Illinois State Science Olympiad

Meteorology 2005

Instructions:

This is the question booklet. It contains the information about the problems you are about to solve. PLEASE DO NOT WRITE IN THE BOOK. The answer sheet has been provided at your station. Please write you responses there. The point totals for each question are as follows:

1 point total for each multiple choice question,
1 point for *each answer* on fill-in-the-blank questions

Keep this in mind when answering questions. Remember, you have **50 minutes**, so use your time wisely. If you don't know the answer to a question, you may wish to skip it and go on. An announcement will go out when 30 minutes, 15 minutes, and 5 minutes remain. If you finish early, you may wish to check over your answers. Do not forget to answer the tie-breaker questions! They will be graded only in the case of a tie.

You may use any references you have available, including notes and textbooks. Calculators must not be programmable. If you have any questions, or are concerned about anything, please ask one of the event supervisors for help. Good luck and have fun!

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1) Lightning kills more people each year than tornadoes and hurricanes combined. However, you can protect yourself by using the 30/30 rule. What is the 30/30 rule?

a) You should protect yourself from lightning only if lightning strikes the ground within 30 yards of you.
b) If you witness at least 30 lightning strikes at your location within 30 minutes, then you should take shelter immediately.
c) If you hear thunder within 30 seconds of a lightning flash, then you should take shelter and remain there until 30 minutes after the last flash.
d) If there is at least a 30% chance of lightning forecast by the National Weather Service, then you should take shelter until 30 minutes after the forecast has expired.

2) When driving in a blizzard during white out conditions, it is possible that you may become stranded in your car. Select from the list below the six items that are most vital to your survival and write them in the spaces provided.

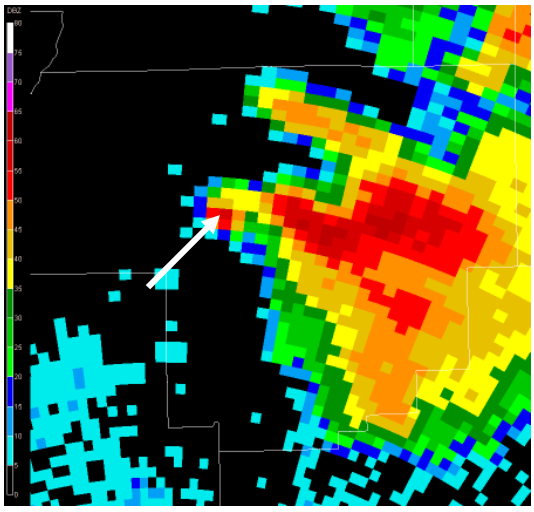
_____ _____ _____

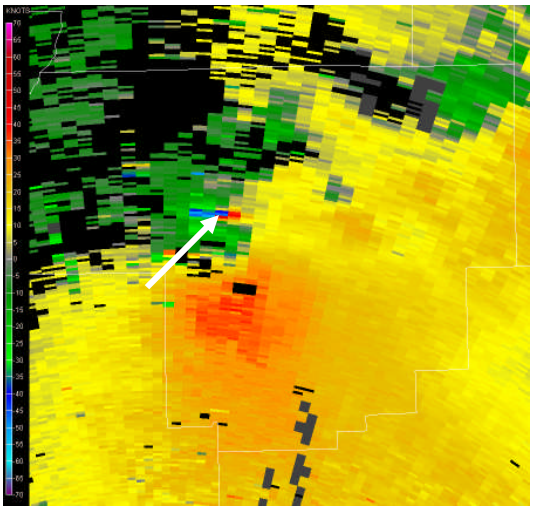
_____ _____ _____

Food	Shovel
Britney Spears Album	Batteries
A Can with a Lid	Snow Cone Maker
Matches and Candle	Soda
A Deck of Cards	Gas to Keep Car Running
Portable Video Game	Megaphone
Blankets	Cell Phone
Snow Shoes	Compass

3) Shown below are reflectivity and velocity radar images for a summer day in Central Illinois. What is the feature present at the arrow?

a) Squall line
b) Hail
c) Tornado
d) Waterspout





4) If you have ever held your finger over the end of a garden hose, you have witnessed the *Venturi Effect*. Basically, this occurs when a fluid is forced to flow through a smaller area and it speeds up. If a tornado hits an overpass head on, what will happen to the wind speed beneath the overpass?

a) Speed up
b) Slow down
c) Stay the same
d) Winds will be blocked

Tornado – Myth or Fact?

