

SI Physics - Full Discipline Demo

Pulleys - Digital

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Physics - Full Discipline Demo
Course	SI Physics - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

⚡ Effort	Pulling force exerted by a string or rope	1
⚡ Free-body diagram	Measure of the multiplication factor for the input force in a simple machine	2
⚡ Load	A simple machine consisting of a grooved wheel turning on an axle	3
⚡ Mechanical advantage	Representation of all the forces acting on an object	4
⚡ Pulley	Output force or object moved by a simple machine	5
⚡ Tension	Input force or applied force required to move an object using a simple machine	6

Correct answers:

- 1 Tension 2 Mechanical advantage 3 Pulley 4 Free-body diagram
5 Load 6 Effort

Identify each statement as true or false.

⚡ A pulley system with a mechanical advantage of 2 reduces the amount of energy required to move an object to half the nominal energy.	
⚡ The efficiency of a simple machine is the ratio of the actual mechanical advantage to the theoretical mechanical advantage.	
⚡ The reduction in tension in pulley systems is called mechanical advantage.	
⚡ The theoretical mechanical advantage is always less than the actual mechanical advantage.	
⚡ The work put into a simple machine must equal the work done by the simple machine.	
True	False
1	2

Correct answers:

1

The efficiency of a simple machine is the ratio of the actual mechanical advantage to the theoretical mechanical advantage.

The work put into a simple machine must equal the work done by the simple machine.

The reduction in tension in pulley systems is called mechanical advantage.

2

A pulley system with a mechanical advantage of 2 reduces the amount of energy required to move an object to half the nominal energy.

The theoretical mechanical advantage is always less than the actual mechanical advantage.

Exploration

A combination of fixed and movable pulleys is called a ____ pulley system.

- ☐ combo
 - ☒ compound ✓
 - ☐ mixed
 - ☐ None of the above
-

Multiple pulleys used together in a system can be used to change the ____ of the applied force.

- ☐ magnitude
 - ☐ direction
 - ☒ direction and magnitude ✓
 - ☐ None of the above
-

The tension of a massless string is ____ the pulling force exerted on one end of the string.

- ☒ equal to ✓
 - ☐ greater than
 - ☐ less than
 - ☐ All of the above
-

In a free-body diagram, all the forces acting on an object start with their head on the dot that represents the object.

- ☐ True
 - ☒ False ✓
-

The net force acting on an object that is not accelerating is ____ .

- ☐ positive
- ☐ negative
- ☒ zero ✓
- ☐ None of the above

The applied force in a pulley system is equal to the ____ for a non-accelerating system.

- ☐ weight
- ☒ tension ✓
- ☐ mass
- ☐ None of the above

The mechanical advantage is defined as the ratio of ____.

- ☒ output force to input force ✓
- ☐ input force to output force
- ☐ input force to applied force
- ☐ None of the above

The output force corresponds to the load.

- ☒ True ✓
- ☐ False

The theoretical mechanical advantage is equal to the number of ____ supporting the load.

- ☐ pulleys
- ☒ string segments ✓
- ☐ effort forces
- ☐ All of the above

Work is defined as the force multiplied by the ____.

- ☐ time
- ☐ mass
- ☒ distance
- ☐ None of the above

✓

For a machine with a mechanical advantage greater than one, the distance over which the input force acts is ____ the distance over which the output force acts.

- ☒ larger than
- ☐ smaller than
- ☐ equal to
- ☐ None of the above

✓

Exercise 1

How does addition of pulleys into a system affect the MA? Is it a linear change? Does the direction of applied force matter? Reference Graph 1 in your answer.

The MA increases linearly with increasing number of pulleys, but the direction in which the force is applied factors in. As can be seen in **Graph 1**, the MA has a linear relationship with pulley number: $MA=n+1$ (n =number of pulleys) for an upward applied force and $MA=n$ for a downward applied force.

