Practice calculations

for drainlaying, plumbing and gasfitting scenarios

Remember trade calculations are used to find out real information. Relate the calculation to your on job experience.

HINTS

Follow the formula steps exactly.

Most errors in calculations are from confusing the measurement units,
e.g. mm with metres, or Joules with KiloJoules.

Check to see if your answer is feasible
(i.e. if your trade experience knows the material excavated from a trench is 1 truck load, being about $6m^3$, if your answer is $60m^3$ go back and check each step).

Read questions calmly and make sure you understand them completely before you answer.

Draw a sketch to help you "picture" the problem in your mind.

Underline or highlight all of the important information.

Check the units and convert to similar units.

When multiplying by the square of a number write it out in full and simply multiply all together, e.g. 8^2 write as 8×8.

To calculate the **area of a flat surface** use the equation

Area = length x width

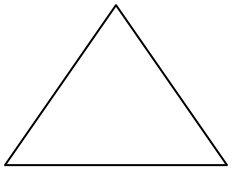
E.g. The area of a path 36 metres long and 1200 millimetres wide is?

First convert 1200mm into metres, 1.2m

Area = 1.2 x 36

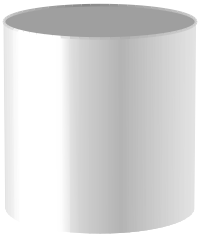
Area = 43.2m²

The **area of a triangle** = ½base x height



The **area of a circle** = 0.7854 x D²

The **volume of any tank** is the base area x the height



So for a **round septic tank** the base is the area of a circle, or 0.7854 x D²

times the height = volume.

Volume = 0.7854 x D² x H

The **volume of a rectangular septic tank**, Volume = Length x Width x Depth

If a tank was 3m long by 900mm wide by 1.2m deep

Once again volume = base area x height

Volume = 3 x .9 x 1.2 = 3.24

= m x m x m =m³

= 3.24m³

The volume of pipe is like a round tank

E.g. a 65mm diameter pipe at 6m long has a volume of:

Volume = 0.7854 x D^2 x H

Volume = 0.7854 x 0.065m x 0.065m x 6m

Volume = 0.0199m^3

This can be converted to litres by x 1000

Volume = 0.0199 m^3 x 1000

= 19 litres

HINT

A common mistake is forgetting to **square** the diameter.

To square a number means to multiply it by itself.

Writing out equations

Often it is useful to do equations with just the symbols as it helps you to understand what is happening. Then write in the numbers on the line directly below the symbols. See examples below.

(a) A = L x W

Then write in the numbers underneath the symbols.

Remember letters and symbols in the formula are simply numbers in code.

(b) If a tank was 1.2 m diameter and 1.5 m high the volume would be

Volume = 0.7854 x D^2 x H

Volume = 0.7854 x 1.2m x 1.2m x 1.5m

= 1.696 m^3

Transposing formula

The rule for transposing formula or isolating the unknown information is:

What you do to one side of an equation so you do to the other side.

E.g.

$4 \times 3 = 12$

Multiply by 2 $2 \times 4 \times 3 = 12 \times 2$

Divide by 6 $(2 \times 4 \times 3)/6 = (12 \times 2)/6$

Simplify each side $4 = 4$

As each equation started balanced and each change was balanced then the last equation is balanced!

Practice questions (SHOW ALL WORKING)

1) A drain is to be laid in level ground at a gradient of 1 in 40. Using the formula $F=1 \div G$ calculate the amount of fall in a trench which is 12 metres in length.

2) The invert level for the drain referred to in (1) at the sewer connection point is 3m below ground level. A vertical riser of 1.25 metres is provided at the sewer connection point to connect the drain to the sewer. State the invert level at the head of the drain assuming the building is on a level site.

Draw sketch before calculating

3) Calculate the average depth of a trench which is 30 metres long, 700 millimetres deep at the head of the trench and 1.8 metres deep at the invert level

4) Calculate the volume of the material to be removed from the trench as set out in Q3. The trench is to be 600 millimetres wide.

