

- 1 Watch. Name three forces that help things move.





Let's learn about ...

- how objects move on land
- how boats float
- how planes fly
- eco-friendly transport



- 2 Look at the picture and answer the questions.
 - a. What different forces can you see illustrated in the picture?
 - b. Which force causes an object to slow and stop?
 - c. How does a plane lift?

- 3 Work with a classmate to complete the following tasks.
 - a. Choose land, water or air and make a list of five types of transport for that element.
 - b. Discuss how their shapes are similar and different.
 - c. Describe how they move. Are they similar or different?

How do objects move on land?

Forces, such as **pulling** and **pushing**, cause objects to move. They can make objects go faster and change direction. **Friction** is another type of force. It can make an object slow down and stop.

Objects need force to be applied for them to start moving. **Contact forces** are when there's physical contact with an object. **Non-contact forces** don't need to make physical contact for an object to move. Gravity is a non-contact force, and we see its effect when an apple falls from a tree.

- 1 Look at the picture and find the different forces that are being applied in a train station. Which are push forces and which are pull forces?



- 2 With a classmate, take turns to say a force that you can see in the picture.

A woman is pushing a wheelchair.

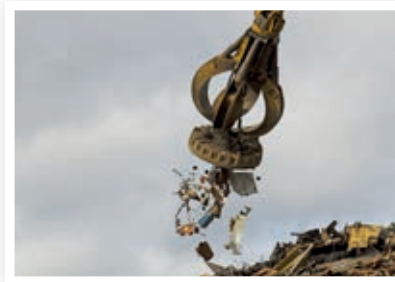


Yes, and upstairs, a man is pulling a chair away from a table.



- 3 Look at the photos of a crane moving scrap metal from one place to another. Choose the correct option for each sentence.

- A magnet **pushes** / **pulls** the scrap metal to the crane.
- Gravity **pushes** / **pulls** the scrap metal to the ground.
- Magnetism and gravity are **contact** / **non-contact** forces.



Friction is a type of contact force. It happens when an object moves against another solid object, liquid or gas, and causes **resistance**. Friction helps objects to slow down or stop completely. There are different types of friction.

sliding friction



Sliding friction happens when an object moves across a solid surface.

rolling friction



Rolling friction happens when a round object rolls on top of a solid surface.

fluid friction



Fluid friction happens when an object meets a liquid or gas as it moves.

4 Look at the photo. Identify the three different types of friction that cause the bike to slow down.

a. The rider takes her feet off the **pedals**. The wheels slow down as they move over the ground without any force being applied by the rider.



pedal

brake

brake pad

b. Air pushes against the rider and the bike and slows the vehicle down.

c. The rider pulls the **brakes**, and the brake pads slide against the wheels.

Friction can help an object to go faster and change direction. The type of surface helps us to choose the best way to move an object.

5 Look at the photos. Discuss the questions with a classmate.



- On which surface is it easier to move objects using sliding friction?
- Which surface makes it easier to move objects using rolling friction?
- Do you think water reduces or increases friction between objects?



At home

Find examples of friction on your journey to school.

How do objects move in water?

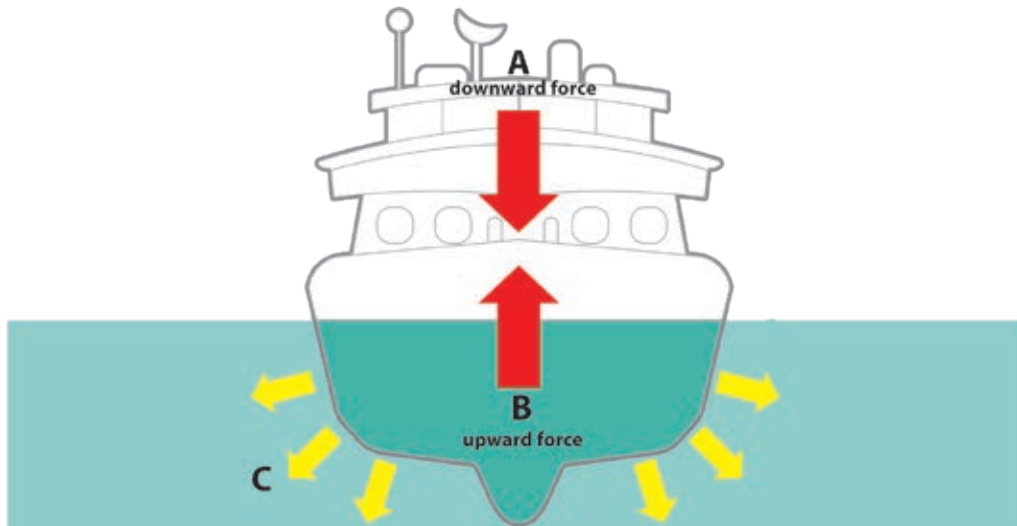
Objects that move on the surface of water must be able to **float**. Objects that float can then move forward using different types of forces. Floating objects move faster when there's less friction with the water.

