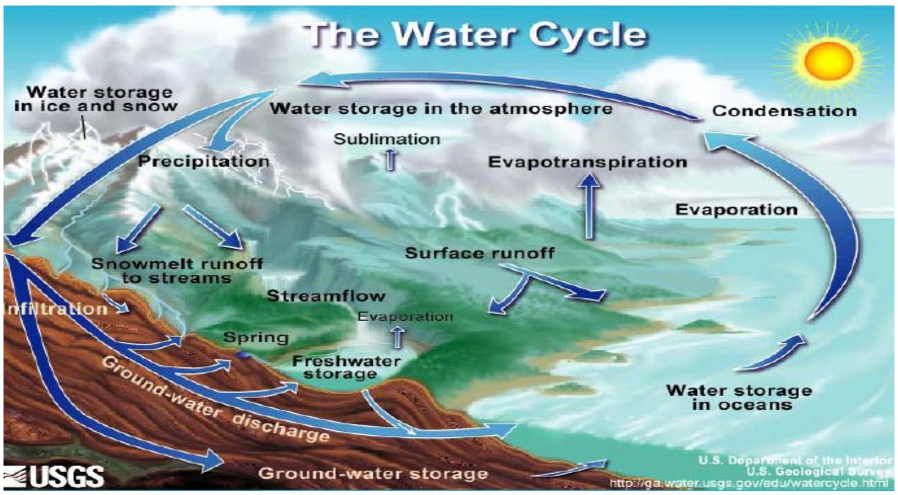
Answers of Assignment 2: Engineering Hydrology

1- Application for engineering hydrology

A) Flood forecasting
B) Flood protection
C) Flood routing
D) Design of hydraulic structures
E) Water resources and water management

2- Hydrologic Cycle



3- $RH = \frac{e_v}{e_s}\ \%$

$$= \frac{40}{e_s}\ \%$$

$$e_s = 611\ e^{\frac{17.27 \times T}{237.3+T}}$$

$$e_s = 611\ e^{\frac{17.27 \times 30}{237.3+30}}$$

$$= 4251.8\ Pascal$$

$$= 42.52\ mbar$$

Then RH = 40/42.52 *100 = 94.07 %

4- $e_s = 611\ e^{\frac{17.27\times T}{237.3+T}}$

$e_s = 611\ e^{\frac{17.27\times 20}{237.3+20}}$

$= 2339.05\ Pascal$

$RH = \frac{e_v}{e_s}\ \%$ = 44% ➡ e_v = 1029.2 Pascal

$At\ Dew\ point\ e_v = e_s$

$1029.2 = 611\ e^{\frac{17.27\times T}{237.3+T}}$

$ln\frac{1029.2}{611} = \frac{17.27\times T}{237.3+T}$

$T = 7.39\ °C$

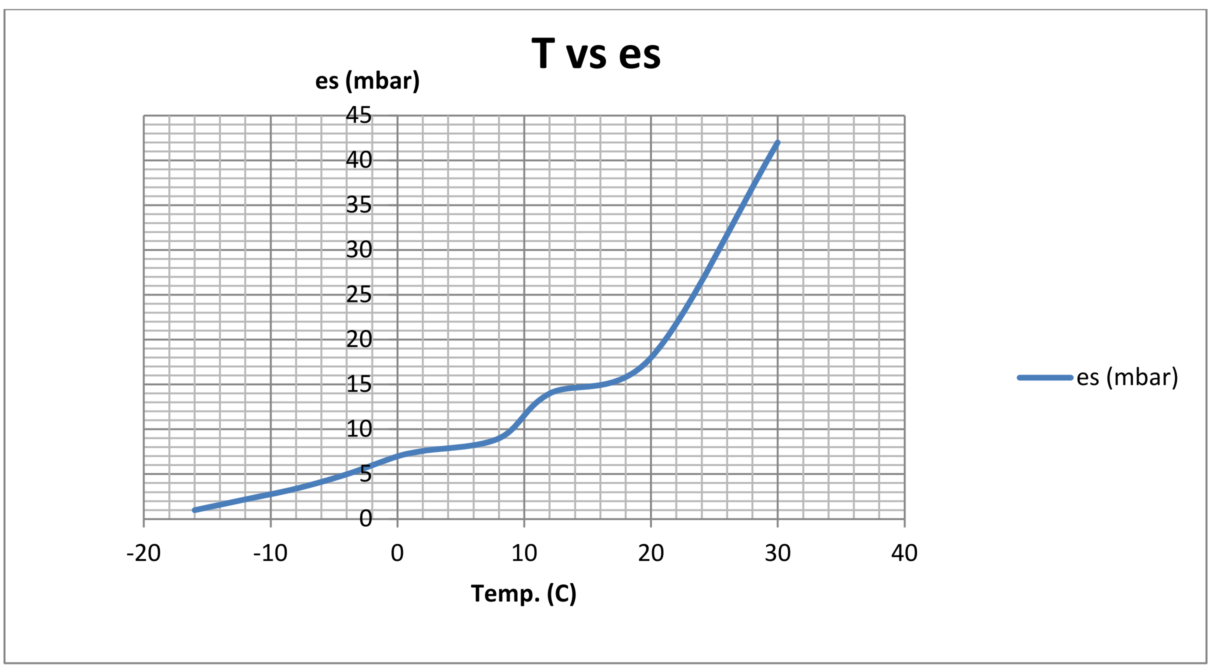
5 – At T = 6°C e_v=e_s = $611 * e^{\frac{17.27\ T}{237.3+T}}$ = $611 * e^{\frac{17.27*6}{237.3+6}}$ = 935.41 Pascal

