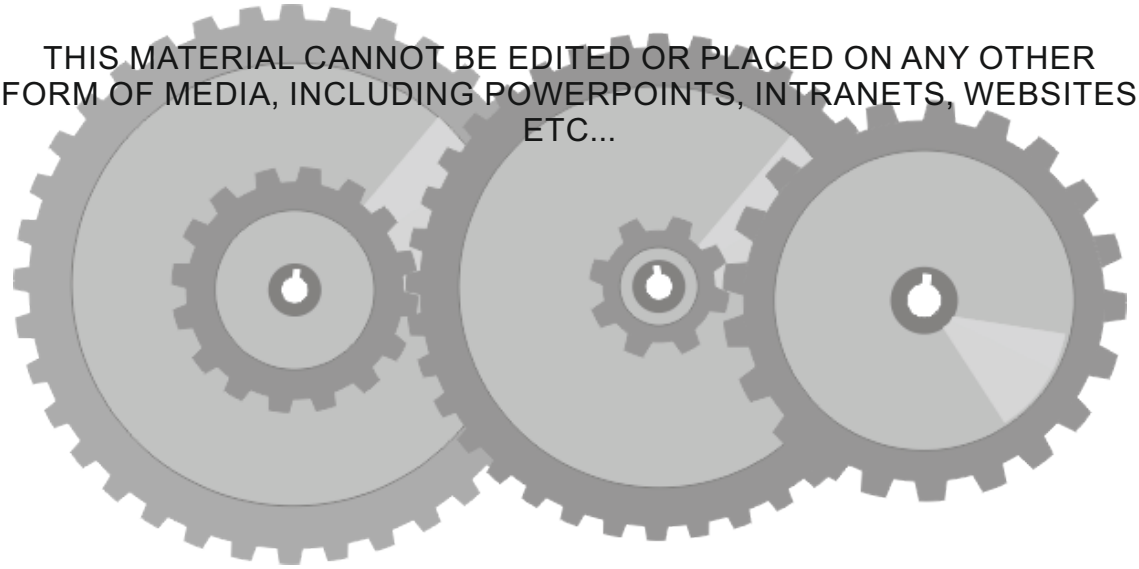
MATHEMATICAL SKILLS

GEARS, GEAR TRAINS AND COMPOUND GEARS

ASSOCIATED EXAMINATION QUESTIONS

DESIGN AND TECHNOLOGY



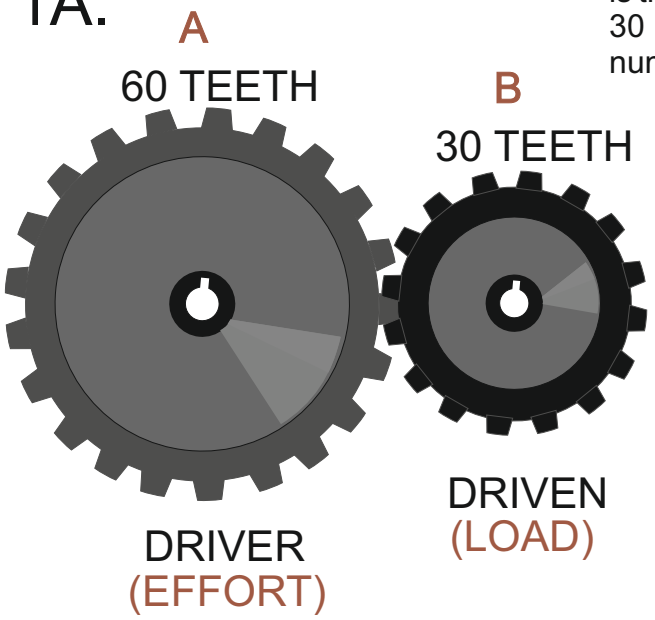
WORLD ASSOCIATION OF TECHNOLOGY TEACHERS https://www.facebook.com/groups/254963448192823/ www.technologystudent.com © 2017 V.Ryan © 2017

CALCULATING GEAR RATIO (VELOCITY RATIO)

In examinations, one of the first questions will be - to work out the 'gear ratio' (sometimes called velocity ratio). As a guide - always assume that the larger gear revolves one revolution. The number of rotations of the second gear has then to be worked out.

1A.

In the example below, the DRIVER has 60 teeth and because it is the largest we say that it revolves once. The DRIVEN gear has 30 teeth. Simply divide 60 teeth by 30 teeth to work out the number of revolutions of the driven gear.



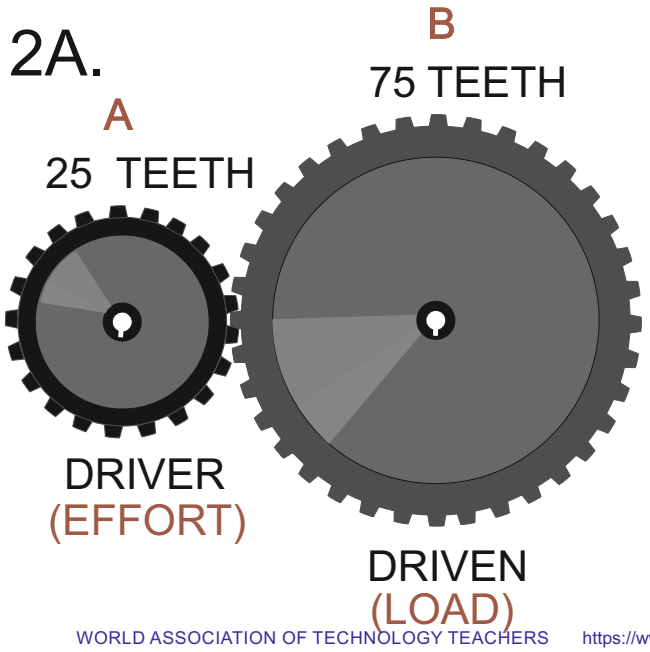
GEAR RATIO / VELOCITY RATIO

$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\text{60T (GEAR A)}}{\text{30T (GEAR B)}}$$

$$= \frac{1}{2} = \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \text{Driver : Driven} = 1 : 2$$

2A.

