* هيدروليكا هندسية *

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Ex water application lake bottom

A lake of ($40 Km^2$) lake receives average water flow of ($0.56 m^3/s$) for the month of January (30 day) while delivers ($0.48 m^3/s$) as outflow. The cumulative precipitation for January is ($45 mm$), while the cumulative evaporation is ($125 mm$) and the cumulative infiltration from the lake bottom is ($25 mm$) calc. the change in the lake water level???

Sol8o

The change in the storage $= \Delta S = (V_{in} - V_{out})$

area $= 40 Km^2$...

average water flow $= 0.56 m^3/s$ ... inflow...

delivers $= 0.48 m^3/s$ outflow

precipitation $= 45 mm$ ... inflow...

evaportation $= 125 mm$ ... outflow...

infiltration $= 25 mm$ ... outflow...

volume inflow 8o (m^3)

($1 Km^2 \rightarrow 10^6 m^2$)

① $0.56 \frac{m^3}{s} * (60*60*24*30) = \boxed{1451520 m^3}$ (average water flow)

② $45 mm * 40 Km^2 * 10^6 * 10^{-3} = \boxed{1800000 m^3}$ (precipitation)

$$\boxed{\sum inflow = 1451520 + 1800000 = \boxed{3251520 m^3}}$$

volume outflow 8o (m^3)

① $0.48 \frac{m^3}{s} * (60*60*24*30) = 1166400 m^3$...

② $125 * 10^{-3} * 40 * 10^6 = 5000000 m^3$...

③ $25 * 10^{-3} * 40 * 10^6 = 1000000 m^3$...

$$\sum outflow = 1166400 + 5000000 + 1000000 = \boxed{7166400 m^3}$$

$\therefore \Delta S = 3251520 - 7166400 = \boxed{-3914880 m^3}$ To find the depth (m)

$\rightsquigarrow$ The depth (m) $= \frac{m^3}{m^2} = \frac{3914880}{40*10^6}$

$\therefore$ depth = drop = -0.097 m

≈ -9.78 cm $\approx \boxed{10\text{ cm}}$ #

*** Ex: (drainage density) *** $\rightsquigarrow \left(D = \frac{\sum^{N} L}{A}\right)$

$\rightsquigarrow w_A \rightsquigarrow$ have $(D = 7)$

$w_B \rightsquigarrow$ have $(D = 3)$

$\boxed{\text{which, is correct??!}}$

(a) Slope A > Slope of B

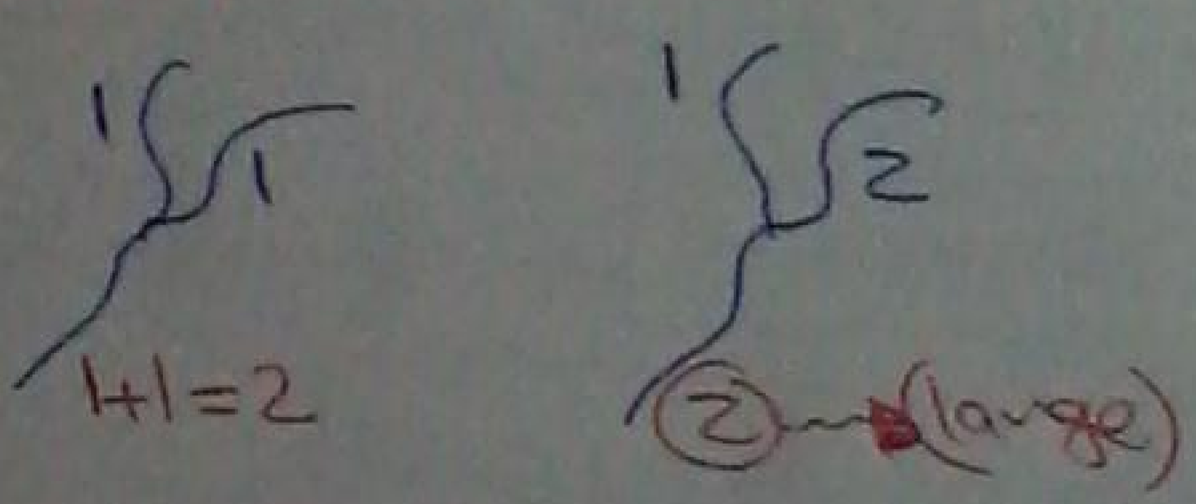
(b) Slope B > Slope of A

(c) Slope A = Slope of B

(d) No Relation...

*** Ex: (stream order) ***

$\rightsquigarrow$ i+1 $\rightsquigarrow$ OR (large order)...



*** Ex: (law of the stream Number and the stream length) ***

$\rightsquigarrow \frac{N_i}{N_{i+1}} = R_n \rightsquigarrow N_i = R_n^{(K-i)} \rightsquigarrow$ (Stream Number)...

$\frac{L_{i+1}}{L_i} = R_L \rightsquigarrow L_i = L_1 R_L^{(i-1)} \rightsquigarrow$ (stream length)...

Ex (The expected value and the variance and standard deviation) ...

Given a historical record of rainfall depth (x) for years (1995–2010) at a gauging station in Jordan estimate the $\boxed{\text{mean}}$ and the $\boxed{\text{standard deviation}}$ of the rainfall depth???

Year	Rainfall (mm) x_i	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
1995	212	34.6875	1203.2
1996	123	54.2125	2949.8
1997	156	21.2125	454.2
1998	225	47.7875	2274.1
1999	134	43.2125	1876
2000	175	2.2125	5.3
2001	237	59.7875	3562.6
2002	249	71.7875	5139.1
2003	188	10.7875	114.2
2004	141	36.2125	1318.6
2005	197	19.7875	387.6
2006	180	2.7875	7.2
2007	96	81.2125	6611.7
2008	150	27.2125	746
2009	207	29.7875	881.3
2010	167	10.2125	106.3
	$\sum x_i = 2837$	$\sum (x_i - \bar{x}) = 552.9$	$\sum (x_i - \bar{x})^2 = 27637.2$

① $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$

$\therefore \bar{x} = \frac{1}{n}\sum_{i=1}^{16} x_i$

$\bar{x} = \frac{1}{16} * (2837) = \boxed{177.2125\ \text{m}}$

② $v = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$

$\therefore v = \frac{1}{15}(27637.2)$

$\boxed{\therefore v = 1842.48}$

③ $S = \sqrt{v} = \boxed{42.92}$

#

*** Ex (weibull plotting position) ***

(a) annual rainfall at gauging station is recorded for year (1995 – 2010). plot the distribution of the rain-fall assuming that the (desigen storm is 210 mm), how frequent such rainfall storm will occur???

(design value)

Year	Rainfall (mm) X_i	Rank (m)	Rainfall (mm)	$P(X \le x) = \frac{m}{n+1}$
1995	212	1	96	0.059
1996	123	2	123	0.118
1997	156	3	134	0.176
1998	225	4	141	0.235
1999	134	5	150	0.294
2000	175	6	156	0.353
2001	237	7	167	0.412
2002	249	8	175	0.471
2003	188	9	180	0.529
2004	141	10	188	0.588
2005	197	11	197	0.647
2006	180	12	207	0.706
2007	96	13	212	0.765
2008	150	14	225	0.824
2009	207	15	237	0.882
2010	167	16	249	$\boxed{0.941}$

(بترتيب ال X_i من الأصغر للأكبر)

بعد ما أعمل هاد الجدول برسم العلاقة اللي بين ال X_i على المحور السيني وال $(P X \le x)$ على المحور الصادي ..

at (design storm $X_i = 210$ mm) from graph $P(X \le x) = 0.74$

$\therefore P(X > x) = 1 - P(X \le x) = 1 - 0.74 = \boxed{0.26}$

$\therefore T = \frac{1}{P(X > x)} = \frac{1}{0.26} = 3.86 \approx \boxed{4 \text{ years}}$ #

(b) estimate the design storm that being (exceeded 40%) of time ???

*** The exceedance probability $(P(X \geq x)) = \boxed{0.4}$

$P(X \geq x) = 1 - P(X \leq x)$

$0.4 = 1 - P(X \leq x)$

$P(X \leq x) = 1 - 0.4$

$\boxed{P(X \leq x) = 0.6}$ from graph at $P(X \leq x) = 0.6$ the value of $\boxed{X_i = 190 mm}$ #

*** Ex 80 (intensity duration frequency) ***

(a) Plot the theoretical distribution for the following (15-minute extreme rainfall depths)

Year	15-min extreme rainfall depth (mm)	X_i (mm)	$(X_i - \bar{X})^2$
2000	12	7	45.1584
2001	17	8	32.72
2002	7	9	22.28
2003	14	11	7.3984
2004	27	12	2.9584
2005	9	13	0.5184
2006	13	14	0.0784
2007	18	15	1.6384
2008	8	17	10.76
2009	15	18	18.32
2010	11	27	176.35
		$\boxed{\sum X_i = 151}$	$\boxed{\sum(\bar{X} - X_i)^2 = 318.2}$

$\bar{X} = \frac{151}{11} = 13.72$

*** $S = \sqrt{U} = \sqrt{\frac{1}{10} * 318.2} = 5.64$

$\therefore \alpha = \frac{\sqrt{6} * 5.64}{\pi} = (4.4)$ $u = 13.72 - (0.5772 * 4.4)$

$\boxed{\therefore u = 11.18}$

مهم

x_i	$P(X\le x)=e^{-e^{-\left(\frac{x-u}{\alpha}\right)}}=e^{-e^{-\left(\frac{x-11.8}{\text{٩.٤}}\right)}}$
7	0.08
8	0.13
9	0.19
11	0.35
12	0.44
13	0.52
14	0.59
15	0.66
17	0.77
18	0.81
27	0.97

~~***~~ نرسم العلاقة المتواجدة
بين ال (X) على محور
السينات وقيمة ال
$P(X\le x)$ على محور الصادات ...

(b) what is the amount of $\boxed{\text{extreme rainfall depth}}$ $(X_{15\,min,\,10\,years})$ that is associated to (15 min) and return period of (10 years).

لل (duration)

~~***~~ The value of (T = 10 years) ...

$$T=\frac{1}{P(X>x)} \rightarrow P(X>x)=\frac{1}{T}=\frac{1}{10}=0.1$$

$$\rightarrow P(X>x)=1-P(X\le x)$$

$$0.1=1-P(X\le x)\rightarrow P(X\le x)=1-0.1$$

$$\boxed{P(X\le x)=0.9}$$

من الرسمة كانت قيمة ال $P(X\le x)$ تساوي ال (0.9)
فإن قيمة ال $\underline{(X=22.5)}$

يمكن إيجاد قيمة ال (extreme rainfall depth) من
خلال قانون مباشرة "دون" الاضطرار إلى ترتيب
القيم ورسم العلاقة بين ال (X) وال $P(X\le x)$ ودون نسب مئوية
...... الخ ..

c) → To calc. The extreme rainfall depth at duration ($d = 15$ min) and return period ($T = 10$ year)...

$$* \; X_{(15,10)} = \overline{X}_d + K_T S_d$$

$$\rightarrow K_T = \frac{-\sqrt{6}}{\pi}\left[0.5772 + \ln\left(\ln\left(\frac{T}{T-1}\right)\right)\right]$$

$$\therefore K_T = -\frac{\sqrt{6}}{\pi}\left[0.5772 + \ln\left(\ln\left(\frac{10}{10-1}\right)\right)\right]$$

$$\boxed{\therefore K_T = 1.3}$$

→ The value of ($\overline{X}_{(15\text{-min})} = 13.72$)

The value of ($S_{(15\text{-min})} = 5.64$)

$$\therefore X_{(15,10)} = 13.72 + (1.3 * 5.64)$$

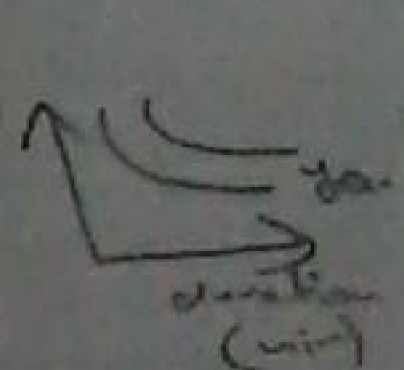
$$\boxed{X_{(15,10)} = 21.052 \text{ mm}}$$

← قريبة من إجابة فرع (b) ...

→ To find the value of intensity Rainfall (i (mm/hr))

$$i = \frac{X_{d,T}}{d} = \frac{21.052}{\left(\frac{15\text{ min}}{60}\right)} = \boxed{84.21} \text{ mm/hr}$$

← أو نكمله أو من منحنى الـ



(أنظر ورقة في القوانين)

at ($d = 15$ min) → ($T = 10$ year)

→ ∴ The value of (i) from graph $\boxed{i = 84 \text{ mm/hr}}$

Ex (To find the value of intensity)

construct the (5-year IDF curve for the following max. rainfall depth of (15-min) and (60-min) duration ..

$\underbrace{\text{5-year}}_{\text{Return period (T)}}$; (15-min) → (d) ; (60-min) → (d)

year	15-min. max rainfall	60-min. max rainfall
2000	24	45
2001	30	75
2002	20	34

(a) at (15-min. max. rainfall)...

$$X_{(15,5)} = \bar{X}_d + K_T S_d$$

$$X_{(15,5)} = \bar{X}_{15} + K_T \cdot S_{15}$$

$$\bar{X} = \frac{24+30+20}{3}$$

$$\therefore \boxed{\bar{X} = 24.67}$$

$$S = \sqrt{\frac{(24-24.67)^2+(30-24.67)^2+(20-24.67)^2}{2}} = \boxed{5.033}$$

$$K_T = -\frac{\sqrt{6}}{\pi}\left[0.5772+\ln\left(\ln\left(\frac{5}{5-1}\right)\right)\right] = \boxed{0.72}$$

$$X_{(15,5)} = 24.67+(0.72*5.033) = \boxed{28.3\text{ mm}}$$

$$\therefore \text{correct } (X_{15,5}) = 28.3*(0.96) = \boxed{27.2\text{ mm}}$$

$$\therefore i = \frac{27.2}{\left(\frac{15}{60}\right)} = \boxed{108.8\text{ mm/hr}}$$

(b) at (60-min. max rainfall)...

