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MAT 397— Fall 2020
Applied Problems:
Multivariable Functions

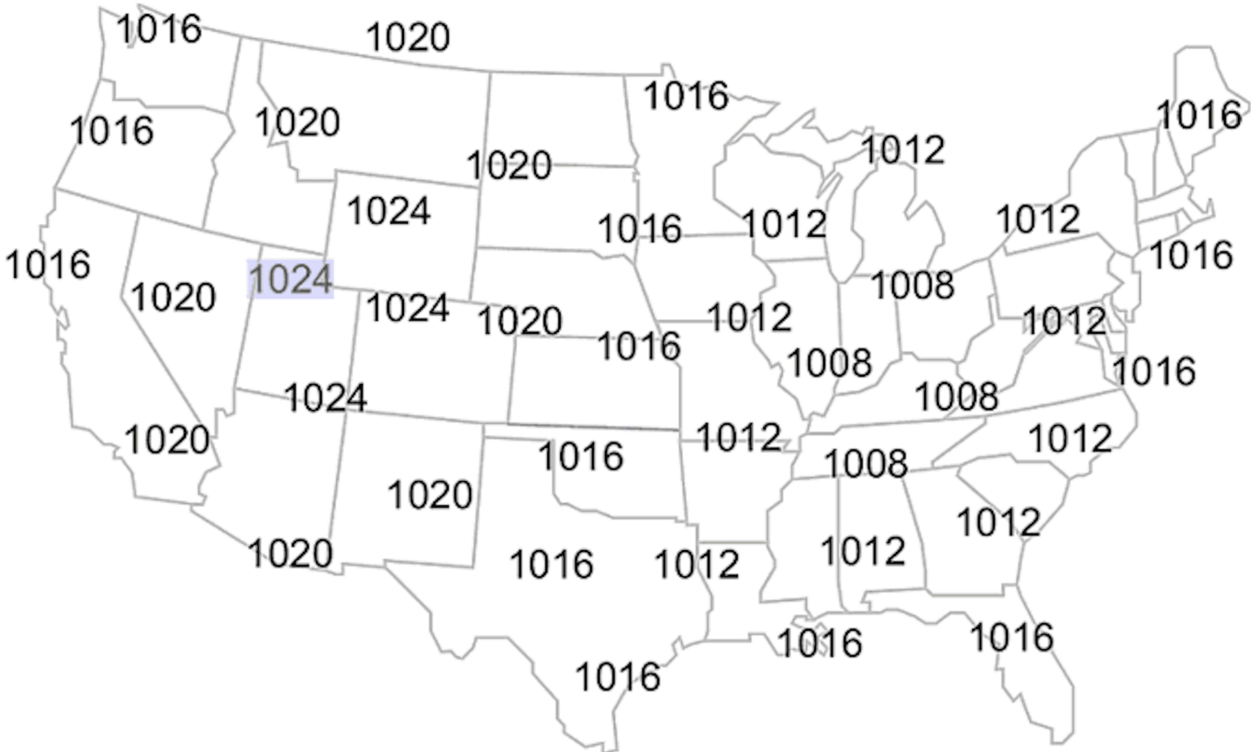
"We all use math every day: to predict weather, to tell time, to handle money. Math is more than formulas or equations; it's logic, it's rationality, it's using your mind to solve the biggest mysteries we know."

– Charlie Eppes, Numb3rs

Meteorology

One of the ways meteorologists begin to track the weather is by examining trends in atmospheric pressures (at sea-level, i.e. surface air pressure). Local atmospheric pressures (measured in millibars) are collected at thousands of locations across the country. [In fact, across the planet.] Using this data, meteorologists are able to create level curves of atmospheric pressure for maps of the United States.