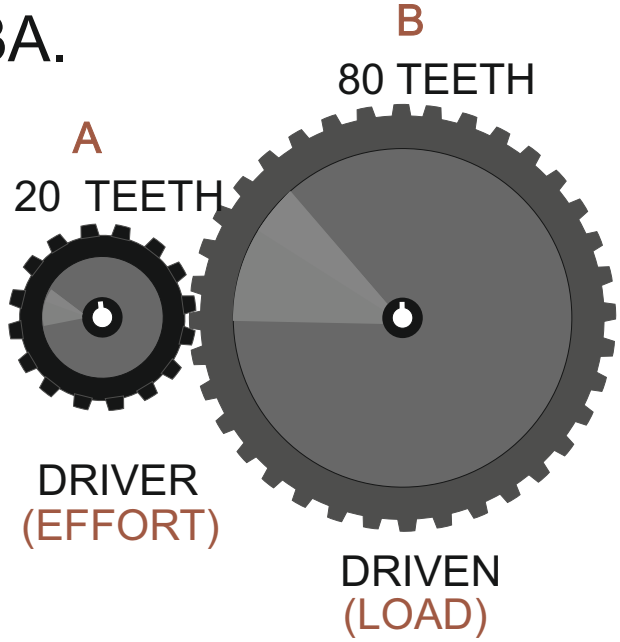


$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\text{25T (GEAR A)}}{\text{75T (GEAR B)}}$$

$$= \frac{3}{1} = \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \text{Driver : Driven} = 3 : 1$$

3A.



$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\text{20T (GEAR A)}}{\text{80T (GEAR B)}}$$

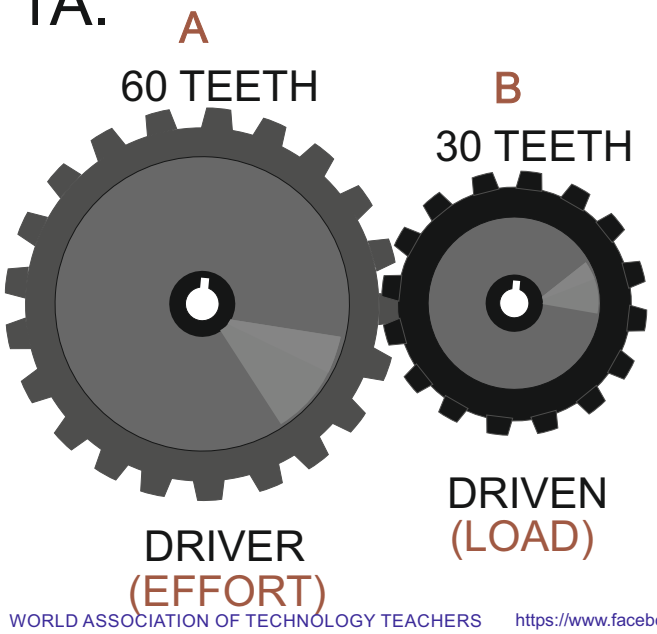
$$= \frac{4}{1} = \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \text{Driver : Driven} = 4 : 1$$

CALCULATING GEAR RATIO (VELOCITY RATIO)

In examinations, one of the first questions will be - to work out the 'gear ratio' (sometimes called velocity ratio). As a guide - always assume that the larger gear revolves one revolution. The number of rotations of the second gear has then to be worked out.

1A.



GEAR RATIO / VELOCITY RATIO

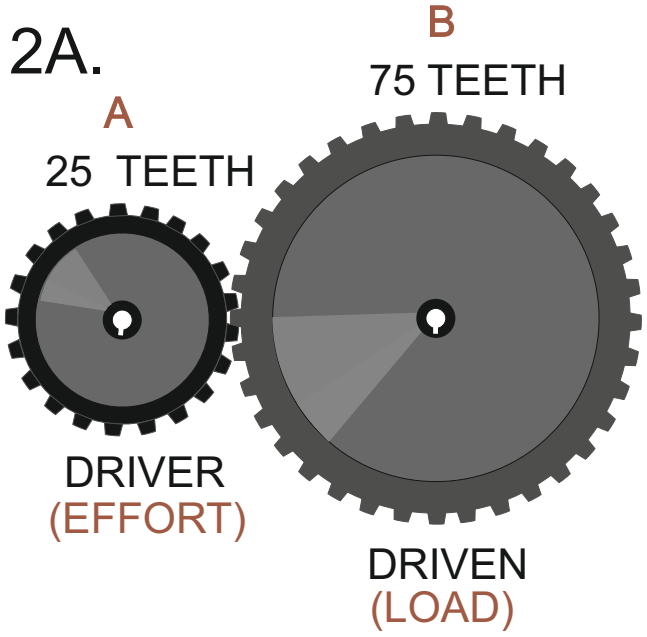
$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\quad}{\quad}$$

$$= - = \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \text{Driver} : \text{Driven}$$

$$:$$

2A.



