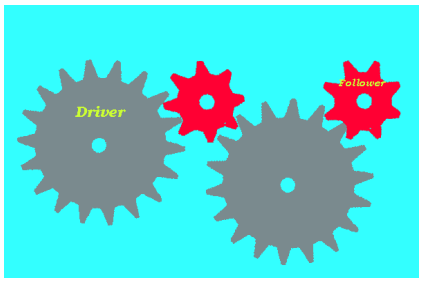
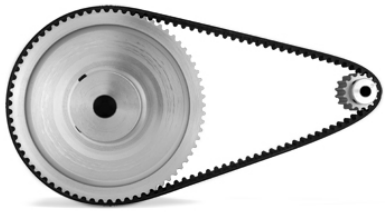
# Motion Transmission Systems

Def: System has one type of movement- rotation



Made up of:

| | |
|---|---|
| driver | Initiates the motion |
| driven | Receives the motion |
| inermediate | Found between the driver and driven |

## Reversibility

def: A system is considered reversible if either gear can be the driver or driven.

## Speed change

The speed of the driver or driven will depend on 2 factors:

- The number of teeth the gears have.
- The diameter of the gears.

**Formula**: Speed ratio = $\frac{\text{\# of teeth of driver}}{\text{\# of teeth of driven}}$

or

$\frac{\text{diameter of driver}}{\text{diameter of driven}}$

| Smaller gear to larger gear | Larger gear to smaller gear | Same size gears |
|---|---|---|
| decrease | increase | No change |
|  |  |  |

Ex:
1) If a driver gear has 20 teeth and the driven gear has 10 teeth, what is the speed ratio?

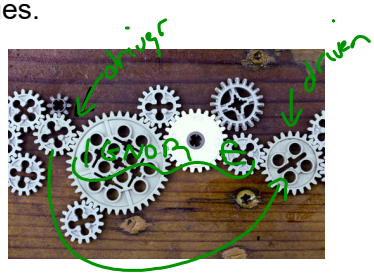
$\frac{20}{10}$ = 2x faster

2) If a driver gear with a diameter of 20 cm and the driven gear has a diameter of 40 cm, what is the speed ratio?

$\frac{20}{40}$ = .5 slower

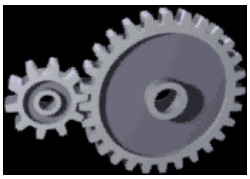
## Speed change with driver, driven and intermediates

- must ignore the intermediates when determining the speed changes.



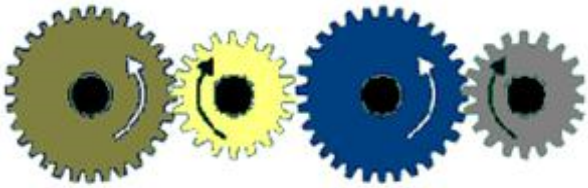
# Types of motion transmission systems

## 1) Gear trains



Contains at least two gears that mesh together.

Direction of parts ⟶ Alternates from one to another

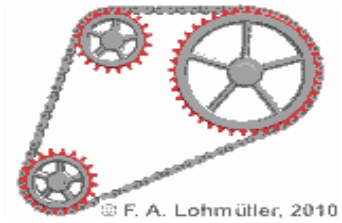


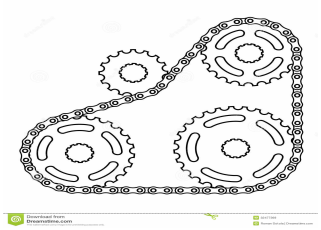
- Reversibility ⟶ yes

Things to consider when building a gear train:

1. Gear teeth (evenly spaced, same size)
2. Gear types (straight vs. bevel (cut at an angle))

## 2) Chain and sprocket



- connects gears which are far apart with a chain.

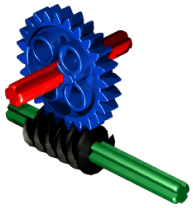
- direction ⟶ interior sprockets all turn same direction, exterior ones turn opposite of interior ones.

