

Tornadoes – the story for teachers

A tornado's spinning direction is determined by its position on the globe. If it is in the northern hemisphere it usually spins anti-clockwise. If it is in the southern hemisphere it usually spins clockwise. This is due to the Coriolis force.

The Coriolis force

The rotation of the earth is an important mechanism in atmospheric circulation.

The Coriolis force is named after a nineteenth-century French mathematician. Another name for it is the 'deflective force', and this tells us what it is all about: on our rotating earth the Coriolis force will try to make things moving over its surface deviate to the right in the northern hemisphere, left in the southern hemisphere. Many of the characteristics of ocean currents and atmospheric systems are determined by the strength of the Coriolis force.

Picture a rotating disc on which objects are deflected. If the disc spins anti-clockwise, then a pencil drawn straight from the centre to a fixed point outside the disc will trace a line that swings to the right. If you were standing on a slowly spinning disc and attempted to throw a ball to a person standing at a fixed point just off the edge of the disc, then to the latter the ball would take a curved path.

Coriolis force varies with the horizontal speed of the air (the wind speed) and the latitude. The effect is greatest at the poles and zero at the equator. You can see the effects of Coriolis in a long pendulum. If swung along a straight line, the plane of the swing will eventually move in a circular direction.

Gravity and centrifugal force also have to be taken into consideration for a proper explanation of the Coriolis force.

Tornadoes

Many tornadoes in the USA are formed where cold and dry winds sweep down from the Rocky Mountains and meet lower, warm, moist air moving north from the Gulf of Mexico. The warm air is trapped near the surface and becomes even more warm and moist. Eventually it forces its way aloft and reaches great height. Thunderstorms develop with huge cumulonimbus clouds. On the edge of these thunderstorms, air rushing in to replenish the severe convection sets the base of the cloud spinning and a funnel reaches down to the ground. The processes inside a tornado are complex and difficult to research. Scientific instruments placed in the path of a tornado are usually destroyed.

A tornado looks like a funnel with the fat part at the top. Inside it, winds may be swirling at 300 miles an hour. If it goes through a town, a tornado can flatten houses, lift up cars and lorries and smash caravans to pieces. Sometimes the path of the tornado is quite narrow; houses on one side of a street may be destroyed while those on the other side suffer little damage. Sometimes people on the ground don't see the funnel. It may be raining too hard, or the tornado may come at night. You can always hear the tornado's roar; it sounds like a thousand trains.

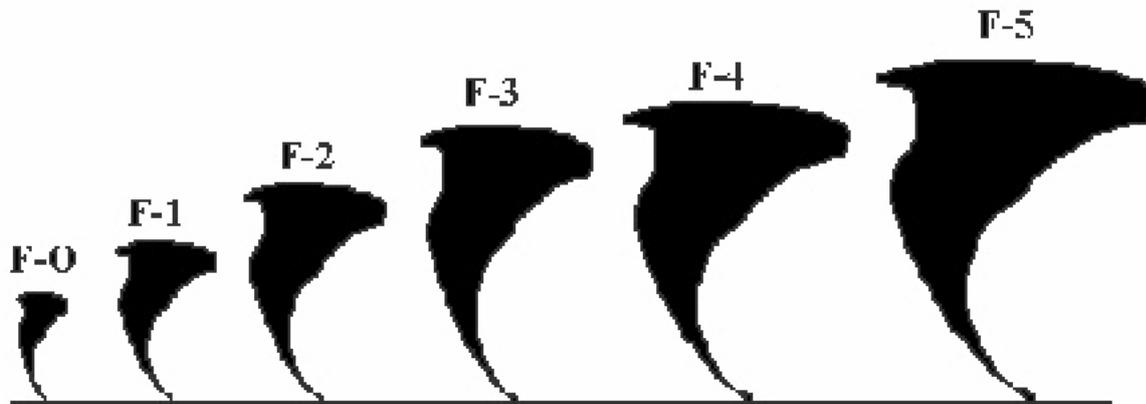
On 31 July 1987, a large tornado ripped through the city of Edmonton, Alberta, killing 27 people, injuring hundreds, and leaving behind over 250 million dollars worth of damage. Edmonton in Canada is much further north than the usual tornado area of the Great Plains of the United States, which is known as 'Tornado Alley'; the danger areas are Texas and Oklahoma. The residents of Edmonton did not expect to be hit and were not prepared.

In Edmonton, warnings are now given:

'When a severe thunderstorm warning is in effect, remain indoors and watch conditions carefully. Shelter in a basement or small interior room if the winds increase or if large hail begins to fall.'

Tornadoes are classified according to the damage they cause, using the Fujita Scale.