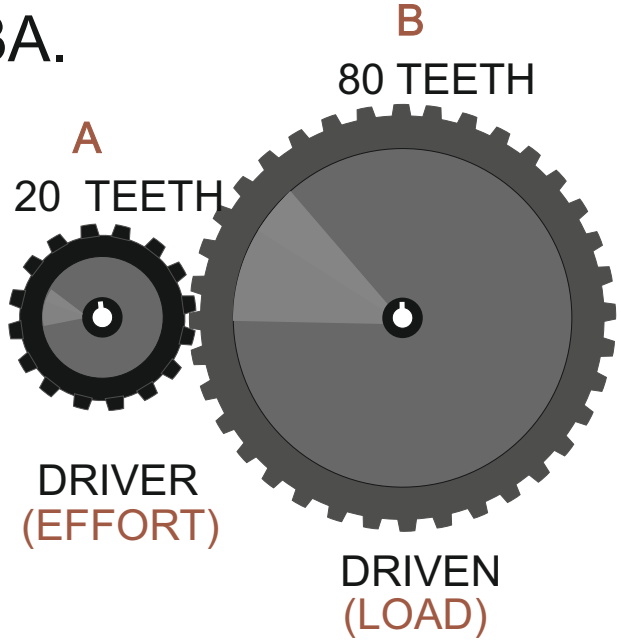
$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\quad}{\quad}$$

$$= - = \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \text{Driver} : \text{Driven}$$

$$:$$

3A.



$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\quad}{\quad}$$

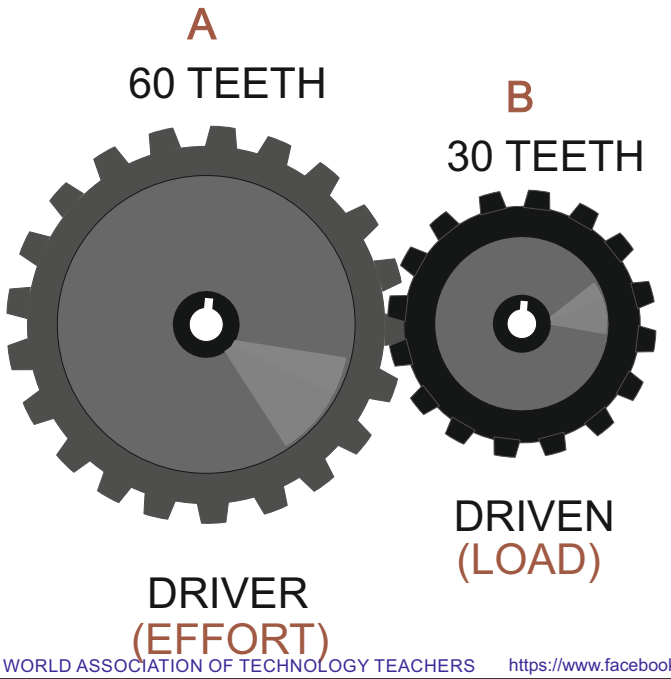
$$= - = \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \text{Driver} : \text{Driven}$$

$$:$$

CALCULATING REVOLUTIONS PER MINUTE (RPM)

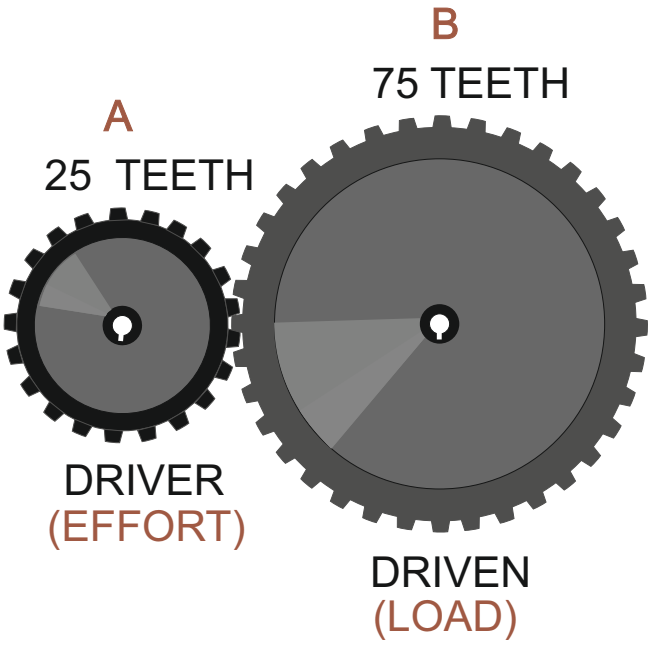
In the example below, the DRIVER gear is larger than the DRIVEN gear. The general rule is - large to small gear means 'multiply' the velocity ratio by the rpm of the first gear. Divide 60 teeth by 30 teeth to find the velocity ratio. Multiply this number (2) by the rpm (120). This gives an answer of 240rpm.



