ScienceCube

Work Done by a Pulley

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1. **Compare the amount of work done by a fixed pulley and a movable pulley.**
2. **Explain the benefits gained from using tools.**

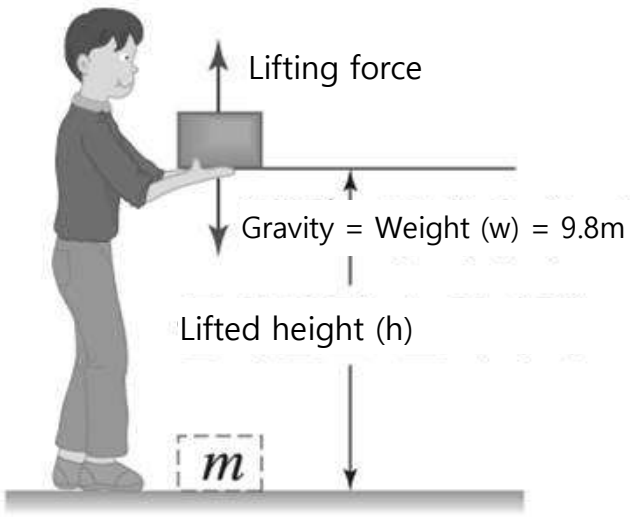
Fundamental Concept

1. Work

1) Meaning of Work: Work is done on an object when a force is applied to it and the object moves in the direction of the force.

Work (W) = Force (F) X Distance (s)

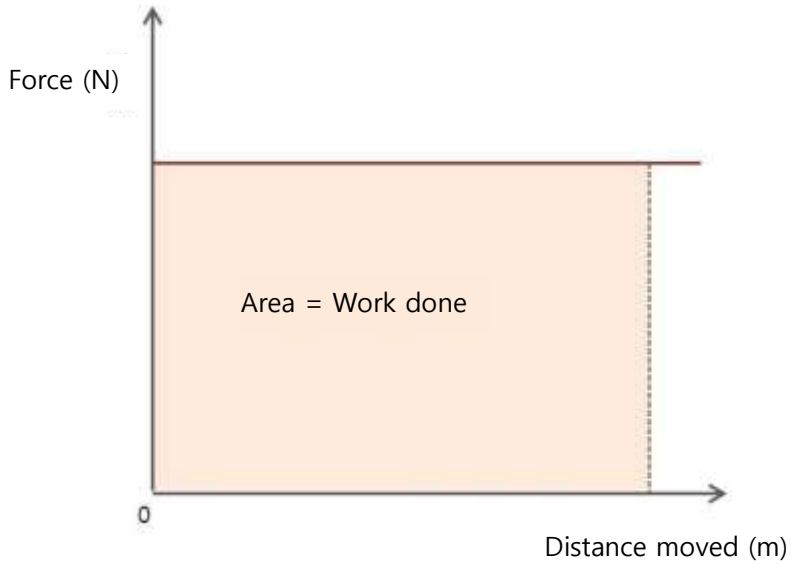
2) Work Done When Lifting an Object



Acting Force	Gravity
Magnitude of Force	To lift an object at a constant speed, a force equal to the weight of the object must be applied..
Distance	The height to which the object is lifted
Amount of Work	Work=Magnitude of Gravity×Height the object is lifted Work=Weight of the object×Height the object is lifted

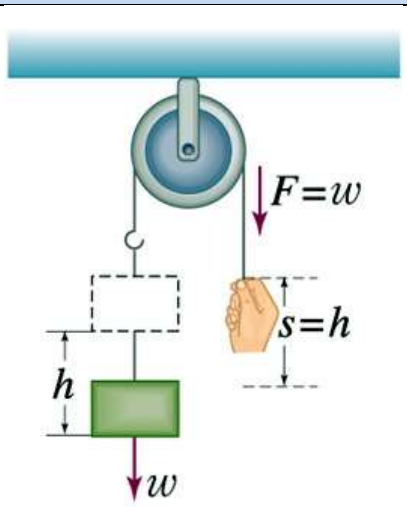
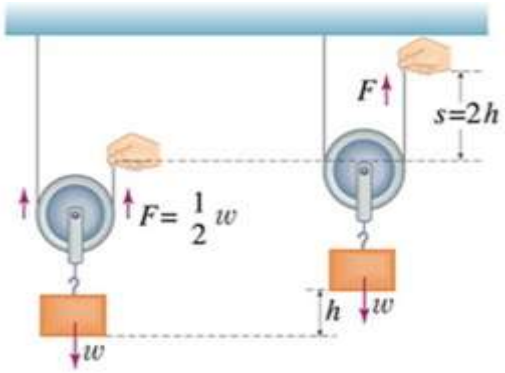
3) Expression of Work by Graph

The work done by a force is equal to the area under the graph.