Tornadoes are attracted to mobile home communities.

MYTH FACT

Tornadoes always rotate counter-clockwise in the Northern Hemisphere

MYTH FACT

If there is a tornado warning, you should open all the windows in your house.

MYTH FACT

When the tornado sirens go off, you should grab your video camera and go outside to catch it on film.

MYTH FACT

Tornadoes cannot hit downtown areas because buildings deflect the airflow.

MYTH FACT

Tornadoes have occurred in all 50 states.

MYTH FACT

If a tornado watch has been issued, then a tornado has been sighted.

MYTH FACT

Tornadoes can be made up of 2 or more smaller tornadoes called suction vortices.

MYTH FACT

If you are driving in a car on the highway and see a tornado behind you approaching rapidly, then you should try to outrun it.

MYTH FACT

When the tornado siren goes off, go to the innermost room on the lowest level of your house or building.

MYTH FACT

To Leave or Not to Leave Your Car… THAT is the Question

Scenario 1:

Your parents pick you up from school during a terrible rain storm. On the way home, you hit an area of deep water and the car stalls. The radio announcer says that there is a Flash Flood Warning in effect for the area. Should you stay in the car and wait for help or get out to find higher ground?

Stay in Car Get the Heck Out!

Scenario 2:
Your family is caught in a snowstorm while driving through northern Illinois. The car hits a patch of ice and goes off the road into a snow bank. Attempts to get out of the snow bank fail… you are stuck! The radio reports blizzard conditions throughout the area. You remember seeing a town about a quarter mile back. Should everyone stay in the car or should someone be sent for help?

Stay in the Car Get the Heck Out!

Scenario 3:
While riding across country, you encounter a nasty looking thunderstorm. You recognize all of the features of a supercell thunderstorm from your studies for the Science Olympiad. The wind picks up and it becomes hard to keep the car on the road, so you pull off to wait out the storm. The sky turns an eerie greenish color and you see a tornado form in the supercell. Should you stay in the car?

Stay in the Car Get the Heck Out!

Scenario 4:
Whew! You survived the tornado and your family gets back on the road to finish the road trip. Along the way, you encounter another supercell thunderstorm. Lucky you, eh? According to the radio announcer, this thunderstorm is not well organized enough to produce a tornado but you can expect large hail in some places. Once again, you pull over on the side of the road to wait out the storm. It starts to rain harder and then, sure enough, you get hail. BIG hail! Should you stay in the car or get out to seek shelter elsewhere?

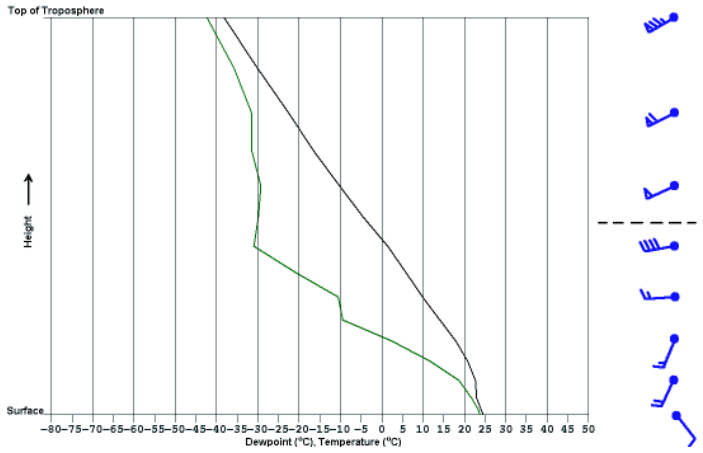
Stay in the Car Get the Heck Out!

Scenario 5:
Now you've survived both tornadoes and hail! You're okay. You are shaken… and there are several big dents in the car… but you're okay. As you start to get back on the road, you realize that you've got a flat tire! Oh boy, it's really not your day to be on a road trip! Lightning is striking all around you. You notice a farmhouse across a field off in the distance. Should you stay in the car or try to make it to the farmhouse for help?

