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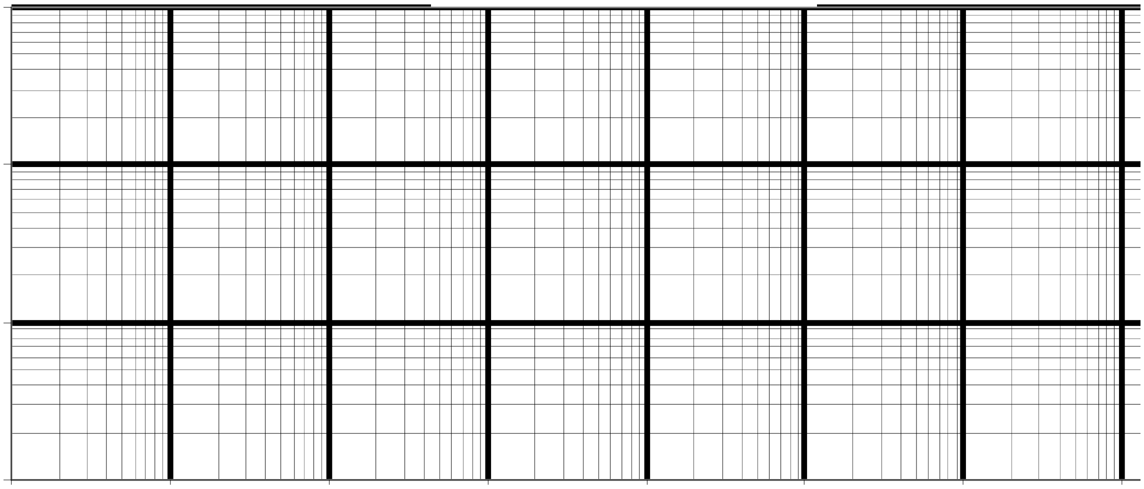
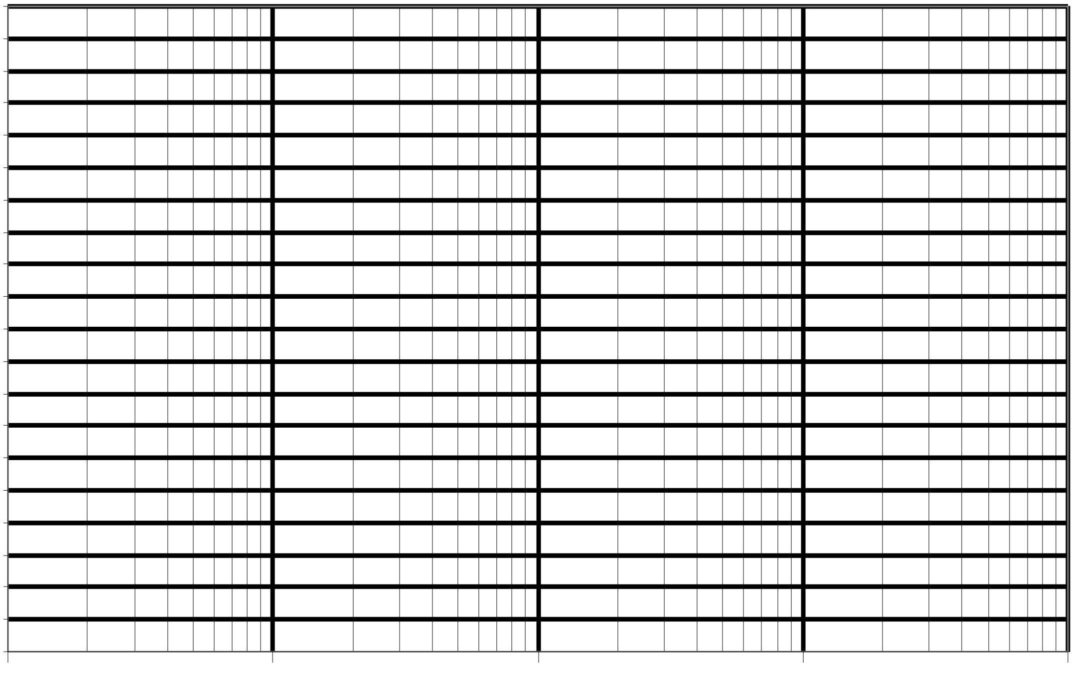
Log-Log Paper



Semi-Log Paper



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$$\frac{72.8g}{cm\,\sec^2}$$

ic viscosity 1 centipoise

Specific weight of water = 62.4 lbs/ft ^{3}

ıtic viscosity 1 centistoke

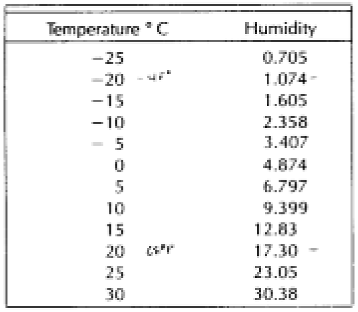
Typical barometric pressures

sea-level ~14.7 psi
Denver ~12.2 psi
Mt. Everest ~4.9psi

$$1centipoise = \frac{0.01g}{cm\,\sec}$$

$$1atm = \frac{1.01325x10^{-6}\,g}{cm\,\sec^2}$$

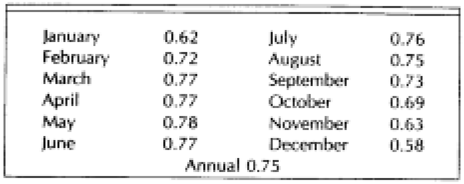
TABLE 2.1. Saturation humidity of air (grams per cubic meter)



