ATSC 201 **Midterm Exam** Name: _____
Prof. Stull (open books, notes, calculator)
Fall 2013 (50 points ≈ 1 minute/point) Student Number: _____

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1. Given a layer of air with (top, bottom) pressures of (30, 80) kPa, and an average virtual temperature of 5°C.

a) (4 points) What is the thickness of this layer? _____ km

b) (3 pts) Is the virtual temperature given above typical for that layer of the atmosphere? Assume dry air.

Circle your answer here (**yes** / **no**), and justify (very short answer):

c) (1 pt) If the layer average were to cool to $T_v = -40°C$, the layer thickness would:
(**increase** , **remain about the same** , **decrease**) [circle one].

••••••••

2) (4 pts). Why does water vapour condense in thunderstorm updrafts?

(very short answer):

••••••••

3) Given the attached Skew-T diagram with the environmental temperature sounding already plotted.

a) (1 pt) The tropopause is at pressure _____ kPa.

b) (1 pt) What static stability class (layer method) is the whole troposphere? _____

c) (1 pt) **Plot** the following near-surface air parcel **on the Skew-T**. $(P, T, T_d) = (100\ kPa, 35°C, 14°C)$.

d) (2 pts) What is the initial relative humidity of this air parcel? _____ %.

e) (4 pts) If this air parcel rises and makes a thunderstorm, what are the pressures (kPa) at:

z_i: _____ , LCL: _____ , LFC: _____ , EL: _____ .
(Hint: to maximize partial credit, draw the air parcel path on your Skew-T diagram.)

f) (1 pt) **On the Skew-T**, shade the CIN region.

g) (3 pts) Is CIN a good thing, or a bad thing, for thunderstorms?

(very short answer)

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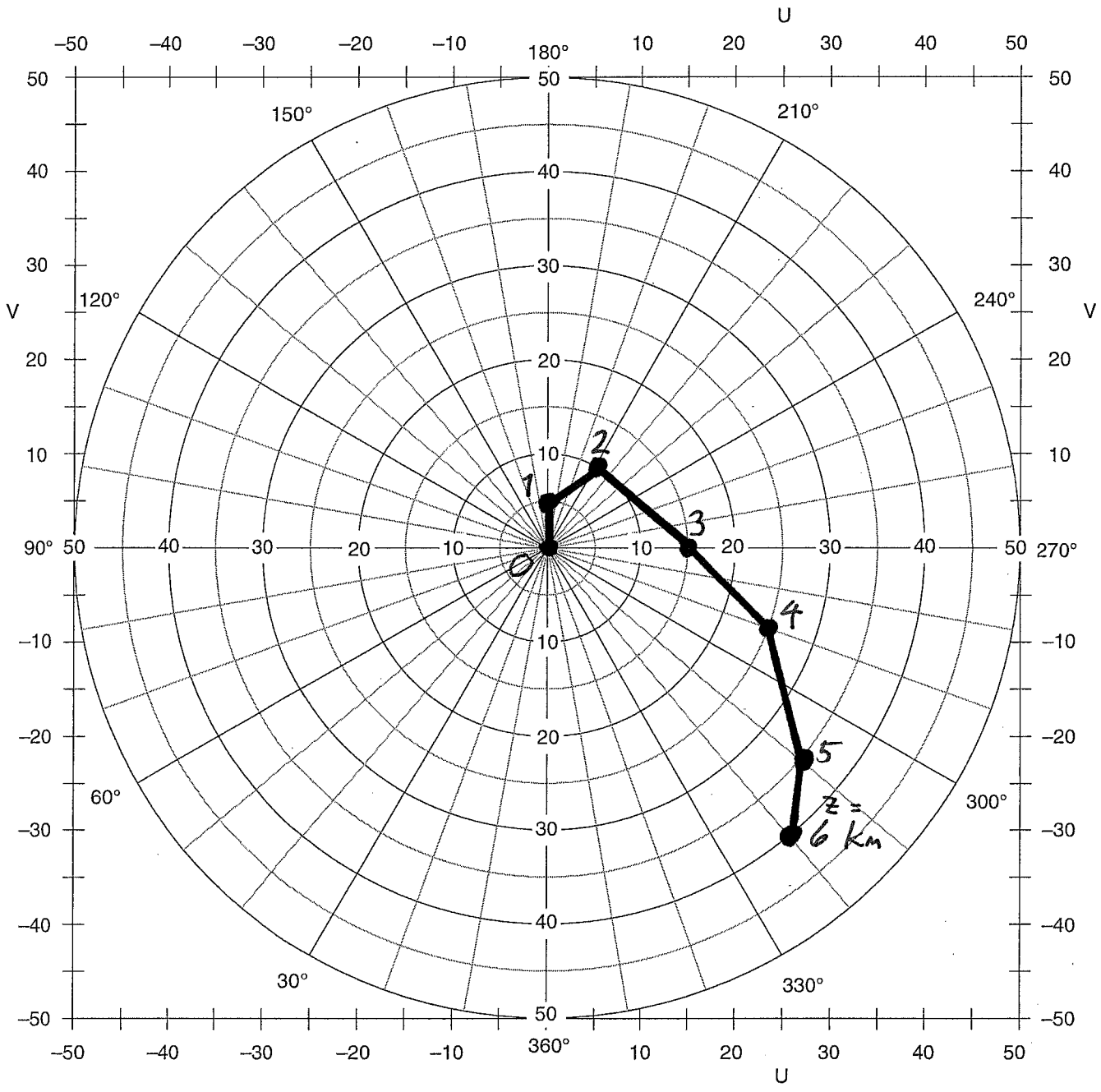


