Topic 7 - Weather

Vocabulary

Air Mass – A large body of air in the troposphere with similar temperature and moisture characteristics

Anemometer – A weather instrument used to measure wind speed

Air pressure – The weight of the atmosphere pushing down on an area

Barometer – An instrument used to measure atmospheric (barometric) pressure

Cloud cover – The percent of the sky covered by clouds

Dew point – The temperature at which the air becomes saturated with water vapor and the relative humidity becomes 100%

Front – The boundary between two air masses

High pressure – An air mass that circulates away from the center where air is falling towards the Earth's surface, indicated by the lack of clouds and precipitation, anticyclone.

Humidity – The amount of water vapor in the atmosphere

Isobar – A line on weather map used to connect points of equal pressure

Jet stream – A concentrated band of high speed wind the travels west to east near the top of the troposphere.

Low pressure – A portion of the atmosphere where air circulates and moves towards the center and rises forming clouds and precipitation, a cyclone.

Occluded front – The boundary between opposing wedges of cold air masses formed when a cold front over take a warm front

Planetary wind belt – Zones on Earth where winds blow from most of the time

Precipitation –Any type of falling water from clouds

Psychrometer – An instrument used to measure the amount of moisture in the atmosphere with a dry bulb and a wet bulb.

Relative humidity – The amount of moisture that the atmosphere can hold compared to how much it can hold at a given temperature.

Stationary front – Different air masses push against one another, no dominance.

Station model – A model that contains symbols representing various atmospheric variables for a given location on Earth

Troposphere – The lowest level of the atmosphere where weather occurs

Visibility – The distance an observer can see unobstructed on the ground

Warm front – The boundary of an advancing warm air mass and a retreating wedge of cold air

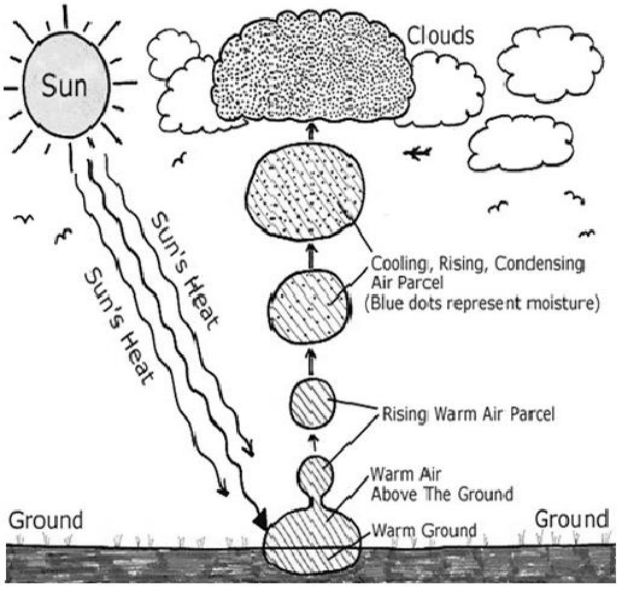
Water vapor – Gaseous water in the atmosphere

Overview of Topic

Weather is the state of the atmosphere at a given time and location. Weather is constantly changing and meteorologist measure weather variables with several instruments to help forecast weather for locations in the near future.

Variations in insolation received from the sun cause uneven heating of the Earth's surface which is distributed into the Earth's atmosphere. As the heat energy moves to achieve equilibrium the weather occurs to stabilize the atmosphere.

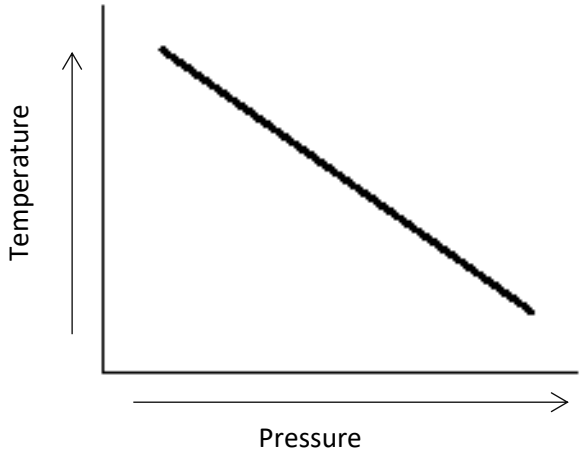
I. Heating of Atmosphere
- Recall as insolation enters the atmosphere how energy behaves.
- Convection transfers heat energy; hot air rises, cold air sinks.
    - Thus is true for energy transfer in hydrosphere and earth's crust (lithosphere)
- Heating and cooling by expansion and compressions
    - As air rises it expands and cools
    - As air sinks it contracts and sinks



The diagram illustrates the behavior of air as it rises. The opposite behavior occurs as the air sinks.

