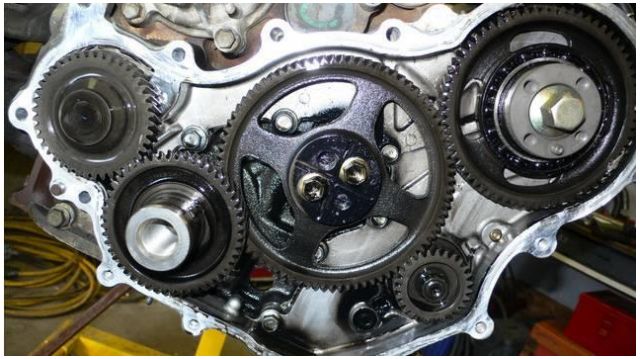
Gears and Sprockets

Gears & Sprockets

These three power train elements transfer energy through rotary motion.

- Change the speed of rotation
- Change the direction of rotation
- Change the amount of torque available to do work



Gears

A gear train is a mechanism used for transmitting rotary motion and torque through interlocking teeth.

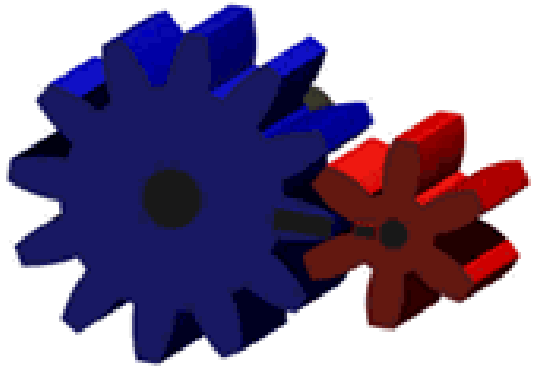
A gear train is made when two or more gears are meshed

Driver gear causes motion

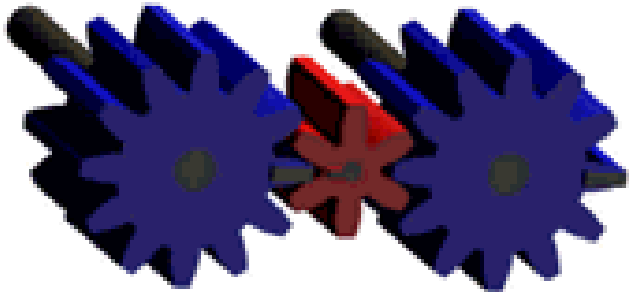
Motion is transferred to the driven gear

Gears

Mating gears always turn in opposite directions.



An **Idler Gear** allows the driver and driven gears to rotate in the same direction.

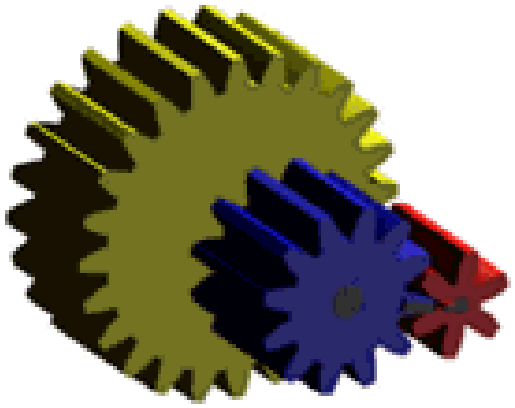


Mating gears always have the same size teeth (diametric pitch).

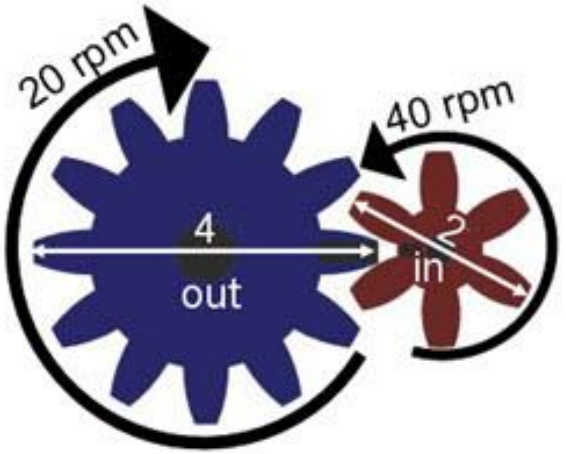
Gears

The rpm of the larger gear is always slower than the rpm of the smaller gear.

Gears locked together on the same shaft will always turn in the same direction and at the same rpm.