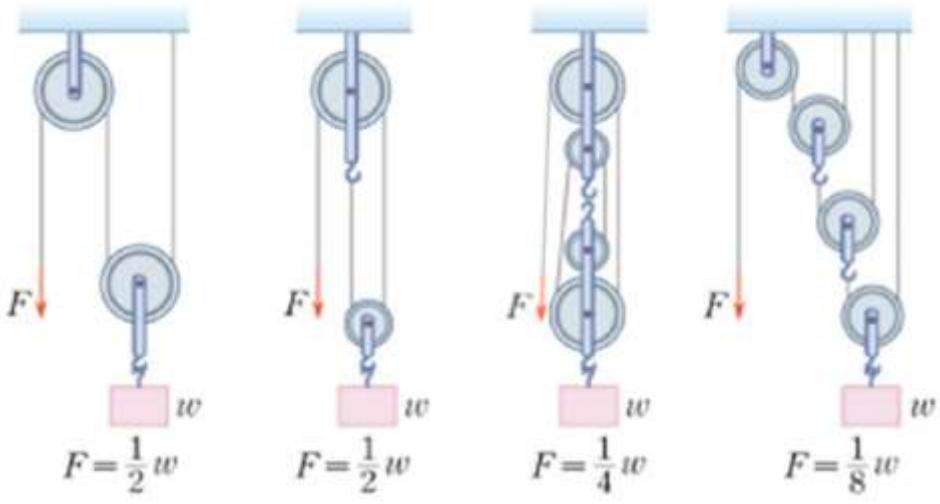
2. Principle of Work

1) Fixed Pulley and Movable Pulley

Category	Fixed Pulley	Movable Pulley
Structure		
Force	F = w	F = 1/2 w
Distance	S = h	S = 2h
Amount of Work	W = F X s = w X h → No advantage.	W = F X s = 1/2w X 2h = w X h → Advantage
Advantage	Can change the direction of force.	Can gain mechanical advantage.
Examples	Well bucket, flagpole	Elevator, tower crane

(F: Force, w: Weight, s: Length of rope pulled, h: Height object is lifted)

- Compound Pulley



Experiment

Materials Needed

Interface, Science# Program, force sensor, stand, string, ruler, 500g weight, pulley, clip.

Preparation of Experimental Apparatus

1. Attach a clamp to the stand and fix a ruler so that the scale can be read from the bottom.
2. Cut a piece of string about 30 cm long and attach a clip to each end.
3. Attach the clip connected to the string to the hook of the force sensor.

