 different methods.

You can simply turn the handle to get it to rotate. Alternatively if the water wheel is in action, the cog system running from the wheel can run the saw.

Thirdly, the more modern steam engine can also create rotating cogs from the other side of the mill that can also be used to run the saw.

A. Imagine a carpenter making planks of a certain size for an order for the Blenheim gamekeeper.

If he can cut 25 in one hour, how many will he make in 6 hours?

B. If he works from 8am until 6pm with two half hour breaks**, how many planks will he make?**

C. If he works the 8 til 6 day from challenge C, **how many days** will it take to fulfil an order of 1350 planks?

D. Using your scientific knowledge see if you can think of an advantage and a disadvantage for each system. (Think: sustainability, efficiency, water cycle etc.)

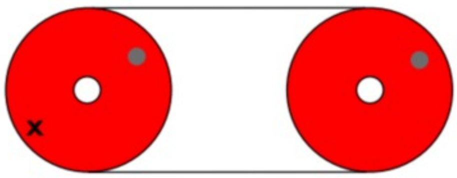
	Advantages	Disadvantages
Hand operation		
Water power		
Steam power		

Pulley model Challenges

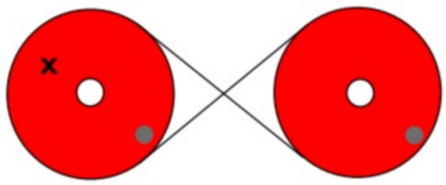
Explore the pulley model board.

A. **Match** up the diagrams with the descriptions to show what happens when you explore different options with pulley systems.

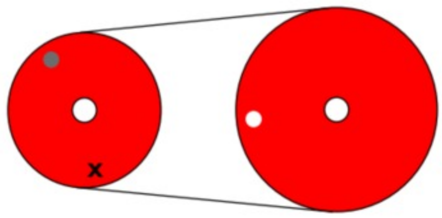
KEY
X Driving handle
O Centre of pulley
● Spot mark



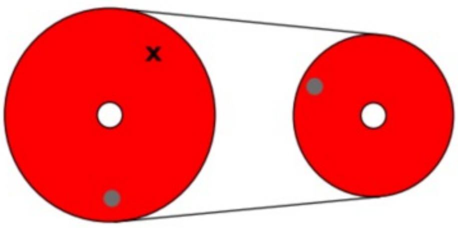
If the drive band is twisted the driven pulley will rotate in the opposite direction



Two pulleys of equal size will rotate at the same speed



A larger pulley will make a smaller pulley rotate faster



A small pulley will make a larger pulley rotate more slowly

D) We can describe the relationship between 2 pulleys in a system with a ratio. If the driving pulley rotates once and its partner rotates once we call this a 1:1 ratio. If the driving pulley rotates once and its partner rotates 3 times we call this a 1:3 ratio.

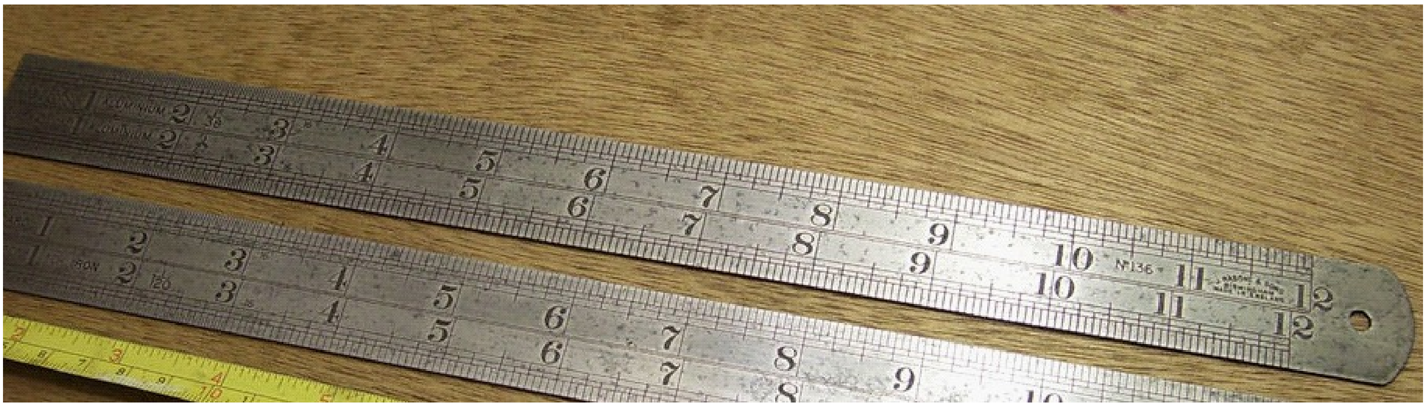
Imagine if I turn the left driving pulley 6 times, **how many times will the partner spin** if there is a **1:4 ratio** between the two pulleys?

