



TeachEngineering

Investigating Ideal and Actual Mechanical Advantage



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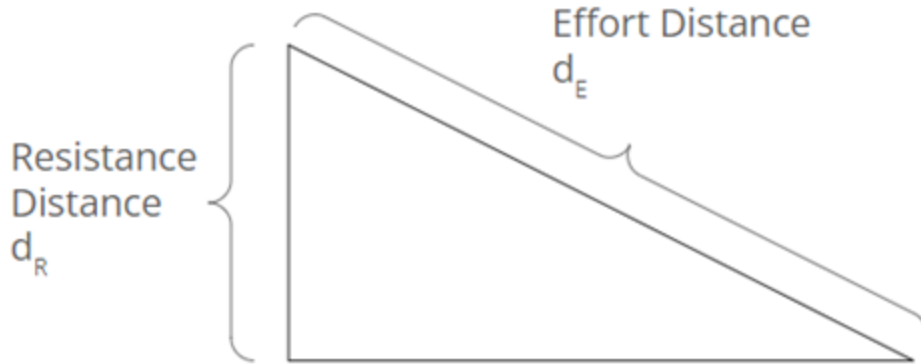
Ideal Mechanical Advantage

Ideal Mechanical Advantage (IMA) is an excellent way to get an apples-to-apples comparison of “theoretical” mechanical advantage between two structures. However, it does not account for friction.

IMA calculation:

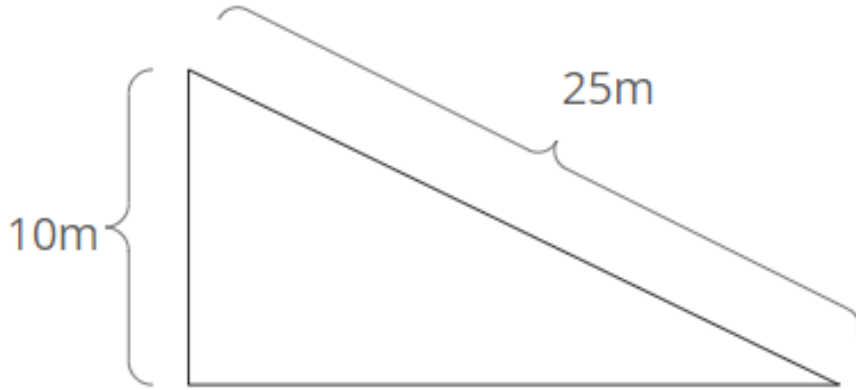
Resistance
Distance

Effort Distance



Ideal Mechanical Advantage

In this example, the resistance distance (d_R) is 10 meters, and the effort distance (d_E) is 25 meters.

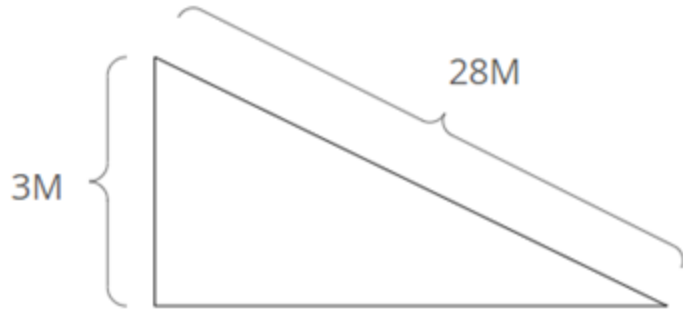


$$\frac{\text{Resistance Distance}}{\text{Effort Distance}} = \text{IMA}$$

$$\frac{10\text{m}}{25\text{m}} = 0.4$$

Ideal Mechanical Advantage

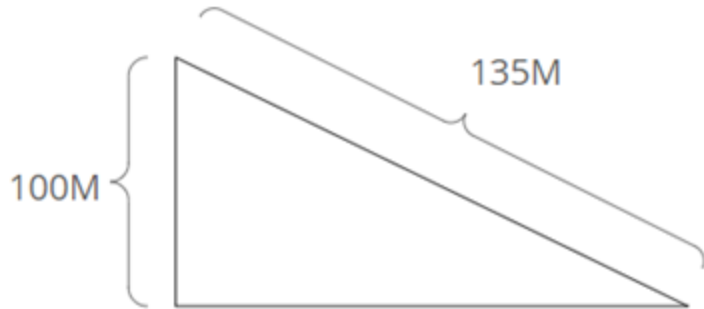
Now you try!



