Name: ______________________________ P: __________ Date: ________________

Simple Machines—Levers

Background Information

Simple machines make work easier to do. One way to express the benefit of using machines is called mechanical advantage (MA). The mechanical advantage of a machine is a number without units. If the mechanical advantage is more than 1, the machine makes work easier by multiplying the effort force. In other words, it causes an effort to seem larger than it actually is when acting against a resistance. If the mechanical advantage is less than 1, the machine makes work easier by allowing the resistance to move farther and faster than the effort. If the mechanical advantage is exactly 1, the machine makes work easier by changing the direction in which the effort must be applied.

A lever is a simple machine that involves two forces and a pivot point called a fulcrum. The force the user applies to the lever is called the effort or the effort force. The force against which the effort acts is called the resistance or resistance force.

There are three classes of levers. The position of the two forces with respect to the fulcrum determines the class of the lever. In this investigation, you will see how different positions of the effort, resistance, and fulcrum affect the mechanical advantage of the lever.

Problem

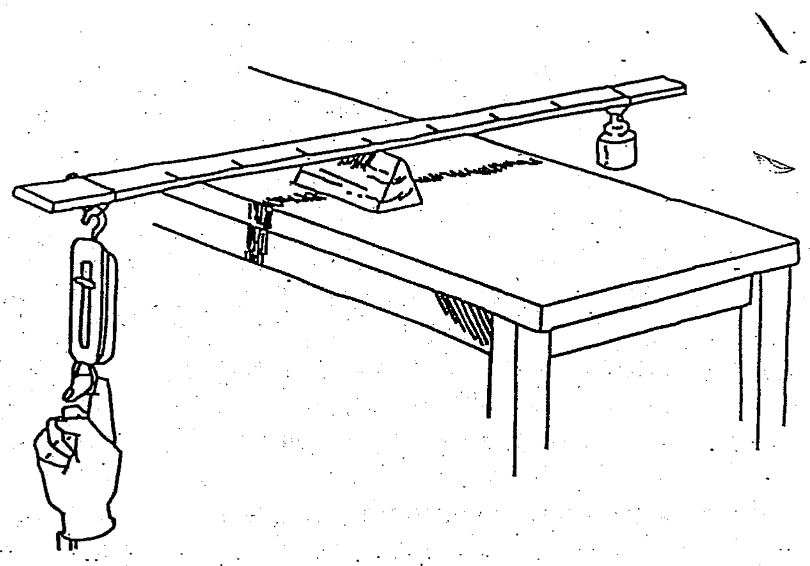
How does changing the positions of the effort, resistance, and fulcrum affect the mechanical advantage of a lever?