1 **Watch.** Copy the diagram. Label it with the words below.

upthrust

water is displaced

weight



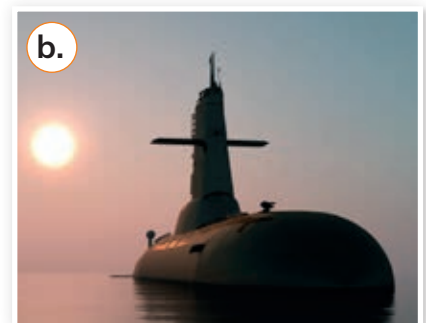
Density is important to how ships float. Density is the amount of a certain type of matter in a specific size of space. The density of an object is equal to its mass divided by its volume. Steel ships are very heavy, but they're also very large. This reduces their density.

2 **Study the diagram above. Which of the following principles help a ship to float?**

- Air inside the ship helps to reduce its density.
- The ship must be made from a light material.
- The downward force from the weight of the ship is the same as the upward force from the water it displaces.

Submarines are large ships that can move above and below water.

3 **Listen to how a submarine works. In which photo is the ballast tank filled with air?**



How do boats move?

Boats use push and pull forces to move. There are different types of forces that move boats, ships and other vehicles in water.

4 Listen and match the photos to the speaker. 023



sailing boat



rowing boat



speed boat



tug boat

5 Work in pairs. Find out what forces move these things in water.

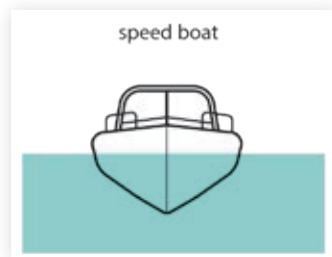
water-ski

jet ski

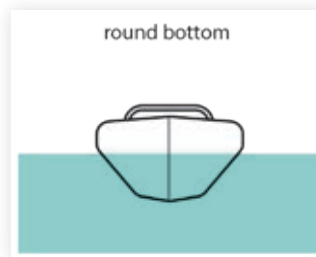
pedal boat

Boats experience fluid friction when they move on the water. A boat moves faster when there's less friction, or resistance, from the water. The shape of a boat has an affect on the amount of friction it experiences.

6 Look at the different shapes of boats. Discuss the questions with a classmate.



speed boat



round bottom



catamaran

- Which boat do you think experiences least fluid friction as it moves?
- Which boat is the most stable in rough water? Why?
- Which boat is best for carrying heavy loads? Why?

7 Design a boat on a piece of paper. Use the questions to guide your design.

- What do you need your boat for? Where will it sail?
- Does it need to travel fast or slowly?
- What type of force will move your boat?



