

Section 2

Understanding Structures and Mechanisms

EXPLORATION 2

One Pulley vs. Many Pulleys

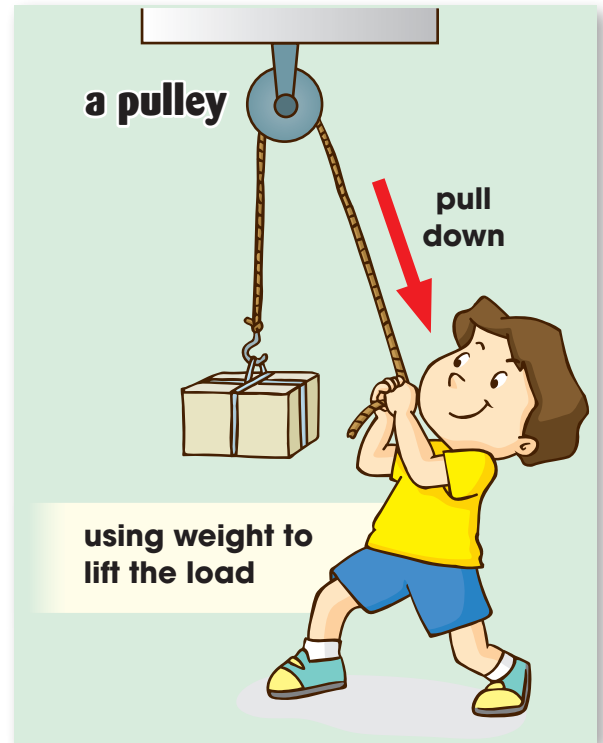
Explore the relationship between the effort needed to lift something and the number of pulleys used.

A pulley is a simple machine that is made by looping a rope over a wheel. It makes it easier for us to lift heavy objects. When a single pulley is used, it changes the direction of the force applied and also allows us to lift the load using our own weight.

There are many uses of pulleys in our daily lives. Here are some examples:

- Elevators use multiple pulleys in order to function.
- Construction cranes use pulleys to lift and place heavy materials.
- Blinds on windows are moved up and down using a pulley system.
- Flagpoles use pulleys to hoist the flags up or bring them down.
- Garage doors are raised and lowered by a pulley system.

The more wheels a pulley system has, the more times the rope is looped around them, making lifting easier. This is because the system multiplies the force applied in addition to changing its direction.



Section 2

Understanding Structures and Mechanisms

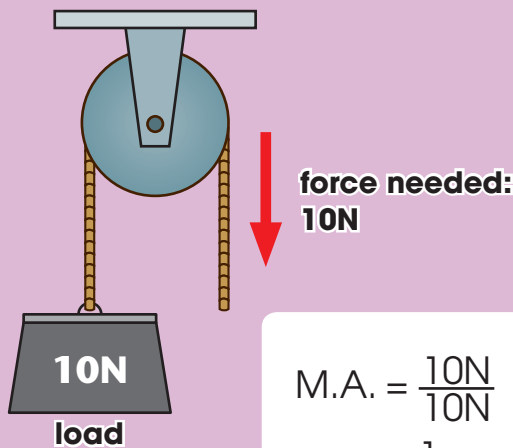
EXPLORATION 2

One Pulley vs. Many Pulleys

Both single pulleys and systems of pulleys give us mechanical advantage (M.A.). The mechanical advantage of a pulley can be found by dividing the output force (the load) by the input force (the force needed to lift the load).

A Single Pulley

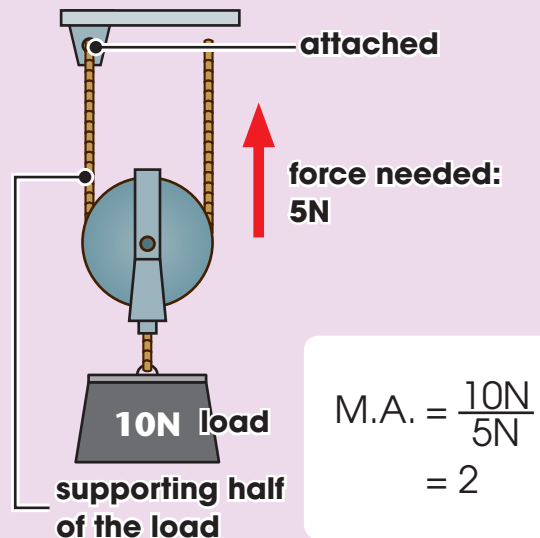
Fixed Pulley



The amount of applied force to lift the load is the same as the force needed to lift the load without the pulley. The mechanical advantage of a fixed pulley is 1.

