

# Grade 9 Physics Formula Sheet

## Unit 5: Simple Machines atenu.hulunem.com

### Key Concepts

- **Simple Machine:** A device that makes work easier.
- **Effort (E):** The force you apply.
- **Load (L):** The force moved by the machine.

### Essential Formulas

**Work Input** = Effort  $\times$  distance moved by effort

**Work Output** = Load  $\times$  distance moved by load

**Mechanical Advantage (MA)** =  $\frac{\text{Load}}{\text{Effort}}$

**Velocity Ratio (VR)** =  $\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$

**Efficiency ( $\eta$ ):** =  $\frac{\text{MA}}{\text{VR}}$

### Formulas for Common Simple Machines

- **1. Lever**

a)  $\text{MA} = \frac{\text{Load}}{\text{Effort}}$

b)  $\text{VR} = \frac{\text{Effort arm } (d_e)}{\text{Load arm } (d_l)}$

- **2. Inclined Plane**

a)  $\text{MA} = \frac{\text{Load}}{\text{Effort}}$

b)  $\text{VR} = \frac{\text{Length of slope } (\ell)}{\text{Height of slope } (h)}$

- **3. Wedge**

a)  $MA = \frac{\text{Force on object (FAO)}}{\text{Force on wedge (FATS)}}$

b)  $VR = \frac{\text{Penetration length } (l)}{\text{Wedge thickness } (t)}$

- **4. Screw**

a)  $IMA = \pi \frac{d}{p}$

where  $d$  = average diameter,  $p$  = pitch.

- **5. Wheel and Axle**

a)  $MA = \frac{\text{Load}}{\text{Effort}}$

b)  $VR = \frac{\text{Radius of wheel}}{\text{Radius of axle}}$

- **6. Pulley**

a)  $MA = \frac{\text{Load}}{\text{Effort}}$

b)  $VR = IMA = N$

where  $N$  is the number of rope sections.

## Notes

- **AMA:** Actual Mechanical Advantage (real situations, includes friction).
- **IMA:** Ideal Mechanical Advantage (no energy loss).
- If no energy is lost:  $AMA = IMA = VR$
- Efficiency is always less than 1 (or less than 100%).