At home

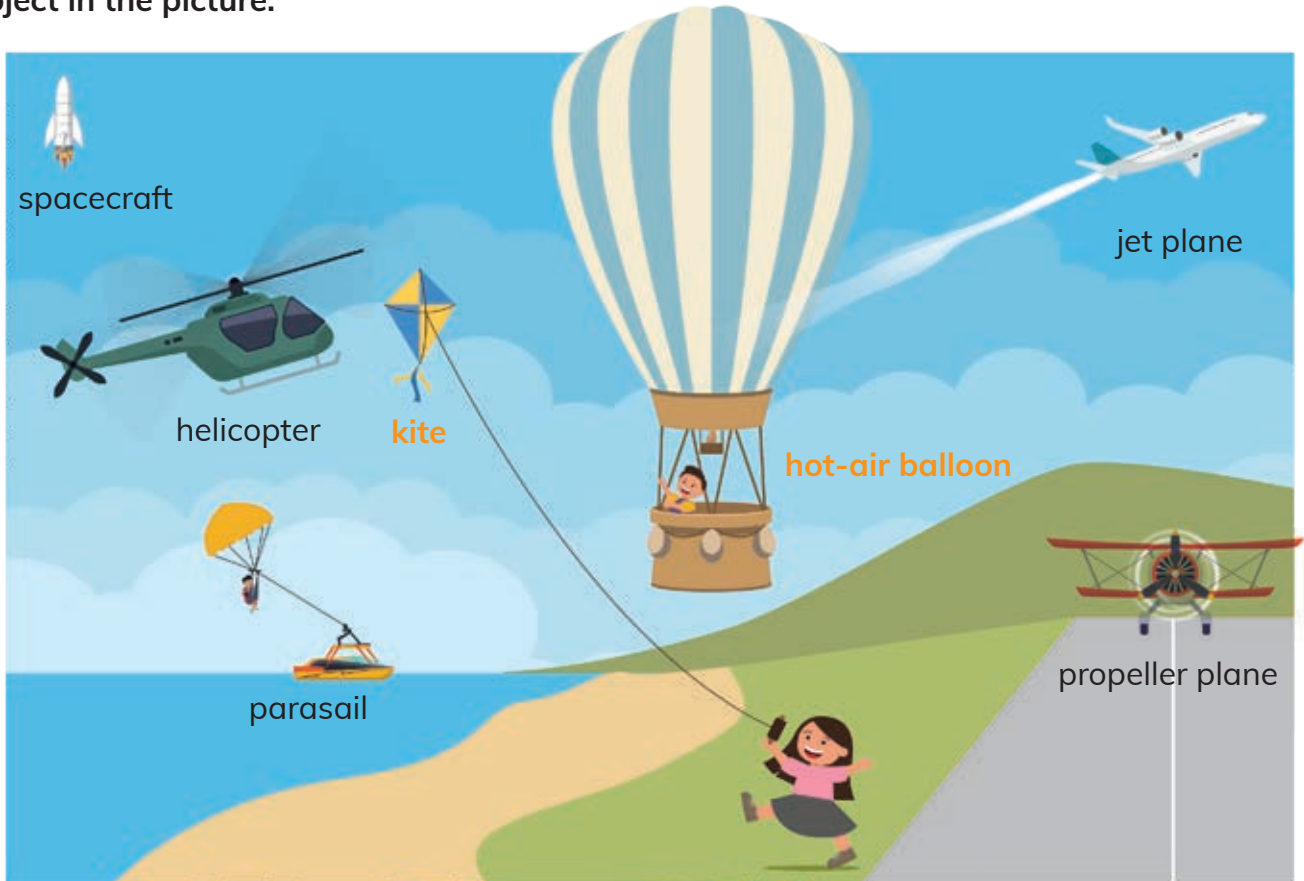
Tell the people at home about the boat you designed.

How do objects fly?

An object needs two forces to fly; **lift** and **thrust**. The shape of a flying object affects the amount of air resistance it experiences.

For an object to fly, it needs a force that pushes it up. The weight of this upward force must be the same as the weight of the object. This is called **lift**. A flying object also needs **thrust**. Thrust is the force that keeps an object moving forward and stops it from slowing because of air resistance.

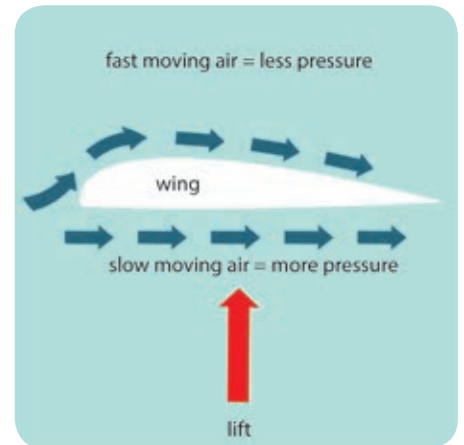
- 1 **▶ Watch.** Work in pairs. Identify what provides the lift and the thrust for each flying object in the picture.



