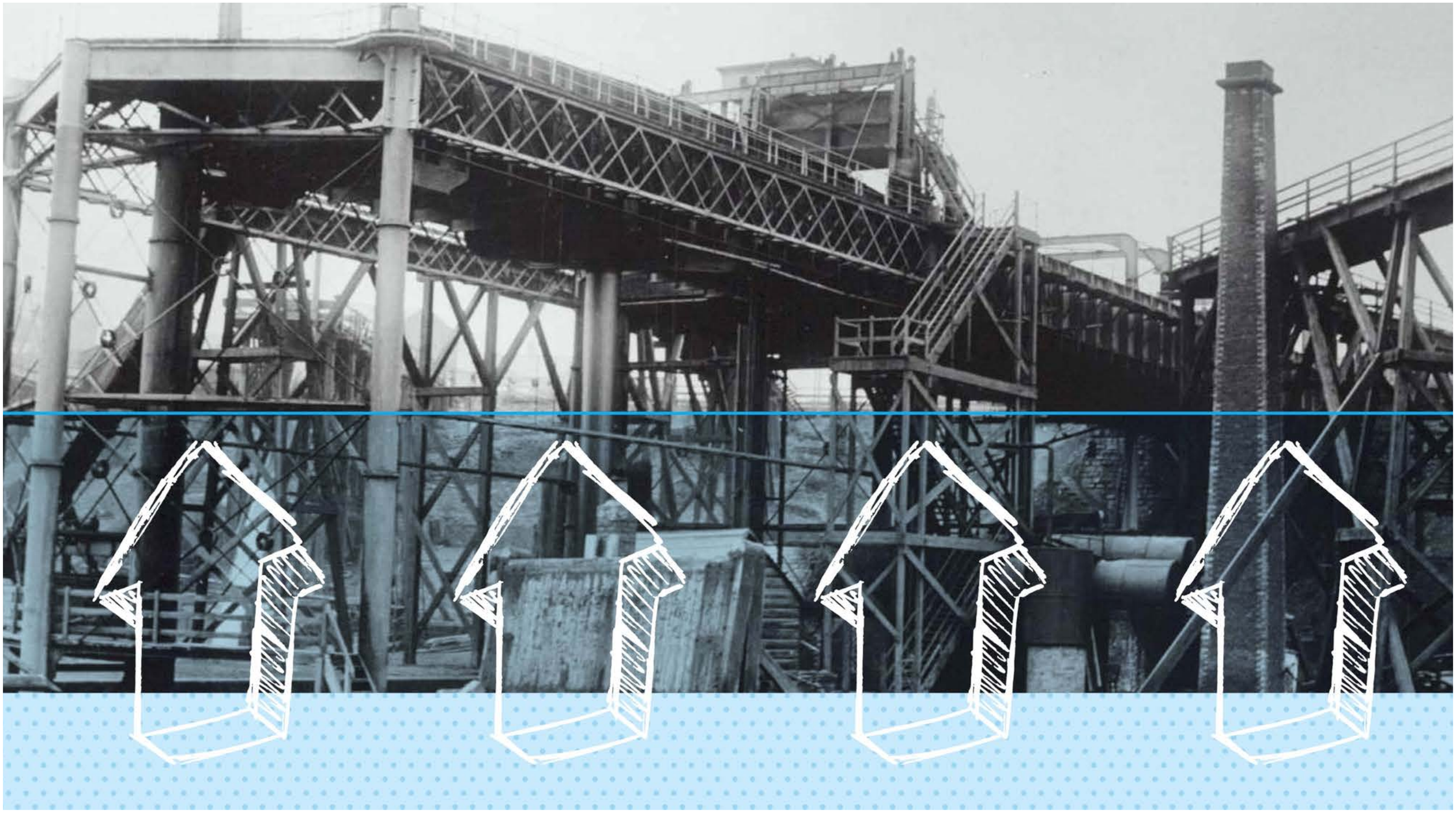
Canal & River Trust

STEM

Boat Lift



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Objectives

- Describe what **hydraulics** are.
- Understand how **Pascal's Principle** works.
- **Apply the concept** of Pascal's Principle to the design of a boat lift.

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Strength test

Who can **squash** this bottle filled with water?

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Properties of liquids

- An important property of many liquids is that they are **incompressible.**
- As they have a fixed volume they can’t be squashed.

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What are Hydraulics?

Hydraulic systems use an **incompressible fluid**, such as **oil** or **water**, to **transmit force** from one location to another within the fluid.

Pascal's Principle - in an **enclosed system**, as **the liquid** in the pipe is **incompressible**, **pressure stays constant** throughout the system.

