Question #1: Phases of water (10 points)

a) (3 points) Please match the process to the appropriate phase change:

<table>
<thead>
<tr>
<th>Process</th>
<th>Phase Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaporation</td>
<td>From vapor to liquid is called condensation.</td>
</tr>
<tr>
<td>Sublimation</td>
<td>From ice to vapor is called sublimation.</td>
</tr>
<tr>
<td>Melting</td>
<td>From liquid to ice is called freezing.</td>
</tr>
<tr>
<td>Freezing</td>
<td>From vapor to ice is called deposition.</td>
</tr>
<tr>
<td>Condensation</td>
<td>From liquid to vapor is called evaporation.</td>
</tr>
<tr>
<td>Deposition</td>
<td>From ice to liquid is called melting.</td>
</tr>
</tbody>
</table>

b) (3 points) Which of these phase change processes is very important in convection for forming thunderstorms?

Condensation – because water vapor molecules condense to form cloud droplets and as we learned before, condensation releases latent heat energy to the atmosphere.

c) (4 points) Why does condensation primarily occur when air is cooled? And why does warmer water evaporate at a greater rate than cooler water?

As air cools, molecules slow down and they are more likely to stick and condense on condensation nuclei particles. At higher temperatures, molecules are moving faster and have more speed to break through the surface of water and evaporate into the air above.

Question #3: Relative Humidity (20 points)

a) (2 points) What are the two primary ways to change relative humidity?

1) By changing the air’s water vapor content
2) By changing the air temperature

b) (6 points) Calculate the relative humidity of 2 cities:

1) City A has an actual vapor pressure of 6 mb and a saturation vapor pressure of 41 mb.
2) City B has an actual vapor pressure of 6 mb also, but a saturation vapor pressure of 18 mb.

c) (3 points) Which city has a higher surface temperature? How can you tell?
City A has a higher surface temperature because it has a higher saturation vapor pressure. Saturation vapor pressure increases with increasing temperature.

d) (4 points) Suppose the dew point of cold outside air is the same as the dew point of warm air indoors. If the door is opened, and cold air replaces some of the warm inside air, would the new relative humidity indoors be (a) lower than before, (b) higher than before, or (c) the same as before? Explain your answer.
The new relative humidity will be (b) higher than before. This occurs because if the temperature of the air decreases, so does the saturation vapor pressure which according to the relative humidity equation, will increase the relative humidity.

e) (5 points) Changes in relative humidity are important in determining the amount of evaporation from vegetation and wet surfaces. Using the concept of relative humidity and its relationship to temperature, explain why is it more effective to water your lawn in the evening than it is on a hot afternoon.
The relative humidity decreases as temperature increases. Therefore, on a hot afternoon when the relative humidity is low, a lot of the water used is going to evaporate quickly from the lawn, instead of soaking into the ground. In contrast, in the evening when relative humidity has increased due to a decrease in temperature, there will be less evaporation and therefore increase the effectiveness of watering.

Question #4: Dew Point (10 points)
a) (5 points) The air temperature in Estes Park, Colorado is 0°F and the dew point is 0°F (relative humidity is 100%). In Phoenix, Arizona, the air temperature is 95°F with a dew point of 50°F (relative humidity is 21%). Which city has more water vapor in the air? Why?
Phoenix, Arizona does because it has a much higher dew point than Estes Park. A higher dew point corresponds to more water vapor in the atmosphere.
b) (5 points) Why is New Orleans much more humid than the southern California coast since they are both located at the same latitude and both next to large bodies of water?

Even though both air masses are nearly saturated with water vapor, the cooler air from the Pacific Ocean that is flowing over the coast of southern California has a lower dew point than the warmer air from the Gulf of Mexico that is flowing over New Orleans. Therefore, the warmer air from the Gulf contains a lot more water vapor than the Pacific Ocean air.
Question #5:  Skew T Introduction (10 points)

Plot the temperature and dew point on the skew T diagram attached at a pressure of 950 mb. Using the skew T, find the mixing ratio and saturation mixing ratio. Using the appropriate equation, please calculate the relative humidity at this location.

*Note: Temperatures are in Celsius on skew T diagrams*

\[ T = 85^\circ F \]
\[ T_d = 65^\circ F \]