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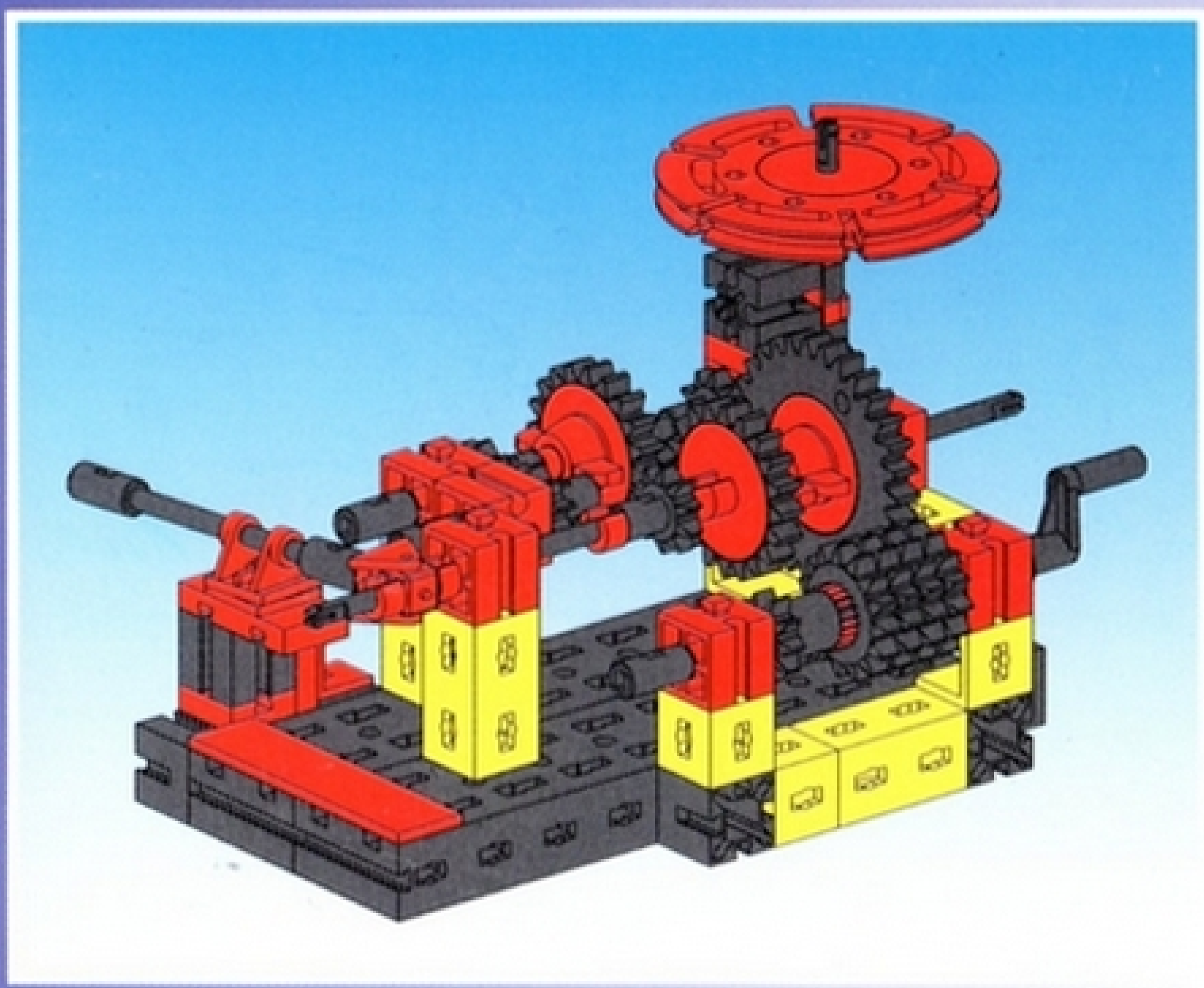
Universal Kit
Curriculum Guide
(Grades 4 and up)



Teacher's Manual

Student's Activities

Universal Kit

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Note

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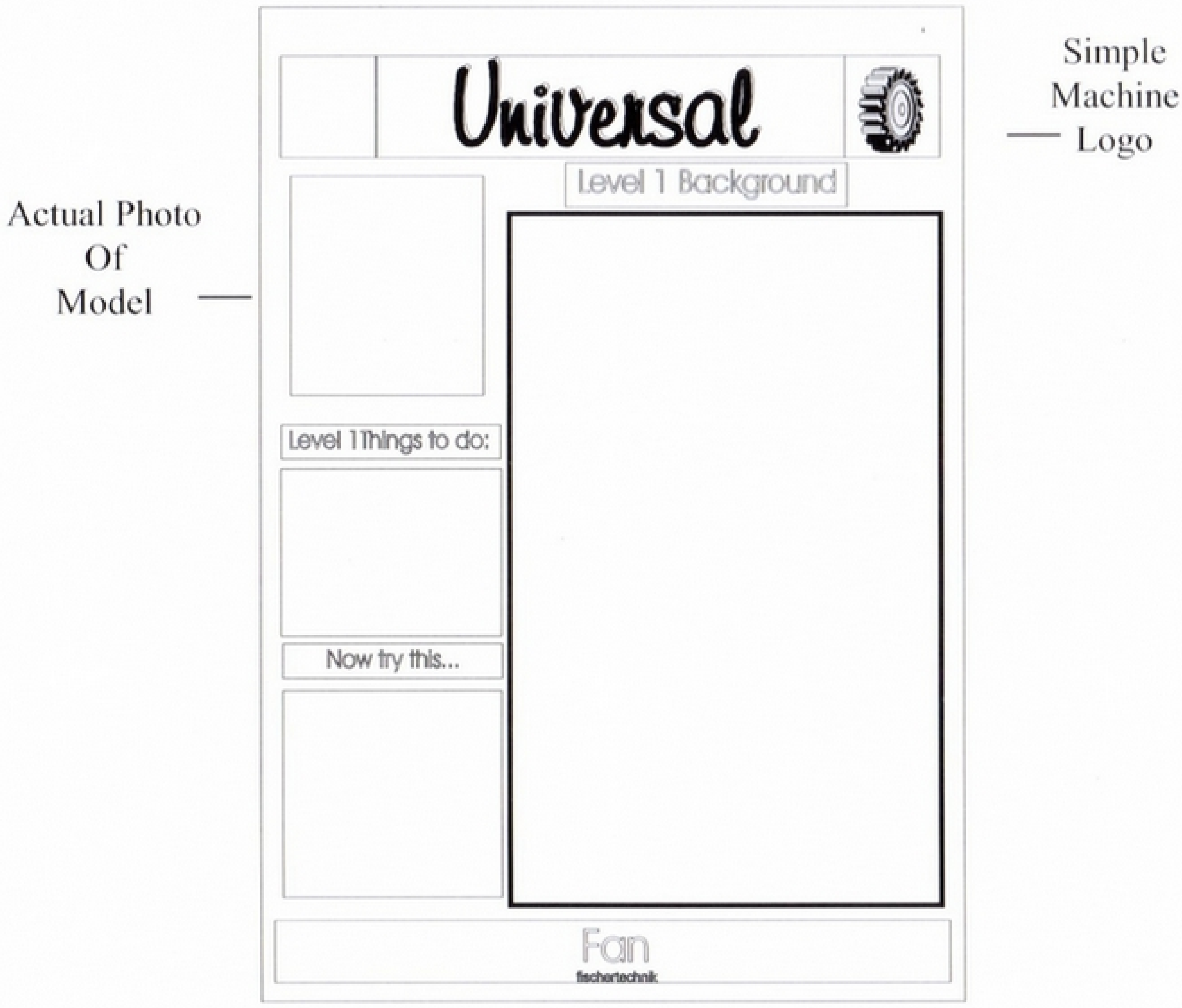
The Card: Explains how the card is set up and to be used by the students.

The card's designed to be used after the student has constructed the appropriate model. The model's name is at the bottom of the card. It appears on the front and back of the card. The type of simple machine that this model demonstrates is indicated in the upper right hand corner of the card. There is a logo for each type of machine. For gears there is a picture of a gear, pulleys has a picture of a pulley system, levers are represented by a picture of a scale, the screw has a picture of a bolt, and the wheel and axle have a picture of a pepper grinder.



Each card has an actual picture of the model that the student built. Next to the actual picture is the level of that card. Below the level indicator is the background. The background is to be read by the student before they attempt to answer the activity questions. The activity questions are divided into two types. The "Think about it! " activity questions are science based questions that can be answered by visually observing how the model behaves as well as physically manipulating the model. The " Try this!" questions are extension questions that ask the student to change the model by adding or changing the pieces so that the new parameters can be met. For example adding smaller gears to make the fan blade spin faster.

The Machines: Below are the models that have activity cards.

Pulleys	Levers	Screw	Wheel and Axle	Gears
• Block and Tackle Hoist	• Scale with Sliding Weight	• Garage Door	• Coping Saw	• Fan
• Construction Crane	• Balance Beam Scale	• Mechanical Lift	• Planer	• Transmission
	• Postal Scale	• Centrifuge Ride	• Stamping Press	• Sewing Machine
				• Food Processor
				• Oil Drill
				• Flying Swings Ride

Card Levels: Level 1 and Level 2

Each card has two ability levels called level 1 and level 2. The front of the card is level 1. This level is for beginners. The background is written with just basic information. Level 1 cards do not get into the mathematical explanations that are commonly used to describe how simple machines work. The back of the card is level 2. The student should have done the level 1 activity before attempting the level 2 activity. The level 2 activity is based on the knowledge learned by doing the level 1 activity. The level 2 background builds on the level 1 background. The level 2 background goes further in detail and contains the formulas needed to calculate the mechanical advantage for the specific simple machines.

The Science: What is mechanical advantage?

Mechanical advantage is the ratio of the resistance force to the effort force. Simple machines are designed to decrease the amount of effort required to move a resistance or load. The more the effort force needed is decreased the better the mechanical advantage. For example a simple machine with a mechanical advantage of 1 is a machine that requires the same amount of effort force as the load the machine is trying to move. If you are trying to lift a 500-pound weight you are going to need an effort force of 500 pounds. When a machine has a mechanical advantage of 5 the same 500-pound weight would only require 100 pounds of effort.

Many of these models are actually compound machines. Compound machines are machines that are made up of more than one type of simple machine, for example the shop crane. It uses pulleys and gears. The activities do not ask students to solve the complicated relationships commonly found in compound machines. They should realize that some of the models do have more than one type of simple machine involved.

When students are making linear measurements they should use the metric system. Most of these measurements can be made in centimeters.

Motorizing the model: Which models can be motorized and what you need?

Some of these models can be motorized. The following models can be motorized:

Pulleys	Screw	Wheel and Axle	Gears
Block and Tackle Hoist	Garage Door	Coping Saw	Oil Drill
Construction Crane	Mechanical Lift	Planer	Fan
	Centrifuge Ride	Stamping Press	Transmission
			Sewing Machine
			Food Processor
			Flying Swings Ride

You may us either the solar set (#30343) or the mini motor set (#30342)

Answers: Below are the answers and helpful hints for the activity cards. For all these models, you should ask the students to list all the simple machines that are in each model. You will find that each machine will have more than one type of simple machine.

Pulleys

Block and Tackle Hoist

Level 1

Things to do!

	The effort force is applied to the winch. The resistance is the weight on the hook.
1.	There are two fixed pulleys.
2.	There is one moveable pulley.

Now try this!

1.	The weight should be easier to move. Using a spring scale will demonstrate this. The weight will move upwards at a slower rate.

Block and Tackle Hoist

Level 2

Things to do!

1.	The estimated MA is 3.
2.	The weight should have moved up one inch.
3.	The MAs should be about equal.

Now try this!

1.	The weight should be easier to move. Using a spring scale will demonstrate this. The weight will move upwards at a slower rate. The MAs should be about the same.

Construction Crane

Level 1

Things to do!

	The effort force will be applied to the handle on the winch. The resistance will be the weight hanging from the crane hook.
1.	Two fixed pulleys.
2.	There are no movable pulleys.

Now try this!

1.	Should be easier to move the weight.

Construction Crane

Level 2

Things to do!

	The weight should have moved 3" also.
1.	MA = 1
2.	The MAs should be the same.

Now try this!

1.	Should be easier to move the weight. The MAs should be about the same.

Screw

Garage Door

Level 1

Things to do!

1.	The screw is at the top of the garage door. It allows the door to open and close.
2.	Answers will vary.
3.	There is the wheel and axle (the handle) and a lever (the garage door).

Now try this!

1.	Add a gear system or move the threads closer together.
2.	There is the wheel and axle (the handle) and a lever (the garage door).
3.	There are about 22 threads in the machine.

Garage Door

Level 2

Things to do!

1.	Answers will vary.
2.	There is the wheel and axle (the handle) and a lever (the garage door).
3.	The MA equals 2(3.14)(the radius of the handle) / the pitch of the screw.

Now try this!

1.	Add a gear system or move the threads closer together.
2.	Answers will vary depending on the gears used.

Mechanical Lift

Level 1

Things to do!

1.	The screw is at the bottom of the lift. The screw moves the lift up or down.
2.	Answers will vary.
3.	There is a wheel and axle (the handle) and levers (the two sets of yellow blocks).

Now try this!

1.	Add a gear system or move the threads closer together.
2.	There are two more simple machines, levers and a wheel and axle. Answers will vary. A gear system would be the easiest.
3.	There are about 22 threads in this machine.

Mechanical Lift

Level 2

Things to do!

1.	Answers will vary.
2.	There is a wheel and axle (the handle) and levers (the two sets of yellow blocks).
3.	The MA equals 2(3.14)(the radius of the handle) / the pitch of the screw.

Now try this!

1.	Add a gear system or move the threads closer together.
2.	Answers will vary. A gear system would be easiest.

Centrifuge Ride

Level 1

Things to do!

1.	The screw moves the rife up or down.
2.	Answers will vary.
3.	There is the wheel and axle (handle), gears (bevel gears), and lever (the base and platform).

Now try this!

1.	Answers will vary.
2.	There is the wheel and axle (handle), gears (bevel gears), and lever (the base and platform).

Centrifuge Ride
Level 2
Things to do!

1.	Answers will vary.
2.	There is the wheel and axle (handle), gears (bevel gears), and lever (the base and platform).
3.	MA equals 2(3.14)(radius of the handle / pitch (distance between threads).

Now try this!

1.	Answers will vary.
2.	You can increase the MA of the screw by moving the threads closer together (decreasing the pitch).
3.	The ride will spin faster if larger gears push smaller gears in the system,

Wheel and Axle

Coping Saw
Level 1
Things to do!

1.	The two handles are part of the wheel and axle machines.
2.	There are two.
3.	The blade moves back and forth.

Now try this!

1.	The handle should be easier to turn.
2.	The saw would move at the same speed.

Coping Saw
Level 2
Things to do!

1.	There are two. The two handles are part of the wheel and axle machines.
2.	The MA = handle radius / axle radius.

Now try this!

1.	The handle should be easier to turn.
2.	The saw would move at the same speed.

Planer

Level 1

Things to do!

1.	The wheel and axles are the handles.
2.	There are two wheel and axle machines.
3.	The saw blade moves back and forth. The table moves from side to side.

Now try this!

1.	The handle would be easier to turn.
2.	The saw would move at the same speed.

Planer

Level 2

Things to do!

1.	There are two wheel and axle machines.
2.	The MA = the radius of the handle / the radius of the axle.

Now try this!

1.	The handle would be easier to turn.
2.	The saw would move at the same speed.

Stamping Press

Level 1

Things to do!

1.	There are two wheel and axle machines.
2.	The press blade moves up and down.
3.	The blade moves up and down.

Now try this!

1.	The handle would be easier to turn.
2.	The press blade would move at the same speed.

Stamping Press

Level 2

Things to do!

1.	There are two wheel and axle machines.
2.	The MA equals radius of the handle / the radius of the axle.

Now try this!

1.	The handle would be easier to turn.
2.	The press blade would move at the same speed.

Gears

Oil Drill

Level 1

Things to do!

1.	The large gear turns in the opposite direction of the small gear.
2.	The small gear turns in the opposite direction of the large gear.
3.	When the large gear makes one complete turn, the oil pump moves up and down once.

Now try this!

1.	The oil pump moves up and down the same number of times the handle turns.
2.	Answers will vary. Large gears pushing small gears will increase the speed. Small gears pushing large gears will decrease the speed.

Oil Drill

Level 1

Things to do!

1.	The driver gear has 10 teeth.
2.	The driven gear has 30 teeth. The ratio is 3:1.
3.	When the handle makes one complete turn, the oil pump moves up and down a third of the way. The handle has to turn three times for the oil drill to move up and down one time.

Now try this!

1.	Answers will vary. Large gears pushing small gears will increase the speed.
2.	Answers will vary. Small gears pushing large gears will decrease the speed.

Fan

Level 1

Things to do!

1.	It turns clockwise.
2.	It turns counterclockwise.
3.	It turns three times.

Now try this!

1.	The fan should turn at the same speed.
2.	Gears smaller than the driver (handle) should turn faster. The opposite is true of larger gears.

Fan

Level 2

Things to do!

1.	It has 10 teeth (the smaller gear).
2.	It has 30 teeth (the larger gear).
3.	The driven turns three times; the ratio is 1:3. The fan blade is three times faster. The driven gear pushes the fan blade.

Now try this!

1.	The fan should turn at the same speed.
2.	A smaller gear (driver) will push a larger gear (driven).

Transmission

Level 1

Things to do!

1.	There are 13 gears in the system. The very small red gear is a spacer.
2.	The red wheel moves in reverse.
3.	The red wheel moves the opposite of reverse and is in first gear.
4.	The red wheel moves in the same direction as first gear. The wheel does move faster in second gear.

Now try this!

1.	The system would have to have the large 40-tooth gear on the same axle as the handle.

Transmission

Level 2

Things to do!

1.	Set the shift handle for each gear. Count the number of times the red wheel rotates compared to one complete turn of the handle.

Now try this!

1.	The system would have to have the large 40-tooth gear on the same axle as the handle.

Sewing Machine

Level 1

Things to do!

1.	The large red wheel turns counterclockwise.
2.	The small gear attached to the handle turns clockwise.
3.	The needle should move up and down three times.

Now try this!

1.	The needle would go up and down the same number of times as the handle is turned.
2.	Answers will vary. Large gears pushing small gears will increase the speed. Small gears pushing large gears will decrease the speed.

Sewing Machine

Level 2

Things to do!

1.	The driver has 30 teeth.
2.	The driven gear has 10 teeth. The ratio is 1:3.
3.	The needle should move up and down three times. The gear attached to the handle has three times the teeth of the smaller gear.

Now try this!

1.	Answers will vary. Large gears pushing small gears will increase the speed. Small gears pushing large gears will decrease the speed.
2.	Answers will vary. Large gears pushing small gears will increase the speed. Small gears pushing large gears will decrease the speed.

Food Processor

Level 1

Things to do!

1.	The large gear turns counterclockwise.
2.	The small gear turns clockwise.
3.	The large gear turns once also.

Now try this!

1.	The new gear (20 teeth) will cause the bowl to spin faster. The bowl would now make two rotations for each complete turn of the handle.

Food Processor
Level 2
Things to do!

1.	The driver has 10 teeth.
2.	The driven gear has 40 teeth. The gear ratio is 4:1.
3.	The large gear and the base are attached. They turn at the same speed.

Now try this!

1.	The new gear (20 teeth) will cause the bowl to spin slower. The bowl will only make two rotations for each complete turn of the handle.

Flying Swings Ride
Level 1
Things to do!

1.	The swings make one complete turn.
2.	They turn in the same direction.
3.	They turn in the same direction.

Now try this!

1.	The handle gear (driver) will be larger than the driven gear.
2.	The handle gear (driver) will be smaller than the driven gear.

Flying Swings Ride
Level 2
Things to do!

1.	The swings make one complete turn.
2.	The MA is one. The gears are all have the same number of teeth.

Now try this!

1.	The beveled gear changes the direction of force 90 degrees.
2.	The handle gear (driver) will be smaller than the driven gear, or the handle gear (driver) will be larger than the driven gear.

Levers

Balance Beam Scale
Level 1
Things to do!

1.	The fulcrum is the pivot point. The resistance is the load, the 10 pennies. The effort is the empty pan.
2.	It should have taken 10 pennies.
3.	The pans are level.

Now try this!

	It should take the same number of pennies.
1.	They are usually equal.

Balance Beam Scale
Level 1
Things to do!

1.	The fulcrum is the pivot point. The resistance is the load, the 10 pennies. The effort is the empty pan.
2.	This is a first class lever.
3.	The MA is one.

Now try this!

	They are usually equal
1.	The MA is one. By definition the forces should be balanced.

Postal Scale
Level 1
Things to do!

1.	The fulcrum is the pivot point (there are two pivot points). The resistance is the black and red set of blocks. The effort is the empty pan.
2.	The red pan moves downward and the red and black set of blocks move upward.
3.	Eventually the weight of the pennies will be more than the resistance blocks. The resistance blocks will not be able to move any more.

Now try this!

1.	There should be little or no effect.

Postal Scale

Level 2

Things to do!

	The effort arm is now longer. It should take less effort (less pennies) to move the resistance.

Now try this!

1.	Eventually the effort arm and its downward force (weight) will move the resistance to its limit.
2.	Make the resistance greater or make the resistance arm longer.

Scale with Sliding Weight

Level 1

Things to do!

	The fulcrum is the pivot point. The resistance is the load, the red pan. The effort is the sliding weight.
1.	The scale will not be balanced. The red pan will move downward.
2.	Move the sliding weight away from the red pan.
3.	The forces are balanced.

Now try this!

	At some point the weight of pennies will be more than the force of the sliding weight moved as far as possible. The scale can't be balanced.
1.	If the pennies are too heavy, the sliding weight must be made heavier, or the effort arm extended.

Scale with Sliding Weight

Level 2

Things to do!

	The fulcrum is the pivot point. The resistance is the load, the red pan. The effort is the sliding weight.
1.	This is a first class lever.
2.	If the effort arm is the same as the resistance arm, the MA will be one. Answers may vary.
3.	The MA should be less than the answer for questions number 2.

Now try this!

1.	At some point the weight of pennies will be more than the force of the sliding weight moved as far as possible. The scale can't be balanced. The MA will decrease.
2.	The MA will increase.

Block and Tackle Hoist

Universal

Level 1 Things to do:

Place a weight onto the hook of the crane. Draw a picture of the machine and label the effort and resistance forces.

1. How many fixed pulleys are there on this machine?

2. How many moveable pulleys are there on this machine?

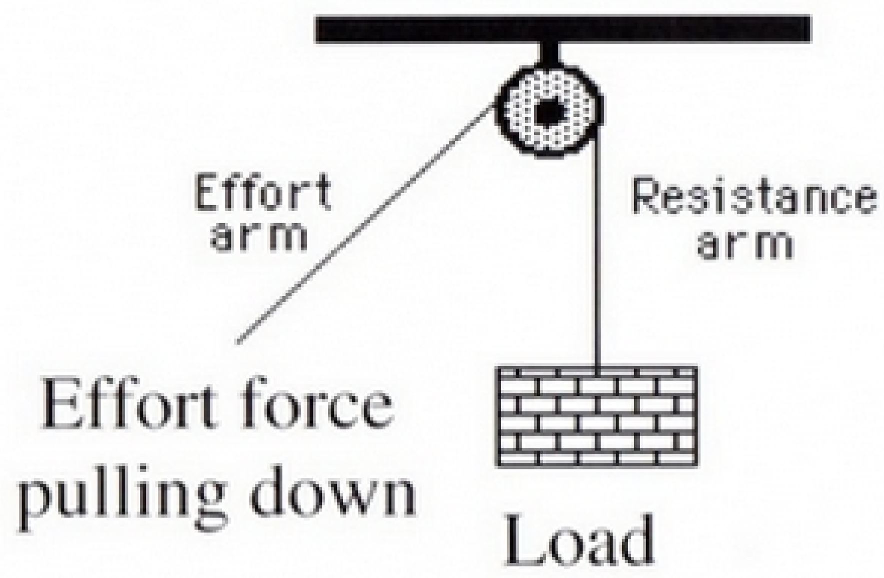
Now try this...

Turn the handle and move the resistance up and down. Notice the effort needed to turn the handle and the speed at which the resistance goes up and down. Add another moveable pulley to pulley system. Turn the handle on the crank observe the movement and the speed of the resistance force.

1. Are there any changes?

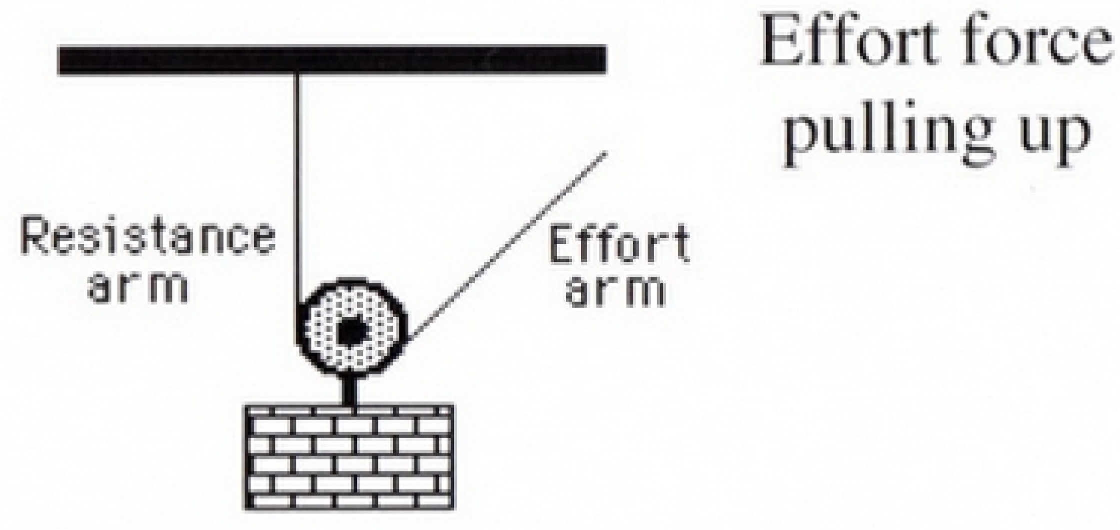
Level 1 Background

There are two types of pulleys. A fixed pulley is a pulley which is attached to an object and can not be moved. A single fixed pulley has one rope that goes over the top of the pulley. The effort is used to move the load. The effort force is applied to the effort arm. See figure A. The resistance arm is attached to the load.



Single Fixed Pulley Figure A

The other type of a pulley is a moveable pulley. The moveable pulley is attached to an object which will move up and down, or slide along the rope.



Single Moveable Pulley Figure B

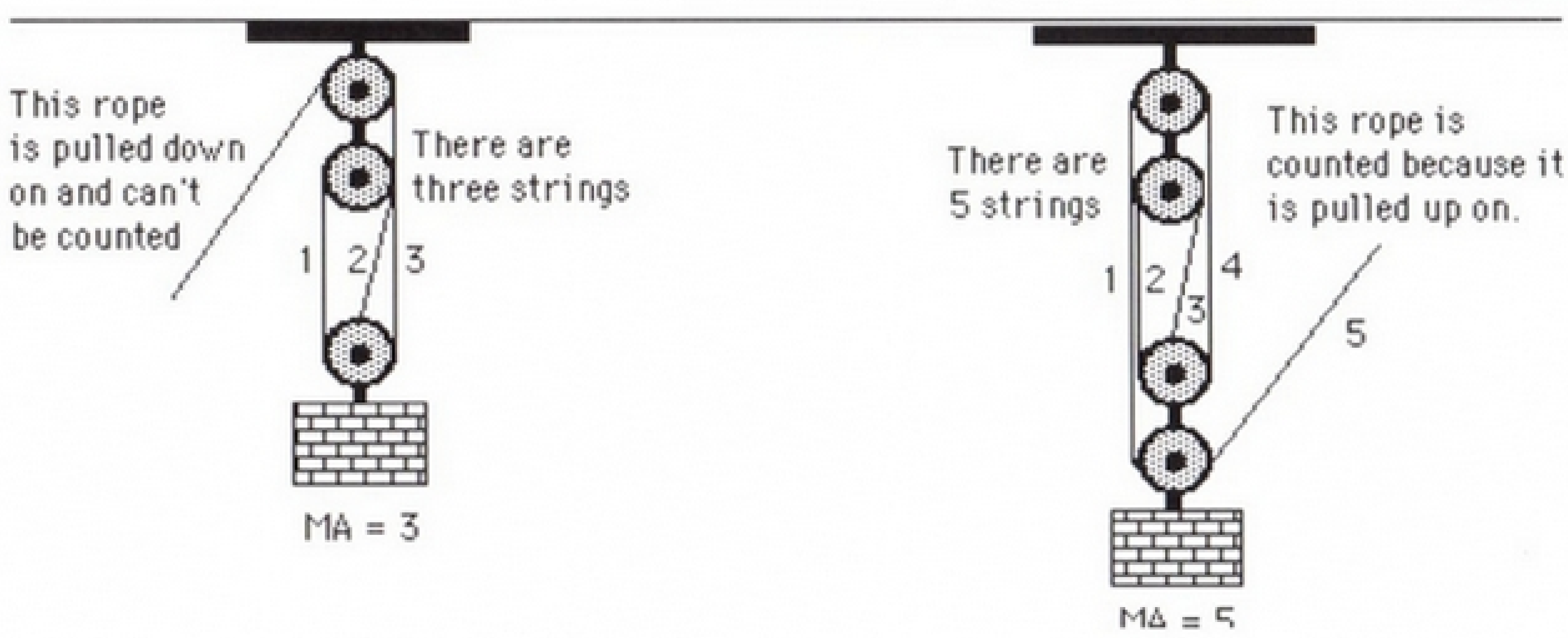
In the block and tackle hoist model the resistance is attached the red hook. When the black handle winds the string, the red hook and its load moves up. This model uses both fixed and moveable pulleys. This means that the effort should be less than the resistance force.

In the model the three pulleys should make it much easier to lift the load on the red hook. The load will move up as the effort force is applied downward.

Level 2 Background

Pulleys like other simple machines have a mechanical advantage (MA) which can be measured and mathematically calculated. There are two formulas for calculating the mechanical advantage, the first uses the effort and resistance arms. The formula is the Effort arm/Resistance arm. The second formula for calculating the mechanical advantage use the resistance force and the effort force. The formula is the Resistance force/Effort force. It is also possible to estimate the mechanical advantage. This is done by counting the number of strings. The rule in counting the number of strings is you count all the strings except the one that the effort force pulls down on. If the effort force is pulling up on the string you may count that string.

Often in real situations where pulleys are used you have a combination of fixed and moveable pulleys. If you arrange these pulleys so that you combined enough fixed and moveable pulleys you can make the mechanical advantage very high thus reducing the amount of effort needed. A block and tackle is an example of such an arrangement. A block and tackle can allow a person to lift a heavy object like a car engine. This would be impossible without the pulleys. Below are some examples of pulley systems with there estimated mechanical advantage.



In the block and tackle hoist model the fixed pulleys are attached to the top set of black blocks. The moveable pulley is attached to the black block and the red hook. When the effort force is applied to the string the fixed pulleys remain where they are and the moveable pulley moves up. The effort force needed to lift the resistance load should be less than if you used the construction crane. The block and tackle hoist has more pulleys lifting the load instead of just changing the effort force like the construction crane.

Level 2 Things to do:

1. Estimate the mechanical advantage for the block and tackle.
2. Place a resistance force on the hook and rest it on the red base. Pull the effort string 3 inches. Measure how far the resistance moved up. Calculate the mechanical advantage.
3. Is there a difference between the actual MA and the estimated MA? Why or why not?

Now try this...

Add another moveable pulley. Repeat the steps above.

1. What affect did having more pulleys have on the actual and estimated MA?

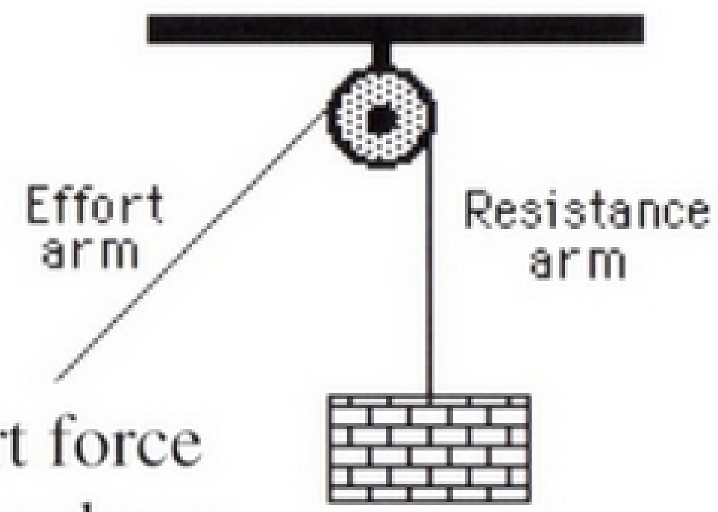
Try adding even more pulleys and find actual and estimated MA.

Construction Crane

Universal

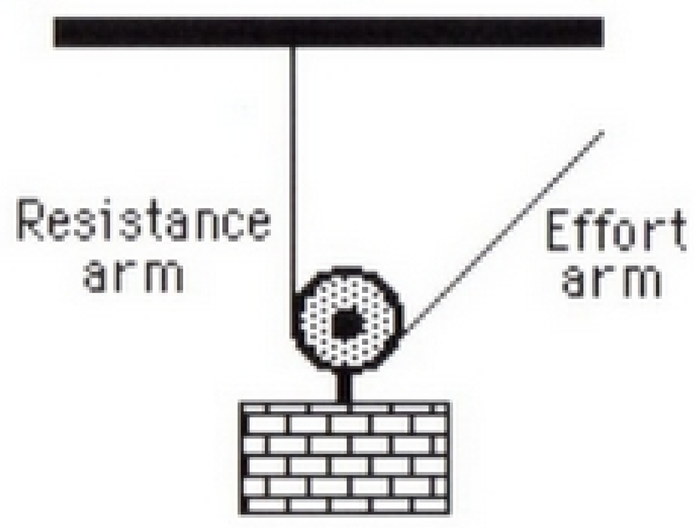
Level 1 Background

There are two types of pulleys. A fixed pulley is a pulley which is attached to an object and can not be moved. A single fixed pulley has one rope that goes over the top of the pulley. The effort is used to move the load. The effort force is applied to the effort arm. See figure A. The resistance arm is attached to the load.



Single Fixed Pulley Figure A

The other type of a pulley is a moveable pulley. The moveable pulley is attached to an object which will move up and down, or slide along the rope.



Single Moveable Pulley Figure B

In the construction crane model the resistance is attached the red hook. When the black handle winds the string, the red hook and its load moves up. These pulleys work the same as figure A. Even though there are two pulleys the resistance still moves up as the string is pulled down.

In the construction crane model the rope is over the top of the pulleys. This only changes the direction of the effort force. The effort force must equal the resistance force if there is no friction in the system.

Level 1 Things to do:

Place a weight onto the hook of the crane. Draw a picture of the machine and label the effort and resistance forces.

1. How many fixed pulleys are there on this machine?

2. How many moveable pulleys are there on this machine?

Now try this...

Turn the handle and move the resistance up and down. Notice the effort needed to turn the handle and the speed at which the resistance goes up and down. Add another moveable pulley to pulley system. Turn the handle on the crank and observe the movement and the speed of the resistance force.

1. Are there any changes?

Construction Crane

Universal

Level 2 Things to do:

Estimate the mechanical advantage for the construction crane.
Place a resistance force on the hook and rest it on the desk. Pull the effort string 3 inches. Measure how far the resistance moved up.

1. Calculate the mechanical advantage.
2. Is there a difference between the actual MA and the estimated MA? Why or why not?

Now try this...

Add another moveable pulley. Repeat the steps above.

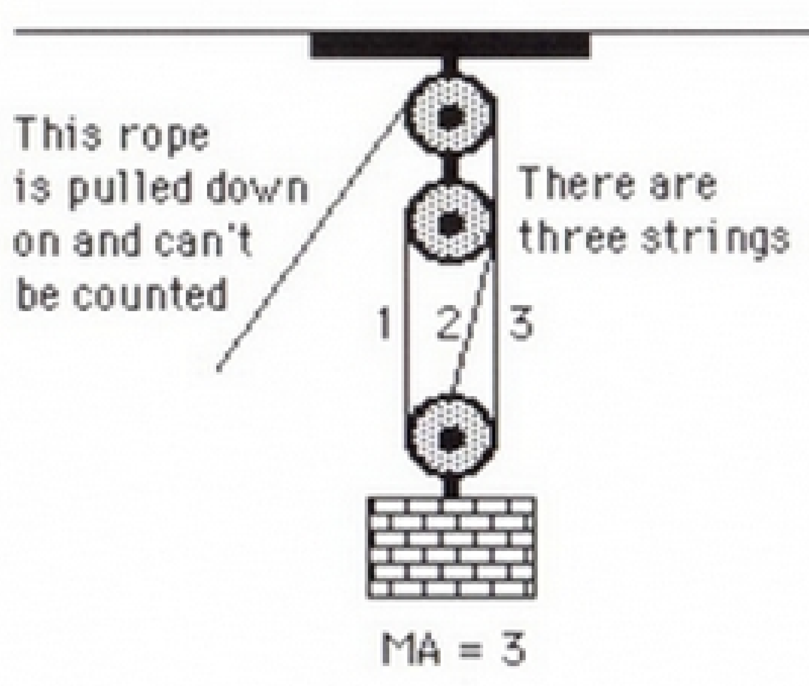
1. What affect did having more pulleys have on the actual and estimated MA?

