Think Lifting

We hope that you have enjoyed the lesson today, and that you learnt some things about the opportunities within the lifting industry.

This handout covers some of the things covered in the class today.

PNEUMATICS | FRICTION | PULLEYS

PNEUMATICS

Pneumatics is the section of Physics where we make pressurised gas do tasks for us, such as moving other objects. We can make pressurised gas by squeezing gas into a small container, such as a pipe. Pressure is a force that the gas exerts on the walls of the container it is in. This pressure will also mean that the gas will escape the container it is in if there is a hole.

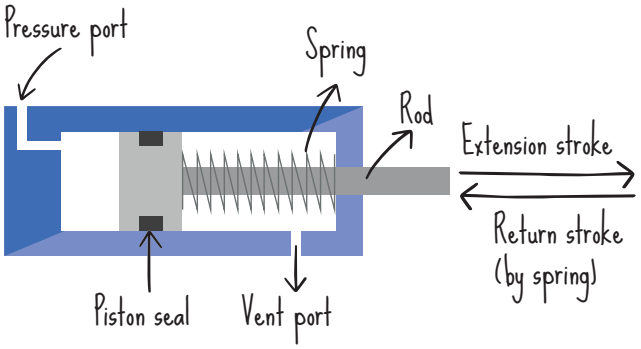
Imagine filling a balloon with air. If you release the balloon before tying it, then it will zip across the room. The pressure pushes the gas out of the hole and causes the balloon to move forward. This is an example of pneumatics, as we are using pressurised gas to move an object.

A piston is a tube with a cylinder inside, which can move up and down and can push other objects into motion. If we insert pressurised gas into the piston then the pressure from the gas will cause the cylinder to move out. If we reduce the pressure of the gas, then the cylinder will move back in. We can use this movement to operate machinery.

There are 2 types of piston:

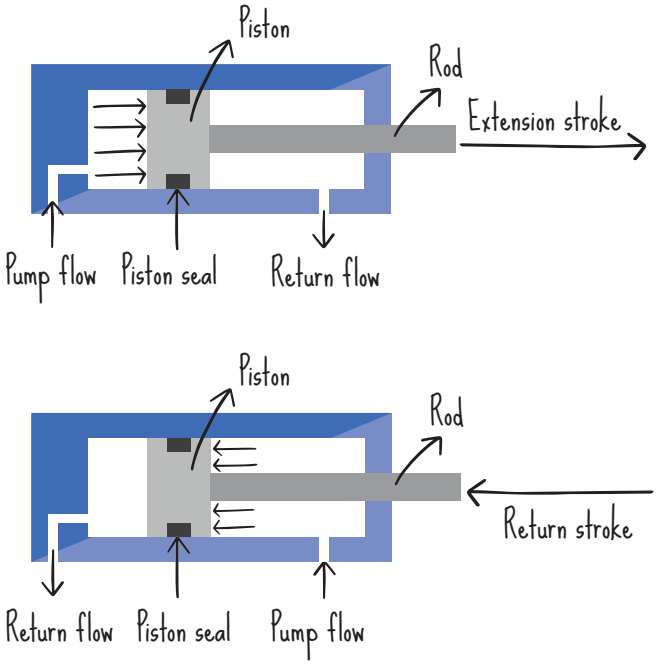
A **single acting cylinder** has one air supply which pushes the cylinder outwards. After the piston has been depressurised, a spring pulls it inwards automatically.

Single acting cylinder

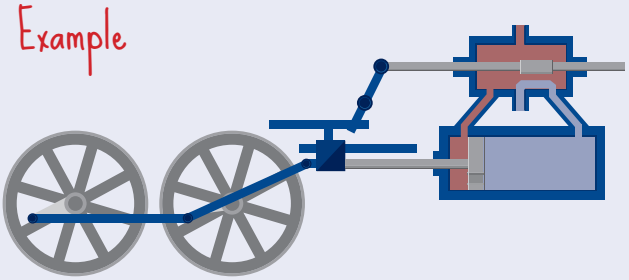


A **double acting cylinder** has 2 air supplies and does not have a spring. One pushes the cylinder outwards and the other pushes it back in.

Double acting cylinder



Example



A steam engine uses pneumatics to move forward. Imagine a double acting cylinder with a wheel attached. As the cylinder is pushed out, the rod moves to the left, and as the cylinder is pulled in, the rod moves to the right. The movement of the rod then rotates the wheel, and this is how the steam engine moves.

