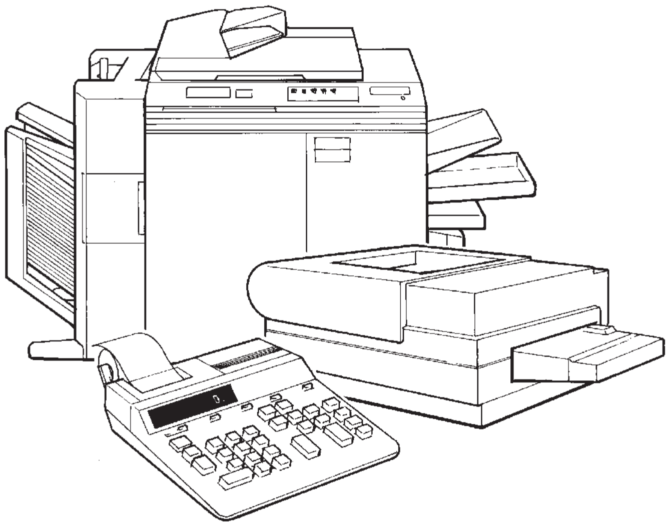
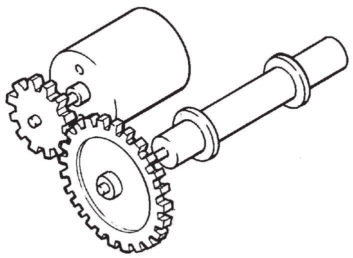
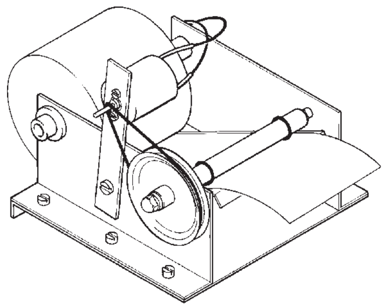
EXAMPLES OF THE USE OF PI

Pi (π) is a special number which is used very widely in engineering calculations. You can work it out by measuring the circumference of a drinks can (or anything circular) with a tape measure and then dividing this figure by the diameter of the can! The diameter goes into the circumference a little over three times. If you did this very accurately, you would come up with a figure of 3.141592654! For most purposes, though, we say 'π' is 3.142. (If we are talking technically, we say that π is a ratio between the circumference of a circle and its diameter. It is also a *constant* because it is always the same for a circle of any diameter.

As you may have noticed from other pages in 'maths help' such as *areas* and *volumes* , π is a very useful figure. Apart from enabling you to calculate some areas and volumes, it can be used in your design work to calculate the speed of something turning or running along. In technology it is important to note that these can never be left to chance or trial and error when designing something like a photocopier. Paper feed speeds can be predicted very accurately if, for example, you know the speed of the driving motor and the velocity ratio in a pulley or gear drive system.



Example 1. Paper feeder feed rate
This example shows how you can work out the speed of paper from a small paper feeder when the speed of the rubber driving wheels is known.

Assume a 10 tooth pinion gear on the motor spindle, a 60 tooth driven gear and 8 mm diameter wheels on the driving shaft.

$$\frac{\text{Speed of driven gear}}{\text{Speed of driver gear}} = \frac{\text{number of teeth on driver gear}}{\text{number of teeth on driven gear}}$$

$$\frac{\text{Speed of driven gear}}{1500 \text{ r.p.m.}} = \frac{10}{60}$$

$$\text{Speed of driven gear} = \frac{10 \times 1{,}500}{60} = 250 \text{ r.p.m.}$$

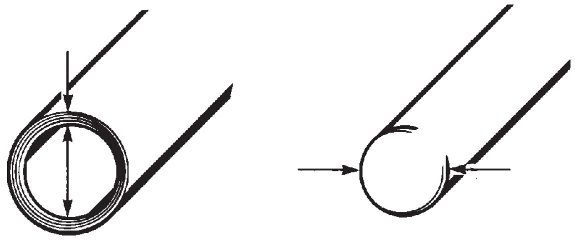
The driving wheels also rotate at 250 r.p.m. The paper feed speed is therefore:

250 × circumference of the 8 mm diameter drive wheels.

Circumference = $\pi d = 3.142 \times 8 = 25.1$ mm.
Paper feed speed is therefore 25.1 × 250 = 6275 mm/min.
This equals approximately 6.3 m/min or 105 mm/s.

Example 2. Length of paper needed for roll-tubes
This example shows how you can work out the length of paper needed for making a roll-tube. Roll-tubes are used in designing and making structures and can be bolted together.

Roll tube dimensions
The inside diameter (I/D) of a roll tube is the outside diameter (O/D) of the mandel - providing the tube is tightly wound.



The outside diameter of a roll tube depends on the number of turns of paper.

• For a required O/D of roll tube, the number of turns of paper required is given by:

No. turns = $\frac{\text{Required outside diameter - mandrel diameter}}{2}$ ÷ paper thickness

For example, **for a required O/D = 8 mm**, mandrel O/D = 5mm and paper thickness = 0.1 mm (ordinary photocopy paper):

Number of turns = $\frac{8 - 5}{2} \div 0.1$ mm = 15 turns.

• The *approximate* length of paper needed for a required O/D of roll tube is given by:

Length = no. turns × diameter of mandrel × π

For example, number of turns = 15, mandrel O/D = 15 mm:

Length = 15 × 15mm × 3.142 = 707 mm approximately.

• A closer approximation is given by:

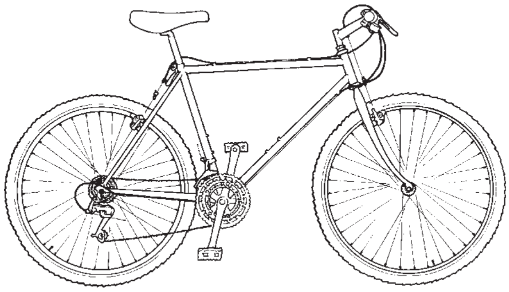
Length = no. of turns × average diameter of tube × π

E.g. no. of turns = 15, mandrel O/D = 15, tube O/D = 18

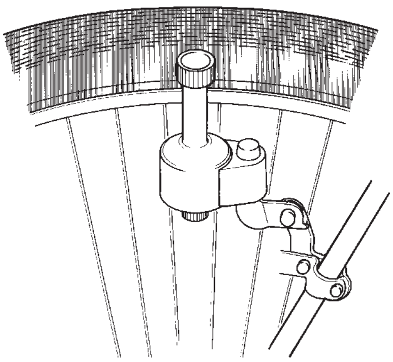
Length = 15 × 16.5 mm × π = 778 mm

Problems:

1. A cycle has wheels with a diameter of 60cms. How much ground will the cycle cover if the wheels revolve 100 times?



2. A cycle generator has to rotate at a minimum speed of 1000 rpm before it generates enough current to supply the lights. What is the minimum speed the cycle has to travel in metres per minute to operate the generator ? (The cycle wheels are 60cms in diameter and the friction wheel driving the generator is 15 mm in diameter.)



HISTORY NOTE

The name 'pi' was first given to this special number in 1706 by a mathematician called William Jones. At that time he could work out its value to about 30 decimal places. A modern computer can work it out to about one million decimal places! Such a large number, though, is of little practical value. Try it for yourself

$$\pi = 4[1-1/3+1/5-1/7+1/9-1/11+.........]$$

$$= 3.14159265389793238 46..$$

A simple approximation is 22/7 = 3.142857 but a better approximation is 355/113 = 3.1415929.