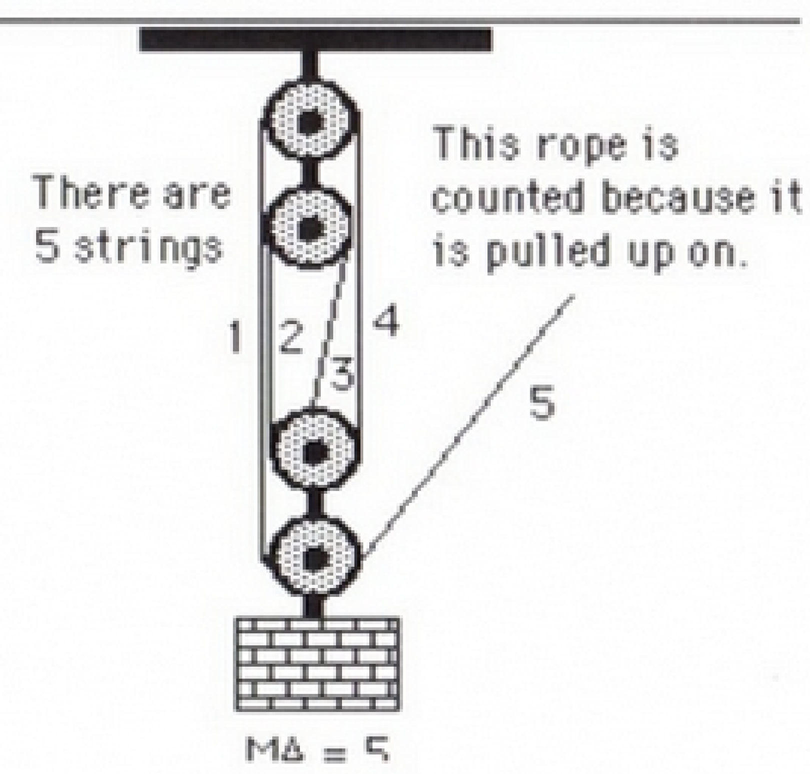
2. Try adding even more pulleys and calculate the actual and estimated MA.

Level 2 Background

Pulleys, like other simple machines, have a mechanical advantage which can be measured and mathematically calculated. There are two formulas for calculating the mechanical advantage, the first uses the effort and resistance arms. The formula is the Effort arm / Resistance arm. The second formula for calculating the mechanical advantage use the resistance force and the effort fore. The formula is the Resistance force / Effort force. It is also possible to estimate the mechanical advantage. This is done by counting the number of strings. The rule in counting the number of strings is you count all the strings except the one that the effort force pulls down on. If the effort force is pulling up on the string you may count that string.

Often, in real situations where pulleys are used, you have a combination of fixed and moveable pulleys. If you arrange these pulleys so that you combined enough fixed and moveable pulleys you can make the mechanical advantage very high thus reducing the amount of effort needed. A block and tackle is an example of such an arrangement. A block and tackle can allow a person to lift a heavy object like a car engine. This would be impossible without the pulleys. Below are some examples of pulley systems with there estimated mechanical advantage.



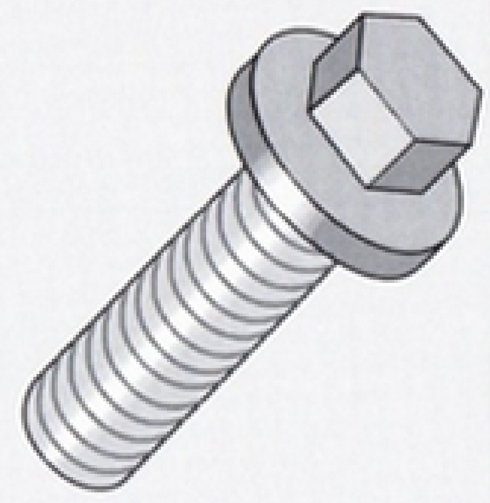


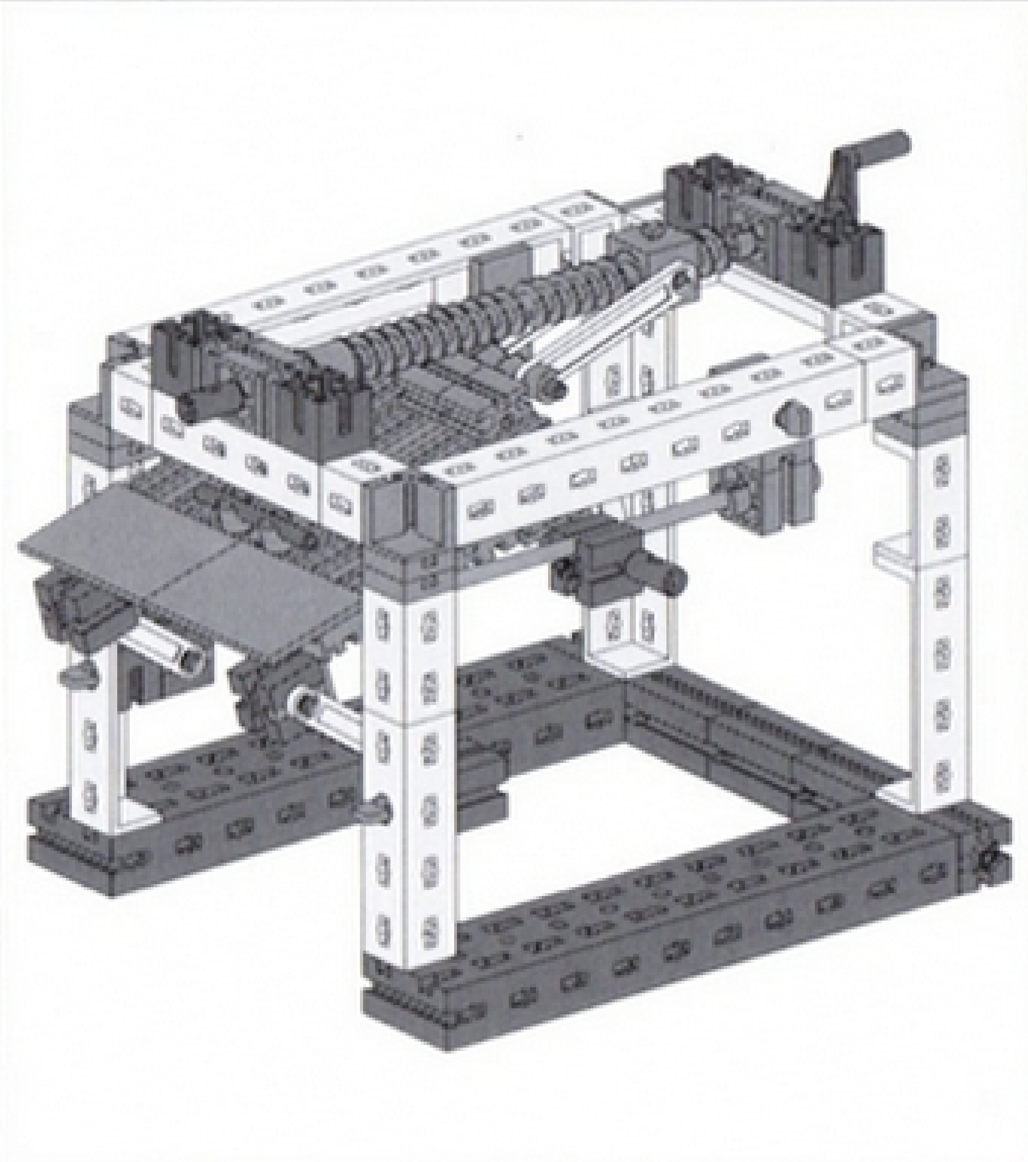
In the block and tackle hoist model the fixed pulleys are attached to the top set of black blocks. The moveable pulley is attached to the black block and the red hook. When the effort force is applied to the string the fixed pulleys remain where they are and the moveable pulley moves up. The effort force needed to lift the resistance load should be less than if you used the construction crane.

The block and tackle hoist has more pulleys lifting the load instead of just changing the effort force like the construction crane.

Garage Door

Universal





Level 1 Things to do:

1. Where is the screw in the garage door? What does it do in this machine?

2. Close the garage door. How many times can you turn the handle on the screw till the garage door opens?

3. What other machines are part of the garage door?

Now try this...

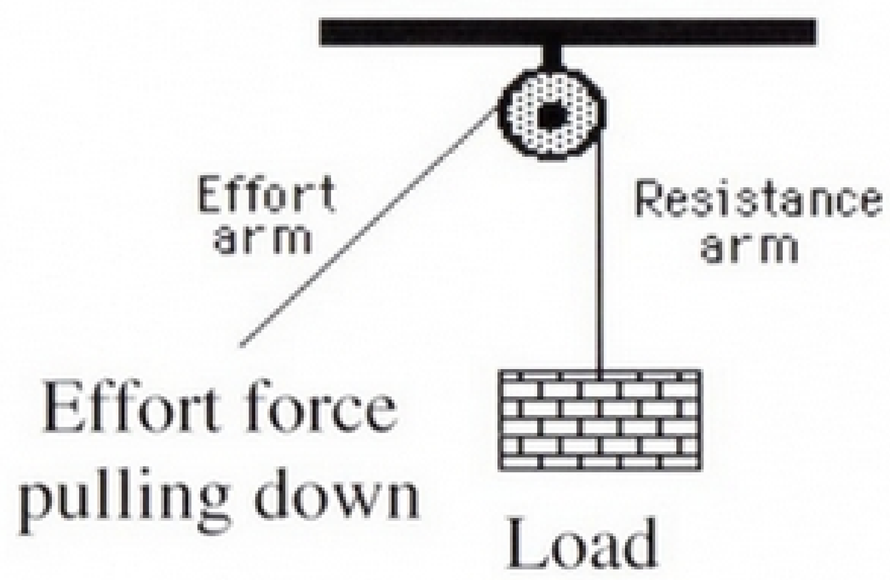
1. How could you make it easier to open the garage door?

2. How many other types of simple machines are there in this model?

3. How many threads are in this machine?

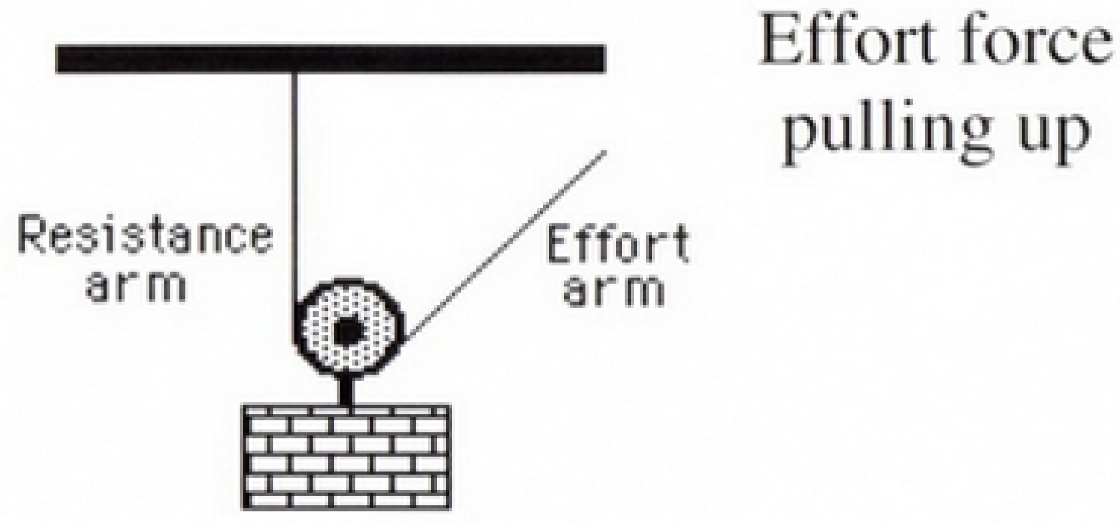
Level 1 Background

There are two types of pulleys. A fixed pulley is a pulley which is attached to an object and can not be moved. A single fixed pulley has one rope that goes over the top of the pulley. The effort is used to move the load. The effort force is applied to the effort arm. See figure A. The resistance arm is attached to the load.



Single Fixed Pulley Figure A

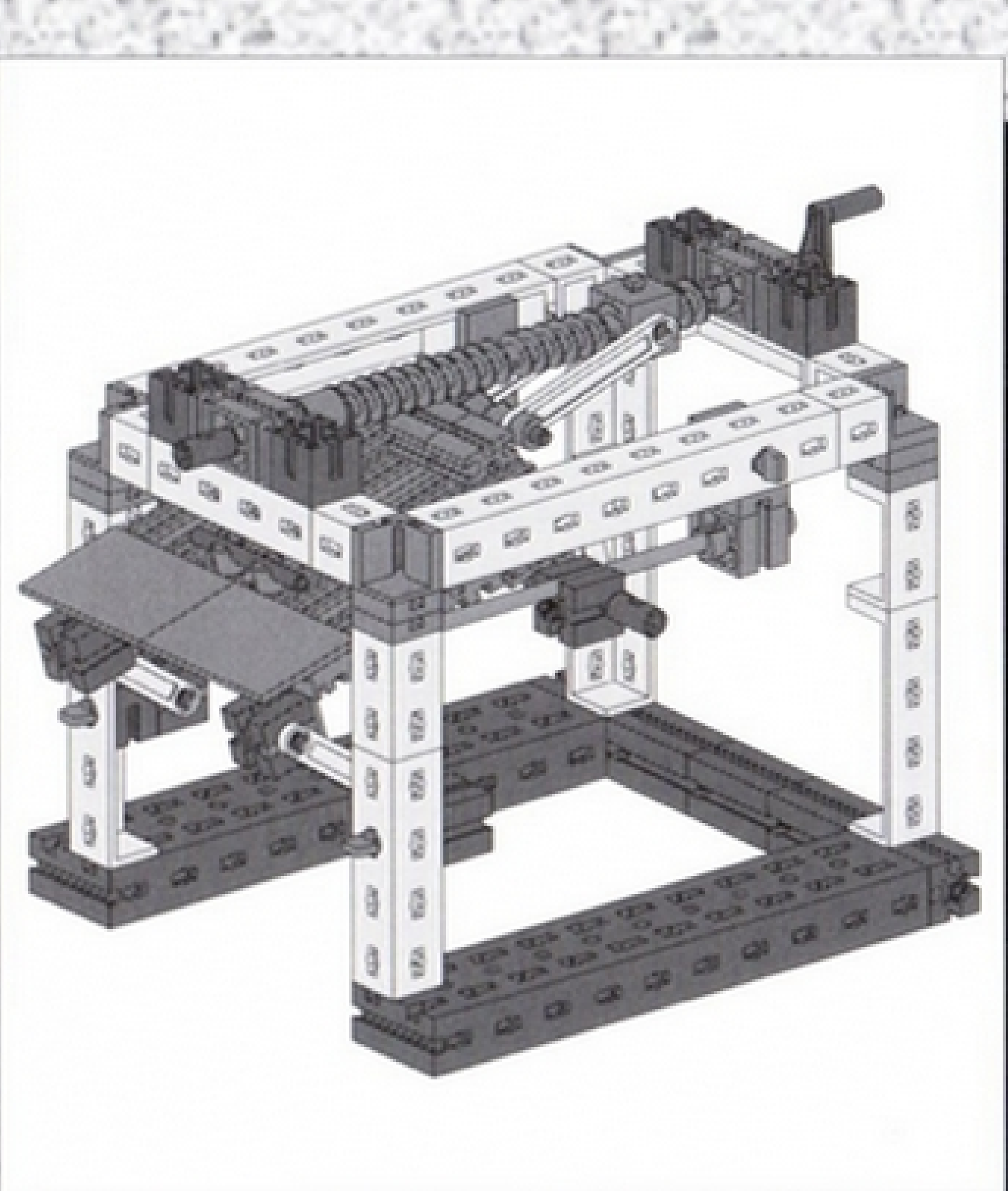
The other type of a pulley is a moveable pulley. The moveable pulley is attached to an object which will move up and down, or slide along the rope.



Single Moveable Pulley Figure B

In the block and tackle hoist model the resistance is attached the red hook. When the black handle winds the string, the red hook and its load moves up. This model uses both fixed and moveable pulleys. This means that the effort should be less than the resistance force.

In the model the three pulleys should make it much easier to lift the load on the red hook. The load will move up as the effort force is applied downward.



Level 2 Background

On a screw, the raised edges are called "threads." The farther apart the threads are from each other, the more effort force must be used to turn them. If the threads are close together, the easier it is to turn them. The distance between each thread on a screw is called the pitch. This is also equal to the distance a wood screw advances into a piece of wood in one revolution. In the garage door model, the handle turns the screw. The screw opens and closes the garage door.

The mechanical advantage of the screw depends on the pitch of the threads and the size of the wheel machine turning the screw. This becomes a ratio between the circumference of the wheel turning the screw, and the pitch of the threads on the screw.

Mechanical advantage = 2 Π radius of the wheel & axle / pitch
Note: Π = 3.14

Figure 1

In Figure 1, we can determine the mechanical advantage of this machine.

Mechanical advantage = 2 Π radius of the wheel & axle / pitch

MA = 2 (3.14) (2 cm) /.25 cm
MA = 12.56 cm /.25 cm
MA = 50.24

Level 2 Things to do:

1. How many times can you turn the handle on the screw until the garage door opens?

2. What other machines make up the garage door?

3. Measure the length of the handle that turns the screw. Measure how far apart each
thread is on the screw. Use the formula to find the mechanical advantage of the screw.

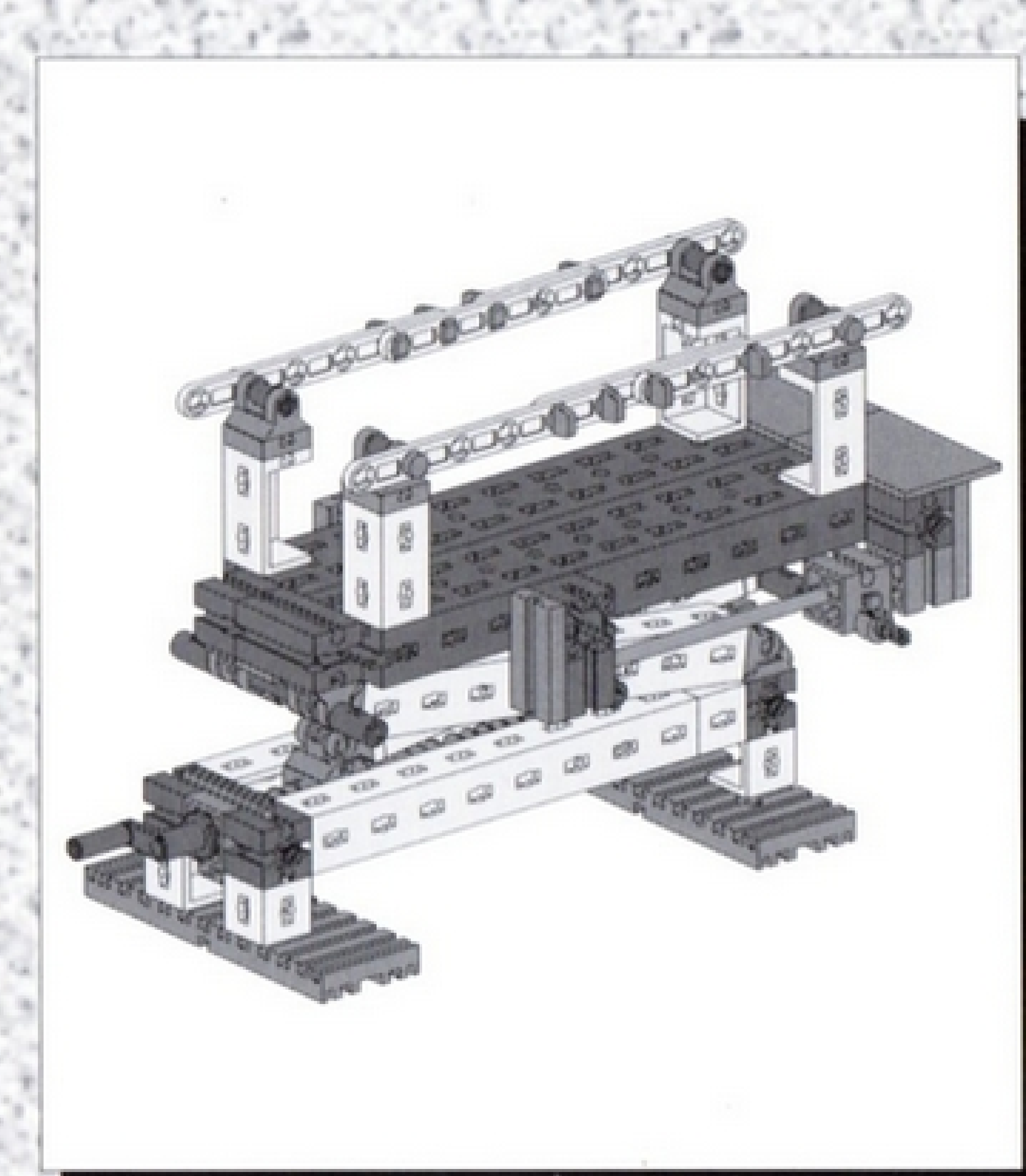
Now try this...

1. How could you increase the mechanical advantage of the screw?

2. How could you make the garage door open or close faster? Modify this machine to make it open and close the door faster.

Mechanical Lift

Universal



Level 1 Things to do:

Think About It

1. Where is the screw in the mechanical lift? What does it do in this machine?

2. Lower the lift. How many times can you turn the handle on the screw till the lift opens?

3. What other machines are part of the mechanical lift?

Now try this...

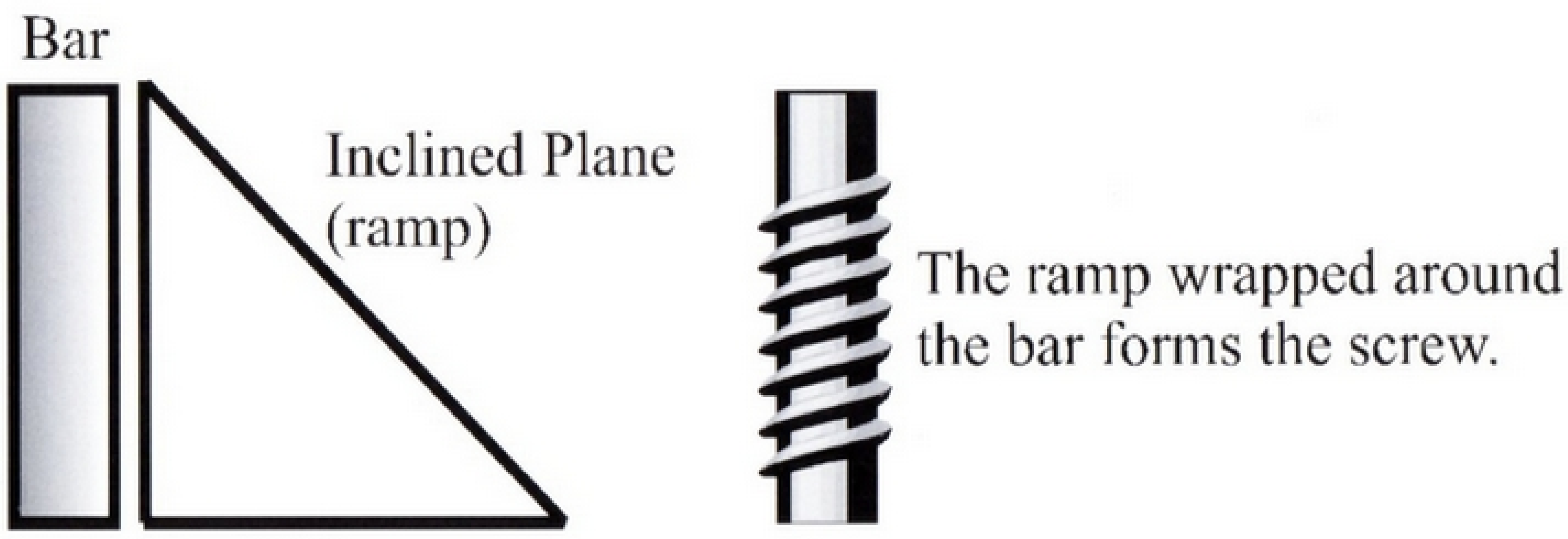
1. How could you make it easier to raise the lift?

2. How many other types of simple machines are there in this model? Can they be changed to help the lift work even better?

3. How many threads are in this machine?

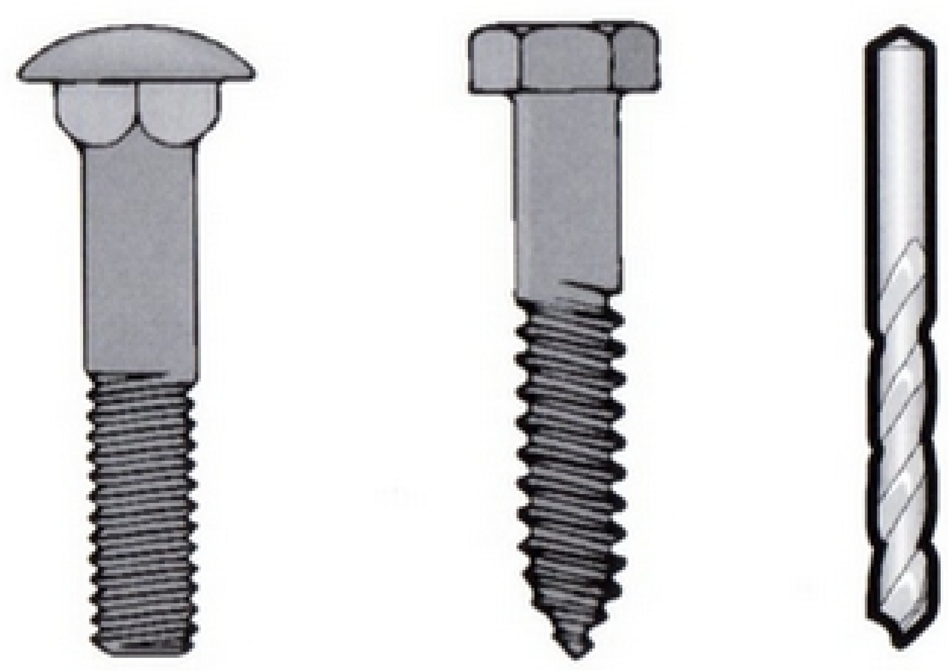
Level 1 Background

The jack screw and wood or metal screw are another type of simple machine. This simple machine can be thought of as an inclined plane (ramp) wrapped around a bar.



In the mechanical lift model, the handle turns the threads of the screw. As the threads turn, they move the long yellow blocks up or down.

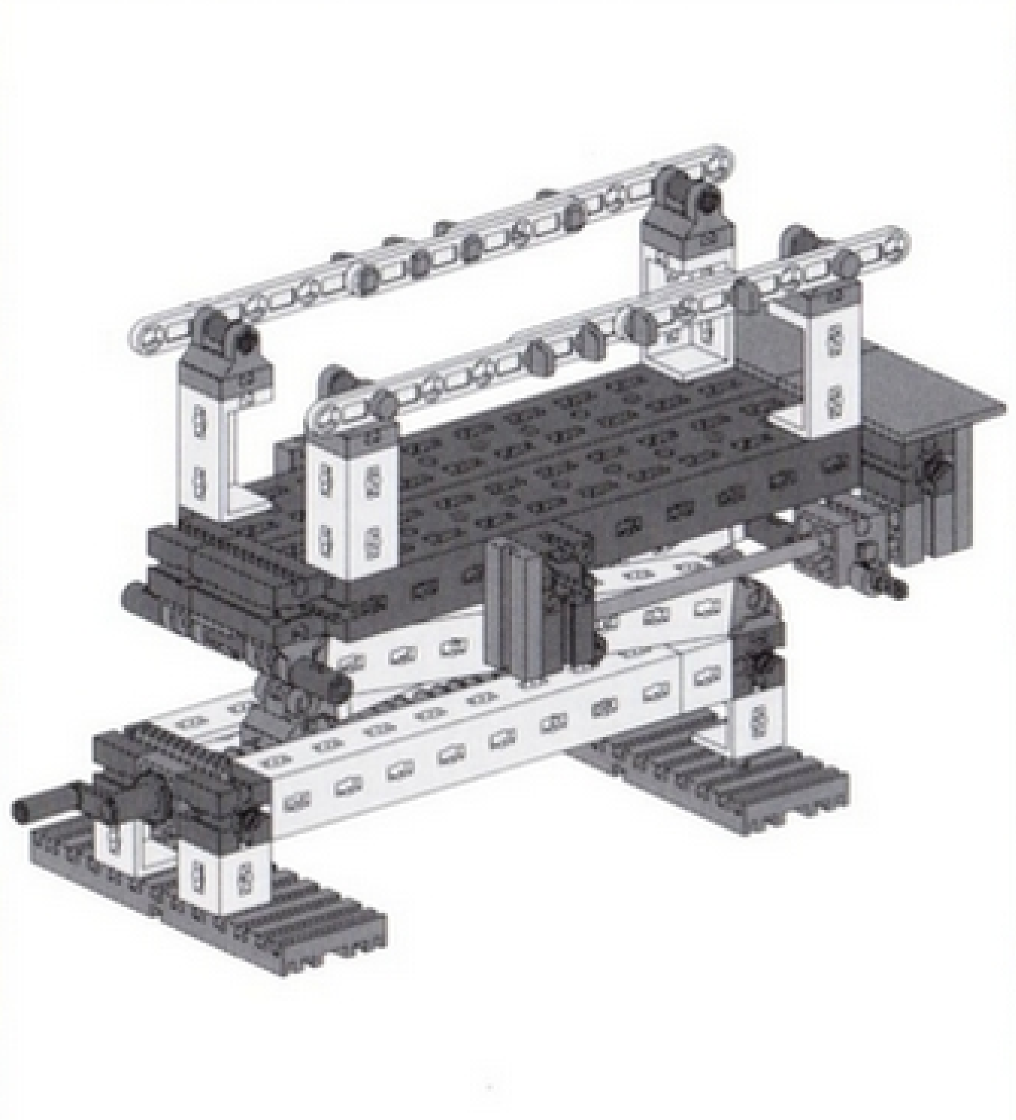
The screw can lift loads, like the jack screw raising a car to fix a flat tire. Wood screws hold objects together. Without friction the screw wouldn't be of much use. A trip to the hardware store will have you find many different sizes and types of screws and bolts. These are all used to fasten objects to one another.



On a screw, the raised edges are called "threads." The farther apart the threads are from each other, the more effort force must be used to turn them. If the threads are close together, the easier it is to turn them.

Mechanical Lift

Universal



Level 2 Things to do:

Think About It

1. How many times can you turn the handle on the screw until the lift raises as high as possible?

2. What other machines make up the lift?

3. Measure the length of the handle that turns the screw. Measure how far apart each thread is on the screw.
Use the formula to find the mechanical advantage of the screw.

Now try this...

1. How could you increase the mechanical advantage of the screw?

2. How could you make the lift move up and down faster? Modify this machine to make it open and close the door faster.

Level 2 Background

On a screw, the raised edges are called "threads." The farther apart the threads are from each other, the more effort force must be used to turn them. If the threads are close together, the easier it is to turn them. The distance between each thread on a screw is called the pitch. This is also equal to the distance a wood screw advances into a piece of wood in one revolution. In the mechanical lift model, the handle turns the long screw. The screw pushes or pulls the long yellow blocks to raise and lower the platform.

The mechanical advantage of the screw depends on the pitch of the threads and the size of the wheel machine turning the screw. This becomes a ratio between the circumference of the wheel turning the screw, and the pitch of the threads on the screw.

Mechanical advantage = 2 Π radius of the wheel & axle / pitch
Note: Π = 3.14

Figure 1

In Figure 1, we can determine the mechanical advantage of this machine.

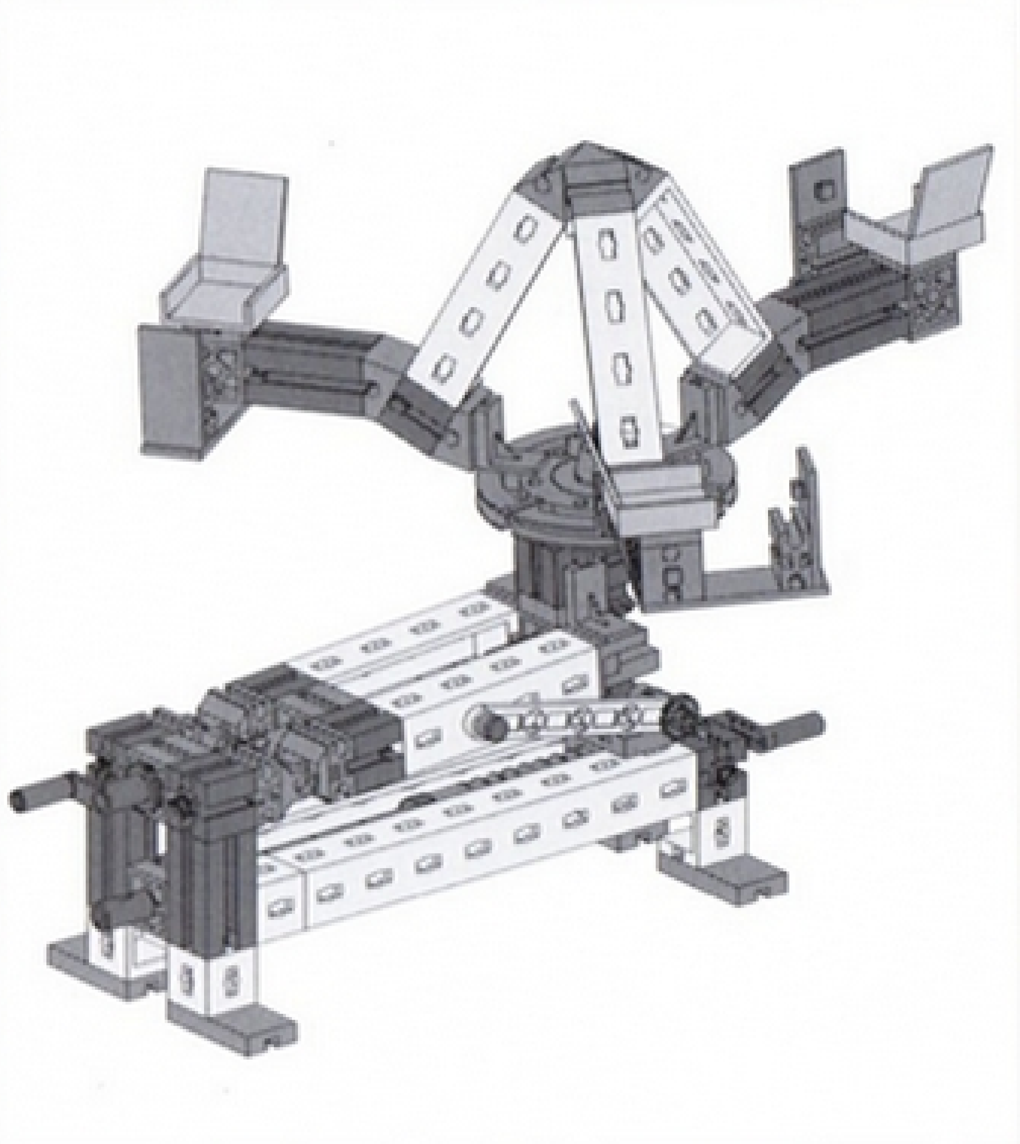
Mechanical advantage = 2 Π radius of the wheel & axle / pitch

MA = 2 (3.14) (2 cm) /0.25 cm

MA = 12.56 cm /0.25 cm

MA = 50.24

Universal



Level 1 Things to do:

1. Where is the screw in the centrifuge ride? What does it do in this machine?

2. How many times can you turn the handle on the screw till the ride moves as high as it can be?

3. What other machines make up the centrifugal ride?

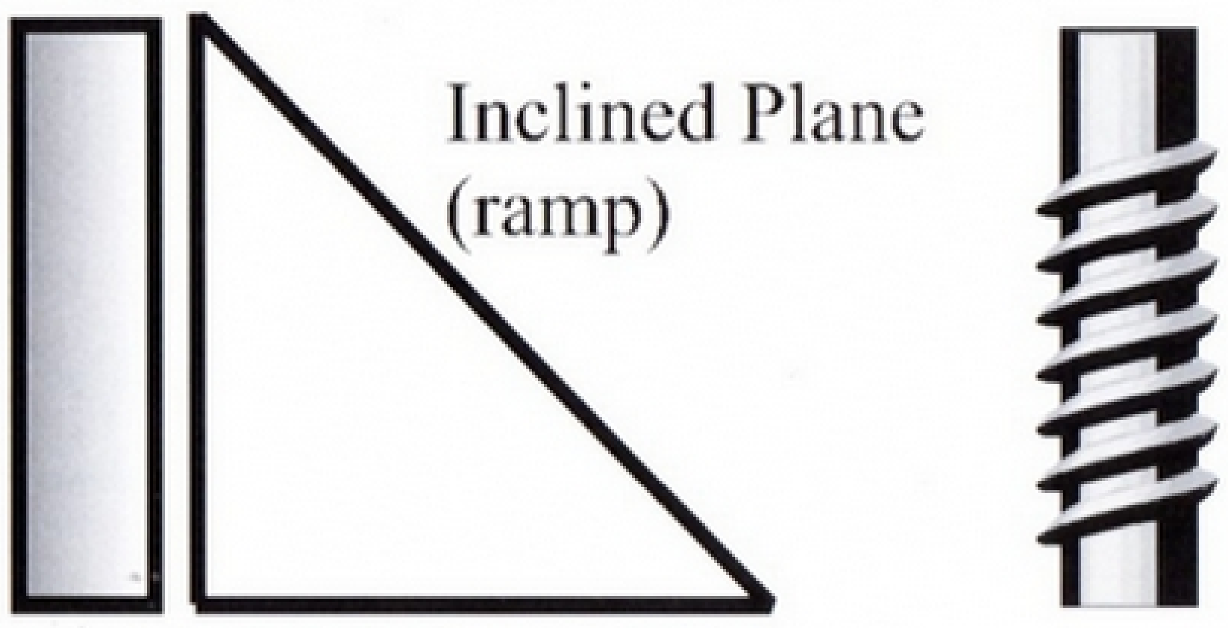
Now try this...

1. Lower the ride as low as it can be. With a ruler, measure how high the ride is at its highest point from the table. Turn the screw till the ride is at its highest point. How much higher did the ride move?