It is easier to lift the load with a fixed pulley because it changes the direction of force applied and lets you use your weight to lift the load.

Moveable Pulley



In a moveable pulley, the rope is attached to a fixed point, the pulley is attached to the object, and the other end is left free.

Since half of the load is supported by the rope attached to the ceiling, the force needed to move the load is only half of the load.

The mechanical advantage of a moveable pulley is 2.

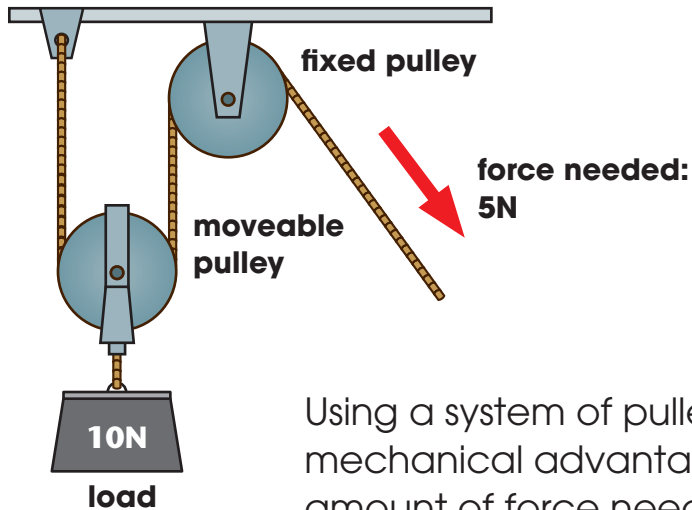
Section 2

Understanding Structures and Mechanisms

EXPLORATION
2

One Pulley vs. Many Pulleys

A System of Pulleys - a fixed pulley and a moveable pulley

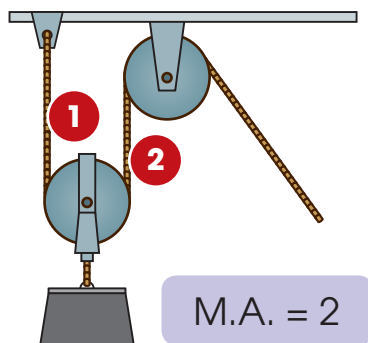


$$\begin{aligned} \text{M.A.} &= \frac{10\text{N}}{5\text{N}} \\ &= 2 \end{aligned}$$

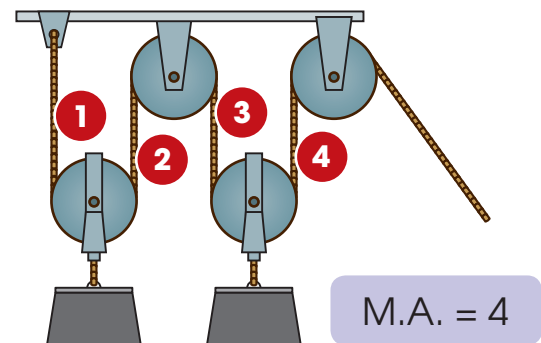
Using a system of pulleys provides a powerful mechanical advantage - greatly reducing the amount of force needed to move a load. The pulley system above has the same mechanical advantage of 2 as the single moveable pulley; however, it changes the direction of the force applied. Therefore, we will find it even easier to lift the load with this system.

Mechanical Advantage

The mechanical advantage of a pulley system is equal to the number of ropes supporting the moveable pulleys.



force applied = half of the load



force applied = a quarter of the load