d_R _____

d_E _____

= IMA _____



d_R _____

d_E _____

= IMA _____

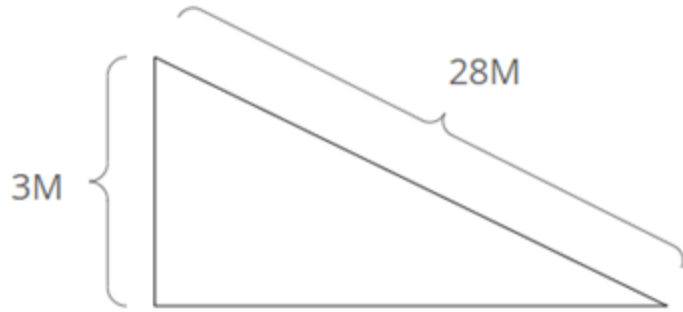
IMA calculation:

Resistance
Distance

Effort Distance

Ideal Mechanical Advantage

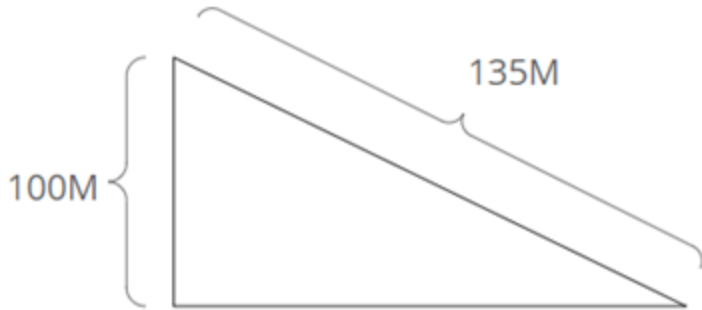
Were you right?



d_R 3m

 d_E 28m

= IMA 0.11



d_R 100m

 d_E 135m

= IMA 0.74

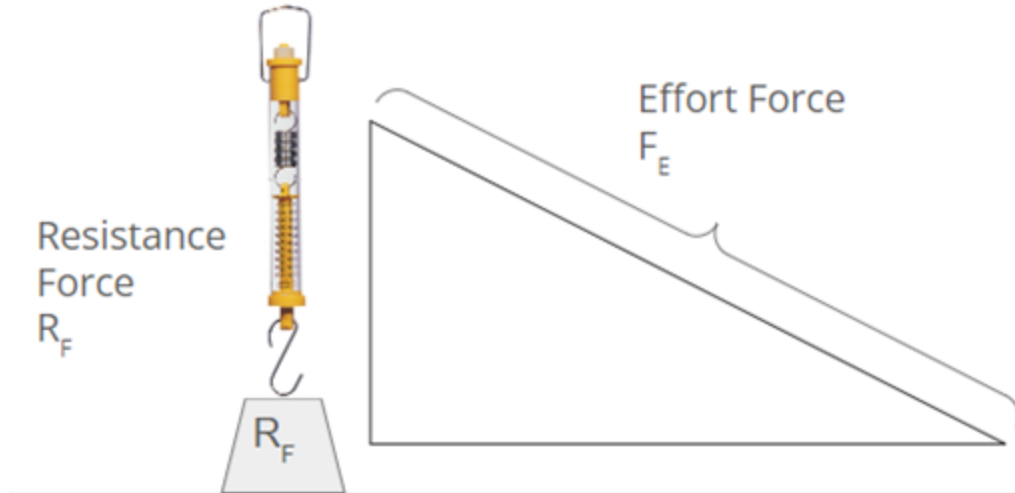
IMA calculation:

Resistance
Distance

Effort Distance

Actual Mechanical Advantage

Actual Mechanical Advantage (AMA) is similar in nature to IMA, but we are now considering the forces of friction in both the weight (resistance force) of the object and distance traveled (effort force) so we can get a more realistic feel. We call these “forces,” measure them in Newtons (N) using a spring scale, and label them as R_F for resistance force and F_E for effort force.