2. How many other types of simple machines are there in this model?

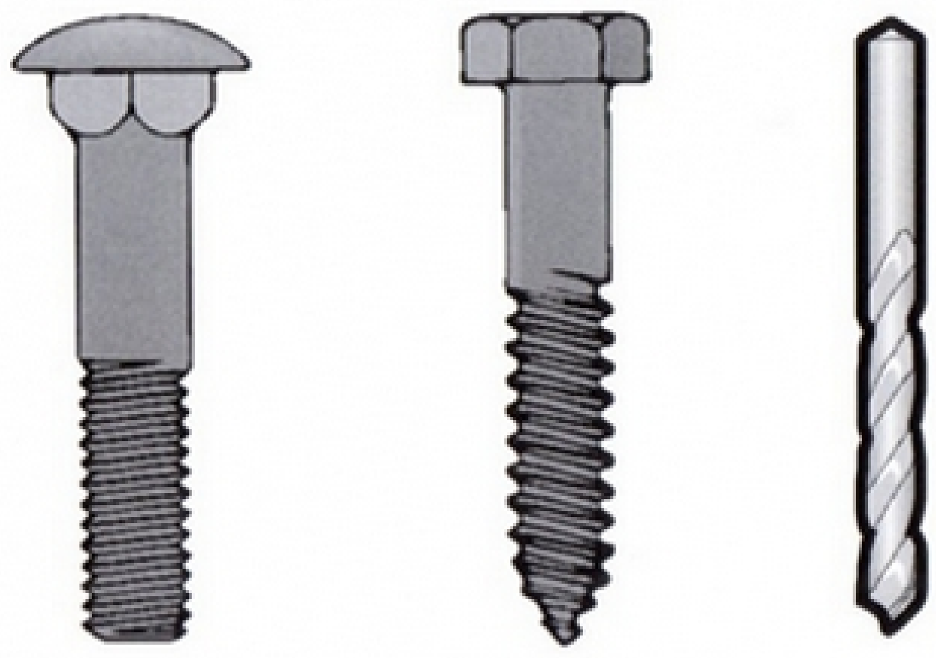
Level 1 Background

The jack screw and wood or metal screw are another type of simple machine. This simple machine can be thought of as an inclined plane (ramp) wrapped around a bar.



In the centrifuge model, the screw helps to raise and lower the top of the spinning platform.

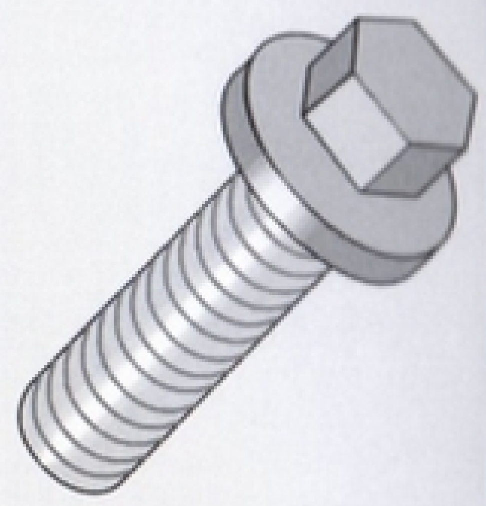
The screw can lift loads, like the jack screw raising a car to fix a flat tire. Wood screws hold objects together. Without friction the screw wouldn't be of much use. A trip to the hardware store will have you find many different sizes and types of screws and bolts. These are all used to fasten objects to one another.

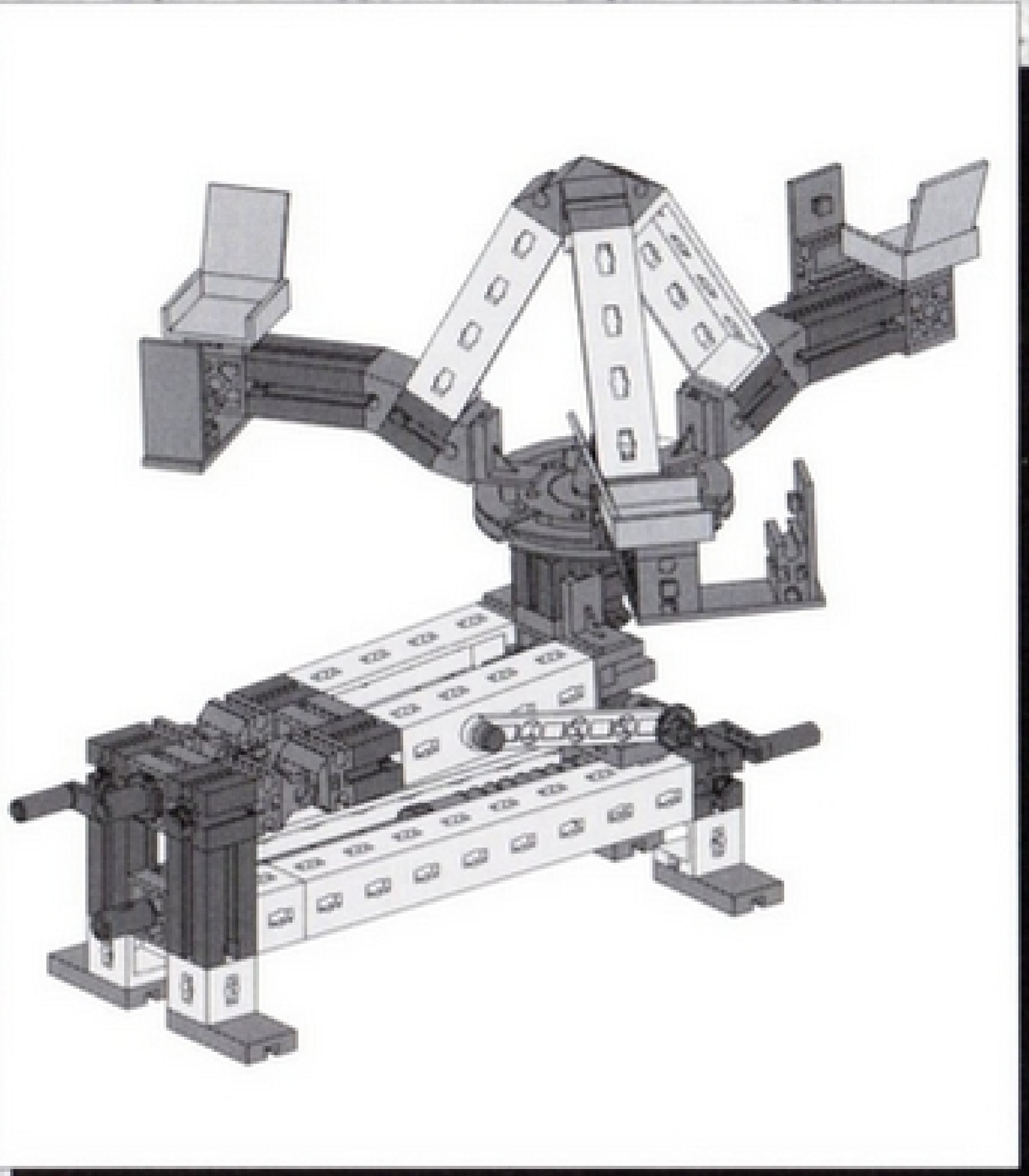


On a screw, the raised edges are called "threads." The farther apart the threads are from each other, the more effort force must be used to turn them. If the threads are close together, the easier it is to turn them.

Centrifuge Ride

Universal





Level 2 Things to do:

1. How many times can you turn the handle on the screw till the ride moves as high as it can be?

2. What other machines make up the centrifugal ride?

3. Measure the length of the handle that turns the screw. Measure how far apart each thread is on the screw. Use the formula to find the mechanical advantage of the screw.

Now try this...

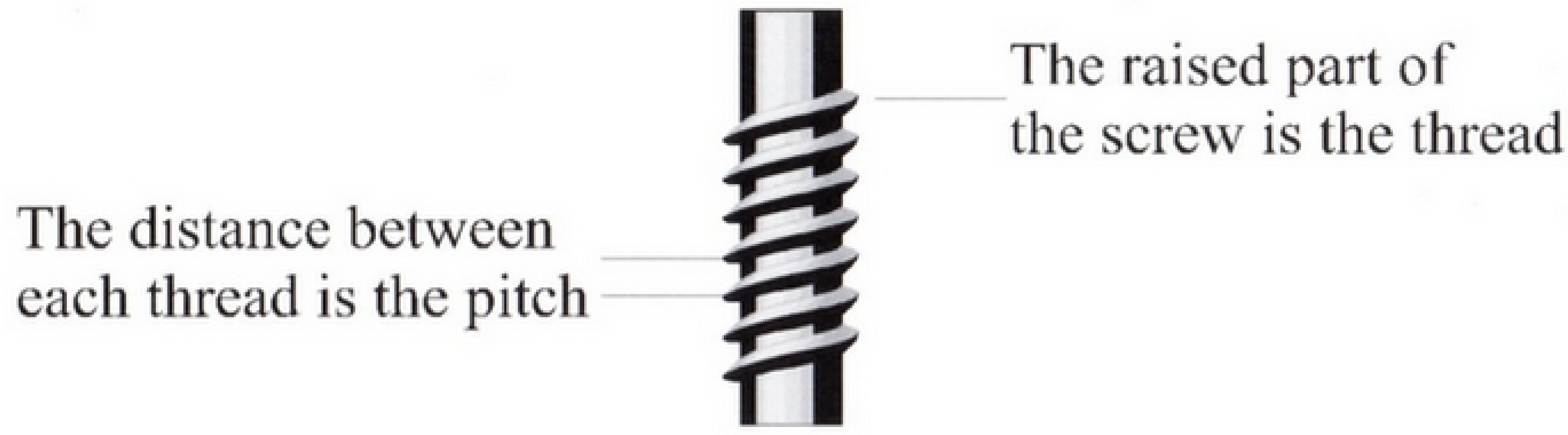
1. Lower the ride as low as it can be. With a ruler, measure how high the ride is at its highest point from the table. Turn the screw till the ride is at its highest point. How much higher did the ride move?

2. How could you increase the mechanical advantage of the screw?

3. How could you make the ride spin faster? Modify this machine to make it spin faster.

Level 2 Background

On a screw, the raised edges are called "threads." The farther apart the threads are from each other, the more effort force must be used to turn them. If the threads are close together, the easier it is to turn them. The distance between each thread on a screw is called the pitch. This is also equal to the distance a wood screw advances into a piece of wood in one revolution. In the centrifuge model, the screw helps to raise and lower the spinning platform.



The mechanical advantage of the screw depends on the pitch of the threads and the size of the wheel machine turning the screw. This becomes a ratio between the circumference of the wheel turning the screw, and the pitch of the threads on the screw.

Mechanical advantage = 2 Π radius of the wheel & axle / pitch
Note: Π = 3.14

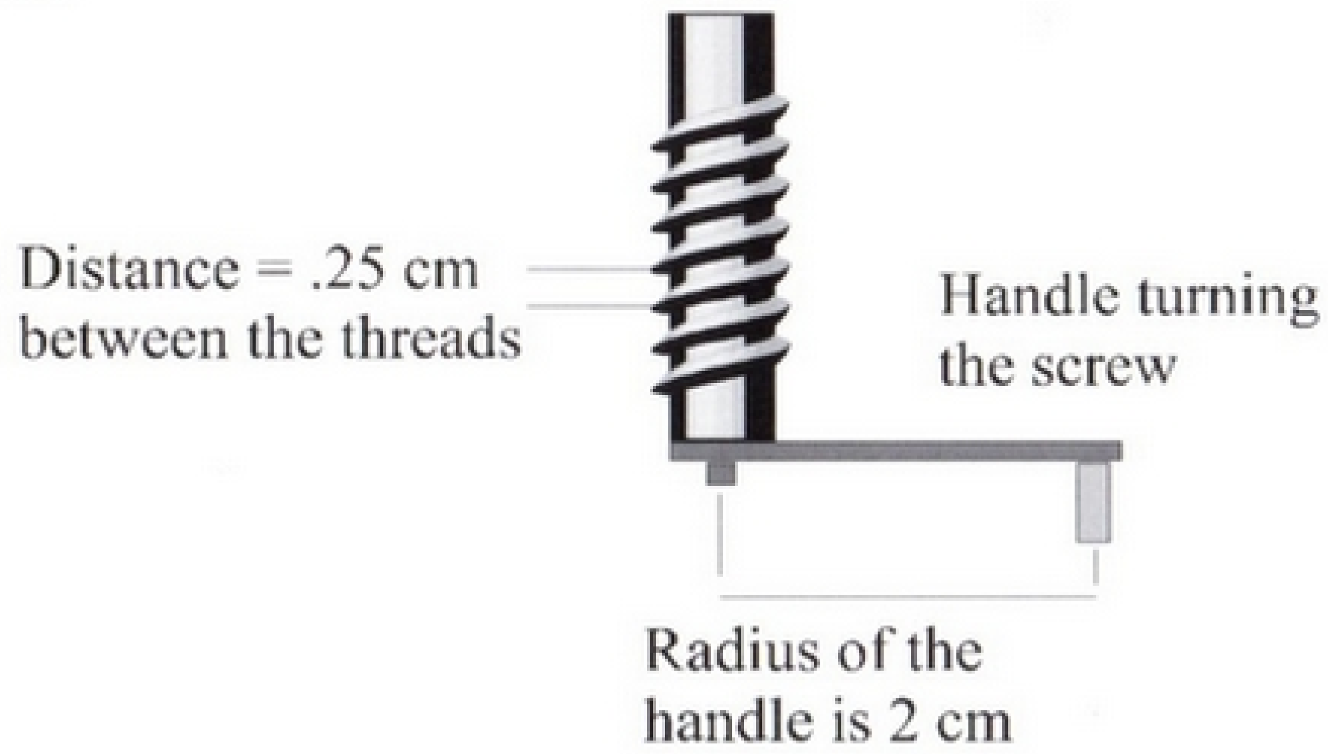


Figure 1

In Figure 1, we can determine the mechanical advantage of this machine.

Mechanical advantage = 2 Π radius of the wheel & axle / pitch

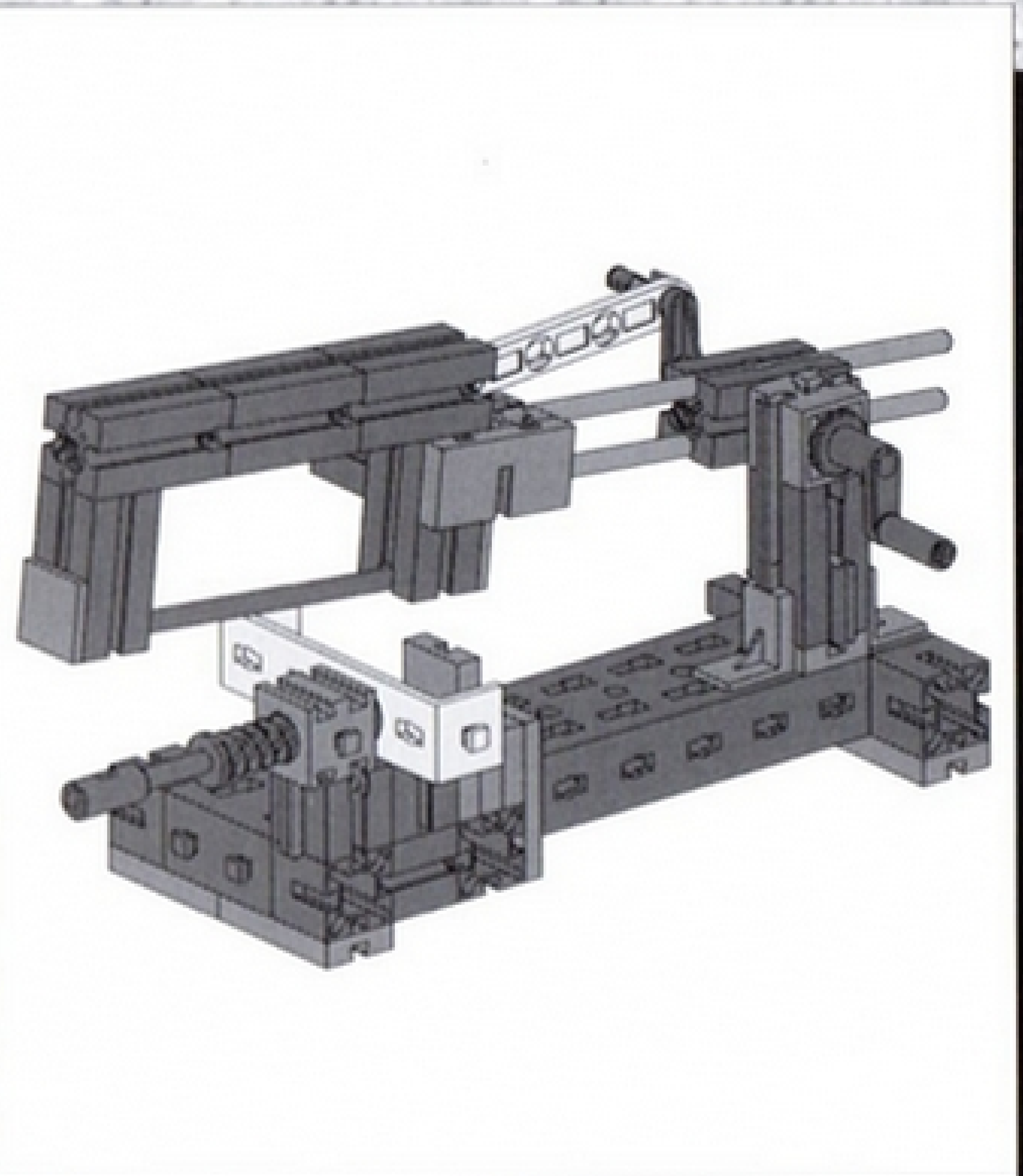
MA = 2(3.14) (2 cm) / 0.25 cm

MA = 12.56 cm / 0.25 cm

MA = 50.24

Coping Saw

Universal



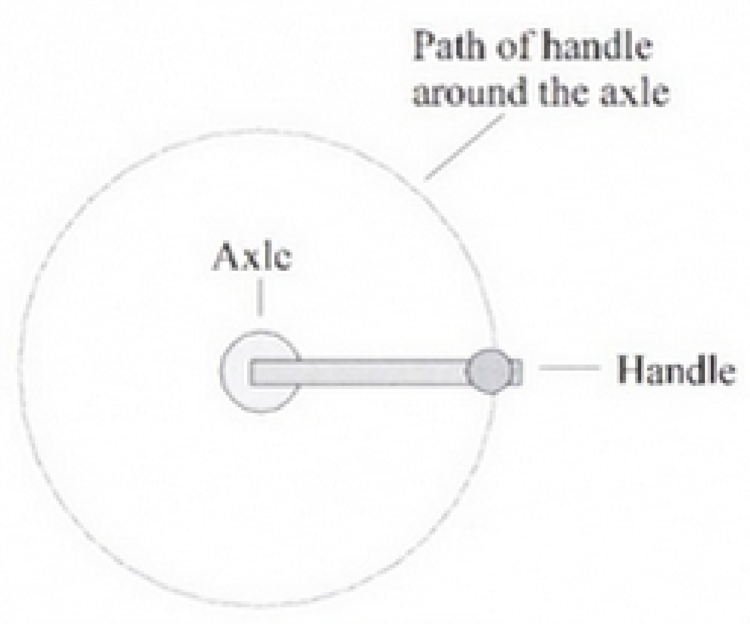
Level 1 Background

The pencil sharpener, water faucet, door knob, or steering wheel on a car are all examples of the simple machine, the wheel and axle. A wheel and axle is made up of an axle or handle attached to the center of a wheel. Your effort moves in a circle as the axle or handle turns. A wheel and axle act like a spinning lever. Both the wheel and the axle turn as effort is applied to the wheel.

Examples of wheel and axle machines

A wheel and axle have the ability to multiply your effort. You must compare the radius of the wheel to the radius of the axle. The radius is the distance from the center to the edge of a circle. The greater the difference in radii, the more the wheel and axle can multiply your force.

Pepper grinder



Handle on a pepper grinder

Figure 1

If the handle of the pepper grinder were made longer, the effort needed to turn the handle would be less.

Level 1 Things to do:

1. Where is the wheel & axle in this machine?

2. How many wheel & axle machines are there?

3. Which way does the saw blade move when the handle is turned?

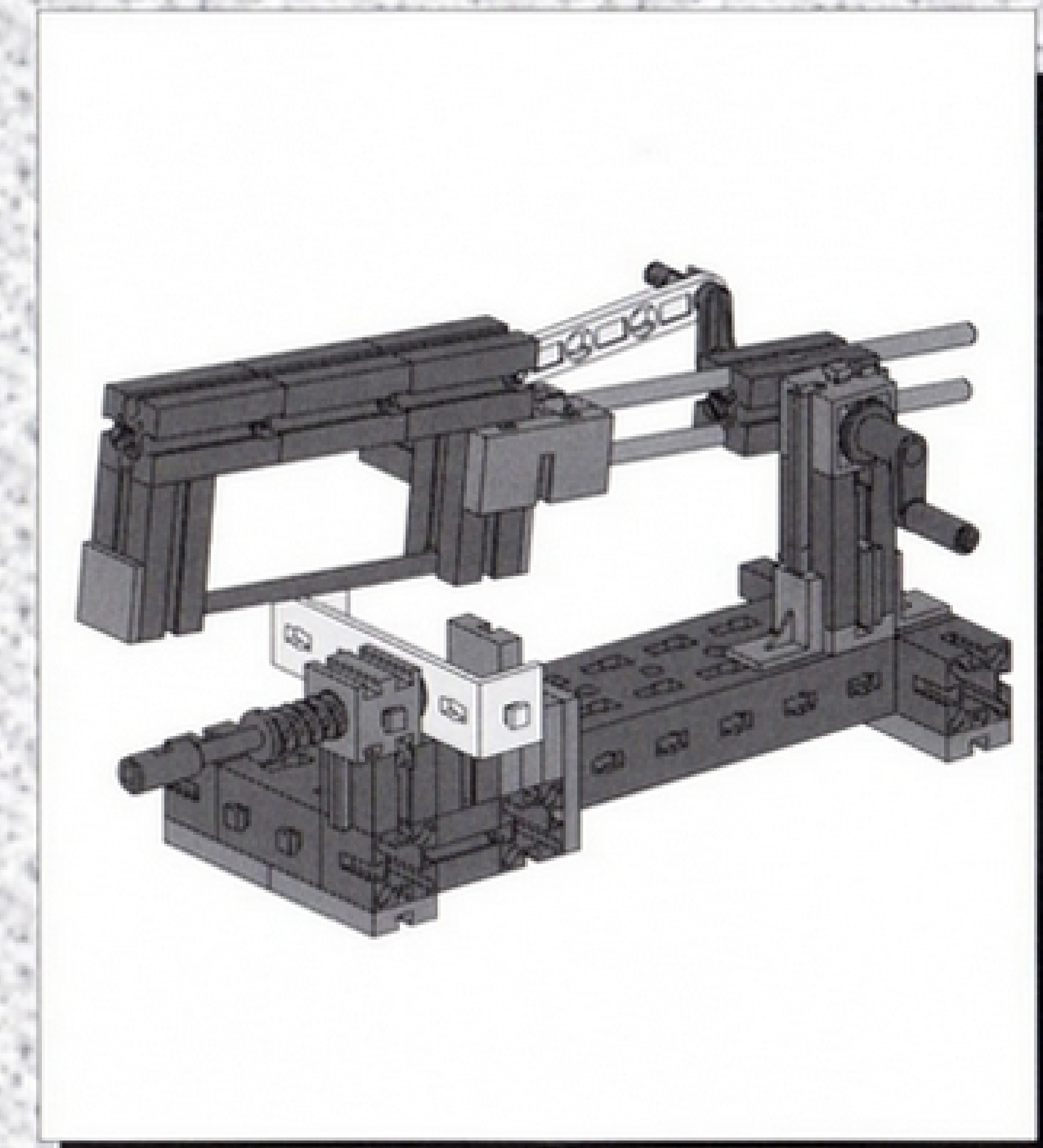
Now try this...

1. What would happen if the handle were made larger?

2. Would the saw move at a different speed if the handle were larger?

Coping Saw

Universal



Level 2 Things to do:

1. How many wheel & axle machines are there?

2. Get a ruler. Measure the radii of the axle and the handle. Use the formula to find the mechanical advantage of the wheel & axle.

Now try this...

1. What would happen if the handle were made larger?

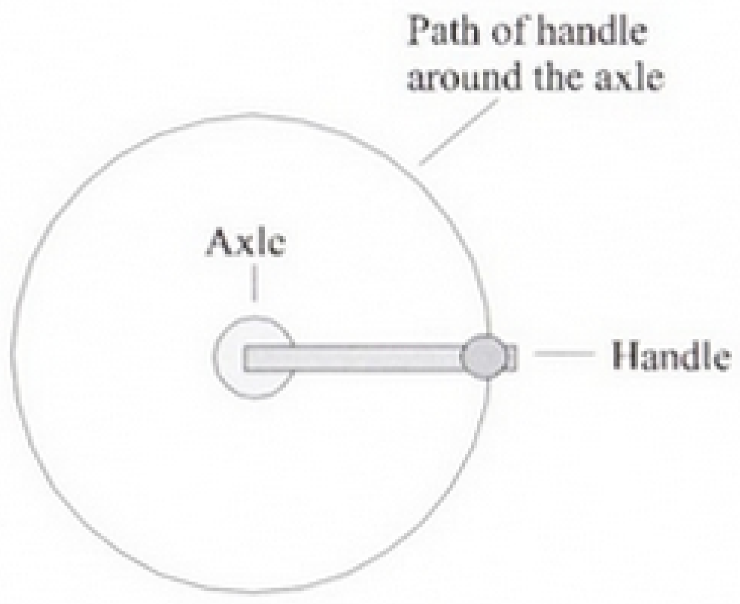
2. Would the saw move at a different speed if the handle were larger?

3. Try to add a gear system to your model. Can you make the saw move back and forth more quickly?

Level 2 Background

A small effort force can be used to move a larger resistance force with this machine. In the coping saw model, the black handle turns another handle, causing the “blade” of the saw to move. The mechanical advantage of the wheel and axle is determined by comparing the radius of the wheel to the radius of the axle. This is very similar to determining the mechanical advantage of the first class lever. The mechanical advantage of the wheel and axle is equal to the radius of the wheel divide by the radius of the axle. This is a ratio of the two radii.

Mechanical advantage = radius of the wheel / radius of the axle



Handle on a pepper grinder

Figure 1

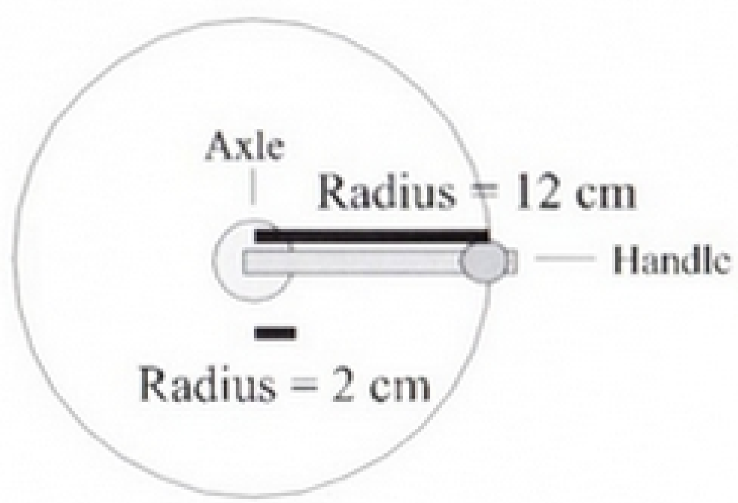


Figure 2

In the example above, the radius of the axle is 2 cm. The radius of the handle is 12 cm. Using these numbers, we can determine the mechanical advantage of the pepper grinder.

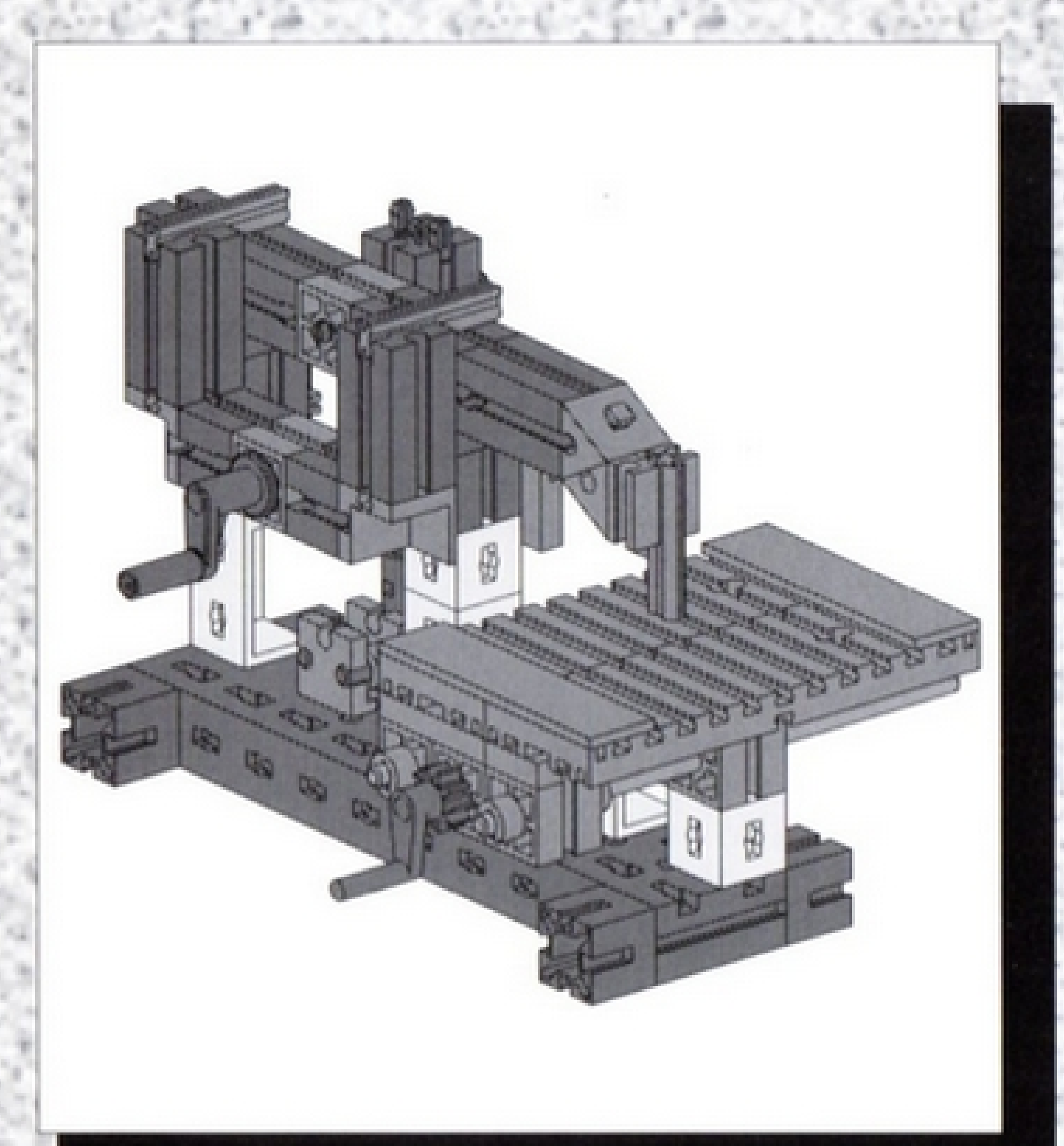
Mechanical advantage = radius of the wheel / radius of the axle

MA = 12 cm / 2 cm

MA = 6

Since the mechanical advantage is six, this pepper grinder increases the effort force six times.

Universal



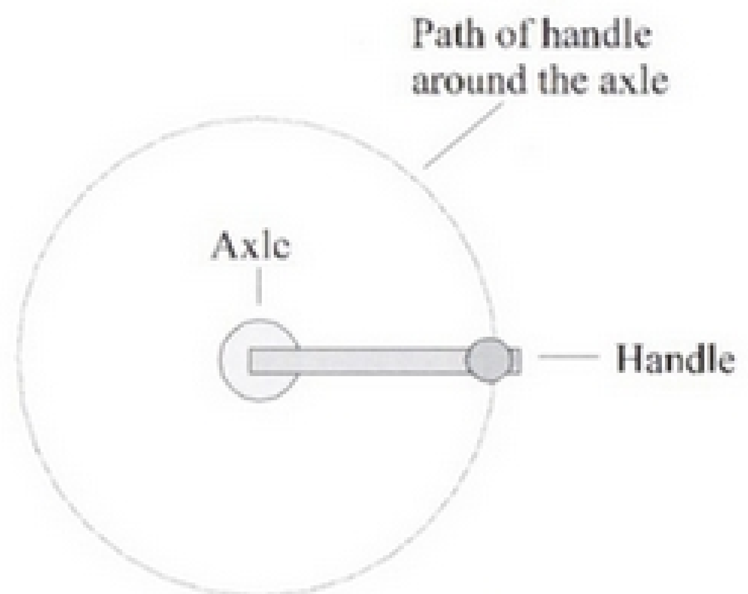
Level 1 Background

The pencil sharpener, water faucet, door knob, or steering wheel on a car are all examples of the simple machine, the wheel and axle. A wheel and axle is made up of an axle or handle attached to the center of a wheel. Your effort moves in a circle as the axle or handle turns. A wheel and axle acts like a spinning lever. Both the wheel and the axle turn as effort is applied to the wheel.

Examples of wheel and axle machines

A wheel and axle has the ability to multiply your effort. You must compare the radius of the wheel to the radius of the axle. The radius is the distance from the center to the edge of a circle. The greater the difference in radii, the more the wheel and axle can multiply your force.

Pepper grinder



Handle on a pepper grinder

Figure 1

If the handle of the pepper grinder were made longer, the effort needed to turn the handle would be less.

Level 1 Things to do:

1. Where are the wheel & axles in this machine?

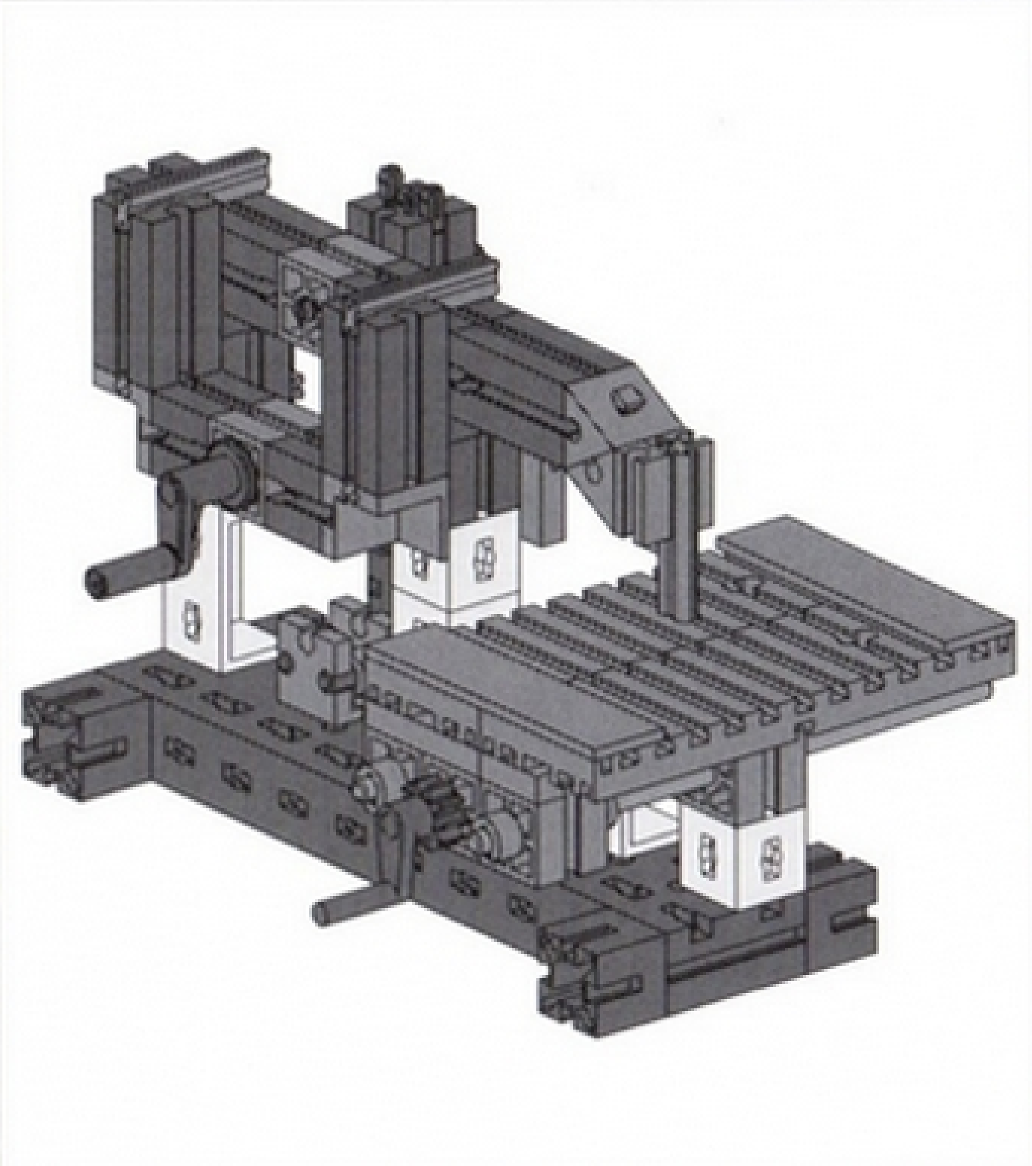
2. How many wheel & axle machines are there?

3. Which way does the saw blade move when the handle is turned? Which way does the table move?

Now try this...

1. What would happen if the handle that turns the saw were made larger?

2. Would the saw move at a different speed if the handle were larger?



Level 2 Things to do:

1. How many wheel & axle machines are there?

2. Get a ruler. Choose one of the handles. Measure the radii of the axle and the handle. Use the formula to find the mechanical advantage of the wheel & axle.

Now try this...

1. What would happen if the handle that turns the saw were made larger?

2. Would the saw move at a different speed if the handle were larger?

Level 2 Background

A small effort force can be used to move a larger resistance force with this machine. In the planer, there are two different wheel and axle machines. One handle causes the saw "blade" to move back and forth. The other handle moves the planer table to move from side to side. The mechanical advantage of the wheel and axle is determined by comparing the radius of the wheel to the radius of the axle. This is very similar to determining the mechanical advantage of the first class lever. The mechanical advantage of the wheel and axle is equal to the radius of the wheel divide by the radius of the axle. This is a ratio of the two radii.

