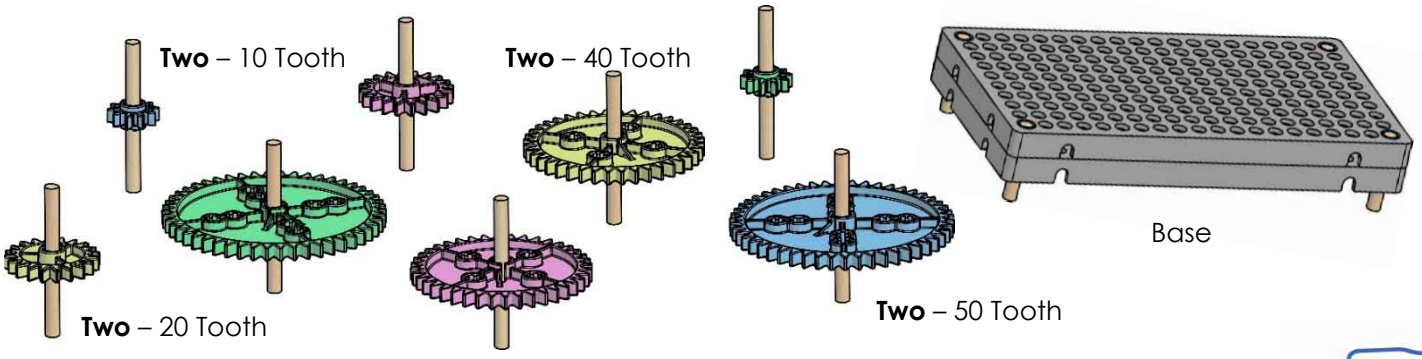
RATIO & PROPORTION LAB — GEARS TINKER SET

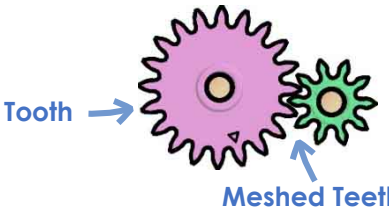
Name: _____ Date: _____

LAB MATERIALS

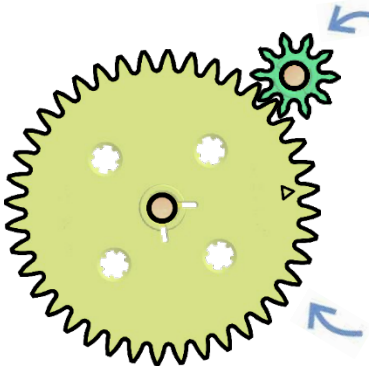
Make sure you built your Tinker Set with the **Set-Up Guide**. Find all our documents, including the **Classroom Overview**, at **teachergeek.com/gears**



WHAT'S A GEAR?



A **gear** is a wheel with **teeth**.
The teeth **mesh** (connect) with other gears, to make them turn together.



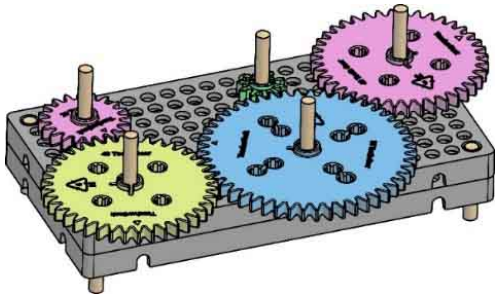
Input Gear: The gear that is powered (turned by you).

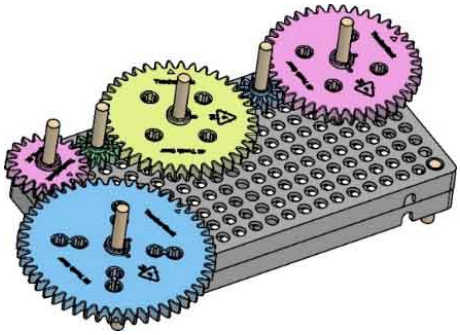
Output Gear: The gear that gets powered (turned by the other gear).

