# Investigation 12D: Gear Ratios

Essential question: How do gears work?
How do the number of teeth affect the turns of a gear machine?

A gear is a wheel with teeth that interlock with matching teeth on another gear. Gears are found in many machines from cars to CD players and bicycles because gears efficiently transmit rotating motion and can create mechanical advantage. In this investigation you will create machines with two and three gears. The goal is to find a formula which relates the number of teeth to the number of turns.

Making a gear ratio

Spacers (3)

Nut

20 Tooth gear

Index mark ◎

40 Tooth gear

Counting turns

Input gear

Count turns until the index marks line up again.
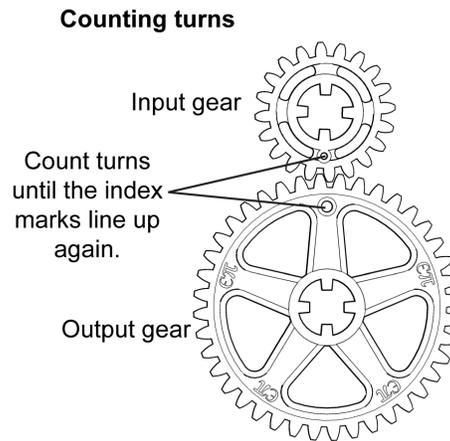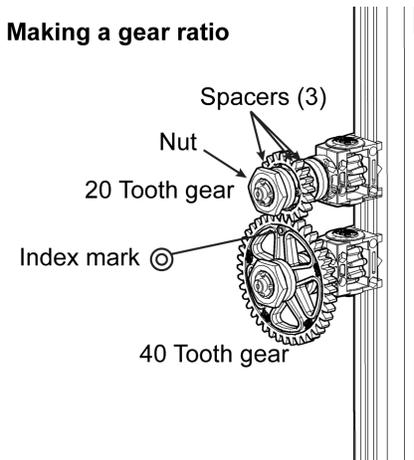
Output gear

Build and test following machines.

1

Input 20 T

Output 60 T

2

Input 20 T

Output 40 T

3

Input 40 T

Output 60 T

4

Input 20 T

40 T

Output 60 T

5

Input 20 T

40 T

Output 20 T
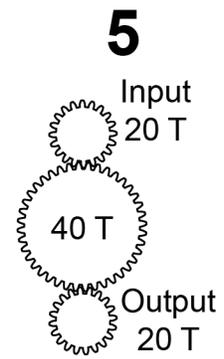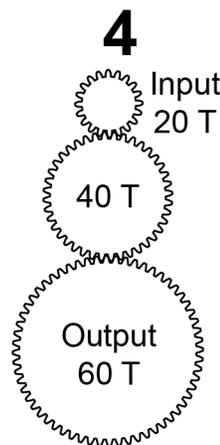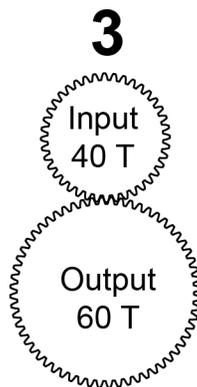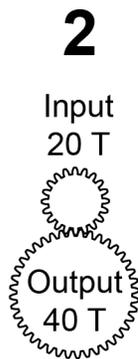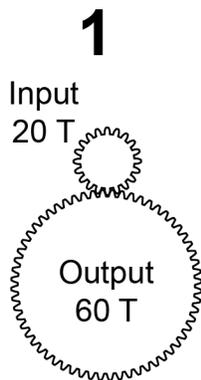
1. For each machine, write down the numbers of teeth in each gear.
2. Count how many turns of the input gear it takes to make one turn of the output gear.

Table 1: Teeth and turns data

Machine	Input gear teeth	Input gear turns	Output gear teeth	Output gear turns
1	20		60	
2	20		40	
3	40		60	
4	20		60	
5	20		20	

Questions and analysis

1. Write a formula for each machine that looks like the formula below.

$$(\ ? \ ) \times (\ ? \ ) = (\ ? \ ) \times (\ ? \ )$$

   Formula:

   Each (?) should be one of the four variables below.

   Input turns, Output turns, Input teeth, Output teeth

2. Test your formula for at least three different combinations.

3. Rearrange your formula to be in the form of two ratios that must be equal.

   Teeth $\dfrac{(\ ? \ )}{(\ ? \ )} = \dfrac{(\ ? \ )}{(\ ? \ )}$ Turns

   Ratio formula:

4. Test your ratio formula for at least two different combinations.

5. Rearrange your formula once again to give the number of output turns in terms of the number of input turns and a ratio of teeth.

$$(\ \text{Output turns} \ ) = \frac{(\ ? \ )}{(\ ? \ )} \times (\ \text{Input turns} \ )$$

Output turns formula:

1. Test your ratio formula for at least two different combinations.