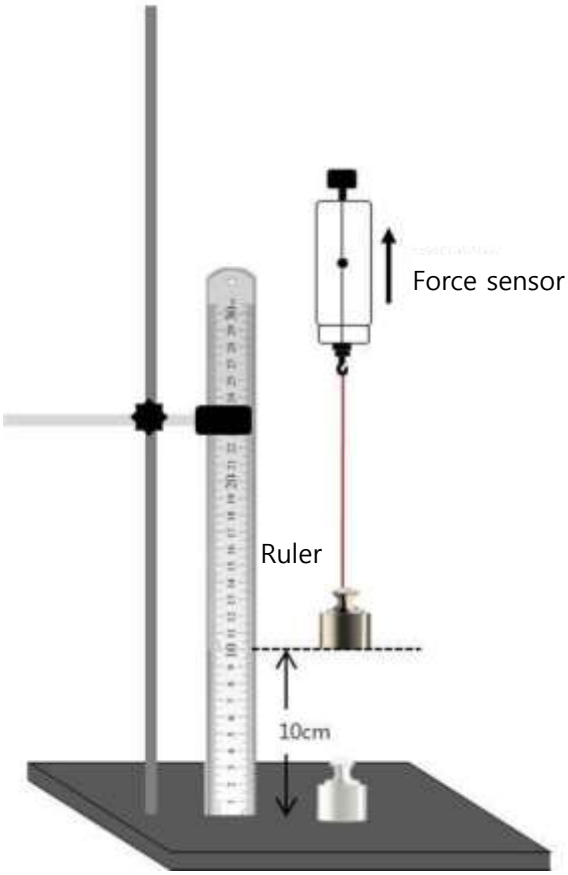
Interface Setup

1.  Run the Science# program.
2. Connect the force sensor to the interface.
3. Click  to set the zero point.

Data Collection

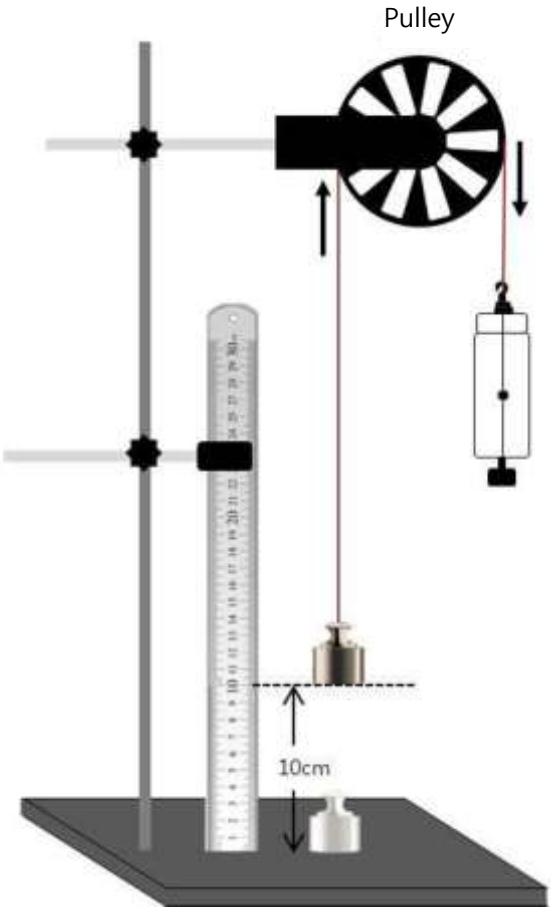
[Experiment 1] Lifting an Object

1. Attach a 500g weight to the clip and slowly pull the force sensor upward to lift the weight 10 cm off the ground.
2. Measure and record the force needed to lift the weight 10 cm off the ground.



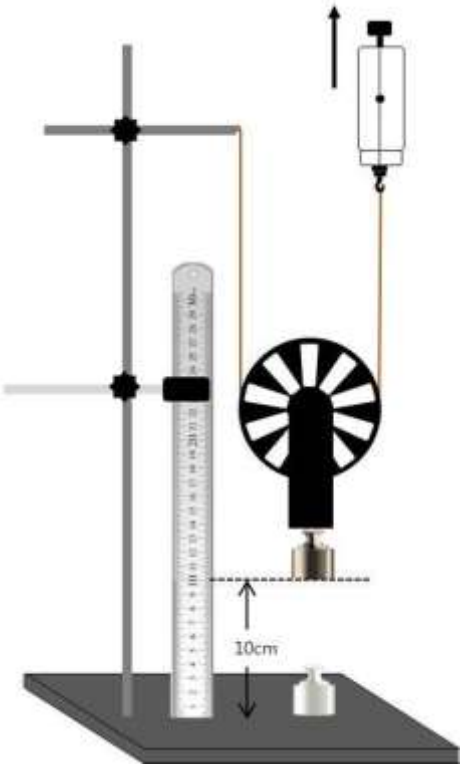
[Experiment 2] Using a Fixed Pulley

3. Attach a holder to the stand and secure the pulley as shown in the diagram.
4. Insert the string through the pulley and attach the 500g weight to one clip and the force sensor to the other clip.
5. Pull the force sensor downward to lift the weight 10 cm off the ground.
6. Measure and record the force needed to lift the weight 10 cm off the ground.



[Experiment 3] Using a Movable Pulley

7. Attach a clip to the pulley support and set up the movable pulley as shown in the diagram.
8. Pull the force sensor upward to lift the weight 10 cm off the ground.
9. Measure and record the force needed to lift the weight 10 cm off the ground..



Data Analysis

Recording Data

1. Record the measured values for lifting the weight 10 cm off the ground with and without using the pulley in the table below.

State	Experiment 1	Experiment 2	Experiment 3
	No tool used	Fixed Pulley	Movable Pulley
Magnitude of Force (N)			
Length of String Pulled (cm)			
Direction of Force			
Amount of Work (J)			

Data Application

1. Explain how the magnitude of force differs when lifting the weight to the same height in [Experiment 1], [Experiment 2], and [Experiment 3].