Fujita Pearson Tornado Scale



F-0	40-72 mph	Chimney damage, tree branches broken.
F-1	73-112 mph	Mobile homes pushed off foundation or overturned.
F-2	113-157 mph	Considerable damage, mobile homes demolished, trees uprooted.
F-3	158-205 mph	Roofs and walls torn down, trains overturned, cars thrown about.
F-4	207-260 mph	Well-constructed houses levelled.
F-5	261-318 mph	Homes lifted off foundations and carried considerable distances; automobiles thrown as far as 100 metres

Do tornadoes ever happen in Britain?

Yes, about 30 each year are reported. They are usually F-1 or F-2 and mostly affect the south of England.

Tornadoes – upper primary

By using a range of materials and activities, we aim to focus on these outcomes and targets:

Pupil Learning Outcomes

- A tornado is the most violent wind storm.
- Tornadoes can occur over land and sea. Those over the sea are called waterspouts.
- Tornadoes can cause complete destruction including death.
- Tornadoes are centred around a spinning centre called a vortex.
- A tornado's spinning direction is affected by the Coriolis force.

Scotland: 5–14 Environmental Studies

People and place: the physical environment

- Level C: describe some main types of weather and climate in the world and ways in which people adapt to them.
- Level D: describe how extremes of weather and climate can disastrously affect people and places.
- Level E: describe and explain simply the main weather and climate patterns in Britain and the wider world, including extremes, and explain their effects on ways of life.

People and place: using maps

- Level D: describe the main features of a range of maps at different scales, e.g. climate maps.

Skills in science – investigating

- Level B: use simple equipment and techniques to make observations and measurements.

Scotland: 5–14 English Language

Writing / imaginative

- Write imaginative pieces in various genres, using appropriate organization and vocabulary.

England and Wales National Curriculum

Geography

Key Stage 2

- 1b: collect and record evidence
- 2a: use appropriate geographical vocabulary
- 2b: use appropriate fieldwork techniques
- 2c: use atlases and globes, and maps and plans at a range of scales
- 2d: use secondary sources of information
- 3a: identify and describe what places are like
- 3d: explain why places are like they are
- 7b: study a range of places and environments in different parts of the world

WALT

We are learning to ...

Describe tornadoes and how they are formed.

Understand the destruction tornadoes can cause.

Phase 1 Overview

Establish the children's prior knowledge:

- What are tornadoes?
- Where do we find them?
- What are they made of?
- Where do they come from?

Phase 2 Input

Show the children the photos on the resources sheet (resources download), which show a tornado, the sort of lightning you can get in a violent storm that might produce a tornado, and the kind of destruction a tornado can cause. Explain to them that a tornado is a violent windstorm of fast rotating air. A tornado starts with an updraught of hot air rising up from near the ground into thunderstorm conditions where there are tall fluffy cumulonimbus clouds (see the photos of these clouds in the Clouds section – resources download). The winds high up near the tops of the storm clouds start rotating at a very high speed. The rotating air is called a vortex.

More air flows in along the ground from all directions, causing the rotating vortex to move downwards, narrowing as it goes. A tornado is visible because the pressure inside the vortex is very low, so the water vapour condenses. Materials are picked up (dirt, litter, trees, etc) which makes the tornado appear black in colour.

Phase 3 Process

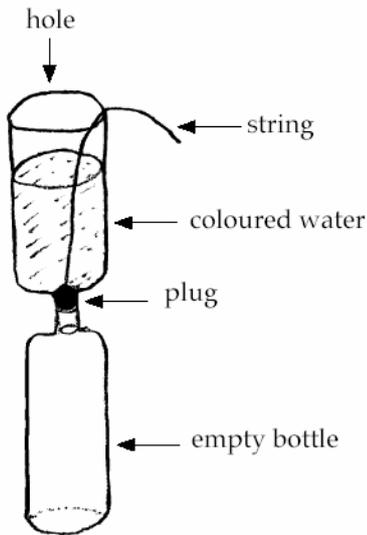
The children will be working around three bases, carrying out an activity at each one:

- making a vortex
- making a twister in a jar
- strange tornado facts

Activity 1 – Making a vortex

What you need:

- two plastic bottles, one with the bottom chopped off, joined securely together by their necks (see diagram)
- blu-tack
- string
- a mixer
- food colouring
- water
- copies of making a vortex worksheet (resources download)



- attach the blu-tack to the string to make a plug for the bottle
- plug the top bottle
- pour in the water with food colouring (to make it visible)
- stir the water vigorously with the mixer
- pull the plug and watch what happens

Observation questions:

What happened when you pulled the plug out?

How is this experiment similar to a real tornado?

Ask the children to draw a picture of the equipment used and fill in the rest of the worksheet.