Metal Ruler Challenge

Look carefully at the metal ruler. It has two sets of measurements on it. One side is used for measuring hot metal objects and the other for cold metal objects. If you made a cog out of hot metal it would contract (shrink) when it cooled.

A) If a metal rod was 12 inches when hot, how long would it actually be once it had cooled?

(Look really carefully at the scale.)



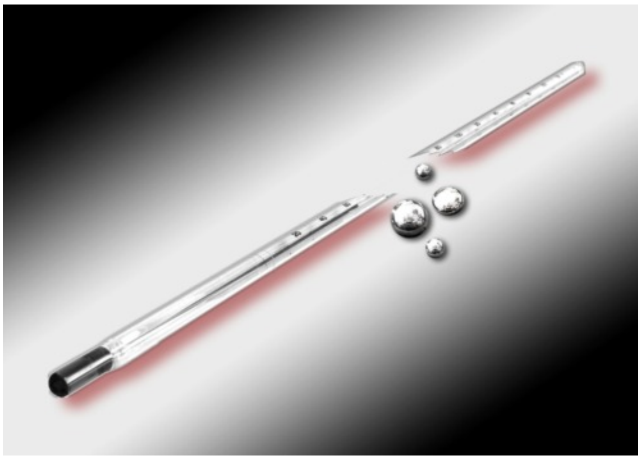
B) What could go wrong if you didn't have a ruler like this?

D) If a metal cog is being made and you want it to end up 24 inches wide, how wide should the mould which you will pour the hot metal into be made?

Thermometer challenge

Warning: Must be done with an adult. The thermometer is infrared and must never be pointed near eyes.

Temperature can be measured in different ways. We often see pictures of traditional thermometers with mercury (a metal) in them which changes depending on the temperature up and down a scale.



More modern and accurate ways are now available to measure temperature.

Have a look at this infrared thermometer.

A. Use it to measure your temperature and record your temperature to 1 decimal place.

(This means you may only write one digit after the decimal place. If there are 2, e.g. 35.69, you have to round, in this case to 35.7)

B. Physical work in a place like the Mill is hard work and can get very hot. Do 40 star jumps and see whether your temperature has increased. If it has, how much has it increased by?

(Use column subtraction to find the difference.)

C. The temperature changes around the year in Combe. If the lowest temperature the workers experienced one year, in the winter, was minus 4.5 degrees Celsius and the highest, in the summer, was 33.8 degrees Celsius, what was the range?

(Use a number line and then a column addition.)

Timeline Challenge

Combe Mill is a sawmill belonging to the Blenheim Estate of the Duke of Marlborough. There has been a mill on this site since Saxon times; the Domesday survey of 1086 refers to a mill at 'Cube', which is known to be Combe, and it is reasonable to assume that the mill had existed for some time before that. In those days the village of Combe was also in the valley, east of the mill, but it was deserted in the fourteenth century, possibly as a result of the Black Death, and now stands at the top of the hill about a mile from the mill, around the fourteenth century church. The present sawmill dates from the mid-nineteenth and was originally powered by a water wheel and a beam engine, both of which survive, both having been restored to working order.

A. Use the timeline in the stairwell, being careful not to trip, to calculate how long the mill has been in Combe since the Doomsday book.

B. Which is the best method for this calculation, a number line or column subtraction?

C. Explain your answer to B.

Measuring Weight Challenge

Before digital scales, weighing accurately was difficult.

Try the problem below, working with few resources to weigh the mystery bags.

Using only the balance scales and 3 weights – 90g, 30g and 10g - you need to calculate the weight of the mystery bags A and B.

(Draw the scales for each answer to show your workings.)

A. What is the weight of bag A?

B. What is the weight of bag B?

C. Could you get the scales to balance with your 3 weights and an object weighing 120g?

D. Could you get the scales to balance if you had just these 5 weights? 21kg, 15kg, 7kg, 3kg and 4kg.

Pendulums

Pendulums - how they help to keep time

When you set a weight swinging on the end of a piece of string what determines whether it goes fast or slow?

If you set it swinging why does it slow down to a halt eventually?

We have set up a swinging metal rod and on it is a heavy weight that can be slid up and down.