Mechanical advantage = radius of the wheel / radius of the axle

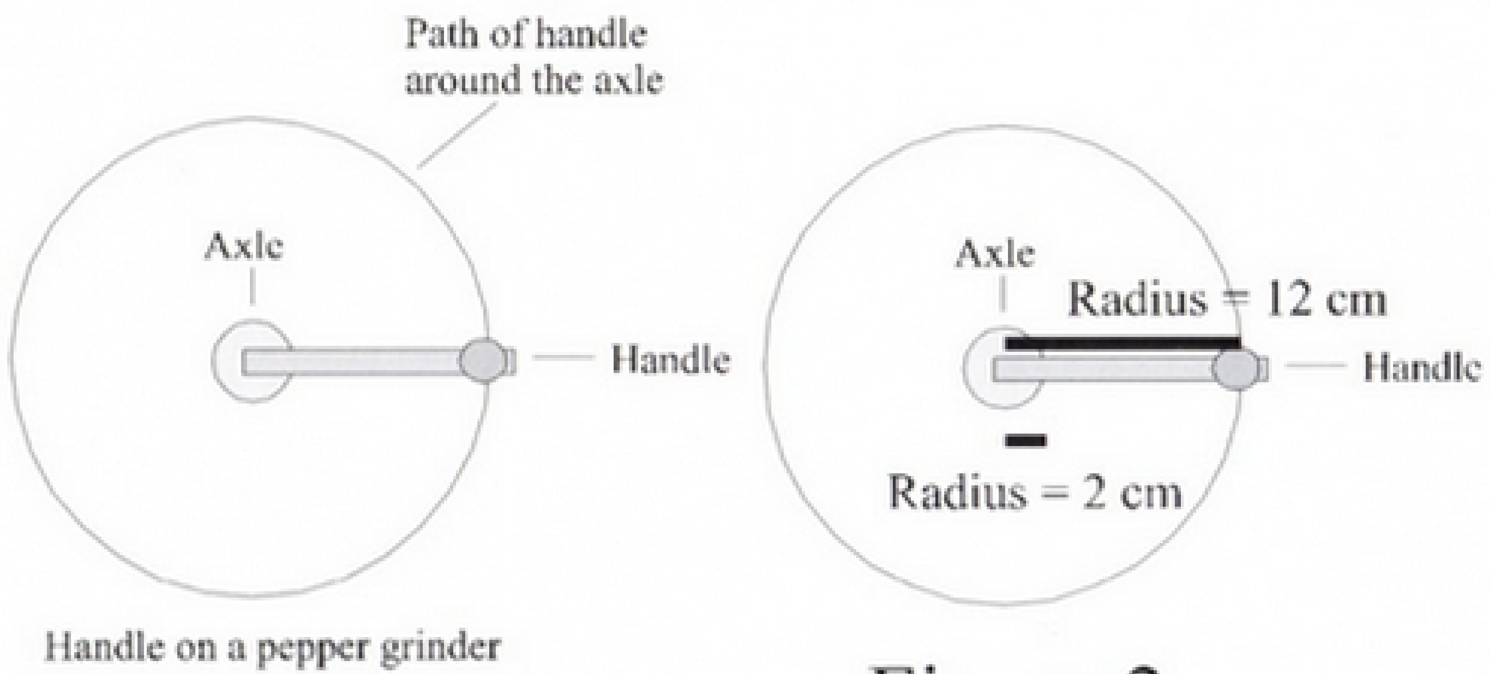


Figure 1 Figure 2

In the example above, the radius of the axle is 2 cm. The radius of the handle is 12 cm. Using these numbers, we can determine the mechanical advantage of the pepper grinder.

Mechanical advantage = radius of the wheel / radius of the axle

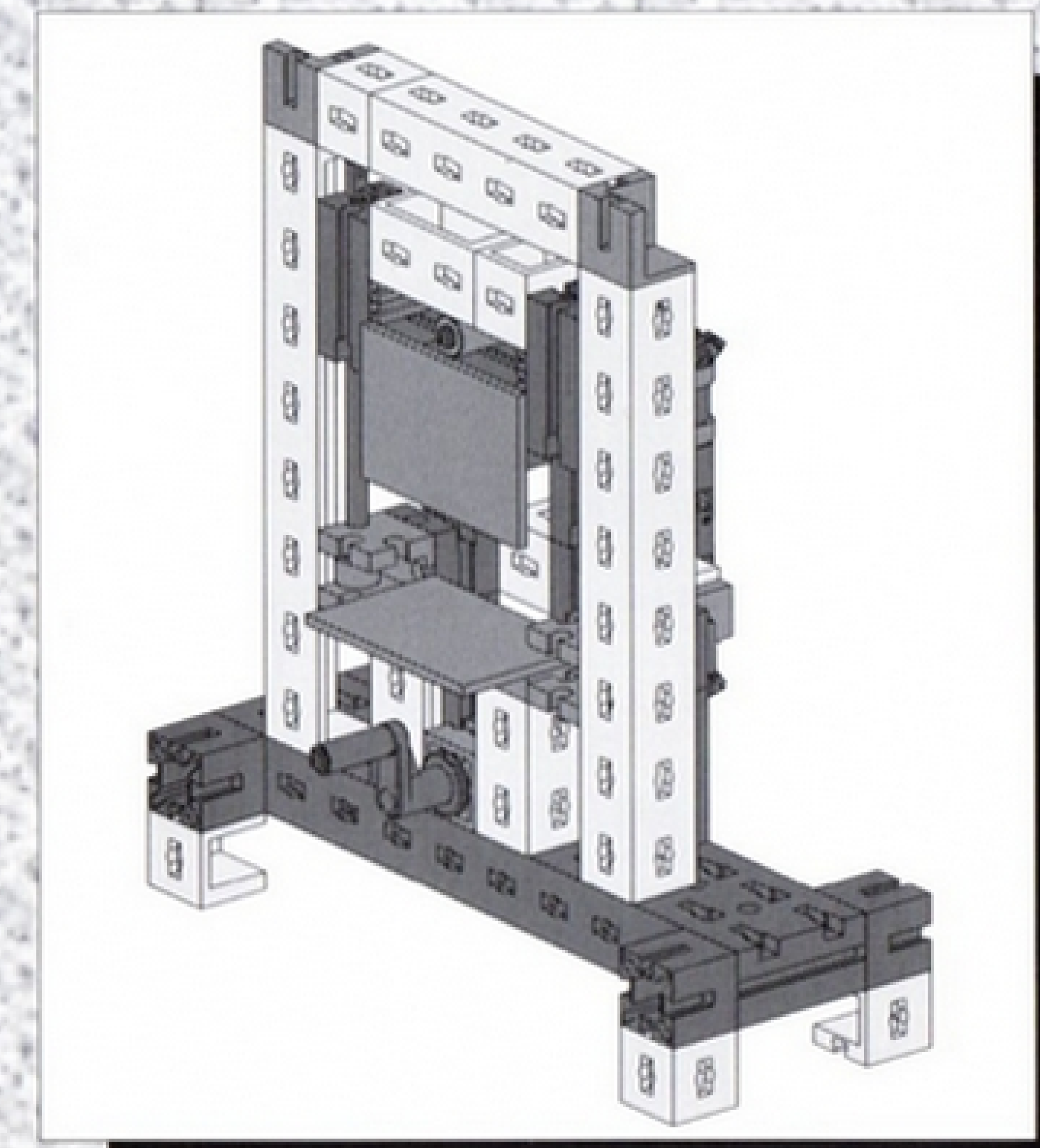
MA = 12 cm/2 cm

MA = 6

Since the mechanical advantage is six, this pepper grinder increases the effort force six times.

Stamping Press

Universal



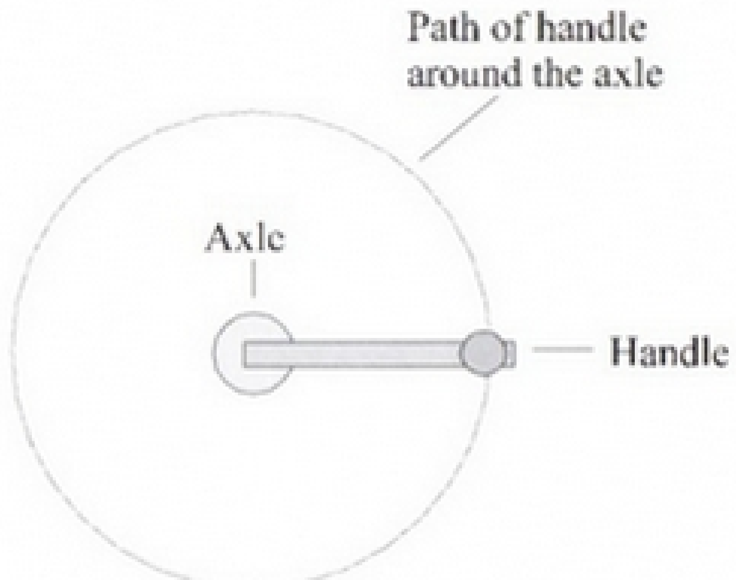
Level 1 Background

The pencil sharpener, water faucet, door knob, or steering wheel on a car are all examples of the simple machine, the wheel and axle. A wheel and axle is made up of an axle or handle attached to the center of a wheel. Your effort moves in a circle as the axle or handle turns. A wheel and axle acts like a spinning lever. Both the wheel and the axle turn as effort is applied to the wheel.

Examples of wheel and axle machines

A wheel and axle has the ability to multiply your effort. You must compare the radius of the wheel to the radius of the axle. The radius is the distance from the center to the edge of a circle. The greater the difference in radii, the more the wheel and axle can multiply your force.

Pepper grinder



Handle on a pepper grinder

Figure 1

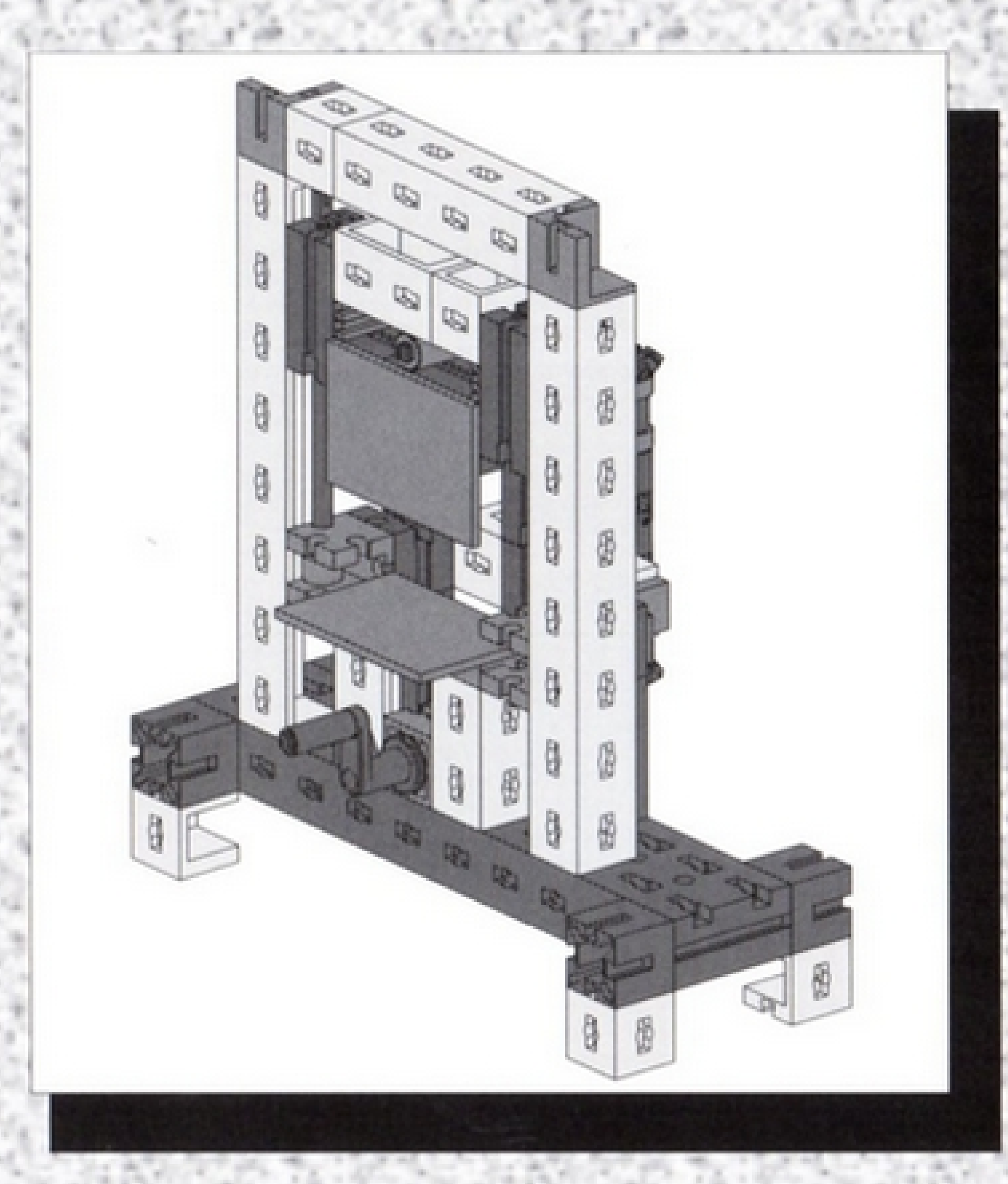
If the handle of the pepper grinder were made longer, the effort needed to turn the handle would be less.

Level 1 Things to do:

1. How many wheel and axle machines are in this model?
2. When you turn the handle clock-wise, which way does the press blade move?
3. When you turn the handle one complete turn, how many times does the press blade move up and down?

Now try this...

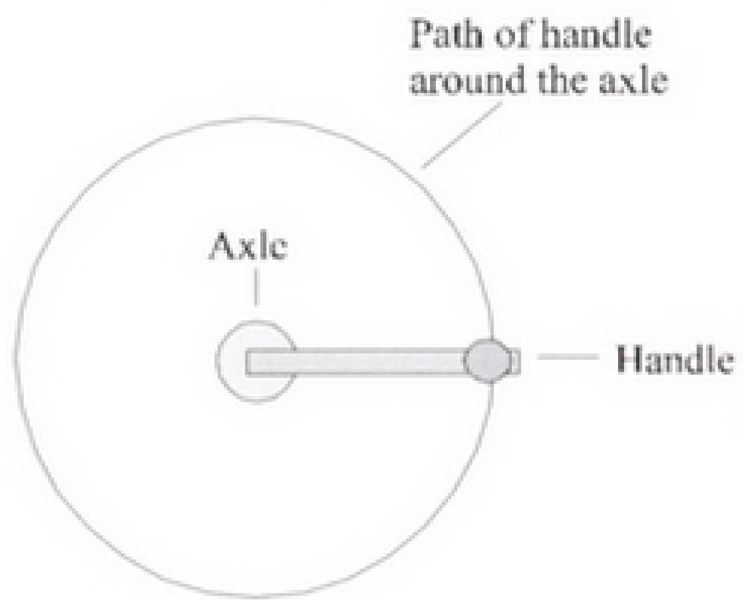
1. What would happen if the handle were made larger?
2. Would the press blade move at a different speed if the handle were larger?



Level 2 Background

A small effort force can be used to move a larger resistance force with this machine. The handle of the stamping press moves the press "blade" up and down. The mechanical advantage of the wheel and axle is determined by comparing the radius of the wheel to the radius of the axle. This is very similar to determining the mechanical advantage of the first class lever. The mechanical advantage of the wheel and axle is equal to the radius of the wheel divided by the radius of the axle. This is a ratio of the two radii.

Mechanical advantage = radius of the wheel / radius of the axle



Handle on a pepper grinder

Figure 1

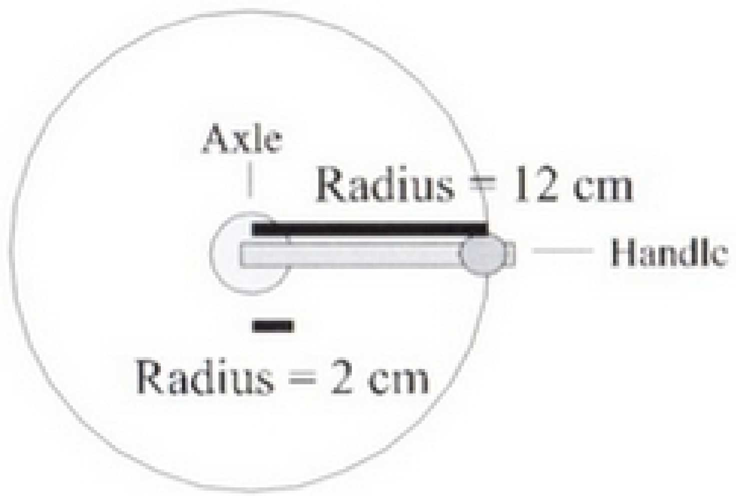


Figure 2

In the example above, the radius of the axle is 2 cm. The radius of the handle is 12 cm. Using these numbers, we can determine the mechanical advantage of the pepper grinder.

Mechanical advantage = radius of the wheel / radius of the axle

MA = 12 cm/2 cm

MA = 6

Since the mechanical advantage is six, this pepper grinder increases the effort force six times.

Level 2 Things to do:

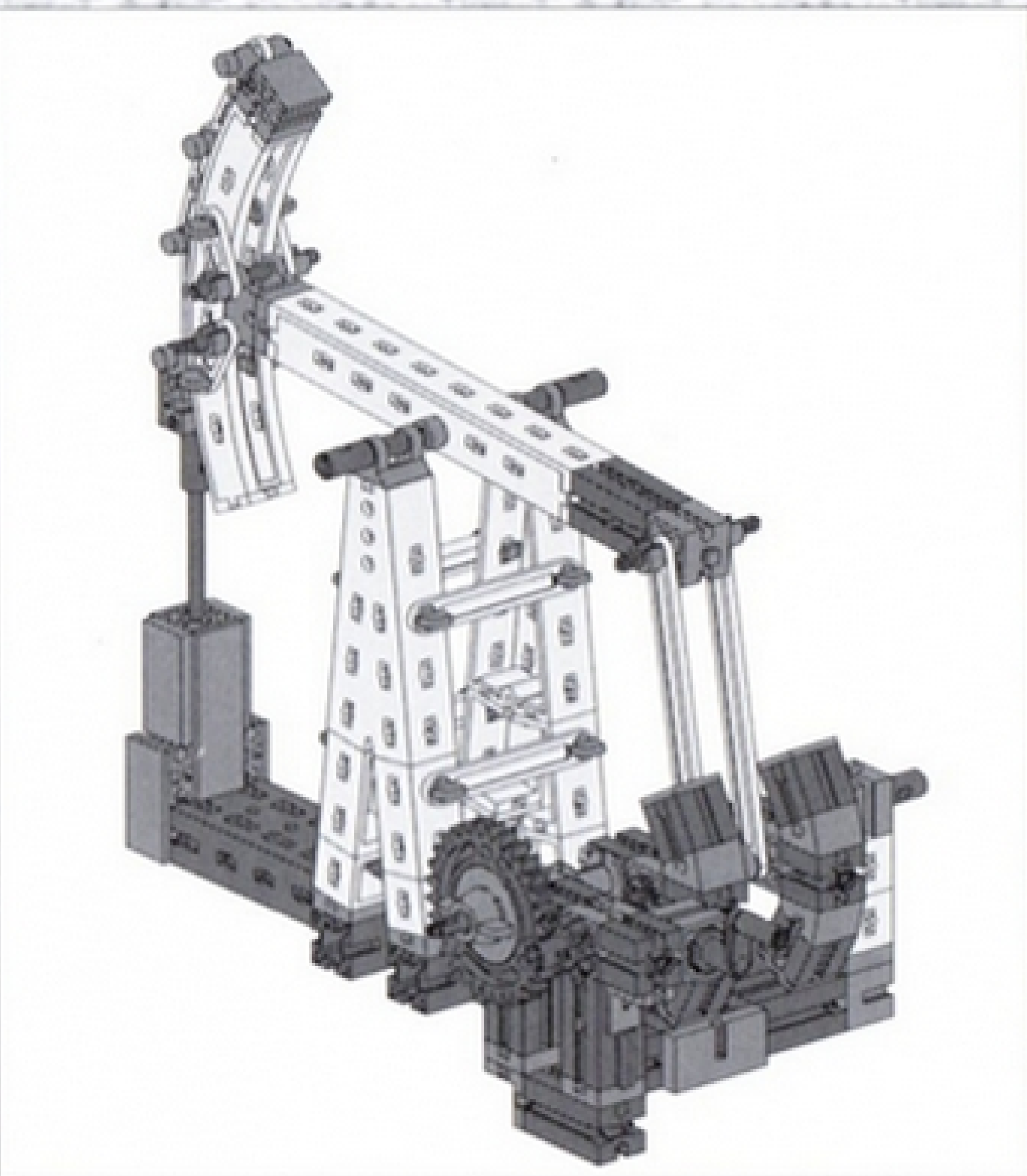
1. How many wheel and axle machines are in this model?
2. Get a ruler. Choose one of the handles. Measure the radii of the axle and the handle. Use the formula to find the mechanical advantage of the wheel & axle.

Now try this...

1. What would happen if the handle were made larger?
2. Would the saw move at a different speed if the handle were larger?
3. Try to add a gear system that will make the handle move the press blade faster. How much faster did it move the press blade?

Oil Drill

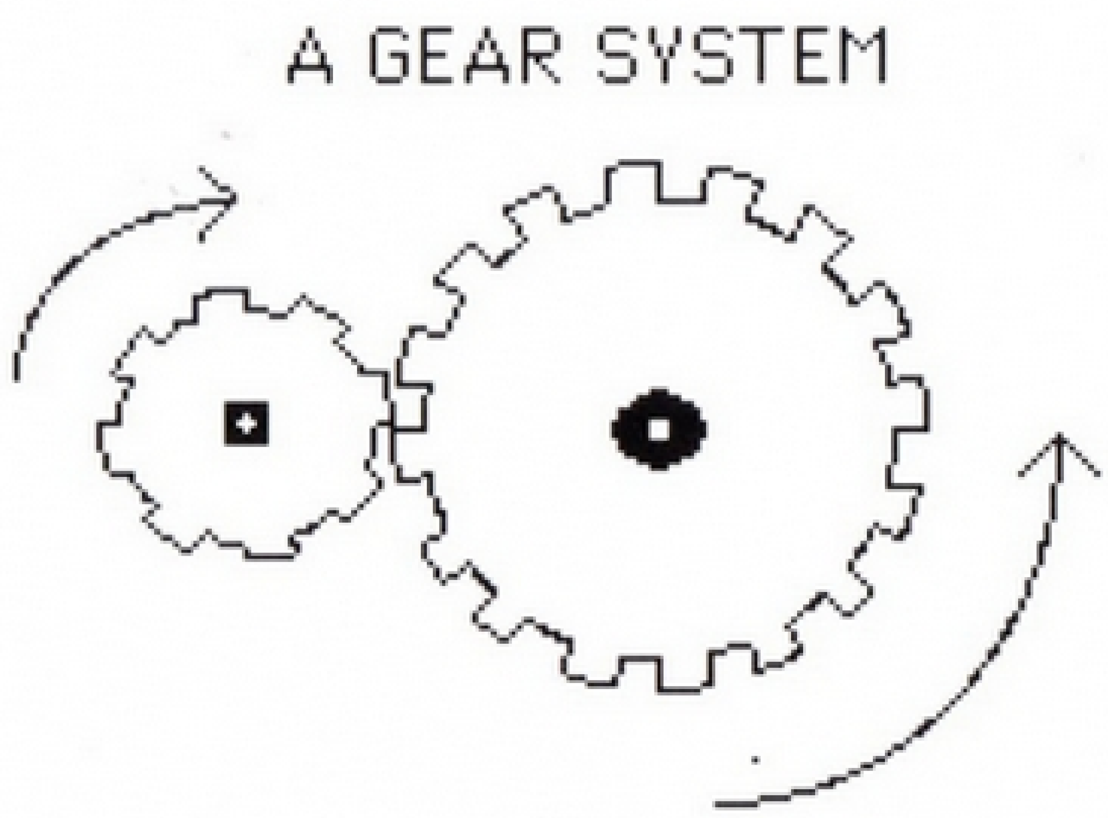
Universal

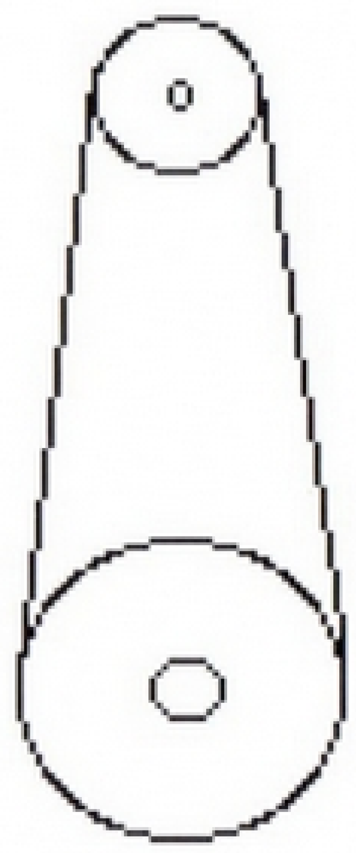


Level 1 Background

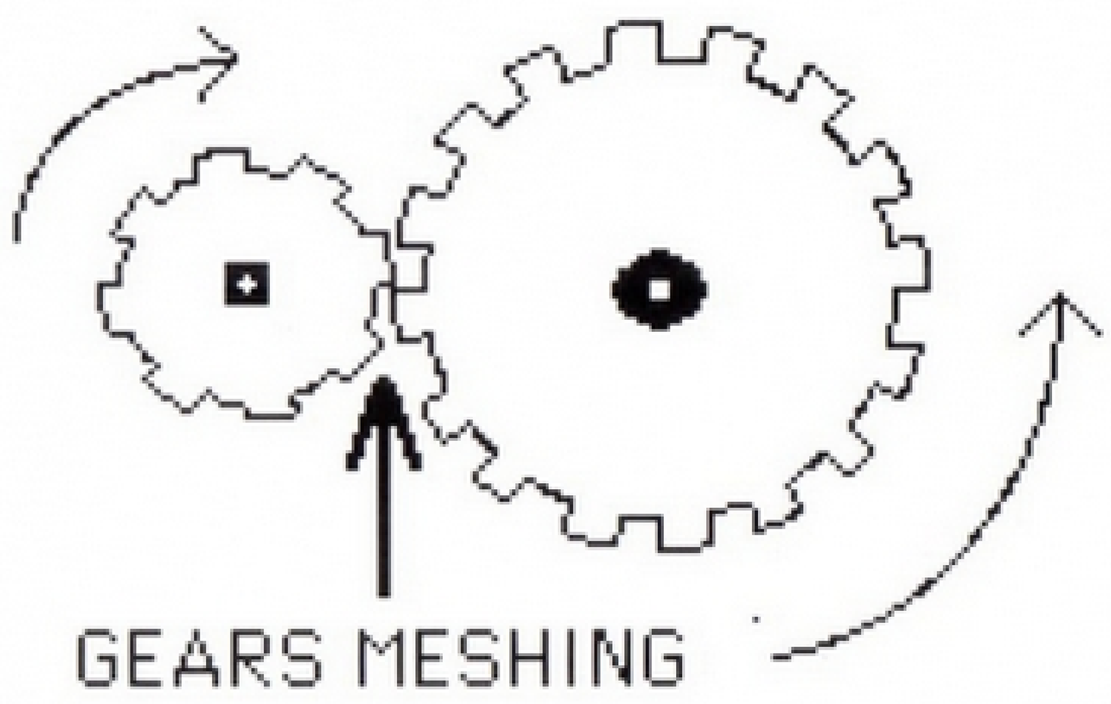
Gears are commonplace in our world. Gears change rotational force, force that is moving in a circular motion. Racing and mountain bikes have gear systems allowing the rear tires to rotate faster or slower than the pedals. In the oil drill model the gears control how fast the pump arm moves up and down. Changing the gears will change the rate at which the oil drill arm moves up and down.

Gears are a type of simple machine. They transfer rotational motion from one wheel to another. The transfer of energy can be done with gears or belt-driven pulleys.





Gears are wheels with teeth on them. Gears work by transmitting force from one gear to another where the two gear teeth mesh.



Level 1 Things to do:

1. Turn the handle clockwise. Which direction does the large gear turn?
2. Which way does the small gear turn?
3. How many times does the oil drill go up and down when the large gear is turned one time?

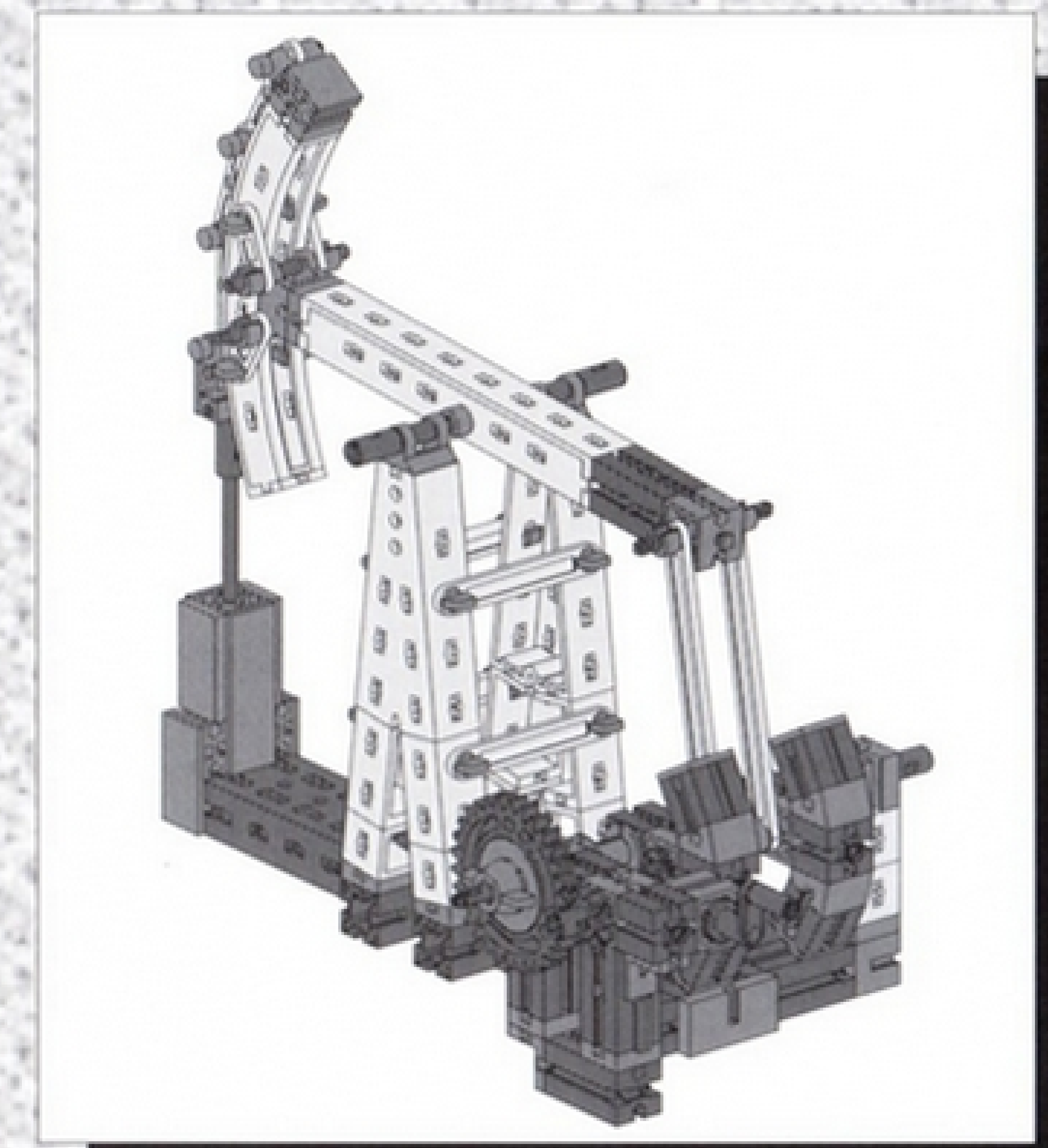
Now try this...

1. Try using the same size gear as the gear attached to the handle. How does this affect the number of times the oil drill goes up and down?

2. Using any of the gears try to make the oil drill go up and down the fastest. Now try to make the oil drill go up and down as slow as possible.

Oil Drill

Universal



Level 2 Things to do:

1. Turn the handle clockwise. How many teeth does the driver gear have?

2. How many teeth does the driven gear have? What is the gear ratio for these two gears?

3. Does the oil drill go up and down the same number of times as the driven gear spins? Why or why not?

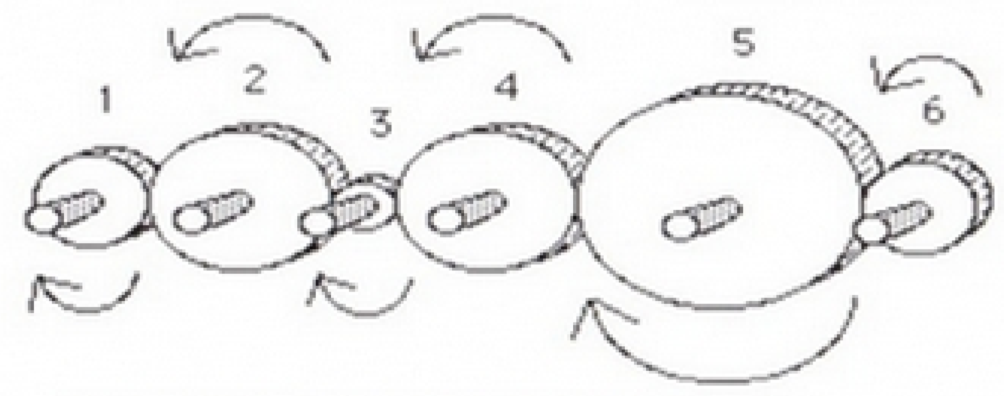
Now try this...

1. Using all the gears you have, build and calculate a gear ratio that will make the oil drill go up and down the fastest.

2. Now calculate a gear ratio that makes the oil drill go up and down spin the slowest.

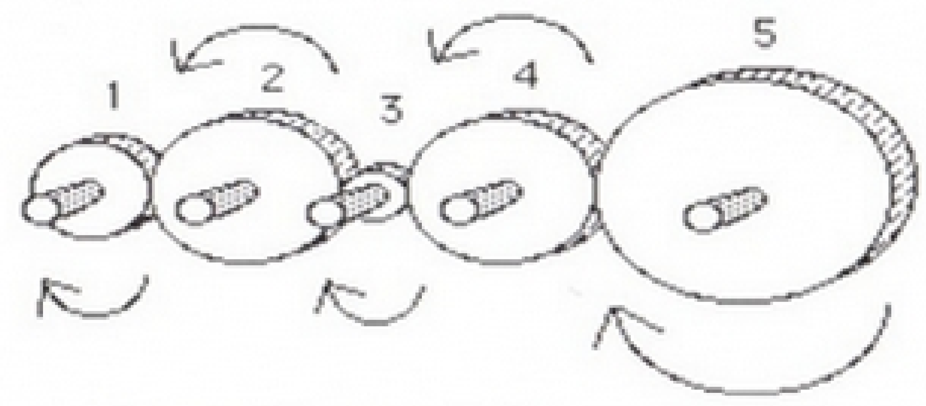
Level 2 Background

Gears can change the direction of motion from clockwise to counter-clockwise. This applies to all gear systems in a straight row. If the number of gear shafts is even, the motion will be opposite that of the first gear (figure A). If the number of gear shafts is odd, then the direction of motion will be the same as the first gear (figure B).



EVEN NUMBER OF GEAR SHAFTS: THE FIRST AND LAST GEAR ROTATE IN THE OPPOSITE DIRECTION.

Figure A

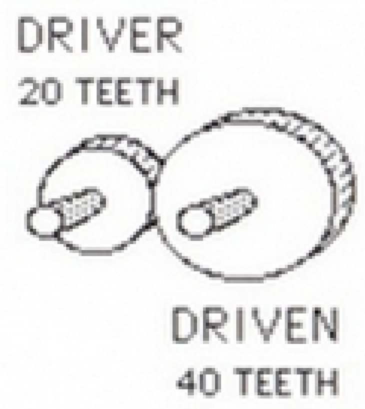


ODD NUMBER OF GEAR SHAFTS: THE FIRST AND LAST GEAR ROTATE IN THE SAME DIRECTION.

Figure B

When there are more than two gears connected together, the system is called a gear train. The number of teeth on a gear effects the number of revolutions of the last gear in a gear system. Relating the number of revolutions of the first gear to the number of revolutions of the last gear is the speed of the gear train..

The gear that causes the motion is the driver gear. The gear to which the motion is transferred is the driven gear. For all types of gears, the following formula applies: **T x N = t x n**

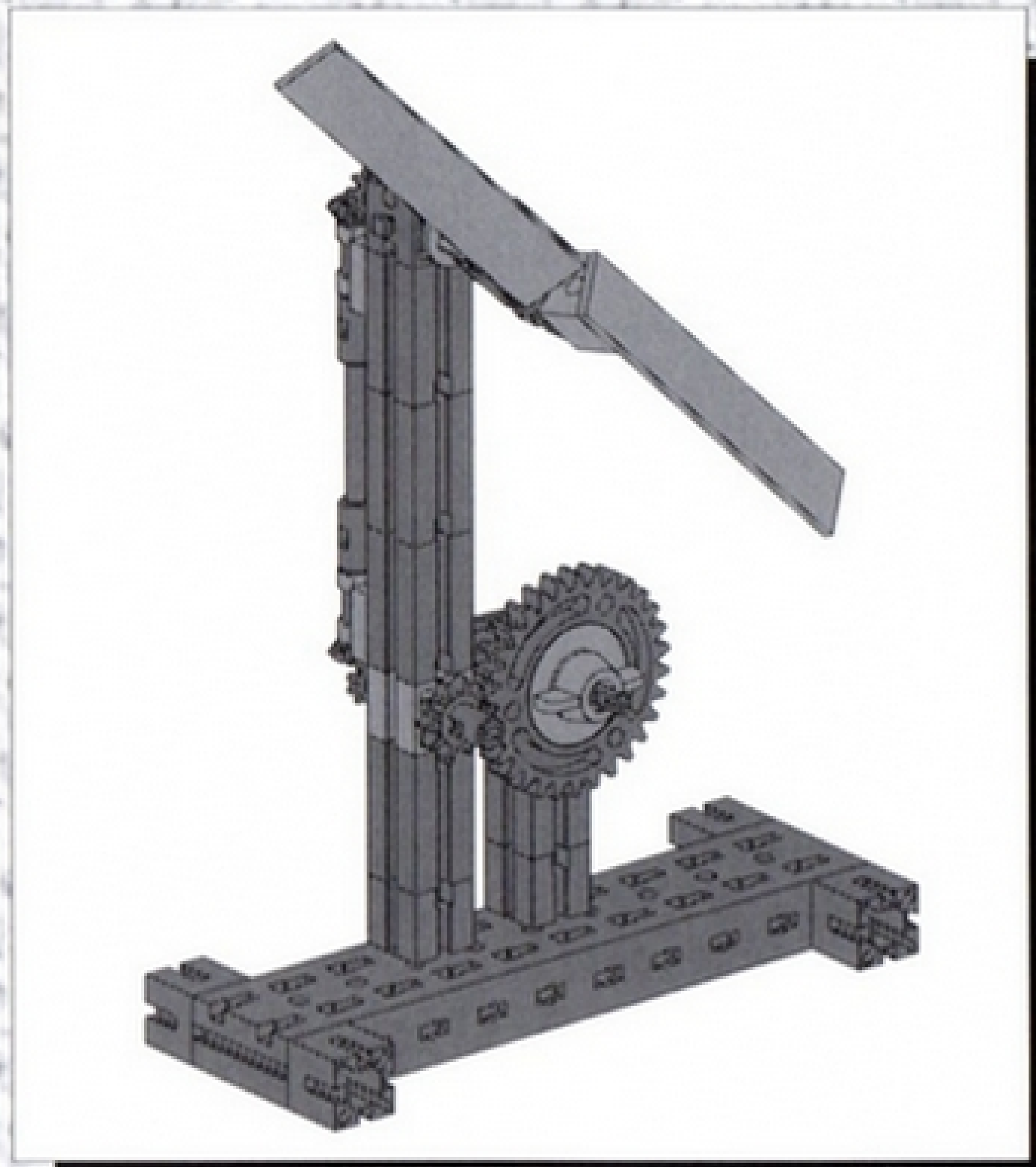


T = the number of teeth on the driver
N = the number of revolutions of the driver
t = the number of teeth on the driven gear
n = the number of revolutions of the driven gear.

