# Unit 3 Investigation skills: mechanical systems

You will learn how to use a single wheel fixed pulley. A single wheel moveable pulley can change the direction of pull (MA – 0), while the force, effort, and weight stay the same. We will show you how you can change the direction of pull by using a block system. We call this type of system a block and tackle. This system will demonstrate how to determine the relationship between load-bearing ropes on moveable pulley wheels and force multiplication (MA). You will discover that it is possible to change the direction of movement and pull by arranging pulleys in different ways.

## 1 Action research: practical investigations of pulley systems

Pulleys are similar to wheels, but since they have such an important function they are put in their own category. The wheel of a pulley has two raised edges that allow a rope or a piece of string to run along the wheel without falling off. We will investigate different kinds of pulleys.

### 1.1 Single wheel fixed pulley

Single wheel fixed pulleys have one wheel and are fixed to a wall, bar, beam or something else. The wheel is fixed, which means that it does not move. You use gravity or your weight to apply the force that you need to raise the object on the other end of the pulley rope. If the object you are trying to lift is heavier than you, you need to put in more effort to raise it. A fixed pulley therefore does not give you any mechanical advantage. It changes the direction of pull, for example you pull down on a rope to lift something up. We can write this as MA = 0.

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## 1.2 Single wheel moveable pulley

Single wheel moveable pulleys change the direction of pull in a slightly different way. We write the way that single wheel moveable pulleys work as MA > 0. In Activity 1, you will do a practical investigation to find out the difference between fixed pulleys and moveable pulleys.

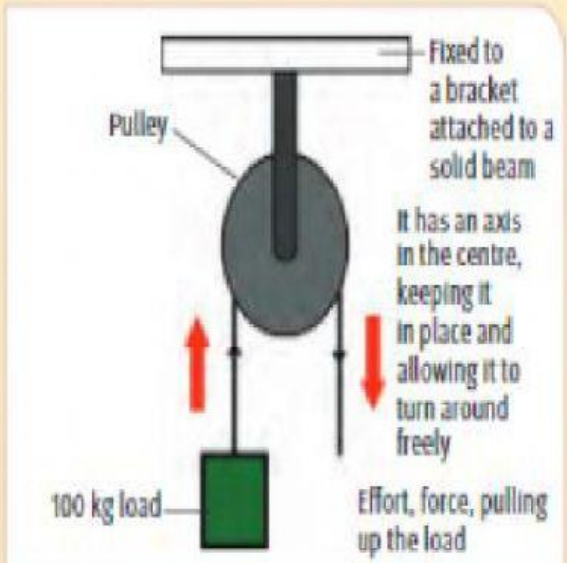



FIGURE 10 A single wheel fixed pulley

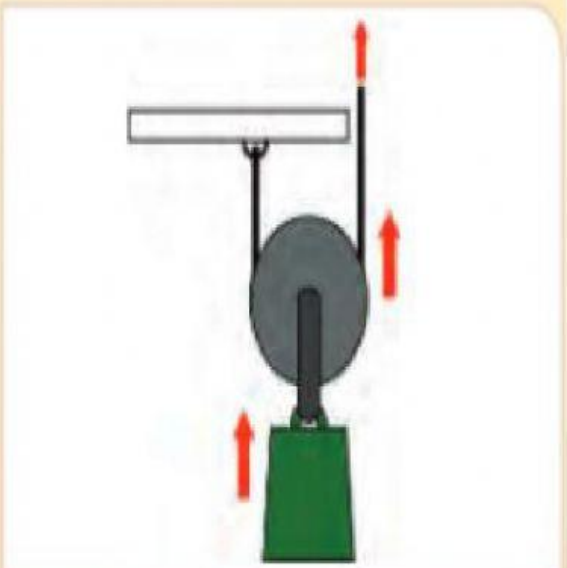


FIGURE 11 A single wheel moveable pulley

## 1.3 Pulley block system

When you want to lift something that is heavier than you, a single wheel fixed pulley will not do the job. You may need to use a block and tackle system. You can make it much easier to lift heavy things by adding one or more pulleys to your system. This will redistribute the weight of your object across the number of pulleys that you add to your system. In a block and tackle system, you are using force instead of distance. Cranes are good examples of a block and tackle system.

