Honors Physics Name _____

# Simple Machines, IMA, AMA, and Efficiency Worksheet

## Ideal Mechanical Advantage IMA

1. A simple machine would be considered ideal if it had no friction.

$$IMA = \frac{\text{effort distance}}{\text{resistance distance}}$$

In theory, this IMA should also equal $\frac{\text{resistance force}}{\text{effort force}}$ however……

## Actual Mechanical Advantage AMA

2. a. Actual machines have friction. They do not have as high of a mechanical advantage as ideal machine because some of the effort is lost in overcoming friction.

$$AMA = \frac{\text{actual measured resistance force}}{\text{actual measured effort force}}$$

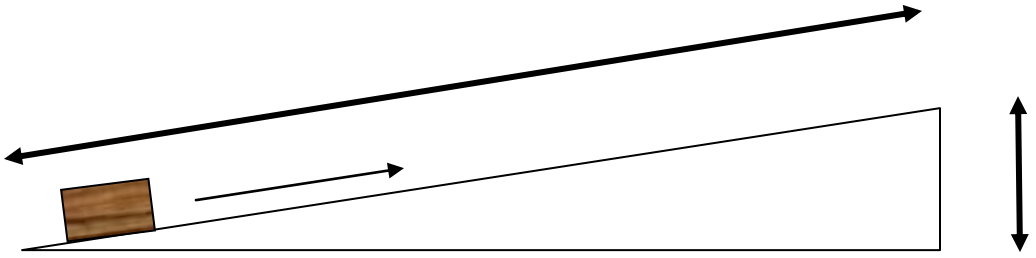
## Efficiency

3. a. A machine multiplies force. How effective the machine is in that is called efficiency.
   b. Efficiency is expressed as a percentage.
   c. Efficiency can be determined by the following equation:

$$\text{efficiency} = \frac{\text{actual mechanical advantage}}{\text{ideal mechanical advantage}} \times 100 \quad \text{OR} \quad \frac{\text{Work OUT}}{\text{Work IN}} \times 100$$

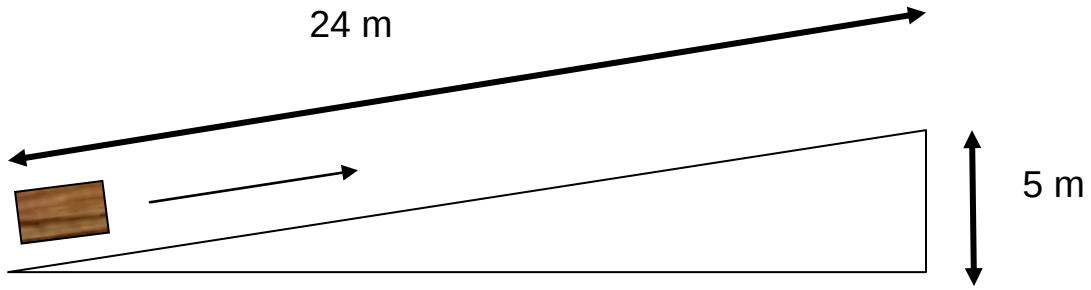
## Inclined Planes

4. The following is how you tell the IMA of an inclined plane.

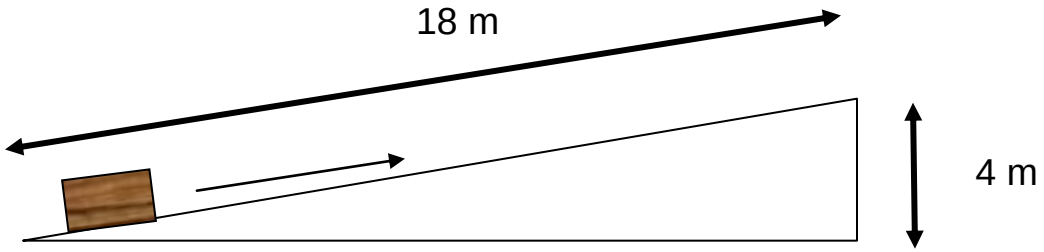


$$\text{ideal mechanical advantage} = \frac{\text{effort distance}}{\text{resistance distance}} = \frac{\text{length of ramp}}{\text{height of ramp}}$$

4a.. What is the IMA of this ramp? Show your work.