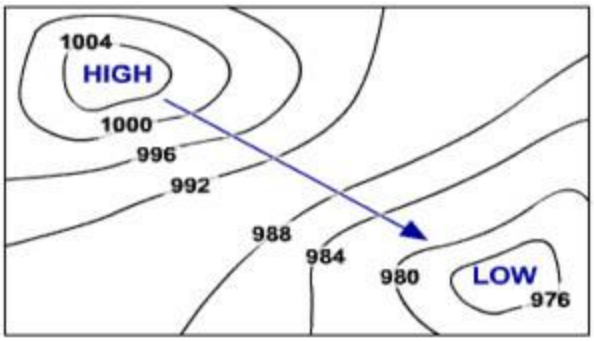
II. Changing Air Pressure

- Effect of Temperature on Air Pressure.
    - Cool air has more pressure
    - Warm air has less pressure
    - In the troposphere the relationship is indirect; cooler air has higher pressure and warmer air has lower pressure



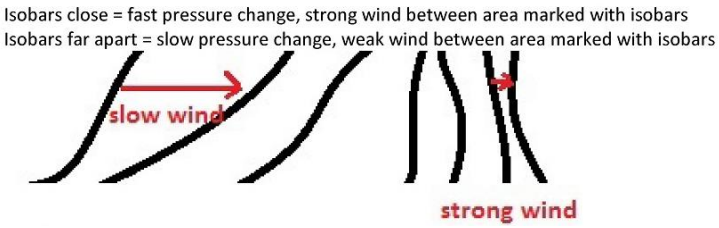
III. Wind

- Created due to differences in air pressure
    - Always flows from High pressure to Low pressure.



The isobars show pressure in millibars (mb).

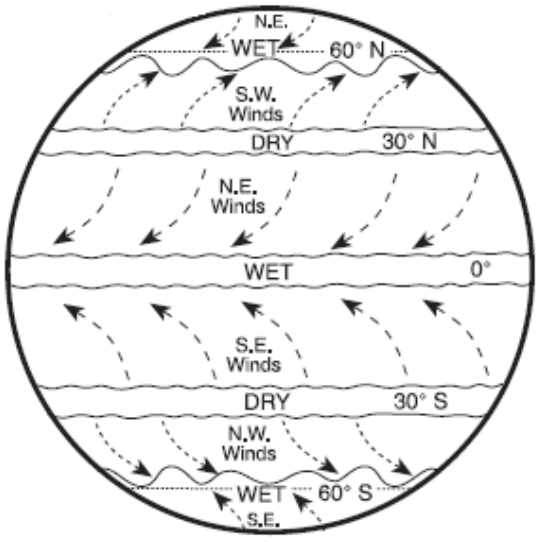
- Greater wind speed is based on how tightly packed isobars are represented on a weather map.



  - A typical question on the Regents would ask; where is the greatest wind velocity (speed) and how to you know.

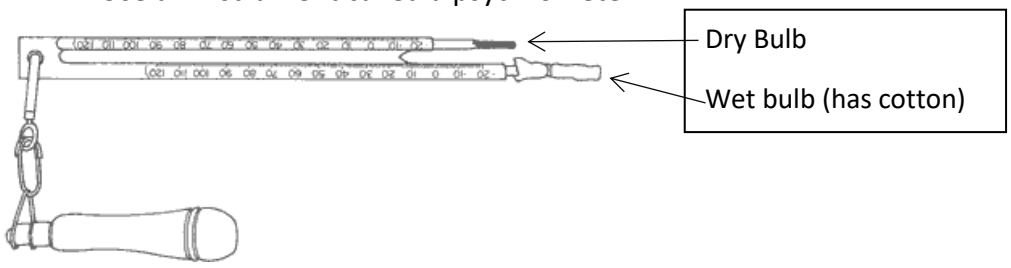
IV. The Winds Belts

- Convections and Earth's rotation are responsible for the wind belts on Earth
  - In North America we are located in the prevailing westerly or the southwest wind belt, between 30°N latitude to 60°N latitude
  - This explains why weather systems move from the west to the east in North America
  - Aids in forecasting