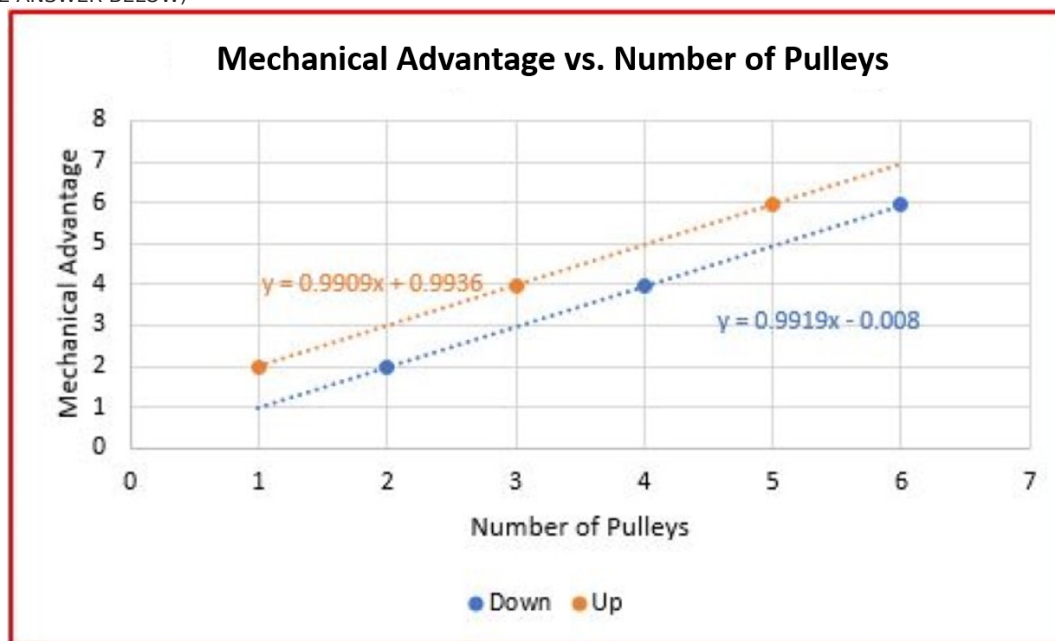
How would the mechanical advantage change on a different planet with a different gravitational force? Explain your answer.

The mechanical advantage would remain the same. This is because the MA is determined by the number of pulleys. The number of pulleys affects the effective amount of strings pulling upward on the mass. Though the necessary applied force necessary to lift would change on a different planet, the gravitational (weight) force of the object would change by the same factor. This makes the MA independent of the gravitational force on the planet.

Data Table 1: Pulley Simulation
(SAMPLE ANSWER BELOW)

Mass (g)	1000	Weight F_{out} (N)	9.81
Number of Pulleys	Magnitude of Effort Force F_{in} (N)	Direction of Force	Mechanical Advantage
6	1.65	D	5.95
5	1.65	U	5.95
4	2.48	D	3.96
3	2.47	U	3.97
2	4.96	D	1.98
1	4.95	U	1.98

Graph 1: Number of Pulleys vs. Mechanical Advantage
(SAMPLE ANSWER BELOW)



Competency Review

A ____ pulley is one that moves during the operation of the pulley system.

- ☐ single
- ☐ fixed
- ☒ movable ✓
- ☐ None of the above

A benefit obtained by using a pulley system is called a mechanical ____.

- ☐ newton
 - ☐ interval
 - ☒ advantage ✓
 - ☐ All of the above
-

As the number of string segments supporting the load in a pulley system increases, the effort needed to move the load ____.

- ☒ decreases ✓
 - ☐ increases
 - ☐ remains constant
 - ☐ All of the above
-

The efficiency of a pulley system is a measure of how similar to an ideal system it is.

- ☒ True ✓
 - ☐ False
-

The work put into an ideal simple machine must be ____ the work done by the machine.

- ☐ greater than
 - ☐ less than
 - ☒ equal to ✓
 - ☐ None of the above
-

As more pulleys are added to a system of pulleys, the efficiency of the system ____.

- ☒ decreases ✓
 - ☐ increases
 - ☐ remains constant
 - ☐ None of the above
-

As pulleys are added to a pulley system, the mechanical advantage ____ with the number of pulleys.

- ☐ increases exponentially
- ☐ decreases linearly
- ☒ increases linearly
- ☐ None of the above

✓

A pulley system with a mechanical advantage of 3 lifts a load of 11 N using an effort of ____ N.

- ☒ 3.7
- ☐ 7.3
- ☐ 33
- ☐ None of the above

✓

Extension Questions

Is it possible to increase the efficiency of a pulley system without affecting the mechanical advantage of the system? If so, describe how, and if not, explain why not. (SAMPLE ANSWER BELOW)

Yes, it is possible to increase the efficiency of a pulley system without affecting the mechanical advantage of the system. The mechanical advantage depends on the number of pulleys supporting the load, or the number of strings supporting the load, so this number must remain constant, but there could be extra pulleys changing the direction of the effort force, which could be removed, and which would increase the efficiency by decreasing the friction in the system. Additionally, the pulleys in the system could be exchanged for ones with less friction, increasing the efficiency of the system.