These level curves (in this case called *isobars* for 'same pressure', thought *isoterms*, or 'equal temperature', are also used in meteorology) are labeled using the last two digits in the pressure reading. For example, a 1020 mb isobar would be labeled as 20 mb, while a 1005 mb isobar would be labeled as 05 mb. This standard is followed also if the reading is less than 1000 mb. For instance, a 990 mb isobar would be labeled 90 mb. Isobar labels typically appear at the end of an isobar near the end of the map—if possible. If two isobars of equal value are 'near enough' to each other, they are drawn connected (called closed isobars). For closed isobars, the isobar value is placed (with a gap in the line) on the isobar line. Consider the surface air pressure map below.



Data taken from the National Weather Service website: https://www.weather.gov/

Problem:

(a) Starting with the highlighted 1024 mb pressure, draw isoterms according to the standards given above. Try to make these isobars as smooth as possible, making them closed when possible. Do not forget to label them.

(b) Label the center of the highest pressure area with an 'H' and the center of the lowest pressure area with an 'L.' Use two different colors to distinguish these regions.

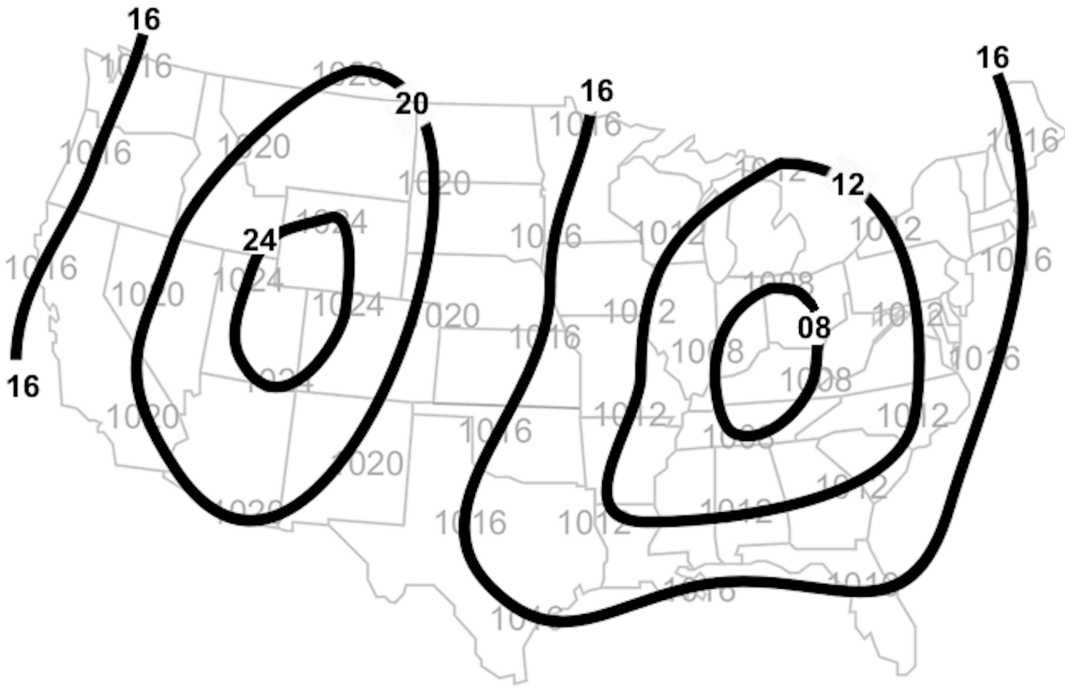
(c) Higher pressure regions are normally associated with nicer, dryer weather because as the air sinks—due to the higher pressures—it warms, and water vapor in the air evaporates. Vice versa, lower pressure regions are normally associated with precipitation because as the air rises—due to the lower pressures—it cools, and water vapor in the air condenses. Shade regions in the map where you would most likely expect precipitation, and shade regions where you would most likely expect clear skies. Use the colors corresponding to high/low you used in (b).

(d) Local/Regional Differences in air pressure are what cause wind, and wind currents. The direction of spin for these currents depends on the hemisphere and the pressure. In the Northern Hemisphere, the wind blows clockwise around centers of high pressure, and blows counter-clockwise around centers of low pressure. Draw arrows on your map to indicate wind direction for your high and low regions.