In the diagram above, let's assume that the driver makes one revolution. We can use the formula to find the number of revolutions the driven gear makes. We substitute:

T = 20 driver teeth	**T x N = t x n**
N = 1 revolution of the driver	**n = T x N / t**
t = 40 driven teeth	**n** = (20 teeth) (1 revolution)/40 teeth
n = ?	**n** = 0.5 revolutions

Universal



Level 1 Background

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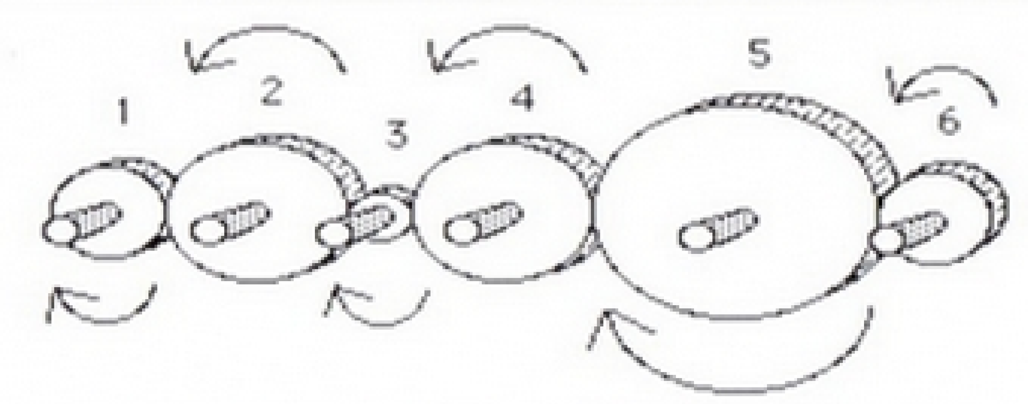

Figure A

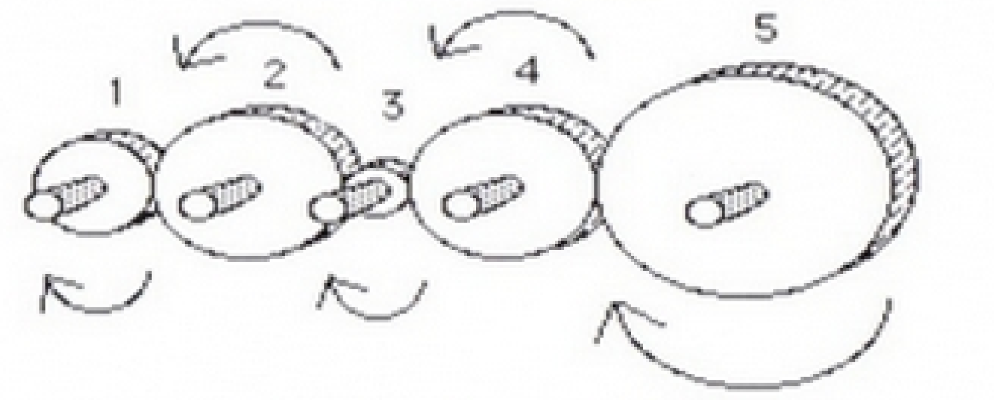

Figure B

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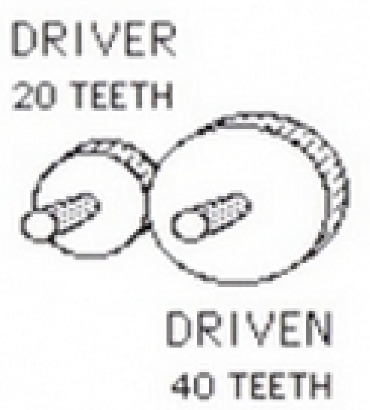

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N = 1 revolution of the driver	**n = T x N / t**
t = 40 driven teeth	**n** = (20 teeth)(1 revolution) / 40 teeth
n = ?	**n** = 0.5 revolutions

Level 1 Things to do:

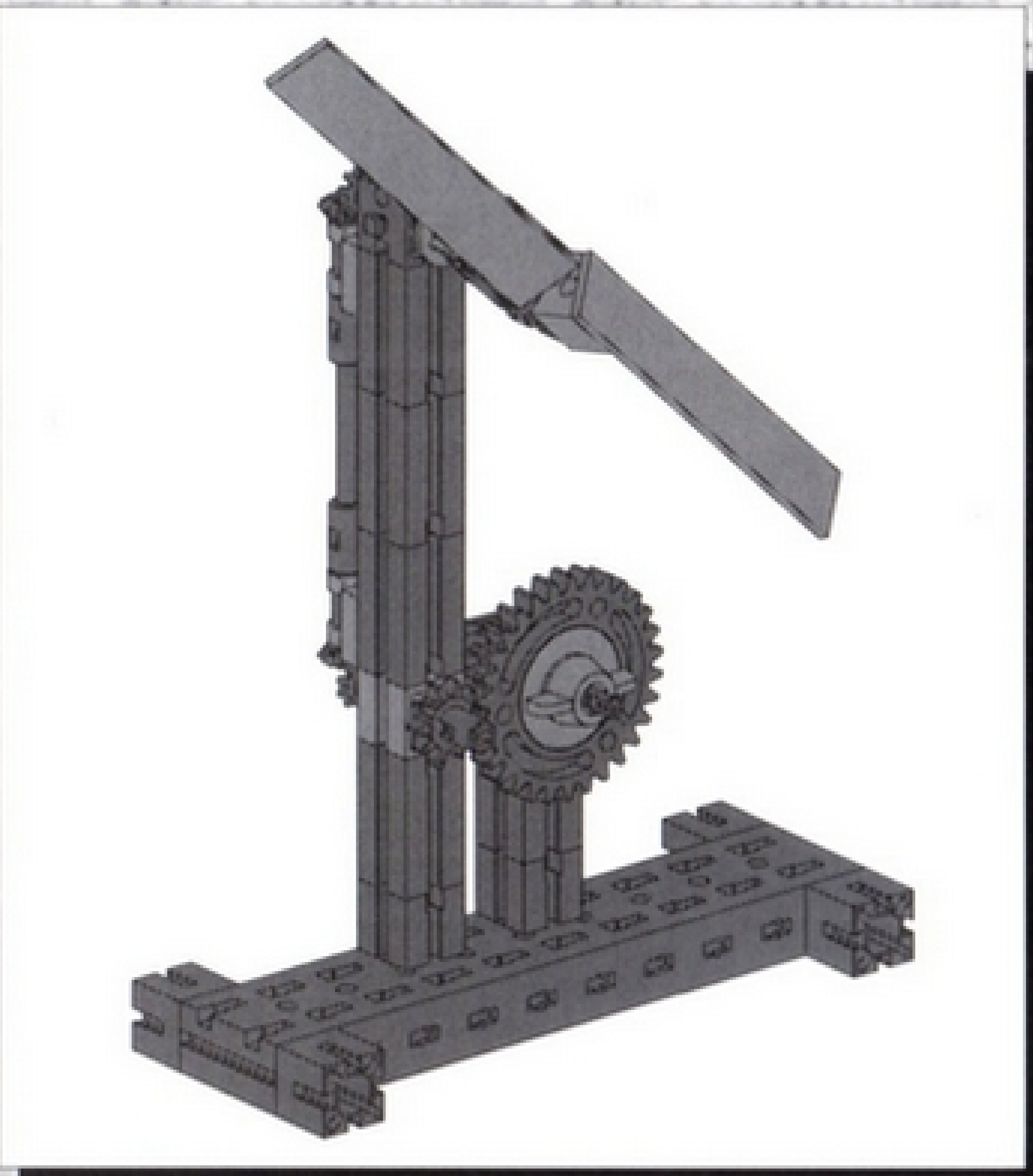
1. Turn the handle clockwise. Which direction does the large gear turn?
2. Which way does the small gear turn?
3. How many times does the fan blade turn when the large gear turns one time?

Now try this...

1. Try using the same size gear as the gear attached to the handle. How does this affect the number of times the fan blade turns?

2. Using any of the gears try to make the fan blade spin the fastest. Now try to make the fan blade spin as slow as possible.

Fan — Universal



Level 2 Things to do:

1. Turn the handle clockwise. How many teeth does the driven gear have?

2. How many teeth does the driven gear have?

3. What is the gear ratio for these two gears? Does the fan blade spin the same number of times as the driven gear? Why or why not?

Now try this...

1. Using all the gears you have, build and calculate a gear ratio that will make the fan blade spin the fastest.

2. Now build and calculate a gear ratio that makes the fan blade spin the slowest.

Level 2 Background

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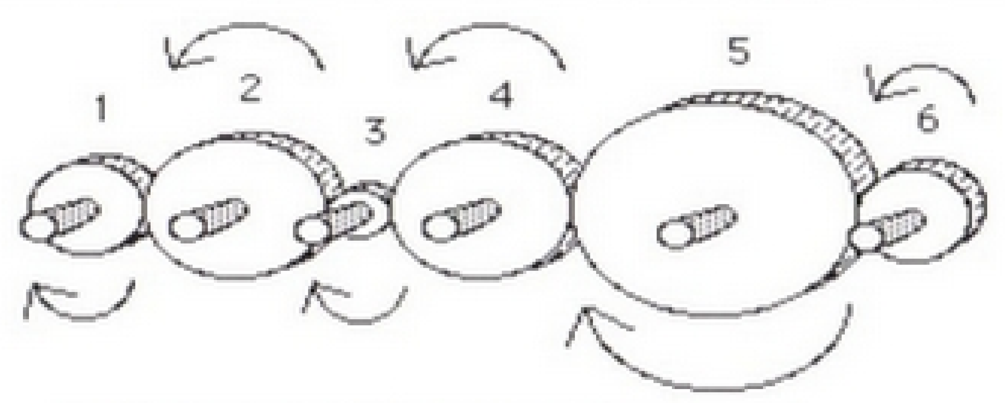
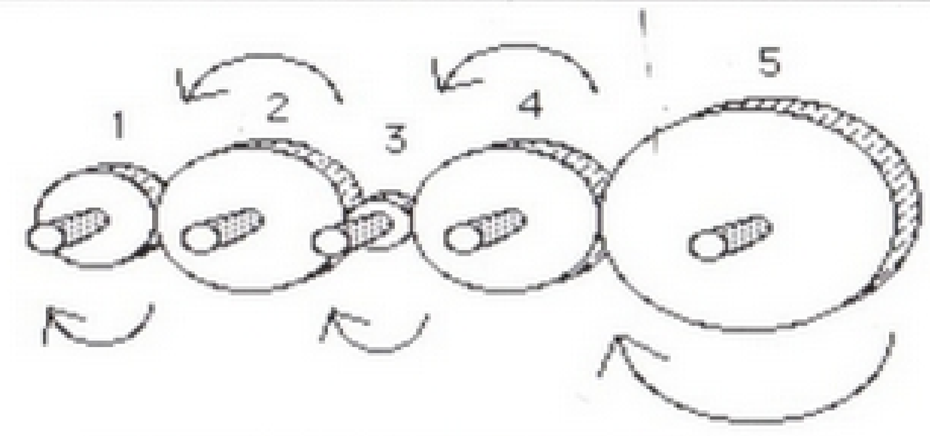


EVEN NUMBER OF GEAR SHAFTS: THE FIRST AND LAST GEAR ROTATE IN THE OPPOSITE DIRECTION.

Figure A

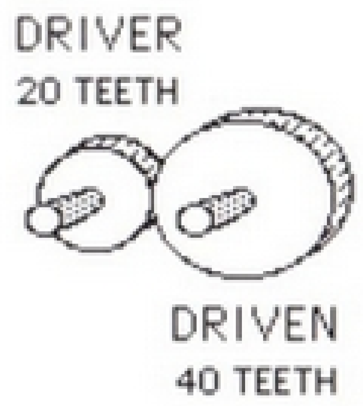


ODD NUMBER OF GEAR SHAFTS: THE FIRST AND LAST GEAR ROTATE IN THE SAME DIRECTION.

Figure B

When there are more than two gears connected together, the system is called a gear train. The number of teeth on a gear effects the number of revolutions of the last gear in a gear system. Relating the number of revolutions of the first gear to the number of revolutions of the last gear is the speed of the gear train..

The gear that causes the motion is the driver gear. The gear to which the motion is transferred is the driven gear. For all types of gears, the following formula applies: **T x N = t x n**



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t = 40 driven teeth	**n** = (20 teeth)(1 revolution) / 40 teeth
n = ?	**n** = 0.5 revolutions

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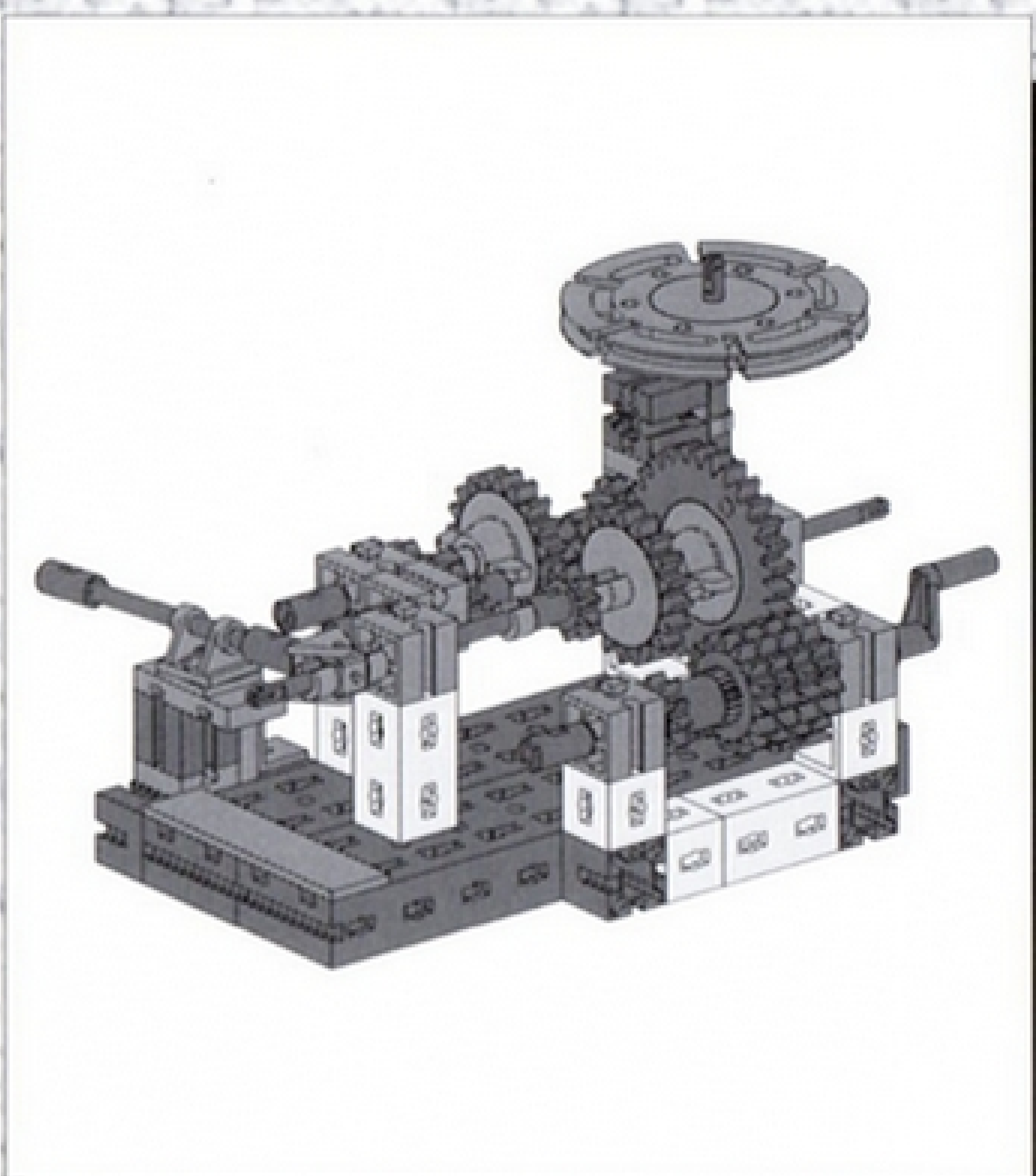
Universal

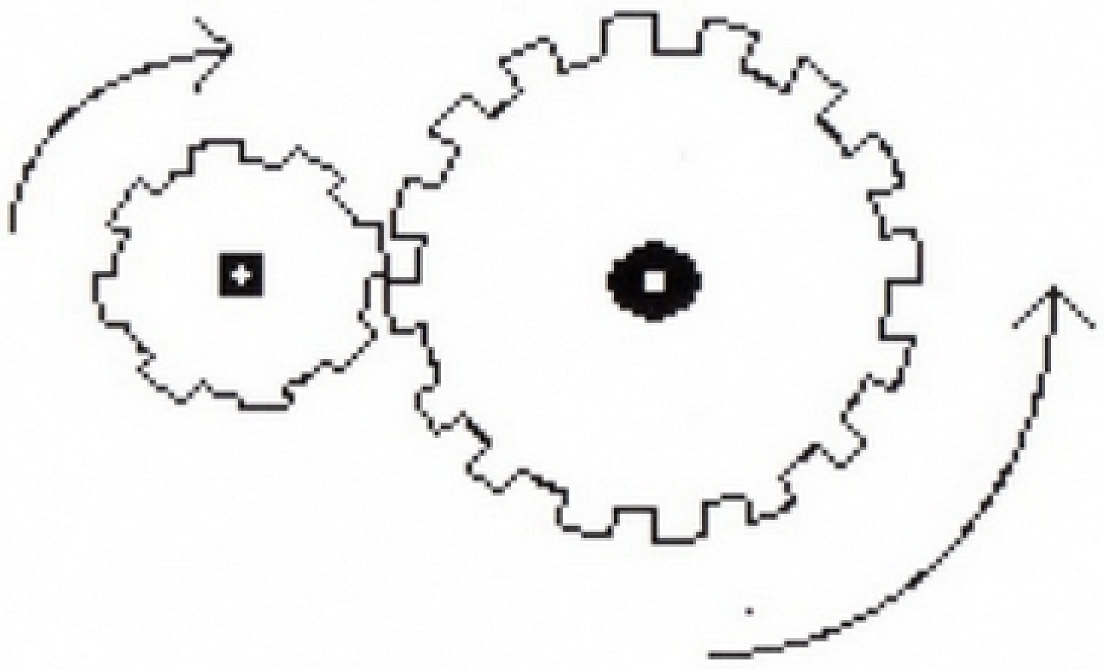


Level 1 Background

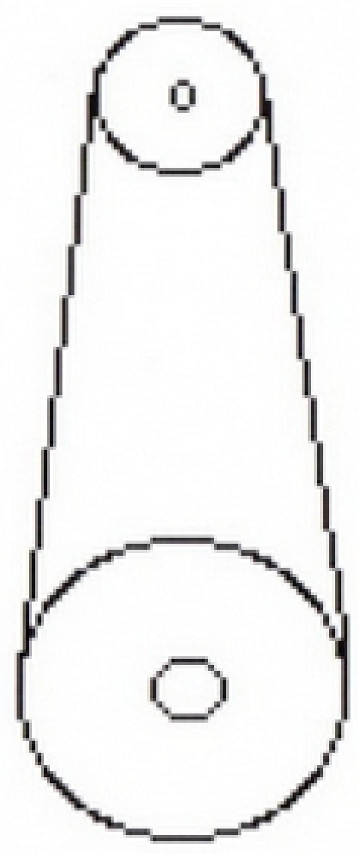
Gears are commonplace in our world. Gears change rotational force, force that is moving in a circular motion. Racing and mountain bikes have gear systems allowing the rear tires to rotate faster or slower than the pedals. The transmission model allows the large red wheel to rotate at different rates. This imitates the transmission of a car.

Gears are a type of simple machine. They transfer rotational motion from one wheel to another. The transfer of energy can be done with gears or belt-driven pulleys.

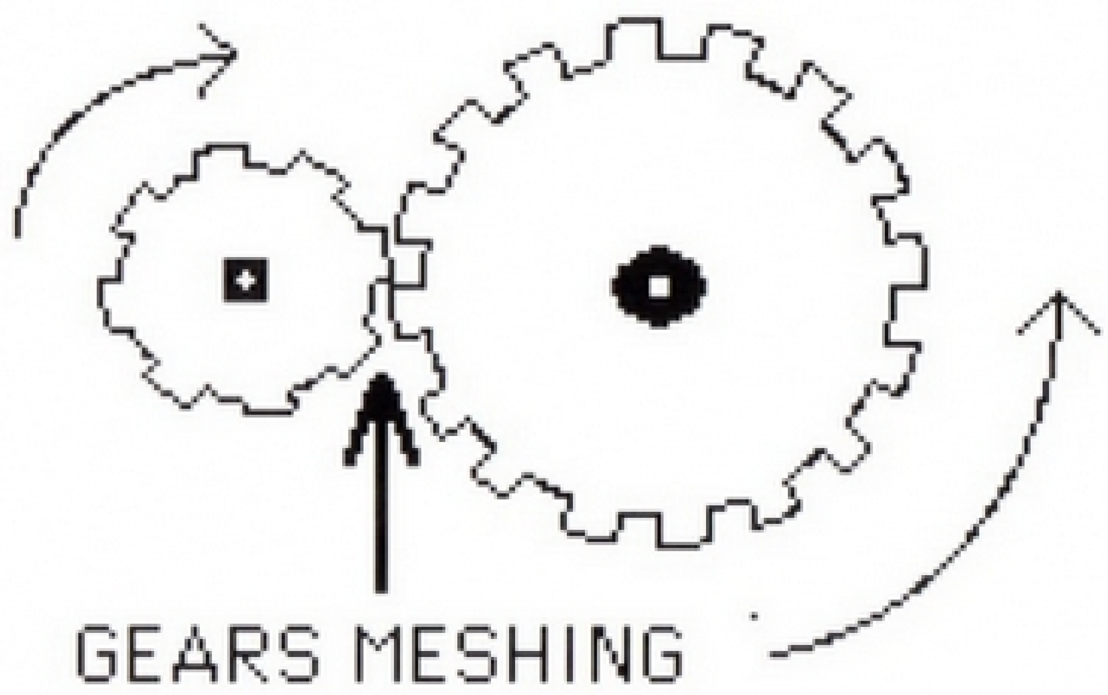
A GEAR SYSTEM



A BELT-DRIVEN PULLEY SYSTEM



Gears are wheels with teeth on them. Gears work by transmitting force from one gear to another where the two gear teeth mesh.



Level 1 Things to do:

1. How many gears are on the transmission?

Looking down at the transmission make sure that the transmission faces the same way as shown in the overhead view on page 35 of the construction manual.

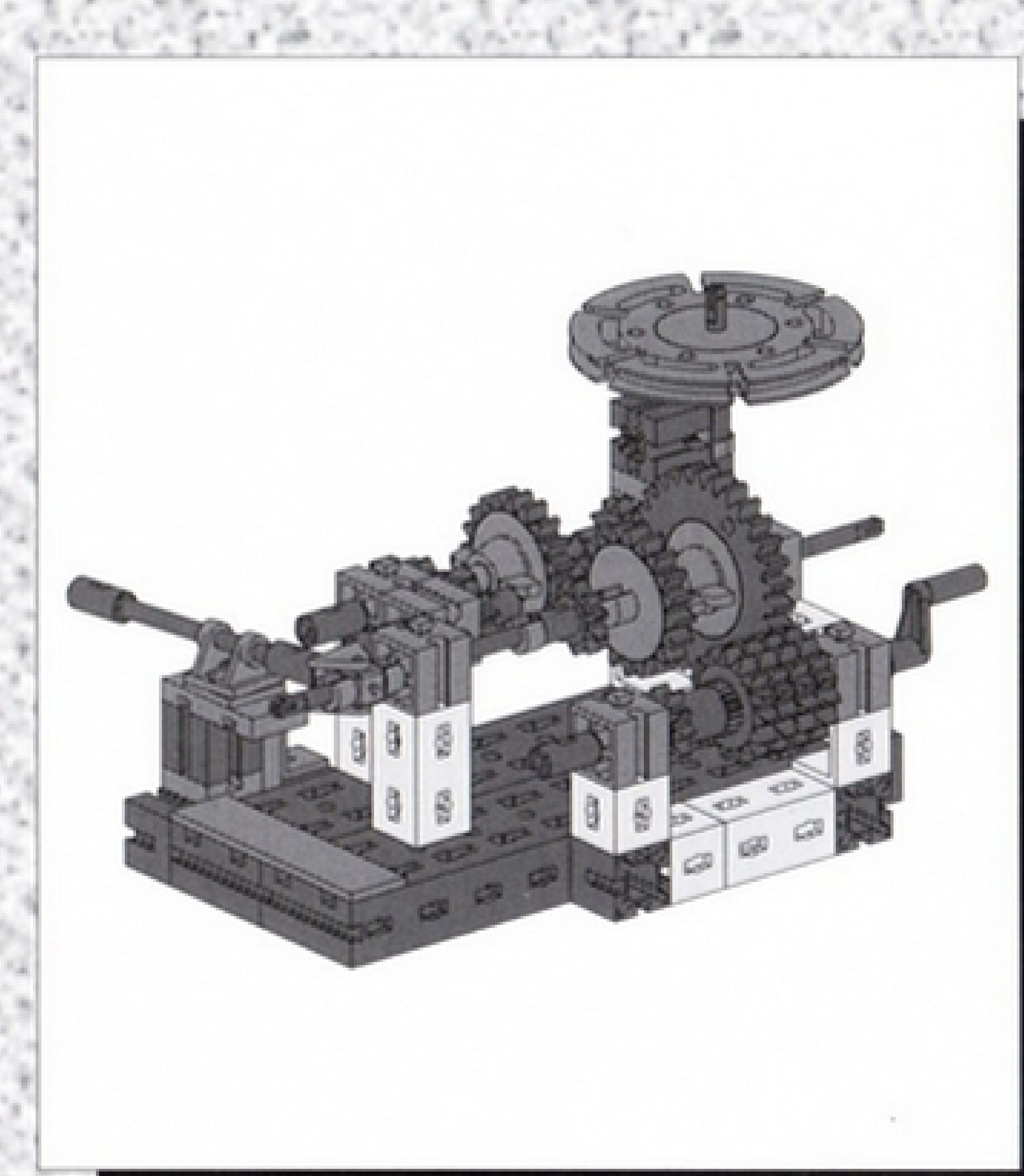
2. Push the lever to the right, turn the handle. What happens to the red wheel?

3. Push the lever to the center, turn the handle. What happens to the red wheel?

4. Push the lever to the middle, turn the handle. What happens to the red wheel?

Now try this...

1. With the handle pushed all the way to the left, which gear or gears would you change to make the red disk spin faster?



Level 2 Things to do:

Looking down at the transmission make sure that the transmission faces the same way as shown in the overhead view on page 35 of the construction manual.

1. Calculate the speed of the red disk in gear 1 , gear 2 and reverse.

Now try this...

1. With the handle pushed all the way to the left, which gear or gears would you change to make the red disk spin faster?

Level 2 Background

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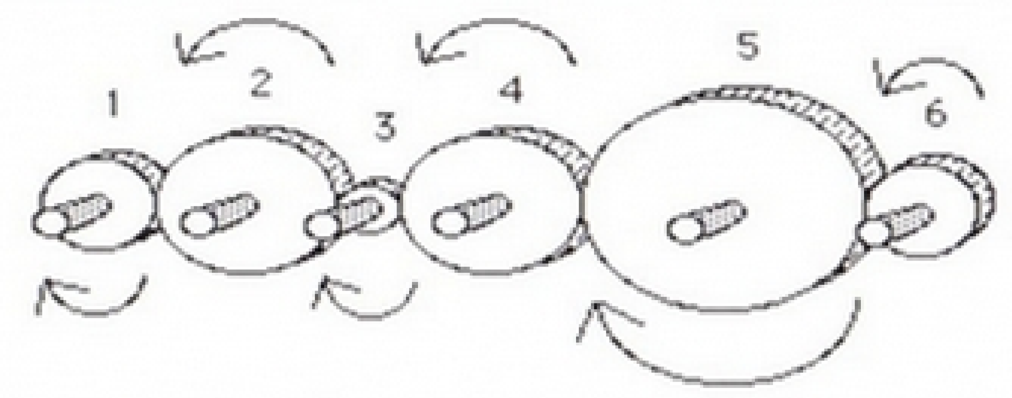
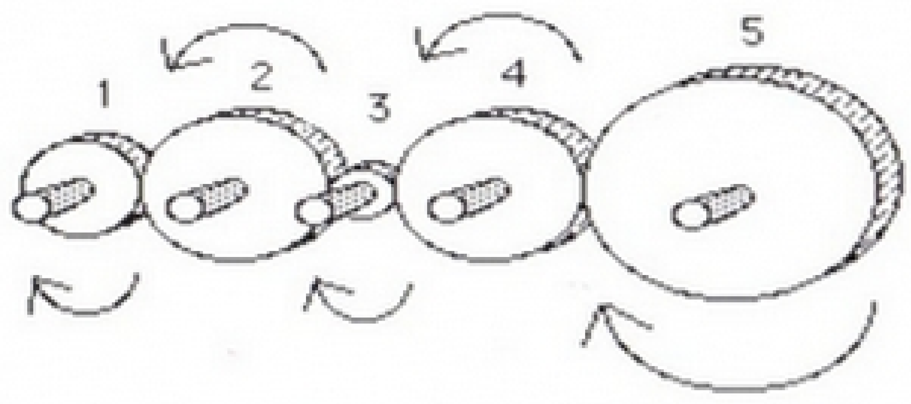


EVEN NUMBER OF GEAR SHAFTS:
THE FIRST AND LAST GEAR ROTATE
IN THE OPPOSITE DIRECTION.

Figure A

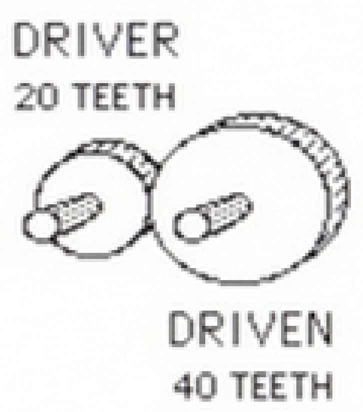


ODD NUMBER OF GEAR SHAFTS:
THE FIRST AND LAST GEAR ROTATE
IN THE SAME DIRECTION.

Figure B

When there are more than two gears connected together, the system is called a gear train. The number of teeth on a gear effects the number of revolutions of the last gear in a gear system. Relating the number of revolutions of the first gear to the number of revolutions of the last gear is the speed of the gear train..

The gear that causes the motion is the driver gear. The gear to which the motion is transferred is the driven gear. For all types of gears, the following formula applies: **T x N = t x n**



T = the number of teeth on the driver
N = the number of revolutions of the driver
t = the number of teeth on the driven gear
n = the number of revolutions of the driven gear.

In the diagram above, let's assume that the driver makes one revolution. We can use the formula to find the number of revolutions the driven gear makes. We substitute:

T = 20 driver teeth	**T x N = t x n**
N = 1 revolution of the driver	**n = T x N / t**
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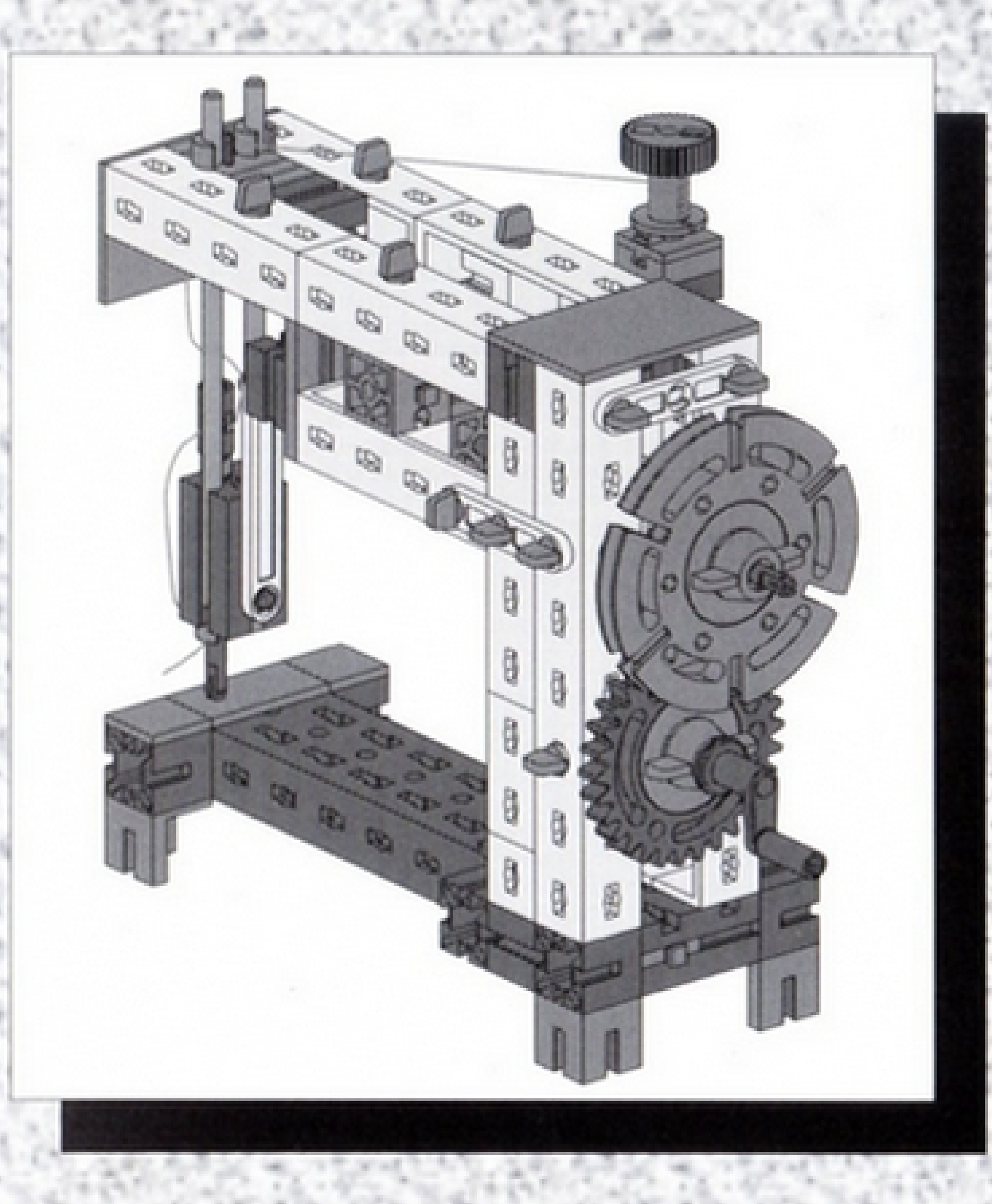
n = ?	**n** = 0.5 revolutions



Level 1 Things to do:

1. Turn the handle clockwise. Which direction does the large gear turn?

2. Which way does the small gear turn?

3. How many times does the needle go up and down when the large gear is turned one time?

Now try this...

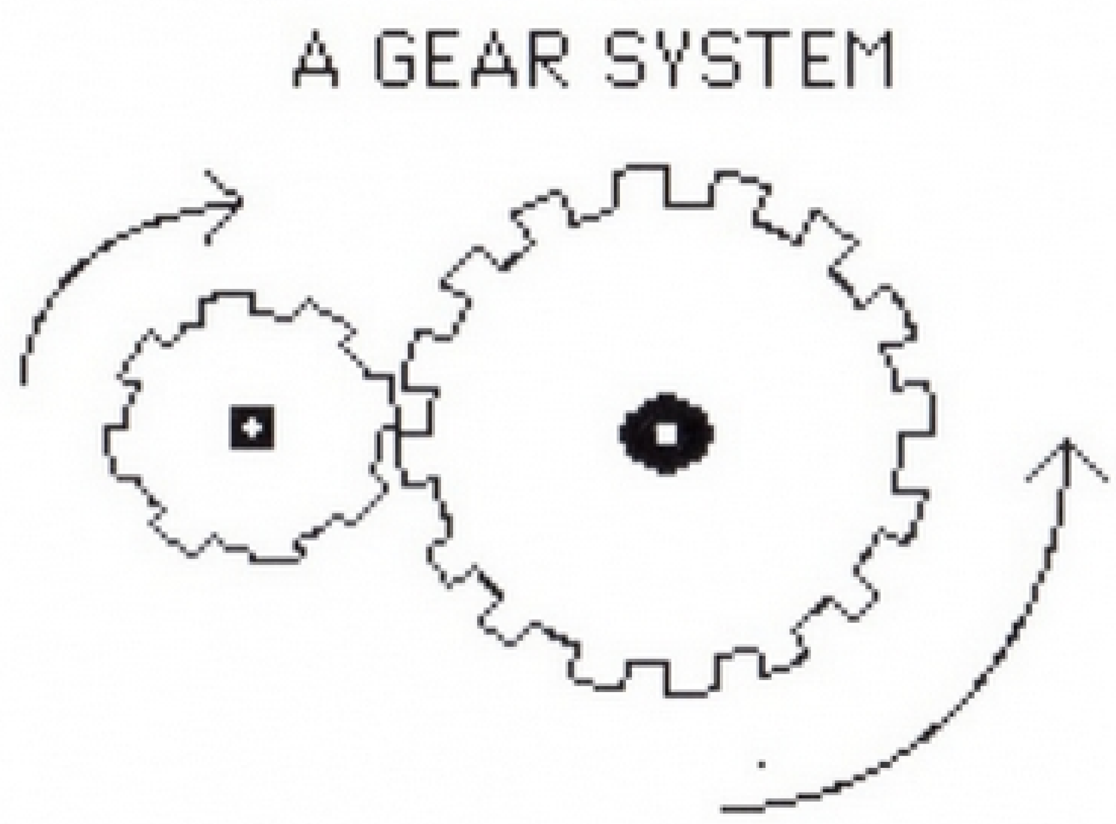
1. Try using the same size gear as the gear attached to the handle. How does this affect the number of times the needle goes up and down?

