2.

10 pts

$V = 10^3\ m^3$

$\downarrow 2600\ N = mg = 1100 + 1500\ N$

Standard Atmos.

$T_{sfc} = 15°C = 288.15\ K$

$T_{2km} = T_{sfc} - \gamma z$

$= 288.15 - (6.5\ K/km)(2\ km)$

$= 288.15 - 13 = 275.15\ K$

Use hypsometric eq. to find p at 2 km

$\Delta z = \frac{RT}{g} \ln \frac{p_{sfc}}{p_{2km}}$ (Average T: $\frac{288.15 + 275.15}{2} = 281.65$)

$2\ km = \frac{(287)(281.65)}{9.81} \ln \frac{1013.25}{p_{2km}}$

$\Rightarrow p_{2km} = 794.5\ hPa$

Total mass of balloon: $\frac{(1500 + 1100)\ N}{g} = 265.3\ kg$

Density at 2 km: $\rho_{air} = \frac{p}{R_d T_{air}} = \frac{(794.5 \times 10^2)}{(287)(~~281.65~~\ 275.15)}$

$= 1.0061\ kg\ m^{-3}$

Force balance:

$$m\not{g} = (\rho_0 - \rho')\not{g} V$$

$$\rho' = \rho_0 - \frac{m}{V} = 1.0061 - \frac{265.3 \text{ kg}}{10^3 \text{ m}^3}$$

$$= 1.0061 - 0.2653$$

$$= 0.7408 \text{ kg/m}^3$$

From $p = \rho' R_d T$,

$$T = \frac{p}{\rho' R_d} = \frac{79450}{(0.7408)(287)} = 373.7 \text{ K}$$

42 pts

4. a) Plot sounding 5 pts

b) 20 pts

p	T	T_d	r_v	f	θ	θ_e	θ_w	T_{sp}
1000	30	20	14.5	14.6/28 52	303	75	22.5	17.7
900	20	18	14.5	14.5/16.5 88	302	72	22.2	18
800	18	10	9.6	9.6/16.5 58	310	66	21	8.0
700	10	5	7.8	7.8/11.2 70	313.5	64	20.5	4
600	1	-4	4.7	[illegible]/6.9 68	317	59	19.5	-5.6
500	-7	-12	3.1	3.1/4.6 67	324.5	62	20	-13.5
400	-17	-25	1.25	1.25/2.5 50	332	64	20.5	-27

6 pts c.
6 pts d.

	Static stability	Conv. unstable?
1000-900	Abs. unstable	Y
900-800	Abs. stable	Y
800-700	C.U.	Y
700-600	C.U.	Y
600-500	neutral (w.r.t. saturation)	N
500-400	Abs. stable	N

5 pts e. adiabatic LWC (parcel 900 mb) @ 500 mb

$$r_{ca} = (14.5 - 5.4)\ g/kg = 9.1\ g/kg$$

$$\rho = \frac{p}{RT_v} = \frac{50000}{(287)(268(1+0.61 * .0054))} = 0.65\ kg/m^3$$

$$\chi = \rho \cdot r_{ca} = (9.1\ g/kg)(0.65\ kg/m^3)$$

$$= 5.9\ g/m^3$$

Problem 6 from Chap. 8 of notes

6. Initial conditions: T = 20 C, r_v = 10 g/kg, p = 1000

a) Find initial T_d: this can be done graphically by reading the T at the intersection of p = 1000 mb and r_v= 10 g/kg. T_d = 13.7 C

b) Find the T at 900 mb after the parcel as ascended over the mountain and then descended on the downwind side. This is done graphically by lifting the parcel to its SP, and then following a saturated adiabat up to 700 mb. At this point the saturation mixing ratio is 5.9 g/kg. The amount condensed is 10.0 – 5.9 = 4.1 g/kg. Of this, 80% is lost to precipitation, so (0.2)(4.1) = 0.8 g/kg remains. The total mixing ratio is then 5.9+0.8 = 6.7 g/kg. Take the parcel down the saturated adiabat until it crosses the 6.7 g/kg saturated mixing ratio line. This defines the new saturation point. From this point, the parcel will descend dry adiabatically to 900 mb. Following a dry adiabat to 900 mb gives the result: T_{900} = 19.7 C.

This process is shown in the diagram below.