4b. What is the IMA of this ramp? Show your work.




5a. To determine the AMA of the inclined plane, you must use force. The effort force is what is measured with a spring scale in Newtons. The resistance force is weight of the box in newtons.



actual mechanical advantage = $\frac{\text{resistance force}}{\text{effort force}}$

$$AMA = \frac{F_R}{F_E} = \frac{35\ N}{15\ N} = 2.3$$

5b. Calculate the AMA of the ramp below. Show your work.

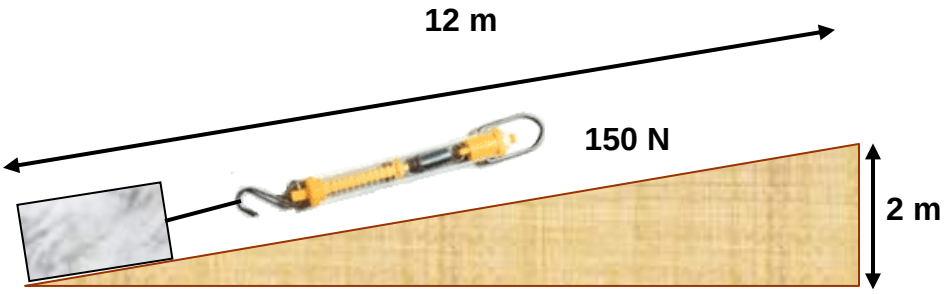


6. The efficiency of a machine can be determined by the following equation.

efficiency = $\frac{\text{actual mechanical advantage}}{\text{ideal mechanical advantage}}$ x 100 OR (Work Out) / (Work In) x 100

efficiency = $\frac{\text{AMA}}{\text{IMA}}$ x 100

6a. Determine the efficiency based on the diagram below. Show work.

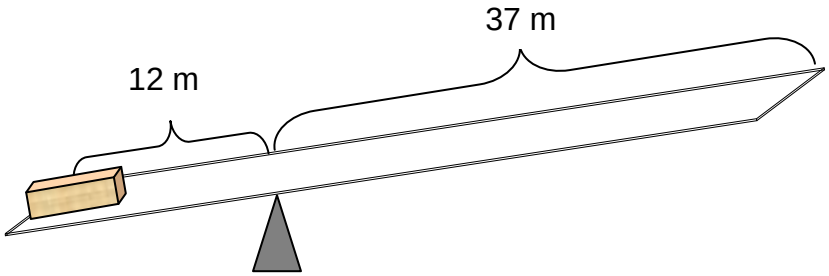



**Levers**

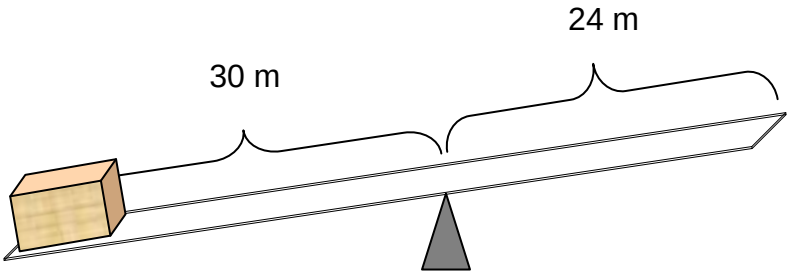
7a. To find the Ideal Mechanical Advantage of a lever, use the following equation.

ideal mechanical advantage = $\frac{\text{effort distance from fulcrum}}{\text{resistance distance from fulcrum.}}$

