The FUTURES Channel®

MOVIE GUIDE

MOVIE NUMBER 5002

Tunnel Number 3

The Movie:

Go deep underground with an engineer as she works to ensure a continuous water supply for millions of people. Featured: Eileen Schnock, Chief Engineer, New York Department of Environmental Protection. *(Movie length: 2:45)*

Background:

The nine million residents of New York City require up to 1½ billion gallons of water a day. Currently this water is brought in through two tunnels that were built about 70 years ago. In order to do maintenance on those tunnels, another source of water must be provided, and thus was born the largest capital construction project in the history of New York City: City Tunnel Number 3.

Twenty-four hours a day, a giant boring machine cuts through the bedrock 800 feet below the city, moving forward slowly, but inevitably. Final completion of the tunnel, which is planned to eventually extend more than 60 miles, is many years in the future.

Curriculum Connections:

Measurement (distance, time, rate) 1

Eileen Schnock states that 5 miles worth of tunnel have been dug in around two years, working 24 hours a day. How many inches per hour is that?

Geometry (solids) 2

Tunnel #3 is to be lined with 1½ feet of concrete. To determine how much concrete would be required for one mile of the tunnel, carry out these two steps:

a) Compute the volume of a cylinder that is 19 feet in diameter and one mile (5,280 feet) long. This is the amount of concrete that would be required to fill the tunnel completely.

b) Compute the volume of a cylinder that is 16 feet in diameter and one mile long. This is the volume of the tunnel space that will remain inside the concrete liner.

c) Subtract (b) from (a). This gives the volume of the concrete lining only.

Measurement (volume) 3

How many cubic feet are in a cubic yard? Explain your answer with a diagram.

Geometry (solids), Measurement (volume) 4

In the movie, Eileen Schnock states that the tunnel being made is 19 feet in diameter, and that each day they carry about 10½ cubic yards of rock away. How much deeper would the tunnel have to get each day to produce 10½ cubic yards of rock?

Ratios 5

Temperature rises as you go deep into the ground, at a rate of 90° F per mile. Tunnel Number 3 is 800 feet below the surface. How much higher is the temperature in the tunnel than it is at the surface?

