

# Mechanisms

## Pupil information sheet

### Motion

There are four basic types of motion:

#### Linear motion



in a straight line

#### Reciprocating motion



up and down in a straight line

#### Rotary motion



in a circle

#### Oscillating motion



backwards and forwards in an arc

### Motion at Thorpe Park

There are many rides at Thorpe Park which display different types of motion

#### Logger's Leap



Linear

#### Eclipse



Rotary

#### Vortex



Oscillating

### Activity

Can you think of three examples of everyday objects which display these motions?

### Mechanisms

Mechanisms use power (energy) to:  transfer motion  change the speed of motion  
 change the type of motion  change the direction of motion

There are 5 main components and devices used in mechanisms:

Levers

Cams and followers

Cranks, links and sliders

Pulleys and belts

Gears

### Mechanisms at Thorpe Park

Many of the rides at Thorpe Park are driven by electric motors, which create rotary motion at a set speed and in one direction. The main components used to create or change this motion in some way are pulleys, belts and gears.

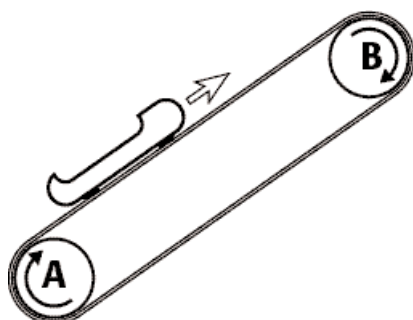


## Pupil activity sheet

### Pulleys and belts

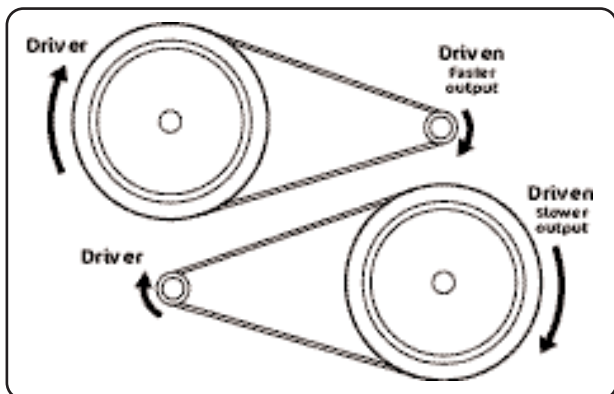
Pulley systems transfer rotary motion from pulley to pulley, create linear motion in the belt and can change the **speed** of rotary motion.

#### Pulleys and belts at Thorpe Park



- Pulleys and belts are used to move the boats on Logger's Leap to the top of the lift hill.
- The boat is moved on a large conveyer belt which is driven by powerful motors.
- Pulley A (input) is driven by the motor and is called the **driver pulley**.
- Pulley B (output) is called the **driven pulley**.

#### Changing the speed of rotation



- Pulley systems can be used to change the speed of the motion.
- If the driver pulley is bigger than the driven pulley, the output speed will be faster (the driven pulley will turn more times).
- If the driver pulley is smaller than the driven pulley then the output speed will be slower (the driven pulley will turn less times).

The number of turns of one pulley in relation to another is called the **velocity ratio**.

$$\text{Velocity ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$$

For example, if the driver pulley has a diameter of 40mm and the driven pulley has a diameter of 20mm:

$$\text{Velocity ratio} = \frac{20}{40} = \frac{1}{2} = 1:2$$

The driven pulley turns twice as many times as the driver pulley

#### Exercise

A driver pulley has a diameter of 60mm.

- i) Will the diameter of the driven pulley be smaller or larger if it is rotating twice as fast?

- ii) What will the diameter of the driven pulley be?

 mm

- iii) Check out your answer by modelling the pulley system.

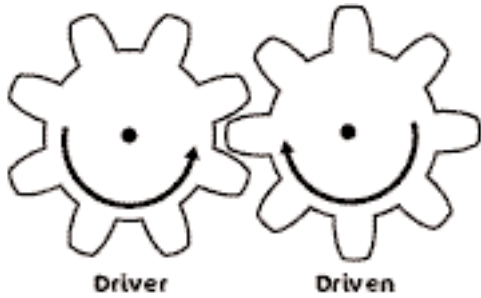


## Pupil information sheet

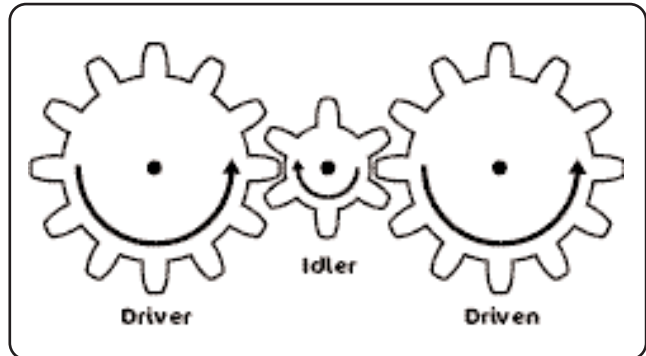
### Gears

Gear systems can change the **direction**, **angle** and **speed** of rotary motion.