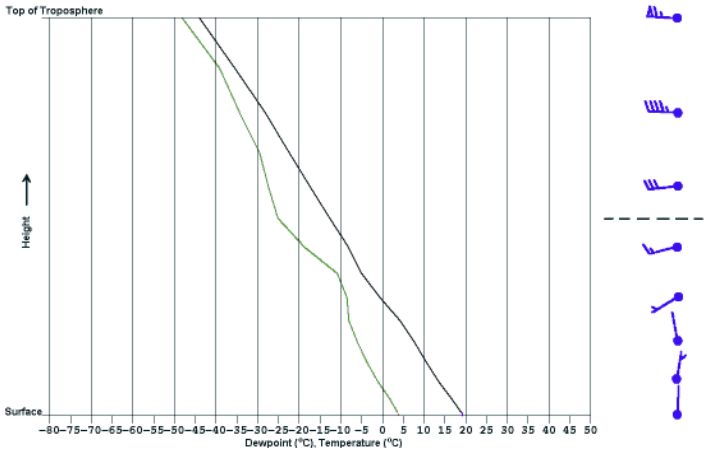
Stay in the Car Get the Heck Out!

Soundings are vertical profiles of the atmosphere, taken by meteorological equipment lifted through the atmosphere by a balloon. Three examples of soundings from the central United States are shown below:

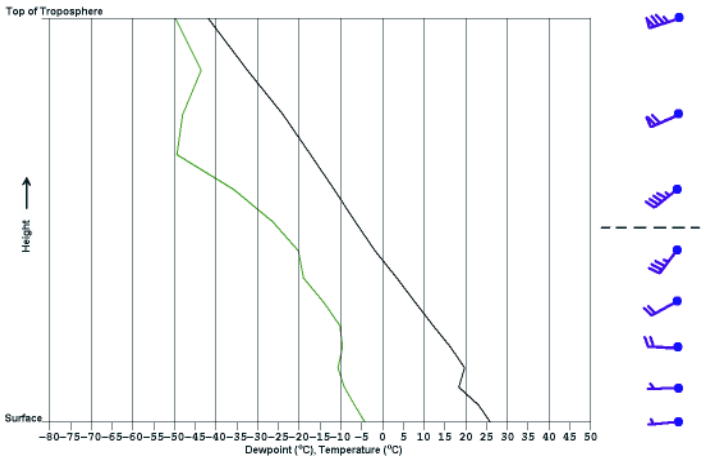
(A)



(B)

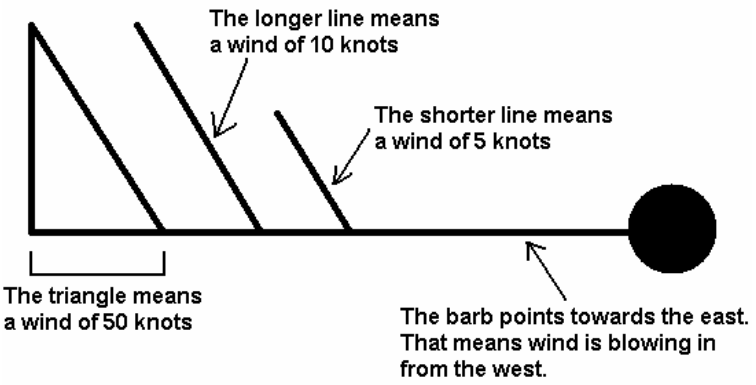


(C)



Each of these soundings shows temperature (right line) and dewpoint (left line) in degrees Celsius, from the surface to the top of the troposphere (about 11 km above the surface). Most weather occurs in this layer of the atmosphere.

On the right of each sounding, horizontal winds are shown using wind barbs.
Wind barbs can be interpreted as follows:



So, the example above shows a wind blowing from the west at 65 knots. Note that wind barbs pointing vertically indicate north and south winds, NOT winds moving vertically upwards or downwards in the atmosphere.

Interpret these soundings to answer the following questions:

Which sounding shows the highest relative humidity at the surface? (Check one)
(A) _____ (B) _____ (C) _____

Which sounding is most likely to be getting moisture from the Gulf of Mexico near the surface? (Check one)
(A) _____ (B) _____ (C) _____

Which sounding is the warmest at the surface? (Check one)
(A) _____ (B) _____ (C) _____

Which sounding has a low-level temperature inversion? (Check one)
(A) _____ (B) _____ (C) _____

Which <u>two</u> soundings show the most low-level directional wind shear (wind changing direction with height below the dashed line)? (Check two)
(A) _____ (B) _____ (C) _____

Which <u>two</u> soundings have the highest low-level speed wind shear (wind speed changing with height below the dashed line)? (Check two)
(A) _____ (B) _____ (C) _____

The likelihood of severe weather increases as more of the above conditions are met. Add up the number of checkmarks for (A), (B), and (C), and write those numbers below:
(A) _____ (B) _____ (C) _____

Based on your answer above, which sounding shows the most potential for severe weather?