V. Moisture in the Atmosphere

- Evaporation and transpiration are responsible for moisture in the atmosphere
- Increase in altitude and moisture decreases
- The amount of moisture depends on the temperature
    - Warmer air holds more moisture
    - Cooler air holds less moisture
- Dew point and Relative humidity show the moisture in the atmosphere
    - Closer air temperature to dew point temperature the more moisture
    - The higher the percent relative humidity the more moisture
- Finding relative humidity and dew point (page 12 ESRT)
    - Use an instrument called a psychrometer



    - Find wet bulb temperature and dry bulb temperature
    - Subtract wet bulb from dry bulb = difference between wet and dry bulb
    - All temperatures are in Celsius degrees
    - Below is an example of the dew point chart, relative humidity is found the same way.

Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	−36													
−12	−12	−18	−28													
−10	−10	−14	−22													
−8	−8	−12	−18	−29												
−6	−6	−10	−14	−22												
−4	−4	−7	−12	−17	−29											
−2	−2	−5	−8	−13	−20											
0	0	−3	−6	−9	−15	−24										
2	2	−1	−3	−6	−11	−17										
4	4	1	−1	−4	−7	−11	−19									
6	6	4	1	−1	−4	−7	−13	−21								
8	8	6	3	1	−2	−5	−9	−14								
10	10	8	6	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

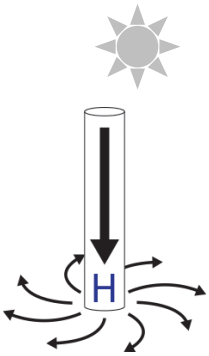
VI. Cloud Formation and Precipitation

- Clouds are result of vapor condensing into water droplets
    - As warm moist air rises it cools to the dew point and water droplets form
    - Condensation nuclei are microscopic surfaces for water to condense onto
    - Increase condensation nuclei could increase clouds

- Precipitation is result of water droplets becoming too heavy to stay aloft.
    - Above freezing rain results
    - Below freezing snow results
    - Variation in the cloud temperature creates hail
        - Rain drops travel from warmer level of cloud into freezing creates hail
    - Freezing rain is liquid until it hits a freezing surface and forms ice on contact.
    - Sleet is water that froze as it fell from a cloud into a pellet.

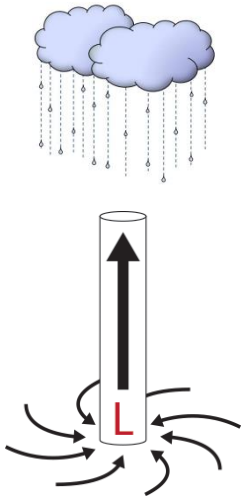
VII. High and Low Pressure Systems

- High pressure (northern hemisphere only)
    - Air circulates clockwise (cw) in northern hemisphere and sinks from center of pressure system, circulates opposite in southern hemisphere
    - Air is cooler than neighboring systems
    - Air is more dense and drier
    - Considered to be fair weather
    - Very few clouds, sunny

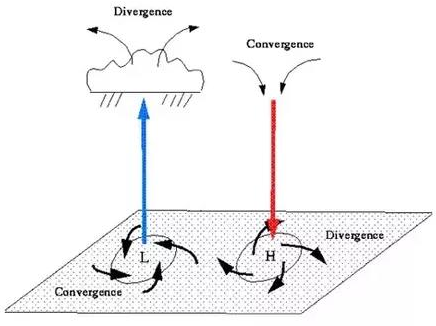


- Low pressure

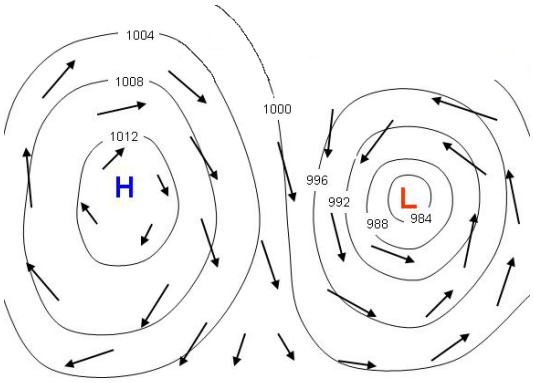
- Air circulates counterclockwise (ccw) in northern hemisphere and rises towards center of pressure system, circulates opposite in southern hemisphere
- Air is warmer than neighboring systems
- Air is less dense and more moist
- Considered to be stormy weather
- Many clouds