- 2 Which flying object in the picture does each sentence describe?
- Hot air is less dense than cold air. When hot air enters this object, it causes it to rise.
 - An engine spins the **propeller** round very fast, which pulls the object through the air.
 - The wind pushes the object upward and a person pulls it forward with a string.
 - A speedboat pulls the object forward and the wind pushes it upward.
 - A jet **engine** pushes the object forward and air passes under the wings and lifts it up.
 - Rotor blades** spin around very fast and pull the object up. It can fly vertically.
- 3 **🔗** There's one more flying object in the picture. Write a description of how it flies.

Air pressure

A plane's engine produces a force that moves it forward. As the plane moves forward, air passes above and below its wings. The air below the wing moves more slowly so the pressure is higher. This causes an upward force.



4 Work in pairs to answer the questions.

- Look at the shape of the wing. How is the top of the wing different to the bottom?
- Does air move more slowly above the wing or below the wing?
- What produces the thrust in a plane?

Streamlined shape

Planes experience fluid friction, or resistance, when they move through the air. You can experience air resistance if you try to walk into the wind on a very windy day. The shape of a plane helps to minimise air resistance. This is called a **streamlined** shape.

5 Look at the photos. Answer the questions.



- Which plane has got the most streamlined shape?
- What are the advantages of each type of plane?
- Which plane experiences the most air resistance?

6 Find out how a bird flies. Work in groups.

- Do research to discover how a bird uses lift, thrust and its shape to fly.
- Draw a diagram to show how a bird flies.
- Use your diagram to tell another group how a bird flies.



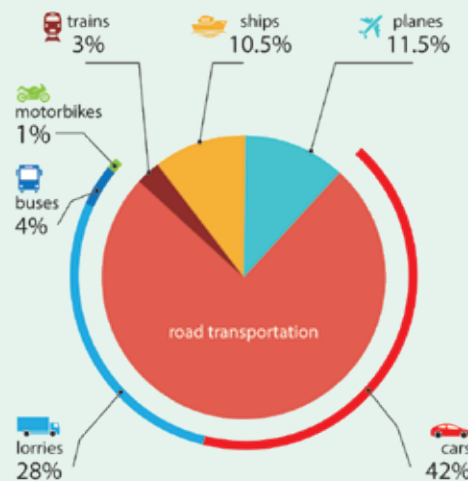
What effect does transport have on the environment?

Many forms of transport use **fossil fuels**. This produces carbon dioxide and other gases that pollute the air and water. Researchers are looking for ways to make transport more eco-friendly.

Pollution from transport

The pie chart shows the amount of carbon dioxide (CO₂) produced by different types of transport in a year.

Worldwide CO₂ emissions by transport



1 **5** Answer the questions with a classmate.

- Which produces the highest levels of CO₂?
- What percentage of CO₂ emissions is road transport in general responsible for?
- Look at the road transport. Is most of the pollution caused by the movement of people or things?

Cars emit more CO₂ globally every year than planes. However, there are also many more cars on the road than there are planes in the sky. The statistics below show the amount of CO₂ that a type of transport produces per person per km.

2 Look at the statistics. Which type of transport has got the highest carbon footprint per km? Which has got the lowest?

type of transport:	domestic flight	international flight	car (1 person)	car (2 people)	sea	train	bus
CO ₂ per km per person	255 g	150 g	192 g	96 g	19 g	41 g	105 g

Travelling by train is better for the environment than travelling by air. However, many people prefer to travel by air because it's quicker.

3 Work in pairs. Discuss the time it takes to travel by plane and train to a big city in Spain. Consider the following questions.

- How far is the nearest train station and airport from where you live?
- How long do you wait at an airport and how long do you need to wait for your luggage?
- How far is the airport from the city centre?

4 **5** When you go to a place that's less than 1 000 km away, you should go by train. Do you agree with this advice? Use your answers in activity 3 to explain why.

Reducing our impact on the environment

Burning fossil fuels causes environmental problems for two reasons. First, it pollutes our air and water. Second, they are **non-renewable energy sources** and will disappear in the future. Many governments and businesses around the world are developing new ways to power the transport we use.

Electric vehicles

5 Listen. Which electric vehicle is each person talking about?  024



6 Work in groups. Discuss the questions.

- What types of electric vehicles are there where you live?
- How do they work and how do they charge?

