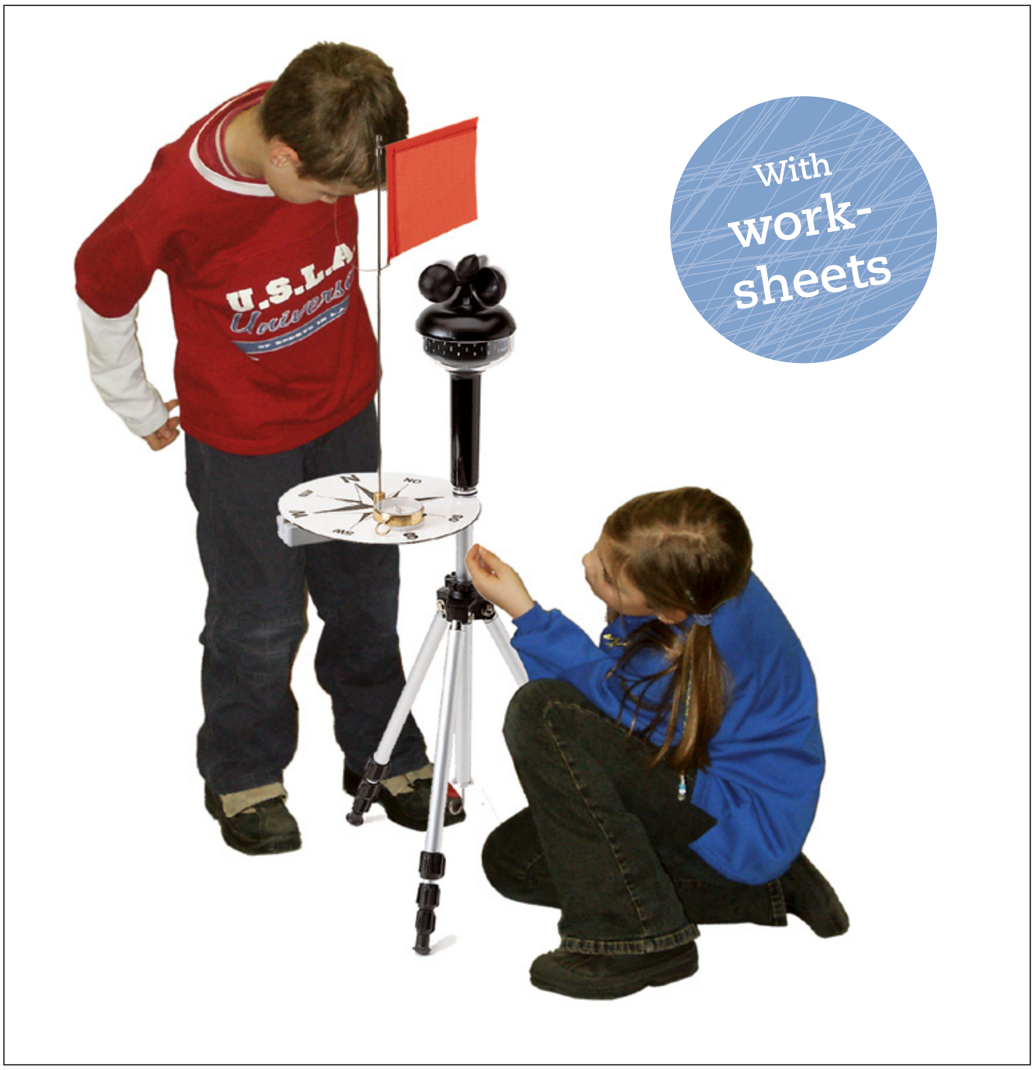
Cornelsen Experimenta

Science kit

Wind and Weather



Cornelsen

Wind and Weather

Science kit

Wind and Weather

Order no. 8959

This Science kit is recommended for students at the age of 9–11.

Contents

Wind and Weather

List of components

Illustr. no.	Qty.	Description	Order no.
1	6	Thermometers, –25 °C to +50 °C	13006
2	6	Rain collectors, with graduation, 83 x 36 mm	13014
3,4	1	Large rain gauge with adaptor (pluviometer)	13022
5	1	Compass with pointer lock, 45 mm dia.	13057
*	1	Compass card with adjustable arrow, 250 mm dia.	2886
*	1	Mirror (cloud mirror), 120 x 120 mm	85108
6	37	Weather symbols printed on plastic cards, with velcro points	303936
7	5	Plastic cards for writing with water-soluble marker, with velcro points	30466
8	1	Water-soluble marker	30644
*	2	Adhesive felt boards (“female velcro”) for wall	30415
9	1	Digital maximum and minimum thermometer	30582
14	8	Velcro strips, self-adhesive (for max. and min. thermometer)	30431
10	1	Telescopic tripod, height 102 cm	30598
15	1	Sac for stabilizing the tripod with weight (stone, etc.)	26930
11	1	Clamping arm for tripod for compass card and wind vane	30601
*	1	Compass card, plastic, 180 mm dia.	2887
12	1	Compass with pointer lock (“female velcro”)	30652
*	1	Wind vane, stainless steel	30636
13	1	Cup anemometer with protective cover	30458
*	1	Demonstration thermometer model, 100 x 450 mm with velcro strips	30660
*	2	Cleaning cloths	18105
*	5	Weather observation tables for 4 weeks	3090

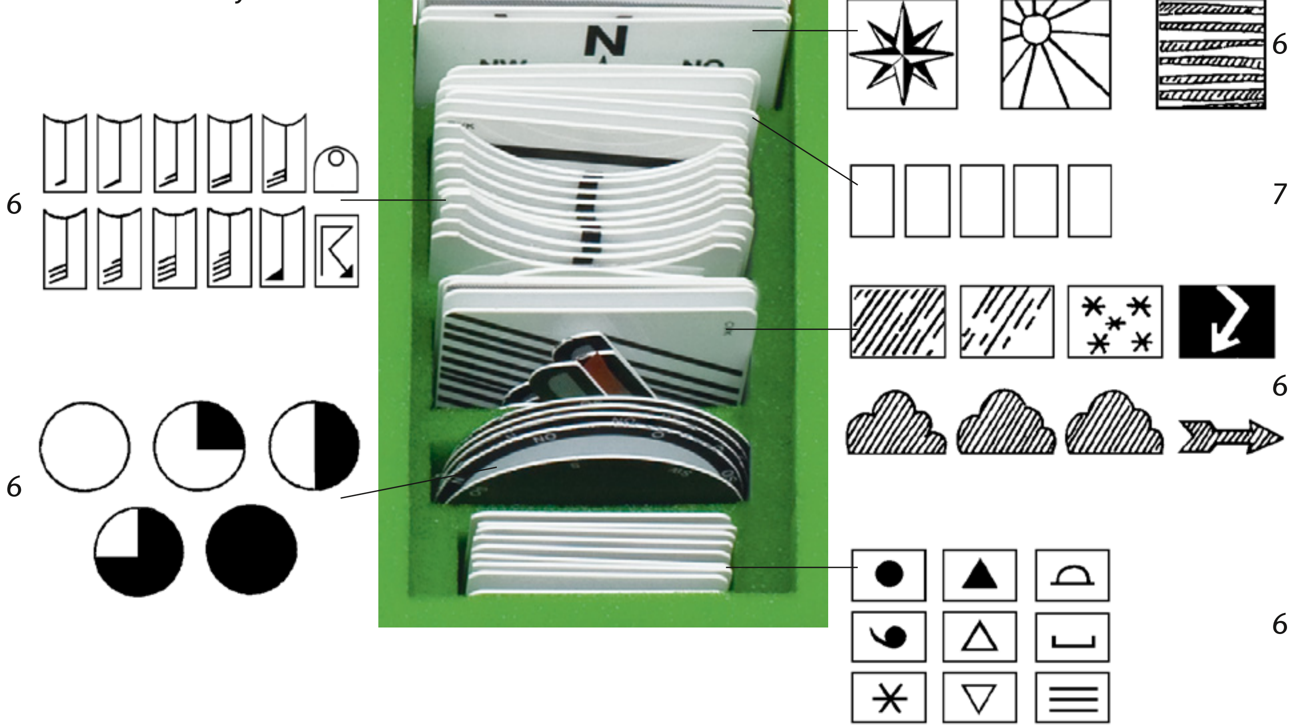
Enclosed printed material:

*	1	Experiment description/Manual ‘Wind and Weather’	895906
–	1	Storing diagram ‘Wind and Weather’	8959036

* These materials are stored in the enclosure of the kit

Storing diagram

Weathersymbols



Wind and Weather

1 Special learning Aims

- The students are made aware of random experiences related to the subject "weather" which occur in their environment.
- The students can describe weather conditions in everyday language and learn about the four specified weather elements: temperature, clouds, precipitation, wind strength.
- The students learn how to read measuring instruments and enter the readings in tables and temperature curves.