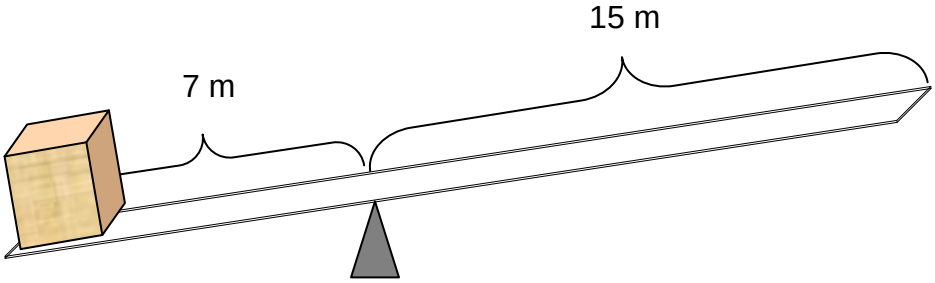
$$IMA = \frac{d_E}{d_R} = \frac{37\text{ m}}{12\text{ m}} = 3.08$$




7b. Determine the IMA for the following. Show your work.



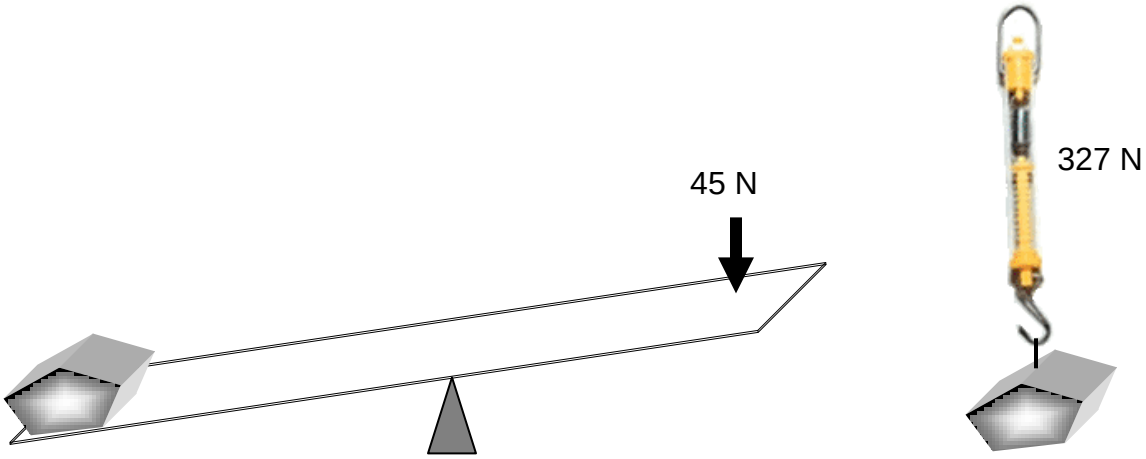

7c. Determine the IMA for the following. Show your work.



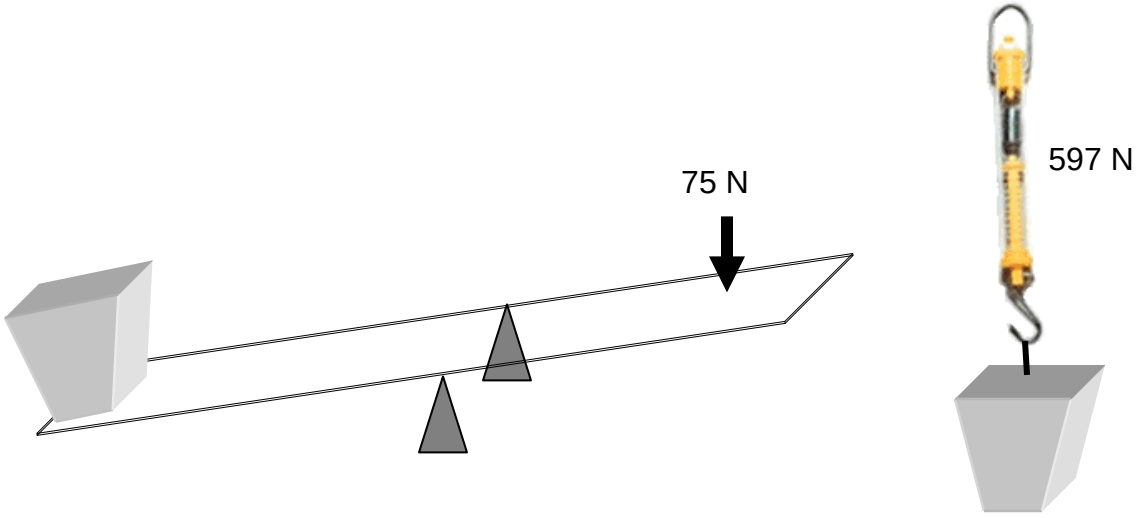
8. To find the Actual Mechanical Advantage of a lever, you use the equation:

actual mechanical advantage = $\frac{\text{resistance force (weight of object)}}{\text{effort force}}$

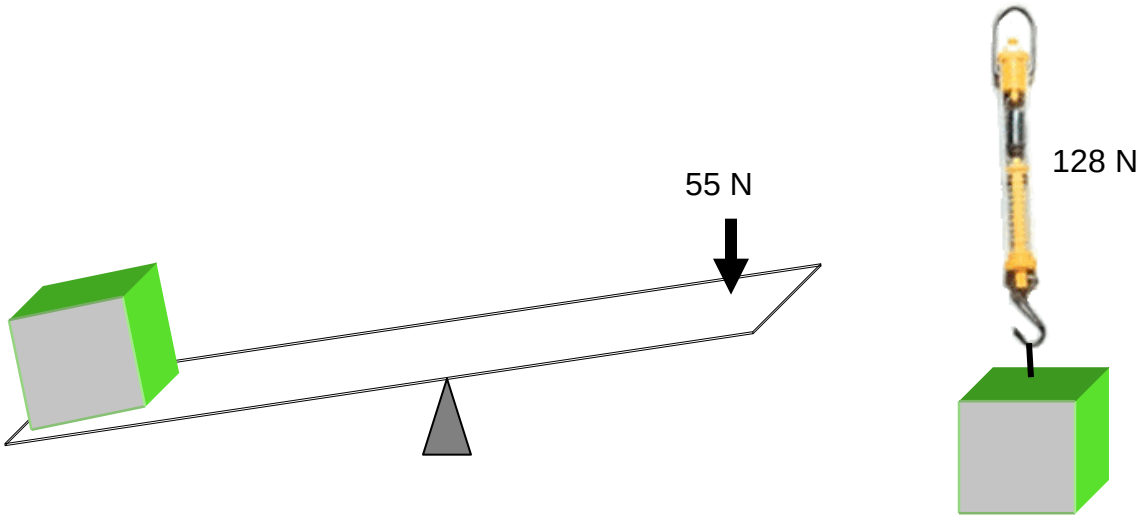
$$AMA = \frac{F_R}{F_E} = \frac{327\ N}{45\ N} = 7.27$$




8a. Find the AMA of the following. Show your work.