FRICTION

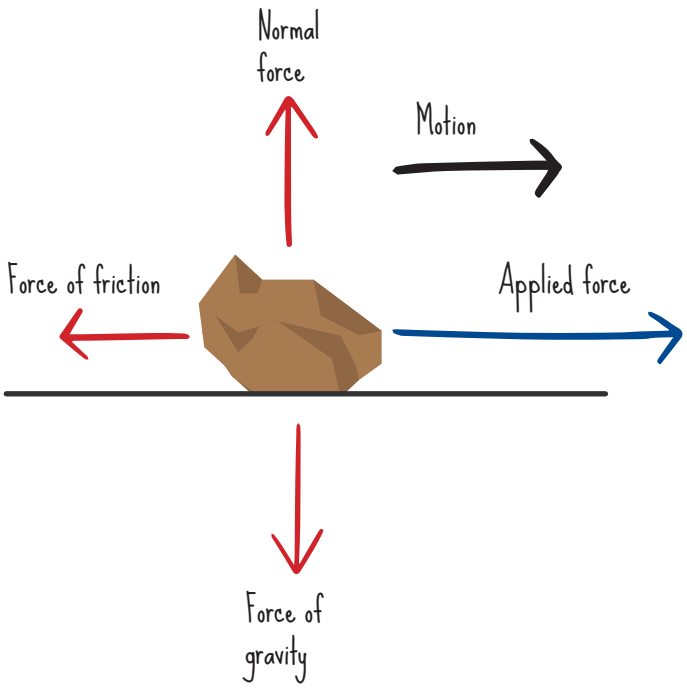
Friction is a contact force which acts between 2 surfaces that are sliding across each other. Friction tries to stop the motion taking place by slowing the surfaces down. This means that it acts opposite to the way the surfaces are sliding.

Friction depends on what type of materials the surfaces are made of. If they are smooth materials, then there is less friction. Some examples of smooth materials are glass and ice. If the materials are rougher, then there is more friction. Some examples of rough materials are fur and Velcro.

We can change friction by changing how smooth a material is. To decrease friction, we lubricate a machine with oil so the pieces will slide over each other easier. To increase friction, we add tread to surfaces such as tyres and shoes or change the surface material completely.

When the surfaces rub together, they produce heat. This is why we rub our hands together when we are cold!

Air resistance is a type of friction, except it is between a material and the air. Imagine a plane flying… As it moves, it hits air particles, and this slows it down.



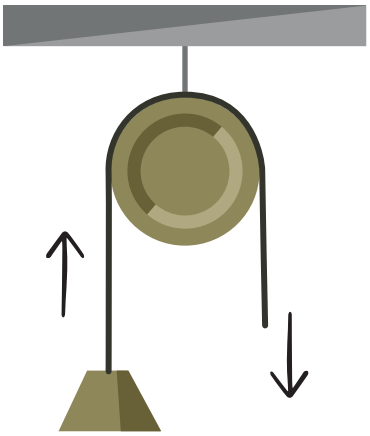
Some examples

You can feel friction acting when you try to push a block across carpeted floor.

Friction stops your feet from sliding across the ground when you try to take a step. Imagine trying to walk on ice - the surface is smooth and there is little friction. This means that it is slippery and easy to fall over. Without friction, we would not be able to walk!

PULLEYS

Let's look at the different type of pulleys!



A simple pulley consists of a rope attached to a wheel. The wheel has dents where the rope fits in.

A fixed pulley system is where the wheel is fixed to a wall whilst the load moves up or down with the rope. In this system, the force required to lift the load is equal to the weight of the load. A simple pulley is an example of a fixed pulley system.

A moveable pulley system is where the pulley is attached to the load itself and so they are both lifted. The weight of the moveable pulley is also added to the overall weight being lifted.

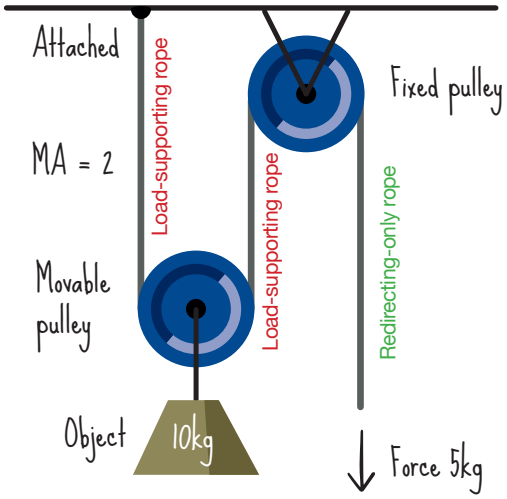
A compound pulley system uses a mixture of fixed and moveable pulleys. Using a combination of these, you can change the force required to lift the load.

So how can we change the force required to lift the load?

In a simple pulley, you pull down and the load rises – it changes the direction of the applied force. For a pulley with one wheel, you must put in a force equal to the weight of the load for it to move.

What if we add in a moveable pulley to make a compound pulley system?

(See the image below) In this system the load is attached to a wheel. This means that the mass of the wheel is also added to the overall mass you need to lift, giving a combined mass of 10kg or a weight of 100N (assuming the gravitational field strength is 10N/kg). However, the load is supported by 2 ropes – one on either side. Each side only holds half of the total weight of the load. In this example, the left load supporting rope holds up 50N of the weight of the load whilst the right-side lifts 50N of the weight up. This means you only need to put in half the amount of force for the load to start moving. Overall, this means that you can put in less force for the load to be lifted.



The factor by which the force decreases if known as the Mechanical Advantage (ME). We can work out the ME by dividing the weight of the load by the force required to lift it. For a pulley that halves the force required, the ME is 2. For a pulley that thirds it, it is 3.