The Canada Science and Technology Museum
presents

Weather Wise:

A Virtual Exploration Guide to Weather and Climate Change

Section 2: Weather

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Introduction

Before beginning this unit, the students should be familiar with the basic elements of the atmosphere: temperature, wind, the water cycle, precipitation, humidity, air pressure, cloud cover.

Here are a few brief descriptions.

Water Cycle

Water circulates from the land to the sky and back. This is called the water cycle.

The heat of the Sun causes water to evaporate from lakes, rivers and oceans into the atmosphere. The atmosphere carries this water vapour over land where it condenses to form tiny droplets in clouds. Water falls from the clouds to the Earth as precipitation (rain, hail, snow). Rivers and underground systems carry this water back to the lakes and oceans, where the evaporation begins again.

Clouds

As warm air rises, it cools. This causes the invisible water vapour to condense and become visible, forming a cloud. There are many ways to make the air rise, cool and form clouds. Mountains force air upwards. When the air is forced up over the mountains it cools and form clouds. Sometimes a moving cold air mass lifts the air in front of it, forming clouds. Often, the Sun heats air which rises, cools and then forms clouds.

Humidity

The atmosphere always has some water in the mixture. Relative humidity is the amount of water vapour in the air, expressed as a percentage of the maximum humidity possible for the conditions (temperature).

Air Temperature

Air temperature is the measure of how quickly the atoms and molecules of the atmosphere are moving (the amount of energy in the air).

Air Pressure

The atmosphere is a thin layer around the Earth. It extends about 80 kilometres above us. Air pressure is caused by the mass of air above the surface of the Earth pressing down.

Wind

As the sun shines on the Earth it heats up its surface, which then heats the surrounding air. Because surface areas over the equator heat more quickly than polar areas, the atmosphere heats up unevenly. As the air molecules warm up, they move further apart. Warm air is less dense (low pressure) than cold air (high pressure). Air flows from high pressure to low pressure, causing wind. Its direction is influenced by the Earth’s rotation.

Weather Elements

What is weather?

It affects us all and especially our outdoor activities – we need snow for skiing, wind for kite flying, cold weather for skating, and hot weather for swimming. Before we plan our weekends, we usually check the weather. And all through the week, we need to know how we should dress to stay comfortable.

Weather describes the elements of the air and the sky at a particular time and place.

We can get some idea of what's coming in the weather by looking at the clouds. If they are large and dark, it could mean rain. If they are white and fluffy it usually means fine weather. But if we want to look further ahead, we turn to the weather forecasters to guide us. Sometimes the forecast is wrong but most of the time, it is right.

In order to forecast the weather, we gather all sorts of information about the atmosphere.

Activity 2.1 Discovering Weather Elements and How We Measure Them

(Recommended for Grades 4 to 7)

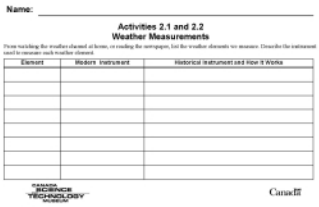
Students will become more aware of the elements that make up the weather.

Have the students watch the weather channel at home or read the newspaper and list in the Activity Sheet 2.1 the elements we measure, and the instrument we use to measure each element. Have them bring in their list to class.

Discuss these charts with the students and explain what each element means. Have them fill in any element they missed.

Teacher's Note:

If you'd like a package of answer sheets, send your request by e-mail to: *virt_prog@technomuses.ca*. Please allow at least a week for us to reply.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Activities 2.1 and 2.2
Weather Measurements

Element	Modern Instrument	Historical Instrument and How It Works

Activity 2.2 Find Historical Measuring Instruments

(Recommended for Grades 5 to 7)

Students will realize we have been measuring the elements of weather for many decades. The instruments we used may have been a little different than those of today.

