Unit 203: Scientific principles for domestic, industrial and commercial plumbing

Outcome 3
Pressure, force and flow of water

Pressure, force and flow of water

SI units of pressure, force and flow

Velocity	Metres per second	m/s
Acceleration	Meters per second squared	m/s^2
Flow rate	Litres per second/minute	l/s or l/m
Force	Newtons	N
Pressure	Pascal (N/m^2)	Pa

Pressure, force and flow of water

Velocity
The rate at which an object changes its position, taking into account speed and direction (m/s).

Acceleration
The rate at which an object increases its velocity.

Acceleration due to gravity
Gravitational pull of 9.81m/s (gravity is 9.81KN/m^2).

Flow rate
The amount of fluid that flows through a pipe at a given time.

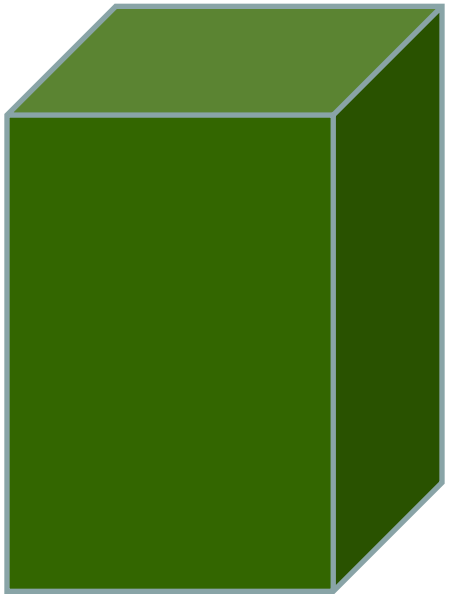
Force
An influence on an object that may cause it to move (N)+.

Pressure, force and flow of water

Pressure

This is the force per area.

Look at this CWSC – both are the same size.
Which is exerting the greatest pressure on the floor? Why?
Which is exerting the least pressure on the floor? Why?

