Powerful Pulleys

Purpose

To understand that pulleys reduce the amount of force needed to lift an object

Materials (per group)

two double pulleys
string
pennies
cup with attached string
clamp and poles from which to hang the pulley system
500 gram mass (weight)
balance
calculator

Procedure

1. Use a balance to find the mass of the bottom pulley system and the attached weight, which is called the load. Record the mass in the chart below.

Object	Mass
Load (Mass of pulleys + 500 g)	

2. Attach the string to the hook on the bottom pulley.
3. Loop the string over the top pulley and attach the cup to the string.
4. Hang the weight from the hook on the bottom pulley. (See Diagram 1)
5. Begin placing pennies in the cup, continuing until the cup balances the weight without anyone having to hold it.
6. Continue placing pennies in the cup until the cup moves. Note: If the cup begins to move and then stops, give the cup a little downward tap. If the cup resumes its motion and moves a good distance, don't add any more pennies. If the cup moves only a few cm and then stops again, you will need to add another penny or two until it moves with a little tap.
7. Place the cup with pennies on the mass balance and record its mass to the nearest gram. The mass of the pennies plus the cup is called the total mass.
8. Repeat steps 5-7 for three more trials and record results in data chart (p. 44). Before each trial, remove 5 or 6 pennies from the cup.
9. Find the average mass for the four trials and record in the data chart. Your answer should be to the nearest gram.
10. To repeat the experiment using 2 strings, attach the string to the top pulley, go around one bottom pulley and one top pulley and then attach the cup to the string. See diagram 2.
11. Now repeat steps 5 through 9 to determine the mass required to lift the load, when it is supported by 2 strings.
12. To find the mass required when using 3 strings, attach the string to the bottom pulley, go around one top pulley, bottom pulley, and the top pulley. See diagram 3.
13. Repeat steps 5 through 9.
14. To find the mass required using 4 strings, attach the string to the hook on the top pulleys and go around one bottom, followed by a top pulley, then the other bottom pulley, and finally the remaining top pulley. See diagram 4.
15. Repeat steps 5 through 9.

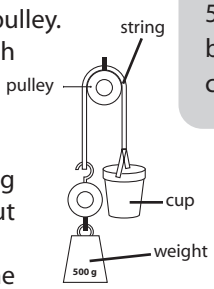

Diagram 1

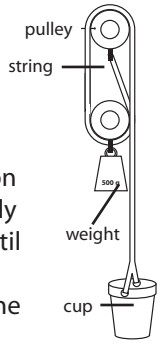

Diagram 2

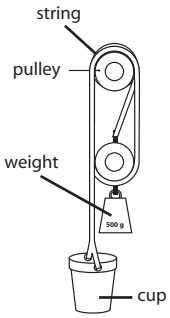

Diagram 3

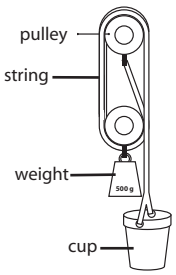

Diagram 4

Data Chart: Total Mass

Number of Strings	Trial 1	Trial 2	Trial 3	Trial 4	Average Total mass
Example:	**212 Grams**	**213 Grams**	**211 Grams**	**212 Grams**	**212 Grams** (212 + 213 + 211 + 212) ÷ 4
1 String					
2 Strings					
3 Strings					
4 Strings					

16. Share your results with the rest of the class and find the class average to the nearest gram.

Group Averages for Total Mass

	1 String	2 Strings	3 Strings	4 Strings
Group 1				
Group 2				
Group 3				
Group 4				
Group 5				
Group 6				
Class Average				

Conclusion:

1. Was the total mass required to move the pulley always less as the number of strings increased?
2. The theory states that the total mass required to lift the load with a pulley system can be found by dividing the load by the number of strings supporting the bottom pulley. Use a calculator to divide the load (Load = mass of bottom pulleys + 500 grams) by the number of strings in each experiment. Record the actual average total mass required to lift the load for each. Find the difference between the two numbers and record.

Number Strings	Load ÷ Number of Strings	Actual Total Mass	Difference
Example: 1	**523 ÷ 1 = 523 g**	**554g**	**31g**
1			
2			
3			
4			

How do you explain the differences between your class's experimental values for Total Mass and the values listed above for Load ÷ Number of Strings?