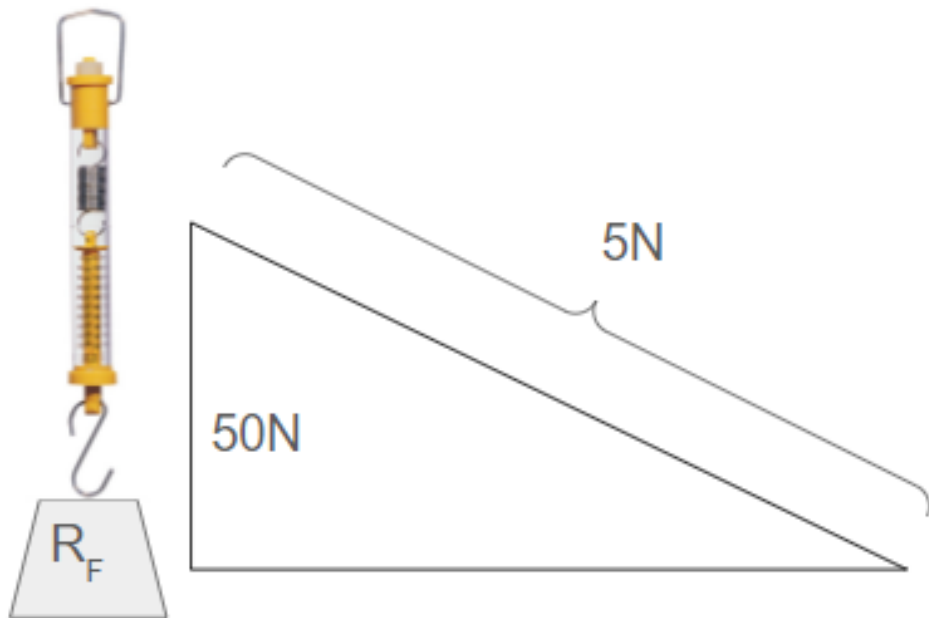
AMA calculation:

$$\frac{\text{Resistance Force}}{\text{Effort Force}}$$

Newton's can easily be converted to units of weight. For example, 1 kg is equal to approximately 9.8 Newtons. Google has a converter built into its calculators.

Actual Mechanical Advantage

In this example, the Resistance Force R_F is 50N as measured by the scale, and the Effort Force F_E is 5N as measured by dragging the weight over the inclined plane.



Resistance Force

Effort Force = AMA

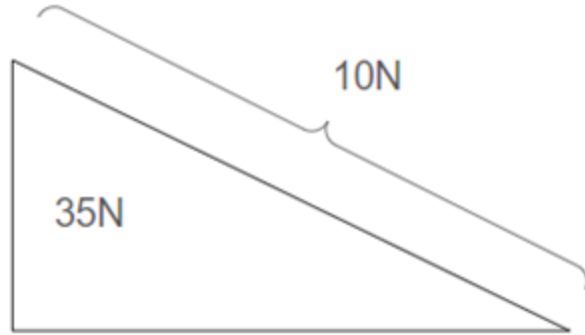
50N

5N = AMA 10

We can say that this inclined plane makes the work 10 times easier!

Actual Mechanical Advantage

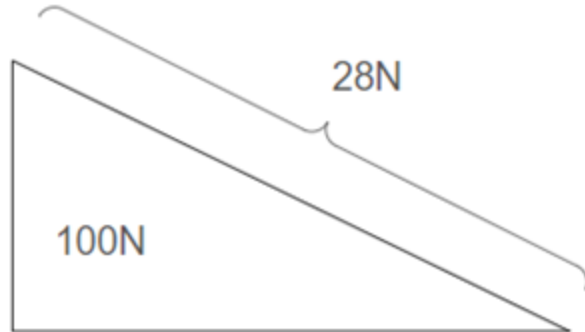
Now you try!



R_F _____

F_E _____

= AMA _____



R_F _____

F_E _____

= AMA _____

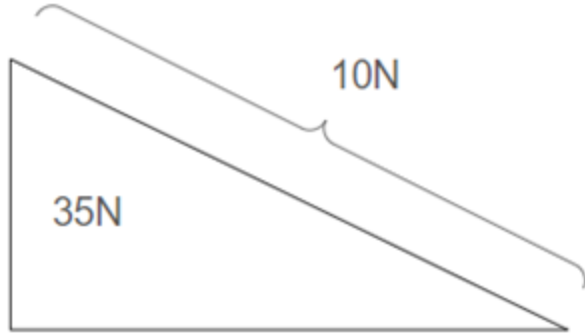
AMA calculation:

Resistance Force

Effort Force

Actual Mechanical Advantage

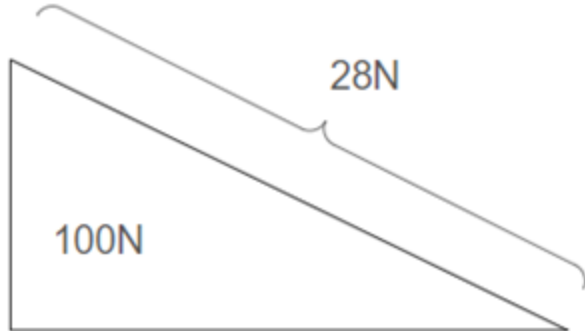
Were you right?



R_F 35N

 F_E 10N

= AMA 3.5



R_F 100N

 F_E 28N

= AMA 3.57

AMA calculation:

Resistance Force

Effort Force

Which one is easier?