- High and Low circulating together

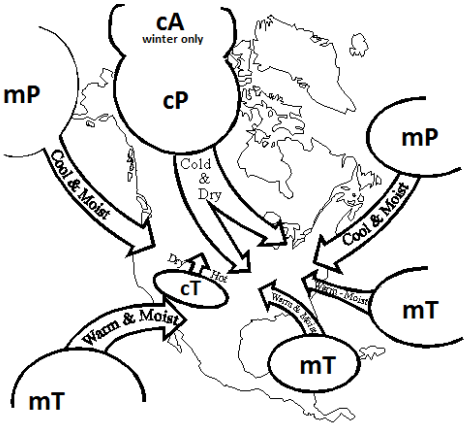


- Wind flow and isobars of High and Low pressure (northern hemisphere)

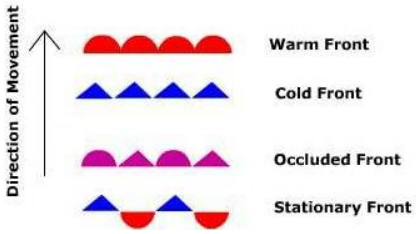


VIII. Fronts and Air Masses

- Most of the weather question will be based on maps of fronts. Previous weather knowledge is often required to answer questions that test fronts and masses.
- Mass masses – 5 types – page 13 ESRT
    - Each air mass is denoted by a symbol, for example **mT.** The first letter is always lower case and shows if the air formed over water or land. The second letter is always UPPER CASE and shows if the air is warm or cold.
        - **mT** – **m**aritime **T**ropical – warm air mass that formed over water (warm and moist air)
        - **mP** – **m**aritime **P**olar – cold air mass that formed over water (cold and moist)
        - **cT** – **c**ontinental **T**ropical – warm air mass that formed over land (warm and dry)
        - **cP** – **c**ontinental **P**olar – cold air mass that formed over land (cold and dry)
        - **cA** – **c**ontinental **A**rtic – very cold air mass that forms over polar regions (very cold and very dry) winter only

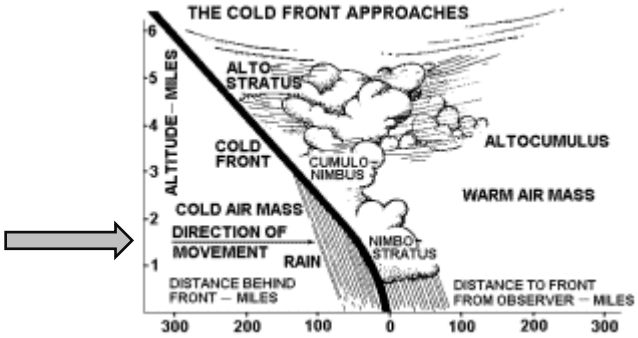


- Fronts are the boundaries between air masses of different temperature and moisture content. https://www.youtube.com/watch?v=M7WmhxeMGjs

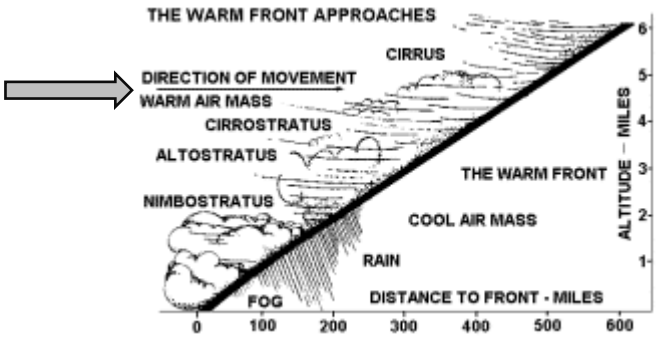


The arrow shows only advancement of the cold, warm and occluded front.