A. Try dropping the pendulum from the blue, red and yellow dots. Each time, time the length of the swing there and back. Does the height you drop from (the colour) change the result?

	Length of swing (seconds)
Red	
Yellow	
Blue	

B. Add some Blutac™ to add weight to the pendulum.

Test it with and without the weight, keeping all other variables constant (height, length, force) and see whether the weight affects the time it takes to swing away and back again.

Clock Face Angle Challenges

When designing clocks accuracy is extremely important. Clock faces are a clever way to show the time that developed from sun dials.

Using the large clock face at the end of the hall, calculate the problems below.

A. How many degrees does the minute hand travel over a 1 hour period?

B. How many degrees does the minute hand travel over a 5 minute period?

C. What is the angle between the two hands at exactly 5pm?

D. How many minutes are there in

i. two thirds of an hour?

Ii. five sixths of an hour?

Iii. six eighths of an hour?

Treadle Lathe Exploratory Challenge

The treadle lathe is powered by foot treadle. You must be careful and work with an adult.

A. If you pump the foot treadle once, how many times does the lathe rotate? Use your Blutac™

B. You can write this as a ratio.

Foot operated: lathe spins

1 : ______

C. How many times would the lathe rotate if you pressed the foot treadle 100 times?

D. If you wanted the treadle lathe to rotate 1000 times, how many times would you need to press the foot treadle?

Temperature Challenge

Approximating temperature is a useful skill. Mill workers would need to know how to achieve different temperatures to get different metals to become malleable (flexible and 'hammerable').

A. Try pairing up the everyday object cards with the Appropriate temperature cards.

(You can flip them over when complete to check if you are correct.)

Draw on your prior knowledge.

What is the freezing point of water? _____

What is the boiling point of water? _____

Stonesfield – St. James's Clock

The Stonesfield clock. It was acquired by Stonesfield's St James the Less church in 1743. The clock was originally made in 1543 and was housed in a nearby manor. It was removed from the church in 1925 and extensively rebuilt before being installed in Judd's Garage, Wootton-by-Woodstock. When Judd's garage was demolished, the clock was taken into the care of the Museum of Oxfordshire, but released to the Combe Mill Society in September 2010 for a 5 year loan.

A. How many years ago was the clock made?

B. How many years did the clock spend in St. James the Less Church in Stonesfield?

Cog Exploration Challenges

Using the plastic equipment explore how you can increase and decrease rotations by putting cogs in a sequence.

A. Try putting 4 cogs of the same size in a sequence. What do you observe?

B. Design a system where you can rotate one large cog and make a cog further along the sequence spin at a different rate.

C. How much faster did your fastest cog go than your slowest?

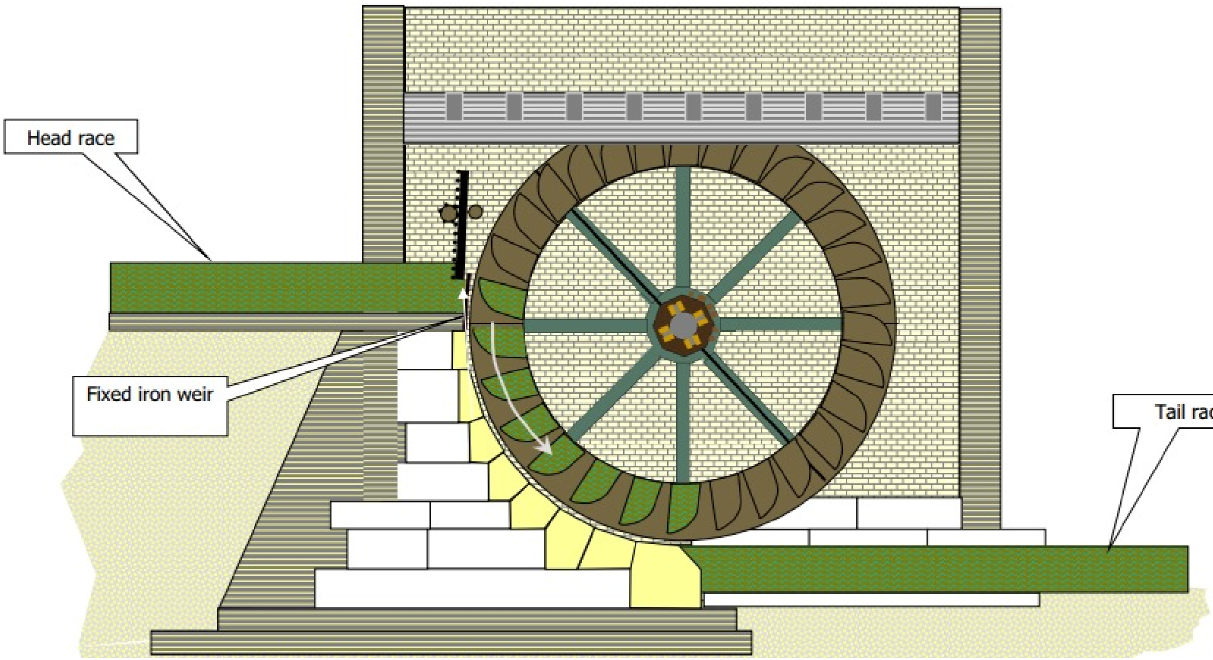
(Three times as fast? Twice as fast?)

