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STEM

Lock Design

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Objectives

1. Describe what **water pressure** is.
2. Understand one key feature of **water pressure.**
3. Apply the concept of water pressure to the challenges of **designing a canal lock.**

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What is water pressure?

Water pressure is the **force applied by water** on its surroundings. It applies this force **because of its weight.**

Do your ears sometimes hurt when you **dive down** too deep?

What does it feel like to **dive to the bottom** of a deep pool?

Does water **weigh** anything?

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The Experiment: Investigating water pressure

1. Fill a bottle with water to the green line
2. Use a stopwatch to time 10 seconds
3. Position the bottle over a jug
4. Open the cap and time how much water escapes in 10 seconds
5. Record the volume of water that escaped on the results table
6. Repeat the experiment 3 times

Do you think the **amount of water** that **escapes** each time will be the **same**? Why?

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Results

What did you find?

As the depth of water increases, water pressure increases. WHY?

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Water has a **weight**
- so as the **depth**
increases
so does the weight.

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Water pressure formula

Pressure(Pa) =

Height of water (m)
x Density of fluid (kg/m^3)
x Gravity (m/s^2)

(Density of water= 1,000kg/m^3)

(Gravity=9.8m/s^2)

Do you think the amount of water that escapes will be the same? Why?

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Real life examples – Bath Deep Lock

Can you work out the **water pressure** using the **formula**?

Water depth 5.9m

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Real life examples – Wolverley Court Lock

Can you work out the **water pressure** using the **formula**?

Water depth 1.82m

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Real life examples

Remember to check your units!

Answers

Pressure = density x gravity x height

Bath Deep Lock Pressure:
= 1,000 x 9.8 x 5.9
= 57,820 Pa

Wolverley Court Lock Pressure:
= 1,000 x 9.8 x 1.82
= 17,836 Pa

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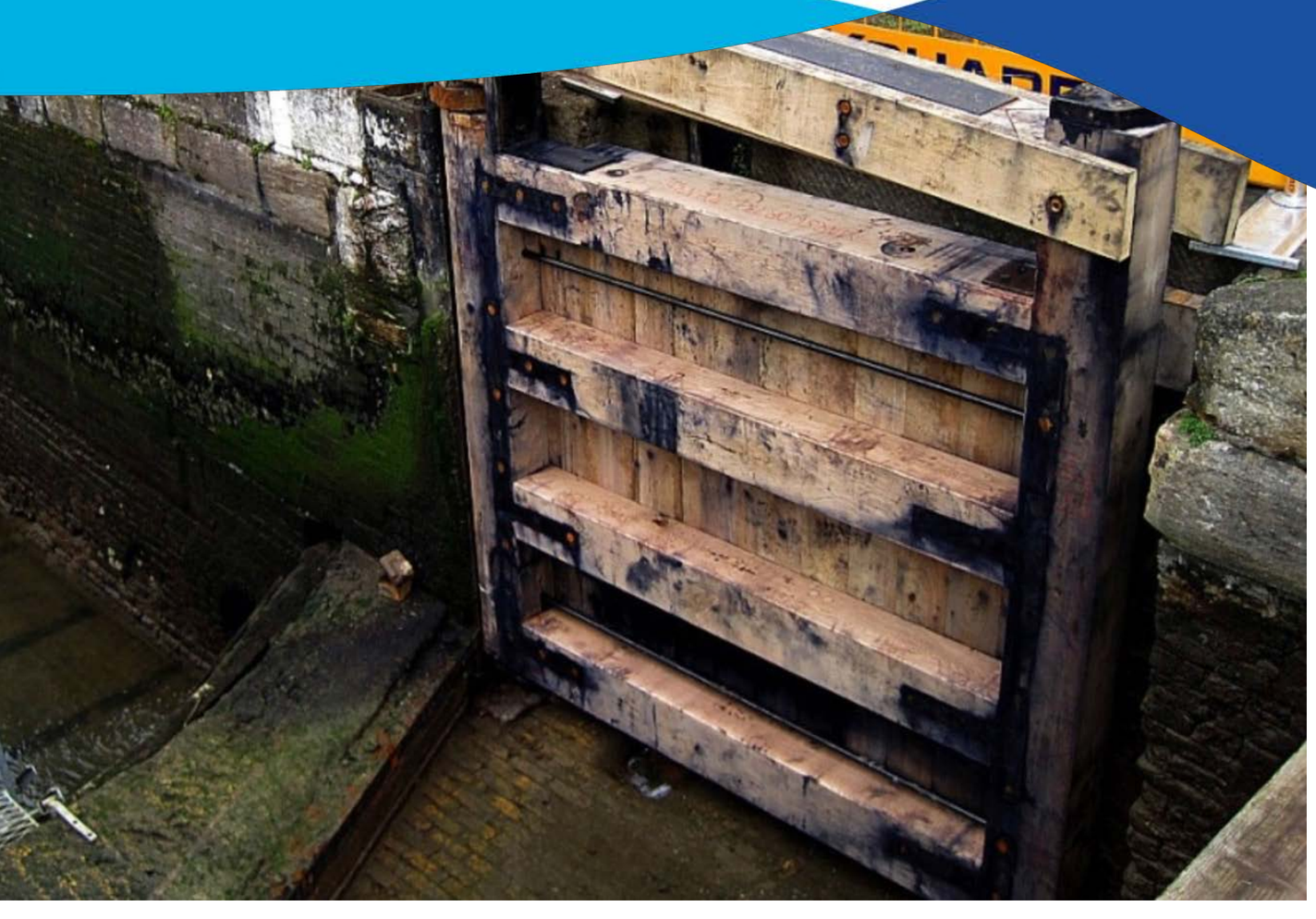
What does this mean for engineering?