Depending on the access your class has to computers either at home or in the classroom, have students, or teams of students find examples of historical weather instruments on Canada Science and Technology Museum site:
http://www.sciencetech.technomuses.ca/english/collection/meteo.cfm

Have the students read through the instruments and, for the elements in their charts, find the historical instrument that measured each element. They should add the instrument name and “how it works” to their chart.

Did the students miss any weather elements on their chart? Have them add the omissions.

For older students with some computer skills:

Have your students make the chart in a spread sheet format and add the images of the instruments on the website to their charts.

Activity 2.3 Charting Temperature and Precipitation

(Recommended for Grades 5 to 7)

Students will learn how to collect data over a period of time.

Assign to each student, or team of students, a Canadian city.


Name: _____

Activity 2.3: Keeping Weather Records

Chart the daytime high temperature and the precipitation for your assigned city for one month. Watch the weather channel or read the newspaper for your data.

City _____ Month _____

Day	High Temperature	Precipitation
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Day 8		
Day 9		
Day 10		
Day 11		
Day 12		
Day 13		
Day 14		
Day 15		
Day 16		
Day 17		
Day 18		
Day 19		
Day 20		
Day 21		
Day 22		
Day 23		
Day 24		
Day 25		
Day 26		
Day 27		
Day 28		
Day 29		
Day 30		
Day 31		
Total		
Average (Total/Days)		

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Using Activity Sheet 2.3 (shown here as a thumbnail), have them chart the daytime high temperature and precipitation for that city over a month, by watching the weather channel on TV or reading the newspaper. (Students could take turns bringing in a newspaper.)

At the end of the month, have them calculate the average temperature and precipitation for the month for that city (i.e. the sum of all readings divided by number of readings *actually* made), and the range of temperatures (i.e. the highest temperature minus the lowest)

Have the students use adhesive notes to post the data for the month to a large class map of Canada. Discuss where the largest ranges occurred.

We cannot measure the climate of an area, but only the individual elements of the atmosphere. Altogether, these elements specify the climate of a given place, for a particular period of time. Temperature is the most commonly measured element.

Weather Instruments

Activity 2.4 Make a Weather Vane or Anemometer

(Recommended for Grades 4 to 7)

Students will gain experience in following instructions and develop skills in constructing instruments that measure the weather.

Have half the class make a weather vane and half make an anemometer. You could group them into teams and have them share the tasks.

Did You Know?

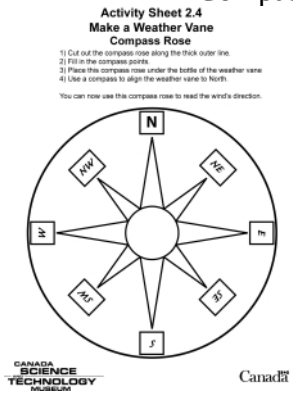
Energy can be produced from the movement of the wind. If you are contemplating using a wind turbine to generate electricity, you need a reliable wind at an average speed of 22 km/h. Wind farms, where a large number of wind turbines are grouped together, are located in windy spots. In Canada, there are over 70 operating wind farms, including those on Cape North P.E.I; Pubnico Point, Nova Scotia; Baie-des-Sables, Quebec; and McBride Lake (Fort McLeod), Alberta.

Activity 2.4a Make a Weather Vane:

(Print this page and give to students if appropriate.)

Equipment:

- Arrow template (see Activity Sheet 2.4)
- Scissors
- Light cardboard (manila file folder or paper plate)
- 2 Drinking straws
- Large straight pin
- Narrow necked bottle (Have students bring in their own; small water bottles are good.)
- Small piece (6 cm x 6 cm) of aluminum foil
- Pan or small aluminum pie plate with stones.
- Compass rose (see Activity Sheet 2.4)



Have the students cut out the triangles from Activity Sheet 2.4 (arrow head and tail) and use them to cut out cardboard ones (paper plate or a file folder). Attach these to each end of a drinking straw, as shown. Balance the arrow on your finger to find the balance point and insert a straight pin vertically through this point. Cover the top of the bottle with a small piece of aluminum foil, make a hole with a pencil at the centre of the foil and insert the second straw through this hole into the bottle. Insert the pin into the open end of the second straw. The arrow should spin freely on top of the bottle. Place the bottle in the pan full of stones. The stones should hold the bottle up. If not, pour water into the bottle to hold it upright. Then place the wind vane outside. The arrow will point in the direction from which the wind is coming.