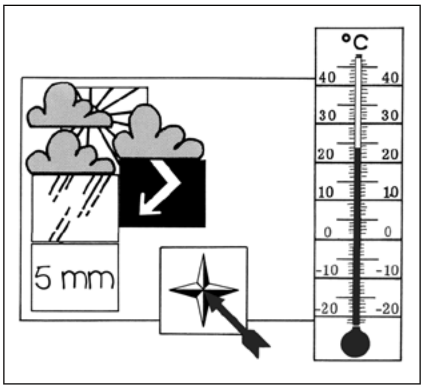
2 Lesson Suggestions

2.1 Lesson Suggestion 1
What makes the weather?

Learning Objectives

- Temperature, clouds, wind and precipitation are important weather elements.
- The students can describe weather conditions in everyday language and learn about the four specified weather elements.

Suggested Procedure



The four weather elements were selected from the complex phenomenon of "weather" since they can directly be observed by students. Due to their abstract nature, atmospheric humidity and atmospheric pressure are not discussed here although they are of great significance to weather and particularly to weather forecasting.

Using everyday language, the students should try to express their observations as clearly as possible. The teacher should attempt to guide them in providing accurate descriptions. Instead of the current weather, the students can also describe weather occurring in other seasons. The descriptions are first written on the blackboard in random order. By underlining in different colours (comments on temperature red, clouds blue etc.), the four important elements can then be pointed out and named.

The terms "clouds" and "rainfall" must be introduced. For example, children do not always immediately refer to clouds – the question as to why the sun cannot be seen on some days draws the attention of the students to the fact that clouds mask our view of it. The students are aware of **precipitation** only in the concrete forms such as rain and snow, occasionally hail, perhaps also dew. These phenomena occur as the result of **precipitation** of the moisture (water vapour) in the atmosphere during cooling, similar to the way water vapour contained in breath condenses on a cold window or a mirror.

After the students have acquired a general sense of the four weather elements, these are discussed individually in the following.

Materials: Weather symbols (6)
Demonstration thermometer (*)

2.2 Lesson Suggestion 2
Recording the temperature

Learning Objectives

- The students can correctly measure the air temperature and record the findings.

Suggested Procedure

The aim is learning to use a thermometer. The students should be instructed in the proper manner to handle a thermometer and how to avoid measuring errors. Recording temperature can be practised for example by measuring the air temperature inside and outside the classroom and also with the aid of containers filled with water at different temperatures.

Reading temperatures above and below freezing point i.e. +3 °C and –3 °C requires special attention. The terms "plus" and "minus" can be initially introduced with the signs "+" and "-". At a later stage in the learning process, steps should be taken, to omit the "+" for temperatures above 0 °C. The findings are entered in a table. Particular attention must be paid to the correct way of writing temperature, i.e. 17 °C and *not* 17° C.

Materials: 1 thermometer, –25 °C to 50 °C (1)

Additionally: Containers

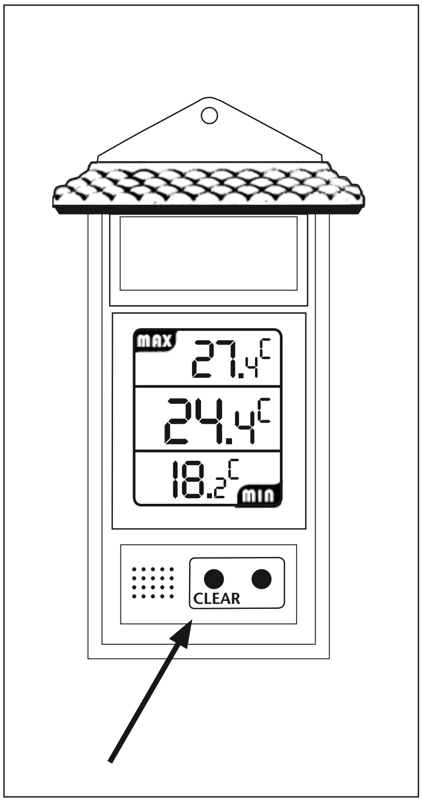
2.3 Lesson Suggestion 3
Maximum and minimum temperature

Learning Objectives

- The students recognize the possible applications of a maximum and minimum thermometer (direct measurement and "storage" of measured figures) they can read the displays of the max. and min. thermometer.

Notes on the Recording Material

With the help of the digital maximum and minimum thermometer it is possible to record the current temperature as well as maximum and minimum values. It is weatherproof and can be used inside and outside.



The thermometer is delivered with a battery inside. However, the battery has to be activated once. To this end you open the battery case with a spoon-handle and remove the plastic strip between the battery and the contact plate. The thermometer is working with a 1.5 V AAA-battery.

The display in the middle shows the current temperature, the upper display the maximum and the lower display the minimum temperature since the memory has been cleared for the last time.

To clear the memory you have to push the button "**Clear**" on the bottom of the thermometer.

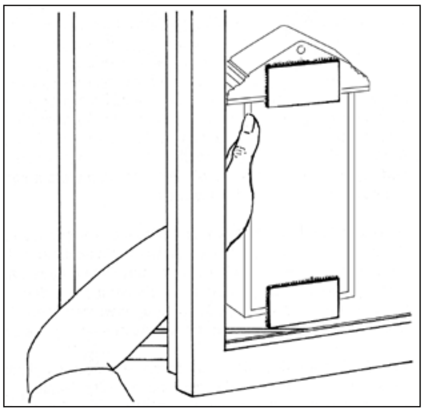
With the help of the button C/F –also on the bottom of the thermometer– you can choose between °C and °F as measuring unit.

Wind and Weather

The thermometer has to be handled properly (no extreme temperatures, no vibrations or the like).

If the signal gets weaker, please change the batteries.

The max. and min. thermometer can either be hung on a nail or attached to a window with the help of the Velcro strips.



(The displays are visible from the inside.) Four pairs of Velcro strips are included in the kit so that the experiment can also be carried out in other classrooms.

Care must be taken to ensure that the max. and min. thermometer is installed in an area which remains in the shade all day. It is advisable to follow the following directions when reading the max. and min. thermometer:

Without removing the thermometer from the window, the current, the maximum and the minimum temperatures are read on the displays. All figures are noted and cross checked.

Suggested Procedure

Maximum and minimum temperatures in the form of average values or current temperatures are often important for weather observations. This can be explained to the students by using one of the following examples: during hot summer weather, the maximum day temperature reveals more about present weather conditions than the average temperature. In spring, recording the minimum temperature indicates whether or not frost occurred during the night.

A recommended measuring exercise is to record the minimum temperature of the following night. For this purpose, a suitable measuring place is determined and the thermometer is set up in this spot at the end of the lesson. On the following day, the thermometer is read at the beginning of the lesson; maximum, minimum and current temperatures are noted.

Materials: Digital maximum and minimum thermometer (9)
Velcro strips (14)

2.4 Lesson Suggestion 4 Measuring the temperature day by day

Learning Objectives

- Weather observations over a long period of time can be compared only when it is carried out daily at the same place and time. The air temperature is recorded outdoors in a shady place which is at least 0.5 m above the ground.
- The students enter the temperature readings (current, maximum, minimum) in a table and later compile the figures to form a temperature curve.

See **Temperature table for one week on** page 25

Suggested Procedure

Before daily recordings of the temperature can begin, a class discussion can be held as to where and when recordings should take place. As a result, the students should remember the following precautions:

Air temperature is recorded

- outdoors
- in a shady place
- at least 0.5 m above ground
- every day at the same time

Use of the Max. and Min. Thermometer

The instructions for use of the max. and min. thermometer must be observed closely. The measuring period for daily recording is 24 hrs. The maximum or minimum temperature could therefore have already been reached by the afternoon or evening of the previous day when the recording takes place at 10 a.m.