Figure 14.51
Blank hodograph for you to copy and use. Compass angles are direction winds are from. Speed-circle labels can be changed for different units or larger values, if needed.

••••••••

4) Given the attached hodograph with winds (m/s) already plotted.

a) (2 pts) **Draw** an "X" **on the hodograph** corresponding to the approximate **normal** movement of a thunderstorm. (Hint: Use the quick graphical estimate method, not equations.)

b) (2 pt) This "X" corresponds to speed _____ (m/s) and direction _____ °.

c) (2 pts) The corresponding Cartesian wind components are (U, V) = _____ m/s, _____ m/s.

d) (3 pts) What characteristics of the wind profile in this hodograph would favour supercell storms?

(very short answer, with justification)

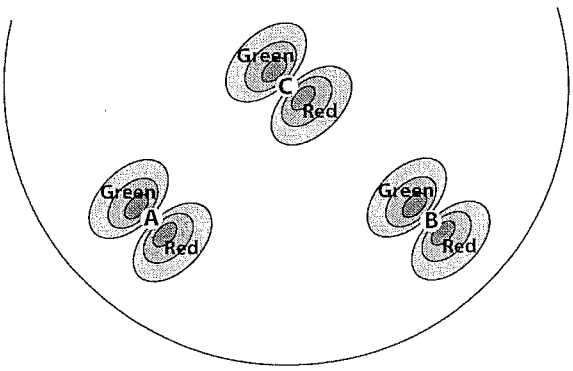
••••••••

5) (3 pts) At right is an image from a Doppler radar. **The radar is located at point "C".** Name the weather phenomenon at point:

A _____

B _____

C _____



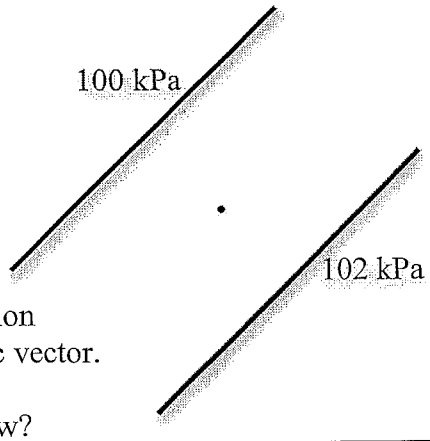
••••••••

6) The isobars on the weather map at right are spaced 1000 km apart. Dot is at 50°N. Density = 1.0 kg m^{-3}.

a) (3 pts) The Coriolis parameter is f_c = _____ s^{-1}.

b) (2 pts) At the dot in the weather map at right, draw a vector representing the **geostrophic** wind.

c) (2 pts) Relative to geostrophic wind, the **boundary-layer** wind speed is (**slower** , **about the same** , **faster**) [circle one], and the direction points slightly to the (**left** , **about the same** , **right**) of your geostrophic vector.



d) (1 pts) Why doesn't the geostrophic wind blow directly from high to low?

(very short answer)

••••••••

7) (5 pts) In the Northern hemisphere, a tornado is rotating **clockwise**.

Its relative vorticity is (**positive** , **near zero** , **negative**) [circle one]?

If the tornado translates further north, will it rotate (**faster** , **not much change** , **slower**) [circle one]?