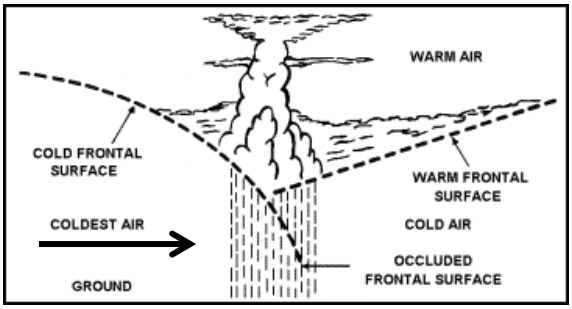
- Cold front – air behind front is colder and advancing



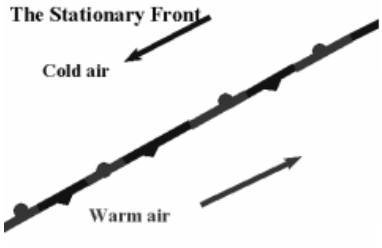
- Warm front – air behind is warmer and advancing



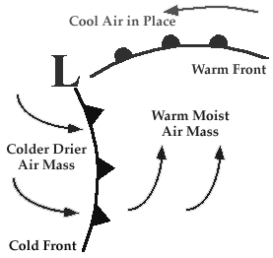
- Occluded cold air advancing on cooler air and pushing warm air up.



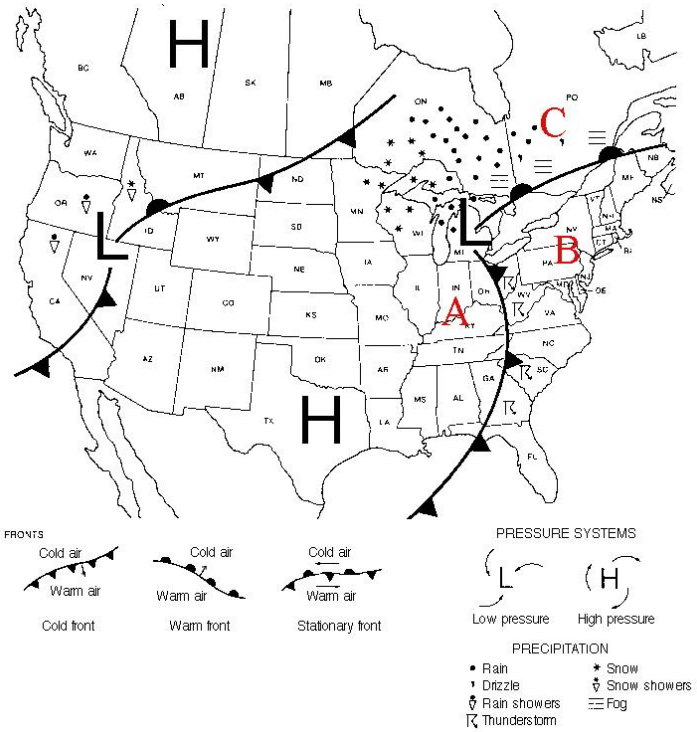
i. Stationary front – cold and warm air are not advancing



ii. The direction the symbol faces shows direction the front is advancing.



- Weather maps
- Synoptic weather maps show the relationships of fronts, air masses and pressure systems.



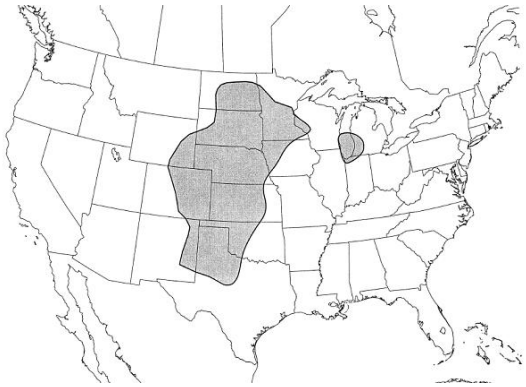
- Point A – air is cool / dry and moving east
- Point B – air is warm / moist and moving north east
- Point c – air cold / moist moving south west
- Low pressure systems all the air converges and precipitation forms.

IX. Severe Weather

- Hurricanes
    - Season is June to November in the north Atlantic
    - Surface water temperature must be higher than 80 ^{o}F (27 ^{o}C).
    - Easterly winds push hurricanes towards southeast US and Caribbean
    - Westley winds push hurricanes along the east coast of the US.
    - Hurricanes are low pressure systems creating weather.
        - Winds greater than 70 mph
        - Large storm surge along the north side of the hurricane.
            - ✓ Most deaths are from storm surge
        - Tornados occur with hurricanes
    - Progress in stages from tropical depression to hurricane.
        - Saffir – Simpson scale

Saffir-Simpson Hurricane Scale	
Storm Classification	*Wind Speed (mph)*
Tropical Depression	0-38
Tropical Storm	39-73
Hurricanes	
Category 1	74-95
Category 2	96-110
Category 3	111-130
Category 4	131-155
Category 5	>155