Noting the measured Figures

The student responsible for recording goes to the measuring place, reads the measured figures and writes them down. All students enter the measured temperature either in their note books or in their copy of the temperature table (see page 25).

At first the temperature in °C is indicated over the thermometer of the respective day. Then temperature is marked on the thermometer scale by a cross line.

At the end of the week, the recording symbols are joined together with a straight line, resulting in a temperature curve. The students describe on which days the lowest and highest temperatures were attained.

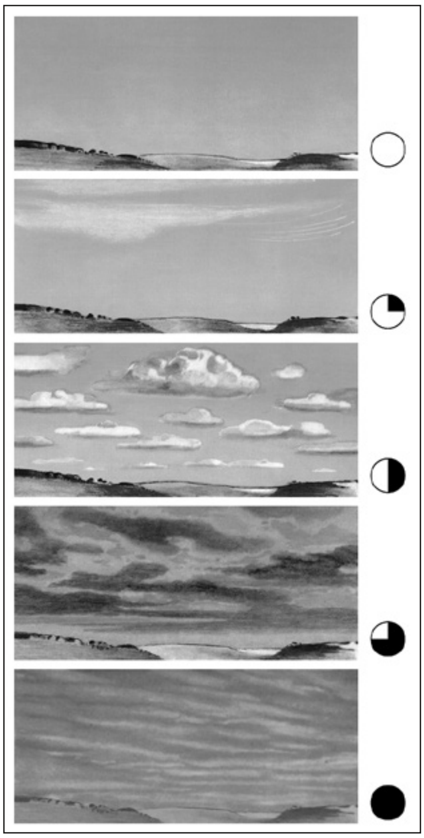
The students can be prompted to provide comments on the progression of temperature during the week by answering the following questions:

- Did the temperature increase, drop or remain unchanged during the course of the week?
- Were changes gradual or sudden?
- On which day was it warmest measuring time, and which day coldest?
- Do the maximum, minimum and current temperature curves always increase or decrease at the same time?
- In which period did the largest temperature fluctuation occur?

Even after the first week, the daily temperature recordings are pursued. These measured values are entered in the weather observation table.

Materials: 3 blank plastic cards (7)
Digital maximum and minimum thermometer (9)
Adhesive board (*)
Demonstration thermometer model (*)
Temperature table for one week on page 25

2.5 Lesson Suggestion 5
Clouds



Learning Objectives

- The degree of cloudiness is indicated by the corresponding black segments of a circle. A distinction is made between

○ clear,

◔ quarter cloud (fair),

◑ half cloud,

◕ three-quarter cloud (cloudy),

● overcast.

The students can determine the degree of cloudiness by observing the sky.

Preliminary Remark

The subject of "clouds" should be introduced at a point when the subject "temperature" has progressed to such a stage that a group can individually measure the temperature outdoors. The different types of clouds are not discussed in this lesson; the students only observe the amount of clouds.

Suggested Procedure

Estimating the amount of clouds is not a simple task. One should imagine pushing the clouds together in the sky and estimate how many quarters of the sky are covered. The estimate of various students will often not coincide. In these cases, after observing the sky once again, a consensus should be reached.

First, the students should stand outdoors with the teacher and observe the clouds, then estimate the amount and enter it in their notebooks.

The amount of clouds should be observed at the same time as the recording of the temperature. After a few days, the group of students measuring the temperature can also observe the clouds. The students of this group work on their own and communicate their results to the rest of the class by writing them on the blackboard (current temperature and the maximum and minimum temperatures).

The corresponding cloud symbol is affixed on the adhesive board.

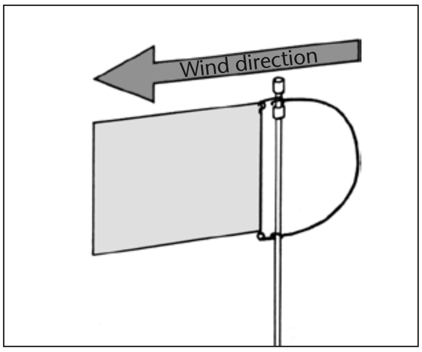
The following week, the figures are entered in the classroom table (as already done for temperature).

Materials: 5 cloud symbols from the set of weather symbols (6)
Adhesive board (*)

2.6 Lesson Suggestion 6
Wind direction

Learning Objectives

- The students learn the points of the compass, N, S, E, W, NE, NW, SE, SW and their representation on a compass card.
- The wind is identified according to the point of the compass from which it blows.
- The wired bow of the wind vane indicates the direction from which it blows. The vane itself indicates the direction towards which it blows.
- The students can read the direction from the wind vane and enter it in their notebooks.

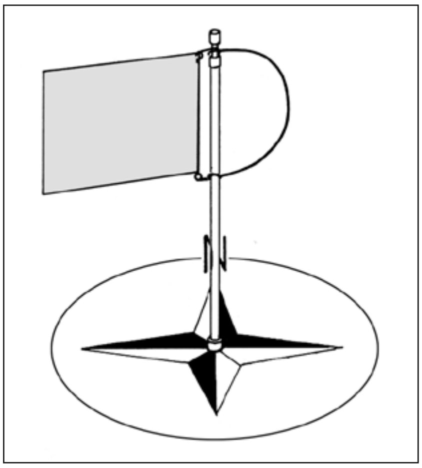


Preliminary Remarks

The students should know the points of the compass and their abbreviations before starting this chapter. The large plastic compass card (with arrow) can be used if revision should be necessary.

The students should be able to read the wind direction from the wind vane with a certain degree of accuracy. The following exercise is suggested for this purpose.

Initially, the teacher provides the students with the following information: The wind is identified after the point of the compass *from* which it blows; the wire bow of the wind vane always shows the direction *from* which it blows and the vane itself points in the opposite direction.



With the help of a ventilator, the teacher moves the wind vane in various directions. (For this purpose the wind vane is assembled with a compass card and clamping arm and mounted onto a table or, in accordance with the instructions, mounted on the tripod.) Students can now practice reading the direction of the "wind".

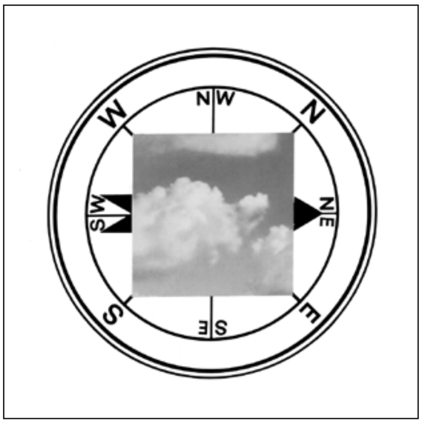
The ventilator offers a considerable advantage: it clearly indicates the direction from which the wind is blowing. As soon as the students can identify the wind direction verbally, they can indicate it in symbolic form on the blackboard.

With the material provided in the "Wind and Weather" kit, two methods of determining the wind direction outdoors can be used:

Method 1:

Direction in which the Clouds move across the Sky

The wind direction can be determined by the direction in which the clouds move across the sky. Using the compass, the students determine the north and place the large compass card on the ground.

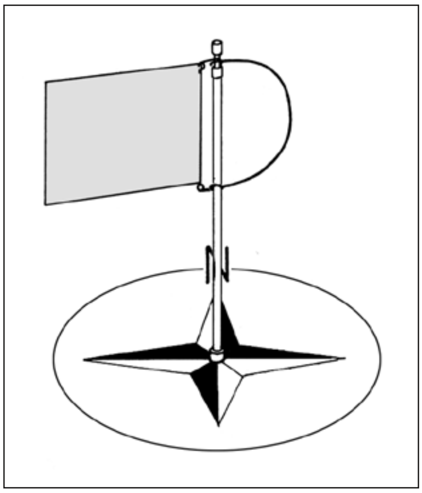


They then place the cloud mirror precisely in the centre of the compass card. The point and tail of the red arrow protrude slightly from under the cloud mirror. The point of the arrow can be turned in the direction in which the clouds are moving (by spinning the tail of the arrow, the mirror also rotates), thereby facilitating the reading. On some days however, the direction in which the clouds move differs from the direction of the wind near the ground. This is the disadvantage of this method since only the direction of the wind near the ground (precisely at a height of 10 m) is decisive for the official weather report.