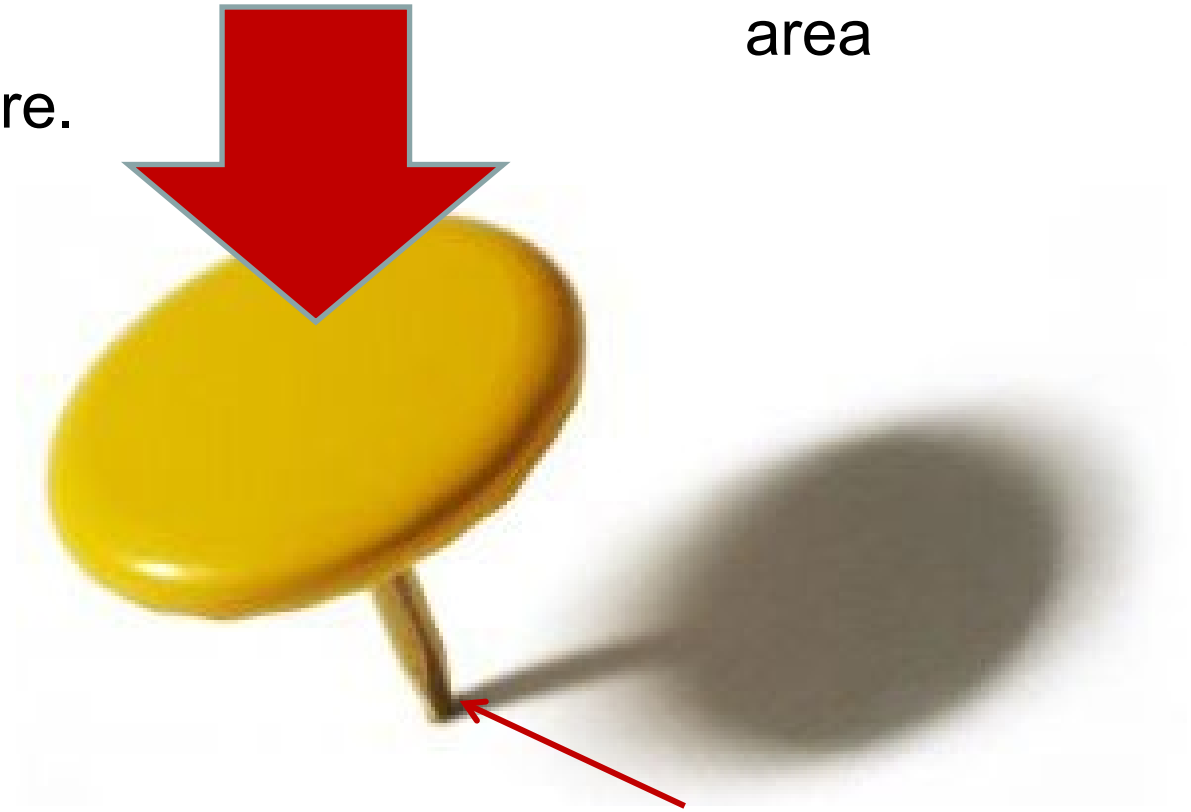


Pressure, force and flow of water

Your thumb pushes down on a large area – low pressure.

Pressure is $\frac{\text{force}}{\text{area}}$ = N/m^2

Pascal = N/m^2

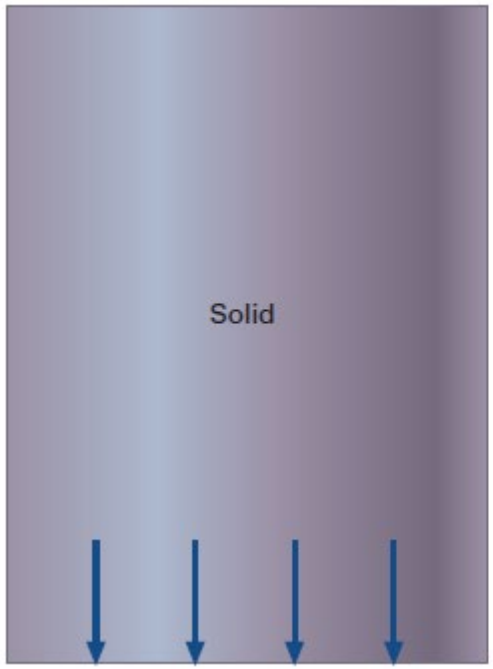


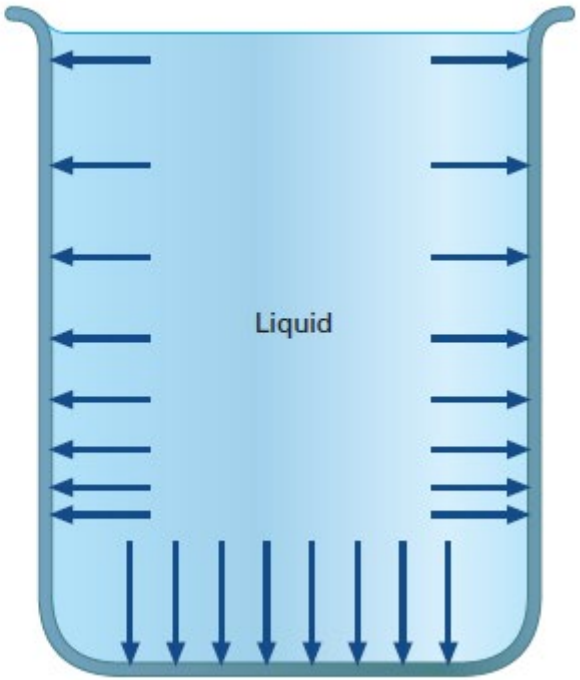
The resultant force on the sharp pin head is high pressure.

Pressure, force and flow of water

The pressure exerted by a solid object is in a downward direction only.

The pressure exerted by a liquid is not only downwards, but outwards as well.