At T = 20°C e_s =$611 * e^{\frac{17.27\ T}{237.3+T}}$ = $611 * e^{\frac{17.27*20}{237.3+20}}$ = 2339 Pascal

∴ RH = $\frac{ev}{es}\ x\ 100$ = $\frac{935.41}{2339}\ x\ 100$ = 40 %

6 –

a)



b) At T 16°C e_s = 15 mbar (from the curve or by using the previous equation)

RH = 40 % = $\frac{ev}{es}\ x\ 100 = \frac{ev}{15}\ x\ 100$ ∴ e_v = 6 mbar = 600 Pascal

At dew point $e_v = e_s = 611 * e^{\frac{17.27\,T}{237.3+T}}$ = 600

∴ T = -0.23 °C

c) ev = 16 mbar

At dew point $e_v = e_s = 611 * e^{\frac{17.27\,T}{237.3+T}}$ = 1600 Pascal

∴ T = 17 °C

7 –

T = 23°C , e_v = 10 mbar ,K = 0.3 , W_{18} = 18 m/s

$e_s = 611 * e^{\frac{17.27\,T}{237.3+T}} = 611 * e^{\frac{17.27*23}{237.3+23}}$ = 2810.35 Pascal = 21.17 mmHg (1mmHg=133Pa)

e_v = 10 mbar = 1000 Pascal = 7.51 mmHg

RH = $\frac{ev}{es}\ x\ 100 = \frac{7.51}{21.17}\ x\ 100$ = 35.5 %

$(\frac{W8}{W\,18}) = (\frac{Z8}{Z18})^k$ ∴ $(\frac{W8}{18}) = (\frac{8}{18})^{0.3}$ ∴ W8 = 14.11 m/s = 50.8 km /hr

∴ E = 0.5 * 21.17 * (1 – ($\frac{35.5}{100}$))*(1+.0625*50.8) = 28.33 mm/day

8 –

E.T = $K_s * K_c$ * E = 0.7* 0.85 * 28.33 = 16.85 mm/day

9- ***Given:*** Wo= 40 km/h Zo= 100 m, Z= 10 m K= 0.2

Required:

W =? mph

Solution:

$W_1/W_o = (Z_1/Z_o)$ ^ K

W_1/40 = (10/100)^0.2

W= 25.238 km/h = 40.63 mph (1 mph= 1.61 km/h)

10- ***Given:*** Z_o = 5 m W_o= 5 m/s, Z_1= 60 m W_1= 10 m/s

Required:

Wind speed at Z=10 m & Z=30 m

Solution:

$W_1/W_o = (Z_1/Z_o)$ ^ K

10/5 = (60/5) ^ K

K= 0.279

For Z_2= 10 m

$W_2/W_o = (Z_2/Z_o)$ ^ K

$W_2/5 = (10/5)$ ^ 0.279

W_2 = 6.067 m/sec

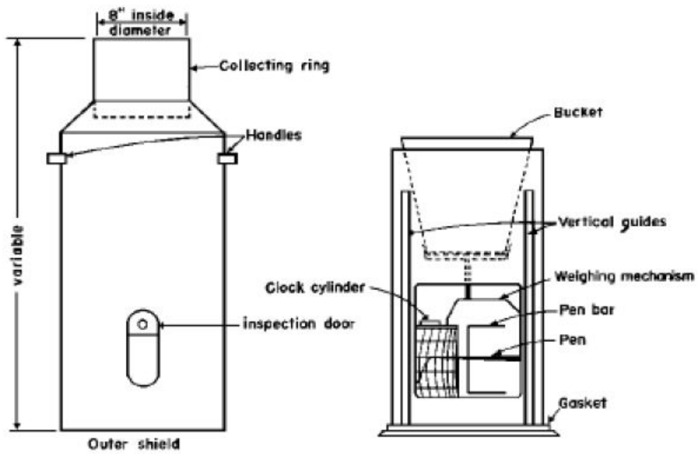
For Z_3= 30 m

$W_3/W_o = (Z_3/Z_o)$ ^ K

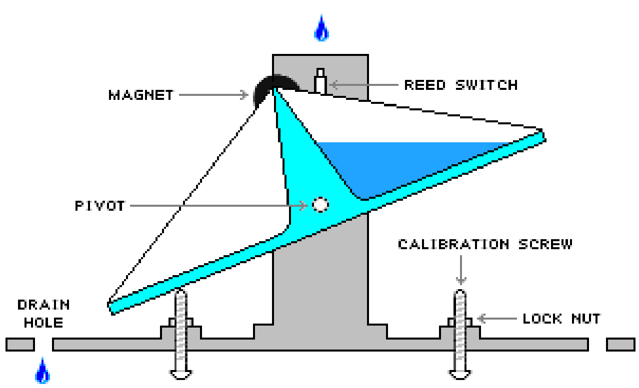
$W_3/5 = (30/5)$ ^ 0.279

W_3 = 8.24 m/sec

11-



1) Weighing Bucket Type



2) Tipping Bucket Type

12- Factors affecting infiltration:

1) Soil characteristics:
   Soil type, porosity, moisture content and land use.
2) Land cover.
3) The characteristics of infiltrated water:
   Such as low temperature which lowers water viscosity that means higher infiltration rate.
4) Land slope.
5) The amount of precipitated water.

13-

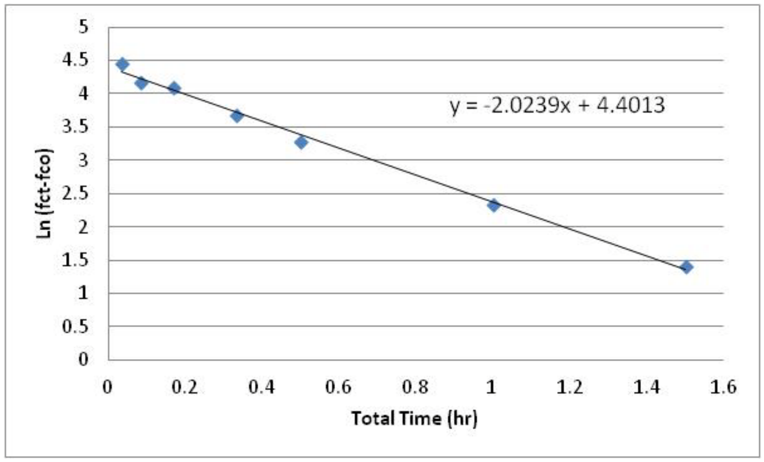
T (min)	T in hr	V_{total} (cm^3)	ΔV increment(cm^3)	Δd increment(cm)	Δd increment(mm)
0	0	0	0	0	0
2	0.033333	300	300	0.311813782	3.118137823
5	0.083333	650	350	0.363782746	3.63782746
10	0.166667	1190	540	0.561264808	5.612648082
20	0.333333	1950	760	0.789928249	7.899282485
30	0.5	2500	550	0.571658601	5.716586009
60	1	3350	850	0.883472383	8.834723832
90	1.5	3900	550	0.571658601	5.716586009
150	2.5	4600	700	0.727565492	7.275654921

ΔT: Time increment (min.)	ΔT: Time increment (hr)	F_{ct} (mm/hr) = Δd/ΔT
0	0	0
2	0.033333	93.544135=F_{co}
3	0.05	72.756549
5	0.083333	67.351777
10	0.166667	47.395695
10	0.166667	34.299516
30	0.5	17.669448
30	0.5	11.433172
60	1	7.2756549=F_{cf}

X (T in hr)	Y ($\ln(f_{ct}-f_{cf})$)
0	0
0.033333	4.457460291
0.083333	4.18175314
0.166667	4.095606715
0.333333	3.691867359
0.5	3.296707452
1	2.341175575
1.5	1.42483504