Wind direction and clouds are both recorded at the same time as the temperature.

Method 2:

Wind Direction near the Ground



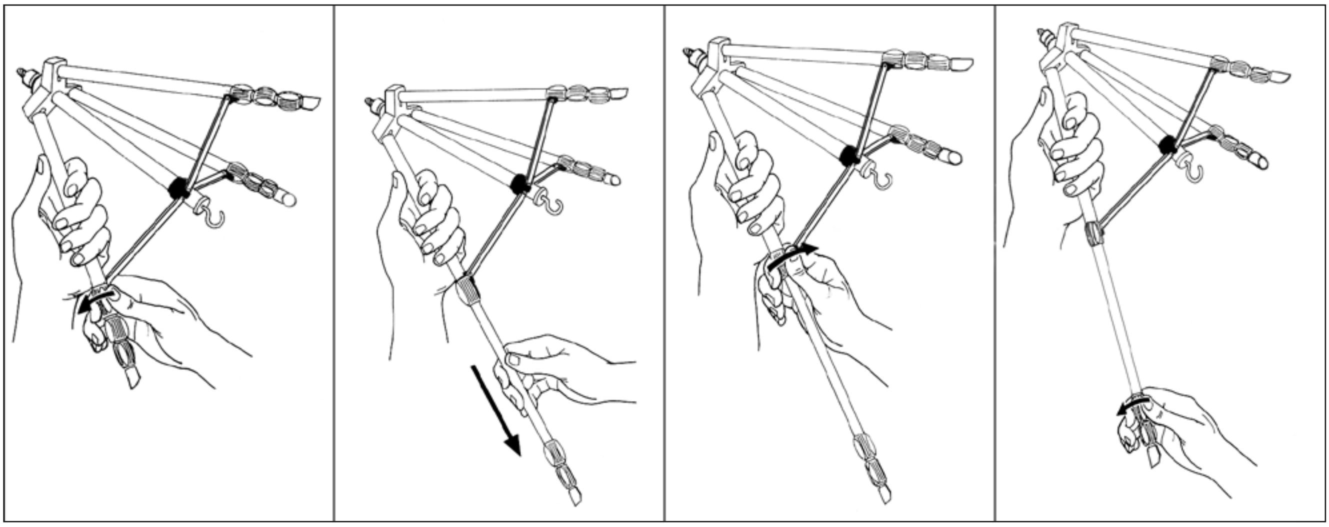
The wind vane and small compass card are used to determine the direction of the wind near the ground. It is also necessary to set up the tripod for this purpose. Areas in the vicinity of large buildings or thick bushes should be avoided in selecting the location (deflection of wind direction, turbulence, sheltered areas). If possible, the observation point for wind strength and direction should be identical as the one for recording temperature and cloudiness.

The tripod is brought daily to the same location at the same time. This also ensures a constant level for the wind vane (and later the anemometer) above the ground. This is important since, in addition to the already mentioned factors, the wind direction and strength are also influenced by friction on the ground and the topography. Even if all the obstacles cannot be completely avoided by the use of the tripod, it does ensure that each measurement takes place under precisely the same conditions.

Notes on the Recording Material

Mounting the Tripod

The leg extensions of the tripod are locked into place with levers. It functions on the same principle as a photographer's tripod.



Wind and Weather

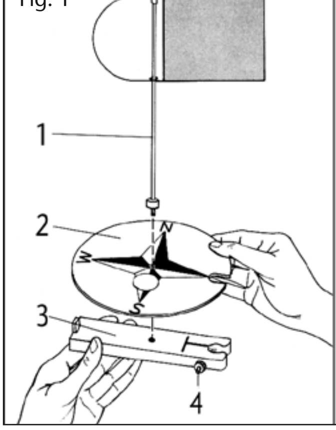
Fig. 1


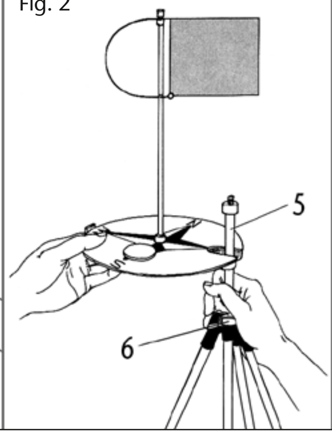
Fig. 2


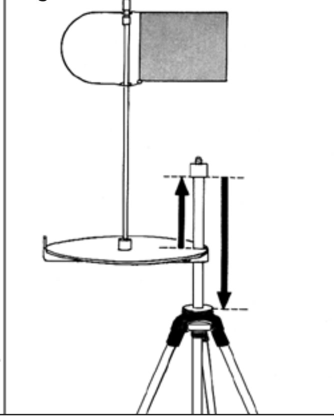
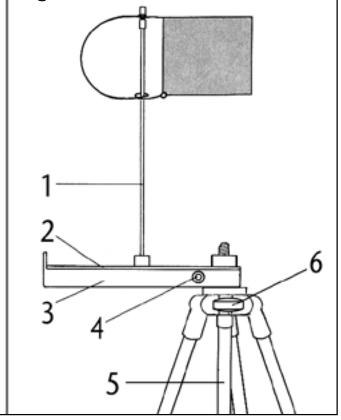
Fig. 3


Fig. 4


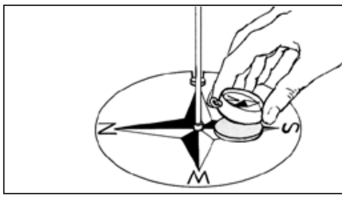
Mounting a Compass Card and Wind Vane

Fig. 1: The smaller of the two compass cards (2) is adjusted in the clamping arm (3). The wind vane (1) is screwed into the arm over the compass card.

Fig. 2: Unscrew the clamping screw (6) on the head of the tripod and pull the central rod (5) upwards. Retighten the clamping screw. Attach the clamping arm, compass card and wind vane laterally onto the central rod.

Fig. 3: Pull the clamping arm upwards against the bolt of the central rod and lock it into place with the small plastic screw (4).

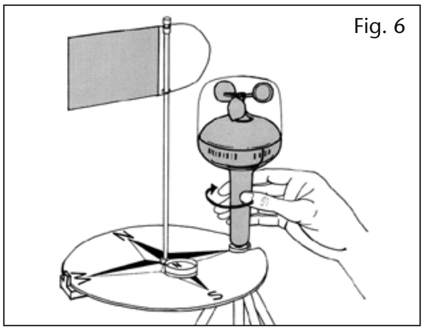
Fig. 4: Loosen the clamping screw (6), slide the central rod down with the compass card as far as it will go and retighten (6). It must still be possible to turn the central rod.

Fig. 5


Attaching the Compass

The compass is attached to the compass card. Ensure that the north-south axes of both compass cards correspond (Fig. 5).

If applicable: Screw the anemometer onto the thread of the central rod, remove protective cap (Fig. 6).

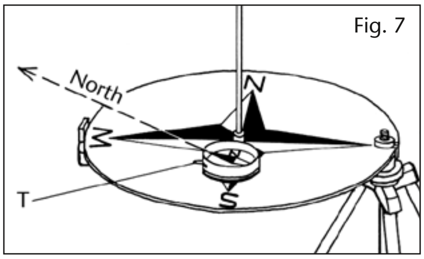
Fig. 6


The enclosed sac in which a weight is placed (i.e. stone, brick) should be hung onto the hook – particularly in the case of strong wind. This greatly increases the stability of the tripod.

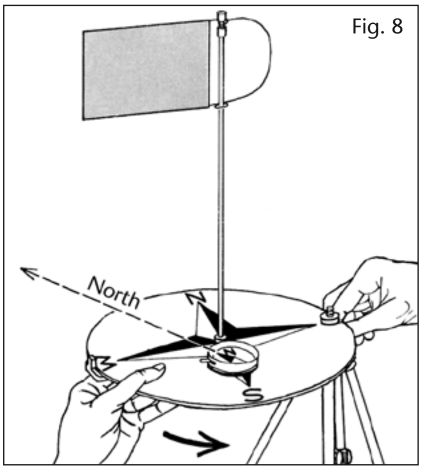
Ideally, the completely assembled measuring device should be stored in the classroom. The anemometer can be easily removed to protect it from possible damage.