#### Changing the direction of rotation



- If two gears mesh they normally turn in opposite directions.
- The gear attached to the shaft of an electric motor is called the **driver** gear (input) and the output is called the **driven** gear.

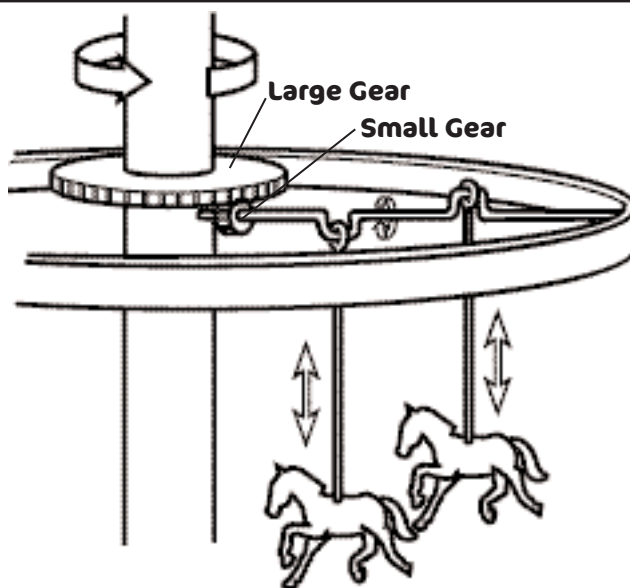


- The direction of rotation can be changed with the introduction of **idler gears**.

#### Gears at Thorpe Park

On the Chief Ranger's Carousel gears are used to change the angle and speed of rotation.

#### Changing the angle of rotation



The rotary motion of the ride is produced by a motor that drives the central shaft.

At the top of the shaft is a very large gear that produces horizontal rotary motion.

The large gear meshes with a smaller gear changing the angle of rotation.

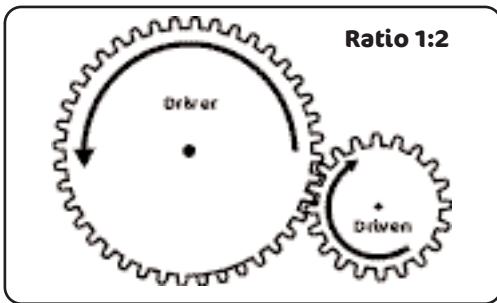
Attached to the smaller gear is a cranked shaft that makes the characters move up and down (reciprocating motion).



### Gears at Thorpe Park cont.

#### Changing the speed of rotation

Changing the speed of rotation on the Chief Ranger's Carousel is achieved by using a large driver gear and a smaller driven gear i.e. gears with a different number of teeth.



- If a driver gear with 40 teeth is driving a driven gear with 20 teeth the gear chain will speed up i.e. for every turn of the driver gear the driven gear will turn twice.
- If a driver gear has 20 teeth and the driven gear has 40 teeth the gear chain will slow down i.e. for every 2 turns of the driver gear the driven gear will turn once.

The number of turns of one gear in relation to another is called a **gear ratio**.

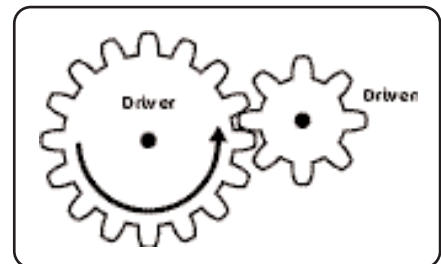
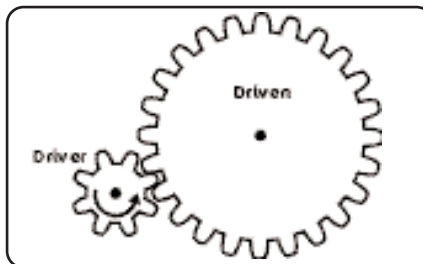
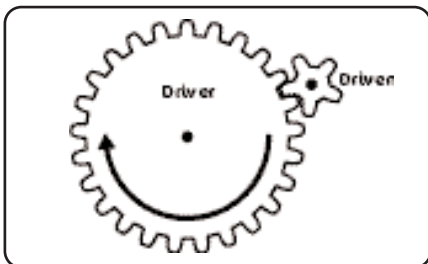
For example, if the driver gear has 5 teeth and the driven gear has 15 teeth:

$$\text{Gear ratio} = \frac{\text{Number of teeth on driven gear}}{\text{Number of teeth on driver gear}}$$

$$\text{Gear ratio} = \frac{15}{5} = \frac{3}{1} = 3:1$$

The driver gear turns three times faster than the driven gear

**Exercise** Work out the gear ratio for the following and mark the direction of the driven gear



In each case, is the gear chain speeding up or slowing down?

#### Further tasks

- The rotary motion of the Chief Ranger's Carousel is changed into reciprocating motion using a motor, gears and a cranked rod.
- Investigate further the mechanisms which change one type of motion into another. Try looking around your workshop, in books or on the Internet.
- Using your knowledge of mechanical systems design an interesting mechanical toy for children, either pull along or stationary, incorporating a change of one type of motion into another.
- Model the mechanism featured in your design using card or kit.