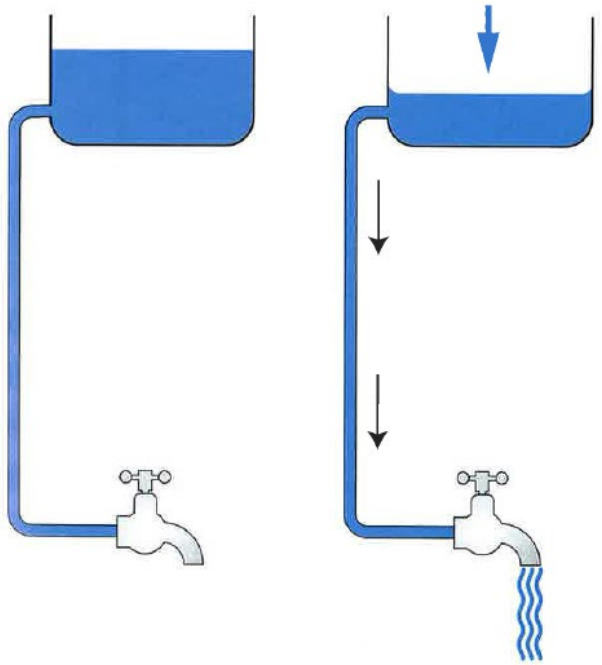




Pressure, force and flow of water

Pressure

Static pressure: water is stationary
Dynamic pressure: water is flowing



Both are worked out the same way:

Head height x 9.81(gravity)
= Intensity of Pressure N/m^2

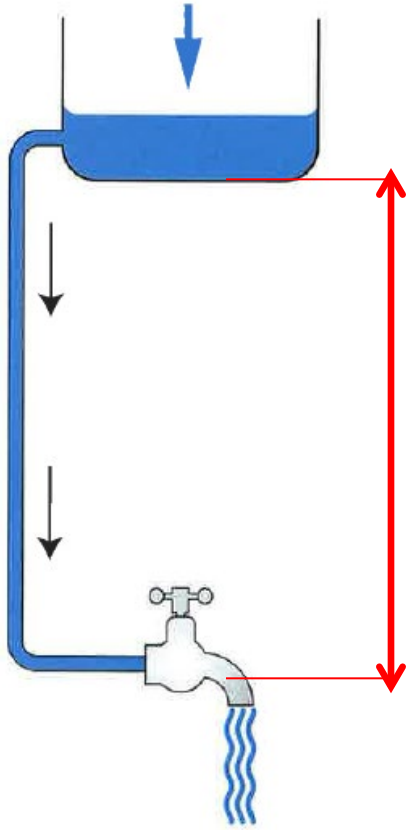
What would the IoP be if the head height was 6m?

If the IoP was 78.48N/m^2 what is the head height?

Pressure, force and flow of water

Pressure: the greater the head, the greater the pressure.

Kilopascals kPa	Bar	Meters head
10	**0.1**	**1**
20	0.2	2
30	0.3	3
40	0.4	4
50	0.5	5
100	**1.0**	**10**
150	1.5	15
200	2.O	20
250	2.5	25



Pressure, force and flow of water

Pressure

Atmospheric pressure is exerted by the atmosphere onto every object.

At sea level, atmospheric pressure is 101.3kPa; below sea level it increases and above sea level it decreases.

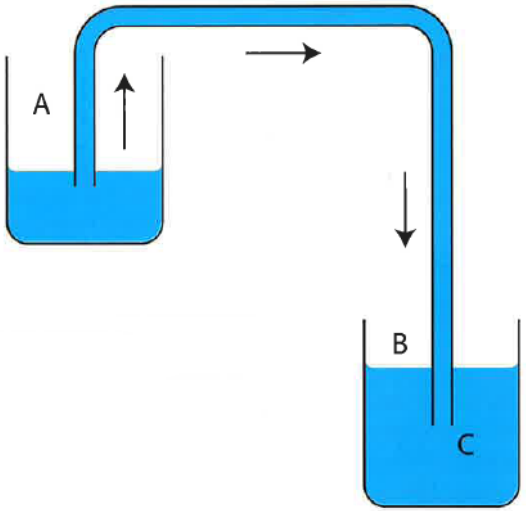
Siphonic action happens due to atmospheric pressure; this is how many WCs flush.