5) If the gradient of a drain is 1/20 what is this in percentage per metre.

6) If the gradient is 1.0% per metre what is the gradient in a ratio of 1: X

7) Calculate the square area of zincalume sheet required to make up a U-section tapered roof gutter that has the following measurements, make no allowance for stop ends or laps.

Length=3.9 metres

Width=300 millimetres

Depth (deep end) =280 millimetres

Depth (shallow end) =120 millimetres

Draw sketch before calculating

8. Discharge of water through pipes

Calculate the flow rate in litres / sec. at a tap if the head is 12m, the length of pipe is 20m, the pipe diameter is 20mm and the resistance to flow is 4m.

$$q = \sqrt{\frac{Hd^5}{25 \times L \times 10^5}}$$

In which q = discharge in litres per second (l/s)
H = head in metres
L = Length of pipe in metres
D = diameter of pipe in millimetres

9) (a) A cylindrical supply tank is to pass through a 550 millimetre square ceiling opening. The tank is to have a capacity of 200 litres.

Calculate the tank height using the formula:

Capacity = $0.7854 \times D^2 \times H \times 1000$

When there must be 25 millimetres clearance on all sides as it passes through the ceiling.

Where Capacity = capacity of cylinder
D = diameter of the cylinder
H = height of cylinder

10) Calculate the time it will take to heat 340 litres of water from 15°C to 65°C when the heat input is 17.280 Mj/hr and the thermal efficiency is 95%.

Time (hr) = mass of water (kg) x 4.2 x temperature difference (°C) x 100

Heat energy input per hour (kJ) x efficiency

Answer to the nearest minute.

11) What will be the water pressure at the outlet of a tap 30 metres below the water level in the water storage tank supplying the hot water heating system?

12) If a system has a head height of 8 metres what is the pressure at a tap 1.2 metres of the ground.

13) What is the capacity of a pipe in litres of 32 millimetres diameter and 4 metres in length.

(14) How many 10 millimetre pipes can be branched off from a 20 millimetre pipe, without there being a reduction in flow?

ANSWERS

1) A drain is to be laid in level ground at a gradient of 1 in 40. Using the formula F=1÷ G calculate the amount of fall in a trench which is 12 metres in length.

F = 1 ÷ 40 = .025 per metre

Total fall is 12 x 0.025 = 0.3 metres

2) The invert level for the drain referred to in (1) at the sewer connection point is 3m below ground level. A vertical riser of 1.25 metres is provided at the sewer connection point to connect the drain to the sewer. State the invert level at the head of the drain assuming the building is on a level site.

Draw sketch before calculating

Invert at vertical riser is 3m – 1.25m = 1.75m

Slope back to house rises 0.3 metres

So invert at the head of the drain is 1.75m - 0.3m = 1.45 metres underground

3) Calculate the average depth of a trench which is 30 metres long, 700 millimetres deep at the head of the trench and 1.8 metres deep at the invert level

Average depth is (.7m + 1.8m)÷2 = 1.25 metres

4) Calculate the volume of the material to be removed from the trench as set out in Q3. The trench is to be 600 millimetres wide.

Volume = length x depth x width

= 30m x 1.25m x .6m

= 22.5m³

5) If the gradient of a drain is 1/20 what is this in percentage per metre.

Percentage is (1 ÷ 20) x 100 = 5%

6) If the gradient is 1.0% per metre what is the gradient in a ratio of 1: X

Equations is (1 ÷ X) x 100 = 1

Divide by 100 1 ÷ X = 1/100

Times each side by X 1 = X 1/100

Divide by 1/100 1 ÷ 1/100 = X

X = 100

So gradient in a ratio is 1:100

7) Calculate the square area of zincalume sheet required to make up a U-section tapered roof gutter that has the following measurements, make no allowance for stop ends or laps.