GEAR A	GEAR B
60 teeth	30 teeth
120 rpm	?

$$\frac{60}{30} = 2$$

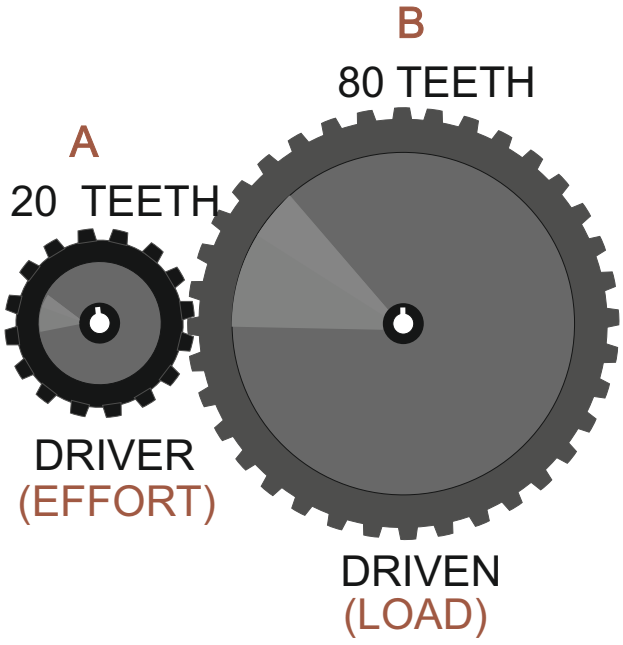
$$= 120 \times 2 = 240 \text{ revs/min}$$



GEAR A	GEAR B
25 teeth	75 teeth
60 rpm	?

$$\frac{75}{25} = 3$$

$$= \frac{60}{3} = 20 \text{ revs/min}$$

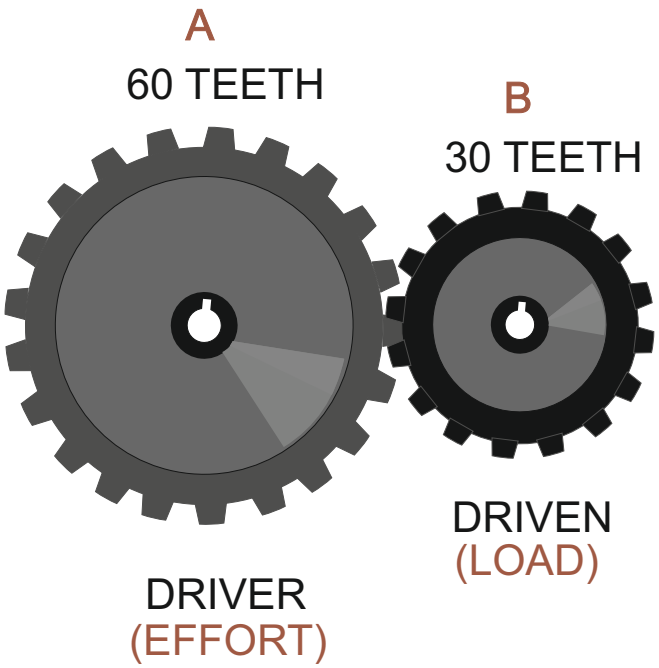


GEAR A	GEAR B
20 teeth	80 teeth
100 rpm	?

$$\frac{80}{20} = 4$$

$$= \frac{100}{4} = 25 \text{ revs/min}$$

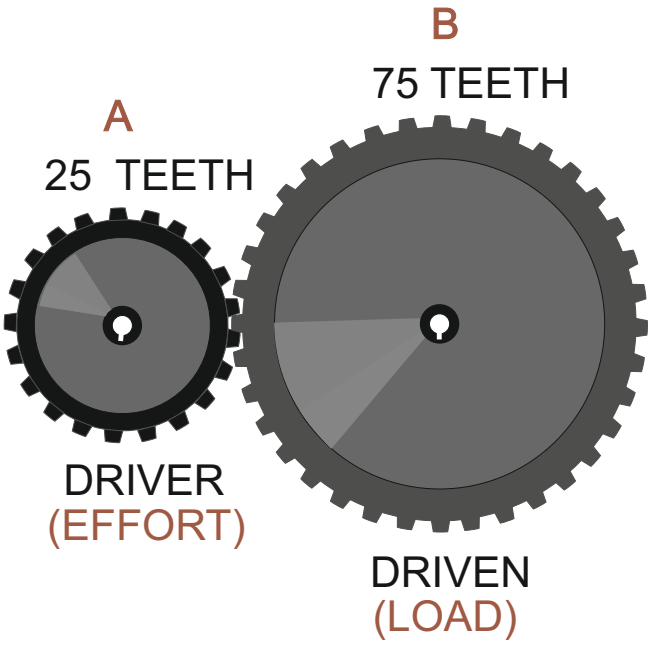
CALCULATING REVOLUTIONS PER MINUTE (RPM)



