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1. (Given the plotted environmental sounding on the attached thermo diagram. (Assume unsaturated.)
- (a) (2 pts). The pressure at the top of the statically unstable layer is _____ kPa.
 - (b) (2 pts). The pressure at the bottom of the unstable layer is _____ kPa.
 - (c) (3 pts). Plot this point on this thermo diagram: $(P, T, T_d) = (100 \text{ kPa}, 20^\circ\text{C}, 5^\circ\text{C})$
 - (d) (2 pts). At the point from (c), its mixing ratio is _____ g/kg. Its saturation mixing ratio is _____ g/kg.
 - (e) (6 pts). If the point from (c) were lifted adiabatically, its LCL = _____ kPa, LFC = _____ kPa, and
EL = _____ kPa

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- 2) For weather radar:
- (a) (2 pts). A reflectivity observation of 65 dBZ indicates _____.
 - (b) (2 pts). A reflectivity observation of 30 dBZ indicates an approximate rainfall rate of _____ mm/h.

(c) (3 pts). Why is there a range limitation of weather radar? (very short answer):

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- 3) (a) (2 pts). 1200 UTC = _____ PST.

(b) (4 pts). An unsaturated layer of air has average $T = 30^\circ\text{C}$ and $r = 25 \text{ g/kg}$. Find its virtual temperature in $^\circ\text{C}$. (show your calculations)

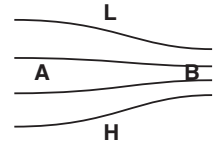
(c) (4 pts). The bottom of the layer of air from (b) is at $P = 90 \text{ kPa}$ and $z = 1 \text{ km}$. If the top of the layer is at $z = 2 \text{ km}$, calculate the pressure (kPa) at the layer top. (Hint: show your work. Do not use a thermo diagram.)

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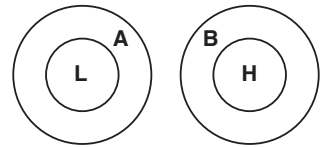
4) Assume **Northern Hemisphere**

(a) (3 pts). Explain how Coriolis force works. (very short answer):

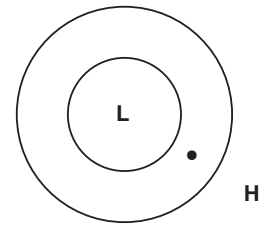
(b) (2 pts). For the figure at right, which location (A or B, circle one) has the fastest geostrophic winds? At that one location, the wind direction is _____ .
(Hint: the lines represent isobars, in all the figures.)



(c) (2 pts). For the figure at right, which location (A or B, circle one) has the fastest gradient winds? At that one location, the wind direction is _____ .
(Hint: H and L represent High and Low pressure, in all the figures.)



(d) (2 pts). For the figure at right draw a thick dark arrow at the dot showing the direction of the boundary-layer gradient winds, and use thin arrows to draw and identify each force acting at that point.



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5. (3 pts). List the factors that could reduce the solar radiation reaching each m² of Earth's surface. (very short answer):

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6) Given a vertical column of air with thickness 10 km, Coriolis parameter 10^{-4} s^{-1} , and which is rotating with relative vorticity = 10^{-4} s^{-1} in the Northern Hemisphere.