- Tornadoes
    - Most destructive wind force on Earth
    - Short lived
    - From intense thunderstorms and hurricanes
    - Tornado alley
        - Mid-western US

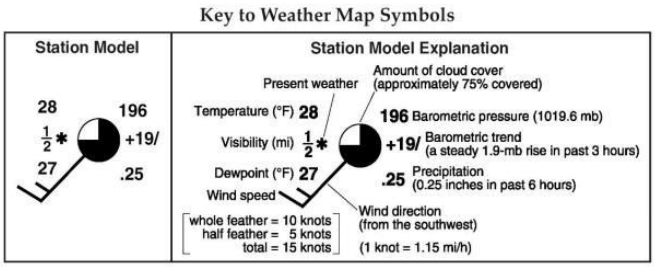


    - Tornados track (the direction of travel) west to east or southwest to northeast.
    - US has more tornadoes than rest of the world

- Blizzards
    - A storm which contains large amounts of snow OR blowing snow, with winds in excess of 35 mph and visibilities of less than 1/4 mile for an extended period of time (at least 3 hours).
    - Can last for a few hours a more
    - Stock up on food, water, emergency fuel source, don't drive, have batteries, extra blankets, etc.…
    - Can happen anywhere there is snow and wind.

X. Station Models (page 13 ESRT) –

- https://www.youtube.com/watch?v=0nFGZl1h2OM
- A system of symbols used by meteorologists around the world to show weather at cites or locations worldwide. This is the same table in the ESRT.



- How to read
  - The positions never change, they represent a value based on the position
  - Temperature and dew point temperature either °F or °C, depending you world location. Regents will use either.
    - Never include units on the table
  - Wind direction and speed
    - Direction is where the wind come from, example is from the southwest
    - Speed is how fast the wind blows in knots.
    - The example is for a wind speed of 15 knots.
    - Notice feather positions. Whole feather can be anywhere; a half feather is never at the end.
    - Regents will keep it simple and should not make it 5 knots only
    - Pressure
      - ✓ Always in millibars (mb)
      - ✓ To convert pressure from the model look at the number
        - Values are between 000 – 499 put a 10 in front and a decimal between the last two digits
        - Values are between 500 - 999 put a 9 in front and a decimal between the last 2 digits

Model reads	Actual pressure (mb)
090	1009.0
992	999.2
897	989.7
000	1000.0
143	1014.3

To convert from actual to station model, just report the last three digits and remove the decimal point.

Actual		Model
1000.2	→	002
897.2	→	972
999.1	→	991
1031.0	→	310

To go from model to actual either add a “10” or a “9” before the numbers and a decimal between the last 2 numbers.

Model		Actual
000	→	1000.0
989	→	998.9
010	→	1001.0
977	→	997.7

Earth Science Reference Table – (ESRT)

Pages from ESRT used in Topic 7.

Page 12 & 13

Page 12 Dew point and Relative Humidity https://www.youtube.com/watch?v=mipaX-2oxwA

Example: (The example is for dew point; however Relative Humidity is the exact same process)

- You have a dry bulb temperature of 26 °C and wet bulb temperature of 20 °C. What is the dew point?

Look the vertical (y-axis) – dry bulb temperature; look at the horizontal (x-axis) across the top – difference between wet-bulb and dry-bulb temperatures.

Dry bulb = 26 °C Wet bulb = 20 °C Difference 26 °C – 20 °C = 6 °C

Find 6 °C on the horizontal axis

Find 26 °C on the vertical axis

Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	−36													
−12	−12	−18	−28													
−10	−10	−14	−22													
−8	−8	−12	−18	−29												
−6	−6	−10	−14	−22												
−4	−4	−7	−12	−17	−29											
−2	−2	−5	−8	−13	−20											
0	0	−3	−6	−9	−15	−24										
2	2	−1	−3	−6	−11	−17										
4	4	1	−1	−4	−7	−11	−19									
6	6	4	1	−1	−4	−7	−13	−21								
8	8	6	3	1	−2	−5	−9	−14								
10	10	8	6	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

Where the column and the row meet is your dew point temperature

Dew point = **15 ºC**

You may be asked to work backwards with a given dew point and a difference.

You have a dew point of 7 ºC and a dry bulb of 28 ºC. What is the difference?