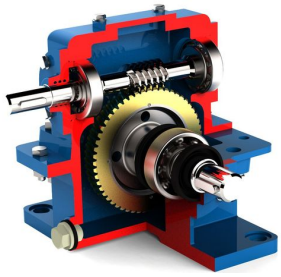
- reversability ⟶ yes

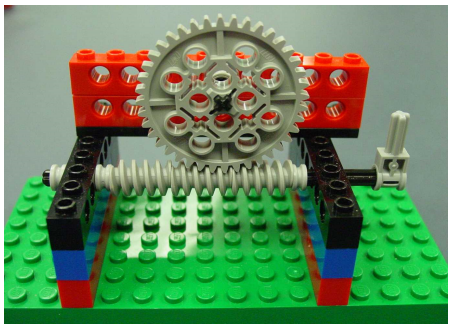
Things to consider when building a chain and sprocket system:

1. Teeth on sprocket must be identical and fit chain
2. System needs lubrification

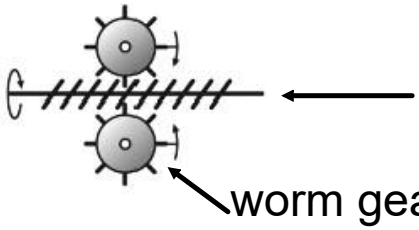
## 3) Worm and worm gear







- consists of a screw and at least one gear

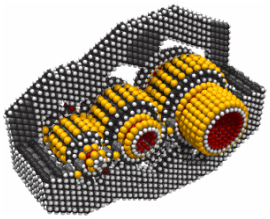


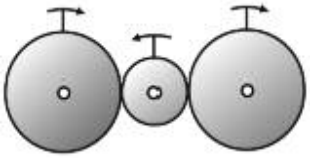

- reversability ⟶ No- worm always driver and worm gear always driven

When building one:

1. Gear teeth must match worm's grooves

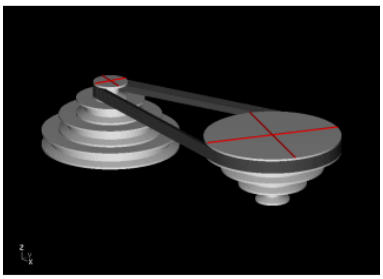
4) Friction gear

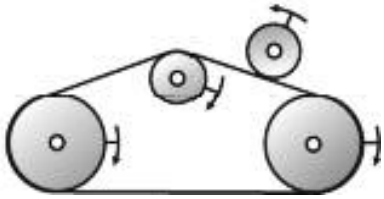




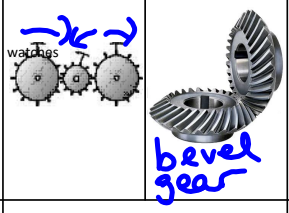
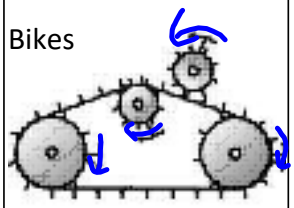
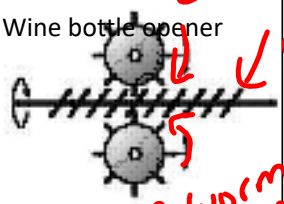
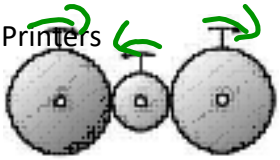
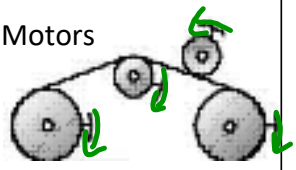
All same info as geat trains except not as efficient as gear trains because gears can slip.

## 5) Belt and pulley system



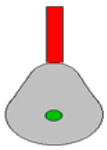


- pulleys have a groove where belt fits.
- belt must adhere to pulleys.
- all same info as chain and sprocket

| Type | Explanation | Picture | Reversibility |
|---|---|---|---|
| Gear train | • One gear rotates which causes all others to rotate<br>• Needs lubrication |  | Yes |
| Chain and sprocket | • Toothed gears connected by a chain<br>• Needs lubrication<br>• Chain is the intermediate | Bikes<br>  | Yes |
| Worm and worm gear | • Rotational movement from worm which causes worm gears to rotate | Wine bottle opener<br>  | No |
| Friction gear systems | • Friction gear rotates and causes others to rotate<br>• Gears can slip | Printers<br>  | Yes |
| Belt and pulley system | • Pulleys connected by a belt<br>• Pulleys have a groove for belt to fit<br>• Can slip | Motors<br>  | Yes |

