1. (8 pts) The map below shows the surface frontal positions, sea level pressure (solid lines), 1000-500 mb thickness field (dashed) of a developing low. The locations of 12 stations (dots) identified by numbers. Match the station number with the meteorological condition.

a. One station, numbered _____ reports freezing rain.

b. Cold air advection is greatest at station number _____

c. Warm air advection is greatest at station number _____

d. The station likely to be warmest is numbered _____

e. The station likely to be coldest is numbered _____

f. The station where the geostrophic wind is greatest is likely _____

g. The station where wind from due east is likely _____

h. The station where the surface vorticity is greatest is likely _____

2. Fill in the blank: (4 pts)

a. ________________________________________ is a process where a cut off low is displaced eastward by a kicker trough and then that kicker trough becomes a new cut off low west of the position of the original cut off low.

b. The ________ m contour is used as an empirical dividing line between frozen and liquid precipitation at sea level.

c. A flow pattern shaped like an $\Omega$ is an example of a __________________________ flow pattern.
3. (1 pt ea.) True (T) or False (F), circle the correct response to the following statements:

T  F  “MRF model” stands for “mostly right forecast model”
T  F  A spectral model like the AVN uses known functions but not grid points.
T  F  The current horizontal resolution of the Eta model is 1x1 degree or 111 km.
T  F  At each grid point in the Eta model, geopotential, temperature, winds, and vertical motion are evaluated.
T  F  In a regression formula, predictands are used to make the estimate.
T  F  The coefficients in a regression formula are obtained by minimizing the sum of the squares of the estimation error for a collection of data.
T  F  The larger the ACC score the larger the error.
T  F  The larger the Brier score the larger the error.
T  F  In objective analysis, the observation increment is an estimate of the error or “noise” in the observation.
T  F  A jet streak is another name for a jet plane contrail.
T  F  Topography can enhance precipitation adjacent to the topography by deflecting the low level flow in such a way as to form low level convergence zones.
T  F  Low level wind directed towards topography can be forced to rise by the topographic slope leading to more precipitation over the mountain slope than over adjacent low lands.
T  F  In short, topography always enhances the precipitation.
T  F  The peak time of day for thunderstorms is later in Missouri than in Kansas because of the change in time zones.

4. (4 pts) State one advantage and one disadvantage for both spectral and for grid point models

Spectral,  Ad:  ________________________________________________________________
Disad:  ________________________________________________________________

Grid point,  Ad:  ________________________________________________________________
Disad:  ________________________________________________________________
5. (4 pts) Identify the following about the Eta model equations below: P for prognostic or D for diagnostic. The common name for the equation.

<table>
<thead>
<tr>
<th>P or D</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\frac{\partial}{\partial \eta} \left( \frac{\partial p}{\partial t} \right) + \nabla \cdot \left( \mathbf{v} \frac{\partial p}{\partial \eta} \right) + \frac{\partial}{\partial \eta} \left( \eta \frac{\partial p}{\partial \eta} \right) = 0, \quad (2.5)
\]

\[
\frac{\partial \Phi}{\partial \eta} = -\frac{RT}{p} \frac{\partial p}{\partial \eta}, \quad (2.6)
\]

6. (4 pts) State one advantage and one disadvantage of the indicated 2 of the 4 coordinate systems below:

For Fig (b)

Ad: __________________________________________
Disad: _______________________________________

For Fig. (d)

Ad: __________________________________________
Disad: _______________________________________

7. (5.5 pts) An equation for a statistical objective analysis scheme estimate of \textbf{temperature (A)} is given below.

\[ A_M = E_M + \sum_{i=1}^{N} B_i \{ C_i - D_i \} \]  

\( (1) \)

a. From the context in which these variables are used, describe each of the following quantities:

- \( B_i = \) __________________________
- \( C_i = \) __________________________
- \( D_i = \) __________________________
- \( E_M = \) __________________________

Caution: be specific, complete, and unambiguous.

c. (6.5 pts) If \( N = 1 \), derive a formula for the weight that minimizes the error based upon \( J \) past events. Hint: it is useful to define simplifying notation. Define any notation that you introduce.