## Physics 11 – Simple Machines

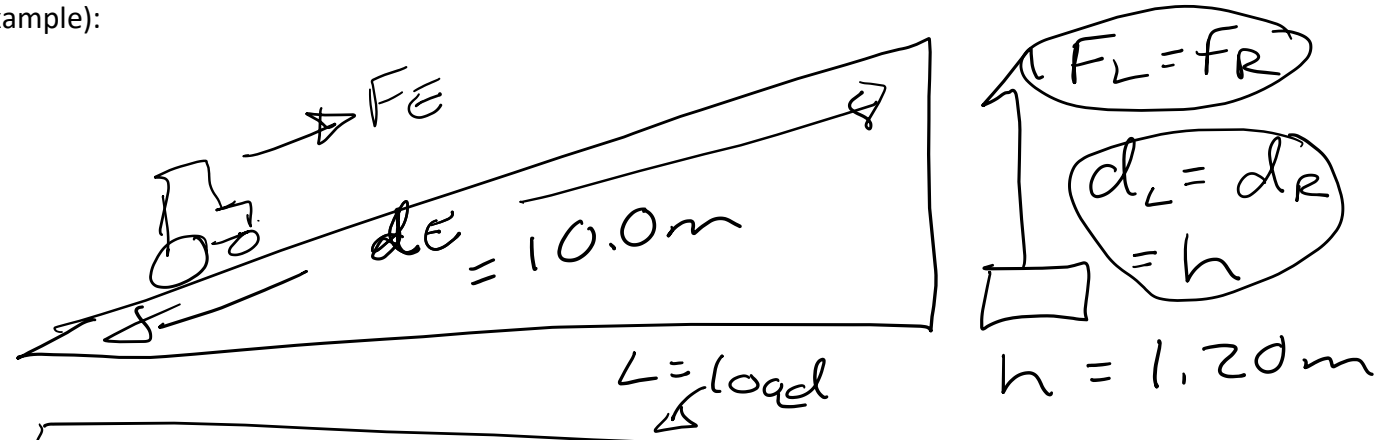
**Machines** make work easier to do. In other words, less Force (effort) is needed than if the same job were done without the use of a machine.

For example, a **wheelchair ramp** allows people with mobility challenges to have more personal autonomy, because they go "upstairs" without help.

Assume that the person plus wheelchair have a mass of 80.0 kg, and they need to go up to a height of 1.20 m. If they were lifted vertically, without a ramp, the lift force would be:

$$F_L = mg = (80.0kg)(9.80\ N/kg) = 784\ N$$

BUT, with a ramp, this happens …. (we'll pretend that the wheelchair and ramp are 100% efficient, without friction – which is impossible, but the idea that effort force is reduced is the key thing in this example):




$W_{out} = W_o = W_L = F_L \times d_L$

$= mgh = (784N)(1.20m)$

$\therefore W_o = 941J$

($F_L = F_R$ = weight of the "load")

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$W_{in} = W_i = W_E$ (effort) $= F_E \times d_E$

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if 100% efficient

$W_{out} = W_{in}$

$$F_L \times d_L = F_E d_E$$

$$F_E = \frac{F_L \times d_L}{d_E} = \frac{(mg \times h)}{d_E}$$

$$F_E = \frac{(80\,kg)(9.8\,N/kg)(1.2\,m)}{10\,m}$$

$$\boxed{F_E = 94.1\,N}$$

this is much easier than trying to lift vertically with a force of $F_L = 784\,N$

The Machine increases the distance, but reduces force, thus making work easier and safer.