A LEVEL DESIGN ENGINEERING

6.4 MECHANISMS PART 4

Learning objectives

- What are levers?
- What are the different types of lever?
- What is the basic machine principle?
- What is mechanical advantage of a lever?

Key words:

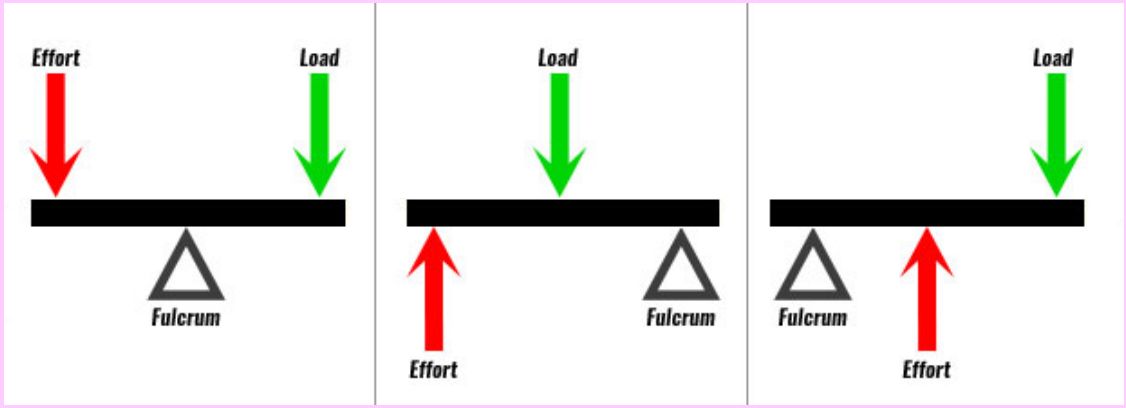
Lever, basic machine principle, mechanical advantage

Learning objectives:

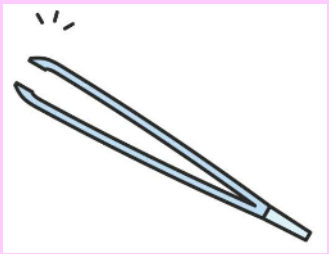
- What is a mechanism?
- What are the types of mechanism?
- How are mechanisms used in products?

Explanation

What are the types of lever?



What are the common applications?

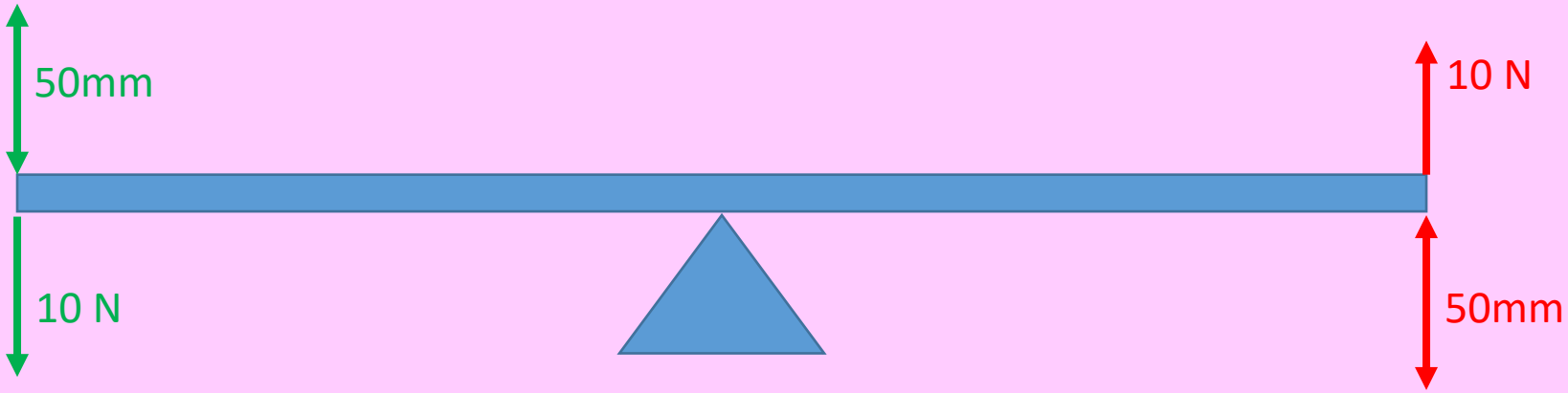


Learning objectives:

- ❑ What is a mechanism?
- ❑ What are the types of mechanism?
- ❑ How are mechanisms used in products?