PLAY!

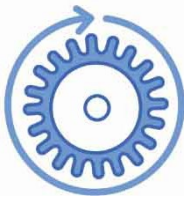
Place gears into the **base**, so they mesh. Give a spin and see what happens. Try different combinations!

▶ **Be Careful:**
If your gears are too close, or too far apart, they won't mesh.

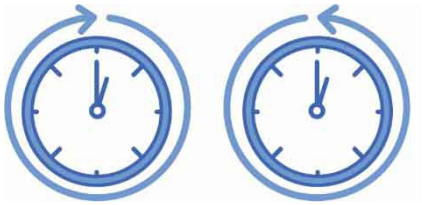




DIRECTION & REVOLUTION



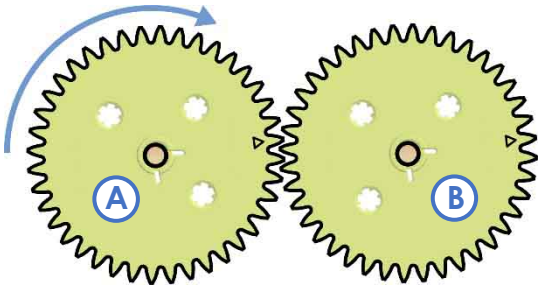
▶ **Revolution:** one full rotation



Clockwise (CW) Counterclockwise (CCW)

▶ **A Clock's Rotation:** The minute hand on a clock makes one revolution every minute.

1 **Mesh** (connect) two 40-Tooth gears together on the base plate. Using the dowel, spin **Gear** Ⓐ clockwise ↻ (direction of the arrow) one **revolution**. Draw an ↷ around **Gear** Ⓑ to show the direction of **rotation** (turn).



40-Tooth

Complete for meshed gears Ⓐ & Ⓑ

Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio
A Input	40	CW ↻	1	
B Output	40			

Input Revolutions

Output Revolutions

▶ A **ratio** is a comparison of two values (numbers). Which values are you comparing? _____

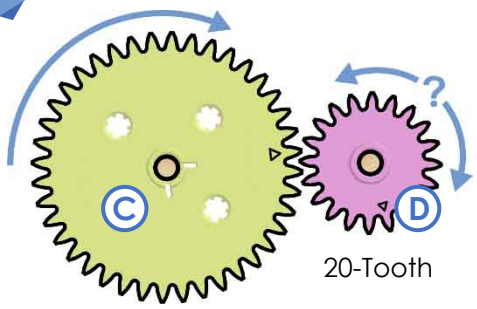
_____

_____

▶ Which **direction** did the output gear rotate?

↻ Clockwise ↺ Counter Clockwise

2 Swap your output for a 20-Tooth gear and spin **Gear** Ⓒ clockwise one revolution.



20-Tooth

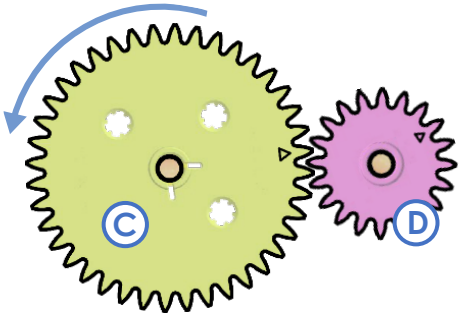
Complete for meshed gears Ⓒ & Ⓓ

Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio
C Input	40	CW ↻	1	
D Output	20			

▶ How did changing the **output gear** size affect the revolutions' ratio? _____

_____

3 Now, spin **Gear** Ⓒ counter clockwise ↺ one full revolution.
Draw an ↷ around **Gear** Ⓓ to show the direction of rotation.



Complete for meshed gears Ⓒ & Ⓓ

Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio
C Input	40	CCW ↺	1	/
D Output	20			

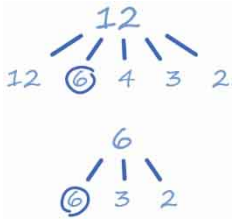
▶ Did changing the **direction of rotation** affect the revolutions' ratio? _____

REDUCING RATIOS

▶ Many ratios can be written with smaller numbers – this is called **reducing**, or simplifying.