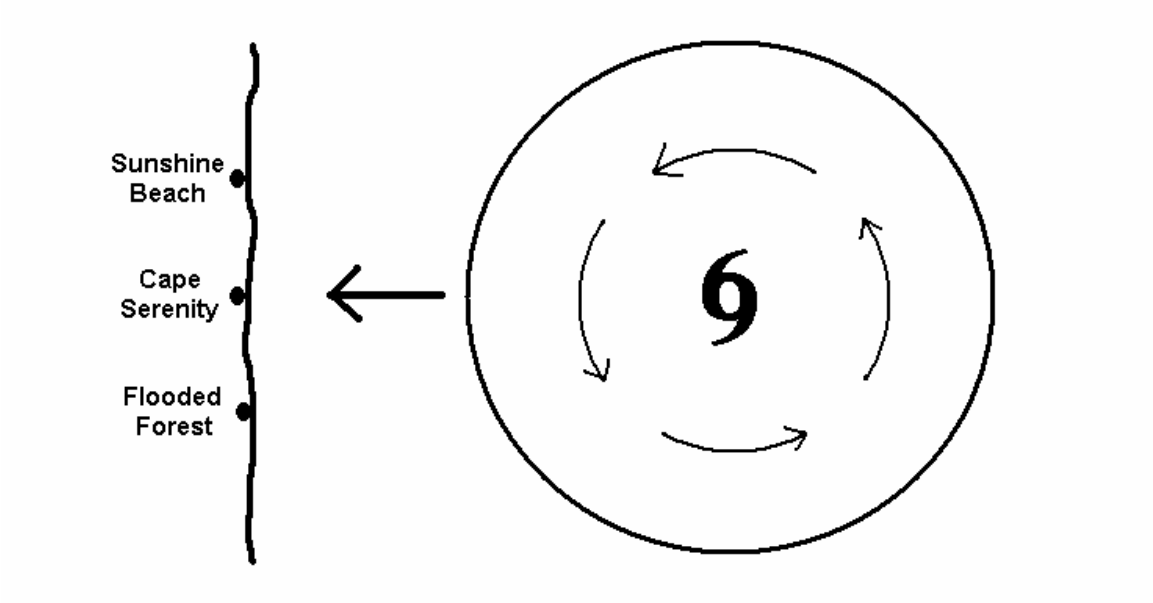
_____

You work for Weathervania's forecast office, and you are in charge of recommending the evacuation of cities to local police stations. Just before you leave for lunch, your boss faxes you the following message:

--- BEGIN TRANSMISSION ---

URGENT

Hurricane is bearing down on Cape Serenity. Map of hurricane is shown below. The dark circle around the hurricane shows the outer limit of the hurricane's severe weather effects. Storm motion is shown by the bold arrow pointed towards Cape Serenity. Storm rotation is shown by the lighter arrows around the hurricane.



Hurricane is expected to make landfall at Cape Serenity in 24 hours. Storm surge is greatest threat from this hurricane. Any city with winds encouraging storm surge should be evacuated.

--- END TRANSMISSION ---

Why does your boss do this? Couldn't he just say "Please evacuate _____ immediately?!?" It's up to you to figure out which city to evacuate. Should you evacuate…