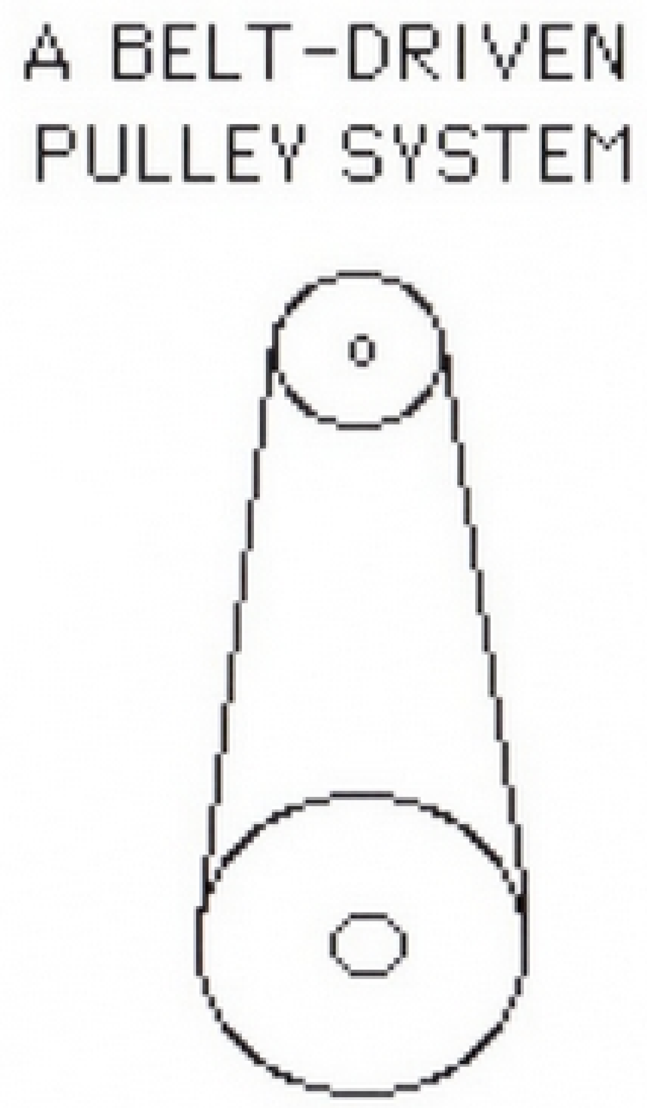
2. Using any of the gears try to make the needle go up and down the fastest. Now try to make the needle go up and down as slow as possible.

Level 1 Background

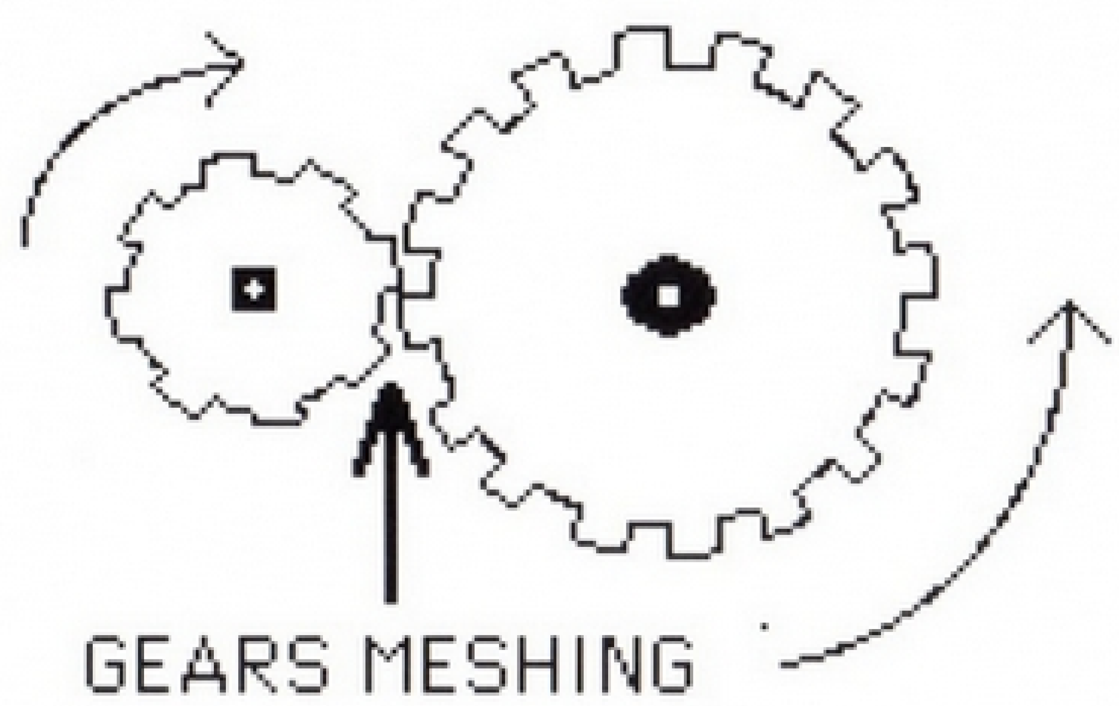
Gears are commonplace in our world. Gears change rotational force, force that is moving in a circular motion. Racing and mountain bikes have gear systems allowing the rear tires to rotate faster or slower than the pedals. In the sewing machine model the gears move the sewing needle up and down. Changing the gears will change the speed of the needle.

Gears are a type of simple machine. They transfer rotational motion from one wheel to another. The transfer of energy can be done with gears or belt-driven pulleys.



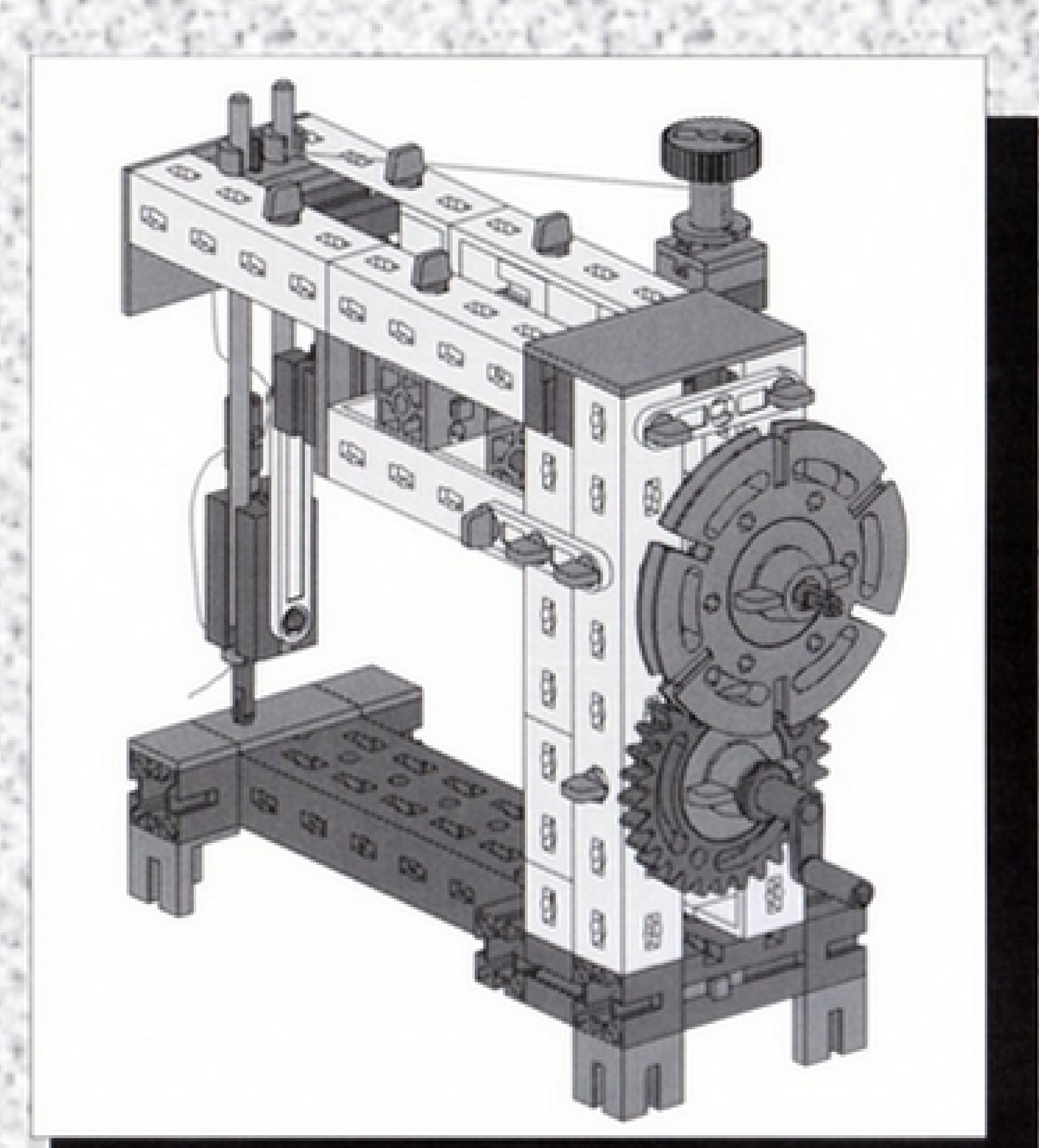


Gears are wheels with teeth on them. Gears work by transmitting force from one gear to another where the two gear teeth mesh.



Sewing Machine

Universal



Level 2 Things to do:

1. Turn the handle clockwise. How many teeth does the driver gear have?

2. How many teeth does the driven gear have? What is the gear ratio for these two gears?

3. Does the needle go up and down the same number of times as the driven gear spins? Why or why not?

Now try this...

1. Using all the gears you have, build and calculate a gear ratio that will make the needle go up and down the fastest?

2. Now calculate a gear ratio that makes the needle go up and down the slowest

Level 2 Background

Gears can change the direction of motion from clockwise to counter-clockwise. This applies to all gear systems in a straight row. If the number of gear shafts is even, the motion will be opposite that of the first gear (figure A). If the number of gear shafts is odd, then the direction of motion will be the same as the first gear (figure B).

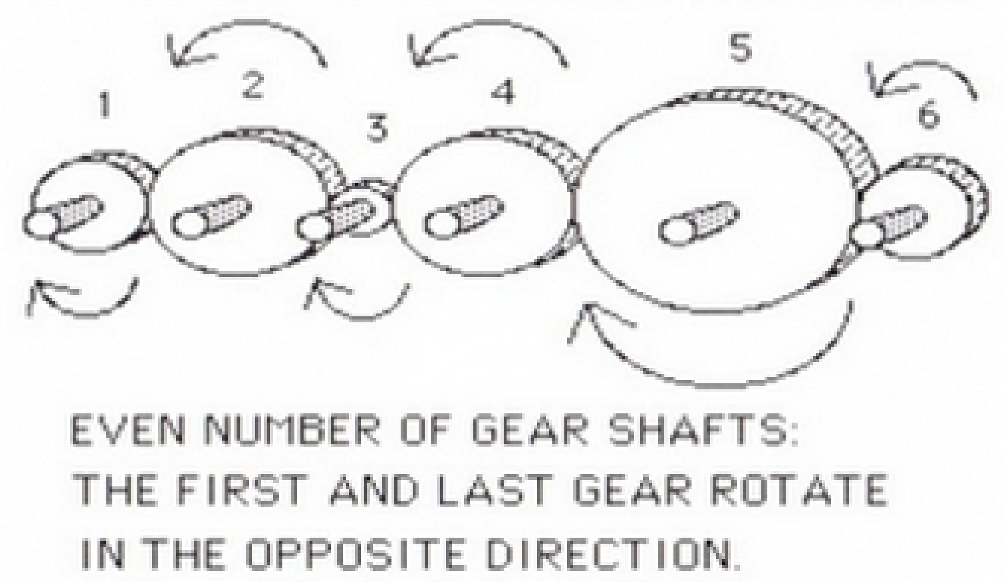


Figure A

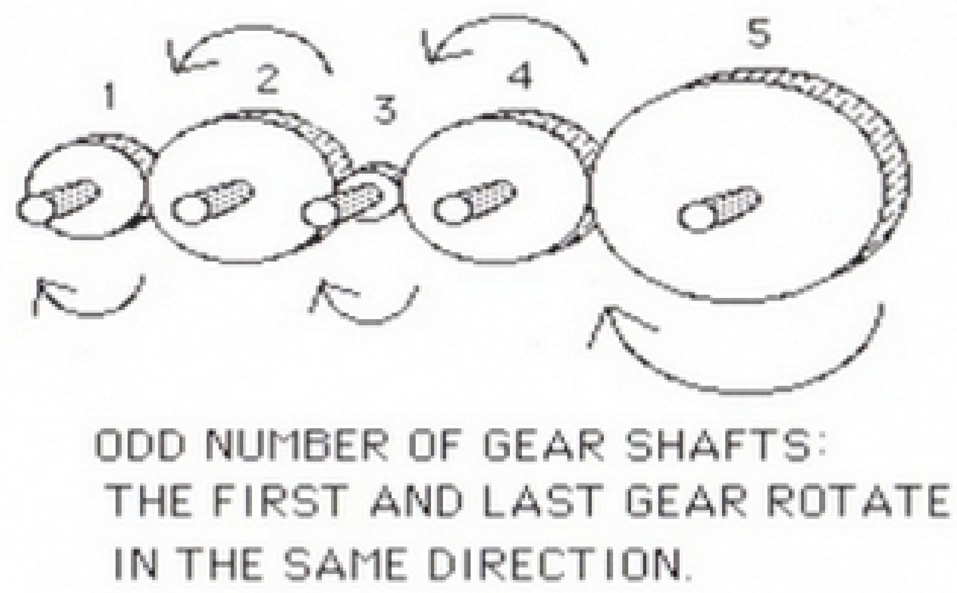


Figure B

When there are more than two gears connected together, the system is called a gear train. The number of teeth on a gear effects the number of revolutions of the last gear in a gear system. Relating the number of revolutions of the first gear to the number of revolutions of the last gear is the speed of the gear train..

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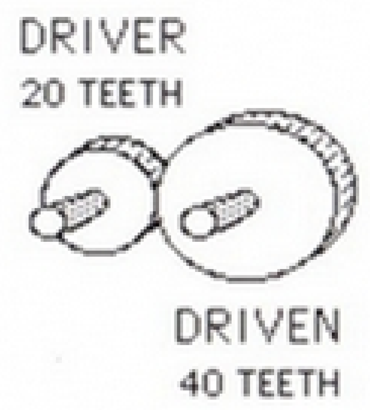

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N = 1 revolution of the driver	**n = T x N / t**
t = 40 driven teeth	**n** = (20 teeth)(1 revolution) / 40 teeth
n = ?	**n** = 0.5 revolutions

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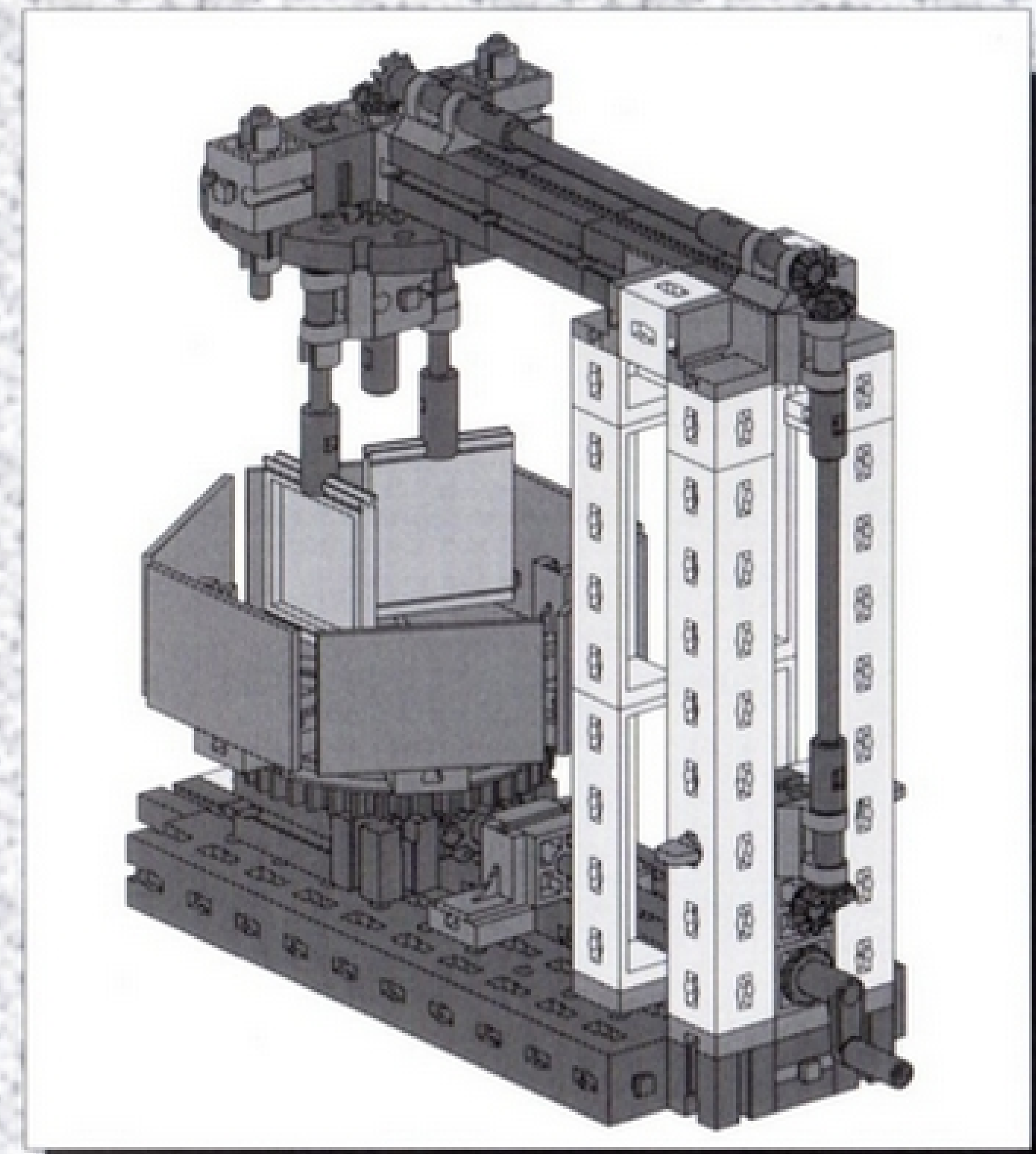
Food Processor

Universal



Level 1 Things to do:

1. Turn the handle clockwise. Which direction does the large gear turn?
2. Which way does the small gear turn?
3. How many times does the food processor base turn when the large gear is turned one time?

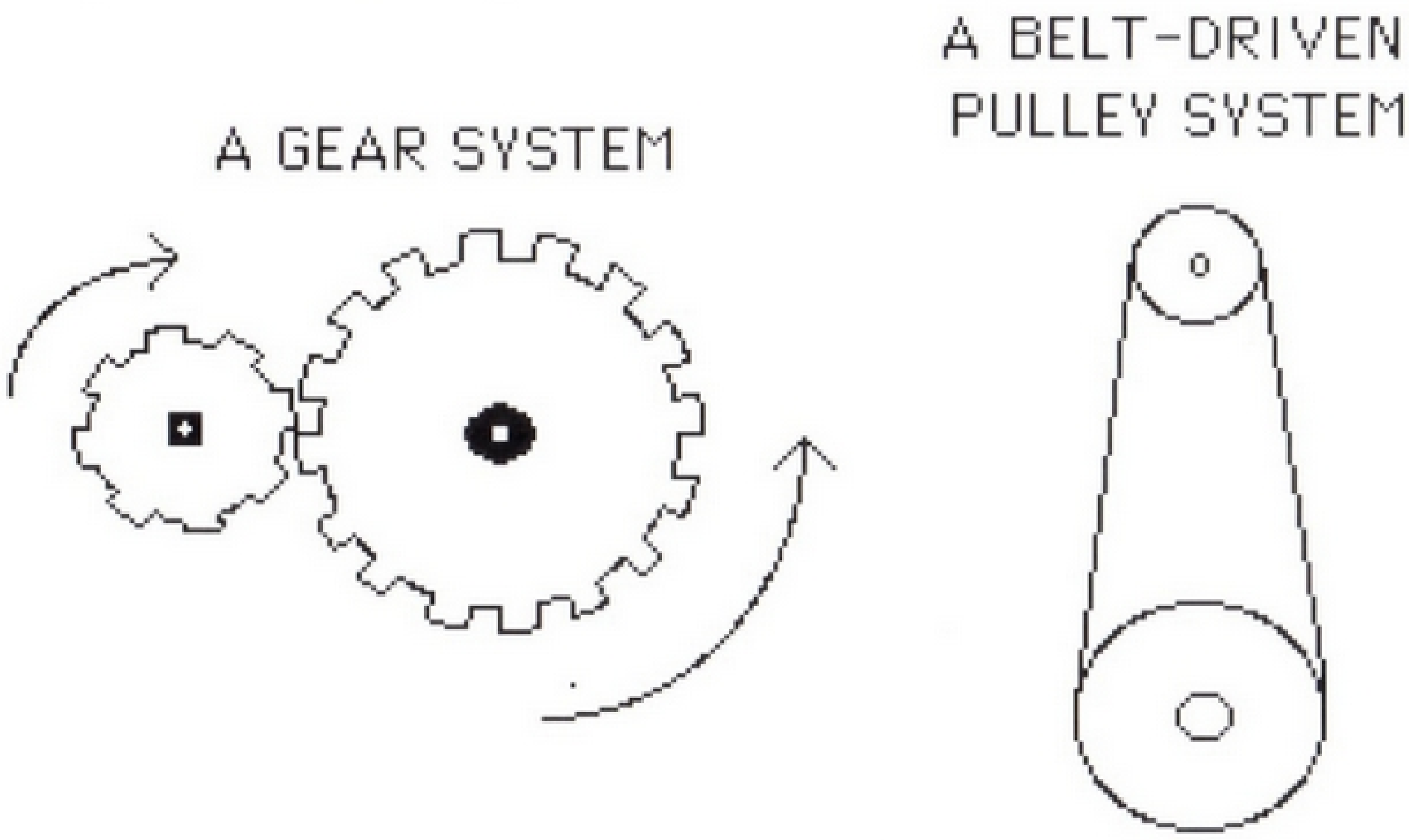
Now try this...

1. What would happen if the gear that pushes the bowl had twice as many teeth?

Level 1 Background

Gears are commonplace in our world. Gears change rotational force, force that is moving in a circular motion. Racing and mountain bikes have gear systems allowing the rear tires to rotate faster or slower than the pedals. This model imitates a food processor and its mixing blades. Changing the gears will affect how fast the blades turn.

Gears are a type of simple machine. They transfer rotational motion from one wheel to another. The transfer of energy can be done with gears or belt-driven pulleys.



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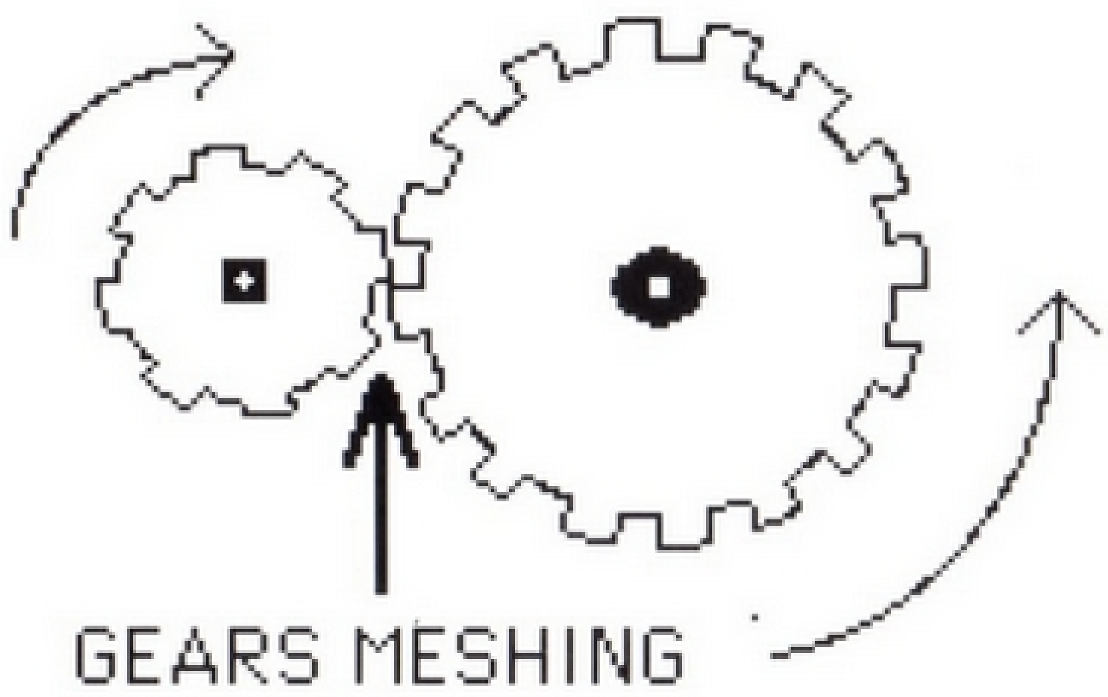
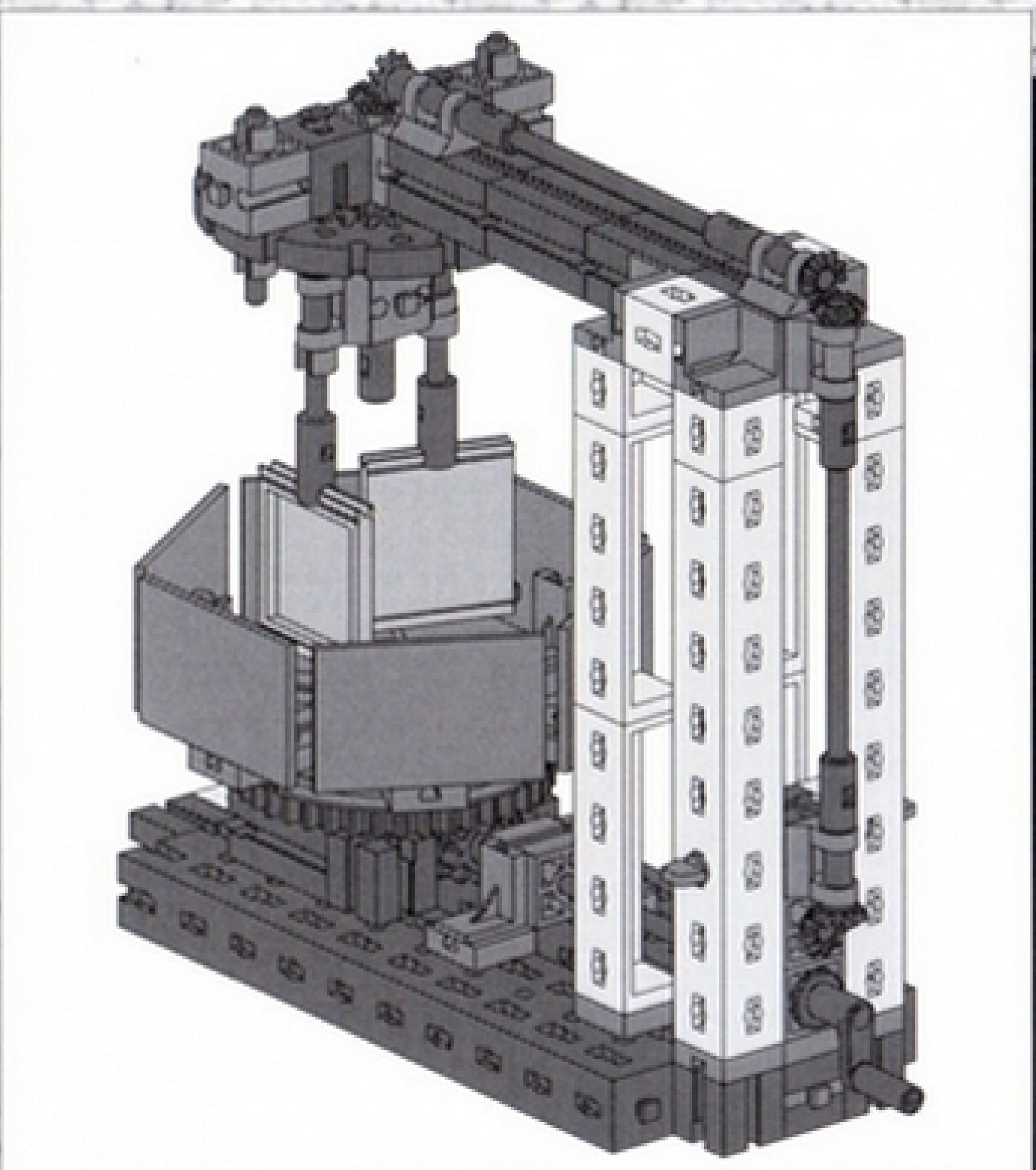


Food Processor

Universal



Level 2 Things to do:

1. Turn the handle clockwise. How many teeth does the driver gear have?

2. How many teeth does the driven gear have? What is the gear ratio for these two gears?

3. Does the food processor base turn the same number of times as the driven gear turns? Why or why not?

Now try this...

1. Using all the gears you have, build and calculate a gear ratio that will make the food processor bowl spin slower.

Level 2 Background

Gears can change the direction of motion from clockwise to counter-clockwise. This applies to all gear systems in a straight row. If the number of gear shafts is even, the motion will be opposite that of the first gear (figure A). If the number of gear shafts is odd, then the direction of motion will be the same as the first gear (figure B).

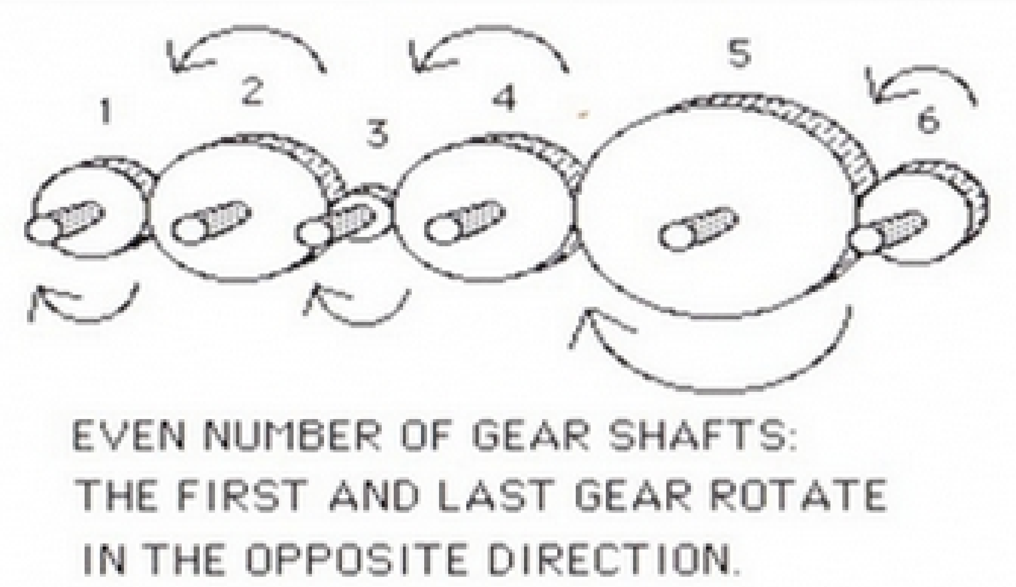


Figure A

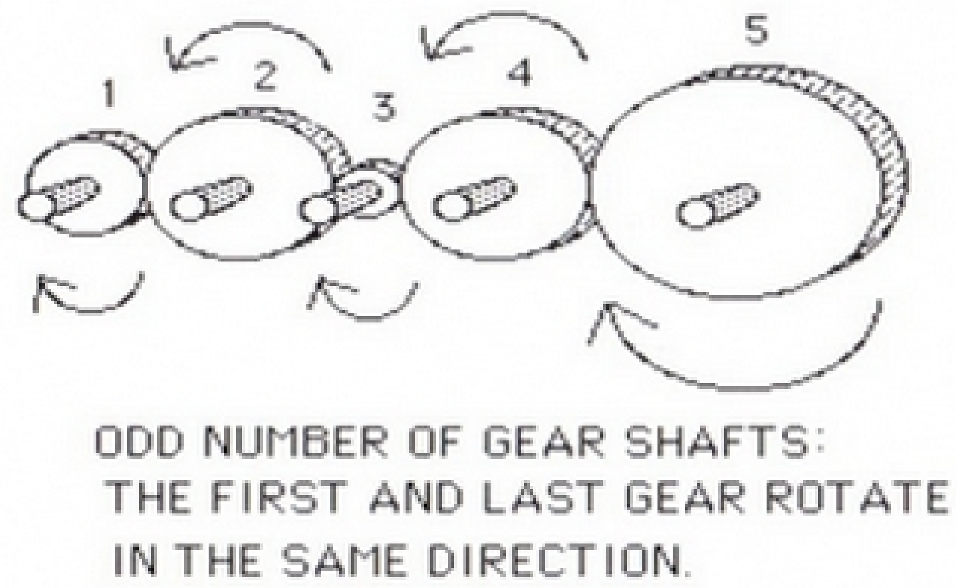


Figure B

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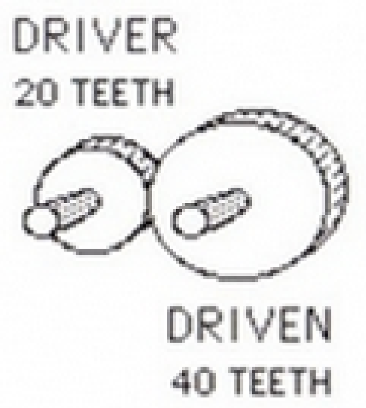

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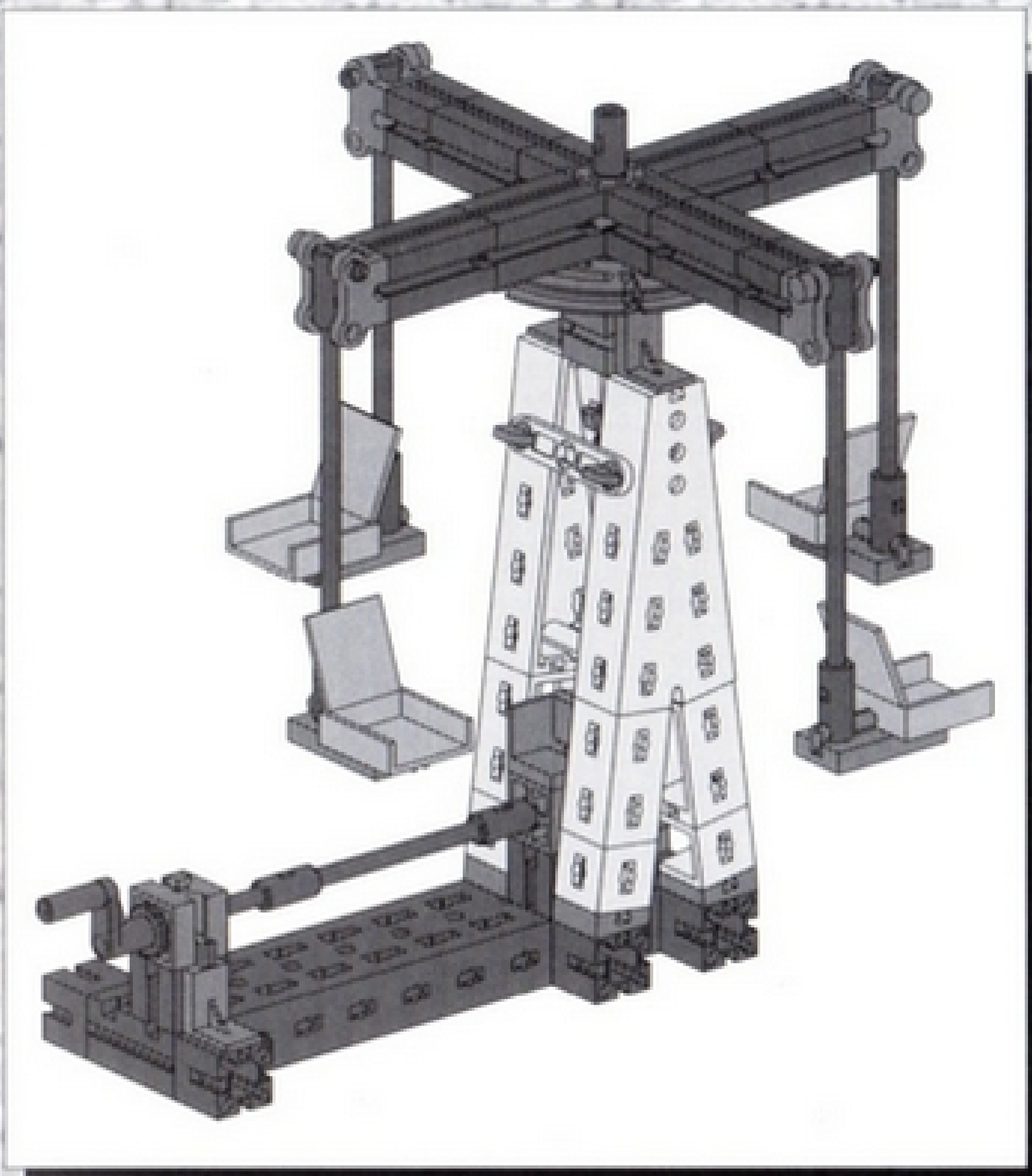
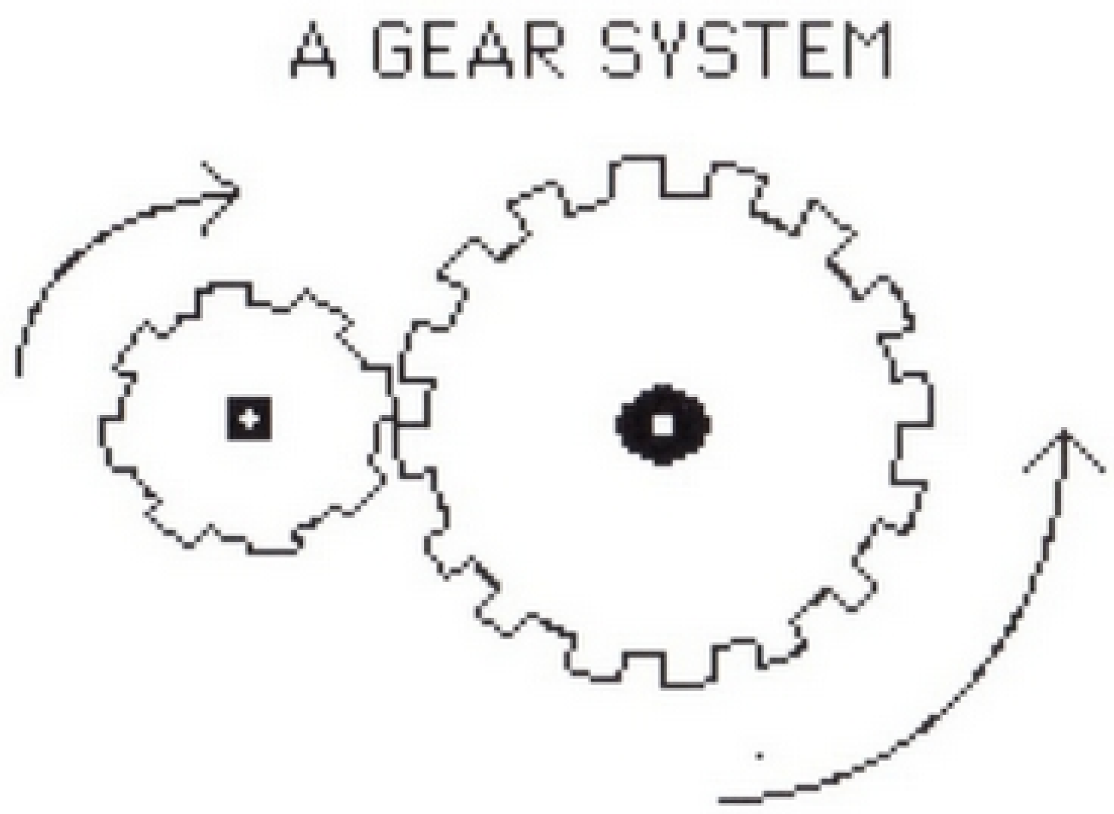
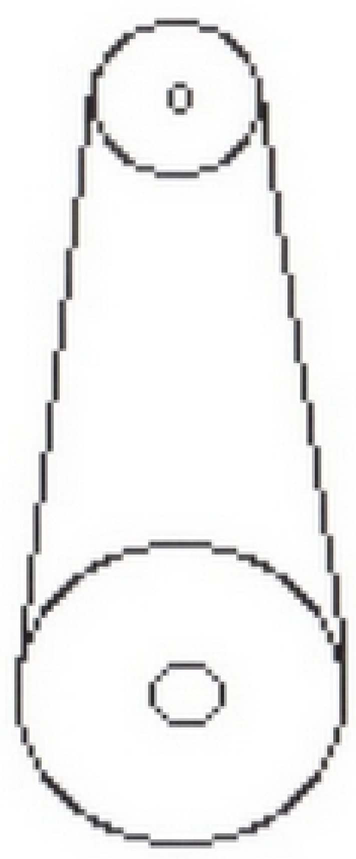


Level 1 Background

Gears are commonplace in our world. Gears change rotational force, force that is moving in a circular motion. Racing and mountain bikes have gear systems allowing the rear tires to rotate faster or slower than the pedals. This model imitates a flying swings ride. Changing the gears will affect how fast the swings rotate.