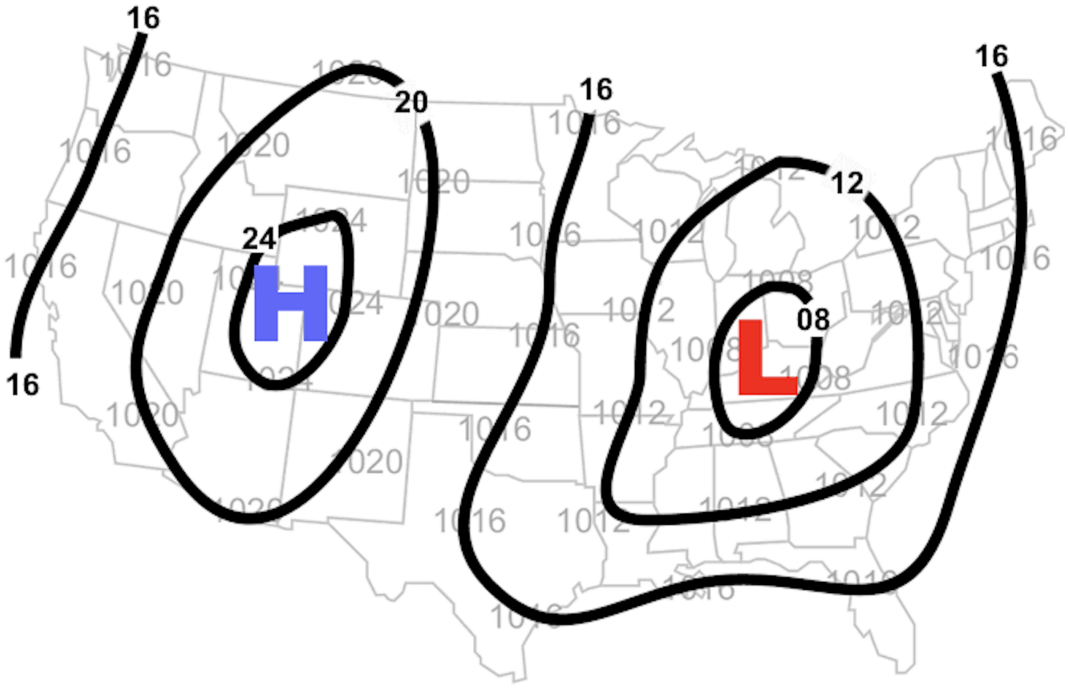
(e) Based on how you drew your isobars, place a (large) dot in the region where there is the most rapid change in pressure. Use a different color than you used in parts (b) and (c).

Solution.

