N5 Mechanisms

Motion

Linear motion - movement in a straight line in one direction.

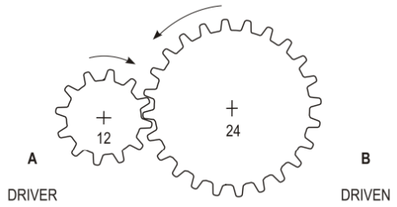
Reciprocating motion - backwards and forwards movement in a straight line.

Rotary motion - turning in a circle.

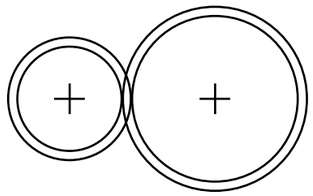
Oscillating motion - swinging backwards and forwards in an arc.

Simple gear train

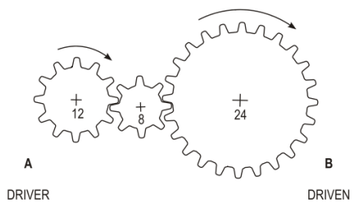
When two or more gears are meshed together they form a simple gear train. The input gear is the driver and the output gear is the driven.



When asked to draw a simple gear train this is how they must be shown.



An idler gear is a gear that can be inserted in to a system to allow the driver and driven gear to turn in the same direction. It has no effect on the multiplier ratio or speed of they system.

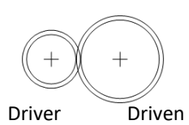


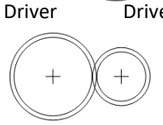
The movement multiplier ratio (MMR) is used to work out ratio between the size of the driver and driven gears. We then use this ratio as the Velocity Ratio to calculate the input or output speed.

$$MMR = \frac{Driven}{Driver}$$

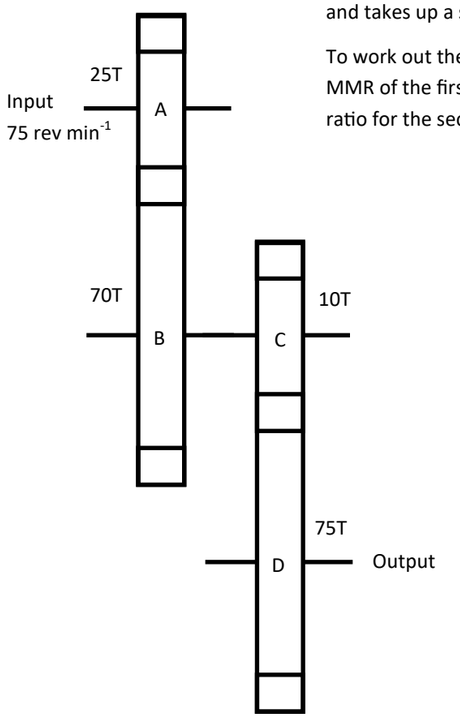
$$VR = \frac{Input\ Speed}{Output\ Speed}$$

The first gear train creates a decrease in output speed as a large gear turns slower than a smaller one. The second gear train creates a speed increase.





Compound Gears



A compound gear system creates a very large change in speed and takes up a small space.

To work out the MMR of a compound gear system you take the MMR of the first meshed gear system and multiply it by the ratio for the second one.

$$MMR = \frac{Driven}{Driver} \times \frac{Driven}{Driver}$$
$$MMR = \frac{70}{25} \times \frac{75}{10}$$
$$MMR = 21$$

$$VR = \frac{Input\ Speed}{Output\ Speed}$$
$$21 = \frac{75}{Output\ Speed}$$
$$Output\ Speed = \frac{75}{21}$$
$$Output\ Speed = 3.6\ rev\ min^{-1}$$

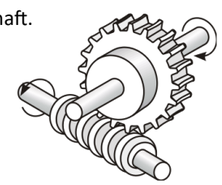
Torque

$$T = Fr$$

Torque is the force required to turn an object.
Torque is measured in Nm.
Force is measured in N.
Distance is measured in m.

Worm & Wheel

Using a worm and wheel produces a large speed reduction. The worm, which looks rather like a screw thread, is fixed to the driver shaft. It meshes with a worm wheel, which is fixed to the driven shaft. The driven shaft runs at 90 degrees to the driver shaft. When considering the speed changes in most worm gear systems, you can think of the worm as if it were a spur gear with one tooth.



Friction

In all drive systems there is friction which produces heat. This can cause the gears to expand which causes damage to the drive system. To help reduce this you can lubricate the system using oil or grease which in turn increases the efficiency of the drive system. Another option is to use bearings as these can be easily replaces when worn out instead of damaging and replacing the whole drive system.

Grease is used to lubricate the gear system within the drill.

(b) Describe a reason for lubricating the gear system. 1

Reduce wear on the gear system

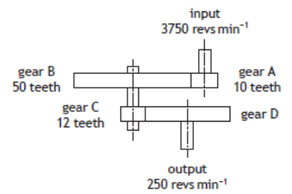
Gears run smoother/quieter

Improve efficiency/battery life of the drill

Less heat/sound/energy losses

13. (continued)

Part of a drive mechanism used in the combine harvester is shown.