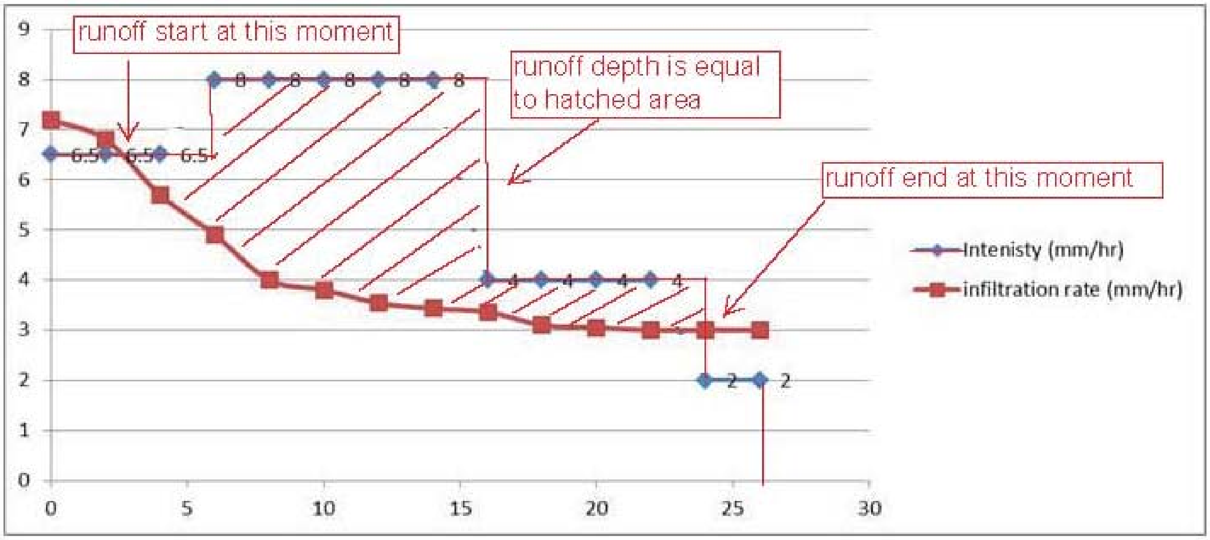
F_{co}= 93.544 mm/hr
F_{cf}= 7.276 mm/hr
Horton's Equation:
$F_{ct}= F_{cf}+(F_{co}-F_{cf})e^{-kt}$
$\ln (F_{ct}-F_{cf})=\ln(F_{co}-F_{cf})-kt$
Y = C -mx
Then K =2.02 hr^{-1}

Or by substituting with different T & F_{ct} to get different K values and taking the avg.



14-

time(hr)	Intenisty (mm/hr)	infiltration rate (mm/hr)
0.01	6.5	7.2
2	6.5	6.8
4	6.5	5.7
6	8	4.9
8	8	4
10	8	3.8
12	8	3.54
14	8	3.43
16	4	3.36
18	4	3.1
20	4	3.05
22	4	3
24	2	3
26	2	3



Run off depth = sum (intensity – average infiltration rate)* 2hr
= 52.44mm or area over the curve.

15-

Vin – vout = Δ Storage

Vin = inflow + precipitation

Vin = 200,000 m^3/day * 30 days
+ (10.5cm/100) * (500 hectare*(10^4))

Vin =6,525,000 m^3

Vout= seepage + evaporation

Vout= (2cm/100)*(500hectare*(10^4))
+(8.5cm/100)*(500hectare*10^4) + 30Q_{out}

Vout=525,000 + 30Q_{out} m^3

Δ Storage = -(0.5*500hectare*10,000)

= -2,500,000m^3

6,525,000 – 525,000 – 30Q_{out} = -2,500,000

Q_{out} = 283,333.3 m^3/d

16-

$\Delta Vol._{Storage} = V_{in} - V_{out}$

Runoff Coeff. = R/P= 0.45

V_{in} = Runoff into the reservoir

$= (0.45*(50mm/1000)*((1.9*10^6)km^2*10^6\ m^2))$

$= 4.275*10^{10}\ m^3$

$\Delta Vol._{Storage} = (2*10^{-6})*(178^{7.46}-175^{7.46}) = 1.46*10^{10}\ m^3$

$\Delta Vol._{Storage} = V_{in} - V_{out}$, $V_{out} = V_{evaporation}$

$1.46*10^{10}\ m^3 = 4.275*10^{10} m^3 - V_{evap.}$

Then $V_{evap.} = 2.815 * 10^{10}\ m^3$

Then $V_{evap.} = 2.815* 10^{10}\ m^3/(5500*10^6*30)*1000 = 170.6$ mm/d