Design and Technology Term 3:

Preparing for the Mechanisms and Controls Test

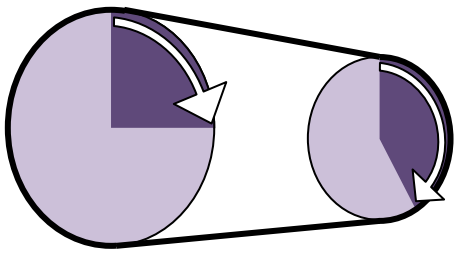
Grade 8

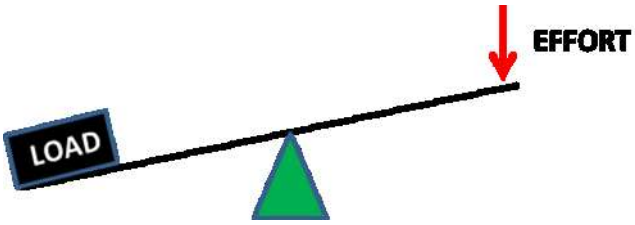
Calculations

MA, VR, Gear Ratio, Efficiency and Speed

IMPORTANT:

- Before using this revision material it is essential that you still refer back to the DT booklet as not all topics are raised here.
- Find the answers to the 'Do it yourself' sections at the end of this document in Appendix 1
- Practice, practice, practice! Try making some examples of your own up so that you are confident in your understanding of this section.

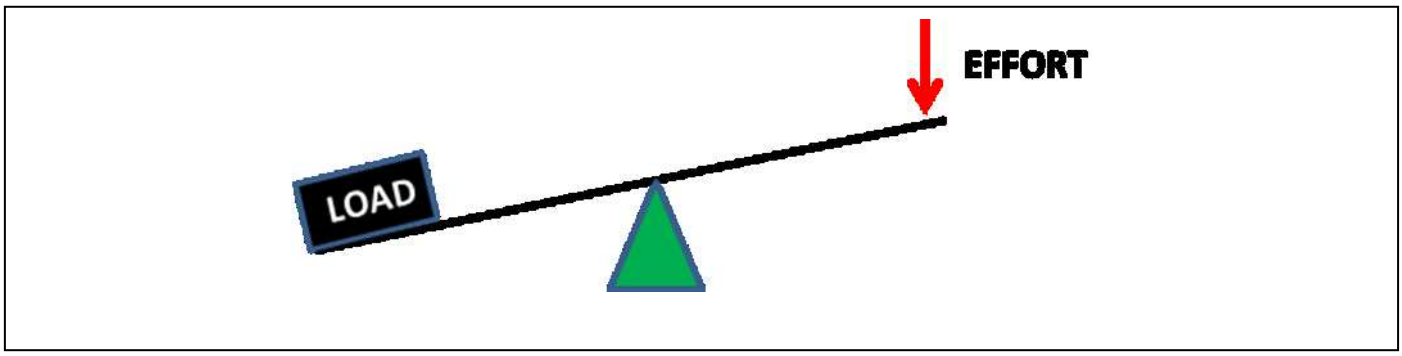




Some important concepts:

- Mechanical Advantage (MA)
  - This is the 'magnification' of effort that is put in.
  - MA is a ratio, so there is no unit of measurement.
- Velocity Ratio (VR)
  - Also known as the Movement Ratio, this tells us how much more distance the effort had to travel than the load did.
  - VR is a ratio, so there is no unit of measurement.
- Efficiency (of systems)
  - Effort is always lost in a system because of friction of some kind so we want to know how efficient a system is.
  - Efficiency is measured in % (percentage).
- Speed
  - This is associated with pulley systems, measuring how fast a wheel makes a full revolution or cycle.
  - Speed is measured in r.p.m. (revolutions per minute).