GEAR A	GEAR B
60 teeth	30 teeth
120 rpm	

— =

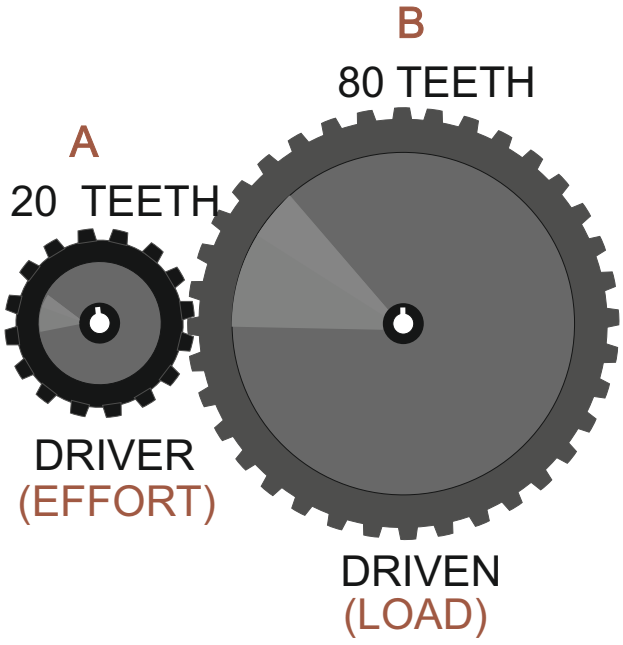
= = revs/min



GEAR A	GEAR B
25 teeth	75 teeth
60 rpm	

— =

= — = revs/min



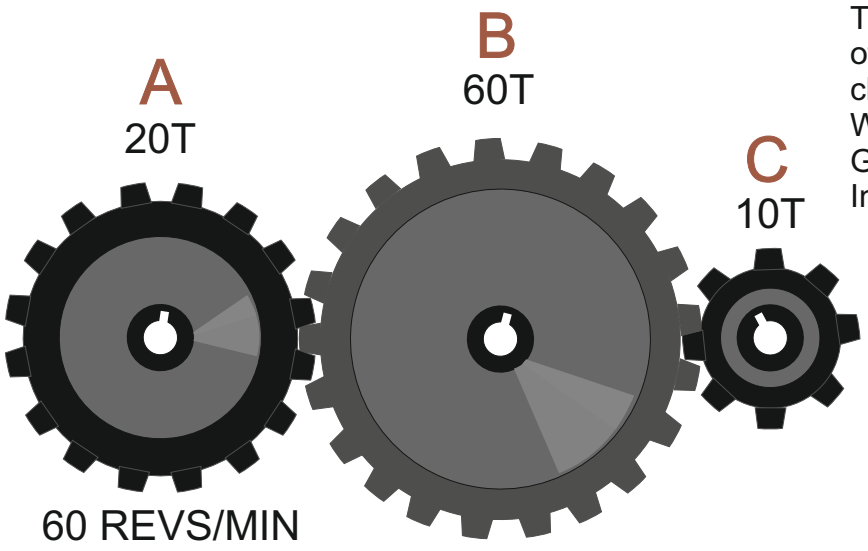
GEAR A	GEAR B
20 teeth	80 teeth
100 rpm	

— =

= — = revs/min

GEAR TRAINS - EXAMPLE QUESTIONS AND ANSWERS

When faced with three gears, the question can be broken down into two parts. First work on Gears A and B. When this has been solved, work on gears B and C.



The diagram above shows a gear train composed of three gears. Gear A revolves at 60 revs/min in a clockwise direction.
What is the output in revolutions per minute at Gear C?
In what direction does Gear C revolve ?

GEAR A	GEAR B	GEAR C
20 teeth	60 teeth	10 teeth
60 rpm	?	?

First work out the speed at Gear B. $\frac{60 \text{ teeth}}{20 \text{ teeth}} \frac{B}{A} = 3$

$= \frac{60 \text{rpm}}{3} =$ 20 revs/min at 'B'

(Remember B is larger than A therefore, B outputs less revs/min and is slower)

Next, take B and C. C is smaller, therefore, revs/minute will increase and rotation will be faster.

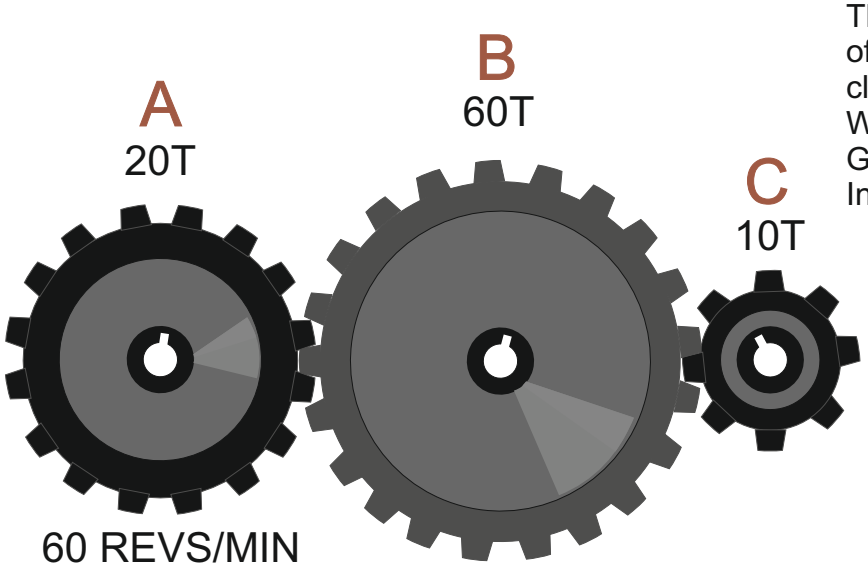
$\frac{60 \text{ teeth}}{10 \text{ teeth}} \frac{B}{C} = 6$

20 REVS X 6 = 120 revs/min at 'C'

What direction does C revolve ?
A is clockwise, B consequently is anti-clockwise and C is therefore clockwise.

