

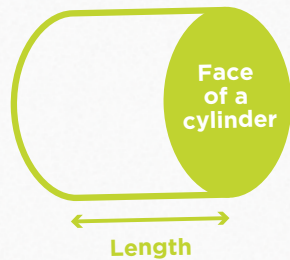
How much soil and rock needs to be excavated?



Our tunnels

Working it out

A tunnel is basically a large cylinder. The volume of a cylinder is found by multiplying the area of the face (a circle) by the length of the cylinder.



Pi (π) is used to calculate the area of the face. Pi is the ratio of a circle's circumference to its diameter. Regardless of the size of the circle, Pi is always the same number, approximately 3.14.

Area of face = $\text{Pi} (\pi) \times \text{radius}^2$

Or:

Area of face = $3.14 \times R \times R$

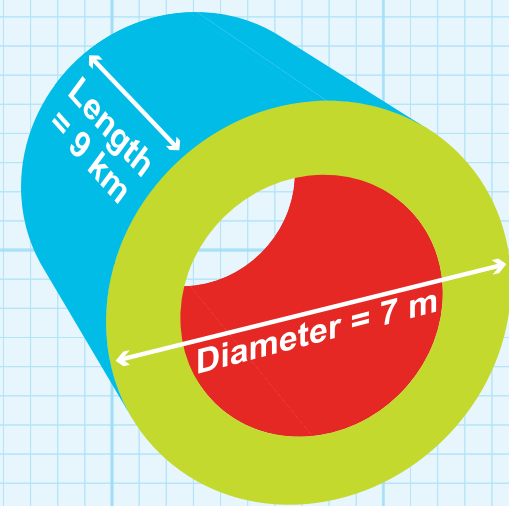
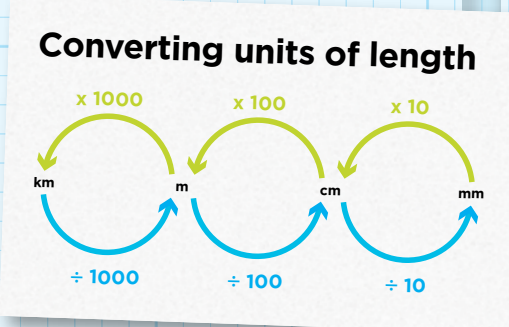
Volume of cylinder = Area of face \times Length of cylinder

Or:

Volume of cylinder = $\pi r^2 \times L$

Remember
There are **two** tunnels, one in each direction!

Note: The area and volume are in **metres**
The length of the tunnel is in **kilometres**



Find the radius
Radius = Diameter \div 2
Radius = _____ m

Area of the TBM face
Show your working out
Area = _____ m^2

Volume of the tunnels
Show your working out
Total volume of tunnels _____ m^3

About the Tunnel Boring Machine

Four giant Tunnel Boring Machines (TBMs) are needed to dig the Metro Tunnel.

BIG AND BEAUTIFUL
At 120 m long, the TBMs are as long as 3 E-Class trams end-to-end. They weigh a whopping 1,100 tonnes, equal to the weight of around 150 elephants.

ROCK AND ROLL
TBMs bore through a variety of ground conditions from hard rock to sand, and travel around 10 m a day. The amount of excavated material removed would fill the MCG 1.2 times!

HEAVE-HO
Up to 14 people work in each TBM at any one time. Workers in the TBM include the operator, who drives the TBM, as well as tunnel and electrical engineers.

HOME SWEET HOME
Each TBM is manned and monitored 24 hours a day, 7 days a week. It is fully equipped with facilities for staff, including an office, kitchen and toilets.

What is the total volume of all the stations and tunnels?
North Melbourne + Parkville + State Library + Town Hall + Anzac + Tunnels = ??? m^3

_____ + _____ + _____ + _____ + _____ + _____ = _____

3.14 x

Note: All dimensions provided are indicative for educational purposes only.