Calculating MA, VR and Efficiency in **Lever Systems:**

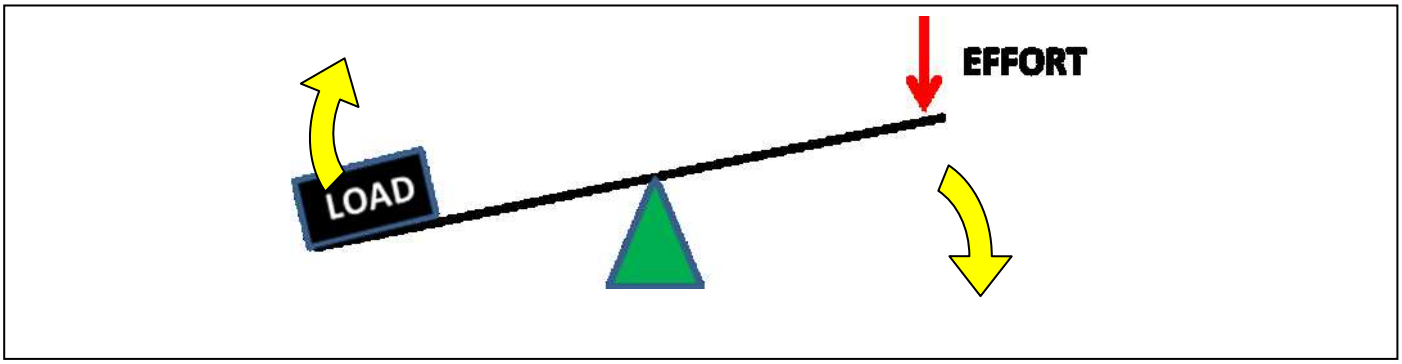


$$MA = \frac{LOAD}{EFFORT}$$

DO IT YOURSELF 1: (Assume that 1N = 10kg)

Calculate the MA for a system where:

1. a load of 60N can be raised using an effort of 16N
2. a load of 10kg can be raised using an effort of 40N
3. a load of 100N can be raised using an effort of 8kg
4. a load of 100N can be raised using an effort of 20N
5. a load of 5kg can be raised using an effort of 3kg



$$VR = \frac{\text{DISTANCE MOVED BY EFFORT}}{\text{DISTANCE MOVED BY LOAD}}$$

DO IT YOURSELF 2:

Calculate the VR for a system where:

1. the effort moves through 1200mm and the load through 300mm
2. the effort moves through 6m and the load through 60cm
3. the effort moves through 10cm and the load through 30mm
4. the effort moves through 90mm and the load through 40mm
5. the effort moves through 80mm and the load through 15mm

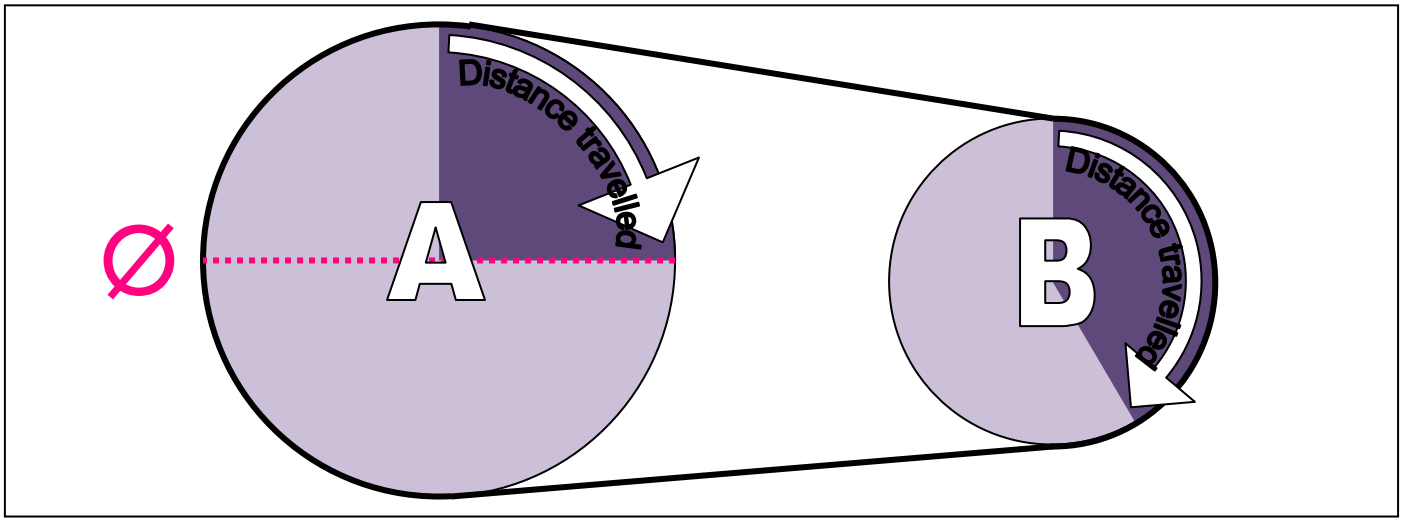
$$\text{EFFICIENCY} = \frac{\text{MA}}{\text{VR}} \times \frac{100}{1}$$