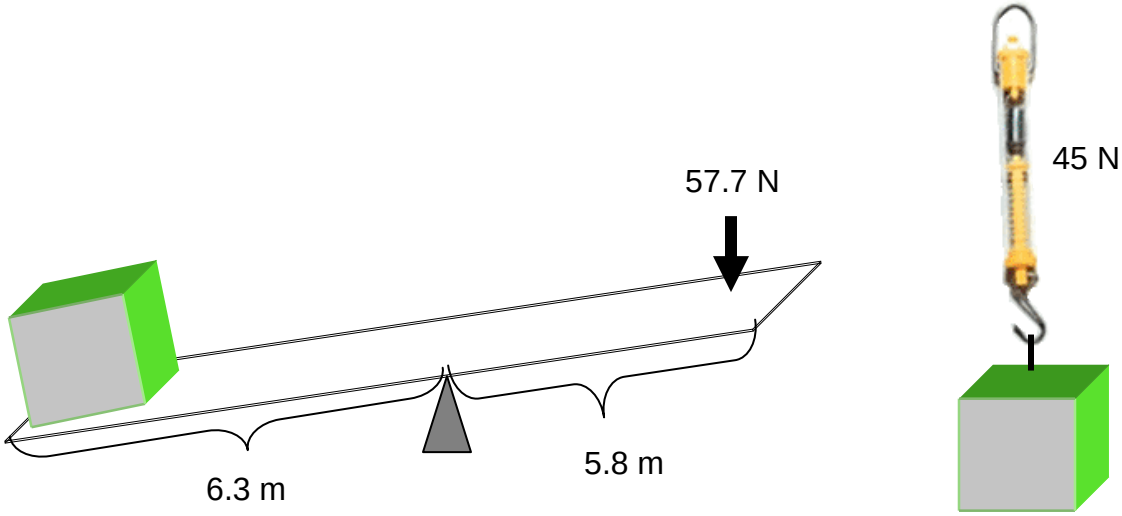


8b. Find the AMA of the following. Show your work.



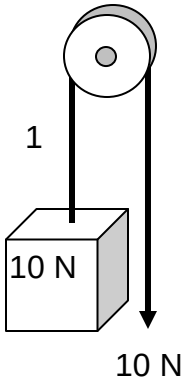

9. Determine the efficiencies of the lever example below. Show your work.

efficiency = $\frac{\text{actual mechanical advantage}}{\text{ideal mechanical advantage}}$ x 100

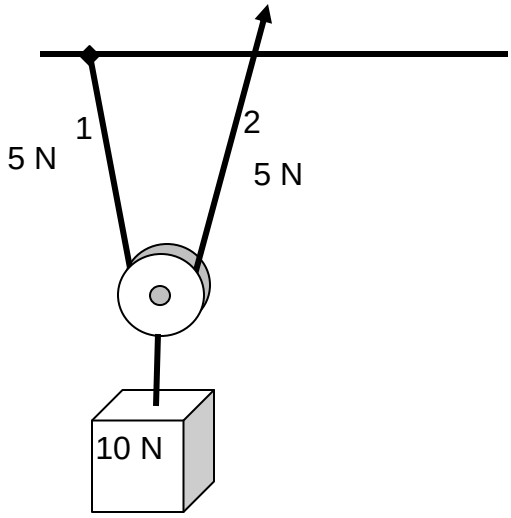


**Pulleys**

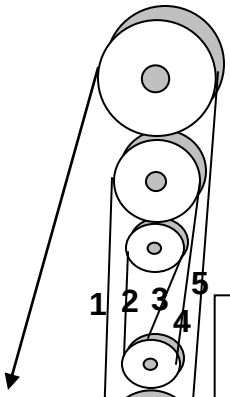
10. The ideal mechanical advantage of a pulley is determined by counting the number of supporting ropes. Look at the following examples. Last one over top does not count!




**IMA = 1**

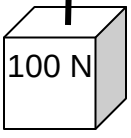



**IMA = 2**

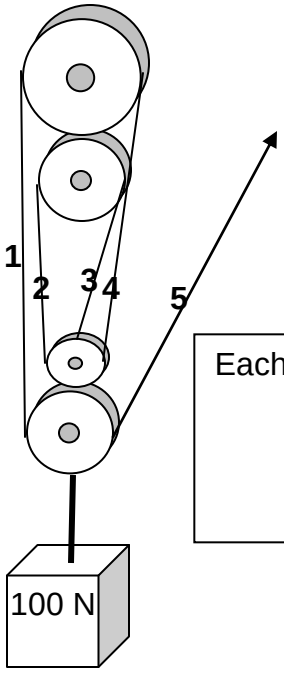



Each rope supports 20 N.

$\frac{100\ N}{5} = 20\ N$




**IMA = 5**

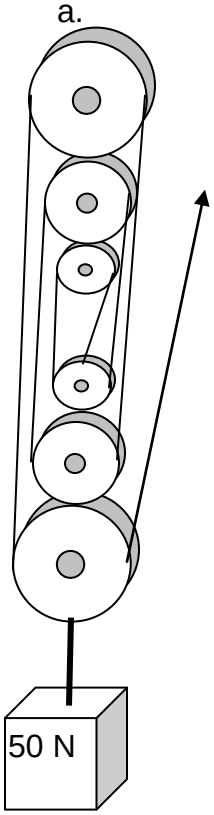



Each rope supports 20 N.