Gears are a type of simple machine. They transfer rotational motion from one wheel to another. The transfer of energy can be done with gears or belt-driven pulleys.





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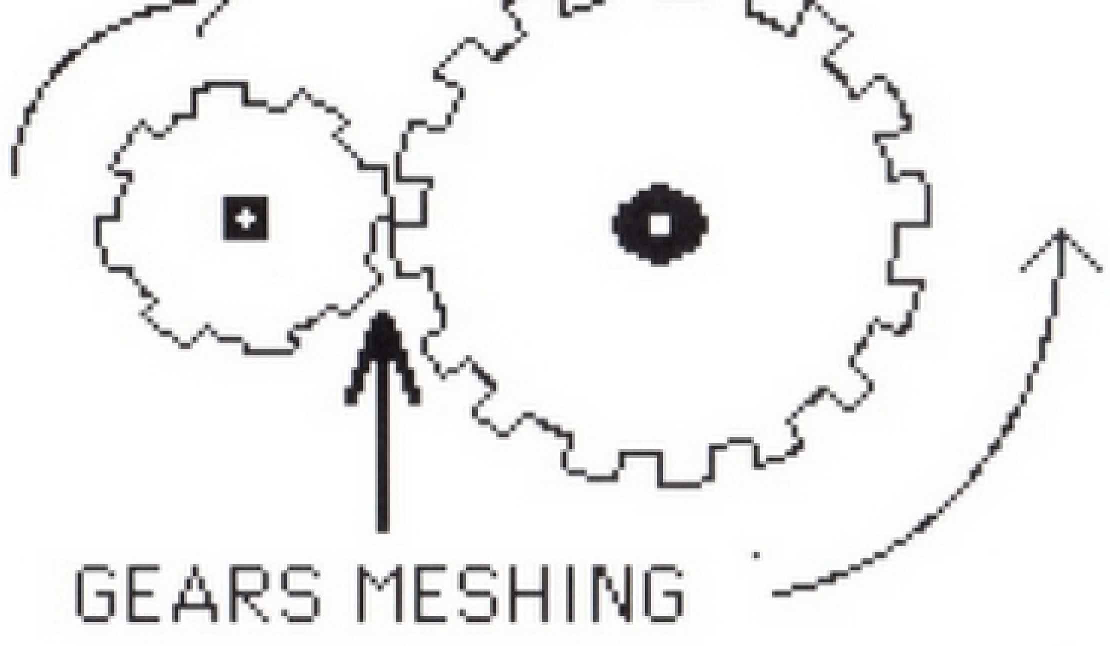


Level 1 Things to do:

1. Turn the handle one time. How many times does the flying swings turn?

2. Turn the handle clockwise. Which direction does the flying swings turn?

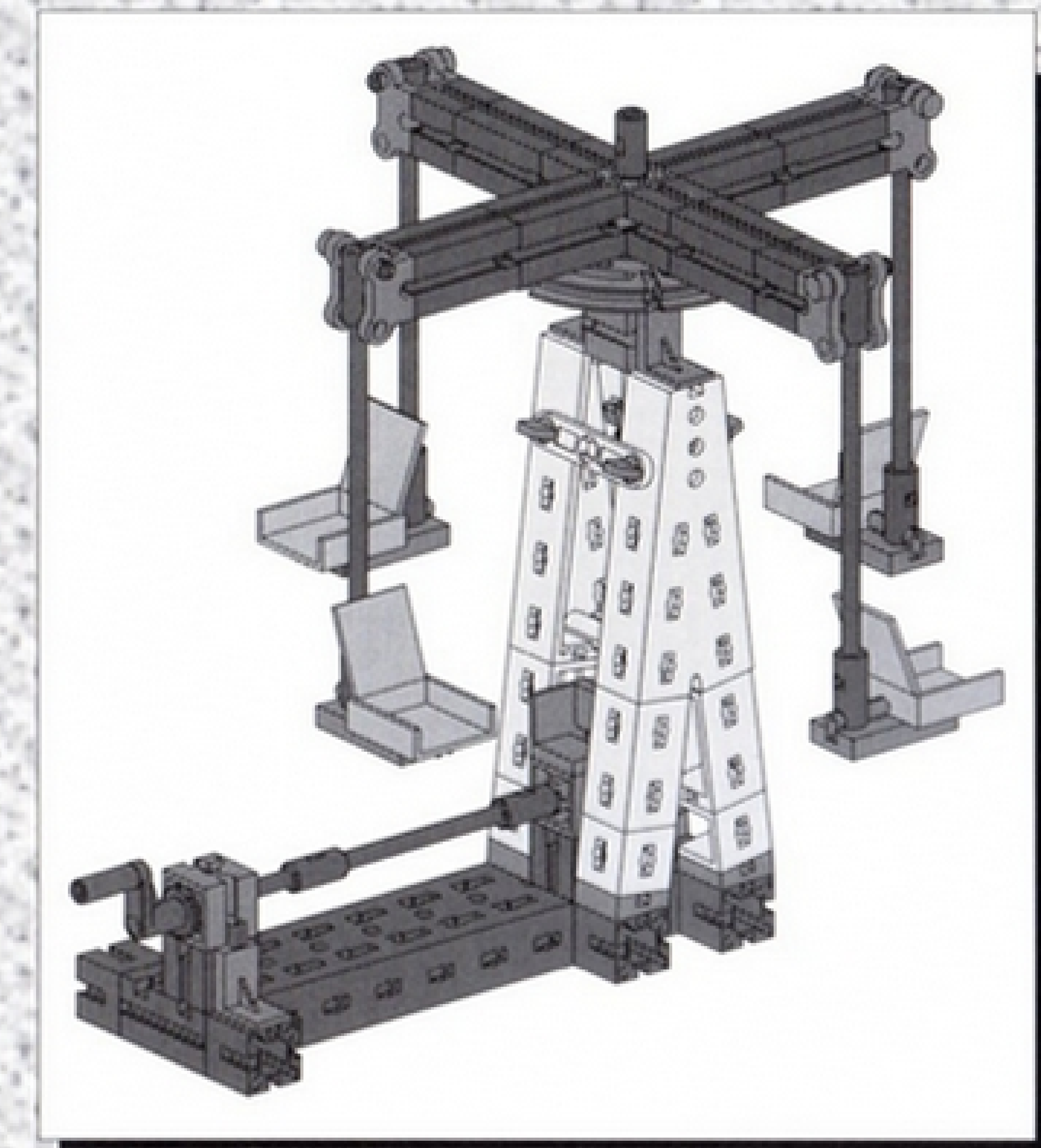
3. Turn the handle counter clockwise. Which direction does the flying swings turn?

Now try this...

Motorized only

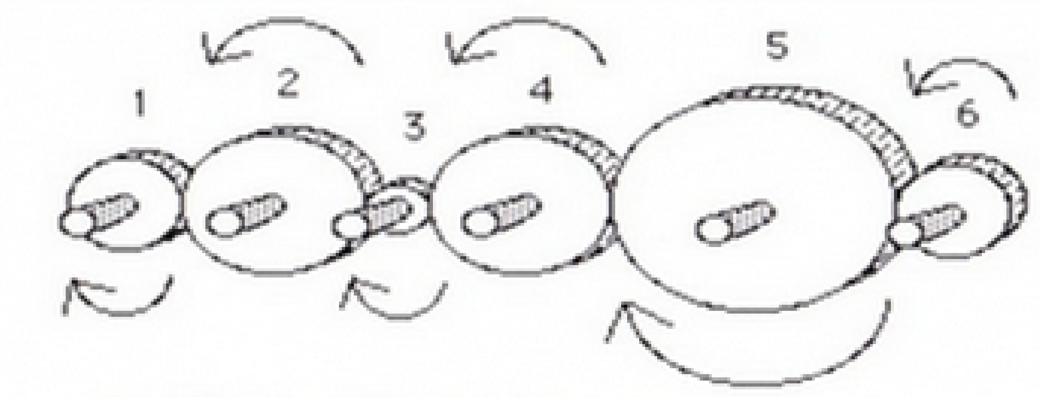
1. Using the gears you have in your kit make the flying swings spin as fast as possible.

2. Now try to make the flying swings spin as slow as possible.



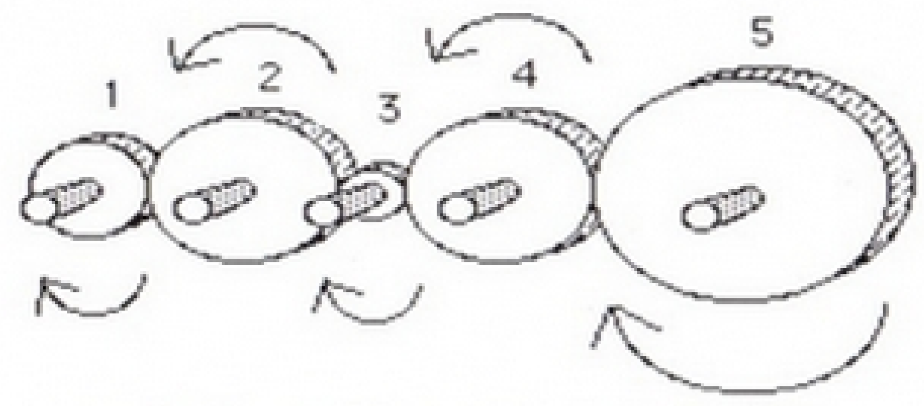
Level 2 Background

Gears can change the direction of motion from clockwise to counter-clockwise. This applies to all gear systems in a straight row. If the number of gear shafts is even, the motion will be opposite that of the first gear (figure A). If the number of gear shafts is odd, then the direction of motion will be the same as the first gear (figure B).



EVEN NUMBER OF GEAR SHAFTS:
THE FIRST AND LAST GEAR ROTATE
IN THE OPPOSITE DIRECTION.

Figure A

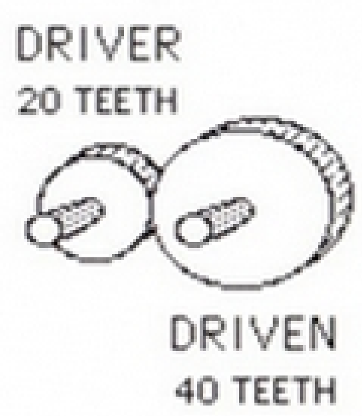


ODD NUMBER OF GEAR SHAFTS:
THE FIRST AND LAST GEAR ROTATE
IN THE SAME DIRECTION.

Figure B

When there are more than two gears connected together, the system is called a gear train. The number of teeth on a gear effects the number of revolutions of the last gear in a gear system. Relating the number of revolutions of the first gear to the number of revolutions of the last gear is the speed of the gear train..

The gear that causes the motion is the driver gear. The gear to which the motion is transferred is the driven gear. For all types of gears, the following formula applies: **T x N = t x n**



T = the number of teeth on the driver
N = the number of revolutions of the driver
t = the number of teeth on the driven gear
n = the number of revolutions of the driven gear.

In the diagram above, let's assume that the driver makes one revolution. We can use the formula to find the number of revolutions the driven gear makes. We substitute:

T = 20 driver teeth	**T x N = t x n**
N = 1 revolution of the driver	**n = T x N / t**
t = 40 driven teeth	**n** = (20 teeth)(1 revolution) / 40 teeth
n = ?	**n** = 0.5 revolutions

Level 2 Things to do:

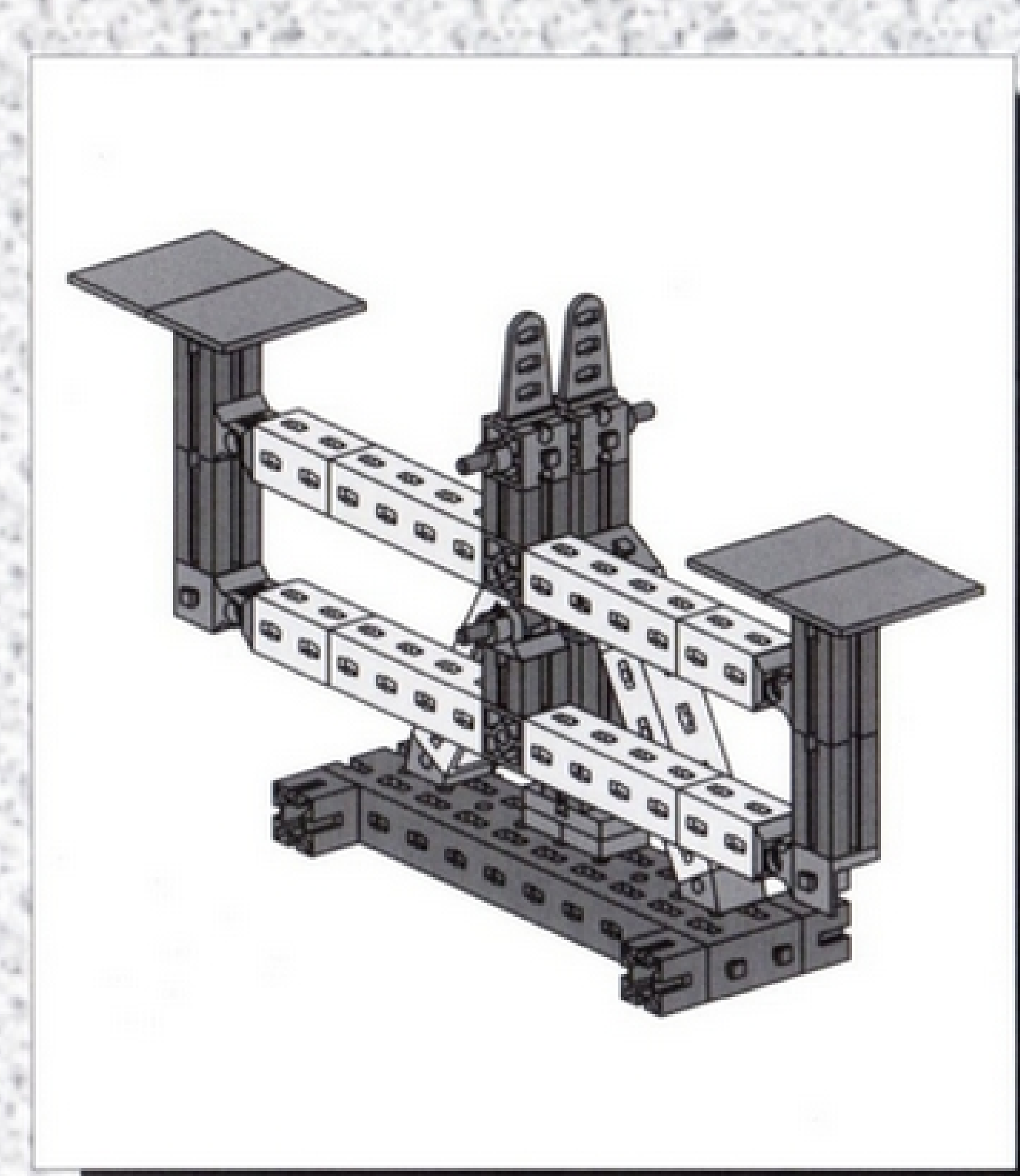
1. Turn the handle one time. How many times does the flying swings turn?

2. What is the gear ratio for the flying swings ride?

Now try this...

1. This ride has special gears called bevel gears. Look at them closely can you determine what a beveled gear does?

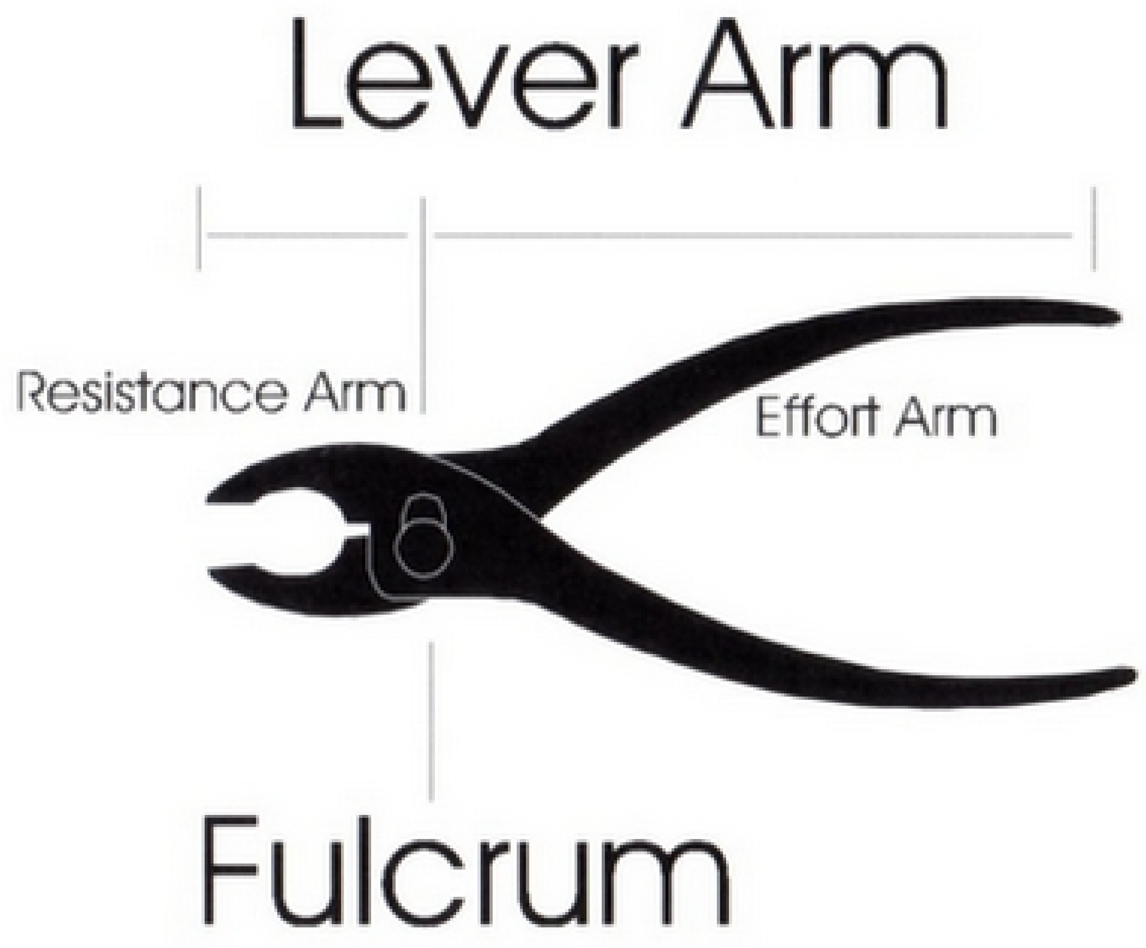
2. How would you change the MA for the flying swings ride? Can you do this with the gears in your kit?



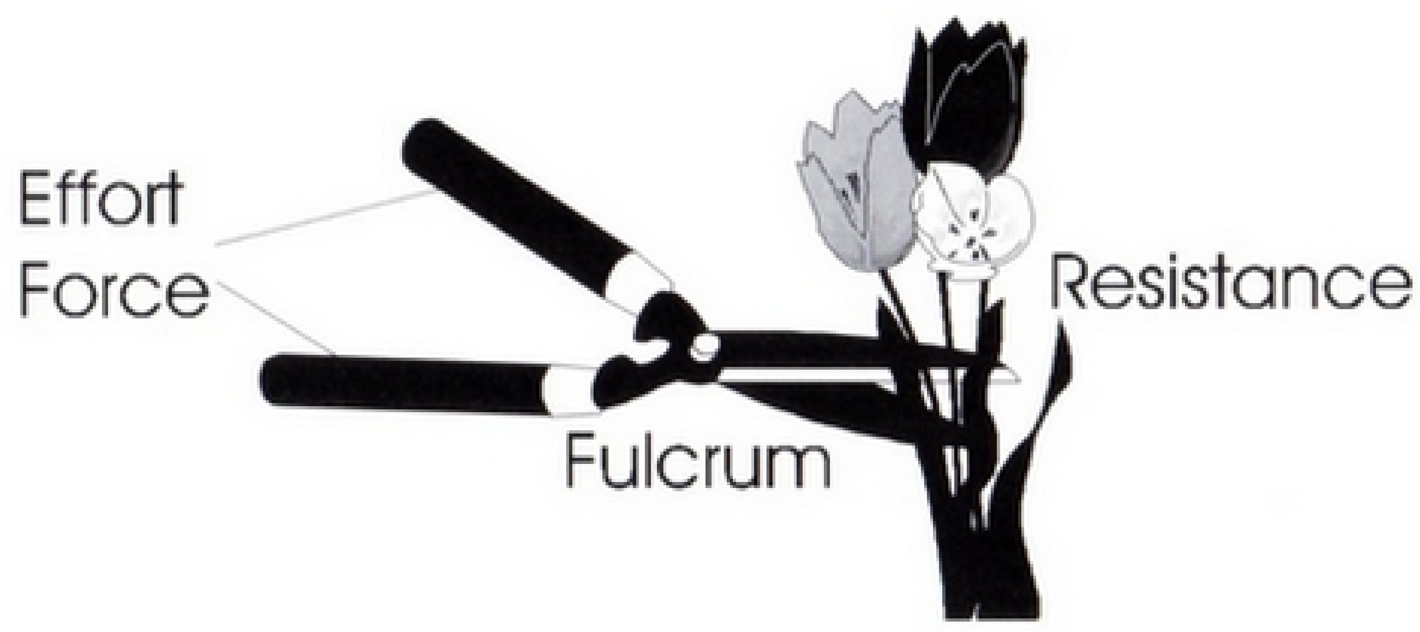
Level 1 Background

Levers are an example of a simple machine. Brooms, tennis rackets, seesaws, scissors, and wheel barrows are all types of levers. The postal scale is also a lever. The resistance is placed on the red pan. The effort force is the black and red weight wheel. The weight wheel moves when the resistance force is applied.

A lever consists of a lever arm and a pivot point, called a fulcrum. The lever arm is made up of a resistance arm and an effort arm.



In every machine there are two forces, the effort force and the resistance force. The effort force is the force applied to the machine. The resistance force is the force overcome by the machine. An example of a lever is using a pair of pruning shears to cut flowers.



In the diagram above, the effort force is applied to each of the handles. The resistance force is the stems of the flowers. The fulcrum is the bolt that holds the shears together.

Level 1Things to do:

1. Place 10 pennies on one of the pans on the balance beam scale. Draw a picture of the scale and label the resistance force, fulcrum and effort force.
2. Place pennies one the other pan until the balance beam scale is balanced. How many pennies did it take to balance the scale?
3. How did you know the scale was balanced?

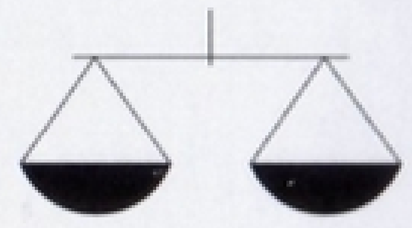
Now try this...

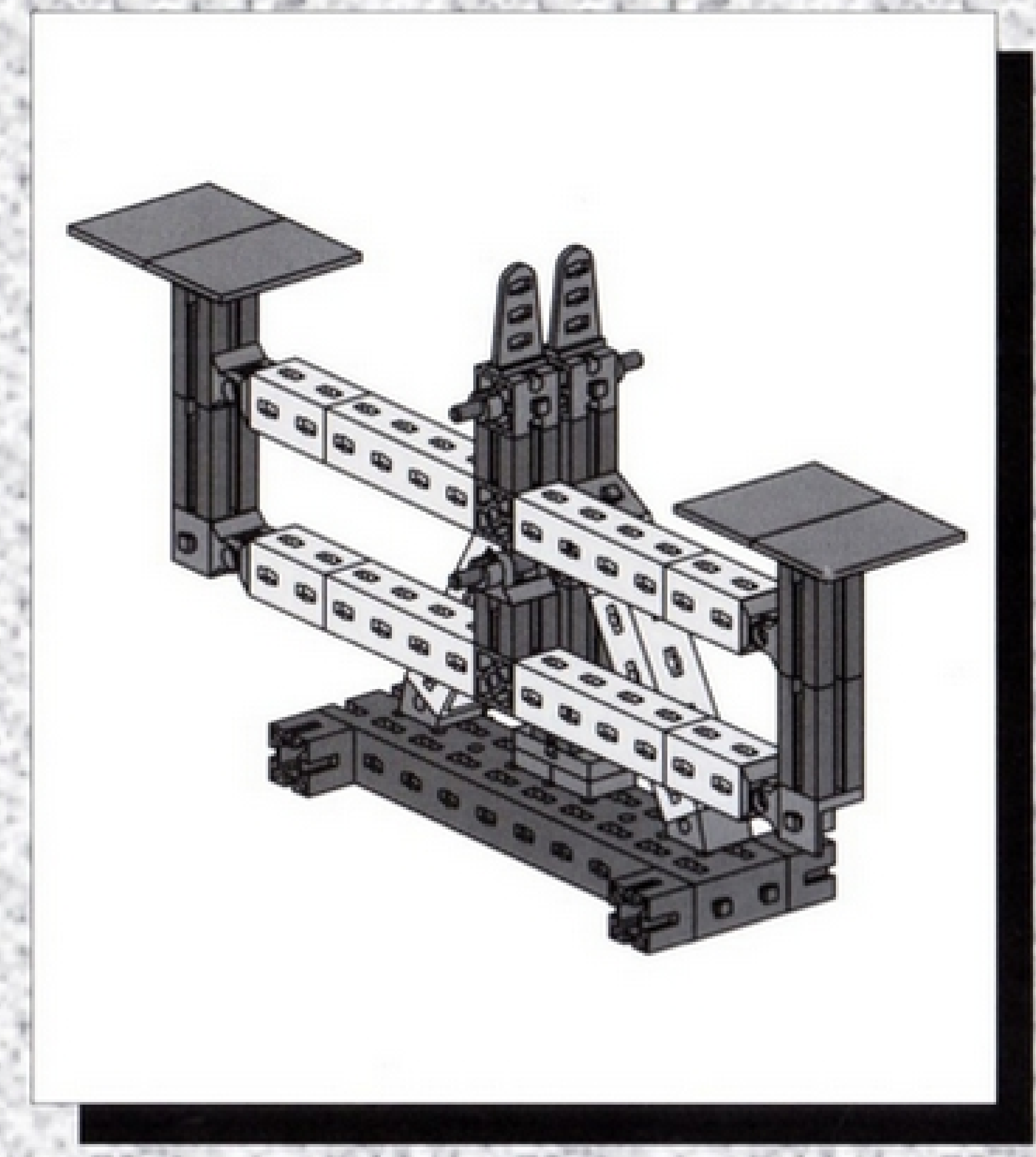
Try 3 pennies, then 6 and finally 9 pennies on the resistance side. Find out how many pennies it will take to balance each the new resistance forces.

1. Are there any patterns between the resistance forces and effort forces?

Balance Beam Scale

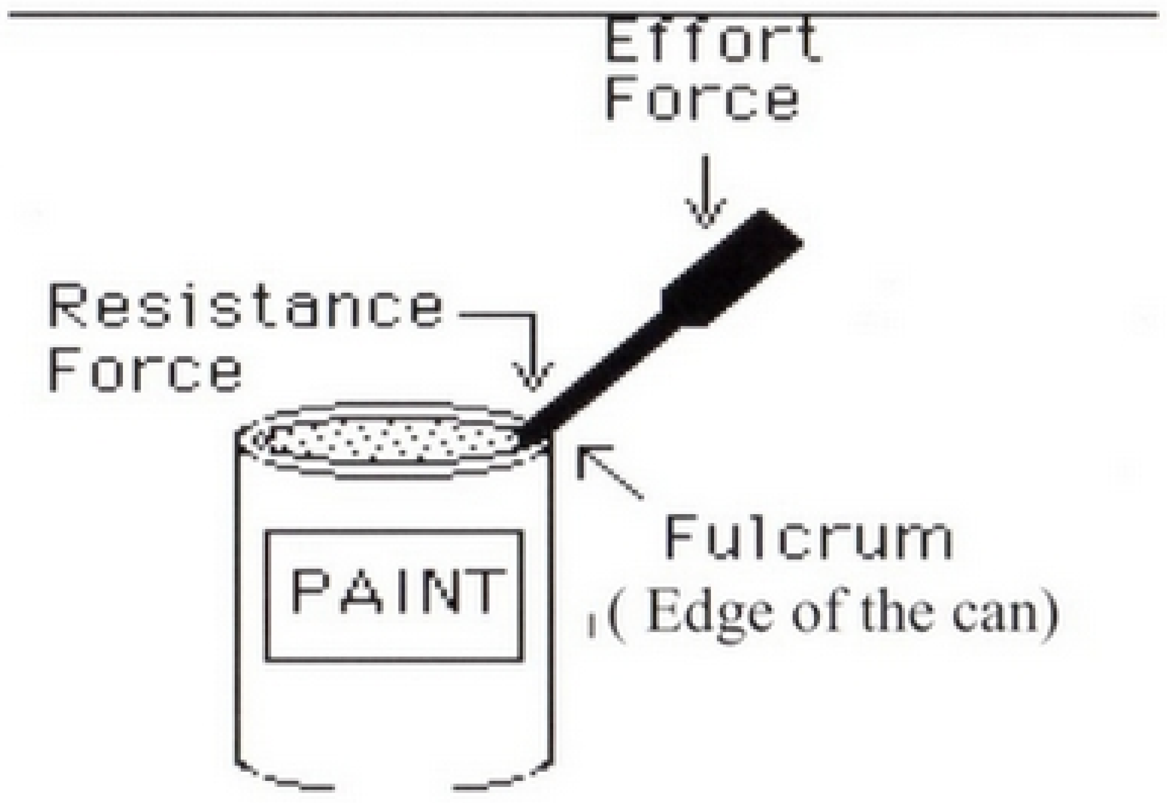
Universal





Level 2 Background

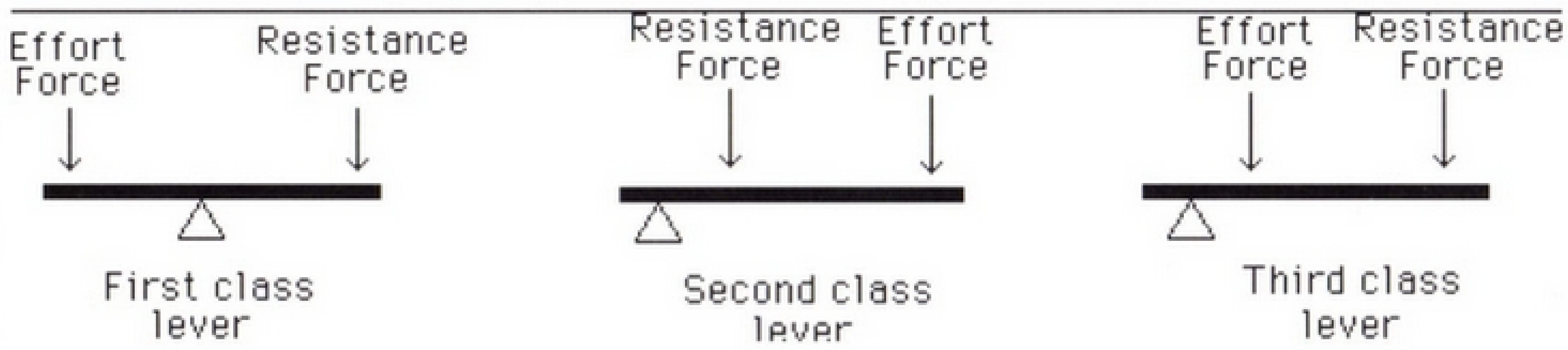
Levers are an example of a simple machine. Brooms, tennis rackets, seesaws, scissors, and wheel barrows are all types of levers. Balance beam scale is also a lever. The resistance is placed on one of the sides of the balance scale. The effort force is placed on the opposite pan. The resistance force and effort force are balanced when the red pans are at the same height.



The effort side of the lever is called an effort arm. The effort arm is from the fulcrum to the effort force. The side of the lever with the resistance force is called the resistance arm. The resistance arm is the distance from the fulcrum to the resistance force. All levers have mechanical advantage. Mechanical advantage is related to the amount of effort force you will need to overcome the resistance force of the machine. The mechanical advantage for levers is the ratio of the effort arm to the resistance arm.

MA Lever = Effort Arm/Resistance Arm

Levers are divided into three classes. First class levers have the resistance force on one side of the fulcrum and the effort force on the other side. Second class levers have the fulcrum at one end and the resistance force in between the effort force and the fulcrum. A third class lever has the fulcrum at the end and the effort force in between the fulcrum and the resistance force.



Level 2 Things to do:

1. Place 10 pennies on one of the pans on the balance beam scale. Draw a picture of the scale and label the resistance force, fulcrum and effort force.
2. What class lever is this?
3. Measure the effort and resistance arms. What is the mechanical advantage for this machine?

Now try this...