A) Sunshine Beach
B) Cape Serenity
C) Flooded Forest

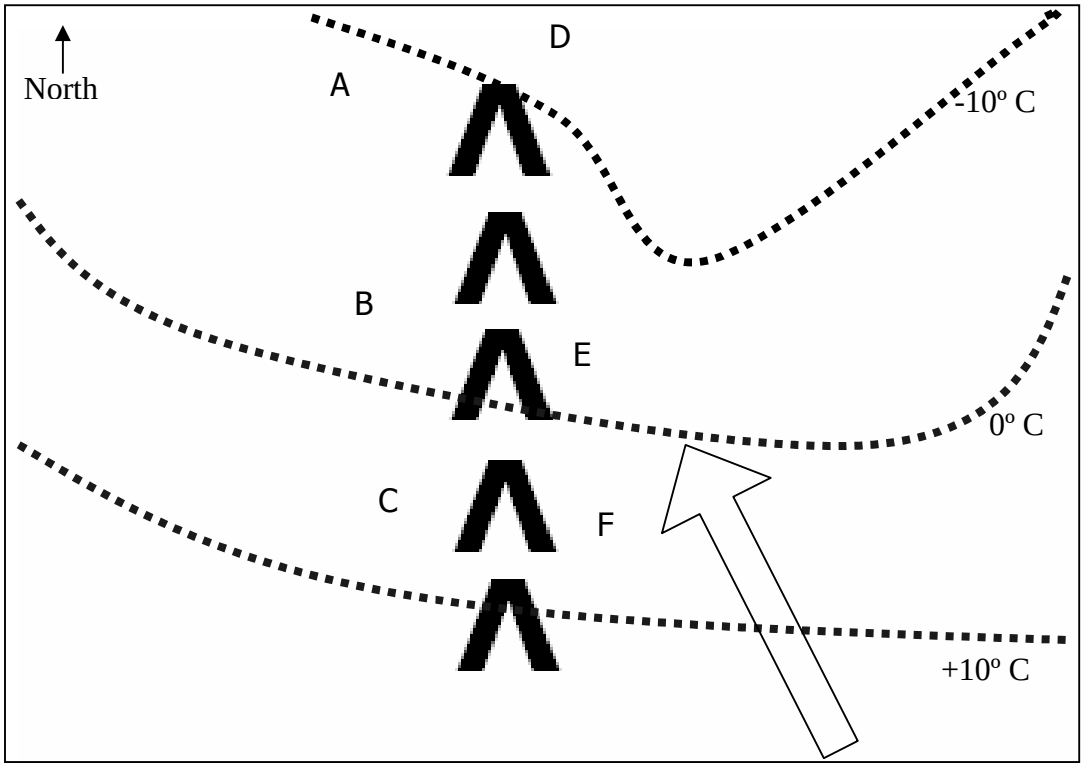
Baking an Ice Storm

Just like when you are baking a cake, several ingredients are needed to make an ice storm. For a cake you need sugar, eggs, flour, a pan, and the right conditions in the oven to cook it up. An ice storm needs three main ingredients:

- A shallow layer of cold air (below freezing temperatures) at the surface.
- Warm moist air to provide the water supply
- Some way of lifting the warm moist air above the cold air to make clouds that produce rain. This rain falls into the cold air and freezes at the surface.

Shown below is a map of "Ice" Land, where ice storms happen a lot. The line of upside-down V's represents a mountain range that runs from north to south on the map. Lines of constant temperature (isotherms) are represented by dashed lines. The big arrow depicts the flow of warm moist air coming from the southeast at a height of 2 km above the surface. The letters indicate locations of several towns in "Ice" Land.

Map of "Ice" Land



Use the map of “Ice” Land to do the following:

(1) Assume there is high pressure located in the middle of the coldest region of air on the map. Place the letter “H” on the map at this location.

(2) Since “Ice” Land is in the Northern Hemisphere, we know which direction the air circulates around it. Draw arrows around the “H” illustrating which way the winds are blowing.

(3) The winds from the high pressure system produce a shallow layer of cold air at the surface. Considering the warm moist air that is blowing from the southeast at a height of 2 km, (the big arrow on the map) is able to produce clouds that make rain, which town is most likely to get an ice storm? (Circle one)

Awfully Cold Village (denoted by ‘A’)

Blistery Winds (denoted by ‘B’)

Coolsville (denoted by ‘C’)

Dang Chilly (denoted by ‘D’)

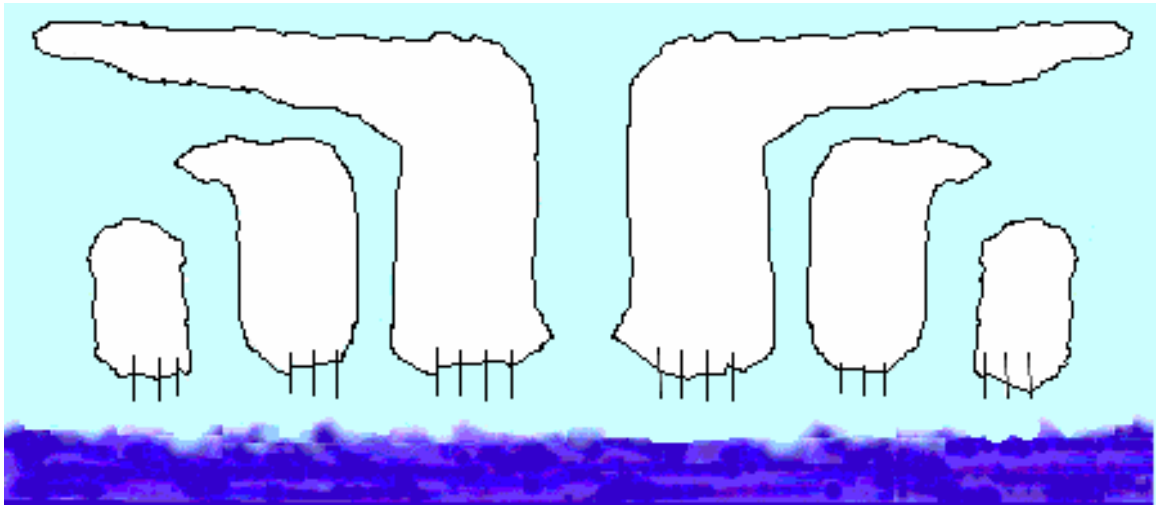
Edge of Tarnation (denoted by ‘E’)