What **key features** are involved in a lock gate?

Robust construction – **thick** wood and **strong** bolts

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What have you learnt about water pressure?

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What did you discover?

- What is **water pressure**?
- **Describe** one of the key features of water pressure.
- What could this mean for **designing canal locks**?

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Extension activities

Drainage time

Looking at lock gate design

Plotting results on a graph

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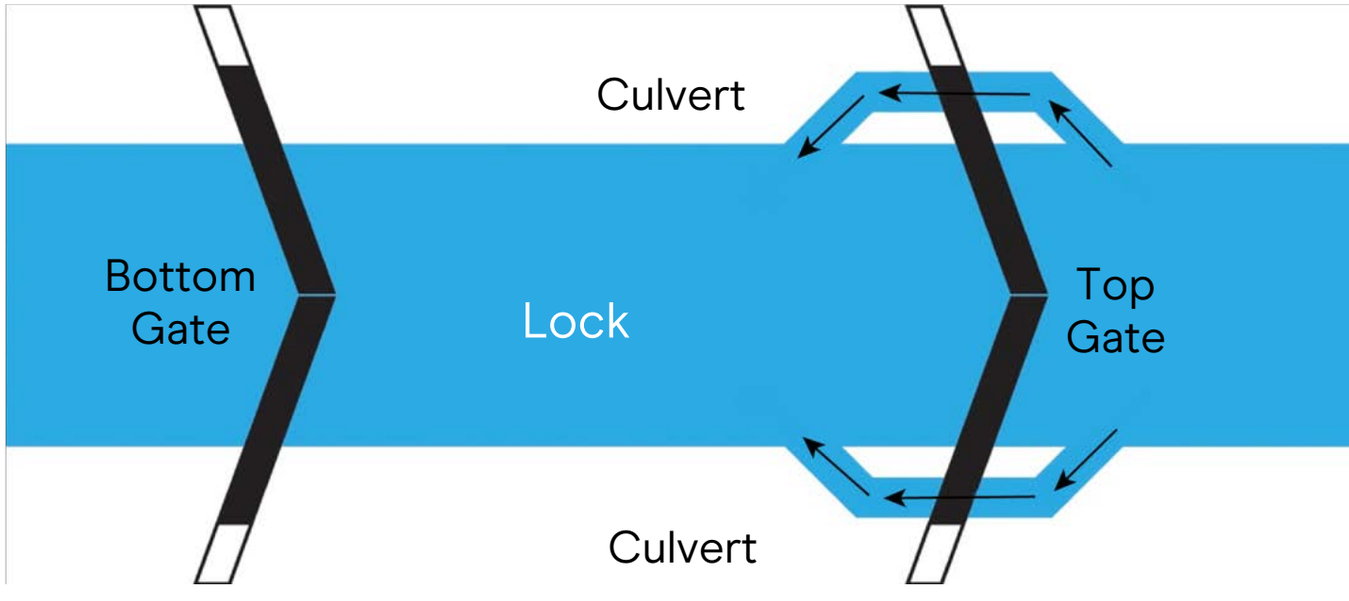
Mitre gates