▶ Reduce both values. Divide each by the same **common factor** (number).

Find the **common factor** that's divisible between the **input** and **output** numbers.



$\frac{12}{6}$ reduced by 6 (common factor) = $\frac{2}{1}$

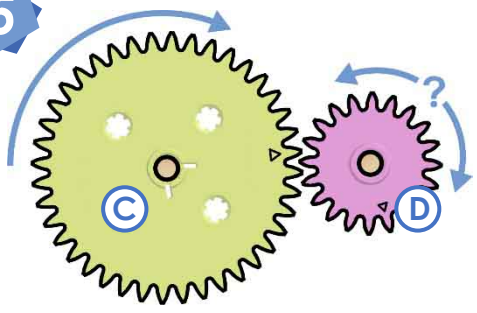
Reduced Ratio

4 Reduce these ratios on your own:

$\frac{10}{5}$ reduced by ___ (common factor) = ___

$\frac{30}{15}$ reduced by ___ (common factor) = ___

5



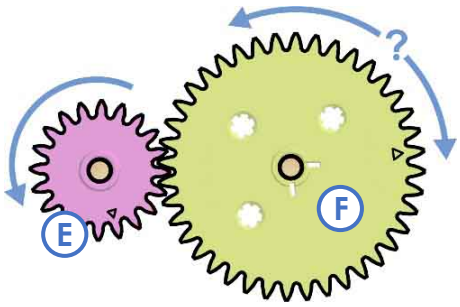
Complete for meshed gears Ⓒ & Ⓓ

Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio	Reduced Ratio
C Input	40	CW ↻	6	/	/
D Output	20				

Reduce to a Fraction

SWITCH IT UP!

6 Switch your 20-Tooth and 40-Tooth gears. Using a dowel, spin **Gear** (E) (now the **input**) clockwise.



Complete for meshed gears (E) & (F)

Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio	Reduced Ratio
E Input	20	CW	6		
F Output	40				

Inverse from before

▶ How did switching input and output gear size affect the revolutions' ratio? _____

_____

GEAR TEETH RATIO

7 **Teeth** allow gears to mesh and indicate gear **size**. Look at the **tooth ratio** of your meshed gears. *How does it compare to the revolutions' ratio?* _____

▶ Reduce the tooth ratio values:

40/40 tooth reduces to: ____ / ____

40/20 tooth reduces to: ____ / ____

20/40 tooth reduces to: ____ / ____

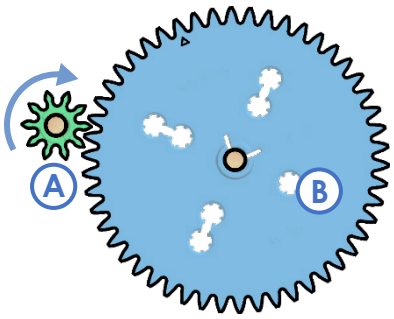
▶ Predict for other gear combinations:

10/50 tooth reduces to: ____ / ____

50/20 tooth reduces to: ____ / ____

10/40 tooth reduces to: ____ / ____

8 Comparing the number of **teeth** in one gear to another is called **gear ratio.** Spin the 10-Tooth and 50-Tooth gear combination on the base. **Reduce** and then compare the results to your above predictions.

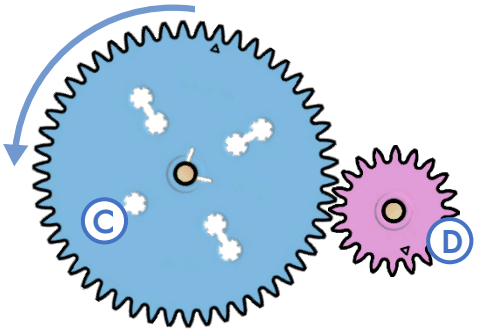


Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio	Reduced Ratio
A Input	10	CW	12		
B Output	50				

▶ Was the reduced ratio the same as the tooth ratio?