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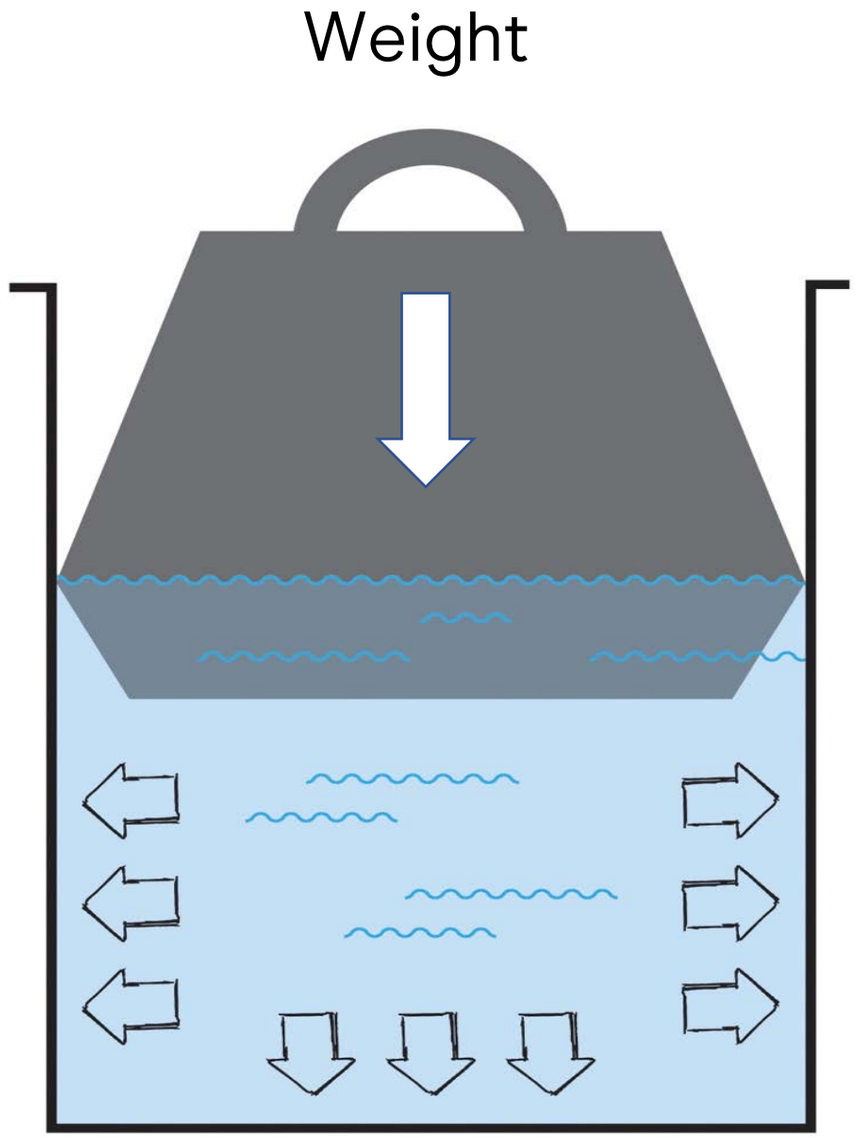
Transferring pressure

- It is possible to transmit a force through liquid by **applying pressure** on one side.

- This pressure is then **equally dispersed** on all the sides.



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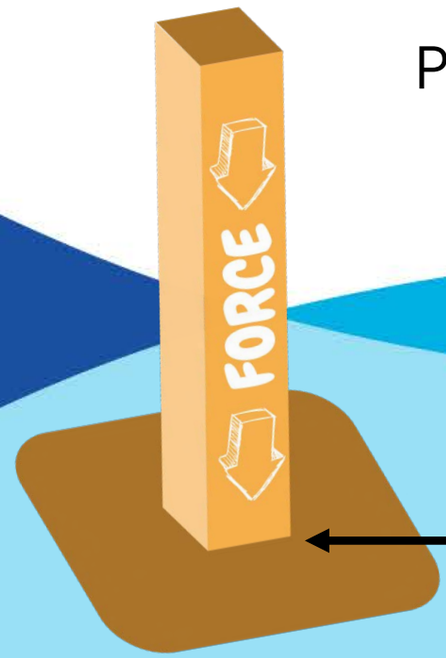
Pressure & force

Pressure is the **force** exerted over the **area** that the force acts on.

$$\text{Pressure} = \frac{\text{FORCE}}{\text{AREA}}$$



Which exerts more pressure on the ground?