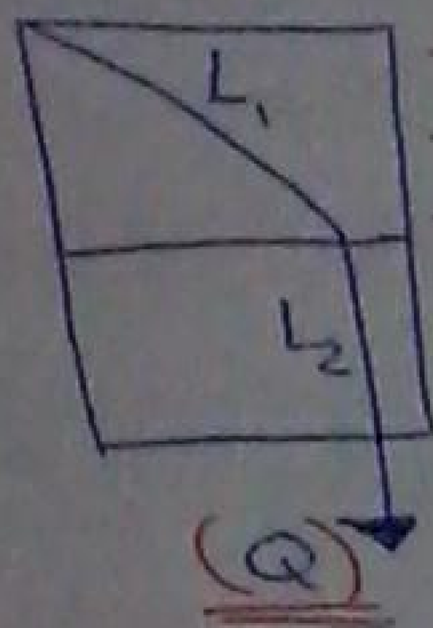
$$\bar{X} = \frac{(45+75+34)}{3} = \boxed{51.33\text{ mm}}$$

$$S = \sqrt{\frac{(45-51.33)^2+(75-51.33)^2+(34-51.33)^2}{2}} = \boxed{21.22}$$

$$\therefore X_{(60,5)} = 51.33+(0.72*21.22*0.96) = \boxed{64\text{ mm}} \longrightarrow i = \frac{64}{\frac{60}{60}} = 64\text{ mm/hr}$$

Ex (to find the value of peak flow)

(a) For the watershed shown below, estimate the peak flow from a storm of (2-year) return period that lasts for (20 min)..



* $C_1 = 0.8$
* $A_1 = 40000\, m^2$
* $S_1 = 1\%$
* $n_1 = 0.025$
* $L_1 = 220\, m$

* $C_2 = 0.9$
* $A_2 = 50000\, m^2$
* $S_2 = 1.5\%$
* $n_2 = 0.03$
* $L_2 = 280\, m$

① find the value of duration should less than the duration $\boxed{20\,min}$ ...

$$*t_{c1} = \frac{0.828\,(L*n)^{0.467}}{S^{0.235}} = \frac{0.828\,(220*0.025)^{0.467}}{\left(\frac{1}{100}\right)^{0.235}}$$

$$\boxed{\therefore t_{c1} = 5.42\, mins}$$

$$*t_{c2} = \frac{0.828\,((280)(0.03))^{0.467}}{\left(\frac{1.5}{100}\right)^{0.235}} = \boxed{5.7\, min}$$

$$t_c = (t_{c1} + t_{c2}) = (5.42 + 5.7) = \boxed{11.1\, mins} < 20\, mins$$

$\boxed{\therefore \text{use the value of duration} = 11.1\, min}$

at $d = 11.1\, min$ and $T = 2$ year

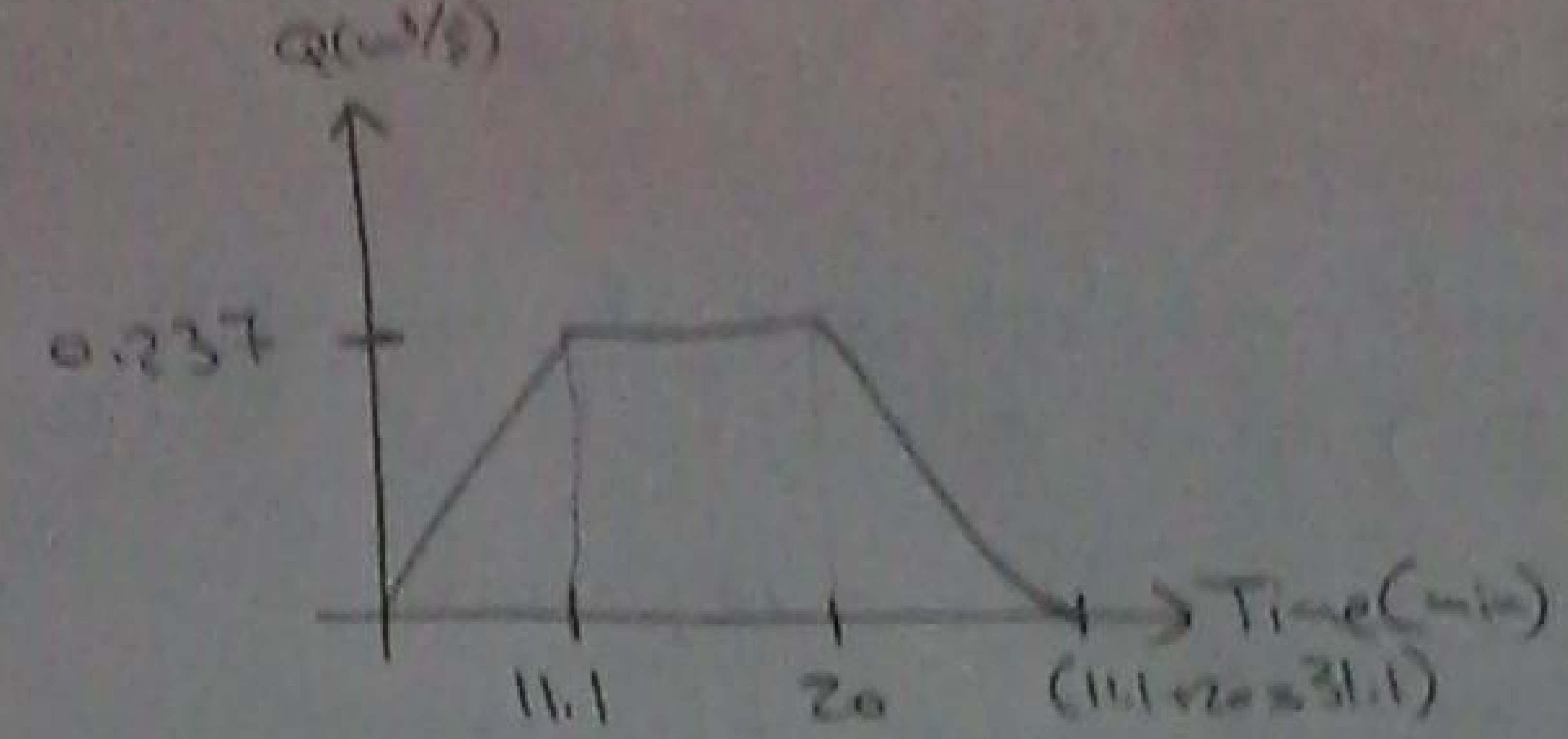
from graph (i (mm/hr) = 11 mm/hr)

The value of $C_{avg} = \frac{C_1 A_1 + C_2 A_2}{\Sigma A} = \frac{(0.8*40{,}000)+(0.9*50{,}000)}{(40{,}000+50{,}000)}$

$$\boxed{\therefore C_{avg} = 0.86}$$

$$\therefore Q = 0.278 * 0.86 * 11 * (40{,}000 + 50{,}000) * 10^{-6}$$

$$\boxed{\therefore Q = 0.237\, m^3/s}$$



(b) estimate the max. potential water volume that can be harvested from the storm given...

- Volume $(m)^3$ = Q * time = area under the curve

$$\text{Volume } (m^3) = \left(\frac{1}{2} * 11.1 * 0.237\right) + \left(\frac{1}{2} * (31.1 - 20) * 0.237\right) + \left((20 - 11.1) * 0.237\right)$$

$$\boxed{\therefore V\,(m^3) = 4.74} * \underbrace{60}_{\text{from (min} \rightarrow \text{sec)}}$$

$$\boxed{\therefore V\,(m^3) = 284.4\ m^3}$$

* * * * *

$$(\overset{Q}{0.237} * \overset{t(sec)}{20 * 60})$$

#

*nearly flat watershead would have drainage density that is: low...

***watershead of high slope value would result in bifurcation ratio that is: high...

***Elongated watershead usually discharge peak flow that appears after: short time...

***when two stream of order (3) and (4) are joined, the resulted stream has the order: 4...

***In the rational method, the (C) coefficient represents: net flow...

***a water-shead with little storage capacity discharge peak flow that appears: early...

***The watershead stream ordering is useful to: classify watershead...

(1) considered two watershead (A and B). The drainage density of watershead $\boxed{A = 2.5}$, having stream length ratio for watershead $A(R_L)$ as $\boxed{2.2}$. if watershead B has area of (26 Km²) having total streams length as (59 Km). estimate the length of length of streams of order $\boxed{(3)}$ in watershead (B) when the (length of streams of order $\boxed{(1)}$ is 8 Km...) → L_1

***solution:

A	B
$D = 2.5$	$A_B = 26\ Km^2$
$R_L = 2.2$	$\Sigma L = 59\ Km$
$\boxed{L_1 = 8\ km \quad L_3 = ???}$	$\boxed{\text{order } i = 3}$

$$\rightarrow D_A = 2.5...$$

$$\rightarrow D_B = \frac{\Sigma L}{A} = \frac{59\ Km}{26\ Km^2} = 2.26...$$

$$\rightarrow (D_A \simeq D_B) \rightarrow \text{(same characteristics)}$$

$$\rightarrow L_3 = L_1 (R_L)^{i-1}$$

$$L_3 = (8)(2.2)^{3-1}$$

$$\boxed{L_3 = 38.72}\ Km \ \#$$

② Q: small watershed area = 0.5 km^2, runoff coefficient ($C = 0.8$) ... discharge flow of ($2.224\ m^3/s$) at 2-years return period, calc. the flow rate when the return period is (10-year) assume the rational is applied...

*** Solution

$$Q = 2.224\ m^3/s$$

$$Q = 0.278 * C_{total} * i * A_{total}$$

$$2.224 = 0.278 * 0.8 * i * 0.5$$

duration equal

$$\boxed{\therefore i = 20} \rightsquigarrow \text{at } (T = 2\text{-year})$$

[illegible] 10 year [illegible] 2 year (60) #

(70) "[illegible]" $\rightsquigarrow \therefore Q = 0.278 * 0.8 * i * 0.5$

$$Q = 0.278 * 0.8 * 60 * 0.5$$

$$\boxed{Q = 6.672\ m^3/s} \ \#$$

2 year → 20

10 year → ???

$$\frac{10 * 20}{2} = 100$$

$$100 - (2 * 20)$$

$$100 - 40 =$$

60

i → ?

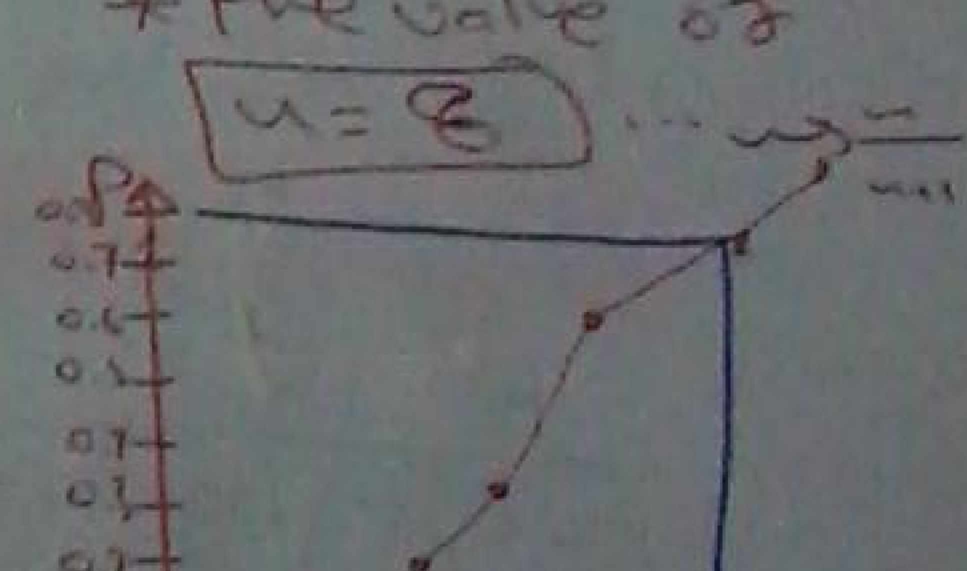
③ Q: according to flow value listed below, a culvert has been designed such that a failure occurs on average once in (5 year). Estimate the value of the design flow? estimate the frequency of a flow that is a half of the design flow...

flow (m^3/s)

* 2.5
* 3.5
* ~~7.0~~
* ~~1.5~~
* ~~2.0~~
* 3.5
* ~~5~~
* 3.5

Rank	x	$P(X \le x)$
1	1.5	0.111
2	2	0.222
3	2.5	0.333
~~4~~	~~3.5~~	~~0.444~~
~~5~~	~~3.5~~	~~0.555~~
6	3.5	0.666
7	5	0.777
8	7	0.888

* the value of $\boxed{u = 8}$



The value of $\boxed{x = 4.5}$

(4.5) m^3/s

$$\rightsquigarrow T = \frac{1}{P(X > x)} \rightsquigarrow P(X > x) = \frac{1}{T} = \frac{1}{5} = 0.2$$

$$P(X \le x) = 1 - P(X > x) = 1 - 0.2 = 0.8$$

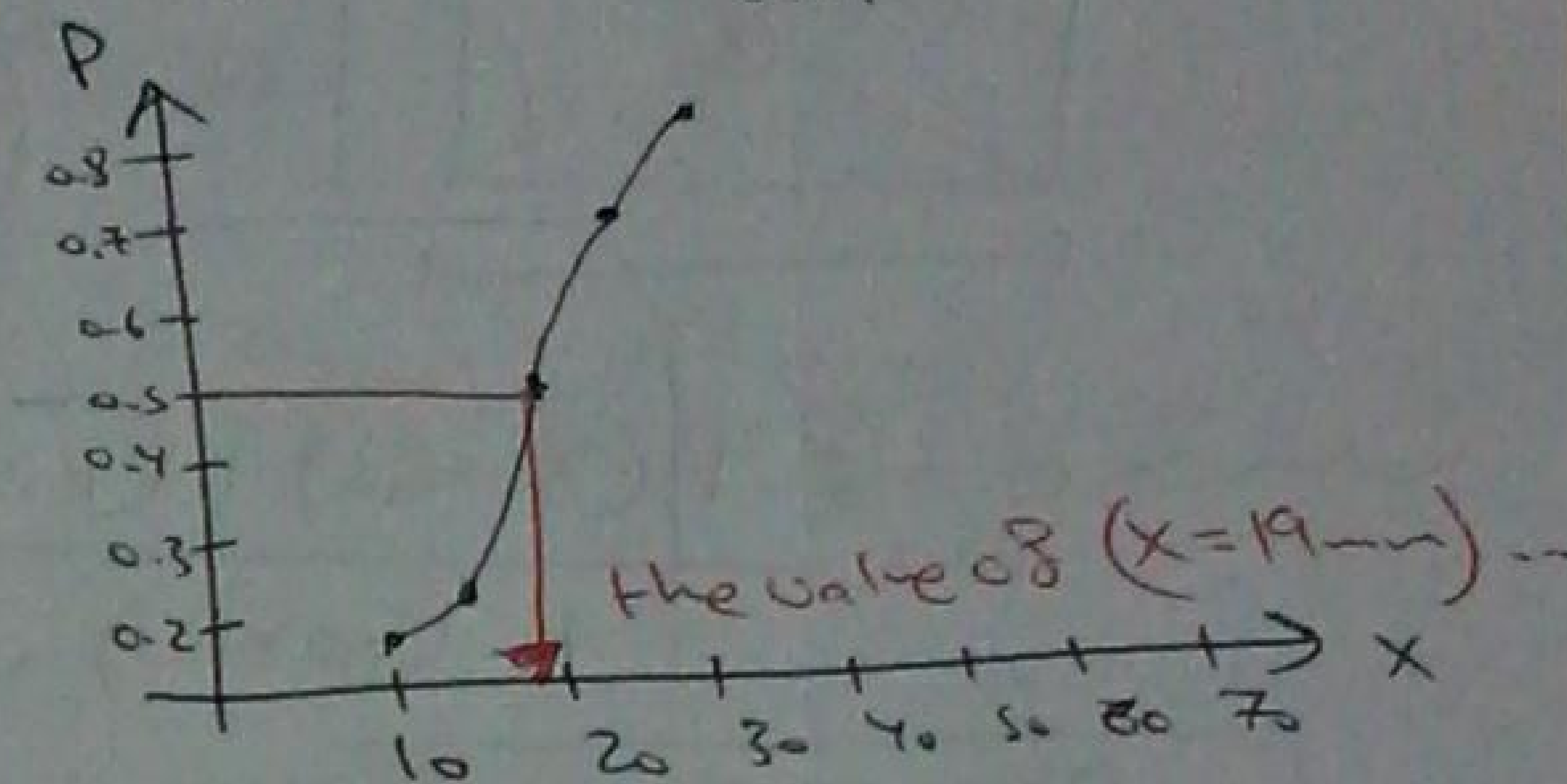
Q(4) total rainfall depth (mm) over a watershed are as follows (30, 20, 15, 25, 20, 10) and ① what is the rainfall depth that is associate to return period of (2 year) ② what rainfall intensity that, being exceeded 70% of the time ???