Explanation

What is the basic machine principle?



Input force x distance moved by input = Output force x distance moved by output

10 X 50 = 10 X 50

500 = 500

Learning objectives:

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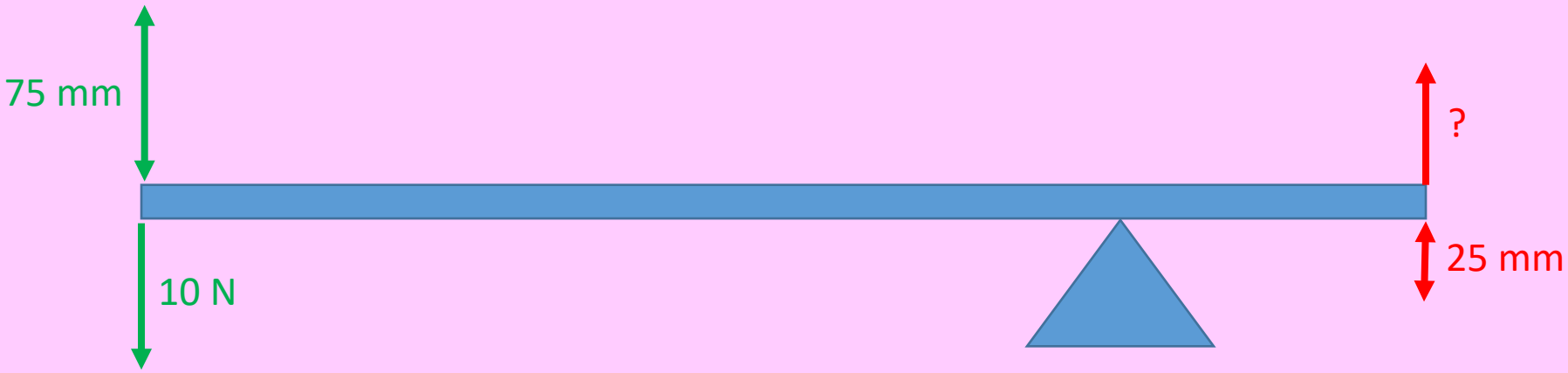
Explanation

What is the basic machine principle?



Input force x distance moved by input = Output force x distance moved by output

10 X 75 = 25 X ?

750/25 = 30 N

Learning objectives:

- ❑ What is a mechanism?
- ❑ What are the types of mechanism?
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Explanation

What do we mean by the term mechanical advantage (MA)?

Definition: the ratio of output force to the input force

$$Mechanical\ advantage(MA) = \frac{output\ force}{input\ force}$$

$MA = \frac{50}{10}$ $MA = 5$

Learning objectives:

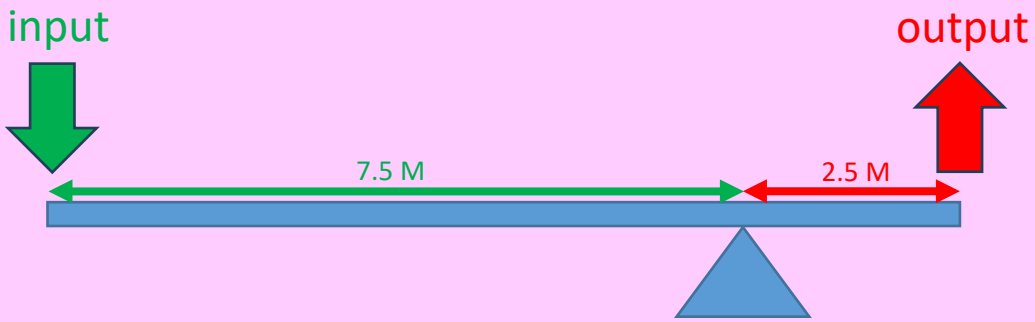
- What is a mechanism?
- What are the types of mechanism?
- How are mechanisms used in products?