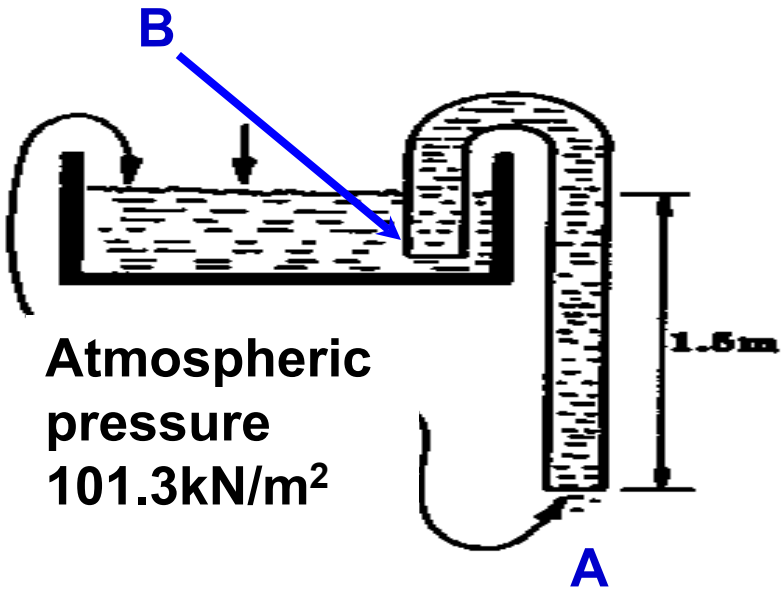
Pressure, force and flow of water

Pressure

Siphonic action happens due to atmospheric pressure.
Both cisterns have atmospheric pressure acting on them.
The lower beaker has greater pressure because it is lower.

When suction is applied at point C, water will flow upwards from beaker A, over the weir and down to beaker B.



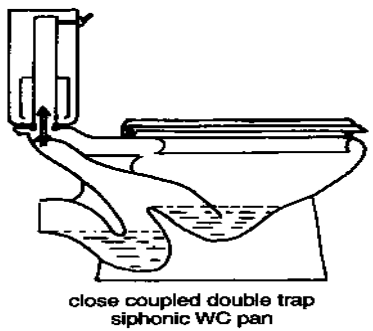


Atmospheric pressure is constant.

- The pressure at point B is below atmospheric pressure.
- The pressure at point A is
- above atmospheric pressure.

The pressure pushing down is:
Atmospheric pressure + the water in the leg of the tube @9.81kN/m^2 per 1m head is acting at point A

Atmospheric pressure = 101.3kN/m^2
plus 1.5 x 9.81 = 14.7kN/m^2
101.3 + 14.7 = 116kN/m^2