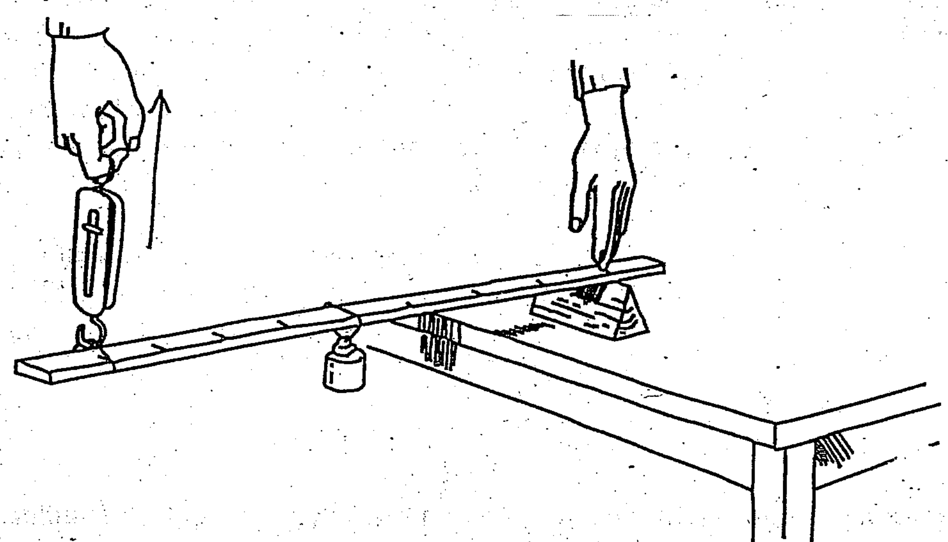
Materials per group

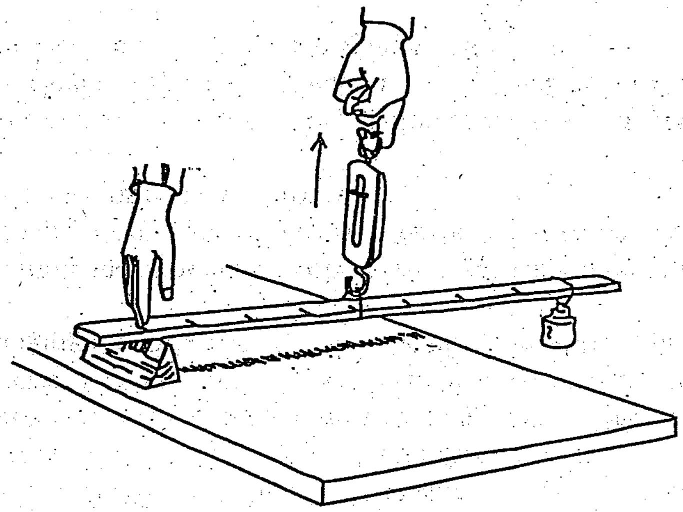
Meter stick
Spring Balance
1-kg mass or larger
Meter stick clamp or holder to serve as fulcrum

Procedure

1. Hang the mass from the spring balance to determine its force (weight) in Newtons. Record this number in Observation as F_R.
2. Set up a first class lever with the fulcrum at the 50-cm mark on the meter stick. Place the resistance (mass) and the effort (spring balance) at the distances indicated as resistance distance and effort distance, respectively, in A of Data Table 1. The effort force is the reading on the spring balance when the balance just balances the resistance. Calculate the mechanical advantage for the first class lever. Record in Data Table 1.
3. Repeat step 2 three more times using the effort distances and resistance distances given for positions B, C, and D in Data Table 1.
4. Set up a second class lever with the fulcrum 10-cm from the end of the meter stick. Place the resistance (mass) and the effort (spring balance) at the distances indicated in A of Data Table 2. Apply the effort and record the effort force reading on the spring balance. Calculate the mechanical advantage for this second class lever. Record in Data Table 2.
5. Repeat step 4 two more times using the distances given for positions B and C in Data Table 2.
6. For the third class lever, keep the fulcrum in the same place as the second class lever. Place the resistance (mass) and the effort (spring balance) at the distances indicated in A of Data Table 3. Apply the effort and record the effort force reading on the spring balance. Calculate the mechanical advantage for this third class lever. Record in Data Table 3.
7. Repeat step 6 two more times using the distances given for positions B and C in Data Table 3.







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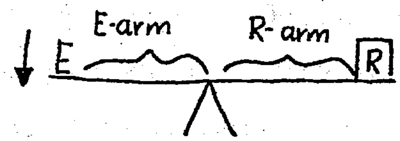
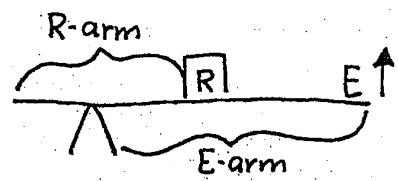
Observations

F_R = ____________N



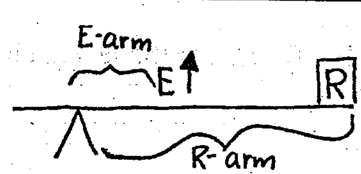
DATA TABLE 1 First Class Lever: Fulcrum at 50-cm

Position	Effort Distance	Resistance Distance	Effort Force FE	AMA F_R/F_E	IMA D_E/D_R
A	40-cm	40-cm			
B	40-cm	20-cm			
C	40-cm	10-cm			
D	20-cm	40-cm			



DATA TABLE 2 Second Class Lever: Fulcrum at 10-cm from end of meter stick

Position	Effort Distance	Resistance Distance	Effort Force F_E	AMA F_R/F_E	IMA D_E/D_R
A	50-cm	40-cm			
B	50-cm	25-cm			
C	50-cm	10-cm			



DATA TABLE 3 Third Class Lever: Fulcrum at 10-cm from end of meter stick

Position	Effort Distance	Resistance Distance	Effort Force F_E	AMA F_R/F_E	IMA D_E/D_R
A	20-cm	80-cm			
B	40-cm	80-cm			
C	60-cm	80-cm			

Conclusion

1. Is the IMA of a second class lever more than, equal to, or less than one? ____________________

   This is due to the fact that the effort arm is always ____________________ than the resistance arm.

   This, in turn, makes the effort force _______________ than the resistance force.

2. Is the IMA of a third class lever more than, equal to, or less than one? ______________________

   This is due to the fact that the effort arm is always __________________ than the resistance arm.

   This, in turn, makes the effort force _______________ than the resistance force.

3. What is the IMA of a first class lever in reference to one? ________________________________

   Explain your findings. ____

   ____

   ____

4. In general, how does the AMA compare to the IMA? ____________________________________

   ____

5. Do you think a lever is a very efficient machine? __________ Why or why not? ________________

   ____

   ____

   ____

6. For a second class lever you gain ____________________ and sacrifice ______________________

7. For a third class lever you gain ______________________ and sacrifice ______________________.

8. Can we make one of the above statements for a first-class lever? Why or why not?

   ____

   ____

   ____

9. Do any of the levers change the direction of the force? If so, which ones? Explain.

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