Explanation

Alternative ways to calculate **mechanical advantage**

Using lever lengths…

$$MA = \frac{input\ arm\ length}{output\ arm\ length}$$



$$MA = \frac{7.5}{2.5}$$

$$MA = 3$$

Learning objectives:

- ❑ What is a mechanism?
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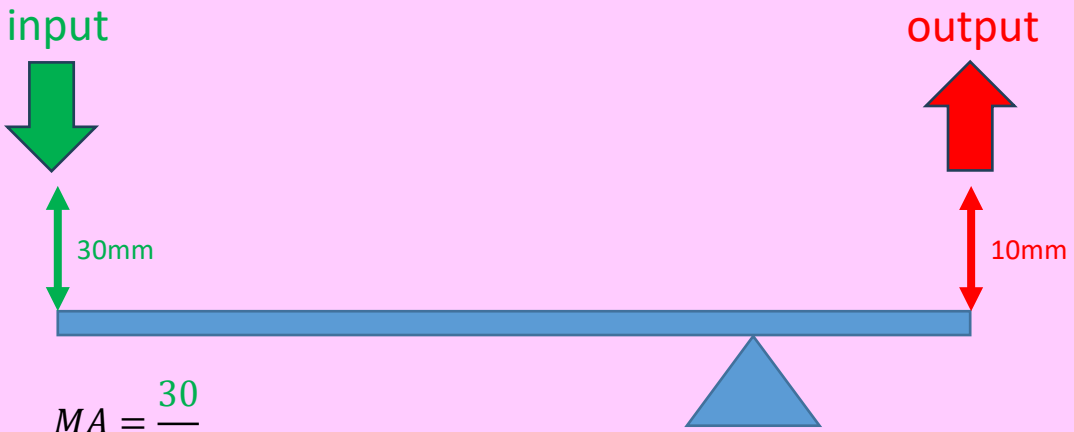
Explanation

Alternative ways to calculate **mechanical advantage**

Using distance moved…

$$MA = \frac{distance\ moved\ by\ effort}{distance\ moved\ by\ load}$$



$$MA = \frac{30}{10}$$

$$MA = 3$$

Learning objectives:

- ❑ What is a mechanism?
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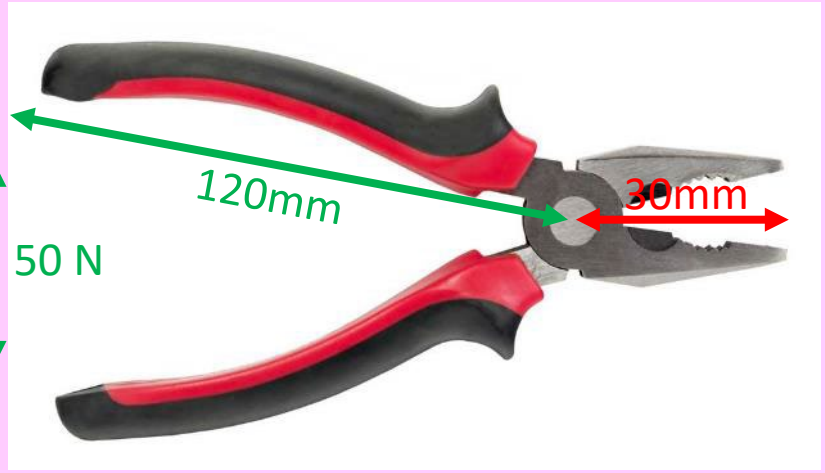
Explanation

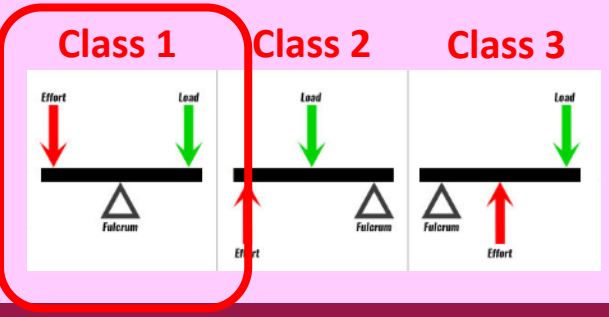
How can we use **mechanical advantage**?



$$MA = \frac{\text{Input arm length}}{\text{Output arm length}}$$

$$MA = \frac{120}{30}$$

MA = 4 Input force = 50 N



output force = input force x mechanical advantage

Output force = 50 x 4

Output force = 200N

Learning objectives:

- ❑ What is a mechanism?
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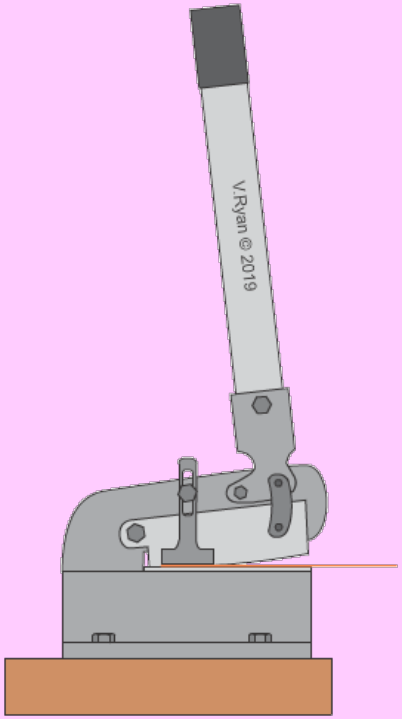
Explanation

What is a compound lever?

A compound lever is a machine comprising of several levers acting in series

Simple single lever



Learning objectives:

- ❑ What is a mechanism?
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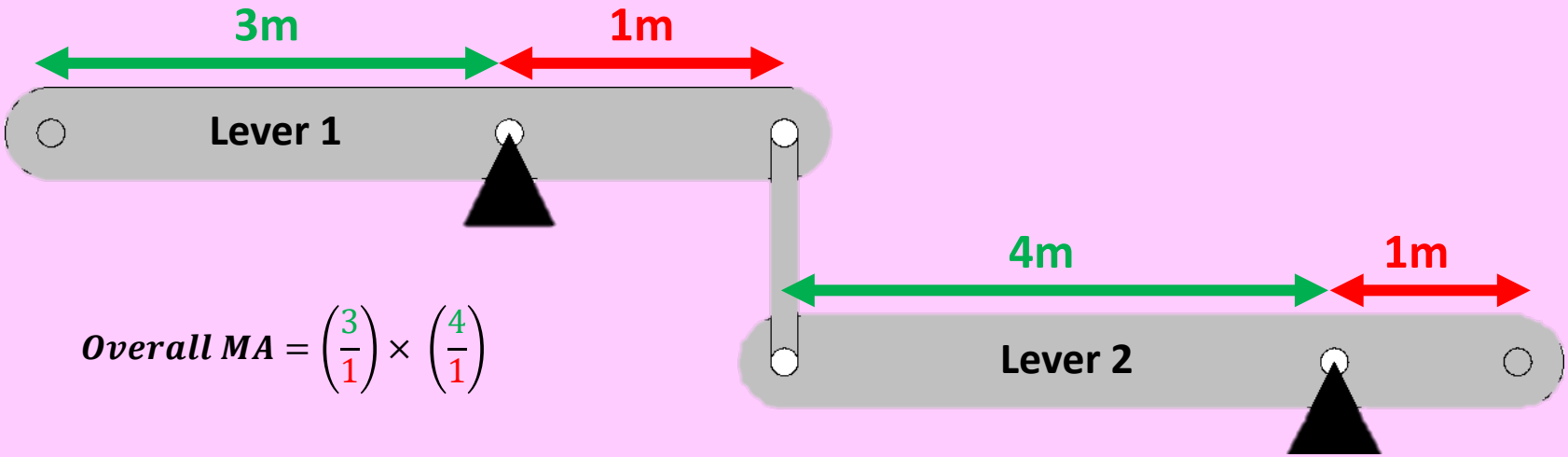
Explanation

How do we calculate mechanical advantage of a compound lever?

Overall MA = MA Lever 1 x MA Lever 2

$$Overall\ MA = \left(\frac{input\ arm\ length}{output\ arm\ length}\right) \times \left(\frac{input\ arm\ length}{output\ arm\ length}\right)$$



$$Overall\ MA = \left(\frac{3}{1}\right) \times \left(\frac{4}{1}\right)$$

$$Overall\ MA = 12$$

Learning objectives:

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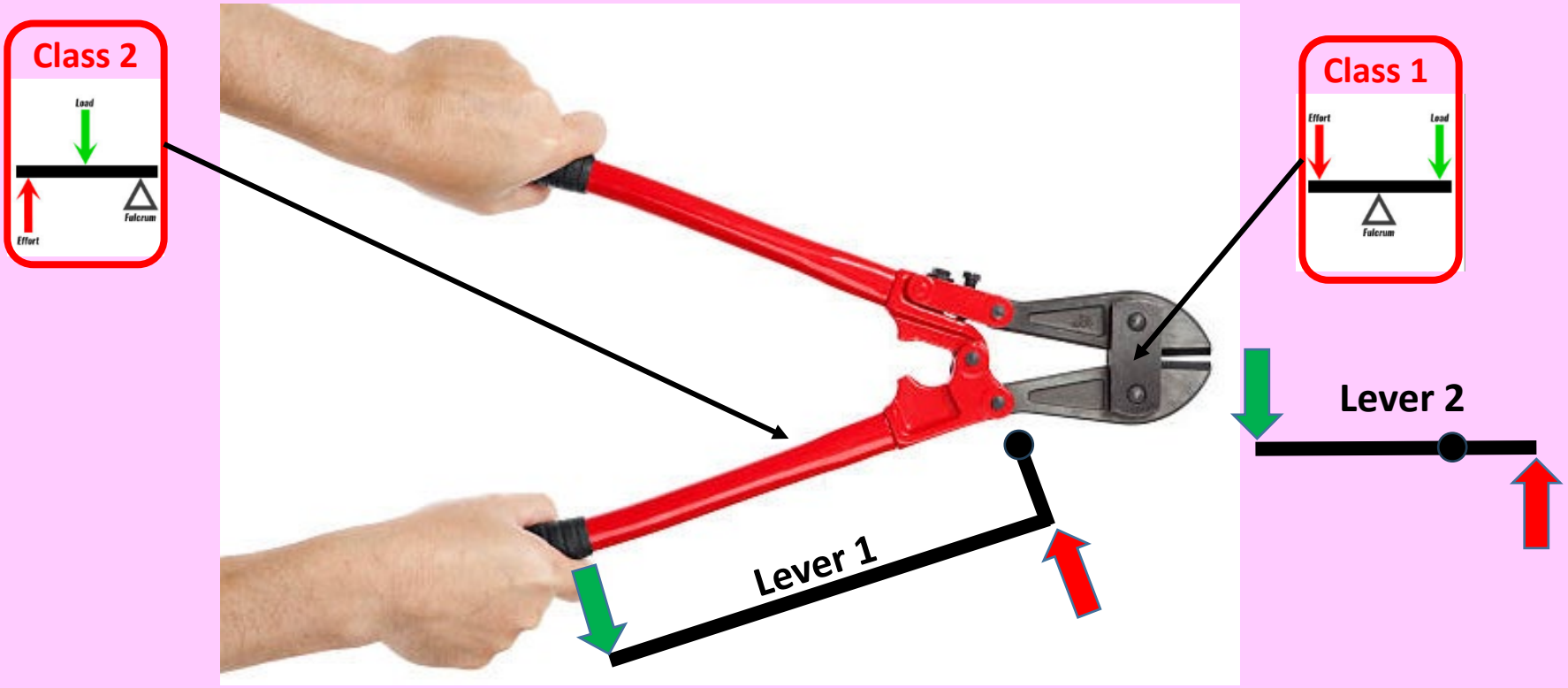
Explanation

How do we calculate mechanical advantage of a compound lever?

Overall MA = MA Lever 1 x MA Lever 2



Learning objectives:

- ❑ What is a mechanism?
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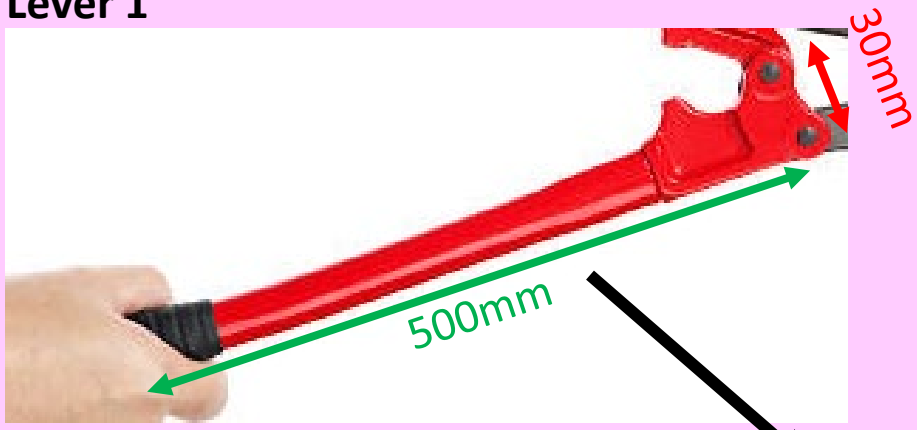
Explanation