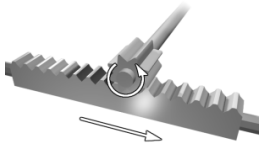
# Transformation systems

def: System has two types of movement: rotational and translational

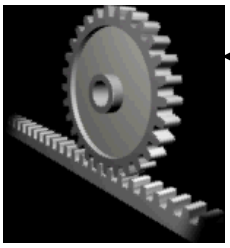


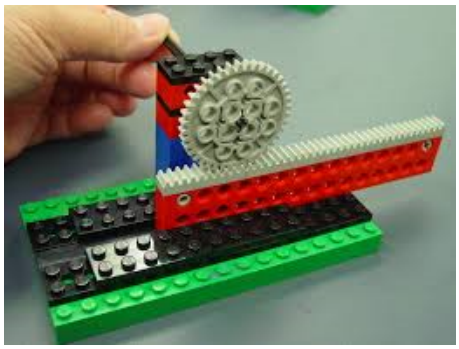
- Has a driver and driven, but no intermediate

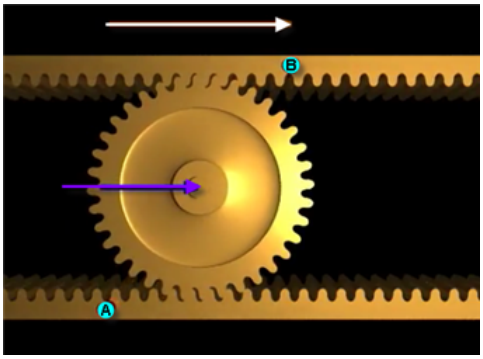
**Reversibility**
Refers to a translational or rotational movement that can be driver or driven. If can rotate or go straight first it is reversible.



## 1) Rack and pinion

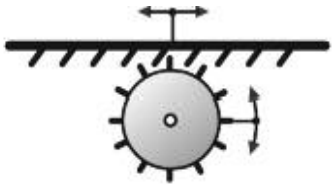





- contains a rack (straight bar with teeth) and a pinion (gear)
- teeth on rack and pinion must be identical
- system needs lubrification

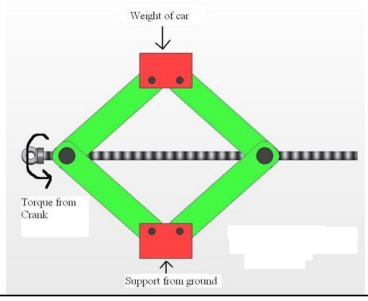
Reversibility ⟶ yes



## 2) Screw gear system

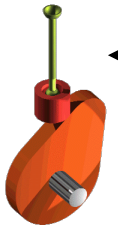
- contains a screw and a nut

## 2 types:

| Type 1 | Type 2 |
|---|---|
| - screw is the driver<br>- rotation to translation | - nut the driver<br>- rotation to translation |
|  |  |

Reversibility ⟶ No

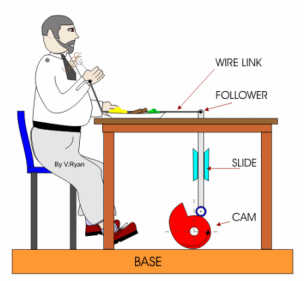
## 3) Cam and follower

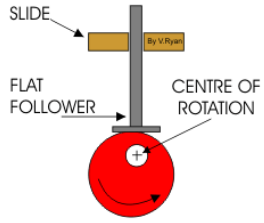


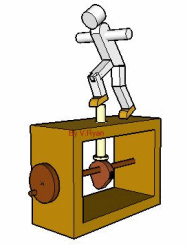
follower

cam

- cam is always the driver and the follower is always the driven
- shape of the cam determines how the follower will move
- spring keeps the follower in contact with the cam



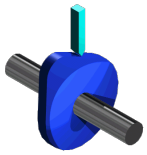



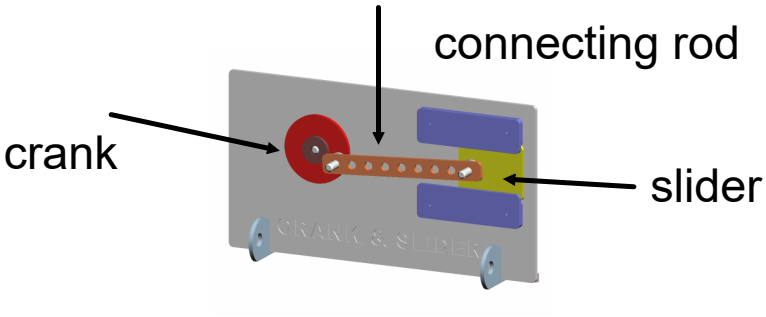
Eccentric cam: rotational axis is off centered

reversibility ⟶ no

Cam: rotational axis is centered.