Gear Ratios



Variables to know

n = number of teeth

d = diameter

ω = angular velocity (speed)

τ = torque

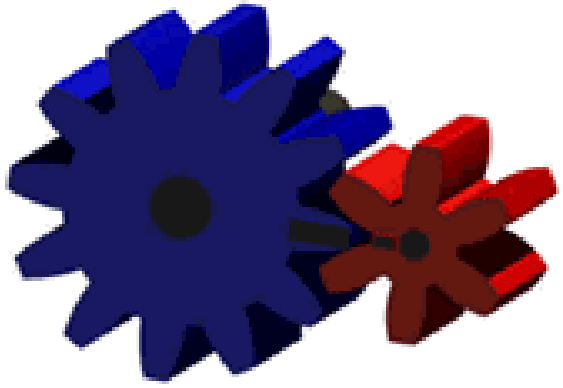
Subscripts in and out are used to distinguish between gears.

$n_{in} = 6$ $n_{out} = 12$

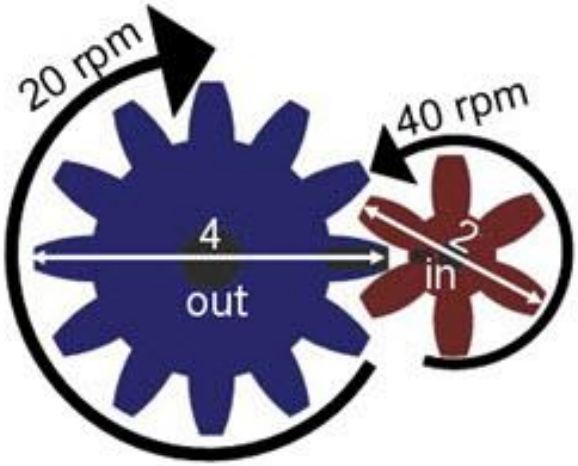
$d_{in} = 2$ in. $d_{out} = 4$ in.

$\omega_{in} = 40$ rpm $\omega_{out} = 20$ rpm

$\tau_{in} = 40$ ft-lb $\tau_{out} = 80$ ft-lb



Gear Ratios



Equations to know

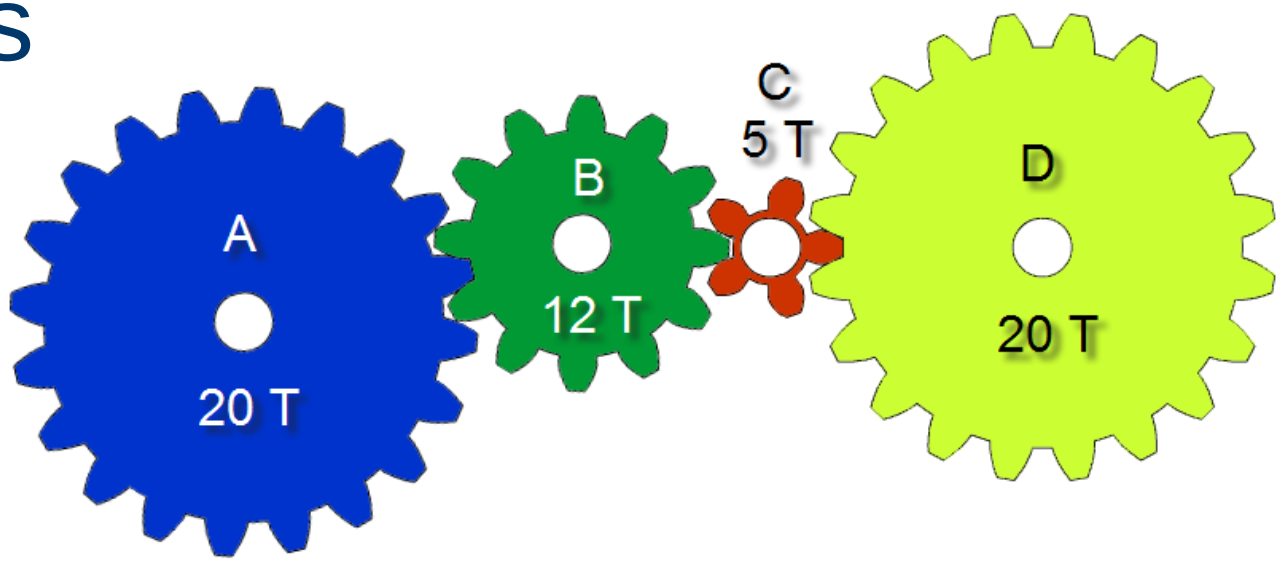
GR = Gear Ratio

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{d_{out}}{d_{in}} = \frac{\omega_{in}}{\omega_{out}} = \frac{\tau_{out}}{\tau_{in}}$$

$$\frac{?}{1} \quad \frac{12}{6} \quad \frac{4\cancel{in.}}{2\cancel{in.}} \quad \frac{40\cancel{rpm}}{20\cancel{rpm}} \quad \frac{80\ ft-\cancel{lb}}{40\ \cancel{ft-lb}}$$

$$\frac{2}{1}$$

Gear Ratios



What is the gear ratio between gears A and B?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{12}{20} = \frac{.6}{1}$$

What is the gear ratio between gears B and C?