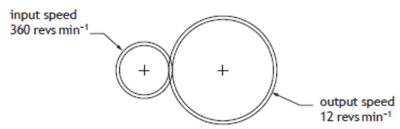
(c) Calculate the number of teeth on gear D. 4

$$VR = \frac{Input\ Speed}{Output\ Speed}$$
$$VR = \frac{3750}{250}$$
$$VR = 15:1$$

$$MMR = \frac{Driven}{Driver} \times \frac{Driven}{Driver}$$
$$\frac{15}{1} = \frac{50}{10} \times \frac{D}{12}$$
$$15 = 5 \times \frac{D}{12}$$
$$\frac{15}{5} = \frac{D}{12}$$
$$3 \times 12 = D$$
$$D = 36\ teeth$$

2. A child's game is shown.

A diagram of the simple gear train inside the game is shown below.



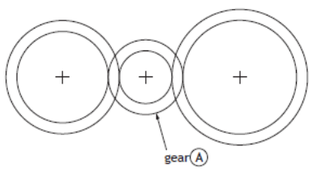
Calculate the velocity ratio of this simple gear train. 2

$$\text{Velocity Ratio} = \frac{\text{Speed of Input}}{\text{Speed of Output}}$$

$$\text{Velocity Ratio} = \frac{360}{12}$$

VR = 30 : 1

1. A gear train is shown below.



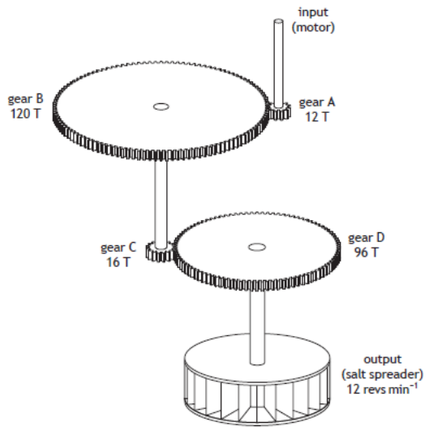
(a) State the type of gear train shown. 1

Simple Gear Train

(b) State the name of gear (A). 1

Idler

The gear train shown below is used to drive the salt spreading system.



(e) Calculate the input speed of the motor. 4

$$MMR = \frac{Driven}{Driver} \times \frac{Driven}{Driver}$$
$$MMR = \frac{120}{12} \times \frac{96}{16}$$
$$MMR = 60$$

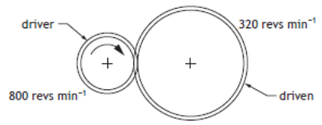
$$VR = \frac{Input\ Speed}{Output\ Speed}$$
$$60 = \frac{Input\ Speed}{12}$$
$$Input\ Speed = 12 \times 60$$
$$Input\ Speed = 720\ rev\ min^{-1}$$

Part of the gear mechanism used to control the gate movement has a velocity ratio of 14:1 and an input speed of 870 revs min^{-1}.

(b) Calculate the output speed of this part of the gear mechanism. 3

$$\text{Velocity Ratio} = \frac{\text{Speed of Input}}{\text{Speed of Output}}$$
$$14 = \frac{870}{\text{speed of output}}$$
$$\text{speed of output} = \frac{870}{14}$$
$$\text{speed of output} = 62.14285$$
$$\text{speed of output} = 62 \text{ revs min}^{-1} \text{ (2 sf)}$$

4. A simple gear train is shown below.



(a) Calculate the velocity ratio of this simple gear train. 2

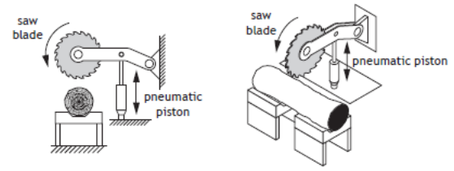
$$\text{Velocity Ratio} = \frac{\text{Speed of Input}}{\text{Speed of Output}}$$
$$\text{Velocity Ratio} = \frac{800}{320}$$
$$\text{Velocity Ratio} = 5 : 2$$

The driver gear in the diagram above rotates clockwise.

(b) State the direction of rotation of the **driven** gear. 1

Anti-clockwise

10. A pneumatic circuit is used in the operation of an industrial saw.



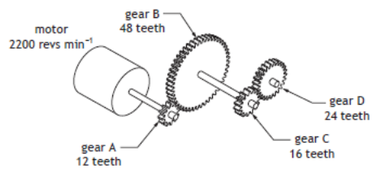
(a) State, with reference to the diagram above, the type of **motion** shown at the 2

saw blade Rotary

pneumatic piston. Reciprocating

A conveyor belt used to transport fruit along the machine is shown below.

Part of the conveyor belt mechanism is shown below.



(b) Calculate the output speed of gear D. 4

$$MMR = \frac{Driven}{Driver} \times \frac{Driven}{Driver}$$
$$MMR = \frac{48}{12} \times \frac{24}{16}$$
$$MMR = 6$$

$$VR = \frac{Input\ Speed}{Output\ Speed}$$
$$6 = \frac{2200}{Output\ Speed}$$
$$Output\ Speed = \frac{2200}{6}$$
$$Output\ Speed = 370\ rev\ min^{-1}$$