1. On 9 February 2012 at 8am, the weather conditions in Austin, Texas were as follows

The air pressure was 102.6 kPa of Mercury at this time. Calculate the specific humidity, vapor pressure and saturated water pressure. For these water vapor conditions, what is the dew point temperature?

- Temperature

$$T_{°C} = \frac{5}{9}(T_{°F} - 32)$$

$$T_{°C} = \frac{5}{9}(38 - 32)$$

$$T = 3.33°C$$

- Saturated Vapor Pressure

$$e_s = 611exp\left(\frac{17.27T}{237.3 + T}\right)$$

$$e_s = 611exp\left(\frac{17.27(3.33)}{237.3 + 3.33}\right)$$

$$e_s = 776Pa$$

- Vapor Pressure

$$R_h = \frac{e}{e_s} = 0.89$$

$$e = e_s R_h = 776 \times 0.89$$

$$e = 691Pa$$

- Specific Humidity

$$q_v = 0.622\frac{e}{p}$$

$$q_v = 0.622\frac{691}{102{,}600}$$

$$q_v = 0.0042$$

(kg water/kg most air)

- Dew Point Temperature

$$e = 611exp\left(\frac{17.27T_d}{237.3 + T_d}\right)$$

$$T_d = \frac{237.3\ln\left(\frac{e}{611}\right)}{17.27 + \ln\left(\frac{e}{611}\right)}$$

$$T_d = \frac{237.3\ln\left(\frac{691}{611}\right)}{17.27 + \ln\left(\frac{691}{611}\right)}$$

$$T_d = 1.7°C$$

2. **An intense thunderstorm is 0.5 km in diameter and rain is falling beneath it at a rate of 50 mm/hour. At what is the power being supplied to this thunderstorm in MW by condensation of moisture within the storm clouds to produce this rate of rainfall?**

$$\rho = 1{,}000\ kg/m^3$$

$$l_v = 2.5 \times 10^6\ J/m^2$$

$H_l = \rho l_v E$

$H_l = 1{,}000\ kg/m^3\ (2.5 \times 10^6\ J/kg)(50\ mm/hr)(1hr/3{,}600s)(1m/1{,}000mm)$

$H_l = 34{,}772\ W/m^2$

$$P = H_l A$$

$$P = 34{,}772\left(\frac{1}{4}\pi d^2\right)$$

$$P = 34{,}772\left(\frac{1}{4}\pi 500^2\right)$$

$$P = 6{,}830MW$$

3. **If the mean annual net radiation over the earth is 105 W/m2 and the annual evaporation from the earth is 57,000 km3/year (Table 1.1.2), what proportion of the earth's net radiation is used to supply evaporation?**

From Table 1.1.2
$A = 5.10 \times 10^8 km^2$

$$E = \frac{577{,}000\ km^3/yr}{5.10 \times 10^8 km^2} = 1.131\ m/yr$$

$H_l = \rho l_v E$

$H_l = 1{,}000\ kg/m^3\ (2.5 \times 10^6\ J/kg)(1.131\ m/yr)(1yr/365d)(1d/86{,}400s)$

$H_l = 90\ W/m^2$

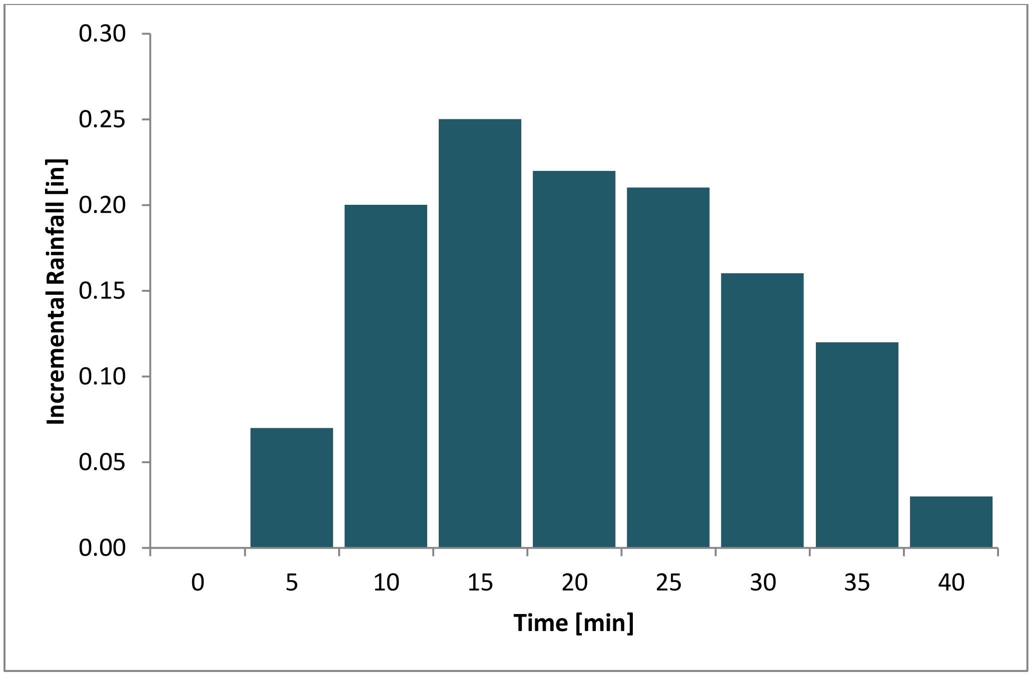
$$P_{\%} = \frac{90}{105}$$
$$P_{\%} = 86\%$$