Solution:

rank	x	$P(X \le x)$
1	10	0.1428
2	15	0.286
3	20	—
4	20	0.571
5	25	0.714
6	30	0.857

the value of $\boxed{n = 6}$

$P(X \le x) = \frac{m}{n+1}$



① $T = \frac{1}{P(X > x)}$ → $P(X > x) = \frac{1}{T} = \frac{1}{2} = 0.5$

$P(X \le x) = 1 - 0.5 = 0.5$

② $\boxed{P(X > x) = 0.7}$ → $\therefore T = \frac{1}{0.7} = \boxed{1.43 \text{ year}}$

$\therefore K = \frac{-\sqrt{6}}{\pi}\left(0.5772 + \ln\left(\ln\left(\frac{1.43}{1.43+1}\right)\right)\right)$

$\boxed{\therefore K = -0.594}$

$X_{d,T} = \bar{X}_d + K_T \, S_d$ → To find $i = \frac{X_{d,T}}{d}$

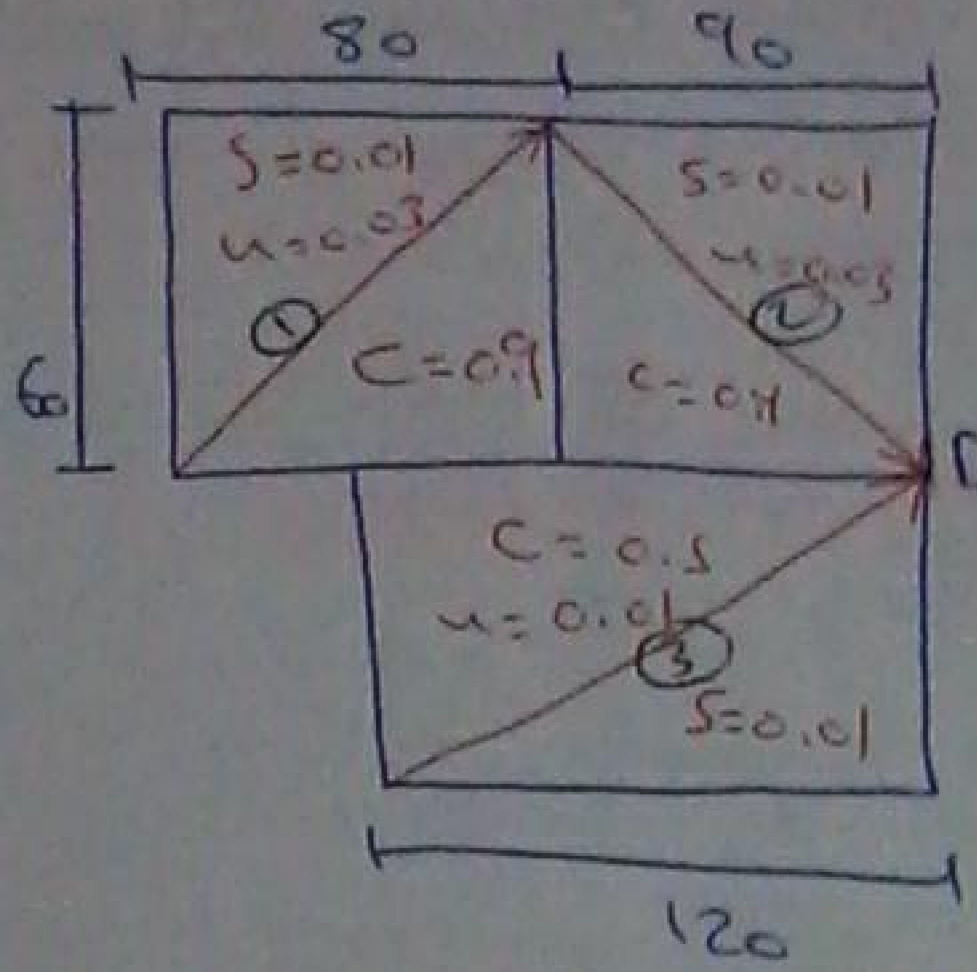
$20 = \frac{10+15+20+25+30}{5}$

7.905

$\boxed{\therefore X_{d,T} = 15.3}$

$\boxed{\therefore i = \frac{15.3}{d}}$ (mm/hr) #

~~⑩~~ using return period = 10 year ...
Calc. peak flow at the point (D) ???



Solution 10

$$Q = 0.278 * C_{total} * I * A_{total}$$

$$* Area_T = (80*60) + (90*60) + (60*120)$$

$$\boxed{\therefore Area = 17400\ m^2}$$

$$C_{Total} = \frac{(0.9)(80*60) + (0.4)(90*60) + (0.5)(120*60)}{(80*60) + (90*60) + (120*60)}$$

$$\boxed{\therefore C_{total} = 0.579}$$

$$t_{c} = \frac{0.828*(L*n)^{0.467}}{S^{0.235}} \quad \sqrt{(x)^2+(y)^2}$$

$$\boxed{\begin{array}{l} \therefore t_{c_1} = 36.86\,min \\ \therefore t_{c_2} = 12.607\,min \\ \therefore t_{c_3} = 13.536\,min \end{array}}$$

check ???

$$t_{c_{T\,max}} = 36.86 + 12.607 = 49.5$$

from curve the value of

$$\boxed{i = 20}$$

$$\therefore Q = 0.278(0.579)(20)(0.0174) = \boxed{0.056\ m^3/s}$$

$\boxed{0.112\ m^3/s}$

Q6 duration = 30 min

acceedance probability = 10% ⟶ 26.5 mm

acceedance probability = 5% ⟶ 29.35 mm

acceedance probability = 50% ⟶ ???

***solution:

$$*K_{T_1} = \frac{\sqrt{6}}{\pi}\left(0.5772 + \ln\left(\ln\left(\frac{10}{10-1}\right)\right)\right) = \boxed{1.305} \ \#$$

$$\boxed{T = \frac{1}{0.1} = 10\ year}$$

$$*K_{T_2} = \frac{\sqrt{6}}{\pi}\left(0.5772 + \ln\left(\ln\left(\frac{20}{20-1}\right)\right)\right) = \boxed{1.867} \ \#$$

$$\boxed{T = \frac{1}{0.05} = 20\ y}$$

$$*K_{T_3} = \frac{\sqrt{6}}{\pi}\left(0.5772 + \ln\left(\ln\left(\frac{2}{(2-1)}\right)\right)\right) = \boxed{-0.164} \ \#$$

$$\boxed{T = \frac{1}{0.5} = 2\ year}$$

***
$$\boxed{\begin{aligned} X_{30,10} &= \bar{X} + K_1 S_{30} \\ X_{30,20} &= \bar{X} + K_2 S_{30} \end{aligned}}$$

$$26.5 = \cancel{\bar{X}} + 1.305\, S_{30}$$
$$29.35 = \cancel{\bar{X}} + 1.867\, S_{30} \quad -$$

$$\boxed{\therefore S_{30} = 5.33}$$

بتعويض $\boxed{\bar{X} = 19.54}$

$$\therefore X_{30,2} = \bar{X} + K_3 S_{30}$$
$$X_{30,2} = 19.54 + (-0.164 * 5.33)$$

$$\boxed{\therefore X_{30,2} = 18.66}$$

$$\therefore i = \frac{18.66}{\frac{30}{60}} = \boxed{37.32} \ \#$$

(T) or (F)

*** The intercepted from precipitation depend mainly on the soil moisture.. (F)

*** The SCS-method is used to estimate the excess rain from large watershead of steep slopes... (F)

*** The 2-hr UH represent the watershead response to 2-hr rainfall of 2cm depth excess rainfall (F)

*** watershead of high storage capacity are charactaristic by large base long time (T)

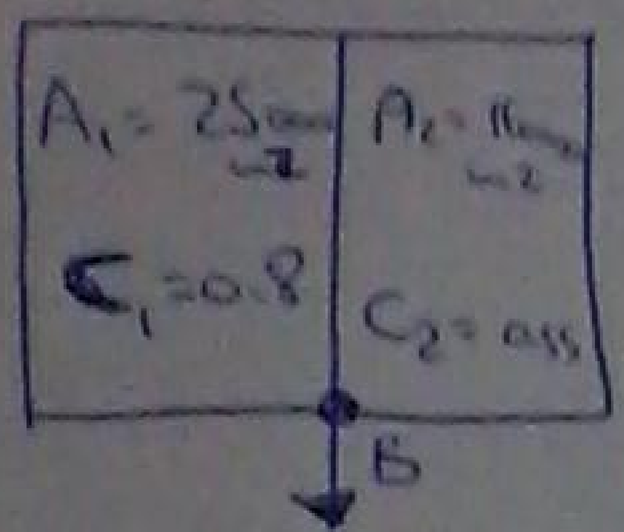
*** Equal watershead produce runoff hydrograph that is flat with low peak flow. (T)

*** The peak flow estimated using the unit hydrograph is usually less accurace than estimate using the UH method. (T)

*** in elongated watershead the peak flow occurs at time shorter than the time of concentration (F)

*** The ground water max. in aquifer depend only the property of the aquifer (F)...

The watershed show consist of area A_1 and A_2 if the 2-year recurrence peak flow for $A_1 = 0.85\ m^3/s$ and at $A_2 = 0.7\ m^3/s$



(1) estimate the 2-year recurrence peak flow from the whole watershead that will be draing at Point (B)???

Solution

$$C_{avg} = \frac{250000(0.8) + 160000(0.55)}{250000 + 160000} = \boxed{0.695}$$

$$\text{Area} = 250000 + 160000 = 410000 = \boxed{0.41\ Km^2}$$

$$Q = 0.278 c i A \longrightarrow i = ???$$

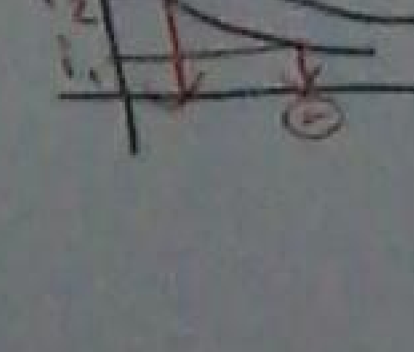
$$Q_1 = 0.278 c_1 A_1 i_1 \longrightarrow 0.85 = 0.278(0.8)(0.25) i_1$$

$$\boxed{i_1 = 15.278}$$

$$Q_2 = 0.278 c_2 A_2 i_2 \longrightarrow 0.70 = 0.278(0.55)(0.16) i_2$$

$$\boxed{i_2 = 22.48}$$

$\rightarrow i_1 \rightarrow$ from curve $\longrightarrow$ Give long time of concentration.



$$\therefore Q = 0.278 * C_{avg} * A * i$$

$$Q = 0.278 * 0.695 * 0.41 * 15.278$$

$$\boxed{Q = 1.211\ m^3/s}$$

(2) if the whole watershead (2 hr) duration calc. peak flow for (10 year) at point B???

Solution from graph (2 hr $\longrightarrow$ 120 min)

at 120 min $\longrightarrow i = 14$

#

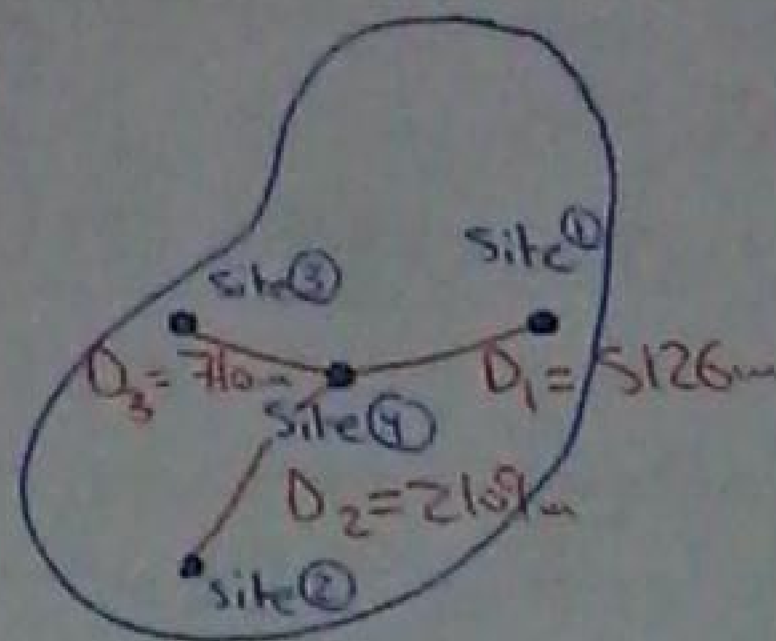
$$\therefore Q = 0.278(0.695)(14)(0.41) = \boxed{1.115\ m^3/s}$$

* Second exam*

*Ex (un-gauged site precipitation) **

estimate the rainfall at the un-gauged site #4, based on the rainfall at the following gauged sites...