Mark the compass directions on the compass rose. (See Activity Sheet 2.4) Place it under the bottle or pan of stones. Align it with the North using a compass and determine the direction of the wind.

Activity 2.4b Make an Anemometer

(Print this page and give to students if appropriate.)

Equipment:

- 5 small paper cups
- 2 straight plastic straws
- A pin
- Paper punch
- Stapler
- Sharp pencil with eraser
- Bright coloured marker

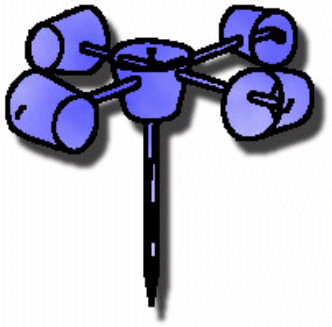


Image courtesy The Franklin Institute Resources for Science Learning.
From "Wind: Our Fierce Friend." www.fi.edu/tfi/units/energy/wind.html

With the paper punch, punch one hole in four of the cups about 1.5 cm below the rim. With the fifth cup, punch four equally spaced holes (at North, South, East and West). If you can, punch a hole through the centre of the bottom of the cup.

Take a cup with one hole punched in it and push the straw from the outside of the cup through the hole until it reaches the opposite inside of the cup. Fold over the end of the straw and staple it to the inside of cup. Repeat this with another one-hole cup and another straw.

Slide the straw from one of these assemblies through two opposite holes in the cup with four holes. Attach another one-hole cup to the end of this straw in the same fashion, making sure the cup faces the opposite direction from the first cup.

Repeat with the other straw assembly and the last one-hole cup.

Align the cups so their open ends will all face in the same direction as the centre cup turns. Centre the straws over the middle cup and push a pin through their intersection. Push the eraser end of the pencil through the bottom hole of the centre cup. If you couldn't punch a hole in the bottom of the cup, use the point of the pencil to make a centre hole. Push the pin into the top of the pencil eraser as far as you can.

Mark one of the cups with a bright coloured marker.

Take the anemometer outside and watch it spin. Count the number of times the marked cup passes by in 30 seconds. Double this and you have the speed in RPM (revolutions per minute). If you multiply this by the circumference of the circle through which the cups spin ($2\pi\mathbf{r}$ where "**r**" is the radius in metres and $\pi = 3.1416$) you will have the velocity of your anemometer in metres per minute, which is an approximation of the velocity of the wind. Try calculating the velocity in kilometres per hour.

Forecasting and the Weather Network

Forecasting the Weather

Today scientists use technology, science and advanced mathematics to forecast the weather. The first step is to take accurate readings of the weather data. All around the world, twice a day weather balloons are launched to collect this data.

These carry instruments that measure and transmit back to Earth information on the temperature, pressure, and humidity in the atmosphere. Radar can track these balloons and determine wind speed and direction at different altitudes. Radar can also look inside clouds at the rain or snow.

All of us have seen weather satellite pictures on TV. Satellites allow meteorologists to look down at the Earth and clouds from space.

The data collected from weather balloons, satellite images and radar, is fed into computers which then, based on certain conditions, calculate and produce weather maps. Meteorologists look at these maps and forecast tomorrow's weather.

Activity 2.5 Radar and Satellite Imagery

(Recommended for Grades 6 and 7)

Students will interact with radar and satellite imagery in real time to measure the weather.