Setting the Compass Card to the North

At the measuring location, the compass card must be orientated to the actual points of the compass. By releasing the small handle (T), the compass needle will be moving freely and point to the north (Fig. 7).

Fig. 7


The central rod of the tripod with the compass card must be carefully turned until the blue end of the compass needle points to “N” (Fig. 8). (Allow the needle to settle.)

Fig. 8


Suggested Procedure

In the initial phase, setting up the tripod and reading the wind direction should be supervised by the teacher. The group of students which later carry out the daily recordings on their own enters the symbols for wind direction, the temperature and cloud recordings onto the adhesive board. The set of weather symbols also includes a plastic card with a small illustration of the compass card and a red plastic arrow. The students adjust the card in the correct position on the adhesive board and place the plastic arrow beside their record of wind direction. (The velcro strip is under the tail of the arrow. The arrow should be affixed in such a way that its head points to the centre of the compass card.)

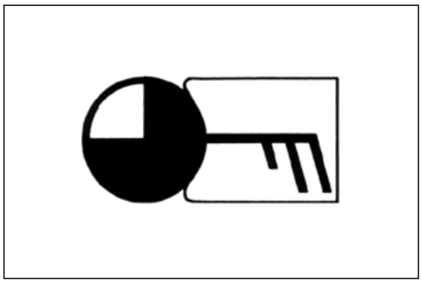
This could be a good time to inform the students that all graphic representations of compasses (on maps, etc.) show the north pointing upwards. In exceptional cases, i.e. in some construction drawings, the north must be specifically identified.

Materials: Small compass card and
Plastic arrow from set of weather symbols (6)
Tripod (10) with clamping arm (11)
Compass with velcro back (12)
Sac for stabilizing with weight (–)
Compass card with arrow, 250 mm dia. (*)
Cloud mirror (*)
Adhesive board (*)
Compass card, 180 mm dia. (*)
Wind vane (*)

Additionally: Ventilator

2.7 Lesson Suggestion 7 Wind strength

Learning Objectives



- The students can observe and describe the effects of the wind.
- The students are introduced to wind measuring devices based on the principle of the anemometer, which they learn how to use. They can read the wind strength and speed and use various units of measure.

Preliminary Remarks

When studying the weather, younger students should not use the complete Beaufort scale since it is too extensive. Learning should be restricted to only a few clearly distinguishable degrees.

Suggested Procedure

Students should not be immediately confronted with the anemometer; rather, it should be introduced, for example, by asking the question: “How can the various wind strengths be recognized?” Only then can the students formulate fundamental considerations on how they would record the wind strength if the actual device had “not yet been invented”. For example, the students could suggest the idea of holding the wind vane horizontally; the deviation from the vertical would then be a rough measure of the wind strength. The deflection of the wind vane can be demonstrated in the classroom with the aid of a ventilator. To produce different “wind strengths”, the flow of air from the ventilator could be partly obstructed.

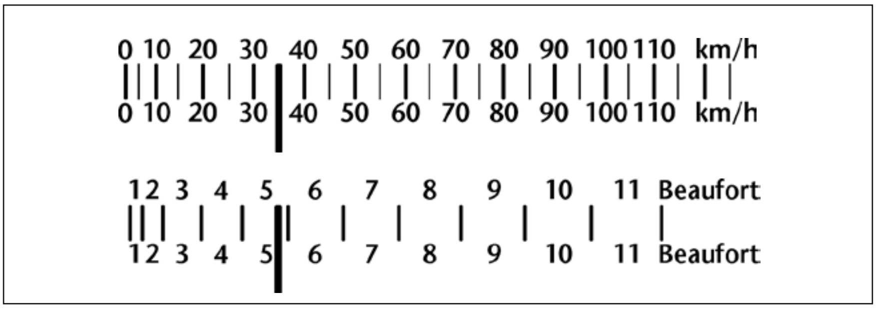
The estimates of the wind strength provided by the students and the "measurements" with the horizontal wind vane will be rather inaccurate; for example, the wind vane continually moves back and forth. At this stage, the necessity of using **precise measuring instruments (the anemometer)** should become clear to the students.

Depending on the students' degree of ability, measurements with the anemometer are based on either the Beaufort scale or wind speed scale. The measurement in km/h is the simpler of the two to comprehend since in most cases the students can associate ideas of speed with this measurement (speedometer, traffic signs, etc.).

The following should be noted when reading the anemometer scale:

The wind speed scale is a regular lined graduation scale: a certain speed value is assigned to each graduation of the scale **(a speed of 35 km/h shown on the illustration).**

The Beaufort scale is a range scale: the ranges between the graduations correspond to the individual wind strengths (wind strength 5 is shown in the illustration).



Explaining the correct use of the anemometer is of considerable importance for students using the instrument for the first time. For this purpose, the students hold the instrument in their hands and determine the proper and improper ways of taking measurements (i.e. areas obstructed by the user or buildings, etc.).

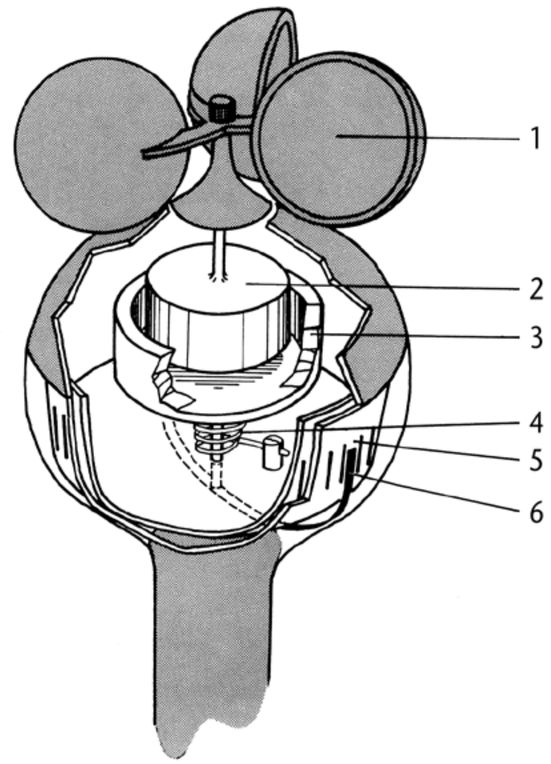
After thorough practice in class, the wind strength and speed should be recorded by the group of students responsible for weather observation. **(Screw anemometer onto tripod.)** The measured results are shown on the adhesive boards. Ten wind strength symbols are provided under the weather symbols along with five blank plastic cards, one of which can be used for recording the wind speed. The students enter the measured results into their notebooks.

Some students will still not be able to comprehend the functional principle of the anemometer. If this becomes a problem, the teacher can inform the students that the instrument works in the same manner as a speedometer.

Notes on the Recording Material:

The operating principle of the anemometer is briefly explained: Instruments of this type are named after their characteristic design features, i.e. **"cup anemometer"**.

Like automobile or bicycle speedometers, their main component is a ring-shaped magnet. (For reasons of clarity: the magnet shown in the figure beside is not ring-shaped but cylindrical.) The magnet (2) rotates along with the wind cups (1).



(1) = Wind cups
(2) = Magnet
(3) = Aluminium bowl
(4) = Spring coil
(5) = Scale
(6) = Indicator needle

The aluminium bowl (3) is not mechanically linked to the magnet; however, it is made to rotate by the changing field of the rotating magnet. The spring coil (4) breaks this movement. The aluminium bowl rotates only a short distance, i.e. the further the movement of the bowl, the greater the speed and therefore the torque of the magnet. The double-ended indicator needle (6) inside the bowl points to the actual wind speed on the scale (5).

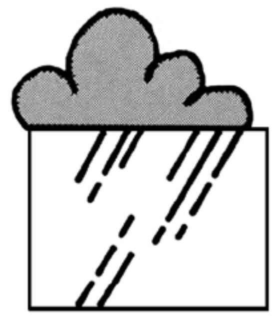
Materials: Anemometer (13) with or without tripod (10)
Wind vane (*)

Additionally: ventilator

2.8 Lesson Suggestion 8
Recording the rainfall

Learning Objectives

- The students can record the level of rainfall in mm with the aid of a **rain gauge**.
- The measuring location for rainfall should be at a reasonable distance from buildings, trees and the ground.