GEAR TRAINS - EXAMPLE QUESTIONS

When faced with three gears the question can be broken down into two parts. First work on Gears A and B. When this has been solved work on gears B and C.



The diagram above shows a gear train composed of three gears. Gear A revolves at 60 revs/min in a clockwise direction.
What is the output in revolutions per minute at Gear C?
In what direction does Gear C revolve ?

GEAR A	GEAR B	GEAR C
20 teeth	60 teeth	10 teeth
60 rpm		

First work out the speed at Gear B. $\frac{\text{\_\_ teeth}}{\text{teeth}} \frac{B}{A} =$

$= \frac{60\text{rpm}}{\text{\_\_}} = \text{\_\_\_revs/min at 'B'}$

(Remember B is larger than A therefore, B outputs less revs/min and is slower)

Next, take B and C. C is smaller, therefore, revs/minute will increase and rotation will be faster.

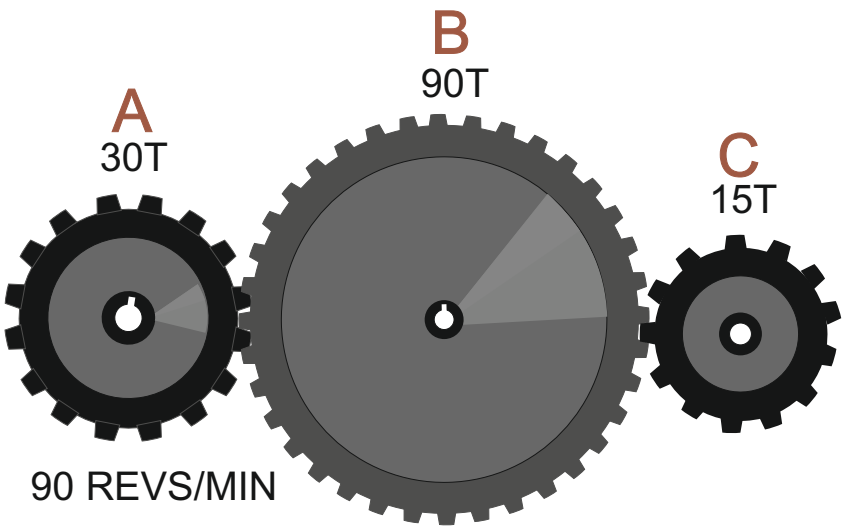
$\frac{\text{\_\_ teeth}}{\text{teeth}} \frac{B}{C} =$

__REVS X __ = ____revs/min at 'C'

What direction does C revolve ?
A is clockwise, B consequently is anti-clockwise and C is therefore _____

GEAR TRAINS - EXAMPLE QUESTIONS AND ANSWERS

When faced with three gears the question can be broken down into two parts. First work on Gears A and B. When this has been solved work on gears B and C.



The diagram opposite shows a gear train composed of three gears. Gear A revolves at 90 revs/min in a clockwise direction.
What is the output in revolutions per minute at Gear C?
In what direction does Gear C revolve ?

GEAR A	GEAR B	GEAR C
30 teeth	90 teeth	15 teeth
90 rpm	?	?

First work out the speed at Gear B. $\frac{90 \text{ teeth}}{30 \text{ teeth}} \frac{B}{A} = 3$

$= \frac{90 \text{rpm}}{3} = 30$ revs/min at 'B'

(Remember B is larger than A therefore, B outputs less revs/min and is slower)

Next, take B and C. C is smaller, therefore, revs/minute will increase and rotation will be faster.

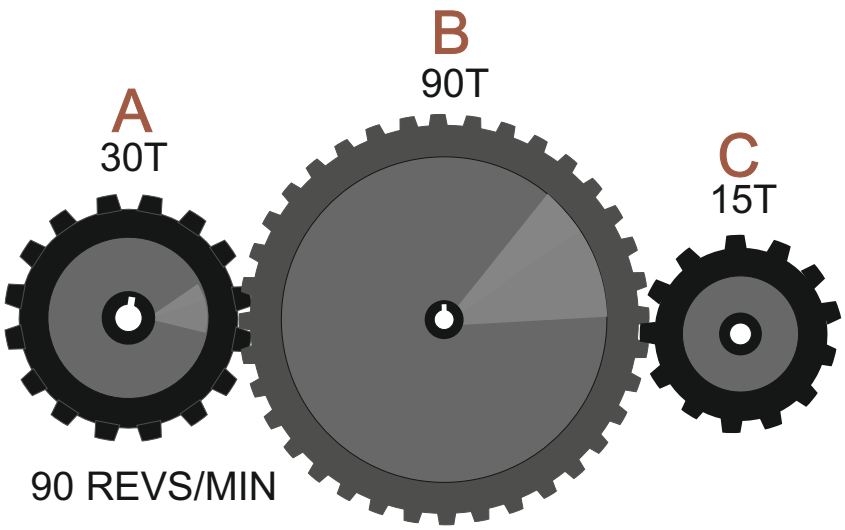
$\frac{90 \text{ teeth}}{15 \text{ teeth}} \frac{B}{C} = 6$

30 REVS X 6 = 180 revs/min at 'C'

What direction does C revolve ?
A is clockwise, B consequently is anti-clockwise and C is therefore clockwise.