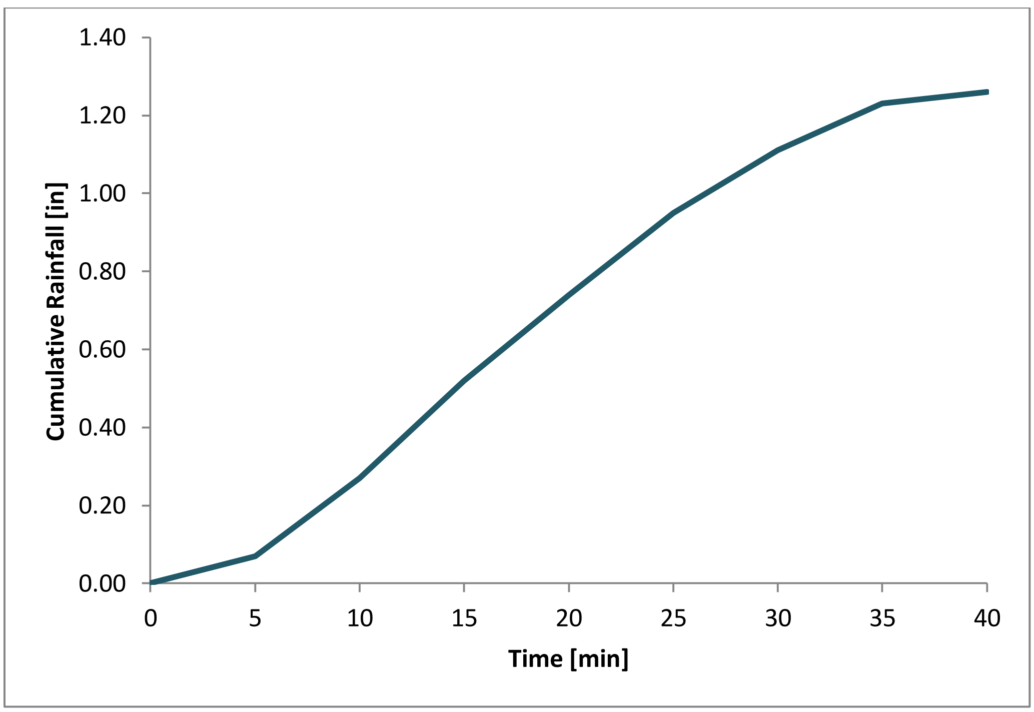
3.4.3 The following rainfall data were recorded at gage 1-Bol for the storm of May 24-25, 1981, Austin, Texas:

Time (min)	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
Rainfall (in)	**-**	**0.07**	**0.20**	**0.25**	**0.22**	**0.21**	**0.16**	**0.12**	**0.03**

Plot the rainfall hyetograph. Compute and plot the cumulative rainfall hyetograph. Calculate the maximum depth and intensity recorded in 10, 20 and 30 minutes for this storm. Compare the 30-minute intensity with the value found in Table 3.4.1 in the text for gage 1-Bee.

Time (min)	Rainfall (in)	Cumulative Rainfall (in)	Running Totals 10 min	20 min	30 min
0	-	0.00			
5	0.07	0.07			
10	0.20	0.27	0.27		
15	0.25	0.52	0.45		
20	0.22	0.74	0.47	0.74	
25	0.21	0.95	0.43	0.88	
30	0.16	1.11	0.37	0.84	1.11
35	0.12	1.23	0.28	0.71	1.16
40	0.03	1.26	0.15	0.52	0.99
Max depth (in)	0.25		0.47	0.88	1.16
Max intensity (in/h)	3.00		2.82	2.64	2.32





The max depth and intensities are smaller in 1-Bol. This is due a smaller storm magnitude.

5. Infiltration occurs on a Loam soil with initial effective saturation of 30%. If the water is initially ponded compute the cumulative infiltration and the infiltration rate at one hour intervals up to 5 hours. Suppose that instead water is not ponded initially but that a rainfall of 1 cm/hr occurs continuously. Determine the ponding time and the time it will take to achieve the same cumulative infiltration as was achieved under ponded conditions.

$s_e = 0.30$

Table 4.3.1 Loam

$\eta = 0.463$

$\theta_e = 0.434$

$\psi = 8.89 cm$

$K = 0.34\, cm/h$

$\Delta\theta = (1 - s_e)\theta_e$

$\Delta\theta = (1 - 0.30)(0.434)$

$\Delta\theta = 0.304$

Cumulative Infiltration Depth

$$F(t) = Kt + \psi\Delta\theta ln\left(1 + \frac{F(t)}{\psi\Delta\theta}\right)$$

Infiltration Rate

$$f = K\left(\frac{\psi\Delta\theta}{F(t)} + 1\right)$$

Time (hr)	F (cm)	Residual	f (cm/hr)
0	0.00	0.00	
1	1.59	0.00	0.92
2	2.40	0.00	0.72
3	3.07	0.00	0.64
4	3.68	0.00	0.59
5	4.26	0.00	0.56

Ponding Time

$$t_p = K\psi\Delta\theta/i(i-K)$$

$$t_p = 0.34(8.89)(0.304)/\left(1(1-0.34)\right)$$

$$t_p = 1.39hr$$

$$F_p = it_p$$

$$F_p = 1(1.39)$$

$$F_p = 1.39cm$$

Time to achieve $F = 4.26cm$

$$F - F_p - \psi\Delta\theta ln\left(\frac{\psi\Delta\theta + F}{\psi\Delta\theta + F_p}\right) = K\left(t - t_p\right)$$

$$4.26 - 1.39 - 8.89(0.304)ln\left(\frac{8.89(0.304) + 4.26}{8.89(0.304) + 1.39}\right) = 0.34(t - 1.39)$$

$$1.434 = 0.34(t - 1.39)$$

$$t = \frac{1.434}{0.34} + 1.39$$

$$t = 5.61hr$$