site	rainfall (mm) (P)
1	14
2	21
3	11



$$P_{un\text{-}gauged} = \frac{\sum P * w}{\sum w}$$

$$w = \frac{1}{D^2} \rightarrow w_1 = \frac{1}{D_1^2} = \frac{1}{(5126)^2} = 3.8 * 10^{-8} * 10^6 \rightarrow D\ (Km)$$

$$w_2 = \frac{1}{D_2^2} = \frac{1}{(2109)^2} = 2.24 * 10^{-7} * 10^6$$

$$w_3 = \frac{1}{D_3^2} = \frac{1}{(710)^2} = 1.98 * 10^{-6} * 10^6$$

$$\boxed{\sum w = 2.245 * 10^{-6}} * 10^6$$

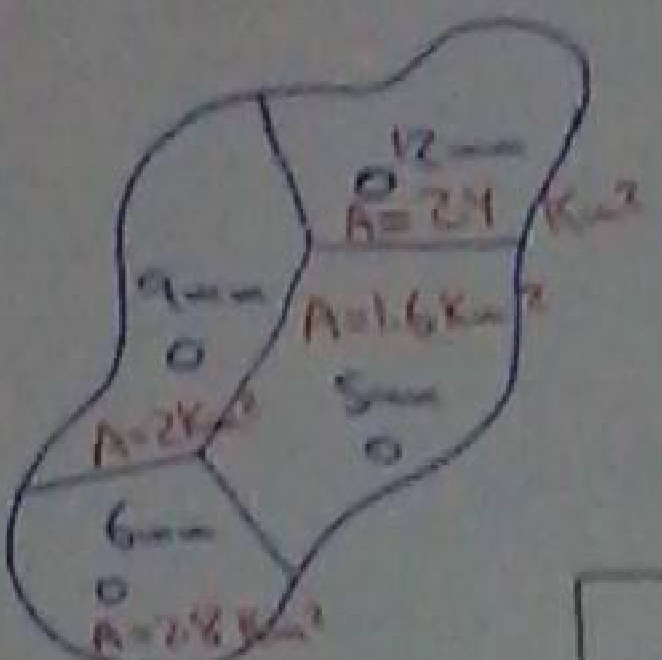
$$\boxed{\therefore \sum w = 2.245}$$

$$\therefore P_{un\text{-}gauged} = \frac{(3.8*10^{-8}*10^6*14) + (2.24*10^{-7}*10^6*21) + (1.98*10^{-6}*10^6*11)}{2.245}$$

$$\boxed{\therefore P_{un\text{-}gauged} = 12.033} \ \#$$

*** Ex (areal precipitation) ***

⟶ estimate the areal rainfall for the following watershed..



$$\rightsquigarrow \bar{P} = \frac{\sum PA}{\sum A}$$

$$* \frac{(12*2.4)+(5*1.6)+(6*2.8)+(2*9)}{(2.4+1.6+2.8+2)}$$

$$\boxed{\therefore \bar{P} = 8.14\ mm}\ \#$$

*** Ex (The evaporation rate)..

⟶ calculate the evaporation rate under net solar radiation of (200)(w/m²) and air temperature of (25°c). assume completely wet soil ($K_s=1$) and in arid region ($K_c=1$)..

$$*E_r = \frac{R_n}{l_v * \rho} * K_s * K_c \quad \rightsquigarrow l_v = 2500 - 2.36T$$

$$l_v = 2500-(2.36*25)$$

$$\boxed{l_v = 2441\,(KJ/Kg)}$$

$$\therefore E_r = \frac{200}{(2441*10^3*1000)} * 1 * 1 = 8.22*10^{-8}\ m/s$$

$$\therefore E_r = 8.22*10^{-8} * 24*60*60*10^3 = \boxed{7.1\ (mm/day)}$$

$$\therefore E_r = 8.22*10^{-8} * 60*60*10^3 = \boxed{0.295\ (mm/hr)}\ \#$$

Ex (infiltration rate and depression storage)

a (2-hr) rainfall storm with pattern as shown below. Given the soil equilibrium infiltration capacity of (0.75 mm/hr), an initial infiltration of (5 mm/hr), and the infiltration constant is (0.29) (what is the net rain available for runoff) assuming that depression storage is for the first hour with total storage capacity of (2 mm/hr) assume completely wet soil in arid region under air temperature of (10°C) and solar radiation of (150 w/m²) neglect interception losses..

hour	Total rainfall intensity (mm/hr) (P_{total})
1	10.3
2	12.5

- $f_c = 0.75$ mm/hr
- $f_0 = 5$ mm/hr
- $K = 0.29$
- $P_n = ???$
- $S_c = 2$ mm/hr (at first hour)
- $T = 10°C$...
- $R_n = 150\ w/m^2$...

(at 1 hr)

$$f = f_c + (f_0 - f_c)e^{-Kt}$$

$$f = 0.75 + (5 - 0.75)e^{-(0.29*1)}$$

$$\boxed{f = 3.93} \text{ mm/hr}$$

$$E_n = \frac{150}{2476.4*10^3*10^3} *1*1$$

$$\lambda = 2500 - (2.36*10)$$

$$\boxed{\lambda = 2476.4}$$

$$\boxed{\therefore E_n = 0.22 \text{ mm/hr}}$$

$$\therefore P_n = 10.3 - 0.22 - 3.93$$

$$\boxed{P_n = 6.15 \text{ mm/hr}}$$

$$\therefore D_s = S_c(1 - e^{-P_n/S_c})$$

$$D_s = 2(1 - e^{-6.15/2})$$

$$\boxed{D_s = 1.9 \text{ mm/hr}}$$

Net = 6.15 − 1.9

$$\boxed{\text{Net} = 4.25 \text{ mm/hr}}$$

#

at (2-hr)

$$f = 0.75 + (5 - 0.75)e^{-(0.29*2)}$$

$$\boxed{f = 3.13 \text{ mm/hr}}$$

$$\boxed{E_n = 0.22 \text{ mm/hr}}$$

$$P_n = 12.5 - 0.22 - 3.13$$

$$\boxed{P_n = 9.15 \text{ mm/hr}}$$

$$\boxed{D_s = 0 \text{ mm/hr}}$$

$$\boxed{\text{Net} = 9.15 \text{ mm/hr}}$$

#

Ex (Hydrologic Parameters) ... the excess rainfall

determine the excess rainfall of the (3 inches) total rain on nearly flat clay loam watershed of (18 Km²) under dry soil conditions among the (18 Km²), (7 Km²) is range land, while the rest is cultivated land..

given: The value of $CN(7 Km^2) = 71$

The value of $CN(11 Km^2) = 88$

$$\therefore CN_{avg} = \frac{(CN_1 * A_1) + (CN_2 * A_2)}{\Sigma A} = \frac{(71*7)+(11*88)}{(7+11)}$$

$$\boxed{\therefore CN_{avg} = 82.5} \rightsquigarrow CN(II)$$

$$\rightsquigarrow CN(I) = \frac{4.2*82.5}{10-(0.058*82.5)} = \boxed{66.5}$$

$$\rightsquigarrow CN(III) = \frac{23*82.5}{10+0.13(82.5)} = \boxed{91.55}$$

$$\rightsquigarrow \therefore S = \frac{1000}{66.5} - 10 = \boxed{5.03 \text{ inches}}$$

$$\rightsquigarrow \therefore P_e = \frac{(P-0.2S)^2}{(P+0.8S)} = \frac{(3-0.2*5.03)^2}{(3+0.8*5.03)} = \boxed{0.56 \text{ inch}} \#$$

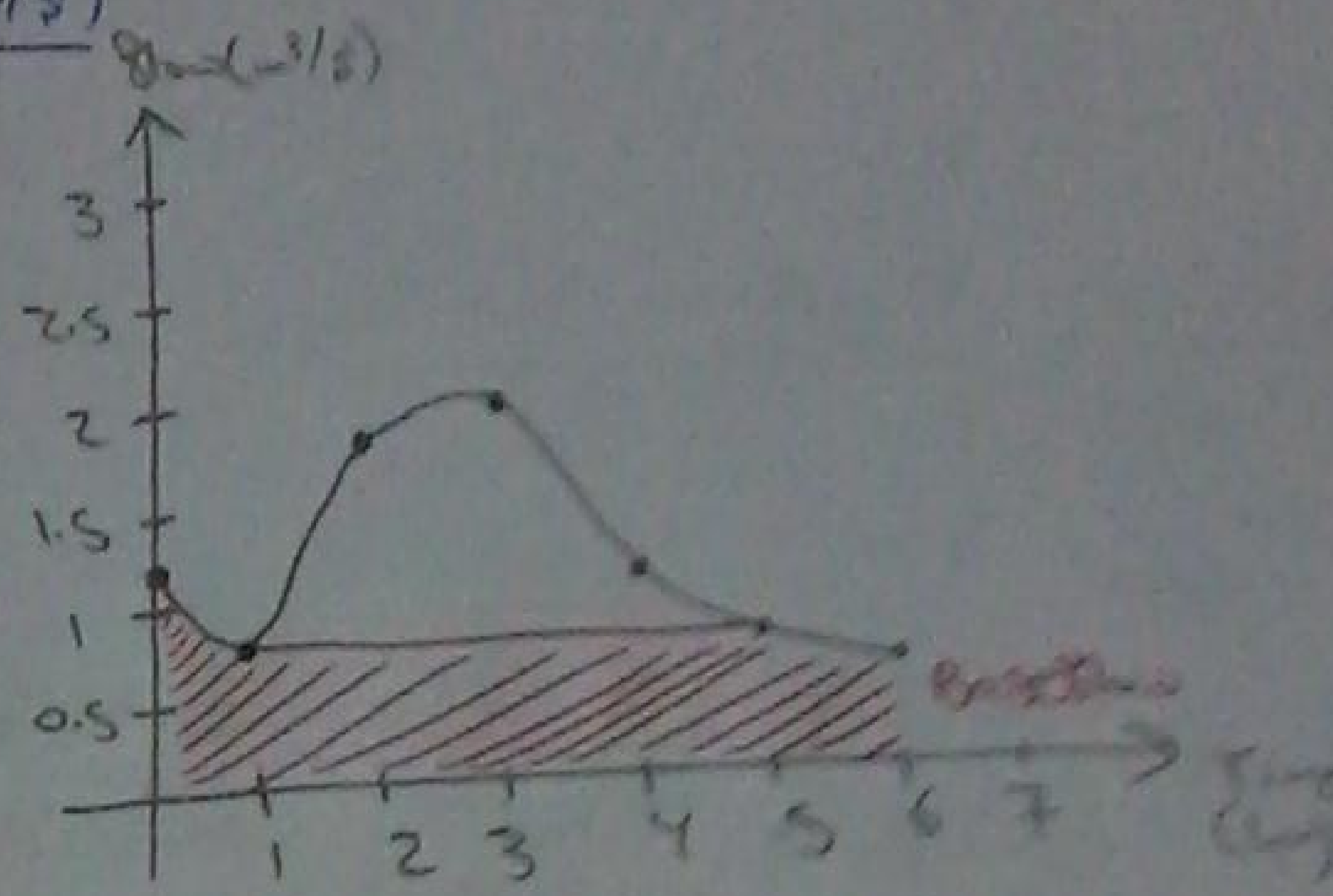
$$\rightsquigarrow \therefore S = \frac{1000}{91.55} - 10 = \boxed{0.92 \text{ inches}}$$

$$\rightsquigarrow \therefore P_e = \frac{(3-0.2*0.92)^2}{(3+0.8*0.92)} = \boxed{2.12 \text{ inches}} \#$$

* Ex (hydrograph)

→ a large watershed discharge runoff to it's outlet the measured total runoff is shown in the table below. estimate the direct runoff (surface runoff)??

Time (hr)	Total Runoff (m^3/s)
0	1.2
1	0.86
2	1.57
3	1.92
4	1.21
5	0.94
6	0.77



*** Sol ***

* دائماً قيم ال (Total Runoff) يجب أن نحول لقيمة ال (direct runoff) ونستطيع عن طريق طرح قيمة ال (Base flow) منها... فلازم ارسم العلاقة بين ال (Time – Total Runoff)

Time	Total Runoff	Baseflow	direct Runoff
0	1.2	1.2	0
1	0.86	0.86	0
2	1.57	0.86	0.71
3	1.92	0.86	1.06
4	1.21	0.86	0.35
5	0.94	0.86	0.08
6	0.77	0.77	0

$$\boxed{* \text{ Direct Runoff} = \text{Total Runoff} - \text{Baseflow}}$$

Ex. (UH - Theory)

ⓐ watershed of $(6.23\ Km^2)$ area discharges flow from (2-hr) storm with excess rainfall as shown in the table. derive the (1-hr UH)

Time (hr)	excess rainfall (mm) بالـ (cm)	direct runoff (m³/s)
1	20 ①	2.3
2	15 ②	12.1
3		26.7
4		17.2
5		2.3

$\rightarrow M$; ⑤ $\# N$

هتلاقي الـ (P) بتاعك في الـ (excess rainfall) وقيم الـ (Q) بتاعك في الـ (direct runoff) إذا كانت (Total runoff) فلازم أطرح منها قيمة الـ (Base flow) عشان تصير (direct runoff) ...

$$u = N - M + 1$$
$$\therefore u = 5 - 2 + 1$$
$$\boxed{\therefore u = 4}$$

لازم نجيب ٤ قيم الـ (U)
(u_1, u_2, u_3, u_4)

$$* Q_u = P_1 U_u + P_2 U_{u-1} + P_3 U_{u-2} + \cdots$$

at $(u=1) \rightarrow Q_1 = P_1 U_1$

$$2.3 = 20 U_1$$
$$U_1 = \frac{2.3}{20} = \boxed{1.15\ cm}$$

at $(u=2) \rightarrow Q_2 = P_1 U_2 + P_2 U_1$

$$12.1 = 20(U_2) + 15(1.15)$$
$$12.1 = 2(U_2) + 1.5(1.15)$$
$$\boxed{\therefore U_2 = 5.19\ cm}$$

at $(u=3) \rightarrow Q_3 = P_1 U_3 + P_2 U_2 + P_3 U_1$

$$26.7 = (2)(U_3) + (1.5)(5.19) + 0$$
$$\boxed{U_3 = 9.46\ cm}$$

at $(u=4) \rightarrow Q_4 = P_1 U_4 + P_2 U_3 + 0$

$$17.2 = 2(U_4) + (1.5)(9.46)$$
$$\boxed{U_4 = 1.51\ cm}$$

(5) Find the Peak Runoff from (3-hr) storm of excess rainfall as shown below...

(*) ايجاد العلاقة بين ال (Q) و ال (T) اي نقطة ذروة الجريان ال (Peak Runoff) ... ال (P) و

Time (hr)	excess rainfall (mm)
1	8
2	10
3	5

نعوض (P)

*** Time	excess rainfall	direct runoff	U (cm)
1	20	2.3	1.15
2	15	12.1	5.19
3	0	26.7	9.46
4	0	17.2	1.51
5	0	2.3	0

نستفيد من هاد الجدول بحيث نجد قيم ال (U) فقط لايجاد قيمة ال (Q) الجديدة ...

