The Weather Merit Badge

A Study Guide

By

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Requirement 1

- **Define Meteorology. Explain what weather is and what climate is. Discuss how the weather affects farmers, sailors, aviators, and the outdoor construction industry. Tell why weather forecasts are important to each of these groups.**

Definition of Meteorology

- Meteorology is the study of the atmosphere and its weather.
- From ”meteoron”, which is Greek for “things in the air”, and
- “Logos”, also Greek, which in this context means “knowledge or discussion”.

Weather and Climate

- Weather: Short term (seconds to days) variations in the atmosphere.

- Climate: The average course or condition of the weather at a given location, usually over a period of years.

Effects on Agriculture

- Rain - Too much or too little and good or bad timing
- Hail – Can damage crops
- Strong winds – Also can damage crops
- Frosts and Freezes – Can kill vegetation

Effects on Mariners

- Winds and Seas are the most important factors
- Fog – sailors can get disoriented
- Freezing Spray – can capsize a boat

Effects on Aviators

- Icing – Can weigh down an aircraft and increase drag
- Turbulence – Can cause loss of control, injure pilots and passengers and damage equipment
- Low ceilings and visibilities – Can obscure terrain and make it difficult for the pilot to see where he is

Effects on Construction

- Rain – Certain jobs require dry weather
- Wind – Can damage unfinished structures
- Temperatures – Can affect ability to do certain tasks

- Severe weather can destroy many structures

Requirement 2

- **Name five dangerous weather-related conditions. Give the safety rules for each when outdoors and explain the difference between a severe weather watch and a warning. Discuss the safety rules with your family.**

Winter Storms

- These can include snow/ice storms, blizzards, and extreme cold combined with strong winds.

Winter Storm Safety Rules

- Stay dry!
- Covered exposed body parts
- Avoid overexertion
- Seek protection from wind
- Build fire, if possible
- Stay in car, if available

Thunderstorms

- These are large cumulonimbus clouds with lightning and thunder. They may contain heavy rain, strong winds, and large hail.

Thunderstorm Safety Rules

- Seek shelter in a house or car
- Become the smallest target you can
- Stay away from open areas and tall objects such as trees or poles
- Stay away from water, metallic objects, or anything that uses or conducts electricity

Flash Floods and Floods

- Flash Floods generally occur due to intense rainfall over a small area or from a dam break, and the waters rise and fall rapidly.
- Floods generally occur on larger rivers and cover a wider area. Floods can take days to rise, crest, and subside.

Flood Safety Rules

- Get to higher ground!
- Do not camp in gullies or near stream beds
- Do not drive into water, especially running water

Tornadoes

- Violently rotating columns of air descending from thunderstorm clouds and in contact with the earth
- Usually visible as a funnel shaped cloud
- Winds can be as high as 300 MPH
- Usually less than a few hundred yards wide, last a few minutes, and trace a path of 1 mile or less.

Tornado Safety Rules

- Main danger is from flying debris, so seek shelter in a basement or a centrally located bathroom
- If trapped outside, find a low place that is not flooded, lie face down and cover your head

Hurricanes

- Large cyclone with winds exceeding 74 mph and up to 200 mph
- Can be from 60 to 600 miles in diameter
- Develops over warm water and breaks up over cold water or land

Hurricane Safety Rules

- Leave the danger area
- If trapped, get to shelter on higher ground.
- Other safety rules are similar to those for floods

Weather Watches

- Issued when the risk of a hazardous weather or warning event has increased significantly, but its occurrence, location, and/or timing is still uncertain.

Weather Warnings

- Issued when a hazardous weather or flooding event is occurring, about to occur, or has a high probability of occurring.
- Now it’s up to you to discuss this with your family. It just might save your lives someday!

Requirement 3

- **Explain the difference between high and low pressure systems in the atmosphere. Tell which is related to good and to poor weather. Draw cross sections of a cold front and a warm front, showing the location and movements of the cold and warm air, the frontal slope, the locations and types of clouds associated with each type of front, and the location of precipitation.**

Atmospheric Pressure

- Atmospheric pressure is simply the weight of the air above a point on the earth or in the air. The column of air above a square inch of the earth's surface weighs about 15 pounds.

