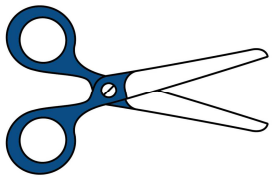
Mechanics and Mechanisms

What is do you think about when you hear the word mechanics?

Mechanics

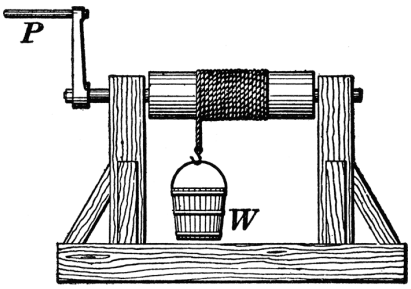
- Mechanics – is the study of how things move
- Concerned with creating useful movement through a range of mechanisms
- Through mechanisms you are generally transferring one type of movement to another
- Example: A Cam and Follower converts rotary motion into linear motion

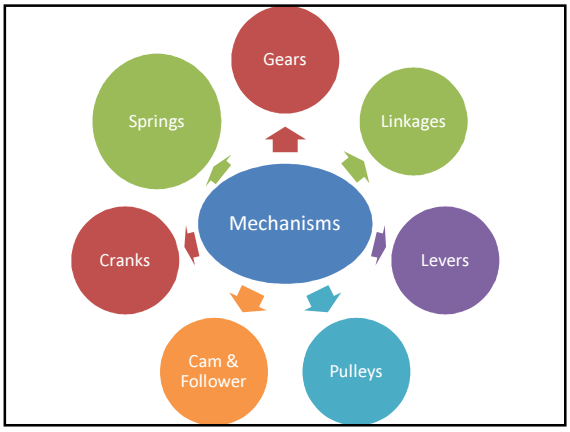
Is this a mechanism?



Is this a mechanism?

Is this a mechanism?



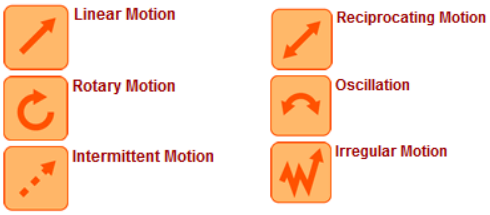


Motion

- Motion = Movement
- Motion is necessary for all mechanism to operate or get started
- Acceleration – Increasing or speeding up motion
- Deceleration – Decreasing or slowing down motion

Name some common types of motion that we may encounter in technology?

Types of Motion



Linear Motion

- Straight line motion
- Example: - A plane flying through the sky

Rotary Motion

- This is movement in a circular direction
- Example:- A Drill in operation

Intermittent Motion

- Intermittent motion is motion which starts and stops regularly
- Usually the end result of a mechanism
- Example:- Clock Mechanism

Reciprocating Motion

- Reciprocating motion is back and forth motion
- Example:- Crank and Slider (Car Pistons)

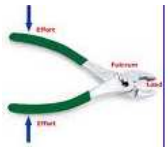
Important Mechanics Definitions

- Load – the force applied to a mechanism
- Effort – The force applied by the user
- Mechanical Advantage – the factor by which the mechanism multiples the force applied to it
  - Mechanical Advantage = Output force / Input force

Name some of the different levers that we encounter in our everyday lifes?

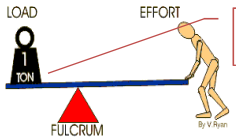
Examples of Levers



Lever

- Lever - A ridge body that rotates around a fixed point know as a fulcrum
- Levers are used to lift heavy weights with minimal effort

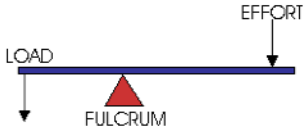


Longer Rod = Lesser effort

Classes of Levers

- Levers are divided into 3 different classes by the position of the load, fulcrum and effort

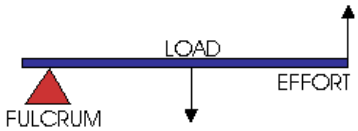
CLASS 1



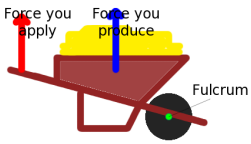
Example: - A Childs see saw

Classes of Levers

CLASS 2

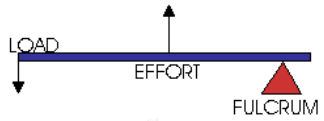


Example:



Classes of Levers

CLASS 3



Example:

How the Egyptians used levers?