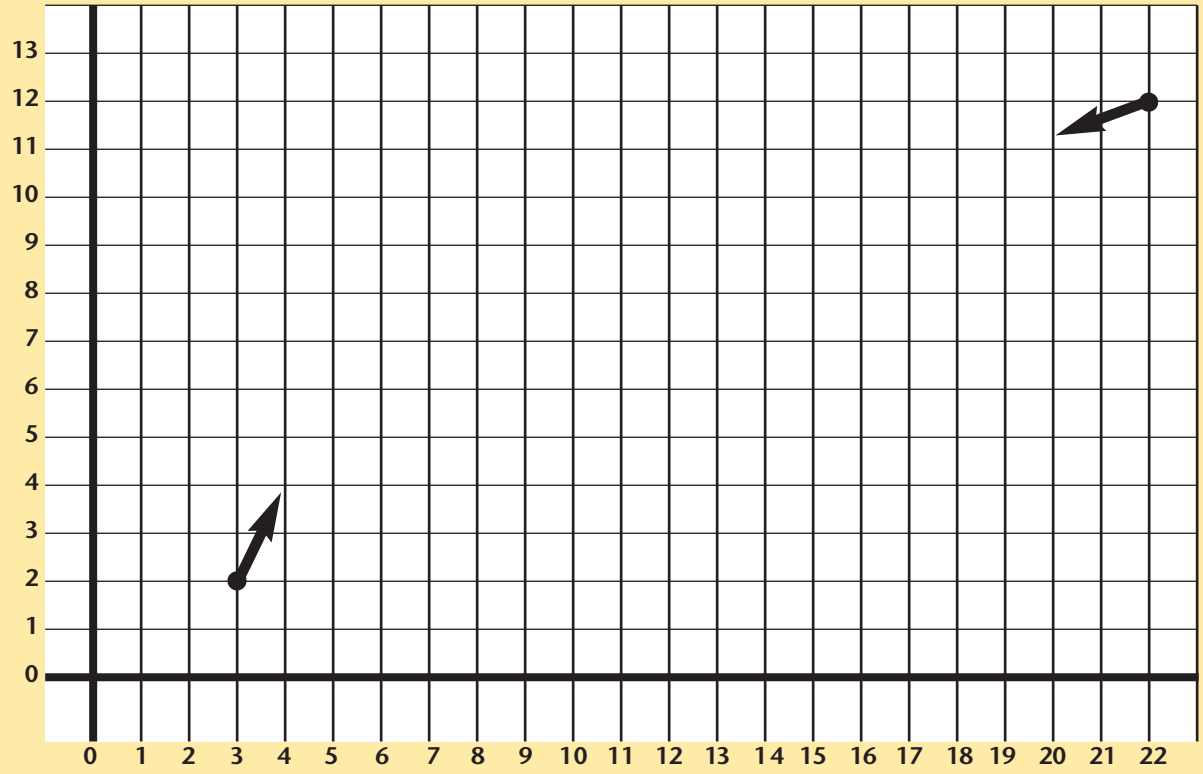
Algebra (linear equations) 6

Two teams are building tunnels. One starts at the point (3,2) and works towards the other on a line with a slope of 2.

The other team starts at the point (22,12) and works towards the first team on a line with a slope of 1/3:

Where will the teams meet?

What slopes should they choose for their lines of motion so that the resulting tunnel is one straight line?

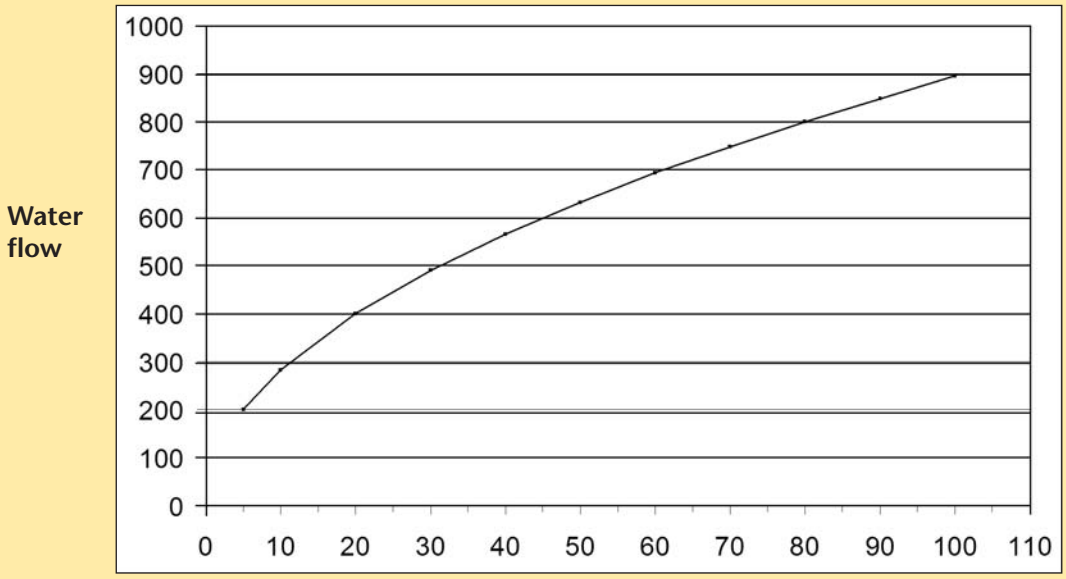


Measurement (energy) 7

A tunnel boring machine can have engines with a total power usage as high as 2,000 horsepower, or more. Convert this to BTU's per minute. If the water that is used to take away the heat generated by a tunnel-boring machine is raised in temperature by 40° F, how many gallons per minute of water flow is required to carry away that heat? (Recall that a BTU is the amount of heat energy required to raise one pound of water by one degree Fahrenheit.)