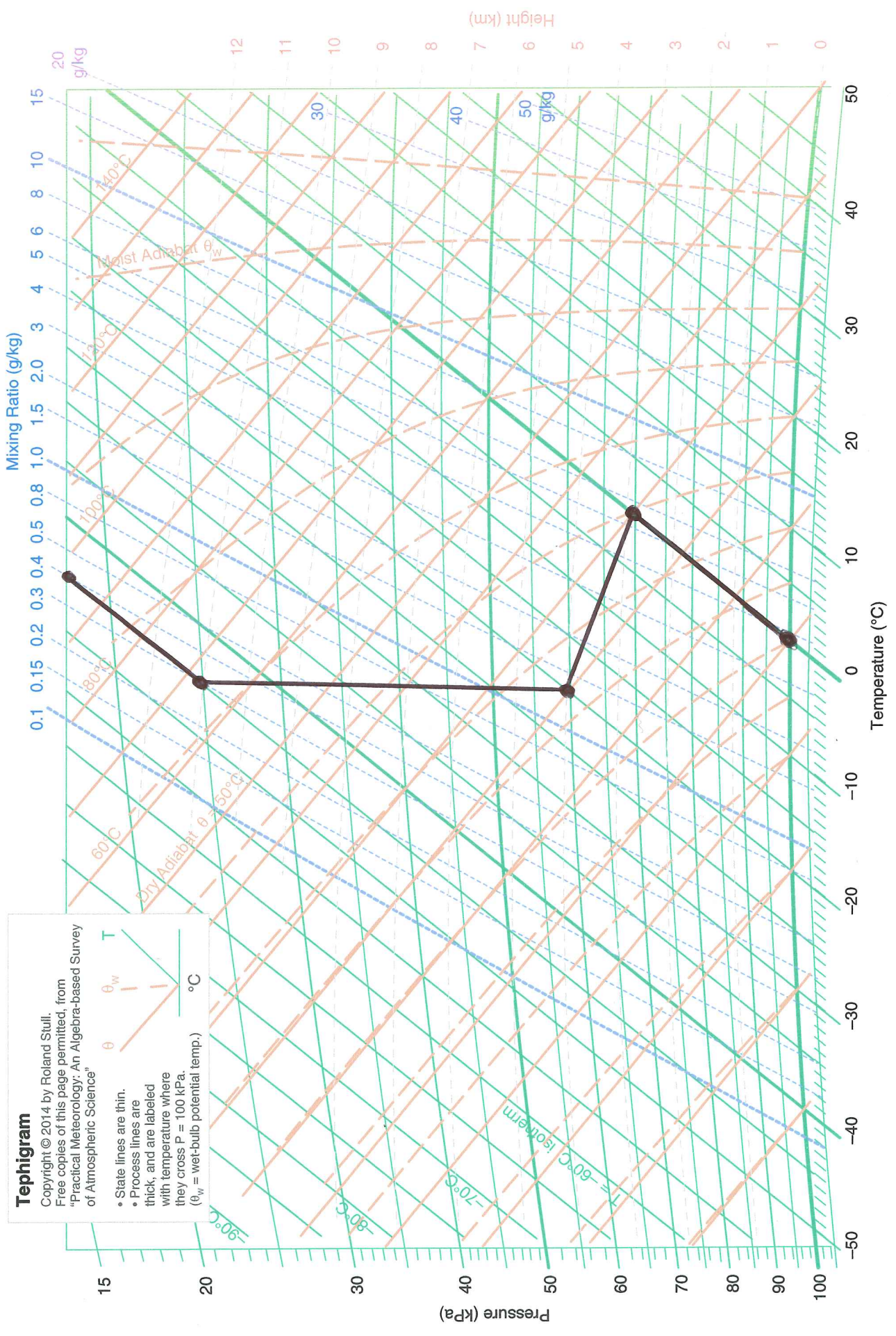
- (a) (4 pts). Its potential vorticity is _____ $\text{m}^{-1} \text{ s}^{-1}$.
- (b) (1 pt). If the column moves northward, its relative vorticity will [decrease, stay the same, increase (circle one)]
- (c) (1 pt). If the column from (a) stretches in the vertical, its potential vorticity will [decrease, stay the same, increase (circle one)]

-end of exam-

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Optional Bonus Question (4 pts).

Explain (in a way that a non-scientist can understand) the meaning and utility of helicity. (short answer):



Tephigram
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 "Practical Meteorology: An Algebra-based Survey
 of Atmospheric Science"

- State lines are thin.
- Process lines are thick, and are labeled with temperature where they cross $P = 100$ kPa. (θ_w = wet-bulb potential temp.)

θ θ_w T
 Dry Adiabats Moist Adiabats Isotherms
 °C °C