$\therefore M = 3 \rightsquigarrow N = 5 \rightsquigarrow n = 5 - 3 + 1$

$\boxed{n = 3}$

at $(n=1) \rightsquigarrow Q_1 = P_1 U_1 \rightsquigarrow Q_1 = 0.8 * 1.15 = \boxed{0.92\ m^3/s}$

at $(n=2) \rightsquigarrow Q_2 = P_1 U_2 + P_2 U_1 \rightsquigarrow Q_2 = (0.8)(5.19) + (1)(1.15) = \boxed{5.3\ m^3/s}$

at $(n=3) \rightsquigarrow Q_3 = P_1 U_3 + P_2 U_2 + P_3 U_1 = (0.8)(9.46) + (1)(5.19) + (0.5)(1.15)$

$\boxed{\therefore Q_3 = 13.33\ m^3/s}$

at $(n=4) \rightsquigarrow Q_4 = P_1 U_4 + P_2 U_3 + P_3 U_2$

$Q_4 = (0.8)(1.51) + (1)(9.46) + (0.5)(5.19) = \boxed{13.26\ m^3/s}$

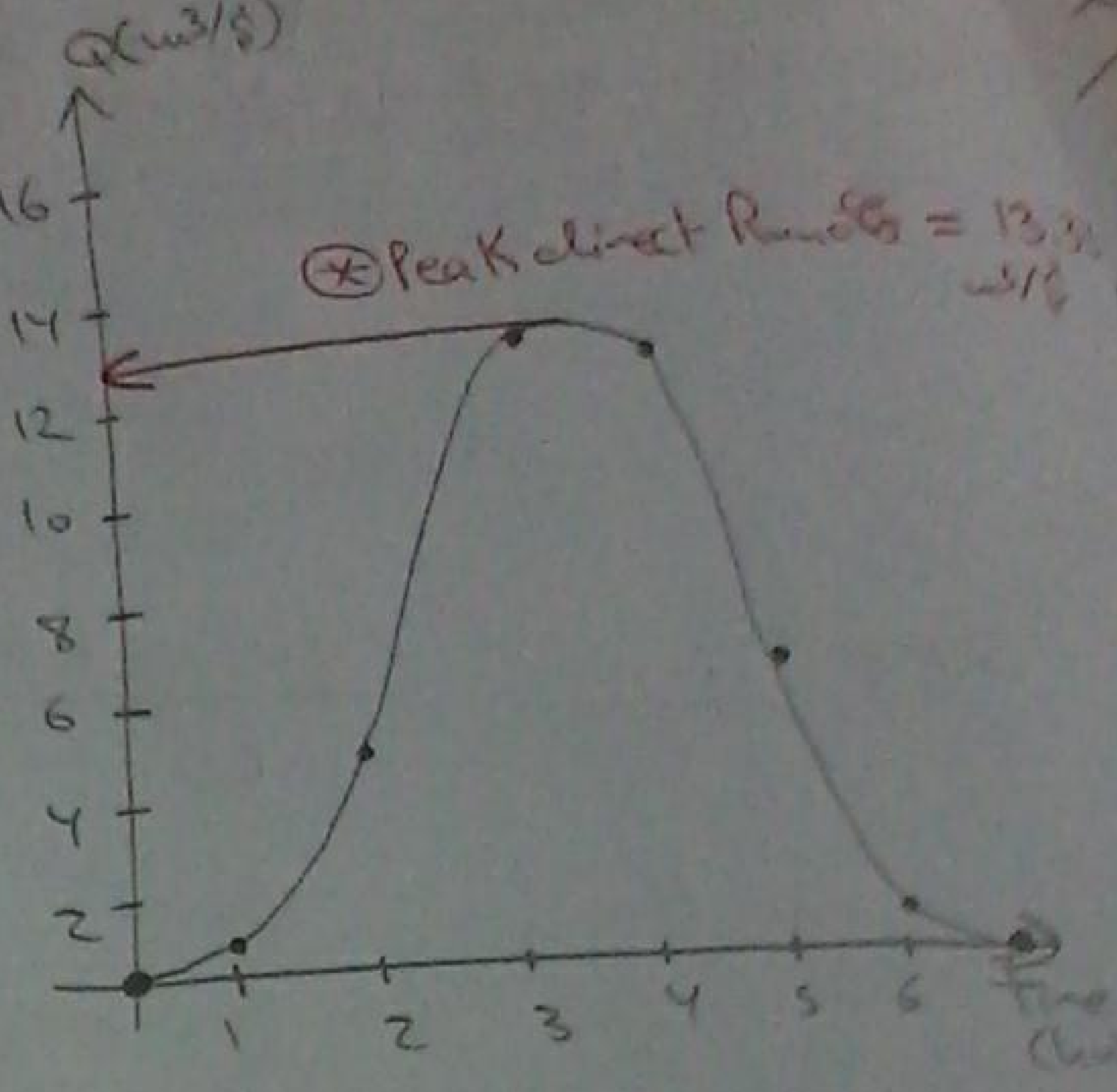
at $(n=5) \rightsquigarrow Q_5 = \cancel{P_1 U_5} + P_2 U_4 + P_3 U_3 = (1)(1.51) + (0.5)(9.46) = \boxed{6.24\ m^3/s}$

at $(n=6) \rightsquigarrow Q_6 = \cancel{P_1 U_6} + \cancel{P_2 U_5} + P_3 U_4 = (0.5)(1.51) = \boxed{0.755\ m^3/s}$

at $(n=7) \rightsquigarrow Q_7 = P_1 U_7 + P_2 U_6 + P_3 U_5 = 0$

at $(n=0) \rightsquigarrow \boxed{Q = 0}$

Time(hr)	Q(m^3/s)
0	0
1	0.92
2	5.30
3	13.33
4	13.26
5	6.24
6	0.76
7	0



*** Ex (Snyder's UH) ***

develop a (2-hr) unit hydrograph for the watershed shown. The basin area is (280 Km^2), and the distance along the main stream to the basin centroid nearest point is (20 Km), use C_t of (1.5), and C_p of (0.8) as of the nearest guaged basin... main stream = 35 Km...

*** $T_L = C_t (L * L_c)^{0.3} = (1.5)(20*35)^{0.3} = \boxed{10.7 hr}$

*** $D = \frac{T_L}{5.5} = \frac{10.7}{5.5} = \boxed{1.95 hr}$

*** $T'_L = T_L + 0.25(D' - D) = 10.7 + 0.25(2 - 1.95) = \boxed{10.72 hr}$

*** $T_b = 3 + \frac{T'_L}{8} = 3 + \frac{10.72}{8} = 4.34 \text{ day} * 24 = \boxed{104 hr}$

*** $T_b = 4 T_L = 4 * 10.7 = 42.8 \ldots$ (for small basins)

*** $Q_p = \frac{2.78 C_p A}{T_L} = \frac{2.78 * 0.8 * 280}{10.72} = \boxed{58.1 m^3/s/cm}$

*** $T_p = \frac{D'}{2} + T'_L = \frac{2}{2} + 10.72 = 10.72 + 1 = \boxed{11.72 hrs}$

*** $W_{50} = 5.87 \left(\frac{Q_p}{A}\right)^{-1.08} = 5.87 \left(\frac{58.1}{280}\right)^{-1.08} = \boxed{32.1 hr}$ #

*** $W_{75} = \frac{W_{50}}{1.75} = \frac{32.1}{1.75} = \boxed{18.3 hr}$ #

Time (hr)	Runoff ($m^3/s/cm$)
0	0
$T_p - \frac{1}{3} W_{50}$	$\frac{1}{2} Q_p$
$T_p - \frac{1}{3} W_{75}$	$0.75 Q_p$
T_p	Q_p
$T_p + \frac{2}{3} W_{75}$	$0.75 Q_p$
$T_p + \frac{2}{3} W_{50}$	$0.5 Q_p$
T_b	0

∴

Time (hr)	Runoff ($m^3/s/cm$)
0	0
1.02	29.05
5.62	43.57
11.72	58.1
23.92	43.57
33.12	29.05
104.02	0

وبرسم العلاقة بين
ال (Time-Q)

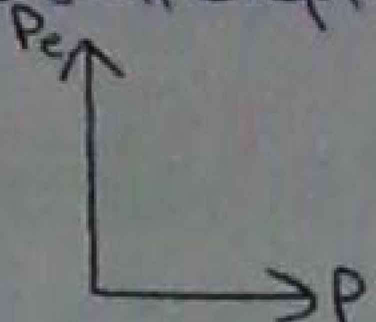
* * * * *

Question (1)

answer the following use the abbreviation of (CBD) can no be determined:

2. ① Given total rainfall of (5"). at watershed of (CN = 70) would retain rainfall depth (will not flow) as ______ (with the curve number)

*Solx from graph



at $P = 5$ inches and $CN = 70$ the value of $P_e = 2$ inches

$$\therefore S = \frac{1000}{CN} - 10$$

$$\therefore S = \frac{1000}{70} - 10$$

$$\boxed{S = 4.3}$$

The value of $P_e = \frac{(P - 0.2S)^2}{(P + 0.8S)}$

$$2 = \frac{(P - (0.2 * 4.3))^2}{(P + (0.8 * 4.3))}$$

$$\boxed{\therefore P = 4.95 \approx 5}$$

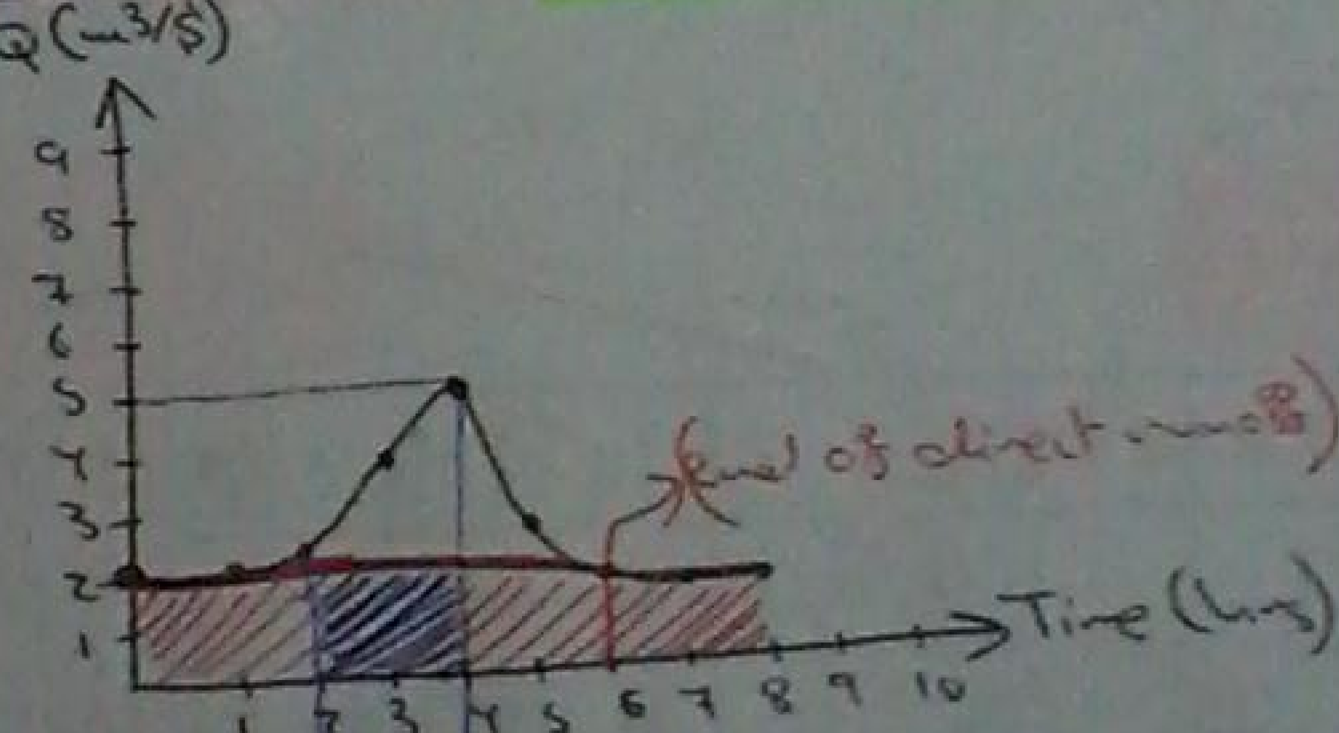
$$CN(I) = \frac{(4.2)(70)}{10 - (0.058(70))}$$

$$\boxed{\therefore CN(I) = 49.49}$$

$$CN(III) = \frac{23(70)}{10 + (0.13(70))}$$

$$\boxed{CN(III) = 84.29}$$

② From the hydrograph shown, the direct runoff due of the excess rainfall ends at the time (6)...



③ From the hydrograph shown, the base flow is nearly (2)...

④ from the hydrograph shown, the rainfall duration is can't be determine...

⑤ from the hydrograph shown, the watershed time of concentration in nearly $4 - 2 = (2)$...