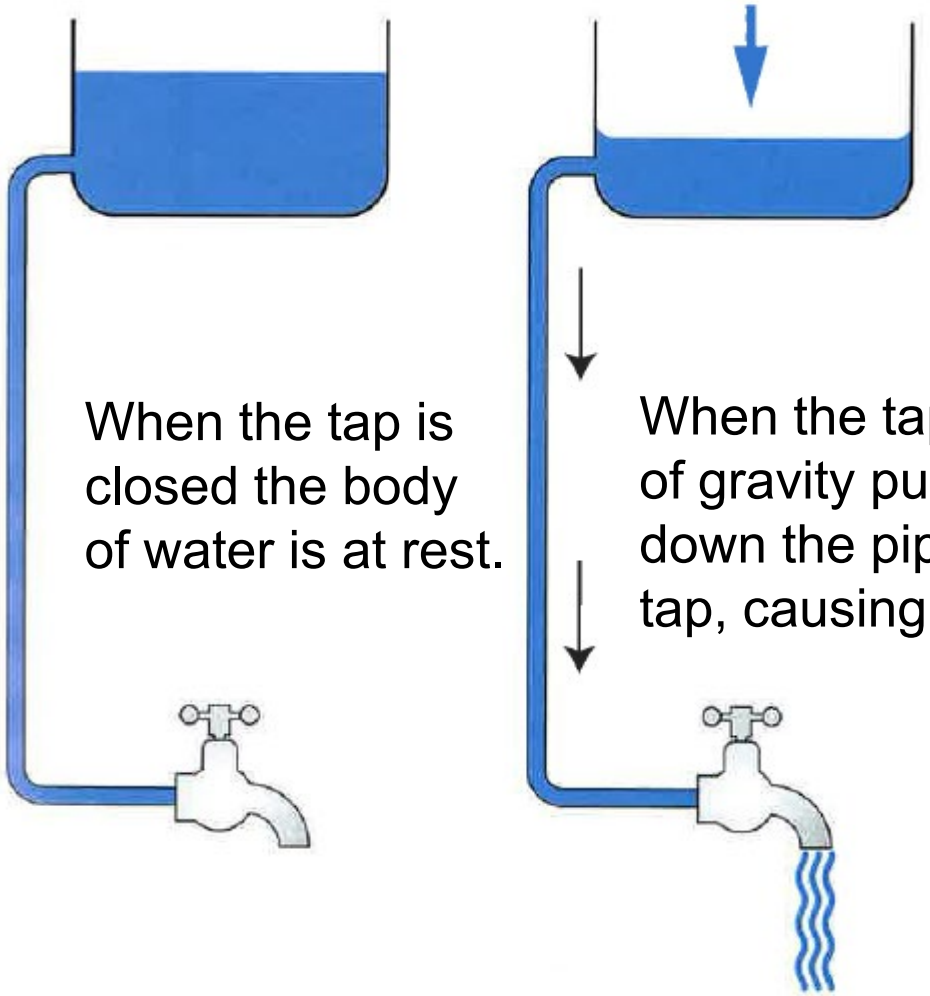

close coupled double trap siphonic WC pan

As there is only 101.3kn/m^2 pushing up, the greater force is pushing down.

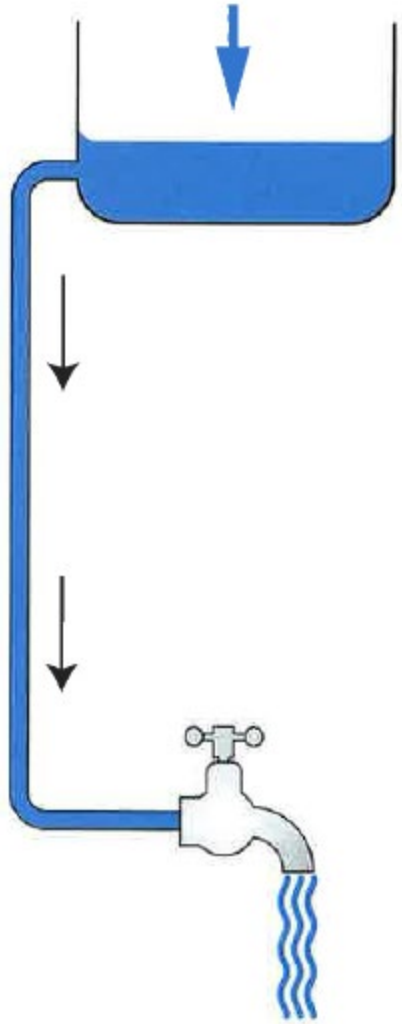
Pressure, force and flow of water

Force

An influence on an object that may cause it to move.



Pressure, force and flow of water



1 litre of water = 1kg

If the cistern holds 40 litres of water, you can work out the force of water leaving the tap.

40kg x 9.81m/s gravity = 392N

Pressure, force and flow of water

Force

If you reduce the pipe diameter, like on this garden hose, the speed increases and the water shoots out further, but the pressure and flow rate have reduced.

