FORCE INCREASING SYSTEM

ANALYZING THE CONCEPTS OF MECHANICAL DEVICES

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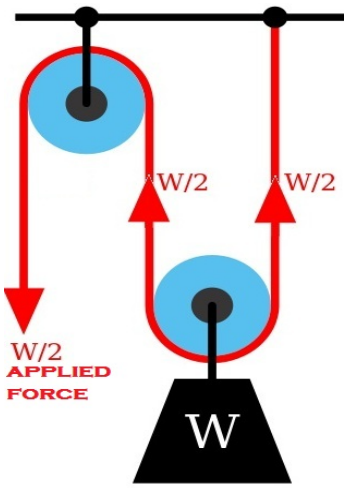
An average person can lift almost equal to his or her body weight (Depending on how often you visit the gym; you may be able to lift more or less than that). Suppose you are asked to lift an object of 100Kg weight and you are sure there is no way you can lift this much weight you can use engineering principles to devise a force increasing system that allows you to lift more weight than the force you apply. Here is a simple system that could help in such a situation.

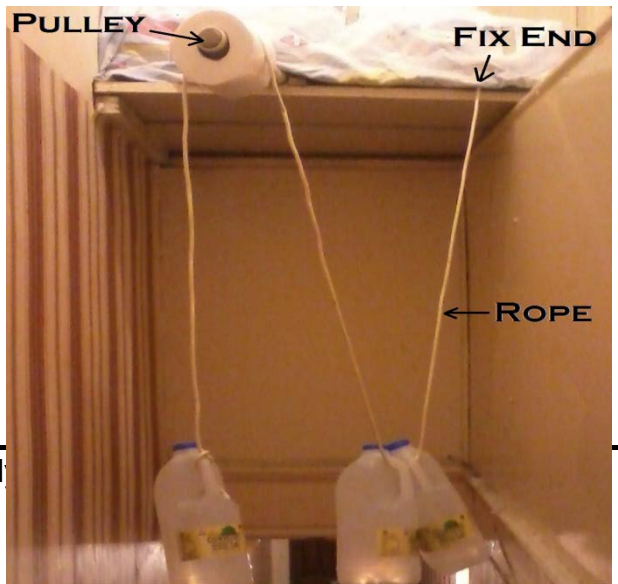


So you could apply a force W/2 and lift an object weighing W. In our case you could lift the 100 Kg object by applying only the force required to lift a 50 Kg object.

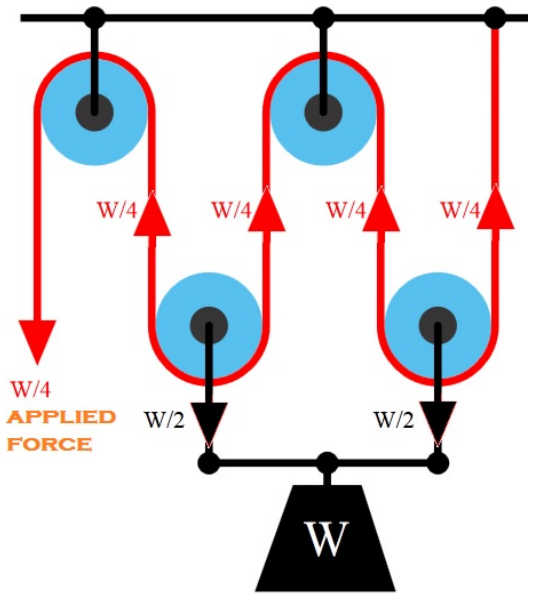
$$Force\ increase\ Factor = \frac{Output\ force\ (Weight\ lifted)}{Input\ force\ applied}$$

$$Force\ increase\ Factor = \frac{W}{W/2} = 2$$

Here is a similar homemade system that lifts 4Kg weight by applying only 2Kg force. (Each bottle is 2Kg)



If you still couldn't lift the weight, you need to devise a system with a bigger force increasing factor. (This factor is actually called the mechanical advantage of the system) You can use the following system.