Far from Anywhere (denoted by ‘F’)

Tie Breaker 1

Shown below is a side view of a hurricane. Using what you know about hurricanes, label the following items:

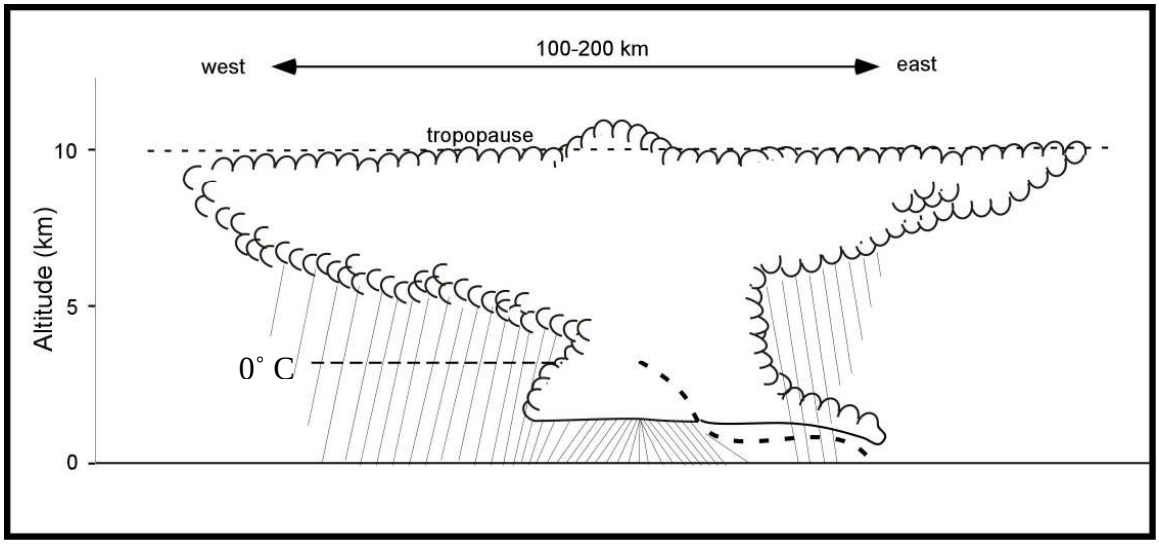
a) Label the region(s) of Lowest Pressure with an “L”.
b) Label the region(s) of Highest Winds with an “M”.
c) Label the region(s) of Heaviest Rainfall with an “R”.
d) Label the Eye of the Storm with an “E”.
e) Label the Spiral Rainbands with an “S”.
f) Label the Eyewall with a “W”.
g) Label Areas of upward air motion with upward-pointing arrows.
h) Label Areas of downward air motion with downward-pointing arrows.



Tie Breaker 2

Identify each of the listed features of a squall line thunderstorm by placing the corresponding letter on the appropriate place on the diagram below.

A – anvil
B – bright band on radar (melting level)
C – dry air
D – base of updraft
E – heavy rain
F – light rain
G – mammatus
H – moist air
I – overshooting top
J – convective region



Credits:

1. "Severe and Hazardous Weather" by Rauber, Walsh, and Charlevoix were used in creating the Myth/Fact questions and tie breakers.
2. Storm Prediction Center for outline maps
3. UIUC for radar and satellite images
4. Mike Wilson, Joe Brewer, Redina Herman, and Mike Spinar for writing and submitting the exam.