- It is believed that a mechanical crane of some form was used to lift the blocks into place

- The lever in the diagram above works because the large weight of the block is *balanced* by the weight of the wooden crate which has been filled with stones
- Once it is balanced it can then be rotated to get the block into position

Moments

- Is the force that moves or turns a lever
- If a lever is not moving it is in a state of equilibrium
- The moment of a lever can be found by multiplying the force by the distance from the fulcrum
- Moments = Force x Distance

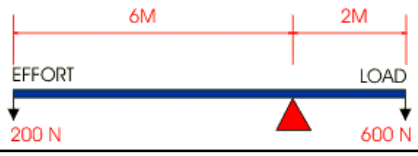
Law of the Lever

- If a lever is balanced then the clockwise moments must equal the anti clockwise moments

Clockwise Moments = Anti Clockwise Moments

Example – Law of the Lever

- The diagram below shows a lever where an effort of 200 N balances a load of 600 N. The effort force is 6 metres from the fulcrum. The load force is two metres from the fulcrum.



Example – Law of the Lever

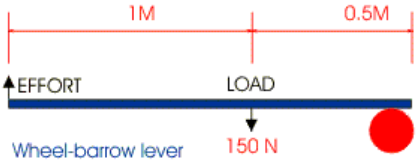
- Clockwise moment = 600 x 2 Nm
- Anti-clockwise moment = 200 x 6 Nm
- In a state of equilibrium,
- clockwise moments = anti-clockwise moments
- 600 X 2 Nm = 200 x 6 Nm
- 1200 = 1200

Test Yourself

In the diagram below a crow-bar is used to move a 400n load. What effort is required to move the load?

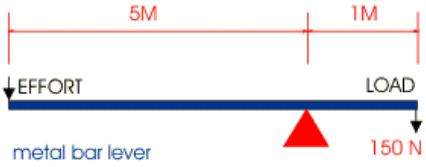
Test Yourself

- A wheel-barrow is used to lift a load of 150N. The wheel acts as the fulcrum. Calculate the effort required.



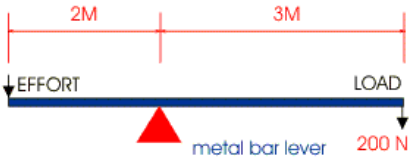
Test Yourself

- A metal bar is used to lever a load of 150N. The load is 1m from the fulcrum and the effort is 6m from the fulcrum. What effort is required to move the load ?



Test Yoruself

- Another metal bar is used to lever a load of 200N. The load is 3m from the fulcrum and the effort is 2m from the fulcrum. What effort is required to move the load ?



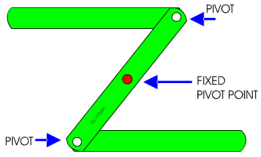
Linkages

- A Linkage is a mechanism that is made by connecting levers together

REVERSE MOTION LINKAGE

- If one rod is moved the other rod will move in the opposite direction, ie. It reverses the motion

Example: if the top rod is moved to the left the bottom rod will move to the right

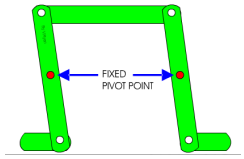


Reverse Motion linkage Application

Example: used to prevent relative sideways motion between the axle and body of the car

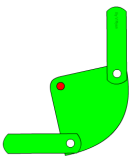
PARALLEL MOTION LINKAGE

- **PARALLEL MOTION LINKAGE**: As the large rod at the top of the diagram moves to the left the two small rods at the bottom move to the right. All the rods are parallel to each other

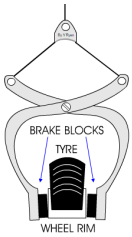


Bell Crank Linkage

- This mechanism allows the motion to be rotated by 90^{o}
- In other words a bell crank mechanism converts horizontal motion into vertical motion