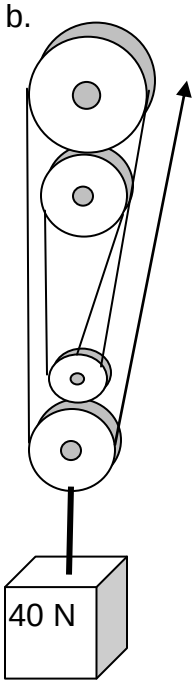
**IMA = 5**

10 Determine the IMA of the following pulleys.

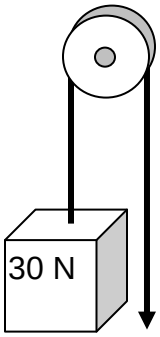
a.



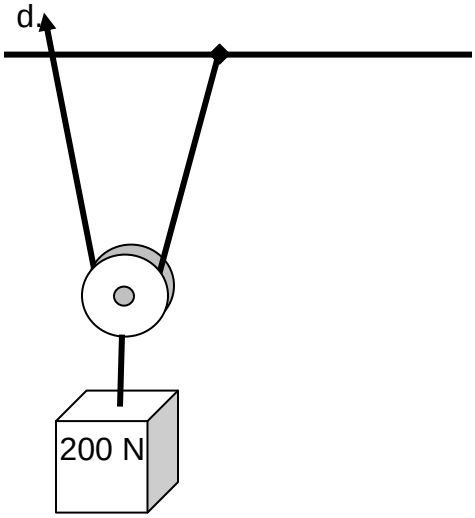

b.



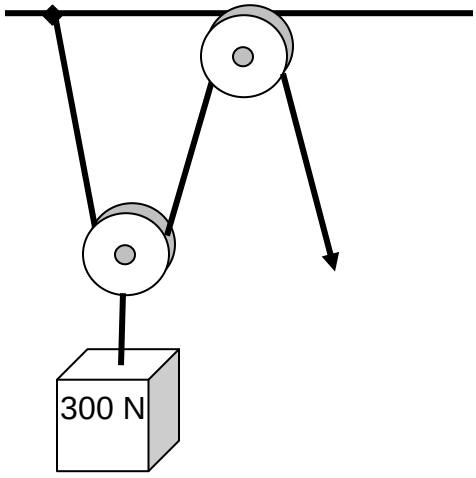

c.



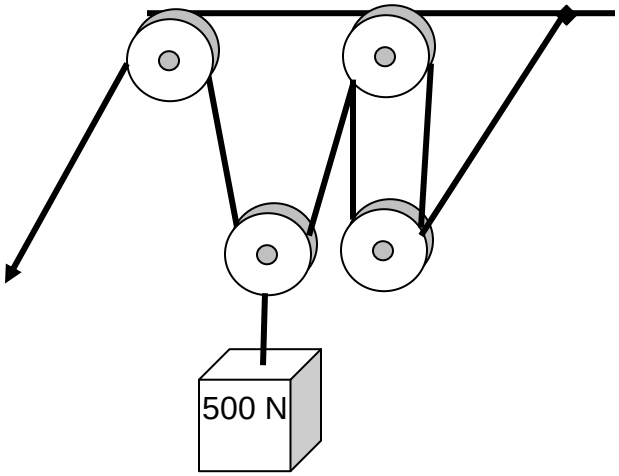

d.




e.

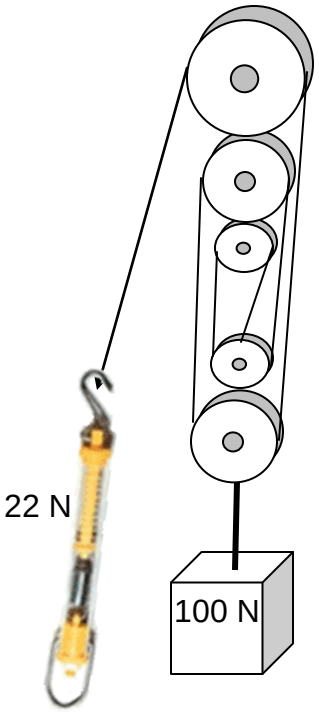



f.