2. Explain how the length of the string pulled differs when lifting the weight to the same height in [Experiment 1], [Experiment 2], and [Experiment 3].

3. Compare the amount of work done with and without using the pulley and explain the reason.

4. Compare the common characteristics and differences of using a fixed pulley and a movable pulley to lift the weight to the same height..

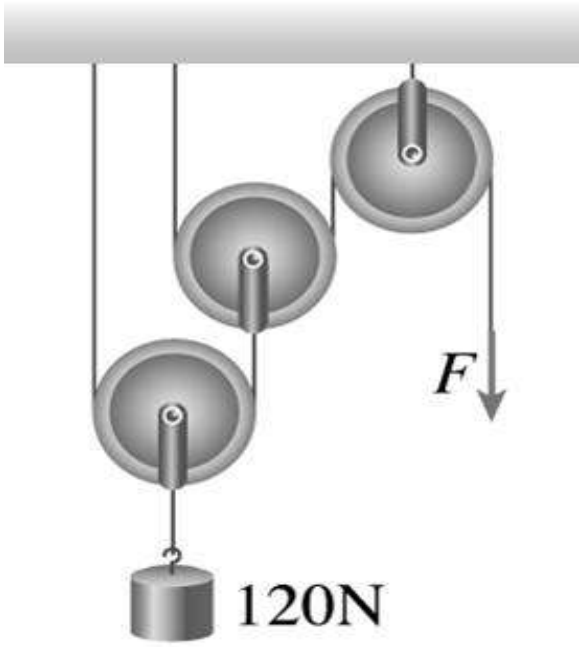
Category	Fixed Pulley	Movable Pulley
Difference		
Commonality		

Extended Activity

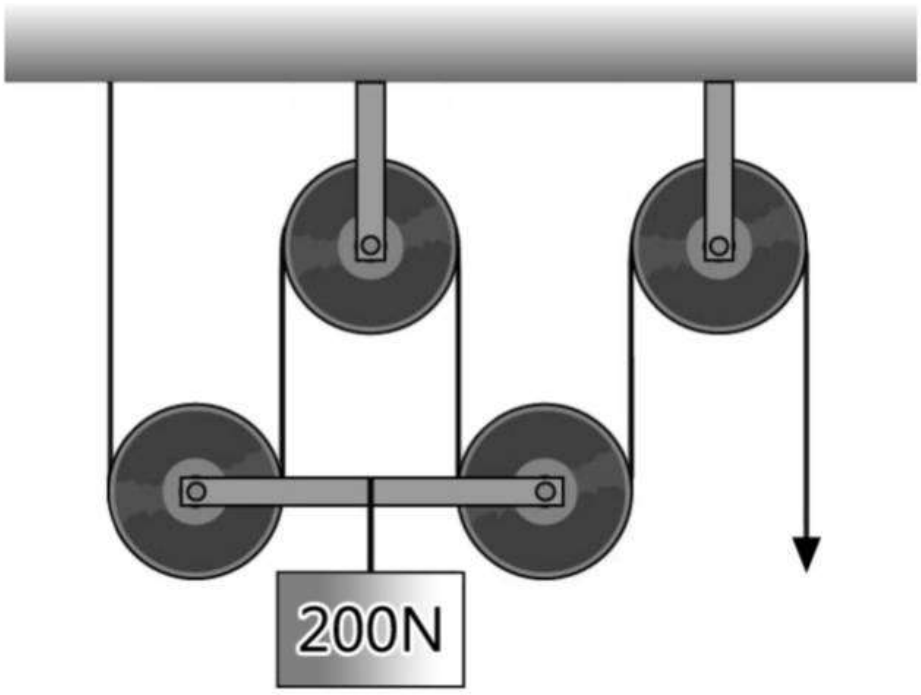
1. Based on the above experiment, explain the advantages of using a pulley compared to not using a tool.

Category	Fixed Pulley	Movable Pulley
Advantage		

2. Using the apparatus shown in the diagram, a 120N weight is lifted by pulling the rope down 6 meters. Write down the force required to lift the object and the length of rope that needs to be pulled. (Assume the weight of the pulley and friction are negligible.)



3. Using the pulley shown in the diagram, a 200N weight is lifted 3 meters. Write down the force required to lift the object and the length of rope that needs to be pulled. (Assume the weight of the pulley and friction are negligible.)

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