A. a person in wellington boots

B. a person in heels

A

B

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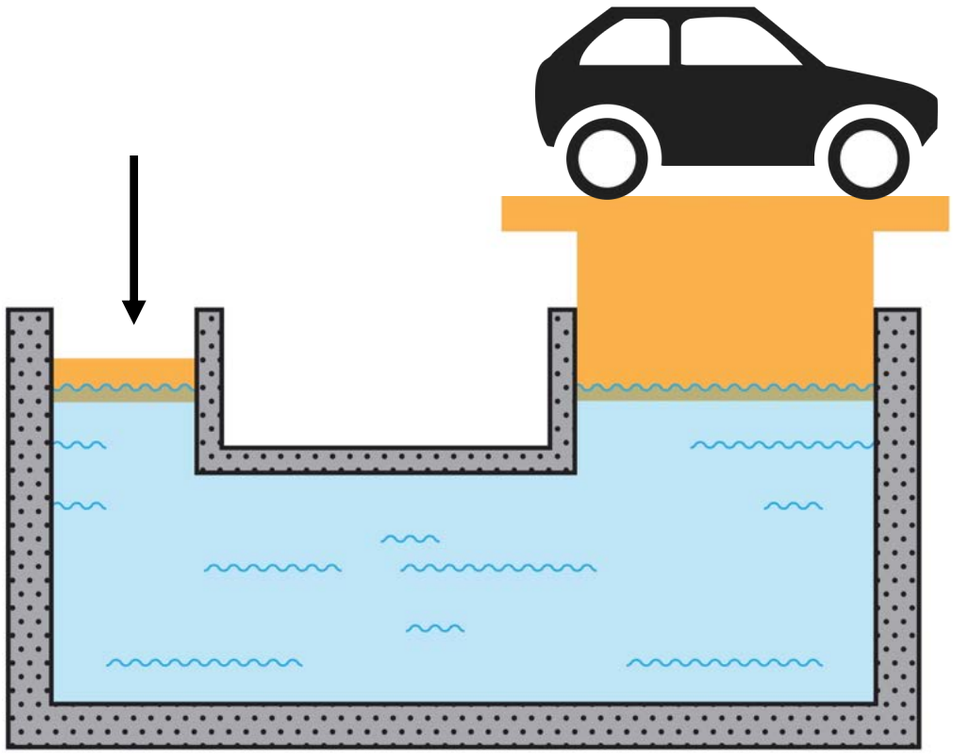
Hydraulics - Pascal's principle & force



If we press down with **a small force** on a **small area** at the left of the tube, there will be a **large force acting upward** on the larger area to keep the pressure equal.

The force is magnified.

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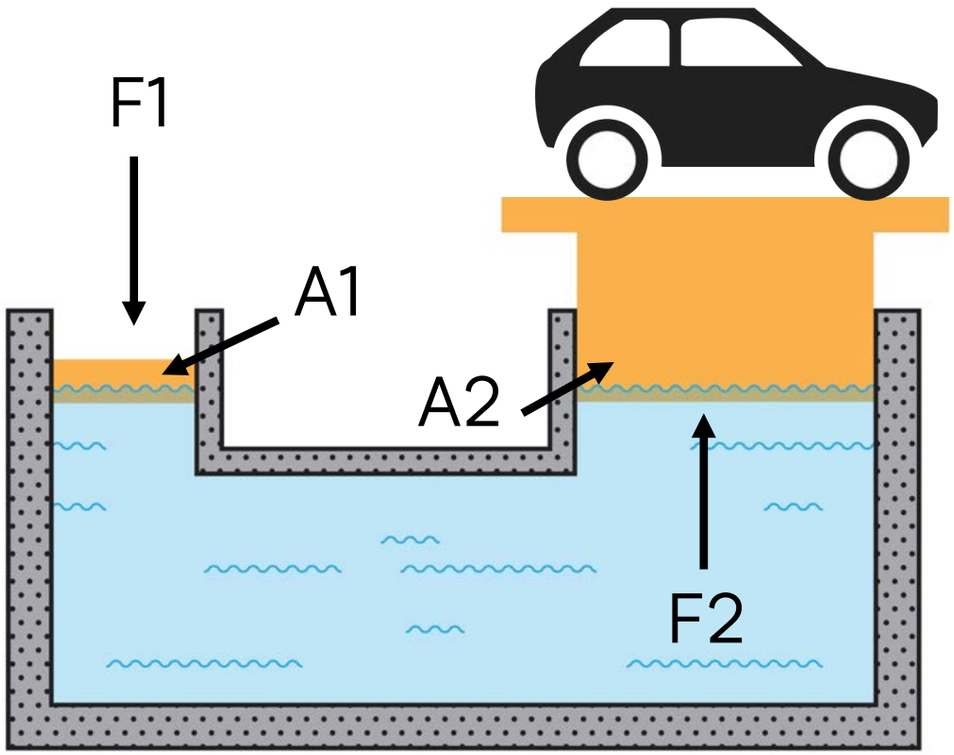
Hydraulics - Pascal's principle & force



P1 = F1/A1

P2 = F2/A2

P1 = P2 Pascal’s Principle

Because A1<A2 this means F1<F2

Note: P = pressure. F = force. A = area.