Preliminary Remark

For students, precipitation is an important weather phenomenon, sometimes even used as a synonym for "weather". Weather observation centres on the type and quantity of precipitation, therefore equal importance should be attached to these two weather factors as it is to temperature, clouds and wind direction and speed.

Types of Precipitation

It becomes obvious to the students that symbols must be used in order to represent the types of precipitation on the weather chart. During a class discussion, the students name the different types of precipitation which they know and develop their own corresponding symbols. These symbols can be used in the weather survey. Initially, the symbols can be restricted to those for rain, snow and dew, and the others can be subsequently introduced as needed. (The term "snow" should not be used but rather "snowfall" so that the students do not enter in the weather table snow which is already on the ground.) In the case of a thundershower, the symbol for rain should be entered in the weather table in addition to the symbol for thunder.

The students' symbols will probably differ very little from the pictograms used in the official weather charts. It is therefore an easy transition to use the official symbols. Weather situations, for which no pictograms are provided in the kit, can continue to be represented by the students' own symbols written on the blank cards.

On this basis, the students can more easily understand the development of the meteorological symbols-stylized raindrops for "rain", snowflake for "snow", etc.

Quantity of Precipitation

In order to convey to students that it is not sufficient for the weather survey to simply indicate the type of precipitation (rain, snow, dew), the teacher could, for example, remind them that during a rain shower, the ground could become only slightly wet while after a long period of rain, large puddles or even flooding can occur. The students will then realize that the quantity of precipitation is also decisive and must be recorded. Generally, any container with a millimetre scale can be used to read the rainfall level.

The term rainfall level can be illustrated to the students in the following manner: several rain collectors are brought out and rain is simulated by a watering can with sprinkler.

Reading the level must be practised by the students. For this purpose, the teacher fills the measuring vessels with water at different levels and numbers them. The students proceed from vessel to vessel reading the "rainfall levels" and noting down their results.

The teacher should explain that their rain collectors are not particularly suitable for accurate recording of rainfall since small quantities of rain cannot be recorded; also, the rain collector should not be placed on the ground since additional water can splash into the collector. For this reason, it is better to use a special rain gauge for regular observation: the **pluviometer.**

The **mechanism of the pluviometer** should be explained in particular detail otherwise the students could easily draw wrong conclusions and confuse the terms "rainfall quantity" and "rainfall level". The surface area at the base of the large rain gauge (pluviometer) is approximately equal to that of the students' rain collector; however, the opening of the large one is much wider than that of the students' one. It thereby collects much larger amounts of rainfall and the liquid level in the pluviometer is much higher. Its scale is therefore calibrated to not indicate rainfall quantity but rainfall level. Consequently, compared to the millimetre scale of the students' rain collector which directly indicates the rainfall level, it is considerably more extended and precise in its measurement.

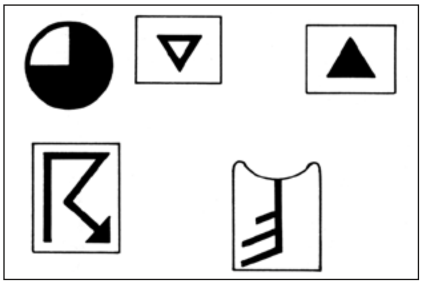
The place where the pluviometer should be installed is determined before daily recordings start. If possible, it should be mounted on a post so that the collecting opening is 1 m above the ground and far away from the nearest obstacles (houses, trees). If, for space reasons, this is not possible, deviation must be taken into account. The intention is not to provide observations and recordings for weather stations but rather to indicate that precipitation can be measured.

Materials: 1 graduated rain collector per group (2)
Pluviometer for continuous observation (3, 4)

Additionally: broom handle as a stand for the large rain gauge (length approx. 1 m), 1 watering can with sprinkler for demonstration purposes

2.9 Lesson Suggestion 9
Using the weather symbols on the adhesive boards

The equipment provided in the "Wind and Weather" kit includes two adhesive boards, one set of 37 plastic cards with weather symbols, 5 small blank cards and a demonstration thermometer model. The daily measured results are shown on the adhesive boards. The possible methods of using the weather symbol boards are again summarized in the following:



Weather symbols (unarranged)

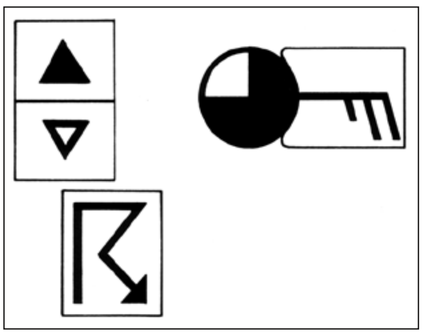
Personal Symbols: The students describe or draw the symbols with the supplied water-soluble marker onto the plastic cards, then affix them to the board.

Predetermined illustrative symbols: The plastic cards with the simple pictograms are used to represent the weather outlook and the thermometer with the velcro strips at the back is used for specifying the current temperature. Weather descriptions for which there are no pictograms can be represented by drawings on blank cards.

The reverse of the thermometer model has the same type of scale as a clinical thermometer. This scale should only serve to demonstrate a 1/10 °C graduation and corresponding reading exercises. It is of absolutely no significance in describing the weather.

Meteorological symbols: The representation of the weather on the board can be represented with the internationally recognized weather symbols. **The master copy on page 27 provides the user with an overview of the official meteorological symbols**. Since these symbols partly appear in combined form (clouds, wind speed and direction are represented by one symbol), combinations are also possible with the symbols provided in the kit.

One procedure is to have the students select the corresponding single symbols and attach them to each other to form a combined symbol. To indicate the temperature and the quantity of rainfall, the students use the blank cards.

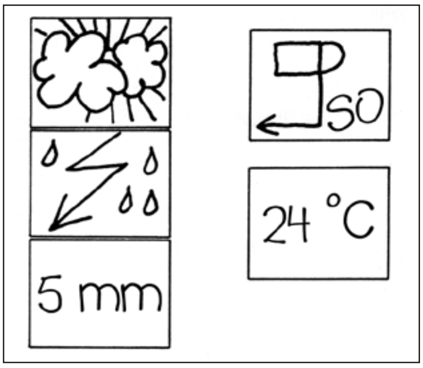


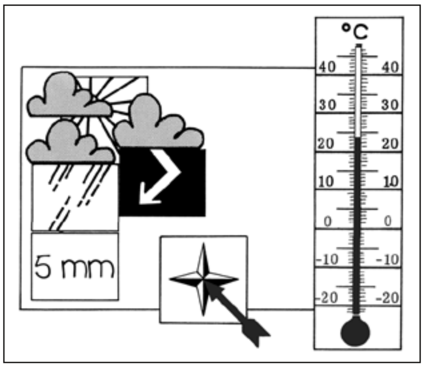
Weather symbols (arranged)

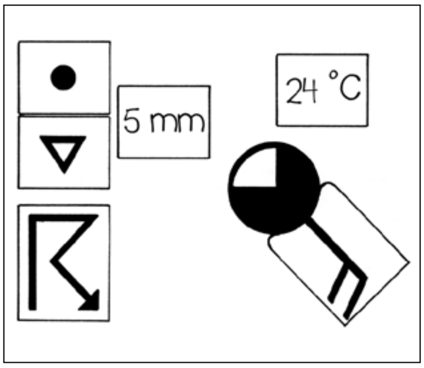
It is possible to place various forms of symbols side by side and slowly introduce the students to the more complex ones.

For example, the measured results can initially be represented freely. The corresponding pictograms are then attached next to them on the second board, serving as a "translation". Finally, the meteorological symbol is added and replaces the other forms of representation.

Various representational options of the same weather condition are shown in the following figures.







2.10 Lesson Suggestion 10
A weather survey over four weeks

For the **weather observation table for four weeks see** page 26

Learning Objectives

- The students can, on their own, observe the weather elements: clouds, temperature, wind (direction, speed) and precipitation (type, quantity) over a long period of time and enter the observed data in a table.