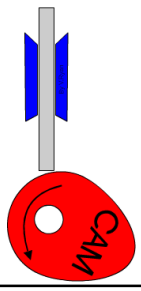
Example of a bell crank linage

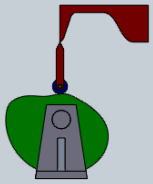


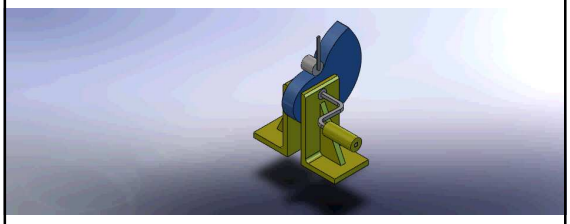
- When the brake is pulled the wire will move up vertically and this will result in the brake blocks been pushed into the rim of the wheel

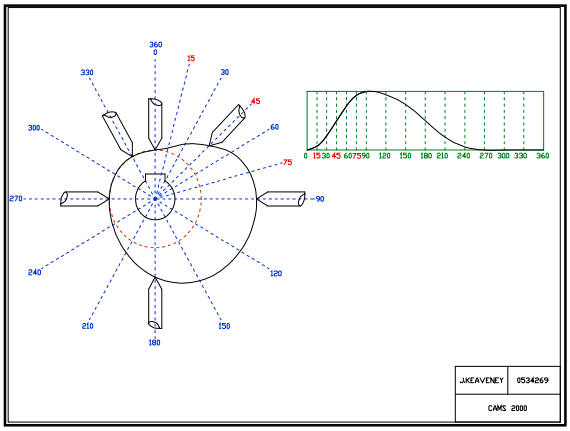
Cams

- A CAM changes the input motion, which is usually rotary motion (a rotating motion), to a reciprocating motion of the follower
- A CAM has two parts, the FOLLOWER and the CAM PROFILE





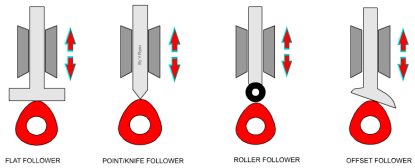




Cams Key Phrases

- ***ONE CYCLE*** **-**One rotation/revolution of the cam.
- ***DWELL*** **-** When the cam rotates but the follower does not rise or fall.
- ***THE RISE-*** That part of the cam that causes the follower to rise.

Cam Followers

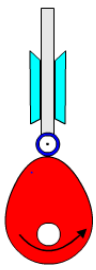


Cam Profiles

- Cams can be shaped in any number of ways and this is determined by the way the follower is to move. The shape of the cam is called the PROFILE

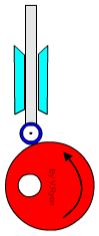
Pear shaped cams

- **Pear shaped cams** - are used on the shafts of cars. The follower remains motionless for about half of the cycle of the cam and during the second half it rises and falls.



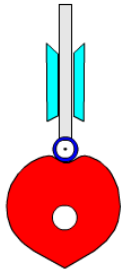
Circular Cams

- Circular cams or eccentric cams produce a smooth motion. These cams are used in steam engines.



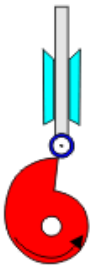
Heart Shaped Cams

- Heart shaped cams allow the follower to rise and fall with 'uniform' velocity.



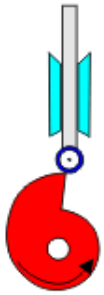
Snail / Drop Cam

- Eccentric, heart shaped and pair shaped cams generally allow for a slow rise and fall of the follower. However, a snail drop cam is used where the drop or fall of the follower must be sudden.



Snail or Drop Cam

- A snail/drop cam usually works efficiently in one direction only. With the aid of diagrams and notes explain why this is the case.



Quick Return Mechanism

- A quick return mechanism is used where there is a need to convert rotary motion into reciprocating motion.

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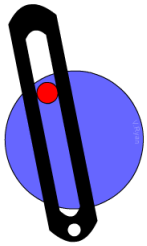
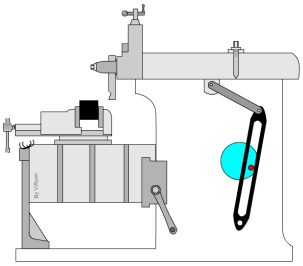
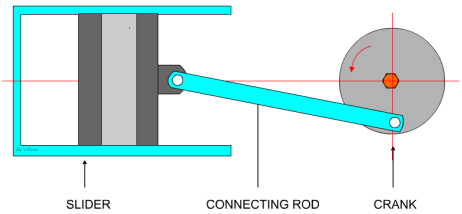