DO IT YOURSELF 3:

Calculate the EFFICIENCY for a system where:

1. the MA is 3.75 and the VR is 4
2. the MA is 2.5 and the VR is 4
3. the MA is 1.3 and the VR is 1.8
4. the MA is 8 and the VR is 11
5. the MA is 3 and the VR is 4

Calculating VR and Speed in **Pulley Systems:**



In lever systems we know that:

$$\text{VR} = \frac{\text{DISTANCE MOVED BY EFFORT}}{\text{DISTANCE MOVED BY LOAD}}$$

In pulley systems, this translates to:

$$\text{VR} = \frac{\textit{DISTANCE}\ \text{MOVED BY DRIVEN PULLEY}}{\textit{DISTANCE}\ \text{MOVED BY DRIVER PULLEY}}$$

Which is **also the same as saying:**

$$\text{VR} = \frac{\textit{CIRCUMFERENCE}\ \text{OF DRIVEN PULLEY}}{\textit{CIRCUMFERENCE}\ \text{OF DRIVER PULLEY}}$$

And:

$$\text{VR} = \frac{\textit{DIAMETER}\ \text{OF DRIVEN PULLEY}}{\textit{DIAMETER}\ \text{DRIVER PULLEY}}$$

DO IT YOURSELF 4:

Note: Diameter is represented by the symbol Ø

Calculate the VR for a pulley system where:

1. the driven pulley's diameter is 30cm, and the driver pulley's diameter is 10cm
2. the driver pulley's diameter is 100mm, and the driven pulley's diameter is 50cm
3. the driver pulley's circumference is 300mm, and the driven pulley's circumference is 1m
4. the distance moved by the driver pulley is 8cm and the distance moved by the driven pulley is 200mm
5. the driven pulley's circumference is 1200mm, and the driver pulley's circumference is

Calculating **Speed:**

To calculate the speed of a pulley in a pulley system, you need to know

- the *diameter of both pulleys* and
- the *speed of the other pulley*.

Remember: Speed is measured in r.p.m.

$$\text{SPEED OF UNKNOWN PULLEY} = \frac{\text{SPEED OF KNOWN PULLEY} \times \text{DIAMETER}}{\text{DIAMETER OF UNKNOWN PULLEY}}$$

DO IT YOURSELF 5:

Calculate the Speed for a pulley (pulley A) in a system where:

1. the known pulley's speed is 1000 r.p.m. with a diameter of 90mm, and pulley A's diameter is 30mm
2. the known pulley's speed is 500 r.p.m. with a diameter of 500mm, and pulley A's diameter is 25cm
3. the known pulley's speed is 2 r.p.m. with a diameter of 10mm, and pulley A's diameter is 20mm
4. the known pulley's speed is 15 r.p.m. with a diameter of 7cm, and pulley A's diameter is 9.5cm
5. the known pulley's speed is 780 r.p.m. with a diameter of 40mm, and pulley A's diameter is 80mm

APPENDIX 1: ANSWERS TO THE DO IT YOURSELF SECTIONS

DO IT YOURSELF 1:

1. MA = 3.8
2. MA = 2.5
3. MA = 1.3
4. MA = 5
5. MA = 1.7

DO IT YOURSELF 2:

1. VR = 4
2. VR = 10
3. VR = 3.3
4. VR = 2.3
5. VR = 5.3

DO IT YOURSELF 3:

1. EFFICIENCY = 93.75%
2. EFFICIENCY = 62.50%
3. EFFICIENCY = 72.22%
4. EFFICIENCY = 72.73%
5. EFFICIENCY = 75.00%

DO IT YOURSELF 4:

1. VR = 3.0
2. VR = 5.0
3. VR = 3.3
4. VR = 2.5
5. VR = 4.0

DO IT YOURSELF 5:

1. Pulley A speed = 3000 r.p.m.
2. Pulley A speed = 1000 r.p.m.
3. Pulley A speed = 1 r.p.m.
4. Pulley A speed = 11.05 r.p.m.
5. Pulley A speed = 390 r.p.m.