@ All readers

When a force remains constant over a displacement, which that force is causing, the work done during that action is the magnitude of that force (typically stated as newtons of force) times the length of that displacement (typically stated in meters).

example 1:

When an object is lifted, its weight (gram force) does not change during that lifting (its weight is constant). That weight can be stated as grams of force or as newtons of force and so on. The calculation of the work done, is simply the force applied to lift the object times the distance it is lifted. (work = force x displacement)

work stated in joules = force times displacement (joules = newtons x meters)
.....
.....
A force (push or pull) caused by a magnet drops off with the distance from that magnet. When a force changes over the course of a displacement which it is causing. In which case force times displacement is too simple of a formula.

The change in the force of a magnet (attraction or repulsion), is different at each increment of distance that an acted upon object (iron or another magnet) is from that magnet.

At close distances, the force exerted by a magnet is NOT LINEAR linear to the distance it is from an affected object.

example 2 of IF magnetic force were linear to displacement:
and IF
Attracting force at 5 mm were 1000 grams of force.
Attracting force at 7.5 mm were 750 grams of force.
Attracting force at 10 mm were 500 grams of force
Attracting force at 12.5 mm were 250 grams of force
Attracting force at 10 mm is 0 grams of force.

The rate of decrease in the force would be represented (in a graph) by a straight line through the points from where 5mm crosses 1000 g to where 7.5 mm crosses 750 g, to where 10 mm crosses 500 g, to where 12.5 mm crosses 250 g, to where 100 crosses 0 g. It would be a LINEAR rate of force change per displacement.

It would be a STRAIGHT LINE on a graph of that interaction.

If IT WERE "linear", then during the calculation of work, the average force between a given first displacement and a given final displacement would be ....the maximum force minus the minimum force divided by 2 (the average force) times the displacement. But that magnet force per distance is NOT linear.

.....
.....
The force (push or pull) exerted by a magnet at close range is NON LINEAR.

The change in force per increment of distance by magnets, is constantly changing.

The change in force per distance by magnets, can only be described upon a graph by a curving line.

That curving line upon a graph, is drawn by using only straight lines. The greater the number of those straight lines drawn, the more nearly that drawing approximates a curved line, and also the force per distance.

Also the more nearly that drawing represents the work done by a magnet.

It would require an infinite number of lines to perfectly describe a curved line. Fortunately we don't need to perfectly describe that curve. As we use more and more lines, we get less and less of an increase in the accuracy of the approximation of that curve by the straight lines We get a diminishing return in the accuracy of the approximation, for the each increase in the number of measurements (lines) used.

At some, number of measurements, we have a very poor approximation. At some other number of measurements, we have a very good approximation.

The work done in magnet force interactions is arrived at by making many small measurements of force times displacement.

The force is changing throughout the displacement. Multiplying that AVERAGE force times the distance of that tiny displacement gives us a good approximation of the work done in that magnet motion.

Neither the peak force nor the minimum force during that displacement, if multiplied by the distance of that displacement will tell us the work done.

During a particular tiny measurement set.... the minimum force subtracted from the peak force divided by 2 (the average force), times the distance of that displacement which occurs during that tiny measurement set, gives us approximately the work done during that tiny displacement.

note....
A short length of a given curve of a line, is more nearly a straight line, than is a longer length of that curve of a line, to being nearly straight.

The total of the approximate work done during these many tiny measurement sets, gives a good approximation of the over all work done. An approximation is all that can be arrived at.

That approximation can be more than adequate for the purposes at hand.

Alternatively.... one might divide ... the total of all of the little ... peak force measurements minus the total of all of the little minimum force measurements .... and divide this by 2.
example:

total the sets and then divide by 2
3g x 5mm = 15
and
4g x 6mm = 24
and
15 + 24 = 39
and
39 / 2 = ...19.5 = work
OR
divide each little set by 2 and total
3g x 5mm / 2 = 15 / 2 = 7.5
and
4 x 6 / 2 = 24 / 2 = 12
and
7.5 + 12 = ...19.5 = work

either will suffice.....

Given that one has two amounts of work done, and that one wishes to compare each the other as a ratio....

Above work (A) 19.5

Below WORK (B)
divide each little set by 2 and total
3g x 7mm / 2 = 21 / 2 = 10.5
and
4 x 5 / 2 = 20 / 2 = 10
and
10.5 + 10 = ... 20.5 = work

Their ratio is 19.5 to 20.5
THEIR RATIO (work A to work B) CAN BE SIMPLIFIED TO 1 to 1.0512

1 / 19.5 = 0.05128205128205128205128205128205
and
0.05128205128205128205128205128205 x 19.5 = 1
and
0.05128205128205128205128205128205 x 20.5 = 1.0512820512820512820512820512821
and this is 1 to 1.0512

example :

a ratio of 5 to 20 can be simplified as = a ratio of 1 to 4

a ratio of 1 to 4 is = 1 per 4 or ..... 1 / 4

1/4 / 2 is = 0.125 or 1/8
and next
a ratio of 15 to 30 can be simplified as = a ratio of 1 to 2

a ratio of 1 to 2 is = 1 per 2 or ..... .1 / 2

1/2 / 2 is = 0.25 or 1/4

The ratio of 1/4 to 1/8 is the same ratio as is the ratio
of 1/2 to 1/4.....

DIVIDING EACH RATIO SET BY 2, DOES NOT CHANGE THE
RATIO OF THOSE RATIO SETS TO ONE ANOTHER.

Had we not divided either work as 24 or work as 20 by 2....
their ratio "work in" to "work out" to one another would still be the same.
(this could have been better be phrased as the RATIOS of work in to work out in our discussion / process).

The same principle applies when we convert grams to newtons and so on.

We are only interested in the ratios AT THIS POINT. None of these conversions change those ratios. None of those conversion will give us a different COP, except that to call it "COP" would confuse people more that they way we are using loosely the word work.

Thanks for the observations, questioning and pointers.

Hope this helps clear things up.
best wishes
floor