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What did we see?

Hydraulics mean we can use a **small force** to move a significantly **larger object** by **magnifying** the force.

- **Was the result what you expected?**
- **Can you think of any uses for this?**

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An engineering problem

How did they move boat between river and canal?

Canal, **goods and materials** at the **top** of the hill.

River and factories at the **bottom** of the hill.

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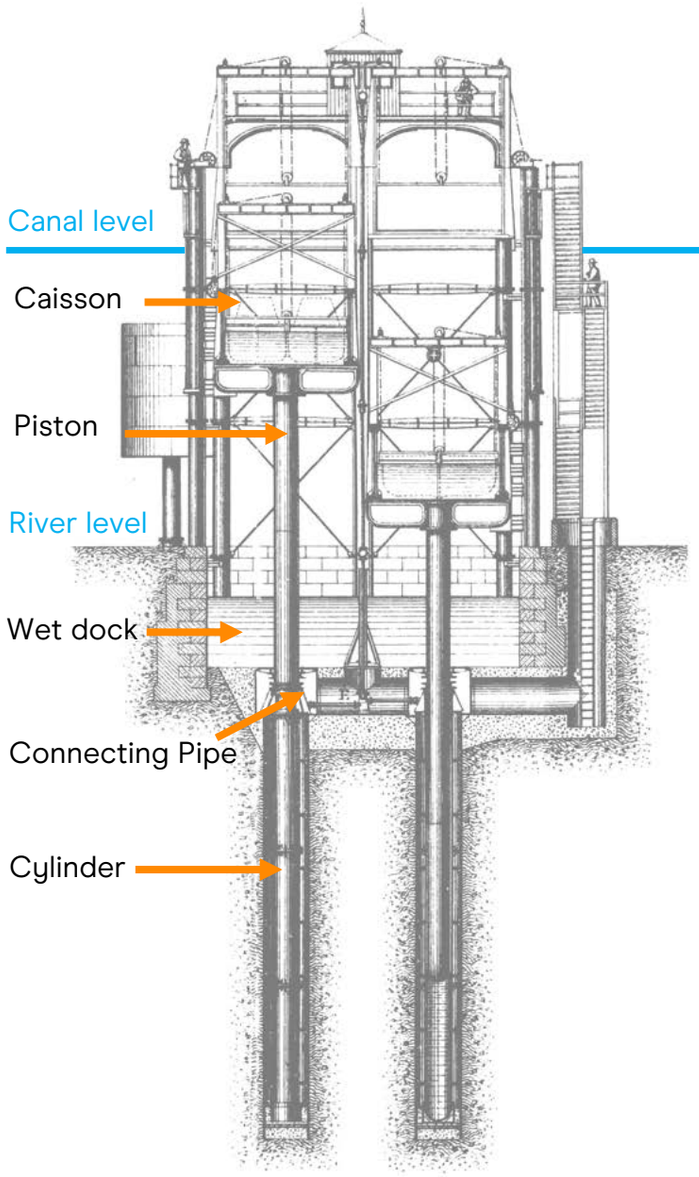
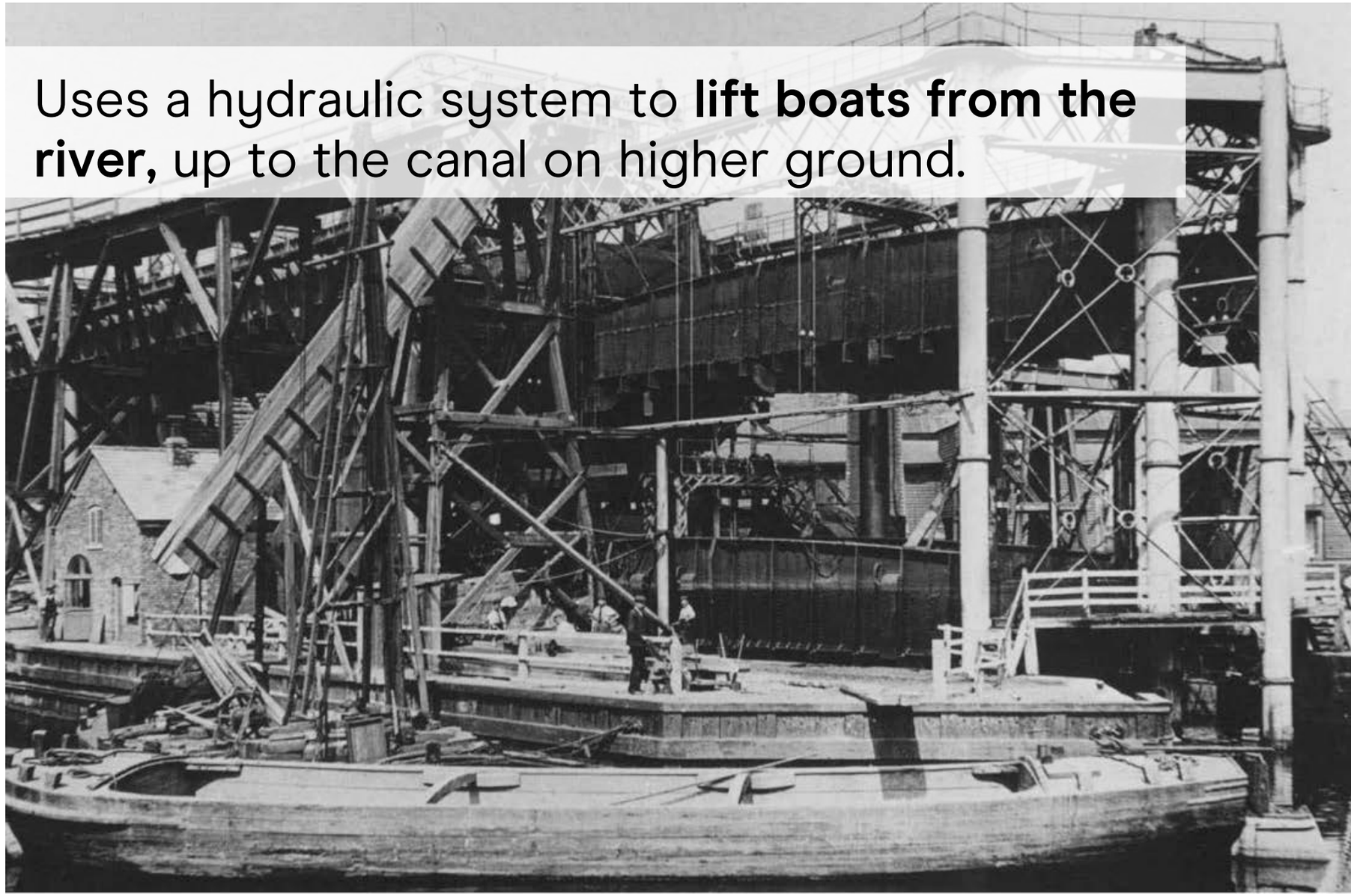
The Anderton Boat Lift