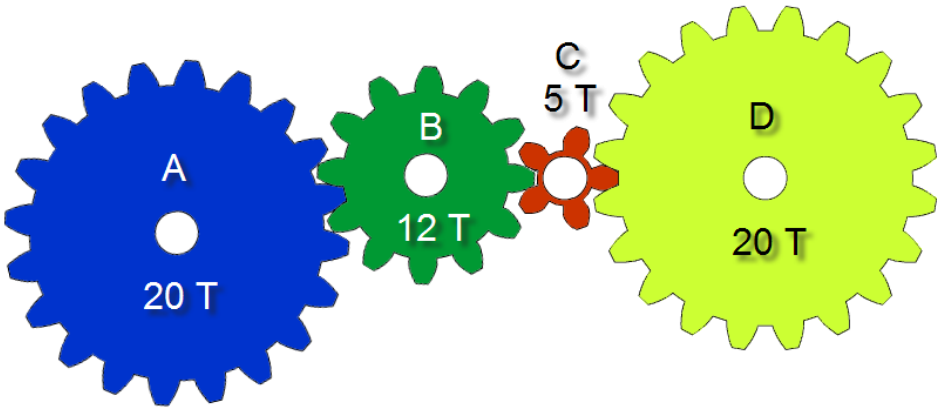
$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{5}{12} = \frac{.42}{1}$$

What is the gear ratio between gears C and D?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{20}{5} = \frac{4}{1}$$

Gear Ratios

Idler gears don't affect GR!



What is the TOTAL gear train gear ratio?

$$\frac{0.6}{1} \bullet \frac{0.42}{1} \bullet \frac{4}{1} = \frac{1}{1}$$

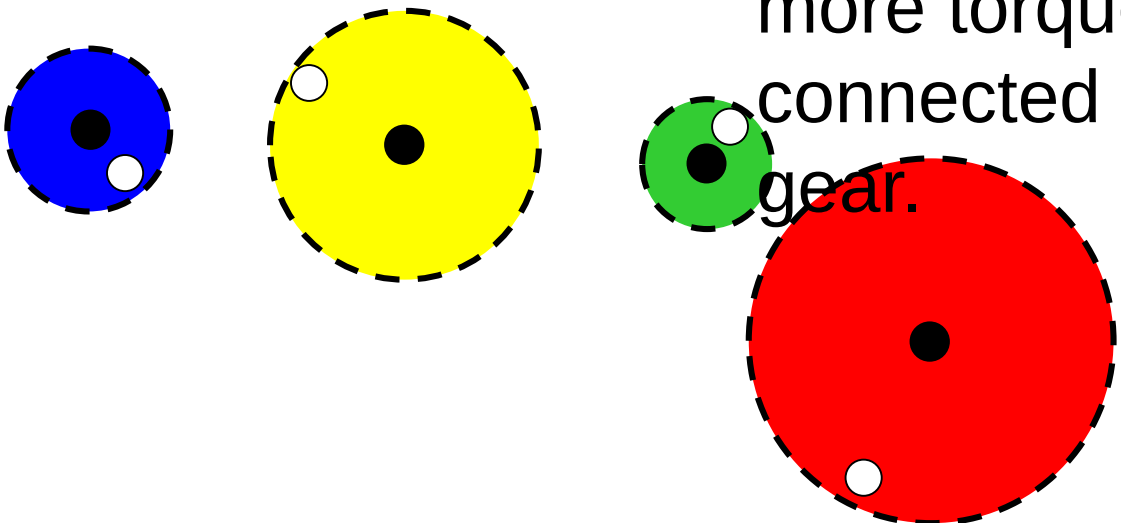
If gears A and D were directly connected to each other, what would the resulting gear ratio be?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{20}{20} = \frac{1}{1}$$

If the last gear had 40 teeth, what would be the total gear ratio?

$$\frac{0.6}{1} \bullet \frac{0.42}{1} \bullet \frac{8}{1} = \frac{2}{1} \quad \text{or} \quad \frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{40}{20} = \frac{2}{1}$$