GEAR TRAINS - EXAMPLE QUESTIONS AND ANSWERS

When faced with three gears the question can be broken down into two parts. First work on Gears A and B. When this has been solved work on gears B and C.



The diagram opposite shows a gear train composed of three gears. Gear A revolves at 90 revs/min in a clockwise direction.
What is the output in revolutions per minute at Gear C?
In what direction does Gear C revolve ?

GEAR A	GEAR B	GEAR C
30 teeth	90 teeth	15 teeth
90 rpm		

First work out the speed at Gear B. $\frac{\text{teeth}}{\text{teeth}}\ \frac{B}{A} =$

$= \frac{90_{rpm}}{\quad} = \_\_\_\_$ revs/min at 'B'

(Remember B is larger than A therefore, B outputs less revs/min and is slower)

Next, take B and C. C is smaller, therefore, revs/minute will increase and rotation will be faster.

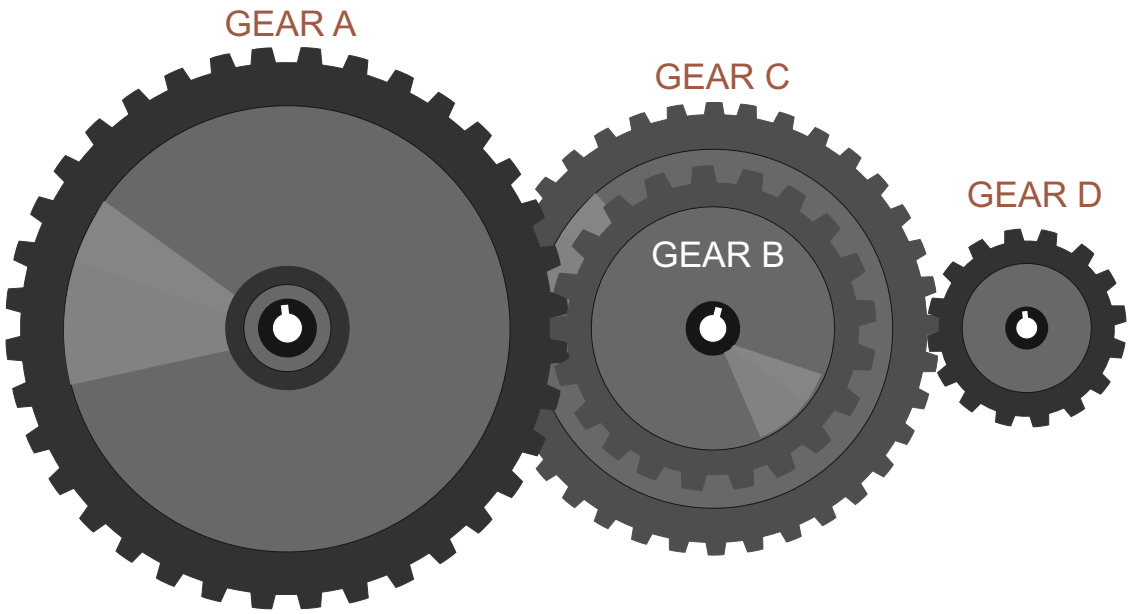
$\frac{\text{teeth}}{\text{teeth}}\ \frac{B}{C} =$

__ REVS X __ = ___ revs/min at 'C'

What direction does C revolve ?
A is clockwise, B consequently is anti-clockwise and C is therefore _____

COMPOUND GEARS - EXAMPLE QUESTIONS AND ANSWERS

Below is a question regarding 'compound gears'. Gears C and B represent a compound gear as they appear 'fixed' together. When drawn with a compass they have the same centre. Two gears 'fixed' together in this way rotate together and at the same RPM. When answering a question like this split it into two parts. Treat gears A and B as one question AND C and D as the second part.



This is an example of a “compound gear train”. Gear A rotates in a clockwise direction at 30 revs/min. What is the output in revs/min at D and what is the direction of rotation ?

GEAR A	GEAR B	GEAR C	GEAR D
120 teeth	40 teeth	80 teeth	20 teeth

First find revs/min at Gear B.

$$\frac{120 \text{ teeth}}{40 \text{ teeth}} \frac{B}{A} = 3$$

30 rpm X 3 = 90 rpm / min

B is smaller therefore it rotates faster and revs/min increase.

C is fixed to B and therefore, rotates at the same speed.