_____

9 Now, spin the 50-Tooth and 20-Tooth gear combination on the base. **Reduce** and then compare the results to your above predictions.

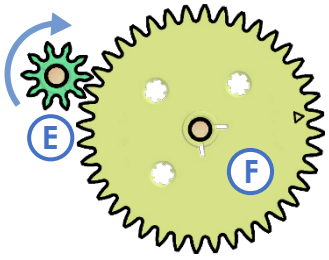


Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio	Reduced Ratio
C Input	50	CCW ↺	12		
D Output	20				

▶ Was the reduced ratio the same as the tooth ratio?

_____

10 Now, spin the 10-Tooth and 40-Tooth gear combination on the base. **Reduce** and then compare the results to your above predictions.



Gear	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio	Reduced Ratio
E Input	10	CW ↻	12		
F Output	40				

▶ Was the reduced ratio the same as the tooth ratio?

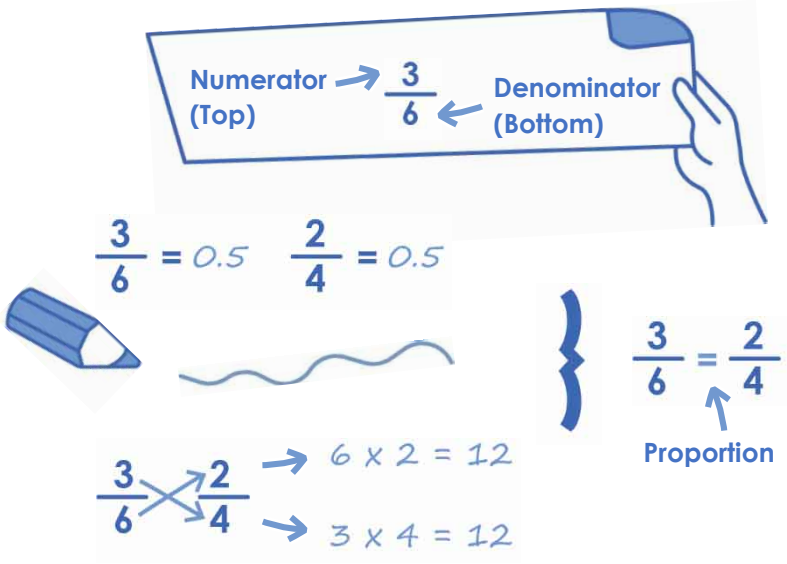
_____

PROPORTIONS

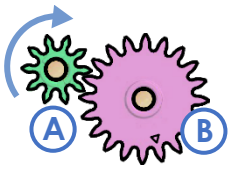
▶ A **proportion** is an equation showing that two ratios are **equal**.

□ **Choice #1:**
Convert ratios into **decimal**s by dividing the **numerator** by the **denominator**.

□ **Choice #2:**
Determine a **cross product** by multiplying the **numerator** of one fraction by the **denominator** of another fraction.

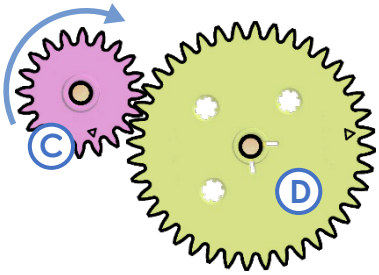


11 Spin the gear combinations to determine their ratio. Write it as a **fraction**.
*The input's revolutions are the **numerator**, while the output's the **denominator**.*



Gears I	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio	Reduced Ratio	Fraction
A Input	20	CW	6			
B Output	10					

Use for Proportion



Gears II	# of Teeth	Rotation Direction	# of Revolutions	Revolutions' Ratio	Reduced Ratio	Fraction
C Input	40	CW	6			
D Output	20					

▶ Were the ratios of meshed gears I & II equal **proportions**?