Activity 2 – Making a twister in a jar

What you need:

- a jar with a lid
- water
- vinegar
- clear washing-up liquid
- glitter
- copies of making a twister in a jar worksheet (resources download)
- fill the jar two-thirds full with water
- add one teaspoon of vinegar
- add one teaspoon of washing-up liquid
- sprinkle in a small amount of glitter
- hold the jar upright and move it round quickly in a small circle so that the contents spin and a twister is formed

Observation questions:

- What happened inside the jar?
- Why do you think this happened?
- How is this similar to a real tornado?
- Ask the children to draw a picture of the equipment used and fill in the rest of the worksheet.

Activity 3 – Strange tornado facts

What you need:

- strange tornado facts (resources download)
- copies of strange tornado facts – true or false? worksheet (resources download)

The strange tornado facts are in large print and can be printed out on to coloured paper or card to display in the classroom. Show the children the ten strange facts and ask them to think about each one and write on the worksheet whether it is true or false. (Each fact is true!)

Here are the facts for reference:

1. The Pampa (Texas) tornado moved machinery that weighed more than 13,610 kg!
2. Tornadoes have been described as sounding like trains, jet planes, waterfalls and swarms of bees!
3. The furthest known distance a piece of paper was carried by a tornado was over 200 miles!
4. In the Great Bend tornado, Kansas, hundreds of ducks were picked up and dropped 25 miles north-east!
5. On 3–4 April 1974, 148 tornadoes were recorded in the mid-western and southern states of the USA!
6. On 20 May 1949, a herd of 13 cows was reportedly carried about 0.5 km by a tornado before being dropped unharmed.
7. The Tri-state Tornado on 18 March 1925 killed 695 people during its 60–73 mph, 219 mile track through Missouri, Illinois and Indiana.
8. The costliest tornado resulted in \$1,250,000,000 (£659,961,250) worth of damage, in central and northern Georgia.
9. Tornadoes kill more than 200 people a year.
10. A school with 85 pupils inside it was demolished by a tornado. The pupils were carried 137 metres and no-one was killed!

Phase 4 Review

The following discussion questions can be explored:

- Describe a tornado.
- How do you think a tornado forms?
- What safety measures should be taken in different places?

Extension

Show the children a video clip of a tornado (City of Edinburgh Council schools can obtain such a clip from the Children and Families e-Team). Now read them a few personal examples of tornado experiences from children in the USA. You can use the following sites as sources:

<http://www.suburbanchicagonews.com/features/specialsections/tornado/stories/story02.htm>

<http://www.nationalgeographic.com/ngkids/9704/tornado/tornb.html>

<http://www.tellitagan.com/fotr.html>

<http://www.fema.gov/kids/tornstry.htm>

http://www.fema.gov/kids/torn_brandon.htm

Explain to the children that they are going to take part in a mind movie. This means that they will be put in a situation where a tornado is about to strike and they need to imagine what will happen next. Ask them to close their eyes and listen very carefully to the following story.

Mind movie

It was a lovely hot summer's day. We had been playing in the garden all afternoon. Mum had made home-made chocolate ice-cream and we sat in the shade enjoying every mouthful. A breeze started up at around 4 pm which gently blew the washing on the line. We were playing an excellent game of hide and seek. Our cousins were over from the UK and we only ever got to see them twice a year so it was great fun!

Mum and Auntie Anne had taken the empty ice-cream bowls inside to wash when all of a sudden mum came rushing out calling 'Children, children, come here and listen'. We stopped playing our game and reluctantly went over to find out what she wanted. She explained that another tornado was on its way and it was due to hit here at around midnight tonight. We looked at each other with excited but scared expressions. My youngest cousin Andrew began to cry. My cousins had never experienced a tornado before – they had only ever seen the awful images on the television. We, on the other hand, were experts. Dad had built us a tornado shelter when the house was constructed a few years back. It had all the mod cons ... running water, a toilet, some fold-away beds and my favourite – a food store!

We explained to our cousins that it would be fun. We had to prepare the house before, though, covering windows with boards, tidying up all the toys and equipment in the garden, turning off the electricity, etc. Mum gave us our orders and we began to help her out. Dad and Uncle Bob were away golfing, but we presumed they would be back fairly soon when they heard about the alert. The wind began to pick up, becoming quite strong indeed. The garden was all cleared, so mum told us to organize the shelter while she boarded up the windows with Auntie Anne.

By 7 pm everything was organized. Dad and Uncle Bob had still not returned and I could tell my mum and auntie were getting very anxious. The wind was howling down the chimney and the rain had started to lash against the window boards making a drumming noise. It was really weird. The house was so dark with the windows boarded up and the candles were flickering, making dancing shadows on the walls. It was almost eerie. Mum and Auntie Anne ushered us down the shelter stairs at about 8 pm. It was time for the adventure to begin ...

Ask the children to describe their experience in the shelter. What do they hear, see and feel?

Explain to them that the house is completely destroyed in the storm.

Now ask them to write about what they discover when the storm is over. How does that make them feel?