Why do the **lock gates** in the diagram **meet at an angle**?

View from above

- Miter gates are designed so that they are held closed by the pressure of water at a higher level.
- A small difference in depth between the lock and the canal means there is a difference in water pressure.
- This exerts a force on the gates, securely holding them together as the lock fills.



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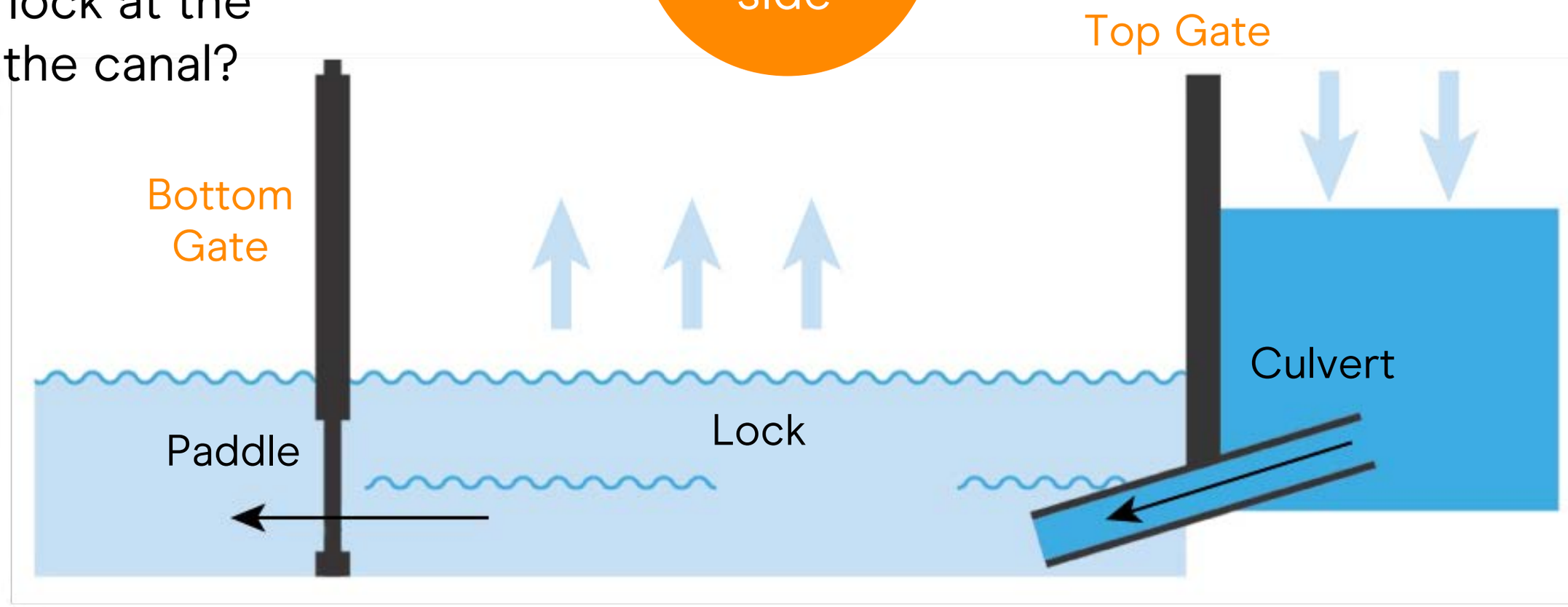
Mitre gates