Suggested Procedure

The observations should take place over a sufficiently long period of time in order to ensure that all students are themselves often enough actively involved. This also ensures that an adequate number of different weather conditions occur, thereby making the survey worthwhile. Four weeks are generally sufficient; it is advisable to select a period in which the weather will most probably be erratic (spring).

Before use the descriptions for the various weather elements should be written in the weather observation table by the teacher.

Materials: Large rain gauge (3, 4)
Weather symbols (6)
Digital maximum and minimum thermometer (9)
Tripod (10) with clamping arm (11)
Compass with velcro back (12)
Anemometer (13)
Adhesive board (*)
Compass card, 180 mm dia. (*)
Wind vane (*)
Weather observation classroom table for four weeks (*)
Weather observation table on page 26

2.11 Lesson Suggestion 11
Evaluation of the weather survey

For the **weather observation table for four weeks see** page 26

Learning Objectives

- From a weather table, the students can read the weather conditions on a single day and the course of the weather over several days.
- Using their own weather table, the students can perceive relationships between the weather elements (i.e. the precipitation does not

occur without clouds, except for dew, the west wind often brings rain; a strong wind blows during a thunderstorm; amount of clouds and sunshine influence the temperature).

Suggested Procedure

Completion of the weather survey requires thorough observation and recording of the weather conditions. When beginning the analysis of the weather table, it is advisable to have the students describe the weather on individual days with the help of the weather table. This exercise will indicate whether the student can read the weather table; also, if the teacher selects particularly appropriate days, the student's attention will be drawn to the relationships between the weather elements.

The following exercises are intended to acquaint the student with the weather table analysis.

1. Using a ruler, draw the three temperature curves of all 28 days.
2. Do the curves gradually rise or decline or are they almost level from the first to the 28th day?
3. Does the temperature curve noticeably rise or fall suddenly from one day to the next? Do clouds, wind and rainfall change at the same time?
4. How great are the distances between maximum and minimum temperature curves?
5. Is there a period in which the sky was mostly overcast or mostly clear?
6. From which direction does the wind blow most often when the sky is overcast?
7. From which direction does the wind mostly blow when the sky is clear?
8. How were cloud conditions when it rained or snowed?
9. Did dew (hoarfrost) mainly occur when the sky was overcast or clear?

The weather chart often shows several periods with different weather conditions. Depending on the time of year and the observed weather, **several of the following aspects could be elaborated**:

In conjunction with the snow melting, heavy rainfall in spring can easily lead to floods, have an adverse effect on agriculture and destroy reinforced river banks and dikes as well as pose a threat to people, animals and buildings.

In summer, heavy rainfall and storms can destroy a large proportion of crops. On the other hand, a summer which is too dry does not allow grain crops to fully ripen. Warm and sunny weather at the weekend and on holidays results in heavy highway traffic. The resorts have an increased turnover while this is not the case during bad weather; their income thus depends on the weather. **Drinking water can become scarce during prolonged periods of dry weather.**

In winter, road traffic is obstructed during heavy snowfalls, accidents are more frequent, a great deal of work and costs are involved in clearing the roads of snow. During prolonged periods of frost, shipping is obstructed by frozen waterways. Construction work must also come to a standstill.

Heavy storms often occur in spring and fall, causing damage to agriculture and forestry as well as to buildings and overhead power lines.

Material: weather observation table on page 26

3 Underlying principles

All weather phenomena can be attributed to temperature, atmospheric pressure and atmospheric humidity.

Atmospheric pressure and humidity cannot usually be directly observed; they are however the cause of clouds, wind and precipitation, i.e. weather conditions with which students are already familiar and which they can observe.

Temperature

Temperature measurement makes use of most substances which expand when heated, and contract when cooled. **The most common measuring instrument is the liquid thermometer, filled with alcohol or a coloured liquid.**

The graduation of a thermometer is in principle arbitrary. With the exception of a few Anglo-Saxon countries, the **Celsius scale** is the most commonly used scale today, determining the **freezing point of water at 0 °C and the boiling point at 100 °C**.

Particular care must be taken when measuring the temperature to ensure that the thermometer is protected from sunlight and water (due to the lowering of temperature during evaporation). Also, the thermometer cannot be located too close to the ground since various types of land can heat up and cool at different rates. The official meteorological stations record the temperature 2 m above the ground in a thermometer hutch located on a grass surface at a minimum distance of 10 m from other buildings.

Extreme temperatures which have been observed on the surface of the Earth range from 58 °C (Sahara) to –88 °C (Antarctic). The highest and lowest temperatures recorded in Central Europe are 44 °C and –39 °C respectively.

Wind

Wind always **occurs as the result of pressure differences in the atmosphere**. Atmospheric pressure differences normally occur under the influence of temperature. For example, land heats up faster than water at the same degree of thermal irradiation. The layers of air above land and water heat up at different rates, resulting in differences in atmospheric pressure. The wind ensures pressure equalization in the atmosphere.

Wind recordings measure the strength and direction of the wind. These recordings must not be carried out directly above the ground since the wind direction and particularly the wind strength are affected by friction on the ground. Also large buildings, hills etc. locally deflect the movement of air from its original direction, or vary its speed. For this reason, wind direction and strength are recorded internationally in open spaces at a height of 10 m above ground level. At a height of 4 m, for example, a wind speed of about 20% less than at a height of 10 m can be expected, while at 30 m the wind speed increases by approx. 20%.

The direction of the wind is specified by the point of the compass from which it blows. For example, a western wind blows from west to east.

In order to obtain comparable data with regard to wind strength, as early as 1805 Admiral Sir Francis Beaufort compiled a table which differentiates twelve different wind strengths in accordance with their effect on land and at sea. The use of this **"Beaufort scale"** table can of course provide only an estimate of the **wind strength**.

Today, **anemometers are normally used** (the Greek word “anemos” = “wind”). They enable precise recording of the wind strength.

Anemometers actually **measure the wind speed**. However, the scale can also be calibrated to the Beaufort scale since the strength of the wind depends only on its speed. The wind strength according to the Beaufort scale and the corresponding speed ranges are listed in the table on the master copy on page 27. Please also see scales on page 16.

Clouds and precipitation

Warm air can absorb more water vapour than cool air. When warm air cools, part of the water vapour contained in it condenses to form extremely fine droplets of water. These fine droplets which form mist or a cloud can remain suspended in the air since they are extremely light and held by ascending currents of air. However, if several of these fine drops combine to form drops of increasing size, they become so heavy that they fall to the ground in the form of **rain**. On the other hand, if these drops of water are quickly carried high up by a strong current, as is often the case in thunder clouds, the drops of water freeze and then fall to the ground in the form of frozen pellets. If, as the result of repeated upward turbulences in the thunder cloud, further ice is formed around the pellets, they are called hailstones. Hailstones can reach a considerable size, however, during their fall through warmer layers of air, they often melt again before they reach the ground. This then results in large raindrops which often occur at the beginning of a thunderstorm. When atmospheric humidity condenses at temperatures below 0 °C, fine ice crystals are formed which in most cases grow together to form **snowflakes**.

The amount of cloudiness is specified in quarters of the sky: clear, quarter cloud (fair), half cloud, three-quarter cloud (cloudy), overcast.

Also, the amount of precipitation which reaches the ground is measured and recorded daily by meteorologists. The rainfall level is determined with the pluviometer. The amount of rainfall can be calculated from the rainfall level.

The rainfall level indicates the amount of rain or water resulting from melted snow, hail, etc. on even ground if no water could escape, seep into the ground or evaporate. **The rainfall level is measured in mm, the quantity of rainfall is calculated in litres per m^2 (l/m^2).**

A rainfall level of 1 mm therefore means that every square millimetre (mm^2) of the ground’s surface carries a cubic millimetre (mm^3) of rainwater.

1 m^2 = 1,000,000 mm^2. One square meter therefore carries 1,000,000 mm^3 of rainfall i.e. 1,000 cm^3 or 1 litre. The level of 1 mm therefore corresponds to the quantity of rainfall of 1 l/m^2 .