Pressure, force and flow of water

Flow rate

The amount of fluid that flows through a pipe at a given time.

Flow rate can be affected by many factors:

- Changes in direction
- Pipe size
- Pressure
- Length of pipe
- Frictional resistance
- Constrictions.

Pressure, force and flow of water

Changes in direction
This will offer resistance to the flow of water. 1 elbow is equivalent to 0.37m of pipe. So 10 elbows = 3.7m.
A machine bend is only equivalent to 0.26m of pipe (because it sweeps).

Pipe size: the larger the pipe, the more water can flow.
Pressure: the greater the pressure, the greater the flow rate.
Pipe length: the flow rate reduces as length increases, due to the frictional resistance of the pipe walls.
Frictional resistance: different materials have different resistance. Polybutylene is smooth; galvanised LCS is rough.
Constrictions: valves and taps offer a lot of resistance.

Pressure, force and flow of water

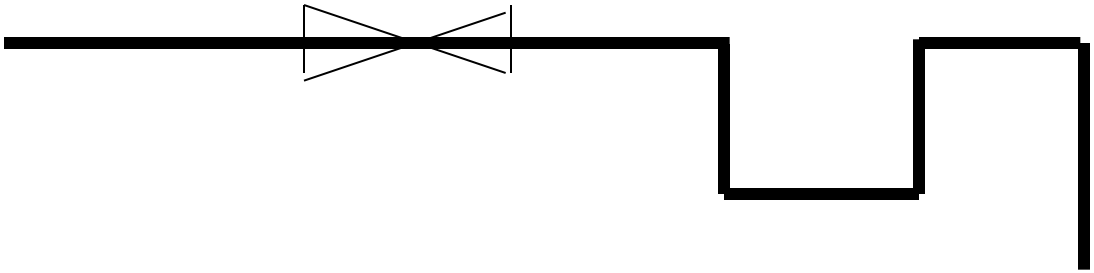
Changes in pipework

If an appliance requires an increase in the flow rate, the elbows should be removed and replaced by machined bends, as this will ease the restriction.

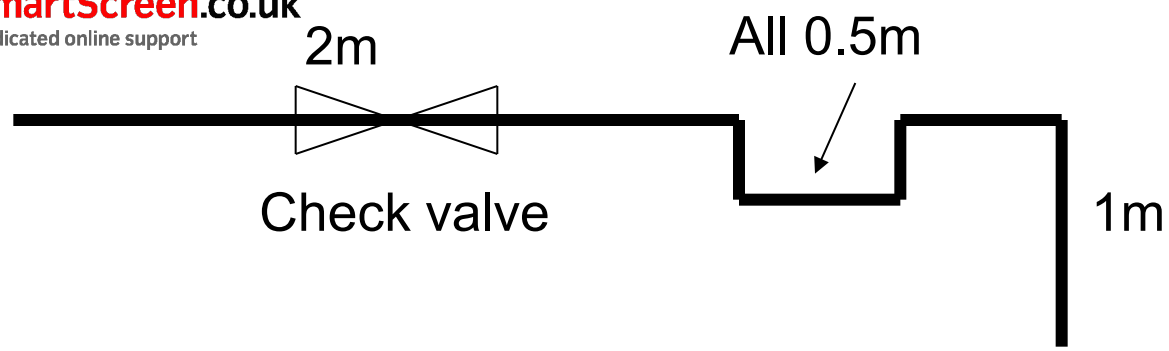
The pipe diameter can be increased, to increase the velocity of the water, which is commonly the case for a bath feed compared to a basin feed.

Pressure, force and flow of water

What is the resistance of the pipework if you use elbows?
What is the resistance of the pipework if you use machine bends?