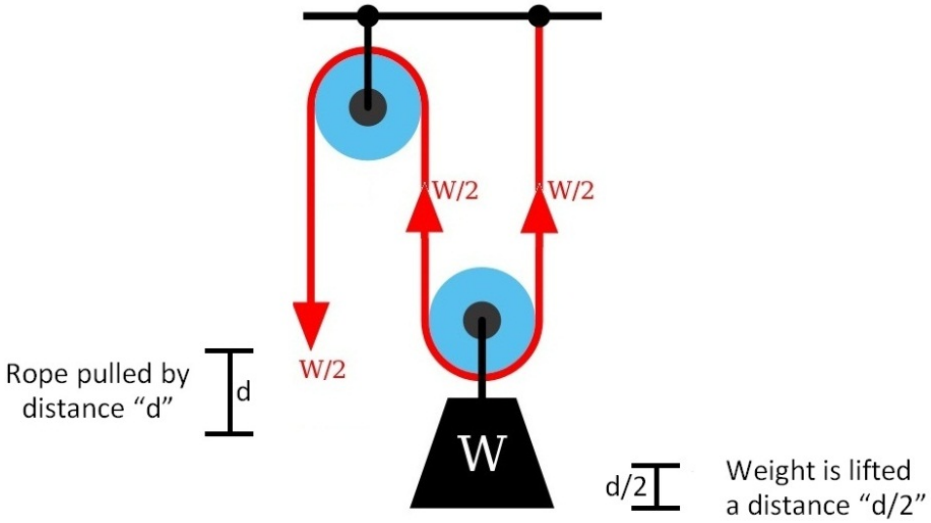
If you used the above system, you could lift the 100 Kg force by applying the force required to lift only a 25 Kg object. (A force increasing factor or mechanical advantage of 4!!!)Further combinations could give you virtually as much mechanical advantage as you desire.

These systems have been known to man for a long time and ancient civilizations used them to build magnificent structures such as the pyramids. The adjacent figure is device that was used in construction by which a person could lift 15,000 Kg!!!

HOW DOES IT WORK.

At first glance, these systems seem to contradict all the laws of conservation you could think of because you get more output force than the input force. But a careful analysis shows that this is not the case and laws of conservation still apply.

In the first system, moving the rope on the left (where you are applying force) by a distance "d" will only lift the weight by a distance "d/2". Hence the work done is constant.



$$Work\ input = \frac{W}{2} \times d = \frac{Wd}{2}$$

$$Work\ output = w \times \frac{d}{2} = \frac{Wd}{2}$$

In other words, using this system you can lift the 100 Kg weight by applying only 50 Kg force but to move the weight by 1 meter, you would have to pull the rope through a distance of 2 meters. So the work you would have to do (Force X Distance) is the same as you would if you lifted the weight without using this system.

Similarly, in our second system which has a mechanical advantage of 4, you have to pull the rope through 4 meters to lift the weight by one meter.

THE LEVER FORCE INCREASING SYSTEM

In lectures of Dr tianjian ji (2010-MACE 60005) it was discussed that a 25 gram and could lift a 4500 Kg elephant if the lever arm ratio was 1 to 18000.

This again seems like the system of lever increases the force of 25 gram to 4500Kg but a careful analysis of the system will prove that if the ant moves the lever down by 1 meter, the elephant will move up by only 1/18000 meters. Hence the work input and output are constant and no net gain of force is achieved.

REFERENCES

Figures adapted from http://en.wikipedia.org/wiki/Pulley (Accessed 28-10-11)

http://www.the-office.com/summerlift/pulleybasics.htm (Accessed 28-10-11)

Figure for ancient pulley system taken from
http://park.org/Korea/Pavilions/PublicPavilions/Public/nsm/eg/pe-3.html(Accessed 30-10-11)

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