The numerical values of the rainfall level (in mm) and quantity of rainfall (in l/m^2) are identical. If we now consider small or large surfaces, then the amount of rainfall is correspondingly small or large; however, the rainfall level is 1 mm regardless of the size of the surface. Generally, the rainfall level can therefore be measured with a cylindrical vessel which has a millimetre scale.

Care must be taken to ensure that splashwater cannot fall into the measuring device along with the rain. For this reason the pluviometer in weather stations is installed at a level of approx. 1 m above the ground. To ensure the rainfall level is not adversely affected by the environment, the rain gauge should be installed away from immediate obstructions (buildings, trees) in such a way that the minimum distance is equal to their height.

4 Weather chart symbols

The data observed by the individual meteorological stations with regard to temperature, clouds, wind and rainfall are entered on the weather chart in order to obtain an overview of the weather situation for a large area.

Well-known symbols are found in:

- the various weather charts provided by television and newspapers, with their familiar, graphic means of representation;
- the official weather charts which use definite, internationally used symbols.

The following internationally recognized symbols are used in the weather reports printed in newspapers:

The degree of cloudiness is indicated by the corresponding black segments of a circle. A distinction is made between:

clear

quarter cloud (fair)

half cloud

three-quarter cloud (cloudy)

overcast

Precipitation is indicated by a symbol next to the circle.

rain

hail

drizzle

snow

hoarfrost

fog

dew

pellet hail

thunderstorm

The addition of this symbol signifies "shower", i.e.:

rain shower

Examples	**8**	**20**
Temperature:	8 °C	20 °C
Wind speed:	45 km/h	0 km/h
Wind strength:	6	0
Wind direction:	NW wind	–
Cloudiness:	three-quarter cloud	clear
Precipitation:	rain	–

On the weather chart, meteorologists connect stations with the same atmospheric pressure with a line called the isobar; atmospheric pressure is written on this line. **The isobars indicate the location of areas of high and low pressure.**

1 Temperature table for one week

Place of measuring: ______________________________

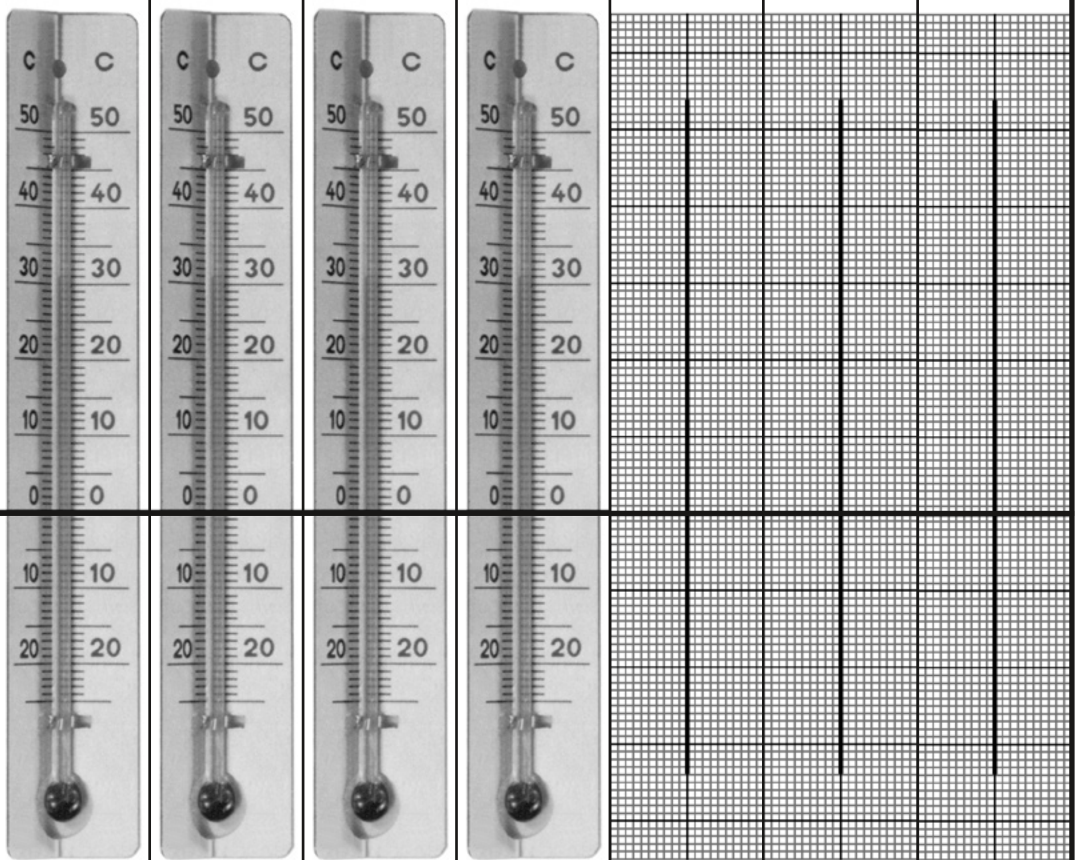
Time of measuring: __________ a.m./p.m.

Day of the week	______	______	______	______	______	______	______
Date	______	______	______	______	______	______	______
Temperature	______	______	______	______	______	______	______

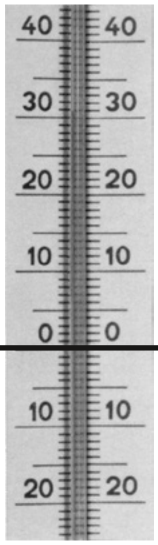
above 0 °C
(+, plus)

0 °C

below 0 °C
(–, minus)



2 Weather observation table (Copy twice for four weeks)

Day of the week Date														
Temperature °C 														
Cloudiness														
Wind direction Wind strength														
Precipitation Type Level in mm														
Symbols														

Cloudiness

- Clear
- Quarter cloud (fair)
- Half cloud
- Three-quarter cloud (cloudy)
- Overcast

Wind strength

- Calm
- Light breeze
- Moderate breeze
- Strong breeze
- Gale
- Storm

Precipitation

- Rain
- Snow
- Drizzle
- Hail
- Pellet hail
- Dew
- Hoarfrost
- Fog
- Thunderstorm
- Shower

3 Meteorological weather symbols

Cloudiness

 Clear

 Quarter cloud (fair)

 Half cloud

 Three-quarter cloud (cloudy)

 Overcast

Precipitation

 Rain

 Snow

 Drizzle

 Hail

 Pellet hail

 Dew

 Hoarfrost

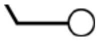
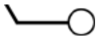
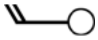
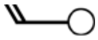
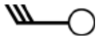
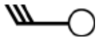
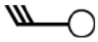
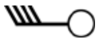
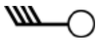
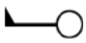
 Fog

 The addition of this symbol signifies "shower", i.e.:

 Rain shower

 Thunderstorm

Beaufort scale and equivalent wind speed

Symbol	Force	Description	Speed in km/h	Specifications (for use on land)
	**0**	Calm	0	Calm; smoke rises vertically
	**1**	Light air	1–5	Direction of wind shown by smoke drift, but not by wind vanes
	**2**	Light Breeze	6–11	Wind felt on face; leaves rustle; ordinary vanes moved by wind
	**3**	Gentle Breeze	12–19	Leaves and small twigs in constant motion; wind extends light flag
	**4**	Moderate Breeze	20–28	Raises dust and loose paper; small branches are moved
	**5**	Fresh Breeze	29–38	Small trees in leaf begin to sway; crested wavelets form on inland waters.
	**6**	Strong Breeze	39–49	Large branches in motion; whistling in wires; umbrellas used with difficulty.
	**7**	Near Gale	50–61	Whole trees in motion; inconvenience felt when walking against the wind.
	**8**	Gale	62–74	Breaks twigs off trees; generally impedes progress.
	**9**	Severe Gale	75–88	Slight structural damage occurs (chimney-pots and slates removed).
	**10**	Storm	89–102	Seldom inland; trees uprooted; considerable structural damage occurs.
	11	Violent Storm	103–117	Very rarely experienced; accompanied by wide-spread damage.
	12	Hurricane	118 and up	Heaviest desolation

 This weather symbol is a combination of:  one symbol for cloudiness and  one symbol for wind.

 The direction of the symbol for the wind indicates **the direction the wind comes from** = wind direction (here: NE wind)

Experiment description/Manual 'Wind and Weather'
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