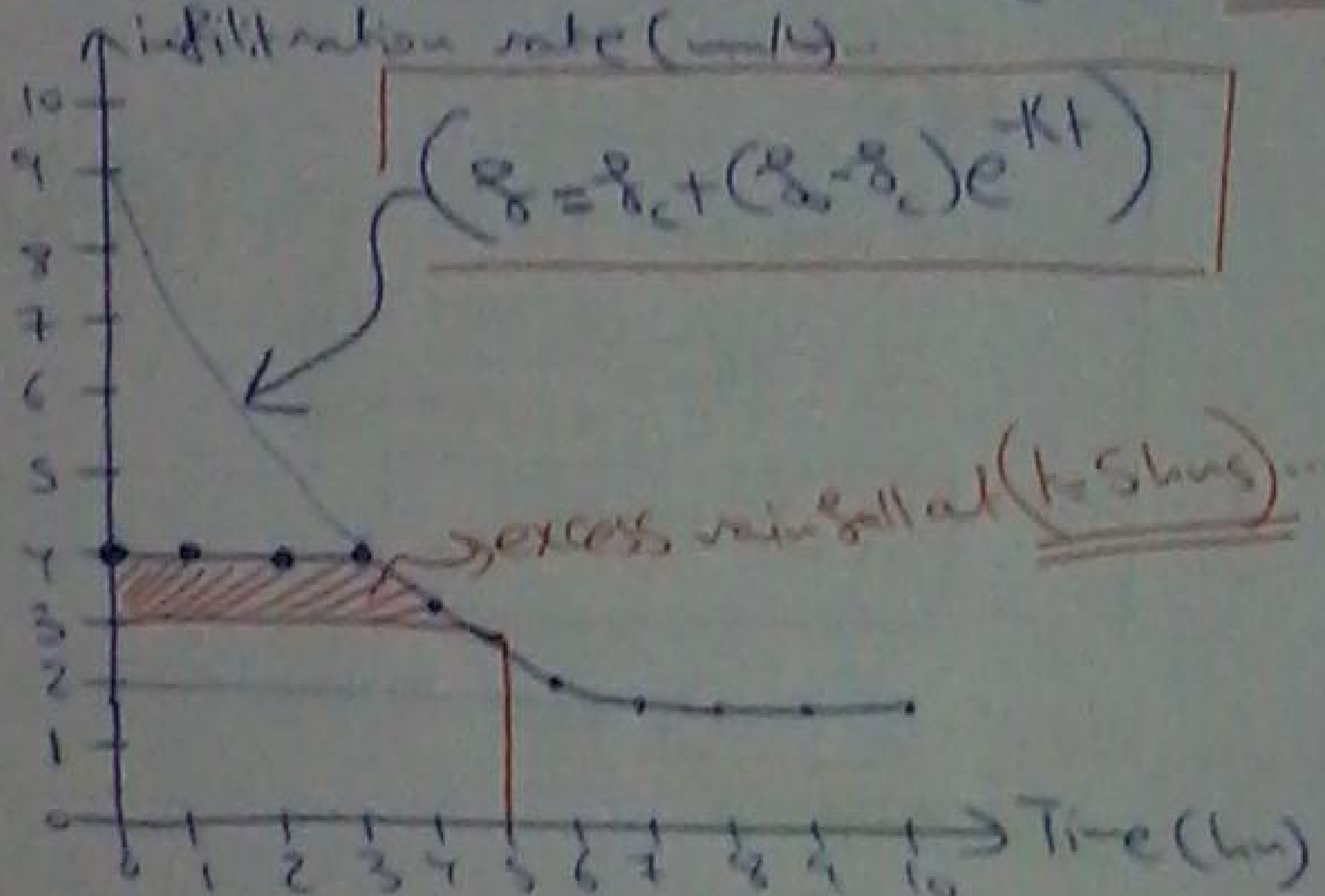
⑥ From the hydrograph shown, the peak flow due to the excess rainfall is $(3) m^3/s^2$... → (5-2)

⑦ for the same watershed, as the rainfall amount increase, the CN values The same... (depend on watershed characteristic) → (stay constant)

Question (2)

A watershed is exposed to rainfall of constant intensity and long duration. The graph below describes the infiltration rate of that watershed. Neglecting the evaporation, interception and storage rates, answer the following short statement and place proper units:

1. The equilibrium infiltration rate (2) mm/hr...
2. The actual infiltration rate at time of (1 hr) (4) mm/hr...
3. The rainfall intensity (4) mm/hr...
4. The excess rainfall at time of 5 hr 4−3 = (1) mm/hr...



* * * * * * *

Question (3)

Time	*P (cm)*	*Q*	*Q new???*
1	1	1.6	1.6 − 1 = 0.6
2	0.6	Q_2	$Q_2 - 1 = Q_2^*$
3	1.5	Q_3	$Q_3 - 1 = Q_3^*$
4	0	2.5	2.5 − 1 = 1.5
5	0	1	1 − 1 = 0

* Base flow = 1 m³/s
* determine (Q_2) and (Q_3)...

← عايزو يعطني قيمة لـ (Base flow = 1 m³/s) فلازم اطرح هاي القيمة من الـ (Q) يلي معطيني اياها...

$$\left.\begin{matrix} N = 4 \\ M = 3 \end{matrix}\right] \rightarrow u = 4 - 3 + 1 = 2$$

$$\text{*at } (u=1) \rightarrow Q_1 = \sum_{m=1}^{1} P_1 U_1 \rightarrow Q_1 = P_1 U_1 \rightarrow 0.6 = 1 * U_1$$

$$\boxed{U_1 = 0.6}$$

$*$ at $(u=2) \rightsquigarrow Q_2 = P_1 U_2 + P_2 U_1$

$$Q_2 = 1 * U_2 + (0.6 * 0.6)$$

$$\boxed{Q_2 = U_2 + 0.36} \longrightarrow (1)$$

$*$ at $(u=3) \rightsquigarrow Q_3 = \cancel{P_1 U_3} + P_2 U_2 + P_3 U_1$

$$Q_3 = \cancel{U_3} + (0.6 U_2) + (1.5 * 0.6)$$

$$\boxed{Q_3 = \cancel{U_3} + 0.6 U_2 + 0.9} \longrightarrow (2)$$

$*$ at $(u=4) \rightsquigarrow Q_4 = \cancel{P_1 U_4} + \cancel{P_2 U_3} + P_3 U_2 + \cancel{P_4 U_1}$

$$1.5 = \cancel{(1)(U_4)} + \cancel{(0.6)(U_3)} + (P_3 U_2) + \cancel{P_4}(0.6)$$

$$1.5 = \cancel{(1)(U_4)} + \cancel{(0.6)(U_3)} + (1.5)(U_2)$$

$$\boxed{1.5 = \cancel{U_4} + \cancel{0.6 U_3} + 1.5 U_2} \longrightarrow (3)$$

? (*) [illegible]

$$\boxed{\therefore U_2 = 1}$$

$$\boxed{\therefore Q_2 = 1 + 0.36 = 1.36} \xrightarrow{+1} (2.36)$$

$$\boxed{\therefore Q_3 = (0.6 * 1) + 0.9 = 1.5} \xrightarrow{+1} (2.5)$$

\#

*** Question 4 ***

The following table shows the total runoff from a watershed. estimate the excess rainfall value (P_1)...

Time	excess rainfall (mm)	Total runoff (m^3/s)	*Q*
0	0	8.45	8.45 − 8.45 = 0
1	P???	22.13	22.13 − 8.45 = 13.68
2	0	18.29	18.29 − 8.45 = 9.84
3	14	32.39	32.39 − 8.45 = 23.94
4	0	25.67	25.67 − 8.45 = 17.22
5	0	8.45	8.45 − 8.45 = 0
6	0	8.45	8.45 − 8.45 = 0

The value of $N = 4$

The value of $M = 2$...

$u = N - M + 1$

$u = 4 - 2 + 1$

$\boxed{u = 3}$ → (يوجد عندي u_1, u_2, u_3 فقط)

$u=1$ → $Q_1 = P_1 U_1$ → $\boxed{13.6 = P_1 U_1}$ → (1)

$u=2$ → $Q_2 = P_1 U_2 + P_2 U_1$ → $9.84 = P_1 U_2 + 0$

$\boxed{9.84 = P_1 U_2}$ → (2)

$u=3$ → $Q_3 = P_1 U_3 + P_2 U_2 + P_3 U_1$

$23.94 = \cancel{P_1 U_3} + 0 + 14 U_1$

$23.94 = 14 U_1$

$U_1 = \dfrac{23.94}{(14 * 10^{-1})}$ → $\boxed{U_1 = 17.1}$

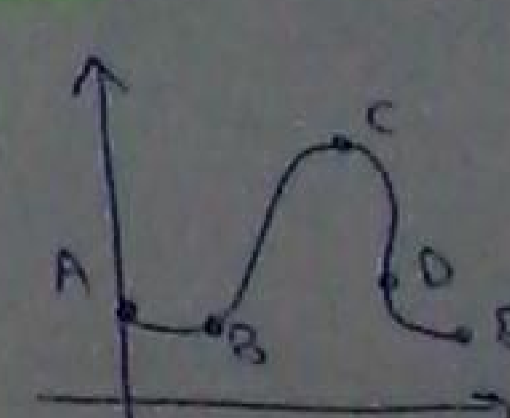
cm

$\therefore 13.6 = P_1 * 17.1$ → $\boxed{P_1 = 0.8}$ #

*** Question (5) ***

Shortly, answer the following sub-questions:

1. The hortonian overland flow occurs when $i > (f, E_v, U$, interception)
2. The depression storage highly affects storms that have ↓ duration
3. The sub-surface flow occurs due to ground water
4. in the hydrograph shown, the surface runoff starts at point B
5. The UH is a characteristics of the watersheds
6. The S-hydrograph is used to 4-hr UH from x-hr
7. The watershead surface roughness ↑ then the excess rainfall ↓ (T)...
8. CN ↑ then the excess rainfall ↑ (T)...



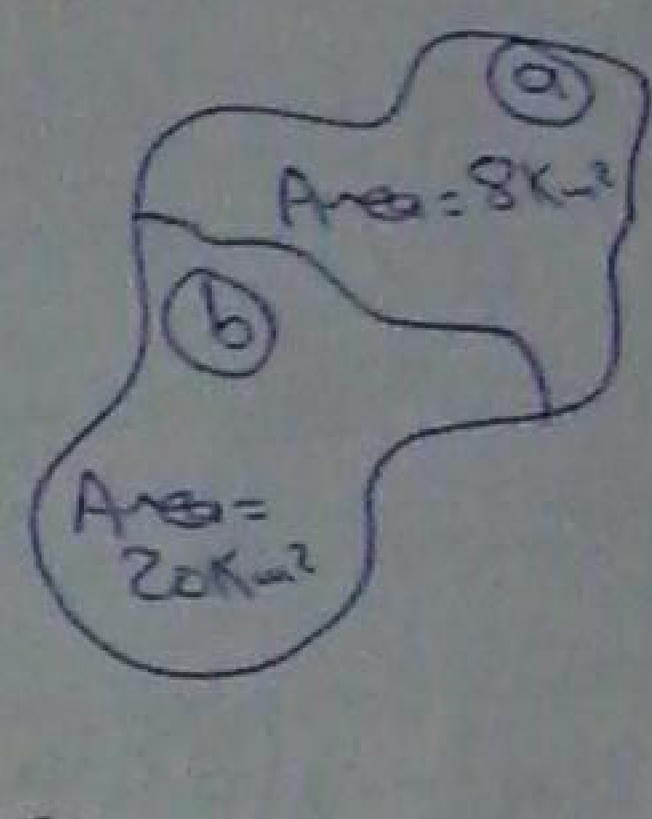
Question (5 8o*)**

① The watershed shown consists of regions ⓐ and ⓑ. Region a has (CN = 50), while region b has (CN = 70)...

① If the whole watershed faces a complete wet condition (AMC III). Estimate the amount of the excess rainfall (P_e) resulted from (25.4 mm) total rainfall. (Hint :- 25.4 mm = 1 inches)

→ P = 1 inches

Solution:



$$CN(II)_{avg} = \frac{(50*8)+(70*20)}{(8+20)}$$

$$\boxed{CN(II)_{avg} = 64.28}$$

$$CN(III) = \frac{23CN(II)}{10+0.13CN(II)}$$

$$\therefore CN(III) = \frac{23*64.28}{10+(0.13*64.28)} = \boxed{80.54}$$

$$\therefore S = \frac{1000}{CN} - 10 = \frac{1000}{80.54} - 10 = \boxed{2.41 \text{ inches}}$$

$$\therefore P_e = \frac{(P-0.2S)^2}{(P+0.8S)} = \frac{(1-0.2*2.41)^2}{(1+0.8*2.41)} = \boxed{0.0916 \text{ inches}} = 2.3114 \text{ mm}$$

② Estimate the volume expected (m^3) from the direct runoff resulted from such watershed?

Solution:

$$V = P_e * area$$

$$V = \frac{0.0916*25.4}{1000} * 28*10^6$$

$$\boxed{V = 65174.87 \, m^3} \#$$

* * * * * *

Question 7

for (1-hr)

Time	P	Q
1	2	1
2	0	2
3	0	1
4	0	0
5	0	0

$\boxed{u=3}$ → $u=3-1+1$ → $(\because x_2, x_3)$ #

for (2-hrs)

Time	P	u	Q
1	0.5	0.5	0.25
2	1	1	1
3	0.5	0.5	2
4	0	0	2
5	0	0	0.75

Solution

- for (1 hr) ...

$Q_1 = P_1 u_1 \longrightarrow 1 = 2u_1$

$\boxed{\therefore u_1 = 0.5}$

$Q_2 = P_1 u_2 + P_2 u_1$

$2 = 2(u_2) + 0$

$\boxed{\therefore u_2 = 1}$

$Q_3 = P_1 u_3 + P_2 u_2 + P_3 u_1$

$1 = 2u_3 + 0 + 0$

$\boxed{\therefore u_3 = 0.5}$

$\therefore u_4 = 0 \longrightarrow Q_4 = 0$

$\therefore u_5 = 0 \longrightarrow Q_5 = 0$

- for (2 hr):

$Q_1 = P_1 u_1 \longrightarrow Q_1 = 0.5 * 0.5$

$\boxed{\therefore Q_1 = 0.25}$

$Q_2 = P_1 u_2 + P_2 u_1 \longrightarrow Q_2 = 0.5*1 + 0.5*1$

$\boxed{\therefore Q_2 = 1}$

$Q_3 = P_1 u_3 + P_2 u_2 + P_3 u_1 \longrightarrow$

$Q_3 = (0.5*0.5) + (1*1) + (1.5*0.5)$

$\boxed{\therefore Q_3 = 2}$

$Q_4 = \cancel{P_1 u_4} + P_2 u_3 + P_3 u_2 + \cancel{P_4 u_1}$

$Q_4 = 1(0.5) + 1.5(1) + 0$

$\boxed{\therefore Q_4 = 2}$

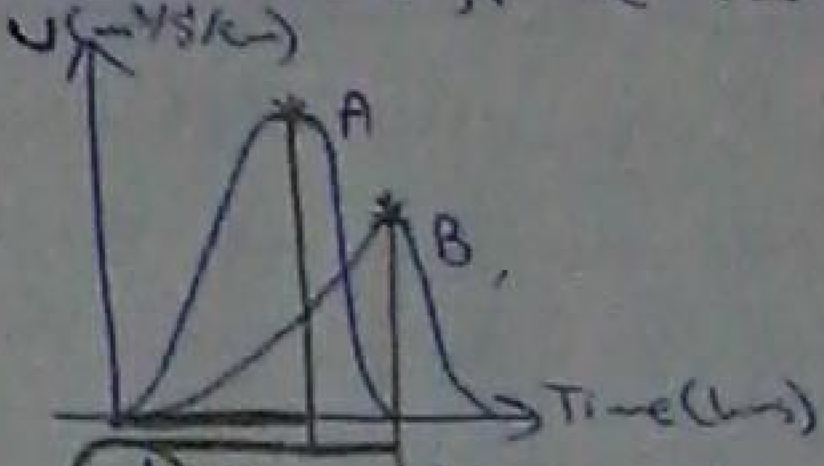
$Q_5 = P_1 u_5 + P_2 u_4 + P_3 u_3 + P_4 u_2 + P_5 u_1$

$Q_5 = 0 + 0 + 1.5(0.5) + 0 + 0$

$\boxed{Q_5 = 0.75}$

Question (8)

(a) The graph shown describes the unit hydrographs for two watershed (A and B). Both watershead have the same soil type and land cover. Based on that, place a circle around the most correct answer:



(1) Compared to watershead (B), watershead (A) has an area that is:

a) larger b) smaller c) the same d) can not be determined.