Why? (very short answer)

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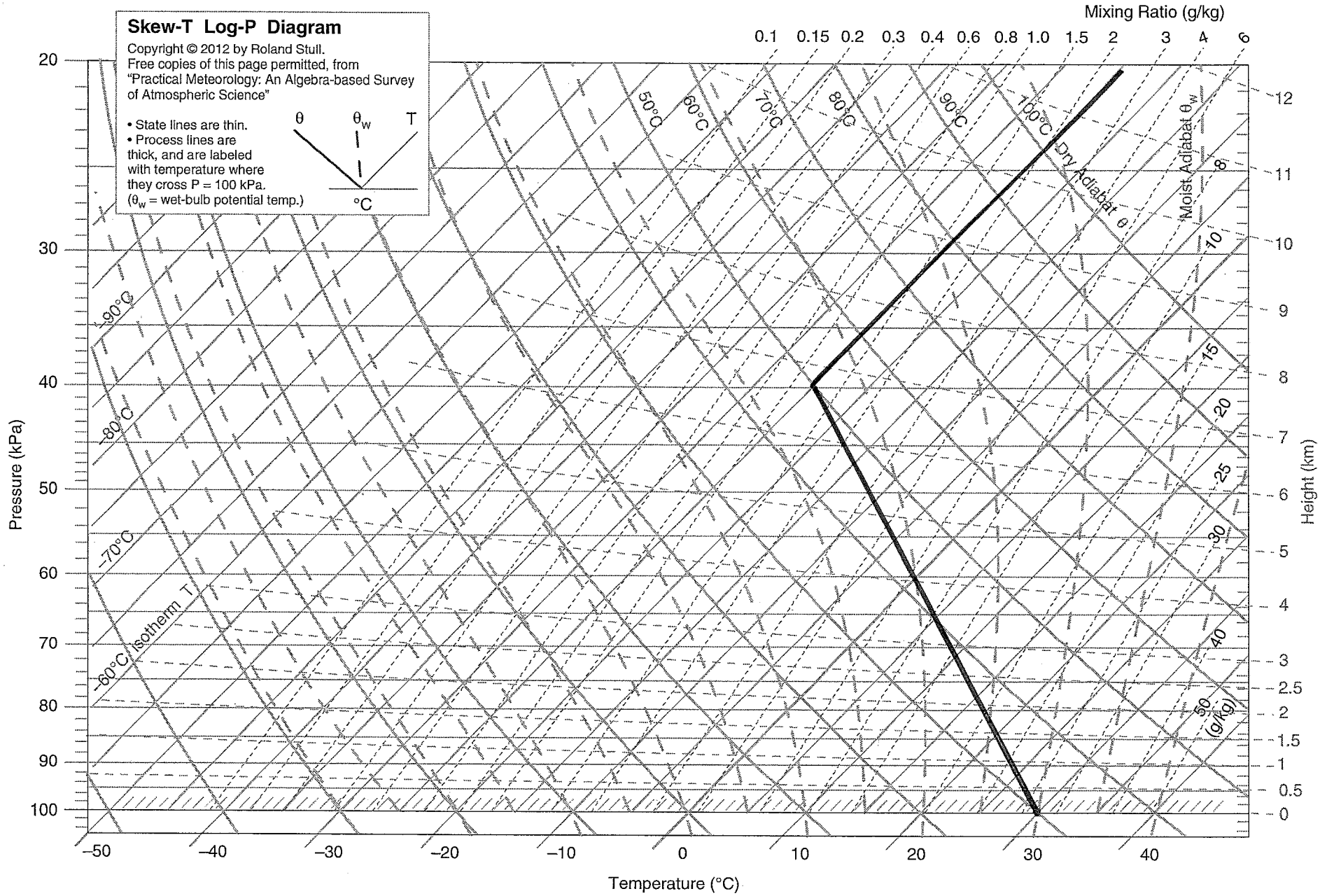
Skew-T Log-P Diagram
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"Practical Meteorology: An Algebra-based Survey
of Atmospheric Science"
• State lines are thin.
• Process lines are
thick, and are labeled
with temperature where
they cross P = 100 kPa.
(θw = wet-bulb potential temp.)
θ θw T
°C
Mixing Ratio (g/kg)
0.1 0.15 0.2 0.3 0.4 0.6 0.8 1.0 1.5 2 3 4 6
50°C
60°C
70°C
80°C
90°C
100°C
Dry Adiabat θ
Moist Adiabat θw
-90°C
-80°C
-70°C
-60°C Isotherm T
Pressure (kPa)
20 30 40 50 60 70 80 90 100
Height (km)
12 11 10 9 8 7 6 5 4 3 2.5 2 1.5 1 0.5 0
8 10 15 20 25 30 40 50 (g/kg)
–50 –40 –30 –20 –10 0 10 20 30 40
Temperature (°C)