Uses a hydraulic system to **lift boats from the river,** up to the canal on higher ground.



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Another engineering problem

Canals were used to carry coal, cloth, wood, food, stone and other heavy items from all over the UK and from as far away as India and Australia.

Warehouses and hydraulic cranes at Ellesmere Port, 1906.

The hydraulic canal crane.

How were hydraulics helpful in this situation?

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Experiment 1: Hydraulics

Build a simple hydraulic system

- Collect your kit
- Connect up the large and small syringes to the plastic tubing
- Add water and bleed the system to expel air – why do this?

Test the system!

- Test the system by moving the small syringe about 4ml.
- Now try moving it 10ml. How far did you move the larger syringe?
- What does this show?

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Experiment 2: Hydraulics

- Collect a crane – what do you notice about the syringes?
- Connect the syringes acting as the hydraulic system so that you can use your crane to lift items.
- Add water and bleed the system.

- Weigh several items.
- Measure the distance travelled for each item.
- Draw a graph to show your results.
- (weight on the x axis / distance travelled on the y axis).

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Other examples of hydraulics

Hydraulics are useful in many situations and have advanced our lives in many ways.

Can you think of other examples?

Hydraulic paddle gear

Road crane

Tower Bridge

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Hydraulics – What did you find out?

- It is possible to **transmit** a **force** through liquid by applying **pressure.**
- Hydraulic systems use an **incompressible fluid**, such as oil or water, to transmit force from one location to another within the fluid.
- **Pascal's Principle.**