Alternative energy sources

The European Union (EU) wants to reduce the amount of energy from non-renewable sources that's used to power planes. **Biofuel** is an alternative **renewable energy source** made from natural waste. The EU has set the following target: *The fuel used by a plane in all flights across Europe must be 2% biofuel by 2025, 5% biofuel by 2030 and 63% biofuel by 2050.*

7  Make a bar chart to represent the EU targets for the use of biofuel.

Centuries ago, people transported products across the world using just wind. Today, most **cargo** ships rely on fossil fuels to move.

8 Look at the design of this modern cargo ship. Answer the questions.

- How is this design similar to ships in the past and present?
- What energy sources does it use?
- How does this ship help the environment?



Oceanbird

9 If all these eco-friendly vehicles existed today, which one do you think would have the biggest impact on the environment? Share your ideas with a classmate.



How does friction affect the movement of an object?

The Greek mathematician Archimedes said that an object in motion will continue to move until something makes it stop. That 'something' is friction. Let's find out how rolling friction affects a moving object.

Hypothesis

Will a smooth or a rough surface cause a vehicle to slow down more quickly? Write your hypothesis.

Materials

- 50 x 30 cm hard cardboard
- 1 sheet of sandpaper
- ruler or measuring tape
- small toy car
- 1 sheet of aluminium foil
- some thin books

Step 1

Work with a classmate. Use some books and the cardboard to make a ramp. Don't make it very steep.



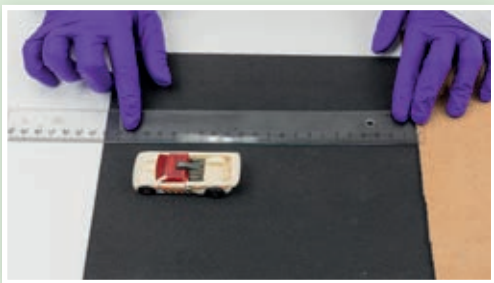
Step 2

Position the sandpaper at the bottom of the ramp so that it touches the cardboard. Hold the car at the top of the ramp.



Step 3

Release the car. When it stops moving, measure its distance from the bottom of the ramp. Write it in your notebook.




Step 4

Repeat the experiment, but replace the sandpaper with a sheet of aluminum foil.



Results

▶ Watch. Compare your results with another pair. Fill in the worksheet. 

Tip 1

Play a word association game

A good way to activate your vocabulary is to think about words related to a specific idea.

1 What words do you think of when you hear the word; transport?

- Work in pairs.
- Set a timer for 1 minute.
- Write as many words as you can associated with 'transport'. They can be nouns, adjectives or verbs.
- Compare lists of words with the class.
- Who wrote most words?

Play again with these words:

plane

eco-friendly

car

boat

train

Tip 2

First conditional

We use the following structure to talk about things which are possible in the present or future.

If subject + present simple, subject + will/won't (+ verb)

Example: If we use eco-friendly vehicles, it will reduce our impact on the environment.

2 Rewrite these sentences in the first conditional.

- If I go to school by bike, I ... (reduce) my carbon footprint.
- We ... (cause) less air pollution if we use more biofuel.
- If large ships have sails, we ... (not need) to use as much fossil fuels to travel by sea.

Tip 3

Ask questions you want to know the answer to

When you're interested in a subject, you're more motivated to find information and learn about it. It makes learning more fun.

3 Write a question you want to know the answer to. Then use the Internet to find the answer.

- Search for photos and images to help you understand.
- Write down any new vocabulary you learn during your research.

4 Share what you've learned with a classmate.

- Explain the answer to a question in your own words
- Use images or diagrams to help you to clarify meaning and concepts.
- Answer any questions your classmates have.

How do rockets fly in space?



Juan de la Cierva



Juan de la Cierva was born in Murcia in 1895. He was interested in aviation at an early age and began building and designing gliders and planes when he was just 17. After one of his planes crashed, he began developing the autogiro.

The autogiro was a plane that had wings and a propeller. However, it used a spinning rotor to lift the plane in the air. This allowed the plane to stay in flight at a low airspeed.

The British Air Ministry were interested in his work. In 1925, Cierva moved to England to continue building new models of his plane. The autogiro has been used in France, Germany, Japan, Russia and the US.



Juan de la Cierva died in a plane crash near London in 1936. He wasn't able to create a truly vertical flying machine. However, he was a pioneer and his work contributed to the development of the modern-day helicopter.