D. Explore what happens when you put cogs of ascending or descending size in order.

Write down any observations you make.

Water Flow Challenge

When water flowed under the wheel the speed varied massively depending on the river speed.



A. Imagine 10 litres pass through the wheel in 1 second. How many litres will pass through in 1 minute?

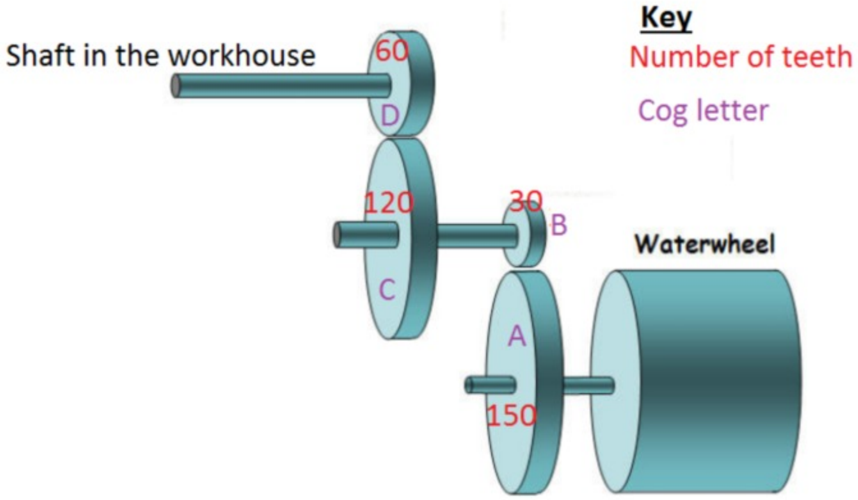
B. If the river speed continues to be 10 litres per second, how many litres would pass through in one hour?

C. If a river speed of 10 litres per second turned the wheel four times in a minute, how long would it take to turn the wheel 100 times?

D. The black metal weir (gate) can increase and decrease flow of water to the wheel. If you raise the metal sluice and increase flow to 15 litres per second, how much water would pass through in 1 hour?

Cog Calculation Challenge

Here is a diagram of the cogs transporting the power from the waterwheel to the shaft (pole) in the workhouse. It shows how the rotation is transported from the water wheel to the workhouse to be used by equipment. The number of teeth on each cog is labelled.



A. If the water wheel turns once, Cog A turns once too. How many teeth does the key show Cog A has?

B.i) If cog A turns once, how many times does cog B turn?

ii) When cog B turns, it is attached to cog C with a 1:1 ratio. Therefore C turns the same number of times as B. How many times does cog C turn?

iii) Cog C has 120 teeth. Cog D has 60 teeth. How many times does cog D which goes into the workshop, turn every time the waterwheel turns once?

C. If the water wheel rotated 80times, how many times would the shaft in the workhouse turn?

D. If you needed the shaft in the workshop to rotate 1800 times in one hour, how many times would the water wheel need to turn in 1 minute?

Scale Factor Challenge

Often people make models of equipment to demonstrate things. Combe Mill has models of many of their machines to show how they work. They even have a model of Combe Mill itself.

It is **'to scale' –** which means in proportion to the real thing, just shrunk down. For example, if the water wheel is 100 times smaller, the cogs would be 100 times smaller too!

Have a look at the model of the mill in the office. We're going to work out how much it has been scaled down.

A. Look at the outside wall where we came into the Mill, down by the river.

How long is it on the model?

____________ (Don't forget to give your unit)

B. Write your answer above in a variety of units.

_____m = _____ cm = _____ mm

C. Measure the wall outside with the trundle wheel.

How long is it in centimetres and metres?

_____ m = _____ cm

D. How much smaller is the model than real life?

You could round your answers to give an approximate answer.

Model size		Mystery scale		Real life size
	X	?	=	