Quick Return Mechanism

Quick Return Mechanism Example

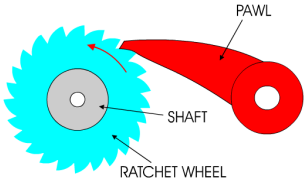


CRANK AND SLIDER MECHANISM



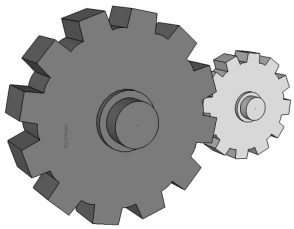
The crank is the rotating disc
The slider moves up and down inside the tube
The connecting rod which joins the parts together.

Ratchet and Pawl



The Ratchet consists of a wheel that has a series of teeth cut out of it
The Pawl follows the wheel as it turns, and from the diagram you will see that it falls into teeth as the wheel rotates and this ensure the wheel can only rotate in one direction

Gears



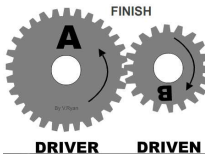
List a range of items that used gears?

Gears

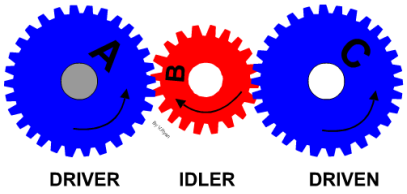
- Gears can be found in many machines in a workshop or factory and at home they are often an important part of mechanical devices.
- In a car the gears help the driver to increase and decrease speed as he/she changes the gears with the gear stick.
- Gear are also used in bicycles to adjust speed and also climb steep hills

Spur Gears

- The gears shown are called spur gears because they mesh together.
- Gear 'A' is called the 'driver' because this is turned by a motor.
- As gear 'A' turns it meshes with gear 'B' and it begins to turn as well.
- Gear 'B' is called the 'driven' gear.



Gear Trains

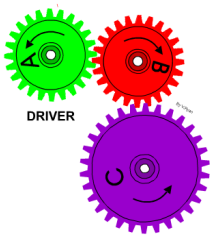


Gear Trains

- A gear train is usually made up of two or more gears
- From the diagram you will see that if A rotates clockwise B will rotate anti clockwise
- In the diagram the idle gear allows the driver and the driven gear to turn in the same direction
- An idle gear will only change the direction of rotation it will never speed up or slow down the gear train

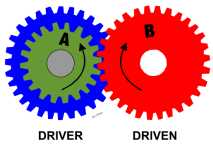
Changing the Speed of gear in a Gear Train

- This is achieved by putting a gear with different numbers of teeth together



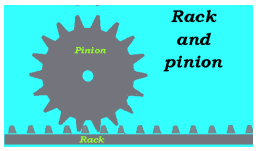
Compound Gears

- A compound gear is a number of gears fixed together. Consequently, they rotate at the same speed
- The gears that make up a compound gear usually differ in size and have a different number of teeth. This is useful if there is a need to speed up or slow down the final output.



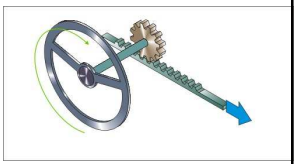
RACK AND PINION

- A **rack and pinion** is a pair of gears which convert rotational motion into linear motion



Rack and Pinion

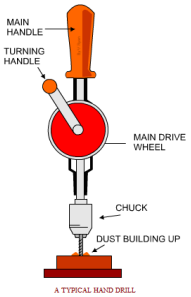
- Rotational motion applied to the pinion will cause the rack to move to the side
- The rack and pinion arrangement is commonly found in the steering mechanism of cars and also on the pillar drill table adjustment



Bevel Gears

Bevel Gears

- Bevel gears can be used to change the direction of drive in a gear system by 90 degrees.
- A good example is seen as the main mechanism for a hand drill. As the handle of the drill is turned in a vertical direction, the bevel gears change the rotation of the chuck to a horizontal rotation.



Worm and Wheel

- Consists of a **worm** (which is a gear in the form of a screw) meshes with a wheel (which is spur gear)

Worm and Wheel

- A worm and wheel changes the direction of the drive by 90^{o}
- A worm and wheel will generally reduce the rotational speed and also give greater torque