90 REVS/MIN at C

Next find revs/min at Gear D.

$$\frac{80 \text{ teeth}}{20 \text{ teeth}} \frac{C}{D} = 4$$

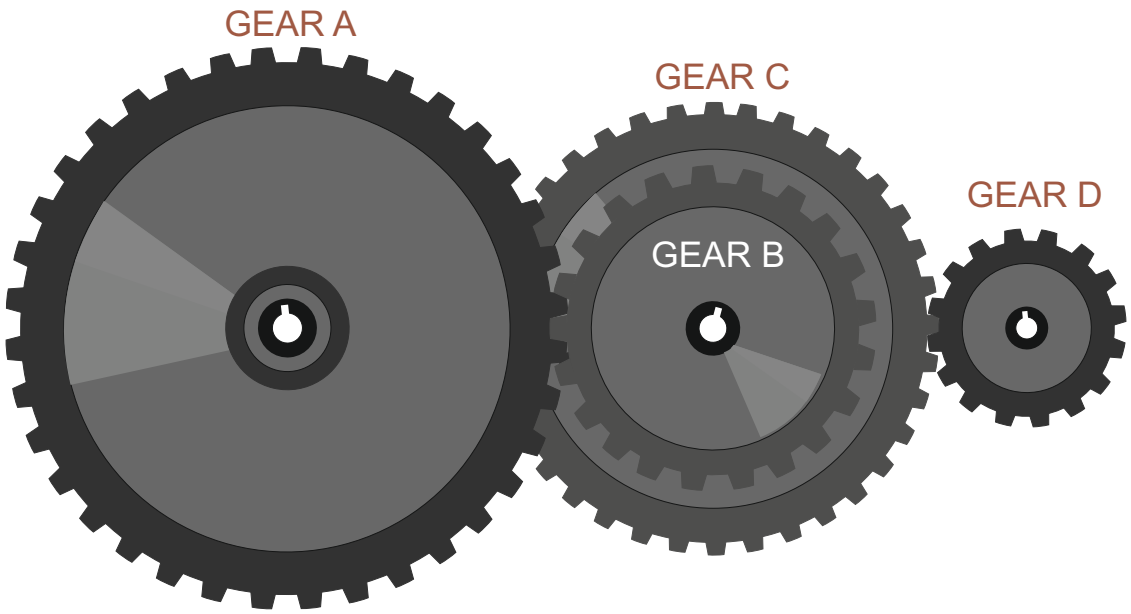
90 rpm (at C) X 4 = 360 rpm / min

D is smaller than C, therefore rotates faster (increased revs/min).

A revolves in a clockwise direction, B is therefore anti-clockwise, C is fixed to B and is also anti-clockwise, which means D revolves in a clockwise direction.

COMPOUND GEARS - EXAMPLE QUESTIONS AND ANSWERS

Below is a question regarding 'compound gears'. Gears C and B represent a compound gear as they appear 'fixed' together. When drawn with a compass they have the same centre. Two gears 'fixed' together in this way rotate together and at the same RPM. When answering a question like this split it into two parts. Treat gears A and B as one question AND C and D as the second part.



This is an example of a "compound gear train". Gear A rotates in a clockwise direction at 30 revs/min. What is the output in revs/min at D and what is the direction of rotation ?

GEAR A	GEAR B	GEAR C	GEAR D
120 teeth	40 teeth	80 teeth	20 teeth

First find revs/min at Gear B. $\frac{\text{teeth}}{\text{teeth}}\ \frac{B}{A} =$

__ rpm X __ = __ rpm / min

B is smaller therefore it rotates faster and revs/min increase.

C is fixed to B and therefore, rotates at the same speed.

__ REVS/MIN at C

Next find revs/min at Gear D. $\frac{\text{teeth}}{\text{teeth}}\ \frac{C}{D} =$

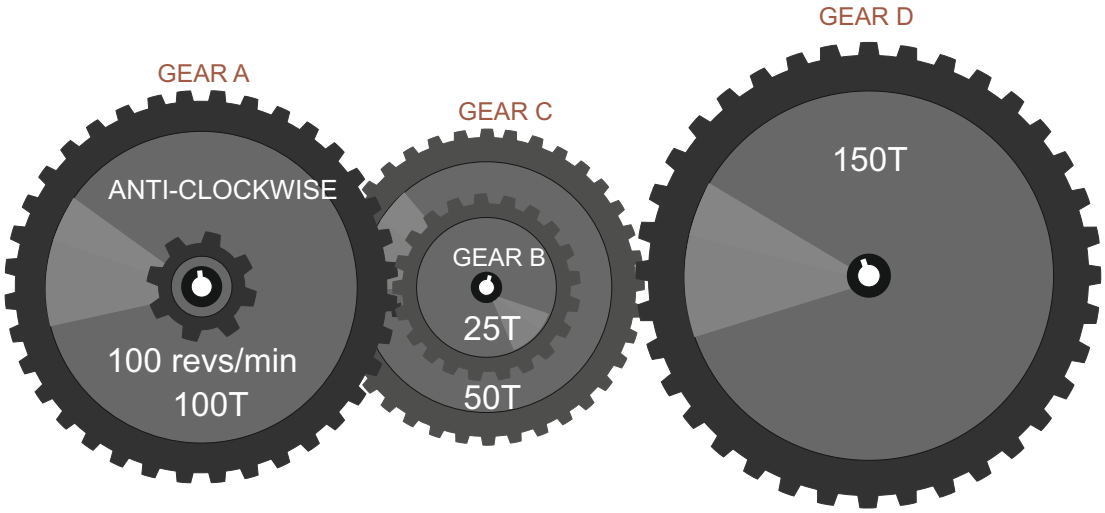
__ rpm (at C) X _ = ___ rpm / min

D is smaller than C, therefore rotates faster (increased revs/min).

A revolves in a clockwise direction, B is therefore anti-clockwise, C is fixed to B and is also anti-clockwise, which means D revolves in a _____ __direction.

COMPOUND GEARS- EXAMPLE QUESTIONS AND ANSWERS

Try the following question:



What is the revs/min at gear D and what is its direction?