High and Low Pressure Pt. 1

- Pressure varies horizontally as well as vertically
- This is due to uneven heating of the earth's surface by the sun
- High pressure tends to develop towards the poles while low pressure develops near the equator
- The atmosphere tries to even out areas of high and low pressure, creating weather in the process

High and Low Pressure Pt. 2

- Low pressure is associated with rising air
- Clouds and precipitation form in areas of rising air
- High pressure is associated with sinking air
- Air warms and dries out as it sinks

Cold Front – Planer and Cross Sectional Views

Cold Front – 3D view

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Warm Front – Planer and Cross Sectional Views

Warm Front – 3D views

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Requirement 4

- **Tell what causes wind, why it rains, and how lightning and hail are formed.**

What Causes Wind?

- As mentioned in Requirement 3, the atmosphere is constantly trying to make the air pressure equal everywhere, moving air from high to low pressure. Wind, which is defined as moving air, naturally results from this process.

Example: Sea Breezes

- Land heats faster than water
- In the afternoon, the land area is hotter than the water
- Warm air rises over the land, creating an area of lower pressure
- Cooler air from the ocean moves in to replace the rising air (a sea breeze)

Example: Land Breezes

- Land cools faster than water
- At night, the land becomes cooler than the water
- Relatively warmer air rises over the water, creating an area of lower pressure.
- Cooler air from land moves in to replace the rising air (land breeze)

Sea/Land Breezes Illustrated

Rain Formation Part 1

Two things are needed to form rain:

- A water source, and
- Rising air

Next, the water must evaporate into the air, transforming into invisible water vapor.

Rain Formation Part 2

- Air at a given temperature can hold a certain amount of water vapor. When it contains that amount of vapor, it is saturated.
- If the air is raised upward in the atmosphere, it cools. Cooler air can't hold as much water vapor, and the excess condenses and forms clouds.

Rain Formation Part 3

- The cloud droplets combine to form bigger droplets.
- When the droplets get so large that they can no longer be suspended in the air, they fall as rain.

Rain Formation Illustrated

Lightning

- Associated with thunderstorms
- As a thunderstorm develops, positive and negative charges form on the ground and in various parts of the cloud.
- When the charge separation gets strong enough, a bolt of electricity jumps between an area of positive charge and an area of negative charge.
- This bolt of electricity is what we see as lightning. It can be cloud-to-cloud, cloud-to-ground, and even cloud-to-air.

Hail Formation

- Also associated with thunderstorms
- Thunderstorms have updrafts and downdrafts, usually rain falls in a downdraft
- Sometimes updrafts form under downdrafts, and rain is swept back up above the freezing level and freezes, and then it falls again.
- This can happen many times. The growing hailstone acquires another layer of ice with each cycle.
- Eventually the hailstone gets too heavy to be held up by the updraft and it falls to the ground.

Hail Formation Illustrated

Requirement 5

- **Identify clouds in the low, middle, and upper levels of the atmosphere. Relate these to specific types of weather.**

Cloud Types

There are four general types of clouds:

- Vertically developing clouds (0-50000 ft)

  Cumulonimbus and Cumulus
- Low Clouds (below 6500 feet)

  Stratus, Nimbostratus, and Stratocumulus
- Middle Clouds (6500-20000 ft)

  Altocumulus, Altostratus
- High Clouds (above 20000 ft)

  Cirrus, Cirrocumulus, Cirrostratus

Cloud Types Illustrated

Clouds and Weather

- Cumulonimbus clouds form showers and thunderstorms
- Nimbostratus clouds are associated with steady precipitation
- Other clouds generally are not associated with precipitation, but may produce rain or snow that evaporates before it reaches the ground (virga).

Requirement 6

- **Draw a diagram of the water cycle and label its major processes. Explain the water cycle to your counselor.**

The Water Cycle Illustrated

The Water Cycle: Main Points to Remember

- Total amount of water on earth doesn’t change much.
- Water is constantly being recycled from ocean to land and back again.

Requirement 7

- **Define acid rain. Identify which human activities pollute the atmosphere and the effect such pollution can have on people.**

Acid Rain

- Acid Rain is normal rained mixed with pollutants containing sulfur particles
- Sulfur particles react with water to form a dilute solution of sulfuric acid
- Main source of pollutants is from power plants burning high-sulfur content coal

Human Effects on Weather

- Desertification of land due to overgrazing, unsound farm practices, or mining
- Breakdown of ozone layer due to chloroflourocarbons
- Global warming due to excessive carbon dioxide in the atmosphere

How People Are Affected

- Desertification of land destroys farmland and leads to less food production
- The breakdown of the ozone layer allows more solar ultraviolet radiation, leading to more skin cancer cases.
- Global warming raises sea level, threatening inundation of low-lying areas where many people live.