(2) Compared to watershead (B), watershead (A) has a slope that is:

a) higer b) lower c) the same d) can not be determined.

(3) Compared to watershead (B), watershead (A) has a time of concentration that is:

a) longer b) shorter c) the same d) can not be determined.

(4) Compared to watershead (B), watershead (A) receives precipitation that is:

a) higher b) lower c) the same d) can not be determined

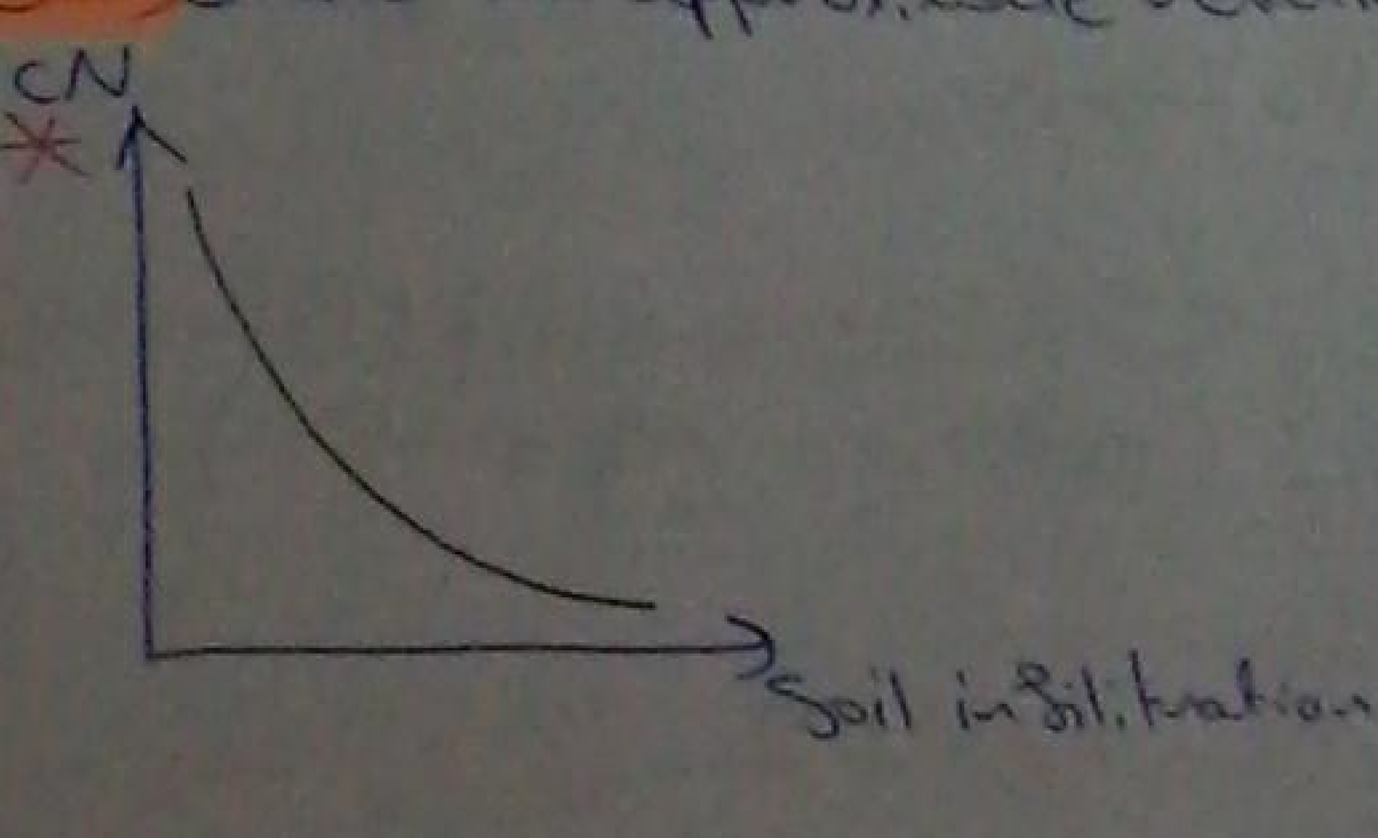
(5) For watershead (A), as the precipitation amount increase (UH) values:

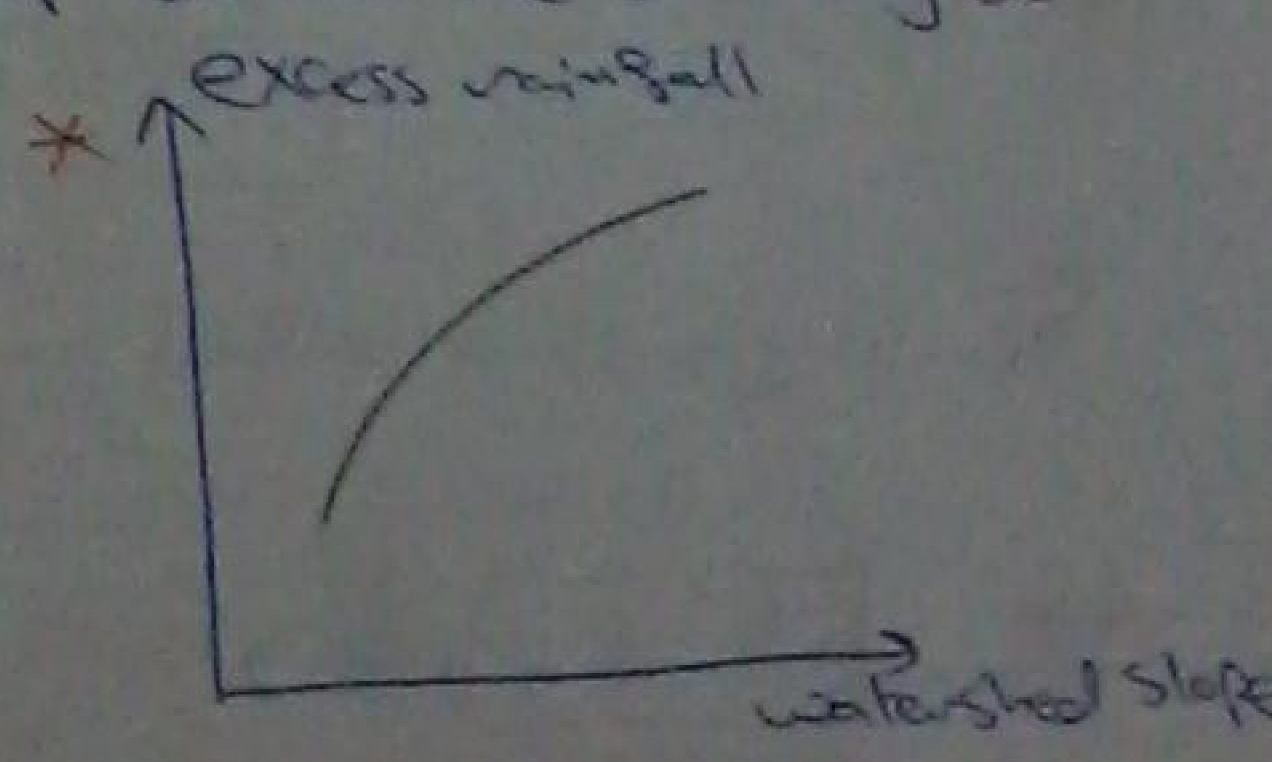
a) increase b) decreas c) remain the same d) slightly increase

(6) If the surface roughness of watershed (B) has increased, then it's (UH) values

a) increase b) decrease c) remain the same d) can not be determined

(B) draw an approximate relationship between the following:





Question (9) 80

A watershed in arid region ($K_s = 0.7$ and $K_c = 1$) faces an average air temperature of (30°c) and solar radiation of (350 w/m2) The watershed soil equilibrium infiltration capacity is (0.7 mm/hr) and the initial infiltration capacity is (9 mm/hr) with infiltration constant (K) as (0.2/hr). compute the excess rainfall at times (t=1) and (t=4 hrs) from the beginning of (5hr) Storm that has constant rainfall intensity of (6mm/hr). neglect the $\boxed{\text{depression storage}}$ and the interception losses.

→ Ds

***Solution 80

$K_s = 0.7 \rightsquigarrow K_c = 1 \rightsquigarrow T = 30°c \rightsquigarrow R_n = 350\ w/m^2 \rightsquigarrow$

$f_c = 0.7\ mm/hr \rightsquigarrow f_o = 9\ mm/hr \rightsquigarrow K = 0.2/hr$

The excess rainfall ??? ⟶ begining (5hr)

- at → t=1 hr
- at → t=4 hr

*** → $\boxed{\text{at } t=1}$ ⟶ $l_v = 2500 - (2.36 * T)$

$l_v = 2500 - (2.36 * 30)$

$\boxed{l_v = 2429200}$

$\therefore E_r = \frac{R_n}{l_v \rho_w} K_s \cdot K_c = \frac{350}{2429200 * 1000} * 0.7 * 1 * 60 * 60 * 10^3$

$\boxed{\therefore E_r = 0.36\ mm/hr}$

$\therefore f = f_c + (f_o - f_c)^{-Kt} \rightsquigarrow f = 0.7 + (9 - 0.7)e^{-(0.2*1)}$ ⟶ $(i < f_o)$

$\boxed{\therefore f = 7.495}$ mm/hr

?∴ The net rainfall availbale for runoff = 6 − 7.495 − 0.36

(ecess run off = −1.855)...

*** → $\boxed{\text{at } t=4}$ ⟶ $E_r = 0.36\ mm/hr$

$f = 0.7 + (9 - 0.7)e^{-(0.2*4)}$

$\boxed{\therefore f = 4.43}$

∴ The net rainfall available for runoff = 6 − 4.43 − 0.36

(ecess runoff = 1.21)...

→ The following table shows the direct runoff from a watershed considering its 1-hr UH($m^3/s/cm$)...
compute the direct runoff (Q_1) and the excess rainfall (P_1)...

Times	excess rainfall (mm)	direct runoff Q(m^3/s)
0	0	0
1	P_1	Q_1
2	0	3.525
3	7	2.802
4	—	1.645
5	—	0.798
6	—	0

*** Solution *** The value of $(M=2)$ → The value of $(N=5)$...

$\therefore M = 5-2+1 = 4$ ... → U_1, U_2, U_3, U_4

Time	excess rainfall (cm)	direct runoff Q(m^3/s)
1	P_1	Q_1
2	0	3.525
3	0.7	2.802
4	—	1.645
5	—	0.798

→ at $(u=1)$ → $\boxed{Q_1 = P_1 U_1}$ → (1)

→ at $(u=2)$ → $Q_2 = P_1 U_2 + \cancel{P_2 U_1}$ → $\boxed{3.525 = P_1 U_2}$ → (2)

→ at $(u=3)$ → $Q_3 = P_1 U_3 + \cancel{P_2 U_2} + P_3 U_1$

$2.802 = P_1 U_3 + P_3 U_1$

$\boxed{2.802 = P_1 U_3 + 0.7 U_1}$ → (3)

→ at $(u=4)$ → $Q_4 = \cancel{P_1 U_4} + \cancel{P_2 U_3} + P_3 U_2 + \cancel{P_4 U_1}$

$1.645 = 0.7 U_2$ → $\boxed{\therefore U_2 = 2.35}$

→ in (eq2) → $3.525 = P_1 * 2.35$ → $\boxed{P_1 = 1.5\ cm = 15\ mm}$

→ at $(u=5)$ → $Q_5 = \cancel{P_1 U_5} + \cancel{P_2 U_4} + P_3 U_3 + \cancel{P_4 U_2} + \cancel{P_5 U_1}$

$0.798 = 0.7 * U_3$ → $\boxed{U_3 = 1.14}$

→ in eq ③ →

$2.802 = P_1 U_3 + 0.7 U_1$

$2.802 = (1.5)(1.14) + 0.7 U_1$

$\boxed{\therefore U_1 = 1.56}$

→ in eq ① →

$Q = P_1 U_1$

$Q = 1.56 * 1.5$

$\boxed{\therefore Q = 2.34 \ m^3/s}$ //

* * * * *

Question (11)

*** The curve below represents the infiltration rate for an soil type under different moisture conditions (condition A and B), study the curve and shortly answer the following sub-questions placing proper units when applicable.

① The soil equilibrium infiltration capacity is about 3 mm/hr

② In terms of dry and wet expressions the soil under condition (A) is dry

③ The soil infiltration constant (K) is $f = f_c + (f_0 - f_c)e^{-Kt}$ → (at 2hrs)

$7 = 3 + (12 - 3)e^{-K(2)}$ → $\boxed{K = 0.405}$

④ at rainfall intensity of 6 mm/hr, the actual infiltration rate at time = 2hrs is about (7 − 6 = 1 mm/h) for soil under condition A, while (6 − 5 = 1 mm/h) for soil under condition B..

⑤ in term of soil material (sand or clay), the soil under condition A behaves like sand while the soil under condition B behaves like clay ..

⑥ at rainfall intensity of 12 mm/hr the excess rainfall rate at time = 2 hr is about 12 − 7 = 5 for soil under condition A, while 12 − 5 = 7 for soil under condition B...

⑦ explain why as the storm duration increase, the infiltration rate decrease

↑ duration ↓ infiltration rate ↓ velocity of wind ↓ temperature and the relative humidity ↓ and the type of the soil effect on this ... ↑ evaporation ... (Type of the soil become more clay)..