Depending on the access your class has to computers, either at home or in the classroom have students (or teams of students) go to the **Environment Canada Radar** site at *http://weatheroffice.ec.gc.ca/radar/index_e.html* and click on the weather stations to find a city in Canada where it is raining. If there are several places, different teams can take different towns.

Record the nearest city and the precipitation (mm/hr) by using the scale on the upper right. Use Activity Sheet 2.5, shown here as a thumbnail. Have some students from each team check the map every 20 minutes. How far has the rain disturbance moved? In which direction? Has the precipitation increased or decreased?


Name: _____

Activity 2.5
Radar and Satellite Imagery: Rainfall

Go to the Environment Canada Radar site and find a city in Canada where it is raining.

City _____ Date _____

National Doppler Radar: visit
http://weatheroffice.ec.gc.ca/radar/index_e.html

Time	Rainfall (mm/hour)

Satellite Images for North America: visit
http://www.weatheroffice.ec.gc.ca/satellite/index_e.html

Questions:

What is the name of the satellite transmitting the data?

_____

On the Infrared view, what do the colours mean? (Check the Frequently Asked Questions page at http://www.msc-smc.ec.gc.ca/msb/msc/faq_e.html#satellite)

_____

_____

_____

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Continue to monitor the disturbance for the rest of the day.

These images are from the National Doppler Weather Radar network. This new network will enable meteorologists to provide better forecasts of significant weather events. Areas threatened by heavy rainfall can be identified more precisely and estimates of the maximum precipitation intensity given more accurately.

For more information, consult the Environment Canada National Radar Program Frequently Asked Questions web page at *http://www.msc-smc.ec.gc.ca/projects/nrp/faq_e.cfm*

There are also **satellite images** available on Environment Canada – Satellite Images web site at:
http://www.weatheroffice.gc.ca/satellite/index_e.html

Have the students click on the left hand menu (Satellite Imagery) to see an animated satellite image of North America. Use small or medium formats.

Set display images (bottom of map) to "all," click on play and watch the weather pattern as it happened over the last 48 hours. It will take a bit of time to download, but then you will be able to see the weather moving across North America.

- What is the name of the satellite that is transmitting this data?
- On the infrared view, what do the colours mean?

Check out the Frequently Asked Questions page at
http://www.weatheroffice.gc.ca/mainmenu/faq_e.html

Explore this site for more information on satellites: Meteorological Services – Satellite images
http://www.weatheroffice.gc.ca/mainmenu/faq_e.html#satellite3

Activity 2.6 History of Forecasting

(Recommended for Grades 6 and 7)

Students will realize that the science of forecasting is relatively young.

Have the students find the following site on their computers at home. If this is not practical, download the information and distribute it to your class.
http://earthobservatory.nasa.gov/Library/WxForecasting/wx2.html


Name:

Activity 2.6
History of Weather Forecasting

Question | Answer

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They should answer the following questions on Activity Sheet 2.6, shown here as a thumbnail.

- What are the names of the three men who invented the first weather instruments?
- Which elements were measured by the first three weather instruments?
- What communications tool first allowed the routine transmission of weather observations across the globe for compilation into weather maps? What year was this invented?
- What is a radiosonde?

See also
http://www.virtualmuseum.ca/Exhibitions/Heirs/index.html

Have students click on the Timeline and find the date when continuous meteorological records began in Canada. (Hint: see the years 1800 –1899.)

Name: _____

Activities 2.1 and 2.2
Weather Measurements

From watching the weather channel at home, or reading the newspaper, list the weather elements we measure. Describe the instrument used to measure each weather element.

Element	Modern Instrument	Historical Instrument and How It Works

Name: _____

Activity 2.3: Keeping Weather Records

Chart the daytime high temperature and the precipitation for your assigned city for one month. Watch the weather channel or read the newspaper for your data.