Requirement 8 Part a

- **Do either this requirement OR the one following in Part b:**

  a. Make one of the following instruments: wind vane, anemometer, rain gauge, hygrometer. Keep a daily weather log for one week using information from this instrument as well as from other sources such as local radio and television stations, NOAA Weather Radio, and Internet sources (with your parent's permission). Record the following information at the same time every day: wind direction and speed, temperature, precipitation, and types of clouds. Be sure to make a note of any morning dew or frost. In the log, also list the weather forecasts from radio or television at the same time each day and show how the weather really turned out.

Making Weather Instruments

- Here are some links to pages describing how to make weather instruments:

- Wind vane: http://www.ehow.com/how_2154709_make-wind-vane.html
- Anemometer: http://www.ehow.com/how_2225384_make-an-anemometer.html
- Rain gage: http://www.ehow.com/how_2086258_make-simple-rain-gauge.html
- Hygrometer: http://www.ehow.com/how_2079001_make-simple-hygrometer.html

Weather Observations

- Resouces for this requirement can be found at this site:

  http://meritbadge.org/wiki/index.php/Weather

- An observation form can be found in “A Concise Study Guide for the Weather Merit Badge” which can be found here:

  http://meritbadge.org/wiki/images/a/a0/Weather.pdf

- If you need more weather observations, go to this site:

  http://weather.gov

Requirement 8 Part b

- **Do either this requirement OR the one listed in Part a:**

  b. Visit a National Weather Service office or talk with a local radio or television weathercaster, private meteorologist, local agricultural extension service officer, or university meteorology instructor. Find out what type of weather is most dangerous or damaging to your community. Determine how severe weather and flood warnings reach the homes in your community.

Weather Experts Near You

- National Weather Service meteorologist
- Television meteorologist
- Private meteorologist
- Agricultural Extension Service Officer
- College professor

Finding a NWS Meteorologist

- Your best bet for finding out how warnings reach homes and dangerous weather in your community.
- Go to this link:

  http://www.weather.gov/organization.php

  There you will find a list of NWS offices. Click on an office near you and you will see their homepage. Contact information can be found at the bottom of that page.

Requirement 9 Part a

- **Do either this requirement OR the one following in Part b:**

- **a. Give a talk of at least five minutes to a group (such as your unit or a Cub Scout pack) explaining the outdoor safety rules in the event of lightning, flash floods, and tornadoes. Before your talk, share your outline with your counselor for approval.**

Resources for Requirement 9a

- All needed information can be found in the section covering Requirement 2
- Once you have prepared the outline, get it approved by your Weather merit badge counselor.

Requirement 9 Part b

- **Do either this requirement OR the one listed in Part a:**

- **b. Read several articles about acid rain and give a prepared talk of at least five minutes to a group (such as your troop, patrol, or a Cub Scout pack) about the articles. Before your talk, share your outline with your counselor for approval.**

Resources for Requirement 9b

- Some required information can be found in the section covering Requirement 7.
- Try googling “acid rain”
- Here are some handy links:

Wikipedia entry on acid rain: http://en.wikipedia.org/wiki/Acid_rain
EPA article on acid rain: http://www.epa.gov/acidrain/what/index.html
USGS article on acid rain: http://ga.water.usgs.gov/edu/acidrain.html

- Once you have prepared the outline, get it approved by your Weather merit badge counselor.

Requirement 10

- Find out about a weather-related career opportunity that interests you. Discuss with and explain to your counselor what training and education are required for such a position, and the responsibilities required of such a position.

Career Opportunities

- TV/Radio weathercaster
- NWS forecaster
- Private weather firm forecaster
- Military meteorologist
- Professor or researcher at a university or other institution

Training and Education

- Most jobs positions require a degree in Meteorology, Atmospheric Science or a related field
- Meteorology is a specialized branch of physics, so a strong foundation in math and science is important.

Required Responsibilities

- Forecasters make decisions that affect lives and property
- Forecasters often work nights, weekends, and holidays
- Must be dependable, capable, and responsible to perform this job well

References

- Glossary of Meteorology, 2nd Edition (2000), published by the American Meteorological Society. ISBN: 1-878220-34-9

- Weather, Boy Scouts of America Merit Badge Series (2006), published by the Boy Scouts Of America. ISBN: 978-0-8395-3274-3

Resources

- A handy site for rank advancement, award and merit badge requirements, including lots of useful web links, can be found here:

  http://meritbadge.org/wiki/index.php?title=Main_Page

- The page for merit badges in general can be found here:

  http://meritbadge.org/wiki/index.php/Merit_Badges

- The specific site for the Weather merit badge worksheet is:

  http://meritbadge.org/wiki/index.php/Weather

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