1 Answer the questions in your notebook.

- | | |
|--|--|
| a. What nationality was Cierva? | c. How was the autogiro different to other planes? |
| b. Why did he want to build a more stable plane? | d. Why did he move to England? |

WebQuest



2 This is Laura Dekker. When you finish your WebQuest, answer the questions in your notebook.

- Where was Dekker born?
- What was her dream when she was young?
- Why didn't she succeed initially?
- At what age did she succeed in her dream?





My electric motor

Before you start

Electric motors are changing the world of transport. It's better for the environment to power vehicles using electricity from renewable sources and not from fossil fuels.

- 1 Which vehicles today use electricity to move?

Can you make your motor spin?



You need ...

- AA battery
- metal screw
- 4 neodymium magnets
- sandpaper
- scissors
- wire



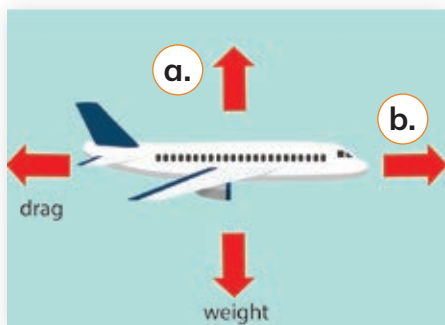
Planning

- 2 Work in pairs. Put two of the neodymium magnets together.
- 3 Place the bottom of the metal screw on top of the magnets. Make sure the screw is in the centre of the magnets.
- 4 Cut 20 cm of wire. Use sandpaper to remove the wire at both ends until you can see 1 cm of copper at each end.
- 5 Place the top of the screw and the magnets at the bottom of the battery. This is the negative end. Make sure the screw is in the centre of the battery.
- 6 Hold the battery with your fingers and let the screw and magnets hang from the battery. Place one end of the wire at the top of the battery. This is the positive end. Hold it in place with your finger. Then place the other end of the wire on the magnets. Observe what happens to the screw.
- 7 Repeat the experiment with more magnets and see how it affects the motor.
- 8 Share your motor with another pair and explain how it works.

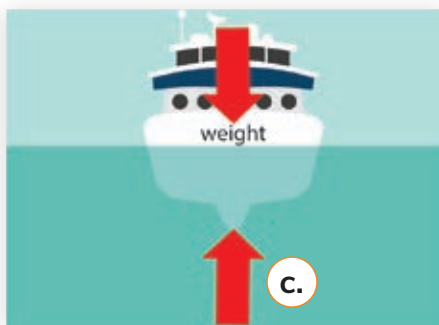


1 Copy the diagrams and label the forces a. to d.

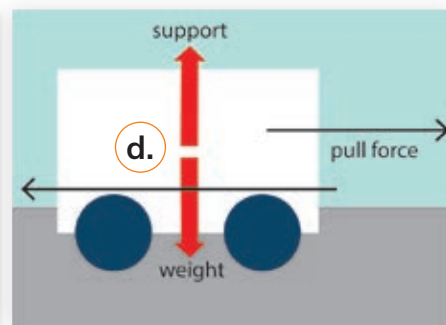
How a plane flies



How a ship floats



Rolling friction



2 Answer the questions.

- a. What kinds of friction are there?
- b. How does a hot-air balloon get its lift?
- c. What type of shape helps a plane or boat to travel faster?
- d. Name one form of transport that is more eco-friendly.

3 Write a sentence about each of these topics.

a. contact forces

b. non-contact forces

c. friction

d. Archimedes

e. eco-friendly vehicles

4 Which types of transport produce the most carbon dioxide worldwide? Put these in order from most to least.



5 Do the quiz!





Reflect

- 1 Read the unit objectives and say what you have learned. Write one thing you can do and one thing you need more practice with.

I can ...



say what contact and non-contact forces are.



I can ...



talk about different types of friction.



I can ...



explain how a boat moves on water.



I can ...



explain how a plane flies.



I can ...



talk about the effects of transport on the environment.



I can ...



explain how friction affects the movement of an object.



I can ...



describe who Juan de la Cierva was.



I can ...



use the Internet to research Laura Dekkar.



I can ...



make a simple electric motor.



Key:

★ I'm not sure.

★★ I need some practice.

★★★ I understand.

- 2 Make a presentation about one of these topics. Use objects to help you demonstrate the action.

how a plane flies

how a boat floats

how friction affects a moving object