City _____ **Month** _____

Day	High Temperature (°C)	Precipitation
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Day 8		
Day 9		
Day 10		
Day 11		
Day 12		
Day 13		
Day 14		
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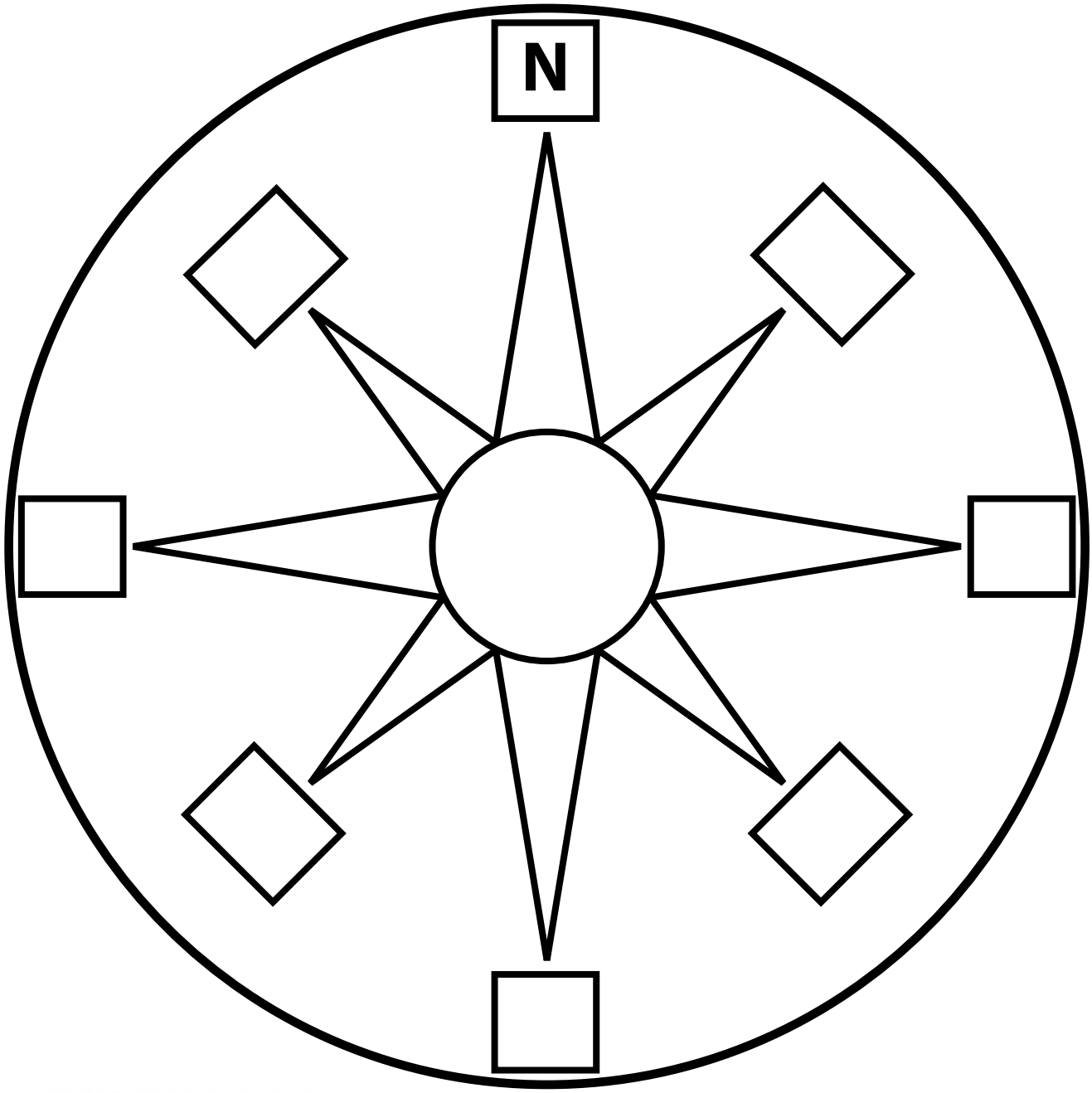
Day 21		
Day 22		
Day 23		
Day 24		
Day 25		
Day 26		
Day 27		
Day 28		
Day 29		
Day 30		
Day 31		
Total		
Average (Total/Days)		