Ex *** (Groundwater hydrology) *** (final)

① The flow from a main well in a confined aquifer of (15 m thick) D is $\left(25 \frac{L}{s}\right)$ Q, if the phreatic surface elevation at two observation wells (50 m) r_1 and (20 m) r_2 away of the main well are (114.6 m) h_1 and (112.5 m) h_2 respectively, find the transmissivity (K) of the aquifer ???

$$Q = \frac{2\pi K D (h_2 - h_1)}{\ln\left(\frac{r_2}{r_1}\right)}$$

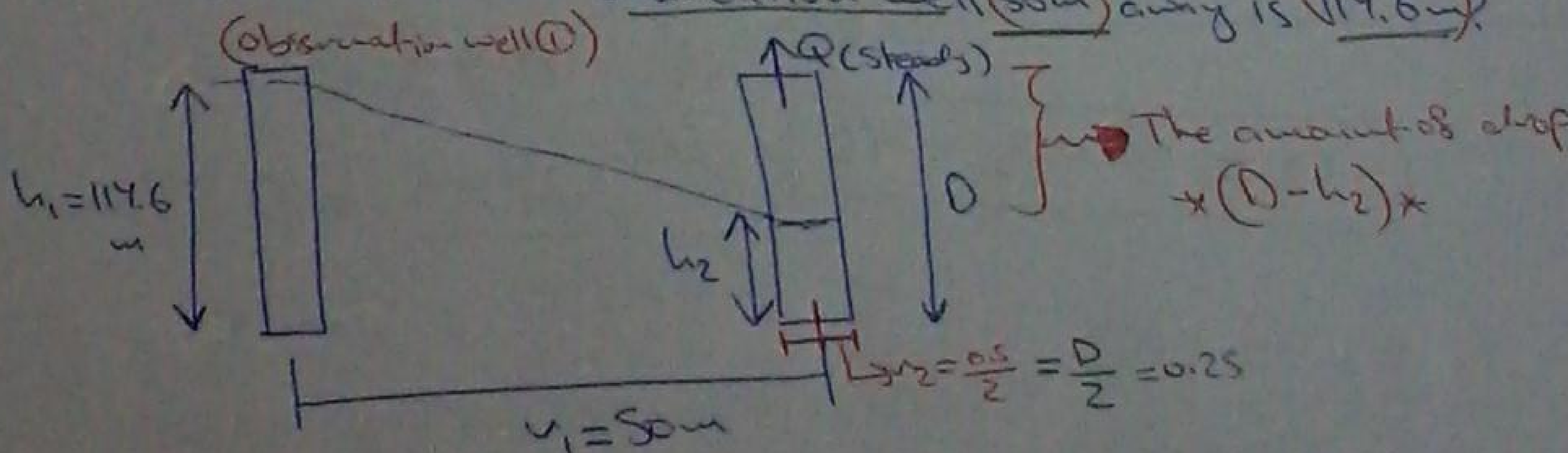
$$\frac{25}{1000} = \frac{2\pi (K)(15)(112.5 - 114.6)}{\ln\left(\frac{20}{50}\right)}$$

$$\therefore K = 1.16 * 10^{-4} \; (*60*60*24)$$

$$\boxed{\therefore K \approx 10 \text{ m/day}}$$

$$\boxed{T = 10 * D = 10 * 15 = 150 \text{ m}^2/\text{day}} \rightarrow (KD)$$

② (Cont) a main well has diameter of (0.5 m) D and transmissivity of (150 m²/day) $(KD) = T$, what is the height of the phreatic surface (water table head) at the main well h_2 if the phreatic surface at an observation well (50 m) r_1 away is (114.6 m) h_1?



$$Q = \frac{2\pi K D (h_2 - h_1)}{\ln\left(\frac{r_2}{r_1}\right)} \rightarrow 0.025 = \frac{2\pi \left(\frac{150}{60*60*24}\right)(h_2 - 114.6)}{\ln\left(\frac{0.25}{50}\right)}$$

$$\boxed{\therefore h_2 = 102.5 \text{ m}}$$

drop = 114.6 − 102.5 = □

③ (cont) a main well of (0.5m) diameter penetrates a confined aquifer of ($K = 20$ m/day) and thickness of (35m). The flow is pumped from the main well such that its water table is maintained at drawdown (drop) of (5m) below the water table of an observation well that is (600m) from the main well, what is the discharge from the main well???

⟿ The value of ($r_2 = \frac{0.5}{2} = 0.25$)

⟿ The value of (KD) = (20 m/day * 35)

$\therefore KD = 700 \ m^2/day$

$\therefore KD = \frac{700}{60 * 60 * 24} = \boxed{8.1 * 10^{-3}}$

⟿ D = 600m ⟿ The drop = 5m

$600 - 5m = \boxed{595m} \rightarrow h_2$

$\boxed{h_1 = 600m}$

$$\rightsquigarrow Q = \frac{2\pi KD(h_2 - h_1)}{\ln\left(\frac{r_2}{r_1}\right)}$$

$$Q = \frac{2\pi(8.1 * 10^{-3})(595 - 600)}{\ln\left(\frac{0.5}{5m}\right)}$$

→ from ② → السؤال السابق

$\boxed{\therefore Q = 0.055 \ m^3/s}$ #

Problem ([illegible]) ***

Ground water well of (40 cm) diameter in confined aquifer of (25 m) thickness having (K = 5 m/day) at eady stream the piezometric surface elevation at two observation well that are (80 m) and (52 m) away from the ground water well are (42 m) and (28 m) respectively. estimate the piezometric surface elevation at the ground water well???

*** (1) $r = \frac{40}{2} = \frac{20}{100} = 0.2\,m = r_1$

Thickness = 25 m

K = 5 m/day

$\therefore T = KD = \frac{5 * 25}{60*60*24} = \boxed{1.45 * 10^{-3}}$

$\rightarrow Q = \frac{2\pi KD(h_2 - h_1)}{\ln\left(\frac{r_2}{r_1}\right)}$

$\therefore Q = \frac{2\pi(1.45*10^{-3})(42-28)}{\ln\left(\frac{80}{52}\right)}$

$\boxed{\therefore Q = 0.296\ m^3/s}$

لو عكست

$\rightarrow \left(\frac{2\pi(1.45*10^{-3})(28-42)}{\ln\left(\frac{52}{80}\right)}\right)$

بطلع نفس الجواب..

$\boxed{\rightarrow \left.\begin{matrix} h_2 \\ r_2 \end{matrix}\right\} \rightarrow \text{المجهول}}$

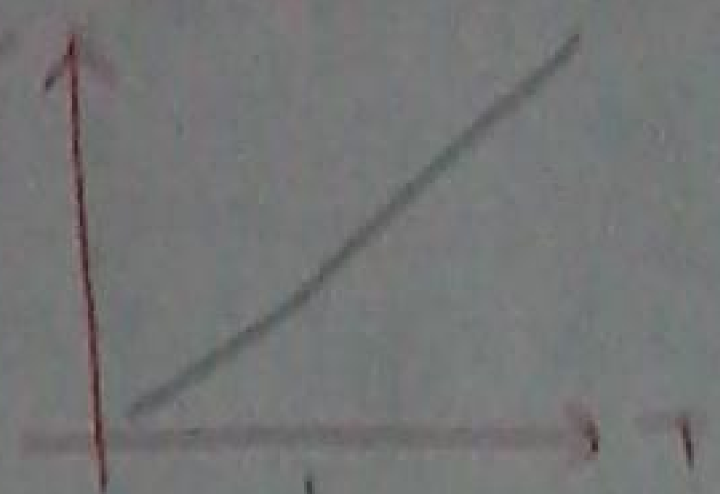
*** (2) $Q = \frac{2\pi KD(h_2 - h_1)}{\ln\left(\frac{r_2}{r_1}\right)}$

$0.296 = \frac{2\pi(1.45*10^{-3})(28-h)}{\ln\left(\frac{0.2}{80}\right)} \Rightarrow \boxed{h = 222.66\,m}$

$0.296 = \frac{2\pi(1.45*10^{-3})(h-42)}{\ln\left(\frac{0.2}{80}\right)} \Rightarrow h = \boxed{-152.66\,m}$ ✓ ok

[illegible]

① The relationship between the I and v...



(direct relationship)

[illegible]

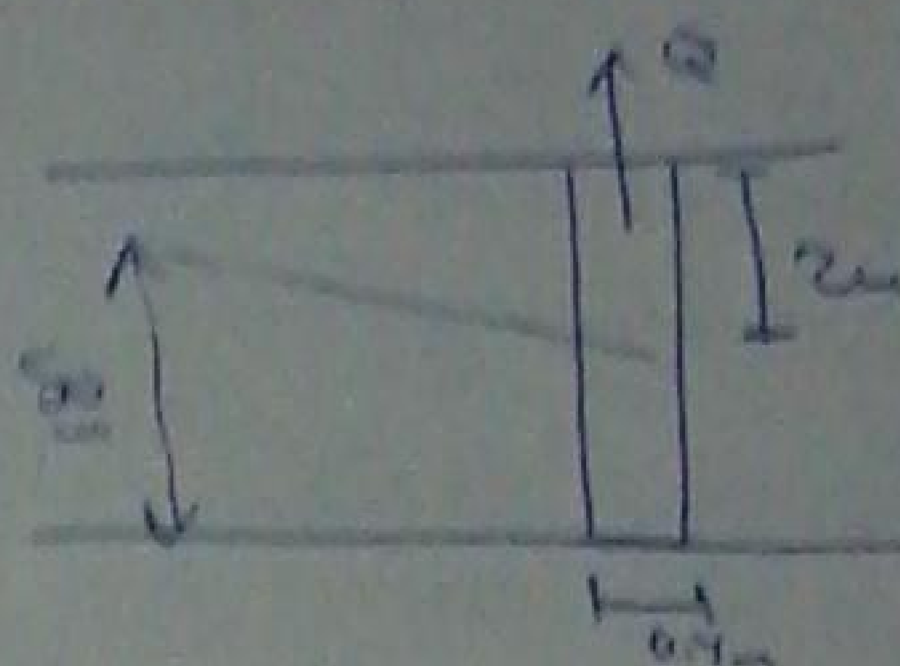
② unconfined

K = 10 m/day

D = 0.4 m

determine r_1 = ???

Q = 1420 m³/h



*** Δh = drop = 2 m

$h_1 = 50m$

$h_2 = 48m$

$r_2 = \frac{0.4}{2} = 0.2m$

r_1 = ???

$$Q = \frac{2\pi K(h_2^2 - h_1^2)}{\ln\left(\frac{r_2}{r_1}\right)} \Rightarrow$$

$$1420 = \frac{2\pi\left(\frac{10}{60\times60\times24}\right)\left((48)^2 - (50)^2\right)}{\ln\left(\frac{0.2}{r_1}\right)}$$

$$1420 = \frac{0.143}{\ln\left(\frac{0.2}{r_1}\right)} \longrightarrow 1420\ln\left(\frac{0.2}{r_1}\right) = 0.143$$

$$\ln\left(\frac{0.2}{r_1}\right) = 1\times10^{-3}$$

$$\frac{0.2}{r_1} = 1$$

$$\boxed{r_1 = 0.20\ m}$$

Exam

an aquifer of ($T = 150\,m^2/day$) ($S = 10^{-4}$) provides flow of ($25\,L/s$) to a main well. find the drop (S_d) at an observation well ($20\,m$) away from the main well after (1 day) and (30 day) of pumping???

*** $$S_d = \frac{Q}{4\pi T} \ln\left(\frac{2.25\,T t}{r^2 S}\right)$$

$$Q = \frac{25}{1000} = 0.025\,m^3/s$$

$$T = 150\,m^2/day = KD$$

$$\therefore T = \frac{150}{60 * 60 * 24} = \boxed{1.74 * 10^{-3}}$$

$t \rightarrow$ 1 day

$t \rightarrow$ 30 day

$$S = 10^{-4}$$

$$r = 20\,m$$

$$\therefore S_d\,(at\,(t = 1\,day)) = \frac{0.025}{4\pi (1.74 * 10^{-3})} \ln\left(\frac{2.25\,\underbrace{(150)(1)}_{day}}{(20)^2 * 10^{-4}}\right)$$

$$\boxed{S_d\,(at\,(t = 1\,day)) = 10.36\,m}$$

$$\therefore S_d\,(at\,(t = 30\,day)) = \frac{0.025}{4\pi (1.74 * 10^{-3})} \ln\left(\frac{2.25 * (150)(30)}{(20)^2 * 10^{-4}}\right)$$

$$\boxed{S_d\,(at\,(t = 30\,day)) = 14.22\,m}$$

$$* \quad \boxed{S_{d\,(at\,(30))} - S_{d\,(at\,(1))} = S_{d\,(at\,(29\,day))}}$$

*** Ex80 ***

a confined well produces flow through an aquifer of ($T = 200\ m^2/day$). The volume released per unit volume of aquifer per unit drop in the water table is (0.008). Calculate the (2 day) drop at an observation well (40 m) away from the main well when the flow for the first day is ($100\ L/s$) while for the second day is ($80\ L/s$)?

*** Sol 80

$$* \; S_d = \frac{Q}{4\pi T} \ln\left(\frac{2.25\,T\,t}{r^2 S}\right)$$

اليوم الأول

$$\rightarrow S_{d_1} = \frac{(100/1000)}{4\pi\left(\frac{200}{60*60*24}\right)} \cdot \ln\left(\frac{2.25(200)(1)}{(40)^2(0.008)}\right)$$

$$\boxed{S_{d_1} = 12.238\,m}$$

$$\rightarrow S_{d_2} = \frac{(80/1000)}{4\pi\left(\frac{200}{60*60*24}\right)} \cdot \ln\left(\frac{2.25(200)(2)}{(40)^2(0.008)}\right) - \frac{(80/1000)}{4\pi\left(\frac{200}{60*60*24}\right)} \cdot \ln\left(\frac{2.25(200)(1)}{(40)^2(0.008)}\right)$$

$$\boxed{\therefore S_{d_2} = 1.906\,m}$$

* كذلك لو كان اليوم الخامس بحسب (S_d) لليوم الخامس وبطرح منه الـ (accum) لليوم (١،٢،٣،٤)

$\therefore$ The Total accumulative drop over the whole (2 day) equal ($12.238 + 1.906 = \underline{14.144\,m}$)

***problem ***

$\rightarrow T = 120\,m^2/day$ and $r = 50$

$S = 0.006$

$s_{d_{total}} = 18$

$Q_1 = 100\ L/s$

$Q_2 = 50\ L/s$

Calc. time???

*** $$s_{d_1} = \frac{(100/1000)}{4\pi\left(\frac{120}{60*60*24}\right)} \cdot \ln\left(\frac{2.25(120)(1)}{(50)^2(0.006)}\right)$$

$$\boxed{s_{d_1} = 16.57}$$

*** $$s_{d_2} = \frac{(50/1000)}{4\pi\left(\frac{120}{60*60*24}\right)} \cdot \ln\left(\frac{2.25(120)(t)}{(50)^2(0.006)}\right) - \frac{(50/1000)}{4\pi\left(\frac{120}{60*60*24}\right)} \cdot \ln\left(\frac{2.25(120)(1)}{(50)^2(0.006)}\right)$$

$\rightarrow s_{d_{total}} = s_{d_1} + s_{d_2}$

$$18 = 16.57 + (2.86 \cdot \ln(18t)) - 8.28$$

$$18 = 8.289 + 2.86 \ln(18t)$$

$$\ln(18t) = \frac{18 - 8.289}{2.86} = 3.395$$

$$\boxed{\therefore t = 1.65\,day}\ \#$$

Problem

(S-hydrograph)

given ($\Delta t_y = 2$)...
given table...
complete the table...

t	1uH	$S(t)$	$S(t-\Delta t_y)$	2hr-UH
0	0	0	0	0
1	0.3	0.3+0=0.3	0	0.15
2	2.6	0.3+2.6=2.9	0	1.75
3	6.2	2.9+6.2=9.1	0.3	4.4
4	4.7	9.1+4.7=13.8	2.9	5.75
5	0.4	13.8+0.4=14.2	9.1	2.55
6	0	14.2+0=14.2	13.8	0.2

المجموع التراكمي

$$\left(\frac{1}{\Delta t_y}\left(S(t) - S(t-\Delta t_y)\right)\right)$$

* * * * *