Length=3.9 metres

Width=300 millimetres

Depth (deep end) =280 millimetres

Depth (shallow end) =120 millimetres

Draw sketch before calculating

Average height is (280+120)÷ 2 = 200mm

Sides are avg height x length x 2 = 0.2m x 3.9m x 2 = 1.56 m²

Bottom is width x length = .3m x 3.9m = 1.17 m²

Total is 1.17 m² + 1.56 m² = 2.73 m²

8. Discharge of water through pipes

Calculate the flow rate in litres/sec at a tap if the head is 12m, the length of pipe is 20m, the pipe diameter is 20mm and the resistance to flow is 4m.

$$q = \sqrt{\frac{Hd^5}{25 \times L \times 10^5}}$$

Q = √Hd.d.d.d.d ÷ 25 x 24 x 10.10.10.10.10

(flow rate Q = √ head x pipe diameter to the 5th power ÷ 25 x length including resistance x 10 to the 5th power)

Q = √Hd.d.d.d.d ÷ 25 x 24 x 10.10.10.10.10

$$Q = \sqrt{\frac{12 \times 20.20.20.20.20}{25 \times 24 \times 10.10.10.10.10}}$$

Q = √12 x 2.2.2.2.2 ÷ 25 x 24

Q = √0.64

Q = 0.8 litres/sec

9) (a) A cylindrical supply tank is to pass through a 550 millimetre square ceiling opening. The tank is to have a capacity of 200 litres.

Calculate the tank height using the formula.

Capacity = 0.7854 x D² x H x 1000

When there must be 25 millimetres clearance on all sides as it passes through the ceiling.

Capacity = capacity of cylinder
D = diameter of the cylinder
H = height of cylinder

Equation is 200L = 0.7854 x (0.5m)² x 1000 x H

Divide both sides by 0.7854, (0.5m)² and 1000

200L ÷ (0.7854 x (0.5m)² x 1000) = H

So H is H = 1.02m

10) Calculate the time it will take to heat 340 litres of water from 15°C to 65°C when the heat input is 17.280 Mj/hr and the thermal efficiency is 95%.

Time (hr) = $\frac{\text{mass of water (kg) x 4.2 x temperature difference (°C) x 100}}{\text{Heat energy input per hour (kJ) x efficiency}}$

Answer to the nearest minute.

Equation is Time (hr)= (340kg x 4.2 x (65-15) x 100) ÷ (17.280Mj/hr x .95)

Time (hr)= 7 140 000 ÷ (17 280 x 95)

Time (hr)= 4.35

0.35 x 60 = 21mins

Time = 4 hours and 21 mins

11) What will be the water pressure at the outlet of a tap 30 metres below the water level in the water storage tank supplying the hot water heating system?

kPa = head height (m) x 9.81 kPa/metres of head

kPa = 30 x 9.81

kPa = 294.3

12) If a system has a head height of 8 metres what is the pressure at a tap 1.2 metres off the ground.

kPa = (8m-1.2m) x 9.81 kPa/ metres of head

kPa = 66.7

13) What is the capacity of a pipe in litres of 32 millimetres diameter and 4 metres in length?

Capacity = 0.7854 x D^2 x L x 1000

= 0.7854 x $(.032m)^2$ x 4m x 1000

Capacity = 3.22m^2

(14) How many 10 millimetre pipes can be branched off from a 20 millimetre pipe, without there being a reduction in flow?

$N = \sqrt{\left(\frac{D}{d}\right)^5}$

i.e. N = √ (D ÷ d) x (D ÷ d) x (D ÷ d) x (D ÷ d) x (D ÷ d)

N = √ (20 ÷ 10) x (20 ÷ 10) x (20 ÷ 10) x (20 ÷ 10) x (20 ÷ 10)

N = √ (2 x 2 x 2 x 2 x 2)

N = √32

N = 5.66