Activity 2.4
Make a Weather Vane
Compass Rose

1) Cut out the compass rose along the thick outer line.
2) Fill in the compass points.
3) Place this compass rose under the bottle of the weather vane
4) Use a compass to align the weather vane to North.

You can now use this compass rose to read the wind's direction.



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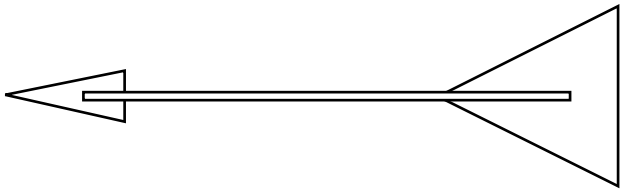
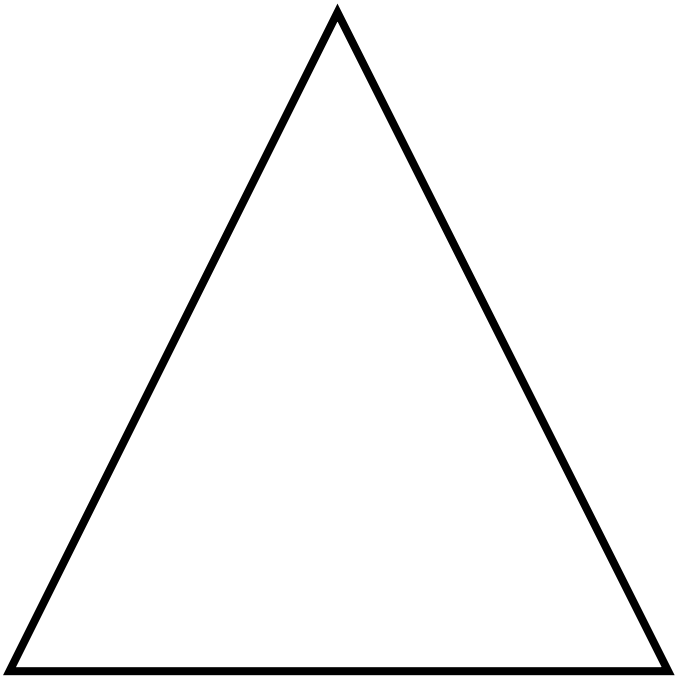
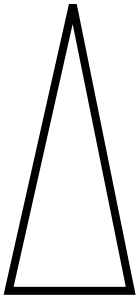
Activity 2.4
Make a Weather Vane

Wind Vane

1) Cut out th lese large vane and smaller pointer.
2) Tape these parts to a drinking straw, as shown in the drawing.







Name: _____

Activity 2.5
Radar and Satellite Imagery: Rainfall

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City _____ **Date** _____

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Time	Rainfall (mm/hour)

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Questions:

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On the Infrared view, what do the colours mean? (Check the Frequently Asked Questions page at *http://www.weatheroffice.gc.ca/mainmenu/faq_e.html#satellite)*

_____

_____

Name: _____

Activity 2.6
History of Weather Forecasting

Visit: *http://earthobservatory.nasa.gov/Library/WxForecasting/wx2.html*
to answer these questions.

Questions	Answers
What are the names of the three men who invented the first weather instruments?	1. 2. 3.
Which elements were measured by the first three weather instruments?	1. 2. 3.
What communications tool first allowed the routine transmission of weather observations across the globe for compilation into weather maps?	
In what year was this invented?	
What is a radiosonde?	
When did continuous meteorological data recording begin and when were the earliest meteorological records in Canada made?	