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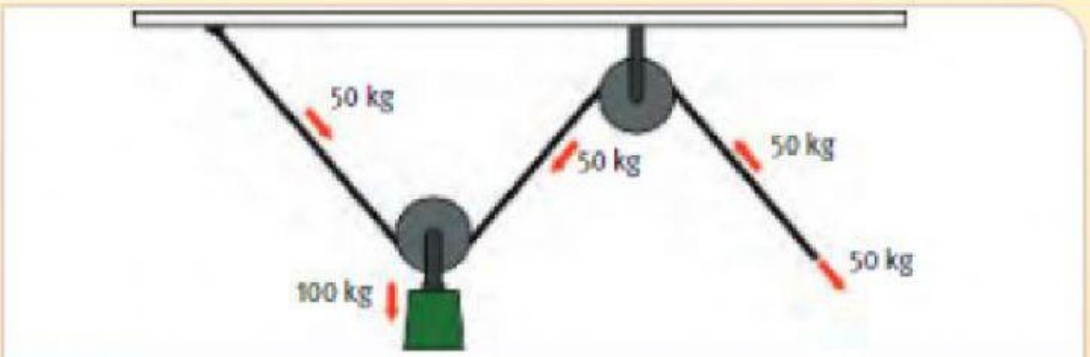



FIGURE 12 A block and tackle system

1 Study **FIGURE 12**. In a class discussion, talk about why the system in **FIGURE 12** is different from the systems in **FIGURE 10** and **FIGURE 11**. How does adding one more pulley change things?

2 Copy these sentences into your workbook and fill in the missing words: You can see that the w_____ is now held by two pulleys rather than one pulley. That means the weight is divided e_____ between the two pulleys so that each pulley holds only h_____ of all the weight. The force has been cut in _____, but the distance the rope must be pulled has d_____.

## 2 Investigate mechanical control systems

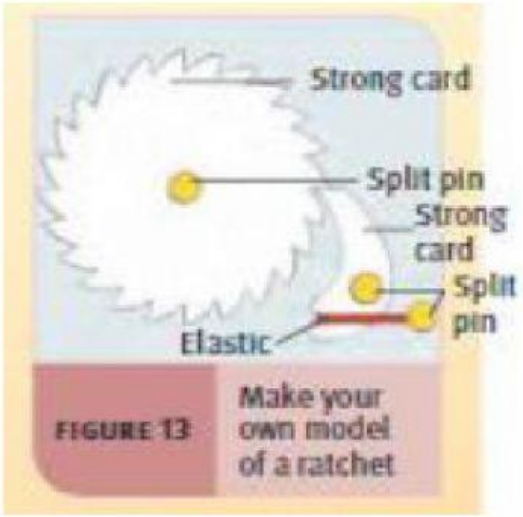
Mechanical control systems enable us to control the movement of objects. We will investigate a ratchet and pawl, disc brakes, bicycle brakes and cleats. You may already know some of these systems because we use them in everyday life.

### 2.1 Ratchet and pawl (a gear system)

A ratchet and pawl is a gear system. Gears are designed to change movement in some way. They can either allow or prevent movement. This is necessary when you want to prevent motion in a mechanism. It is also necessary when you apply pressure or the mechanism bears a load. A ratchet screwdriver is an example. The ratchet allows you to turn a screw in one direction. However, when you turn the handle of the screwdriver in the opposite direction, the screw will not move. Ratchet screwdrivers have two settings that allow you to turn a screw either in or out. This action will allow you to turn screws in and out faster and with less effort.

The teeth of a ratchet are cut at a specific angle. You can see this in **FIGURE 13**. The pawl is designed to fit the teeth of the ratchet. The shape of the ratchet teeth allows the pawl to slip over the teeth when it moves in one direction. When it moves in the opposite direction, the pawl will block the ratchet teeth and prevent movement.

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Draw a model of a rachet.

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