Elbow	0.5m
Tee	0.6m
Stop valve	4.0m
Check valve	2.5m
Pulled bend	0.3m



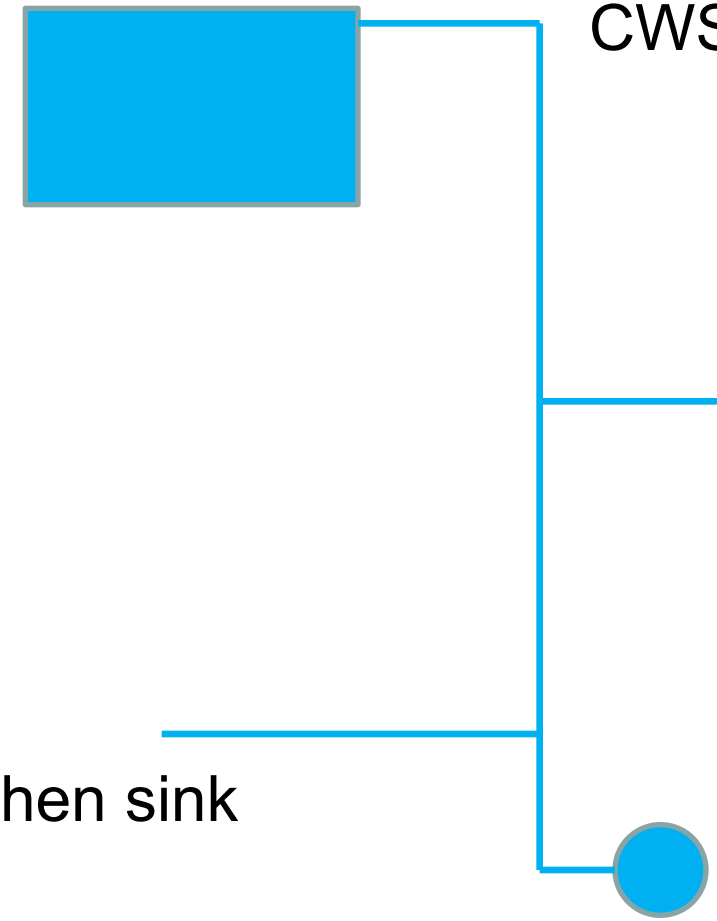
Firstly, we will work out resistance if we used elbows, then if we used pulled bends.

1. Number of corners 5 x 0.5 = 2.5
2. Number of valves 1 x 2.5 = 2.5
3. Length of pipe 2 + (0.5 x 4) + 1 = 5.0 **Total = 10m**

1. Number of corners 5 x 0.3 = 1.5
2. Number of valves 1 x 2.5 = 2.5
3. Length of pipe 2 + (0.5 x 4) + 1 = 5.0 **Total = 9m**

Pressure, force and flow of water

In a property

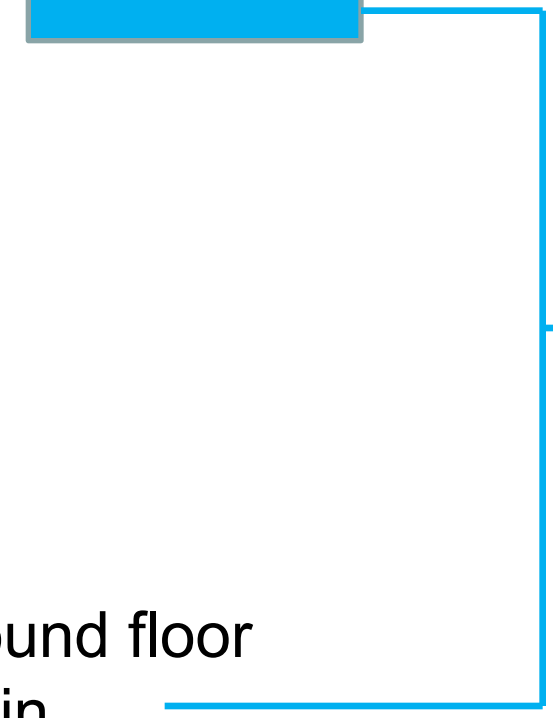


The incoming main and rising main to a property.

Discuss where you think the pressure is the highest and why.

Pressure, force and flow of water

In a property



The cold distribution, fed from the CWSC in the loft.

Discuss where you think the pressure is the highest and why.