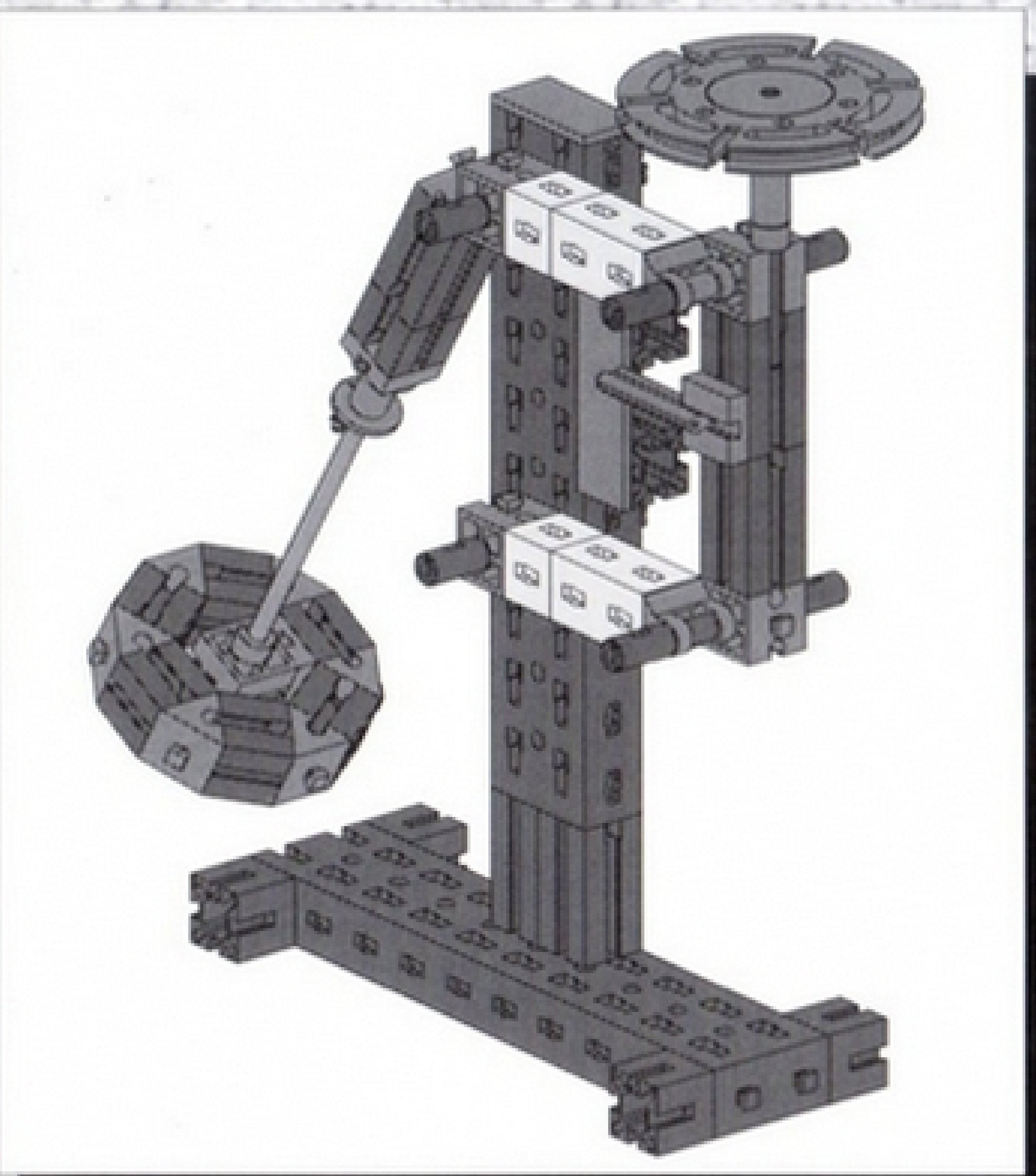
Try 3 pennies, then 6 and finally 9 pennies on the resistance side. Find out how many pennies it will take to balance each the new resistance forces.

1. Are there any patterns between the resistance forces and effort forces?

2. How is this pattern related to the mechanical advantage for this machine?

Postal Scale

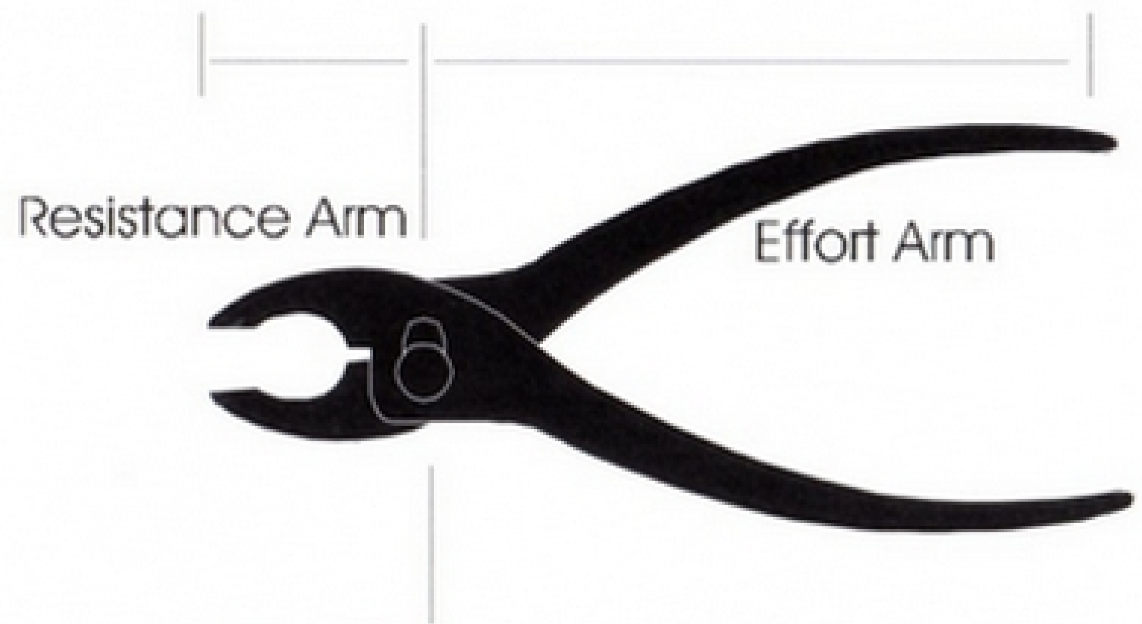
Universal



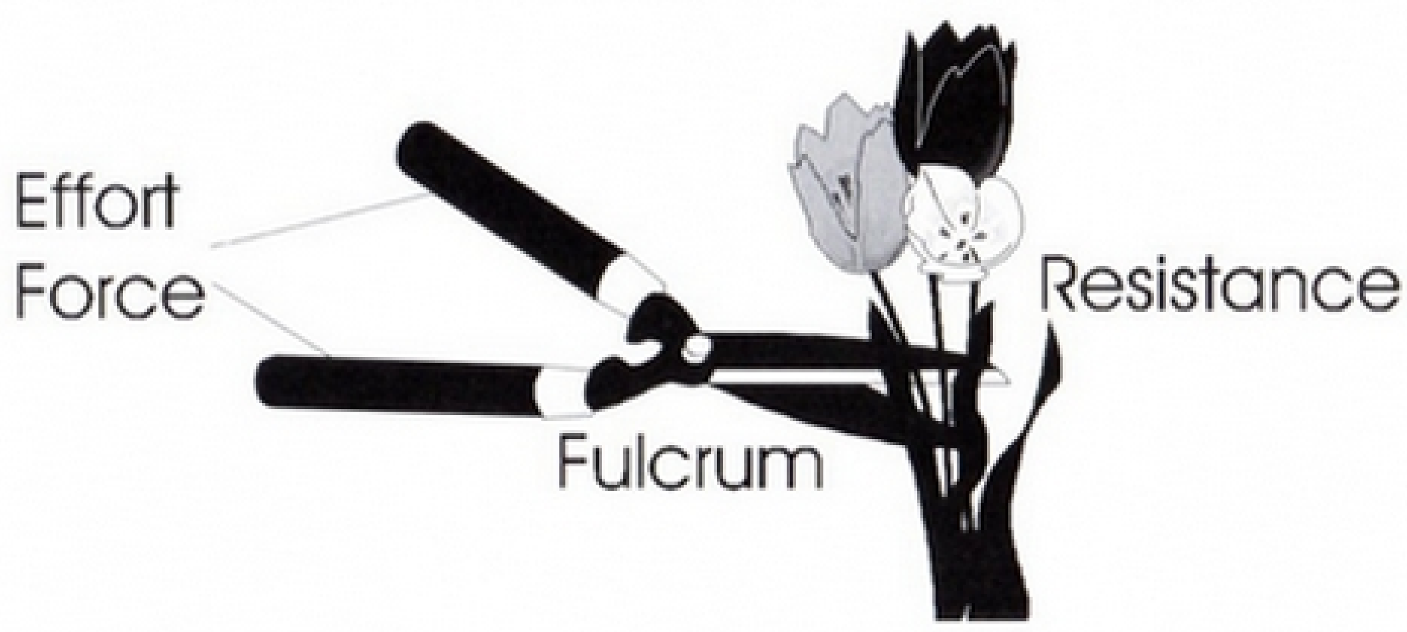
Level 1 Background

Levers are an example of a simple machine. Brooms, tennis rackets, seesaws, scissors, and wheel barrows are all types of levers. The postal scale is also a lever. The resistance is placed on the red pan. The effort force is the black and red weight wheel. The weight wheel moves when the resistance force is applied.

A lever consists of a lever arm and a pivot point, called a fulcrum. The lever arm is made up of a resistance arm and an effort arm.



In every machine there are two forces, the effort force and the resistance force. The effort force is the force applied to the machine. The resistance force is the force overcome by the machine. An example of a lever is using a pair of pruning shears to cut flowers.



In the diagram above, the effort force is applied it each of the handles. The resistance force is the stems of the flowers. The fulcrum is the bolt that holds the shears together.

Level 1 Things to do:

Draw a picture of the scale and label the resistance fore, fulcrum and the effort force. (Be careful)

Add pennies one at a time.

1. What happens to the scale as you add the pennies to the resistance side?

2. Can you measure as many pennies as you want? Why or Why not?

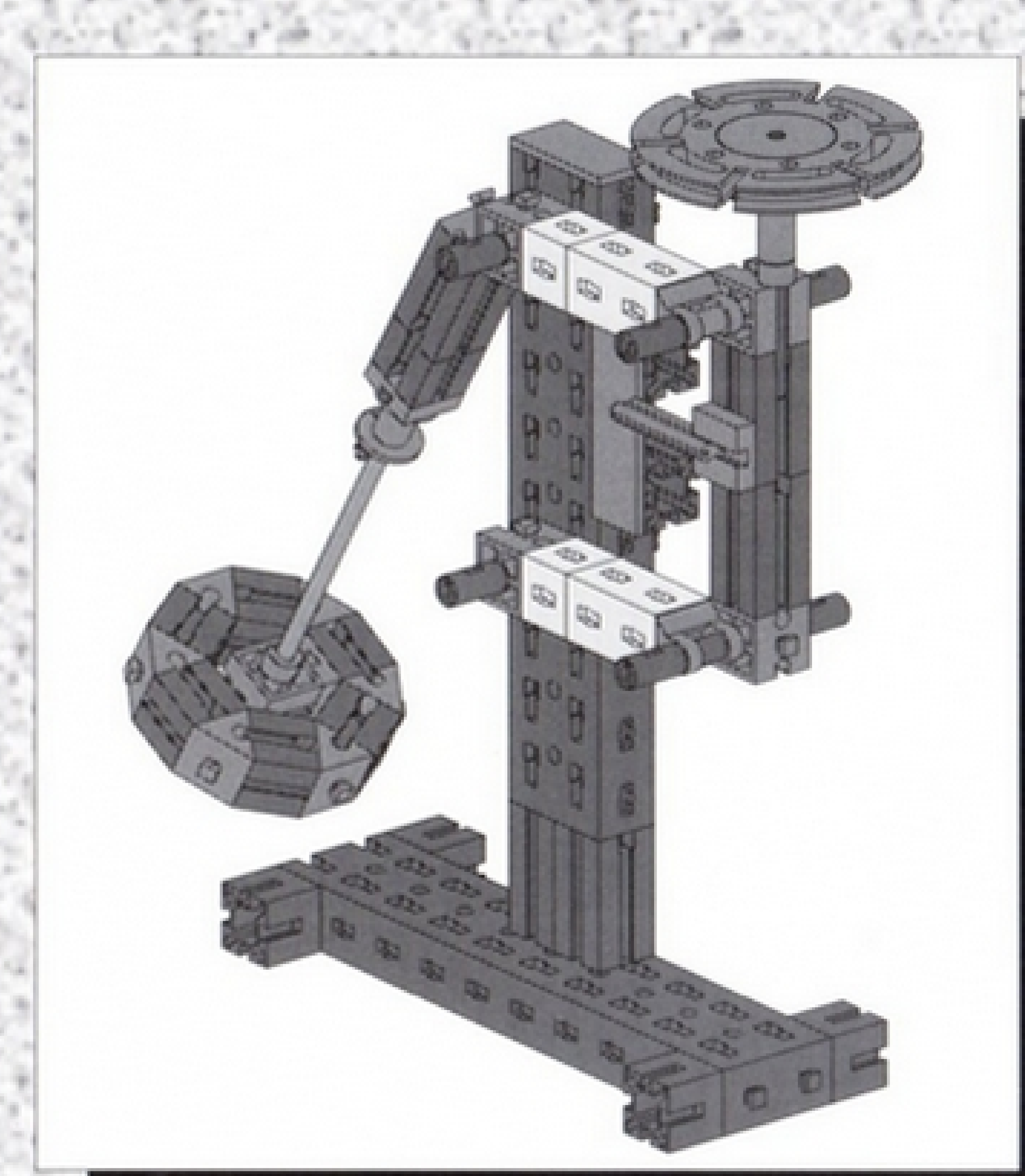
Now try this...

Change the black rod that holds the effort force. Try making it longer and then shorter.

1. Is the number of pennies you can balance on the scale changed as a result of the longer or shorter rod?

Postal Scale

Universal



Level 2 Things to do:

Change the length of the effort arm by adding a yellow block. Add pennies to the effort side.

How did changing the length of the effort arm, change the number of pennies you could place on the scale?

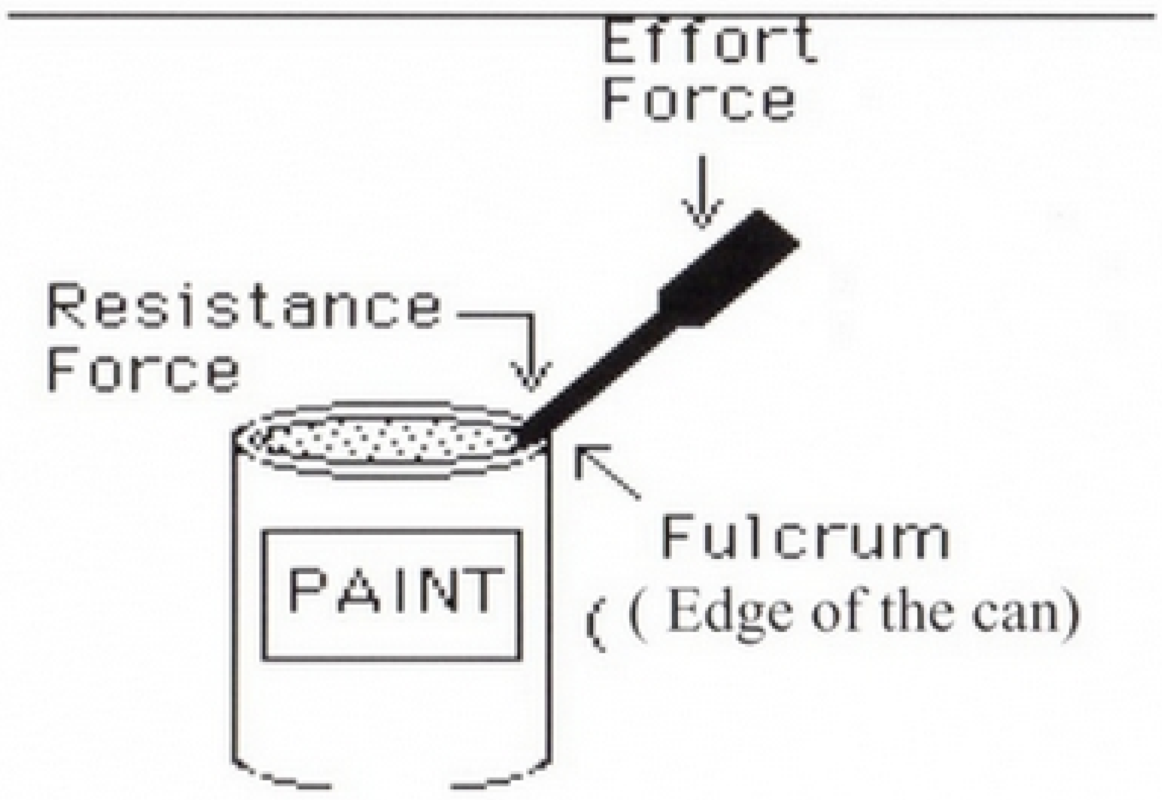
Now try this...

1. Is there a certain effort arm length that will cause the scale to no longer to function? Why or why not?

2. How could this problem be corrected?

Level 2 Background

Levers are an example of a simple machine. Brooms, tennis rackets, seesaws, scissors, and wheel barrows are all types of levers. The postal scale is also a lever. The resistance is placed on the red pan. The effort force is the black and red weight wheel. The weight wheel moves when the resistance force is applied.



The effort side of the lever is called an effort arm. The effort arm is from the fulcrum to the effort force. The side of the lever with the resistance force is called the resistance arm. The resistance arm is the distance from the fulcrum to the resistance force. All levers have mechanical advantage. Mechanical advantage is related to the amount of effort force you will need to overcome the resistance force of the machine. The mechanical advantage for levers is the ratio of the effort arm to the resistance arm.

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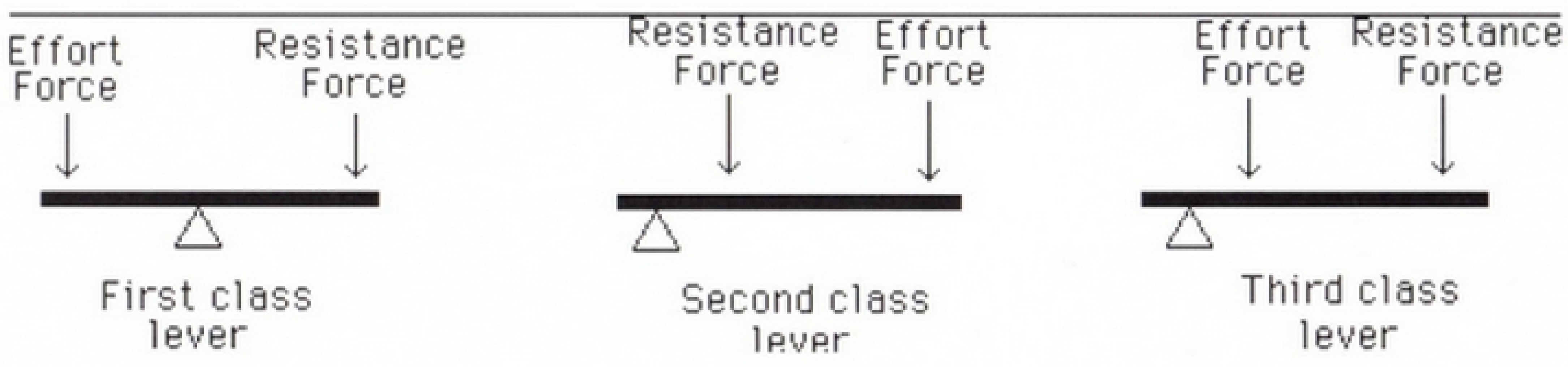

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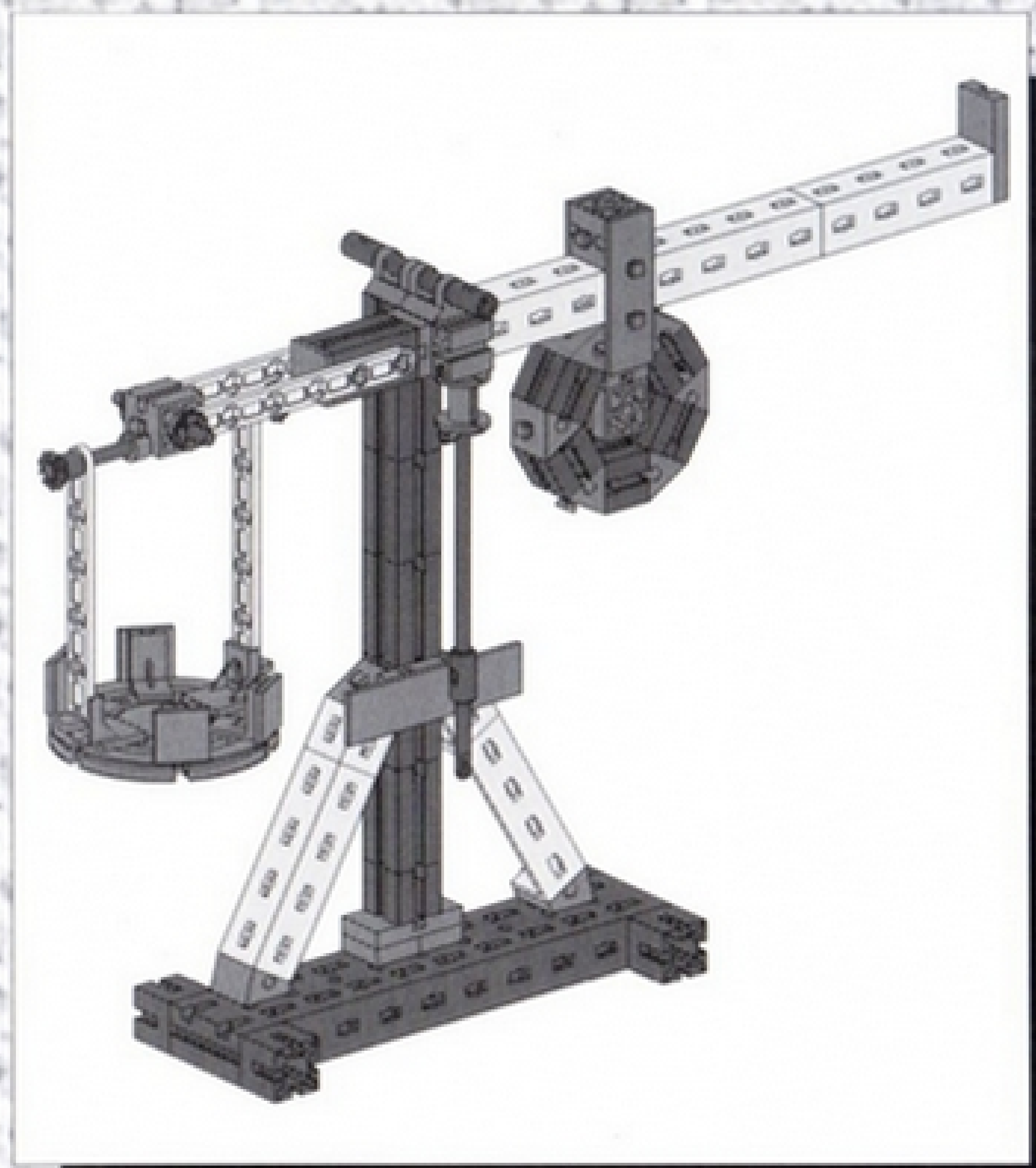
Scale with Sliding Weight

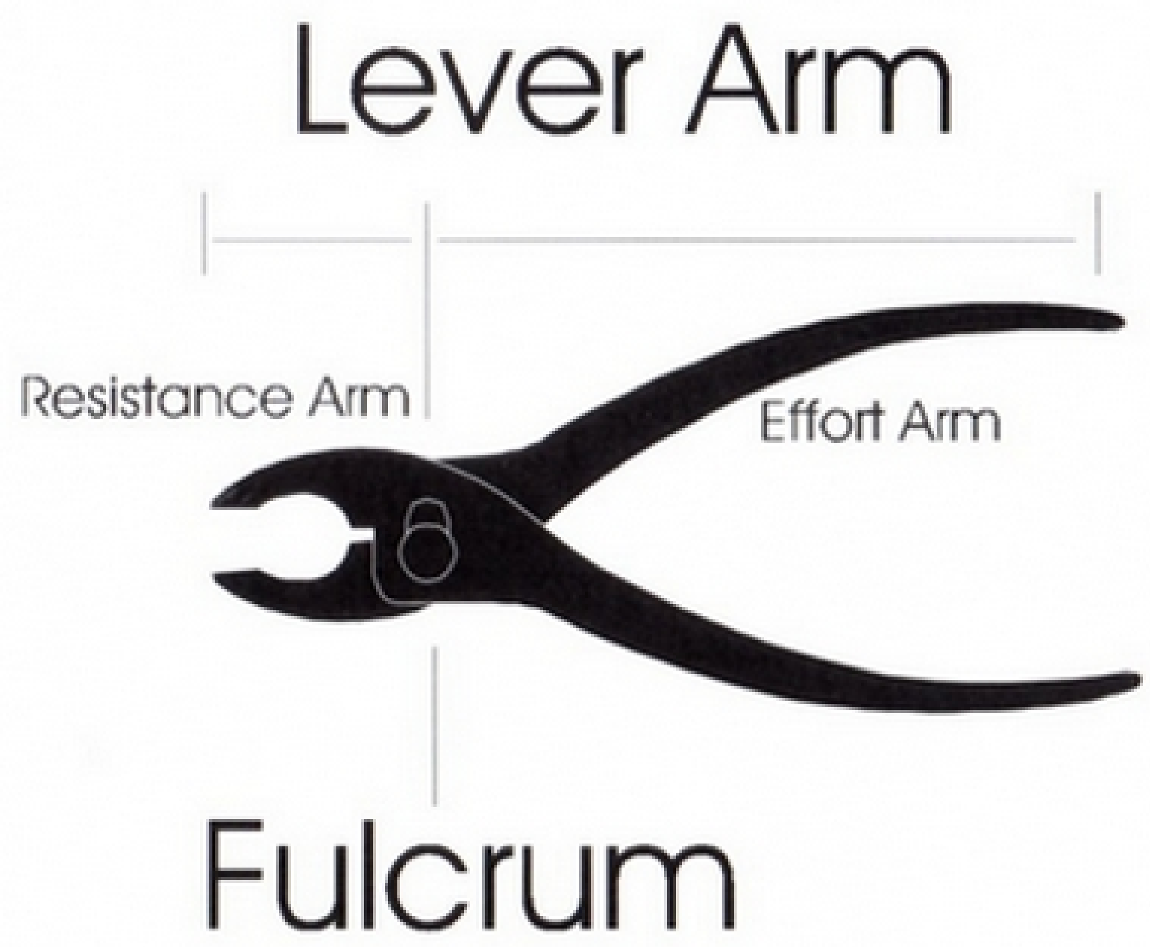
Universal



Level 1 Background

Levers are an example of a simple machine. Brooms, tennis rackets, seesaws, scissors, and wheel barrows are all types of levers. The scale with sliding weight is also a lever. The resistance is placed on the red pan. The effort force is the black and red weight wheel. The weight wheel can be moved to balance the resistance and effort force.

A lever consists of a lever arm and a pivot point, called a fulcrum. The lever arm is made up of a resistance arm and an effort arm.



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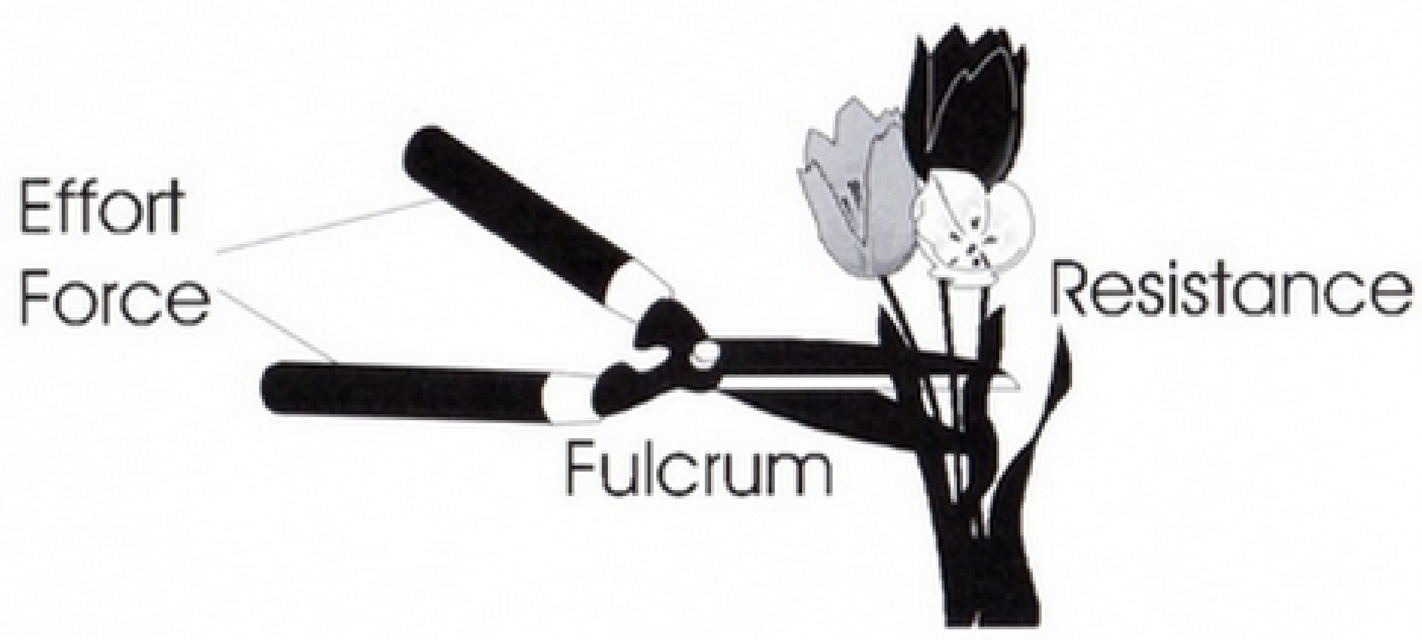


In the diagram above, the effort force is applied it each of the handles. The resistance force is the stems of the flowers. The fulcrum is the bolt that holds the shears together.

Level 1 Things to do:

Slide the weight wheel so that the scale is balanced. Draw a picture of the scale and label the resistance force, fulcrum and the effort force.

1. Add 10 pennies to the resistant side. Does the scale change? How?

2. How can you make the scale balance?

3. Why does the scale balance?

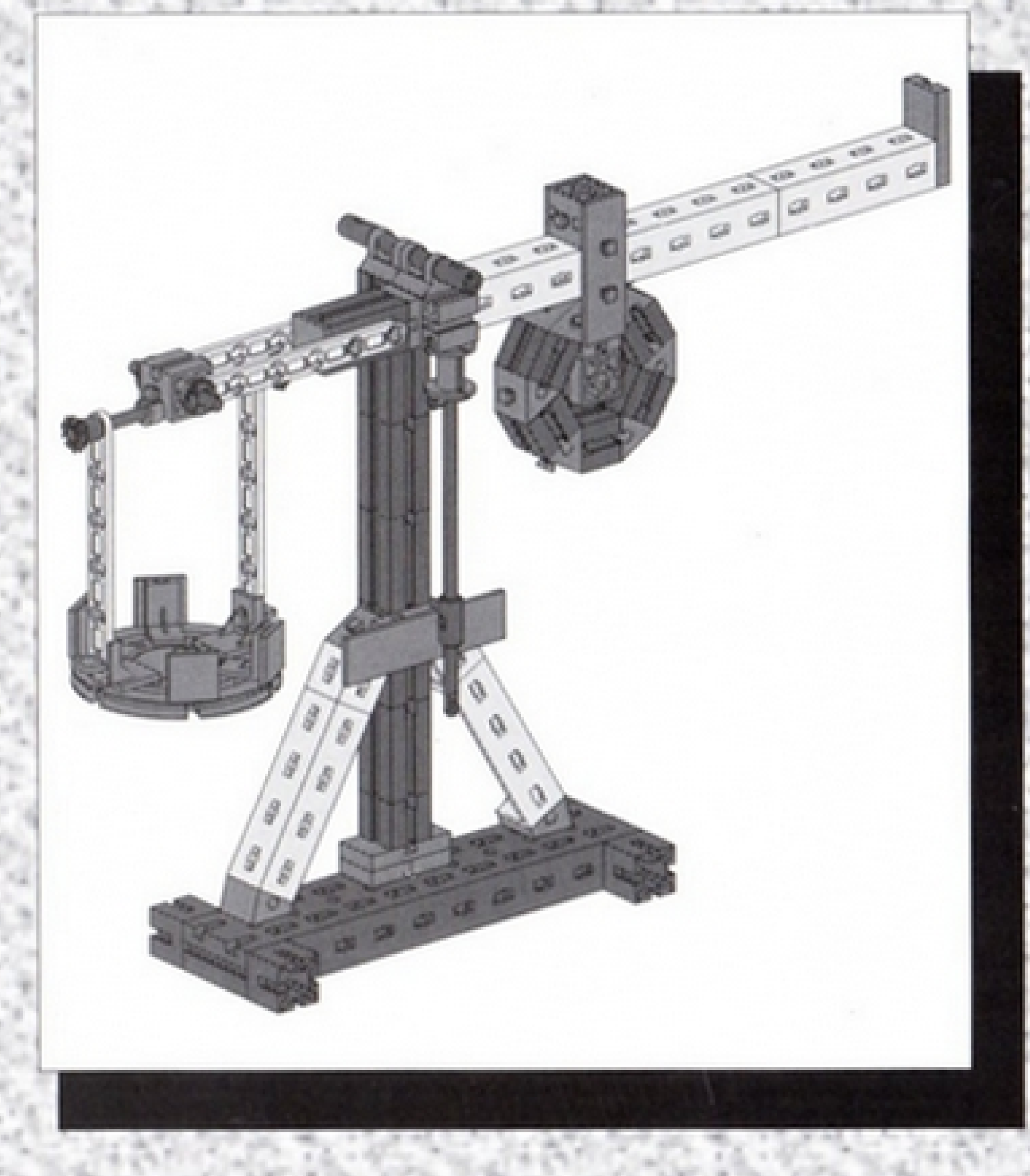
Now try this...

Shorten the arm with the sliding weight on it. Try the steps from above.

1. How does this change the forces needed to balance the scale?

Scale with Sliding Weight

Universal



Level 2 Things to do:

Balance the scale. Draw a picture of the scale and label the resistance force, fulcrum and the effort force.

1. What class of lever is this?
2. Measure the effort arm and resistance arm. What is the mechanical advantage?

Add 30 pennies to the balance and balance the scale. Measure the effort arm and resistance arm.

3. What is the mechanical advantage?

Now try this...

Shorten the effort arm by one yellow piece. Repeat the above steps.

1. How does this change the way the balance works and the resulting mechanical advantages?

Lengthen the effort arm by one yellow piece. Repeat the above steps.

2. How does this change the way the balance works and the resulting mechanical advantages?

Level 2 Background

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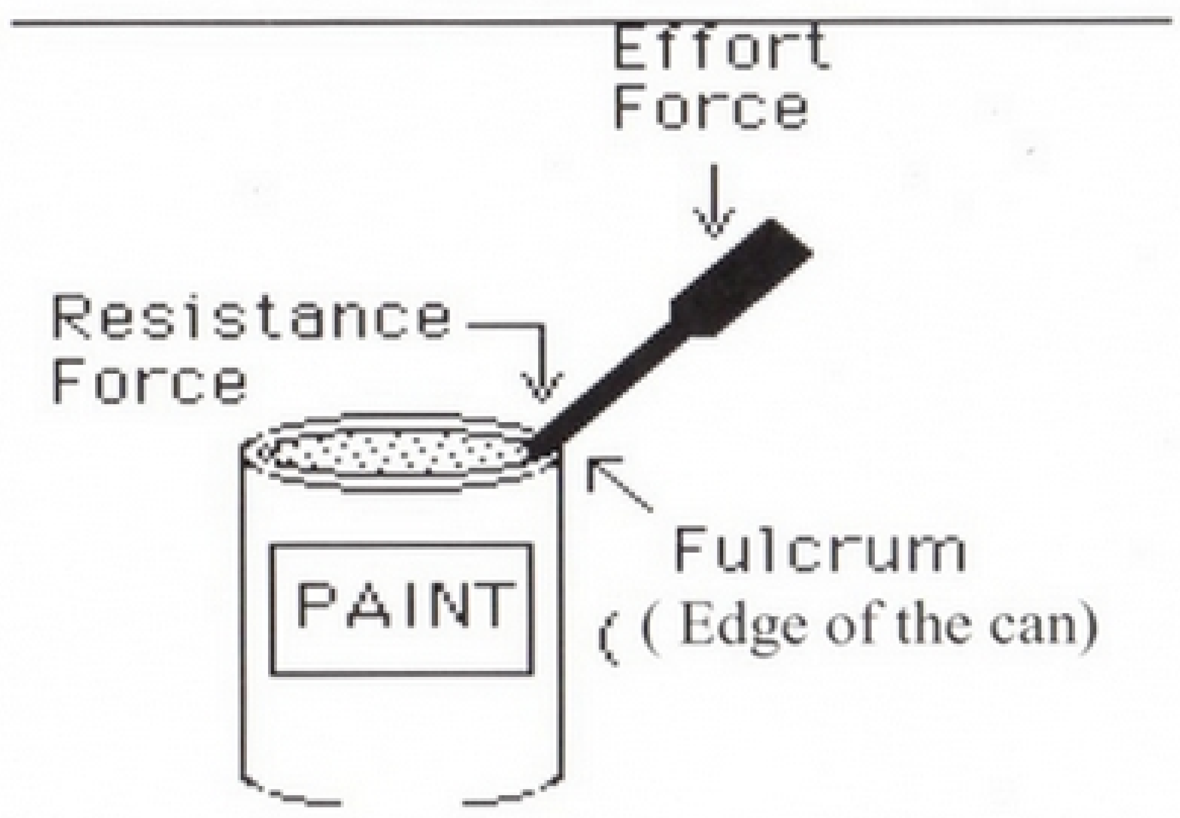

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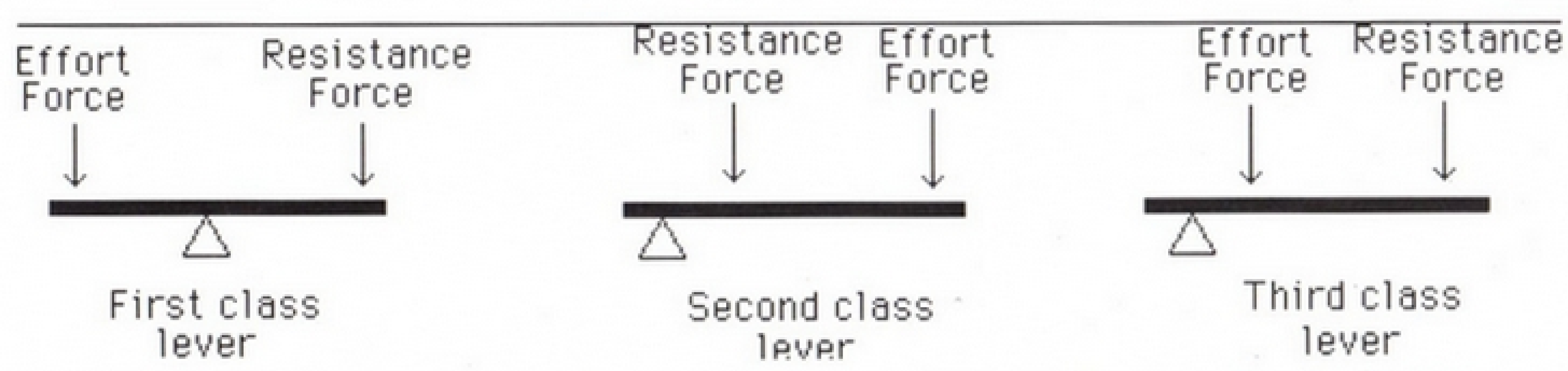

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