Greater depth = greater pressure so the lock fills and empties more quickly

Why put the **culvert to fill** the lock and the **paddle to empty** the lock at the **bottom** of the canal?

View from the side



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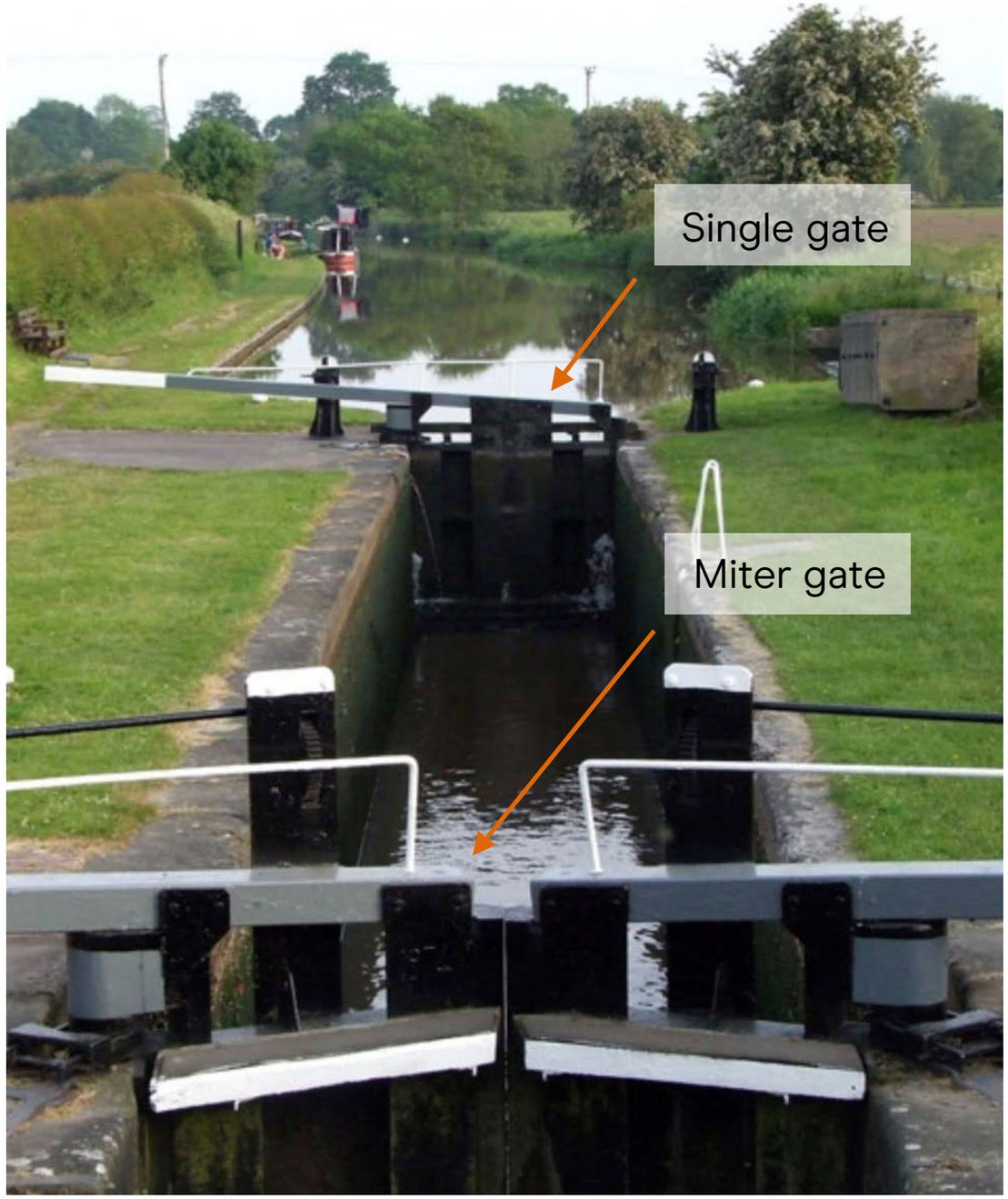
Lock gate design