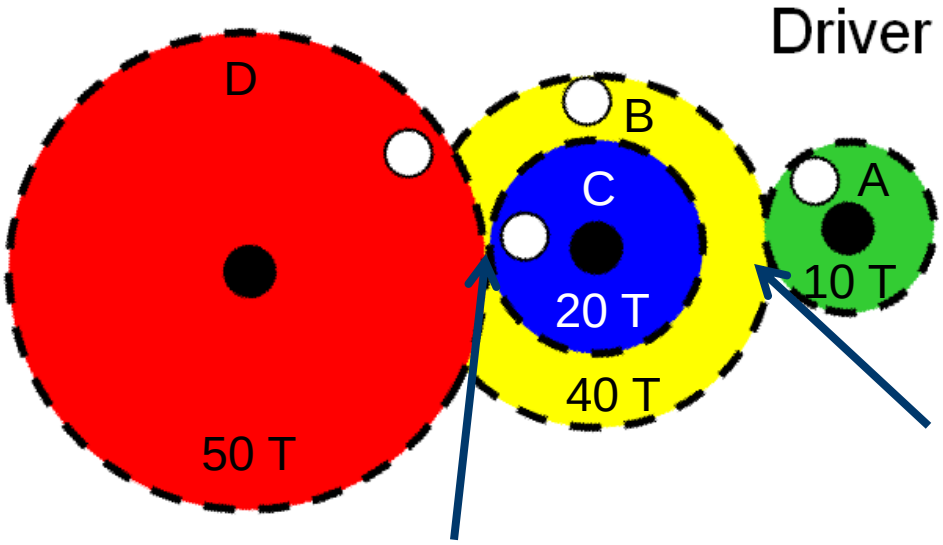
Compound Gear Train



The two middle gears share a common axle, so they rotate at the same speed.

This allows the final gear to rotate slower and produce more torque than if it were connected only to the driver gear.

Compound Gear Ratios



What is the gear ratio between gears A and B?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{40}{10} = \frac{4}{1}$$

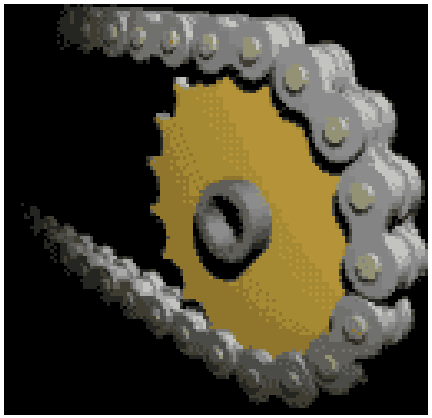
What is the gear ratio between gears C and D?

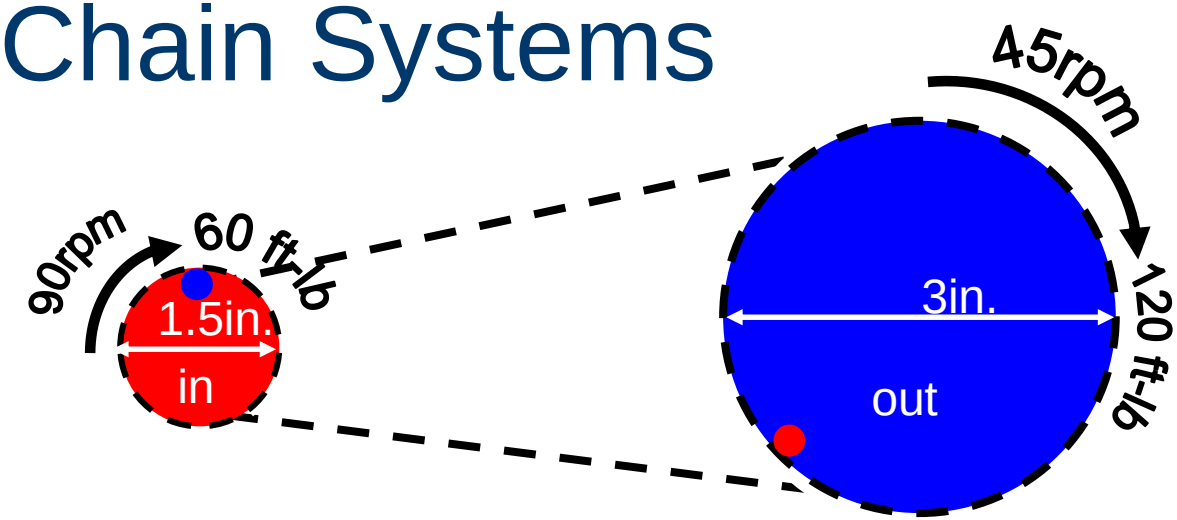
$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{50}{20} = \frac{2.5}{1}$$

What is the gear ratio of the entire gear train?

$$\frac{4}{1} \bullet \frac{2.5}{1} = \frac{10}{1}$$

Sprocket and Chain Systems





$$\frac{n_{out}}{n_{in}} = \frac{d_{out}}{d_{in}} = \frac{\omega_{in}}{\omega_{out}} = \frac{\tau_{out}}{\tau_{in}}$$

$$\frac{22}{11} \quad \frac{3\cancel{in.}}{1.5\cancel{in.}} \quad \frac{90\cancel{rpm}}{45\cancel{rpm}} \quad \frac{120\ \cancel{ft-lb}}{60\ \cancel{ft-lb}}$$

n = number of teeth *d = diameter* *ω = angular velocity (speed)* *τ = torque*