_____

_____

Gears I Fraction $\frac{\square}{\square} = \frac{\square}{\square}$ Gears II Fraction

12 Balance the **proportions** below by converting to decimals or multiplying the cross products.

$\frac{50}{40} = \frac{\square}{32}$ $\qquad \frac{3}{5} = \frac{6}{\square}$ $\qquad \frac{86}{2} = \frac{43}{\square}$

GEAR TRAINS

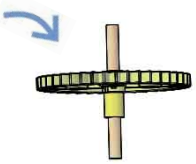
Meshing multiple gears together creates a **gear train**, transmitting **force** (power) to do one of three things:

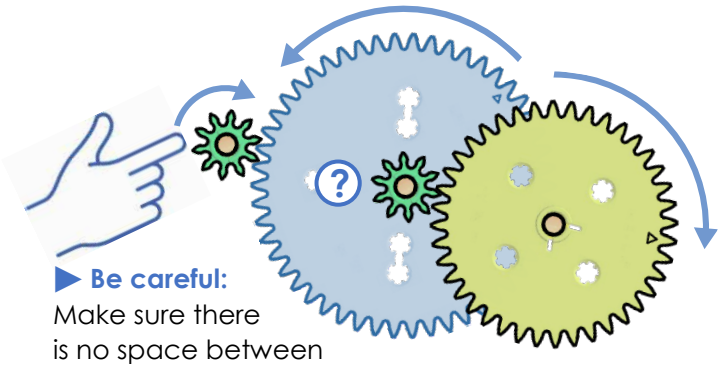
- ▶ **Change Speed**
- ▶ **Change Force (Power)**
- ▶ **Change Direction**

Compound gear trains are attached gears that rotate around the same **center**.

Gear Trains can be as small as two gears, or many more in big, industrial machines.

13 Create a **compound gear** by stacking a 10-Tooth on a 50-Tooth Gear and meshing the 10-Tooth with a 40-Tooth gear that has **slide stop** on its dowel.



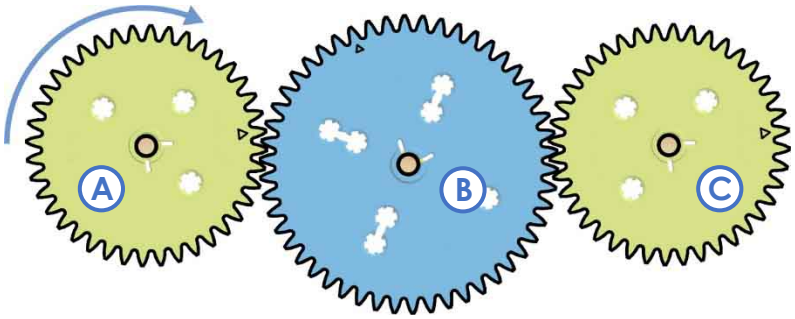


▶ **Be careful:**
Make sure there is no space between the stacked gears.

▶ Which **direction** did the 10-Tooth gear on the **compound gear** rotate?

Clockwise ↻ Counter Clockwise ↺

14 Mesh two 40-Tooth gears on either side of a 50-Tooth gear on the base plate. Spin **Gear** Ⓐ clockwise ↻ one full **revolution**. Draw an ↷ around **Gear** Ⓑ and **Gear** Ⓒ to show their directions of **rotation**.



Gear	# of Teeth	Rotation Direction	# of Revolutions
A Input	40	CW ↻	1
B Output	50		
C Output	40		

▶ The revolutions' ratio for **Gear** Ⓐ and **Gear** Ⓑ ? _____ : _____

▶ The revolutions' ratio for **Gear** Ⓑ and **Gear** Ⓒ ? _____ : _____

15 A gear inserted *between* two or more gears is known as the **idler-wheel**. It works to keep the direction of rotation of the input and output gears the same, without affecting **gear ratio**.

▶ Which gear in the gear train above acts as the idler-wheel? Why? _____

_____

_____

▶ Multiply the two ratios together.
(_____ : _____) x (_____ : _____)
= _____ : _____ (**reduce** if you can).