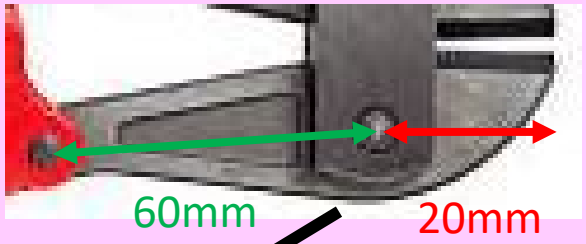
How do we calculate mechanical advantage of a compound lever?

Overall MA = MA Lever 1 x MA Lever 2

Lever 1



Lever 2



$$\textbf{Overall MA} = \left(\frac{input\ arm\ length}{output\ arm\ length}\right) \times \left(\frac{input\ arm\ length}{output\ arm\ length}\right)$$

$$\textbf{Overall MA} = \left(\frac{500}{30}\right) \times \left(\frac{60}{20}\right) \qquad \textbf{Overall MA} = 16.7 \times 3 \qquad \textbf{Overall MA} = 50$$

Learning objectives:

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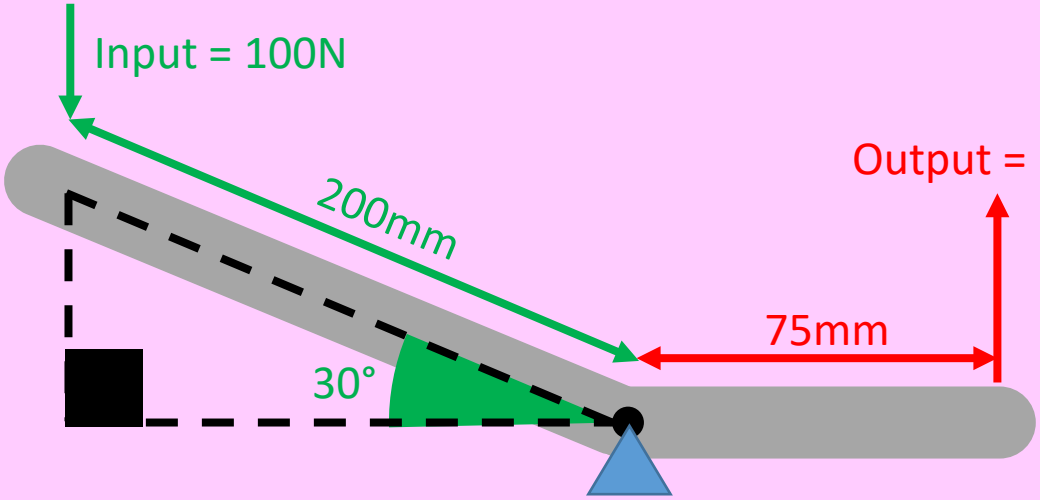
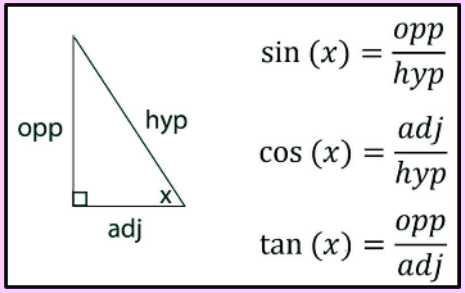
Explanation

How do we calculate mechanical advantage when forces act at angles?





$$\cos x = \frac{adj}{hyp} \qquad \cos 30° = \frac{output\ arm\ length}{200}$$

$$\cos 30° \times 200 = output\ arm\ lenght$$

$$output\ arm\ lenght = 173mm$$

$$\boldsymbol{MA} = \frac{input\ arm\ length}{output\ arm\ length}$$

$$\boldsymbol{MA} = \frac{173}{75} \qquad \boldsymbol{MA} = 2.3$$

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