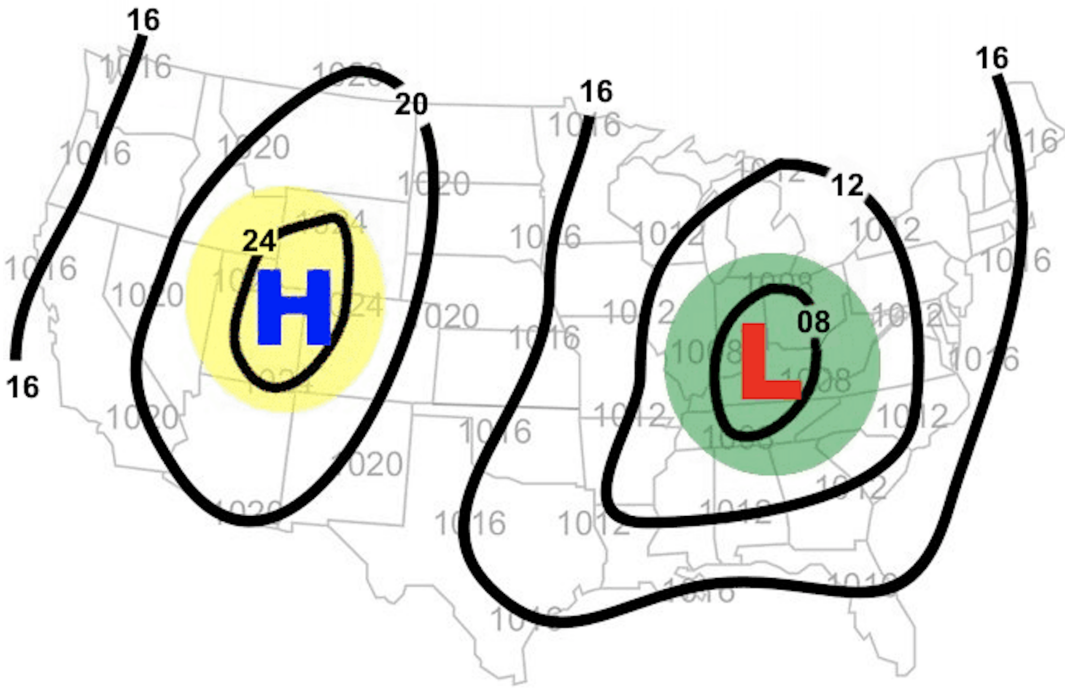
(a)



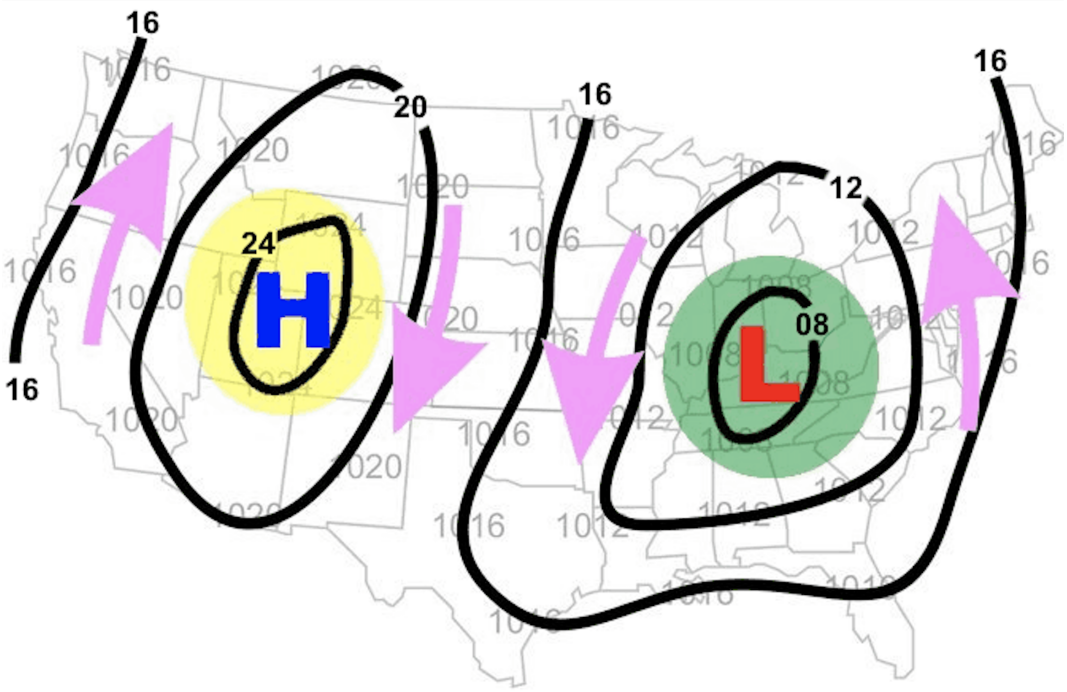
(b)



(c)



(d)



(e) The region where there is the most rapid change in pressure is the region where the isobars are densest, i.e. the closest together.