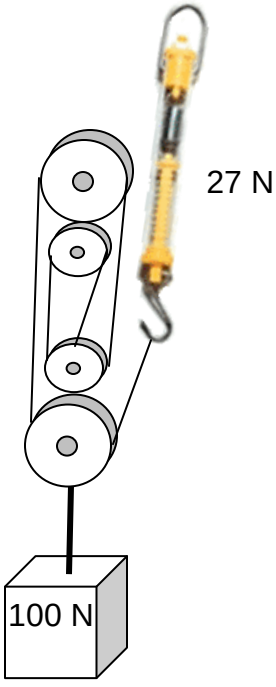



11. Tell how much force is on each rope in each case a-f above.

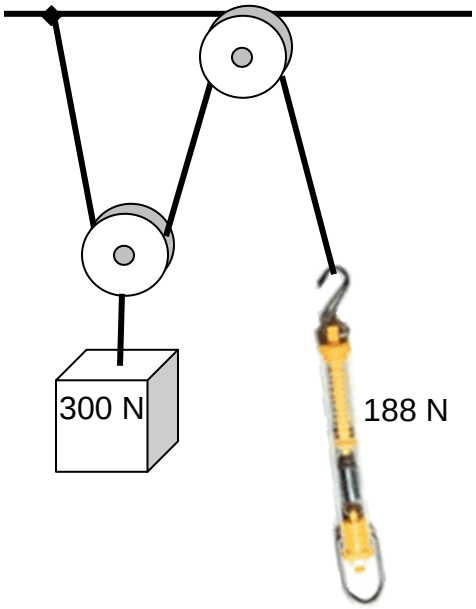
12. Determine the efficiency of the following pulley system.



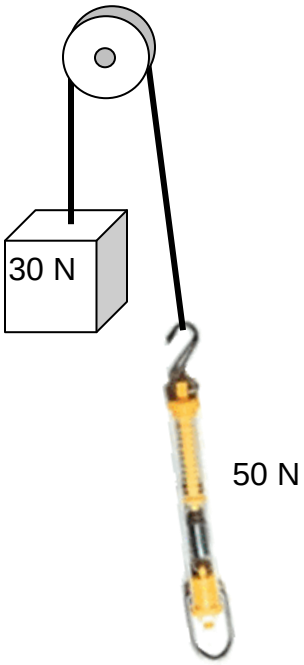

13. Determine the efficiency of the following pulley system.



14. Determine the efficiency of the following pulley.




15. Determine the efficiency of the following pulley.



16. **Wheel and Axles**

a. if effort is applied to the wheel, then force is increased, but speed and distance are decreased.

b. If effort is applied to the axle, then force is decreased, but speed and distance are increased.

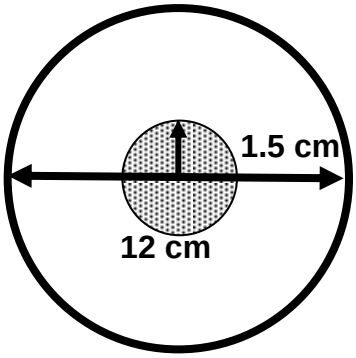
c. If the wheel portion is not fixed to the axle, then it is not a wheel and axle.

d. The wheel and axle is made up of two circles: the smaller one is the axle and the larger one is the wheel. Every time the wheel is turned, the axle turns, too. One rotation of the wheel causes one rotation of the axle.

e. IMA of a wheel and axle

$$\text{IMA} = \frac{\text{radius of wheel}}{\text{radius of axle}} \quad \text{OR} \quad \text{IMA} = \frac{\text{diameter of wheel}}{\text{diameter of axle}}$$

f. What is the IMA of the wheel and axle?




g. What is the IMA of the wheel and axle?