Some lock gates don't use the Miter Gate format, they use a single gate.

Why do you think this is? When would you use a single gate?

- **Cost** - a single gate is cheaper to make, install and maintain
- **Easier and quicker** - you only need people to open one gate
- **Narrow locks** - smaller lock gates are required
- **Upper Chamber** - on the top end the gate is shallower and weighs less



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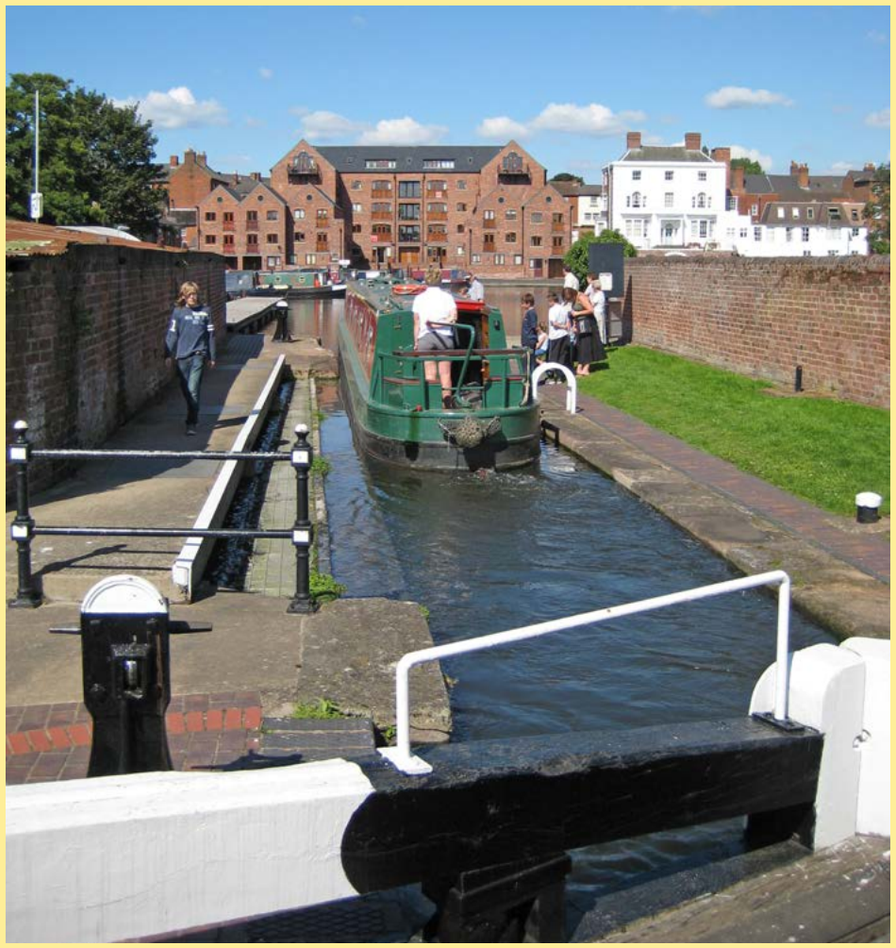
Plenary



Discuss in pairs one thing you have learnt in this activity.

Can you relate this to any other real-life examples?

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