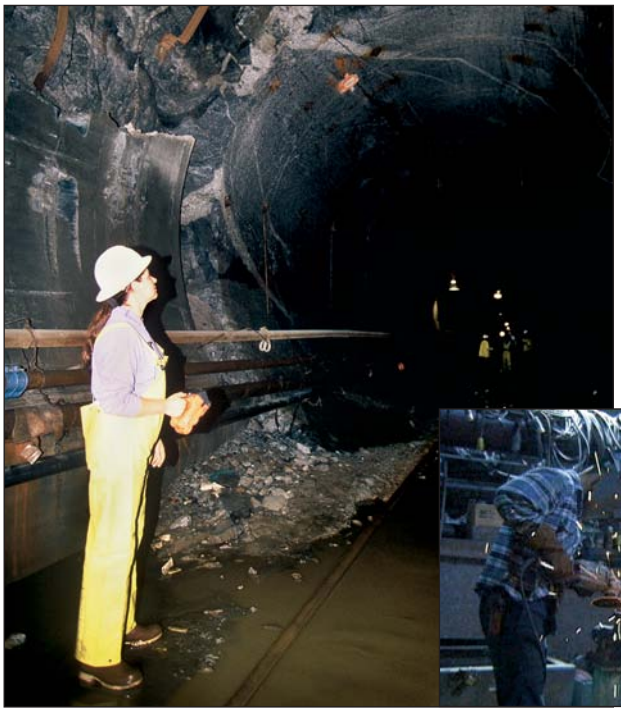
Algebra (functions) 8

When you apply higher pressure to push water through a pipe, you get a greater flow of water. This graph shows an example of that relationship:



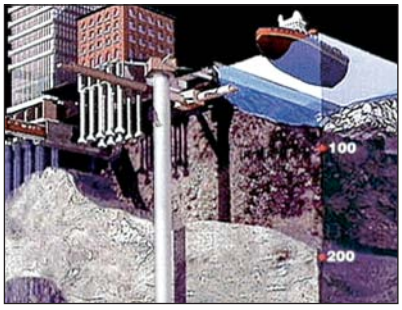
Determine which of these equations comes closest to representing the relationship between pressure (x) and flow (y), and find the value of ***a*** that gives a curve as similar as possible to that above.

$$y = ax$$
$$y = ax^2$$
$$y = ax^{1/2}$$



Ratios, Measurement (distance, weight) 9

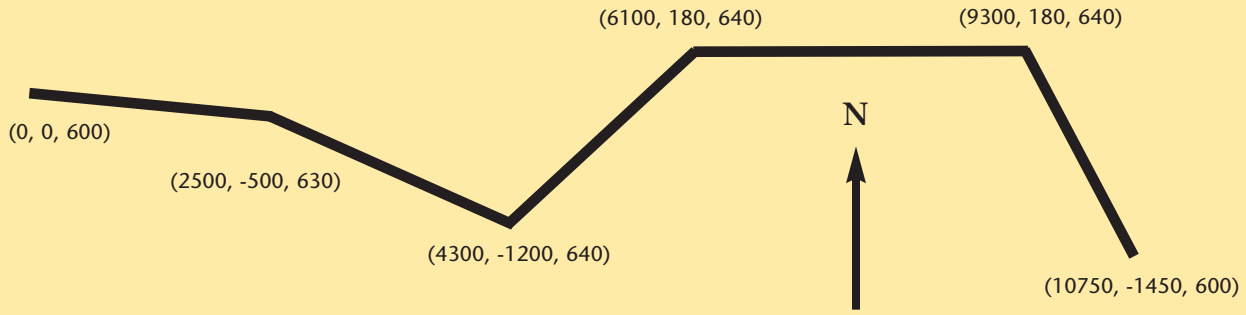
Rock weighs approximately 0.1 pounds per cubic inch. How many pounds of rock were lifted out of tunnel #3 during the time that its length increased by 5 miles? (Recall that the diameter of the tunnel is 19 feet.)



Algebra (coordinates) 10

This diagram shows the path of a tunnel. The numbers at the beginning, end, and turning points of the tunnel represent coordinates of those points, expressed as east-west distance from the starting point, north-south distance from the starting point, and depth.

All numbers refer to distances in feet. Find the total length of the tunnel.



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Water Supply, #5001	The water that comes out of your tap has traveled a long way to get there.
Water Tanks, #5006	Almost every building in New York City is topped by a water tank.
The New York City Subway, #5005	The New York City subway moves millions of people every day, thanks to the skills of a team of remarkable people.