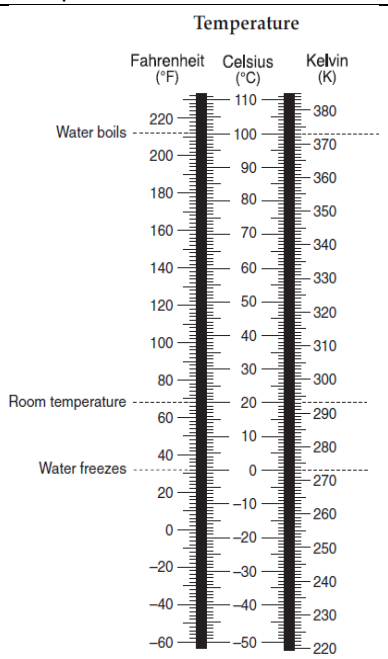
In this example the difference is 12 ºC

Look for the dry bulb of 28 ºC, and then locate 7 ºC on the chart follow the column to the horizontal axis which is 12 ºC.

Page 13 – Pressure and Temperature

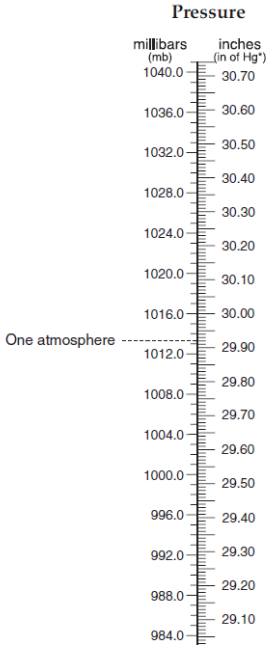
<table>
<tr><th colspan="2">Temperature</th><th colspan="2">Pressure</th></tr>
<tr>
<td>Use this scale to convert easily between the different scales.

In Earth Science most temperatures are reported in the metric system ºC.

Pay attention to the graduations in each scale they are not the same.</td>
<td> 
</td>
<td>This scale is used to between inches of mercury (inHg) and millibars (mb).

Millibars is the metric system and is preferred and is reported on station models.

Pay attention to the graduations in each scale they are not the same.

(Not full scale, go to ESRT)</td>
<td> 
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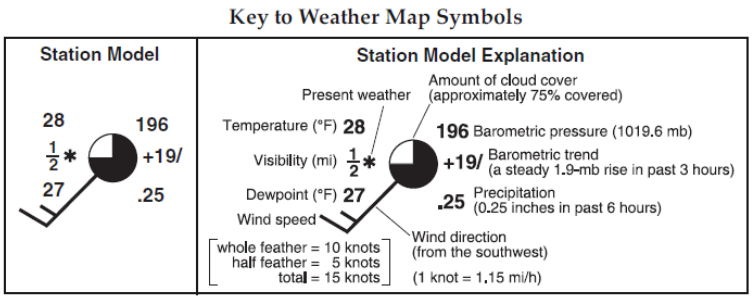
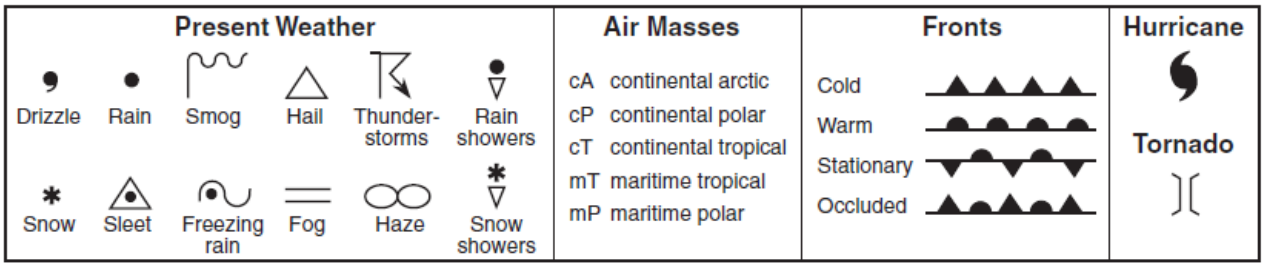
</table>

Page 13 – Station Models and Symbols

https://www.youtube.com/watch?v=0nFGZl1h2OM





Every location is specific and in some cases needs to be converted / translated.

Any symbol the exams asks on a test or wants a student to look up is from this box here. Also air masses and front symbols are here too.