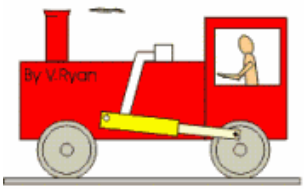


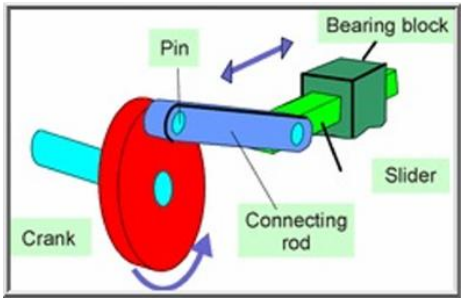
4) slider and crank



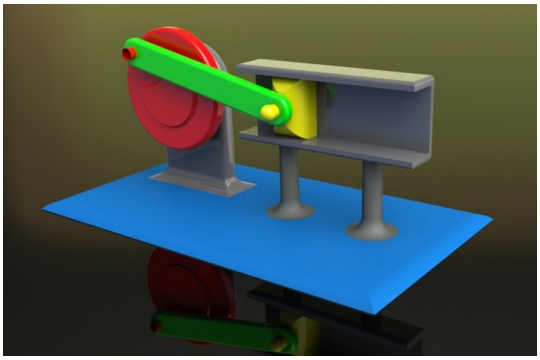

- rod connects slider (piston) to crank

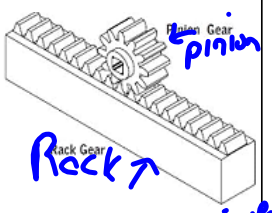
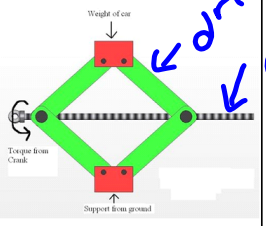
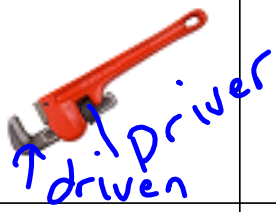
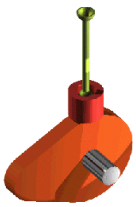
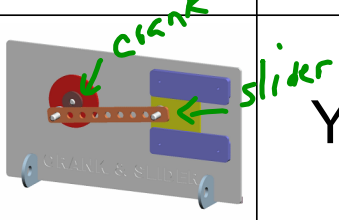
- requires lubrification



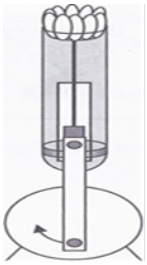

reversibility ⟶ yes

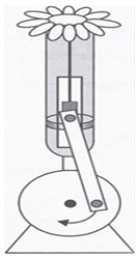


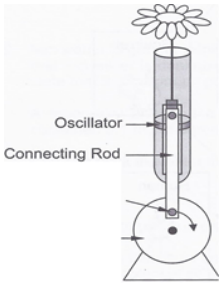
| Type | Explanation | Picture | Reversibility |
|---|---|---|---|
| Rack and pinion | Pinion rotates and rack translates. |   | Yes |
| Screw gear System Type 1 | Screw rotates FIRST which causes the translation of apparatus. |   | No |
| Screw gear system Type 2 | Nut rotates FIRST which causes the translation of apparatus. |   | No |
| Cam and follower | Cam rotates which CAUSES the follower to translate.<br><br>Moving the center of rotation closer to the outside of the cam and increasing the size of the cam causes the rise of the follower to increase<br><br>Eccentric cam: rotation is off centered |  | No |
| Slider and crank mechanism | The slider translates which causes the crank to rotate. |   | Yes |

## Past exam question

1. The mechanism illustrated below moves a paper flower in and out of a container.








a- Is this a motion transmission or motion transformation mechanism?
b- Is the system reversible?
c- From the list of changes suggested below, choose the combination of **two** changes that should be made to the mechanism so that the flower can come further out of the container.

Change 1- Increase the diameter of the crank.
Change 2- Decrease the diameter of the crank.
Change 3- Move the connecting rod pivot away from the center of the crank.
Change 4- Move the connecting rod pivot closer to the center of the crank.