Temperature ° C	Humidity
−25	0.705
−20 −4°F	1.074
−15	1.605
−10	2.358
− 5	3.407
0	4.874
5	6.797
10	9.399
15	12.83
20 68°F	17.30
25	23.05
30	30.38

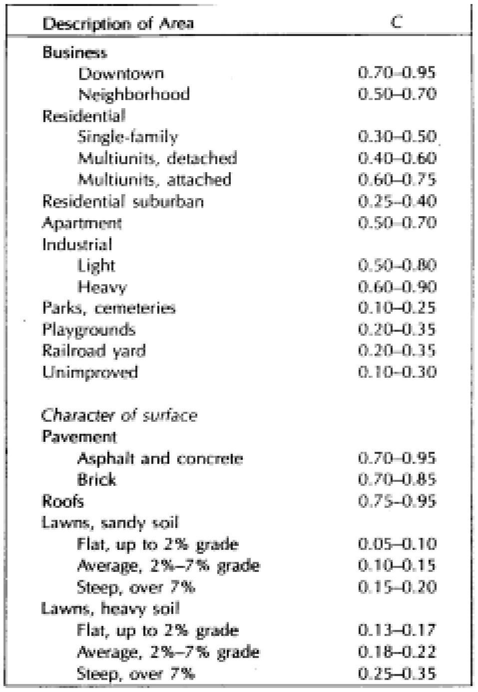
SOURCE: *Handbook of Chemistry and Physics* (Cleveland, Ohio: CRC Publishing Company, 1976).

TABLE 2.2. Class-*A* land pan coefficients for midwestern United States



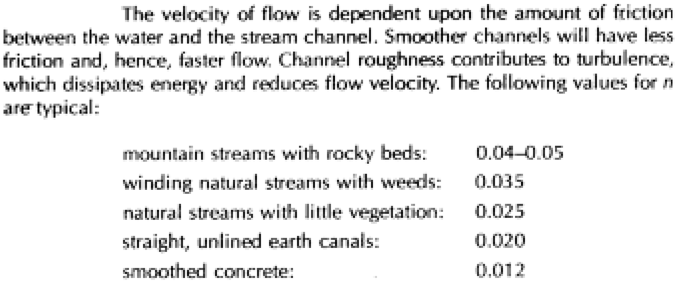
January	0.62	July	0.76
February	0.72	August	0.75
March	0.77	September	0.73
April	0.77	October	0.69
May	0.78	November	0.63
June	0.77	December	0.58
Annual 0.75			

SOURCE: W. J. Roberts and J. B. Stall, Illinois State Water Survey Report of Investigation 57, 1967.



Description of Area	C
Business	
Downtown	0.70–0.95
Neighborhood	0.50–0.70
Residential	
Single-family	0.30–0.50
Multiunits, detached	0.40–0.60
Multiunits, attached	0.60–0.75
Residential suburban	0.25–0.40
Apartment	0.50–0.70
Industrial	
Light	0.50–0.80
Heavy	0.60–0.90
Parks, cemeteries	0.10–0.25
Playgrounds	0.20–0.35
Railroad yard	0.20–0.35
Unimproved	0.10–0.30
Character of surface	
Pavement	
Asphalt and concrete	0.70–0.95
Brick	0.70–0.85
Roofs	0.75–0.95
Lawns, sandy soil	
Flat, up to 2% grade	0.05–0.10
Average, 2%–7% grade	0.10–0.15
Steep, over 7%	0.15–0.20
Lawns, heavy soil	
Flat, up to 2% grade	0.13–0.17
Average, 2%–7% grade	0.18–0.22
Steep, over 7%	0.25–0.35

SOURCE: American Society of Civil Engineers, *Manuals and Reports of Engineering Practice No. 37*, 1970.



The velocity of flow is dependent upon the amount of friction between the water and the stream channel. Smoother channels will have less friction and, hence, faster flow. Channel roughness contributes to turbulence, which dissipates energy and reduces flow velocity. The following values for *n* are typical:

mountain streams with rocky beds:	0.04–0.05
winding natural streams with weeds:	0.035
natural streams with little vegetation:	0.025
straight, unlined earth canals:	0.020
smoothed concrete:	0.012

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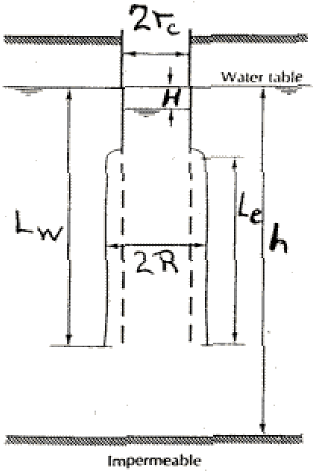
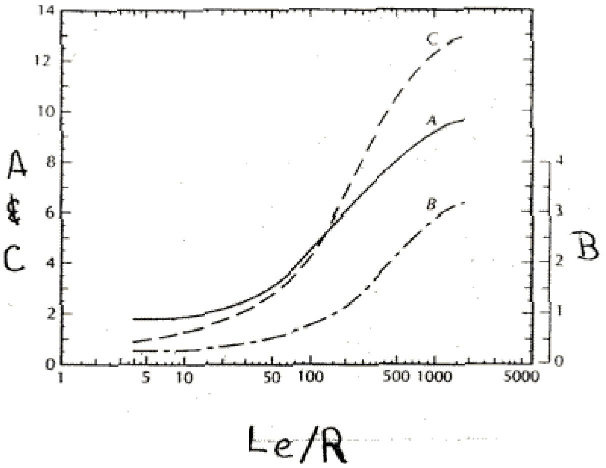
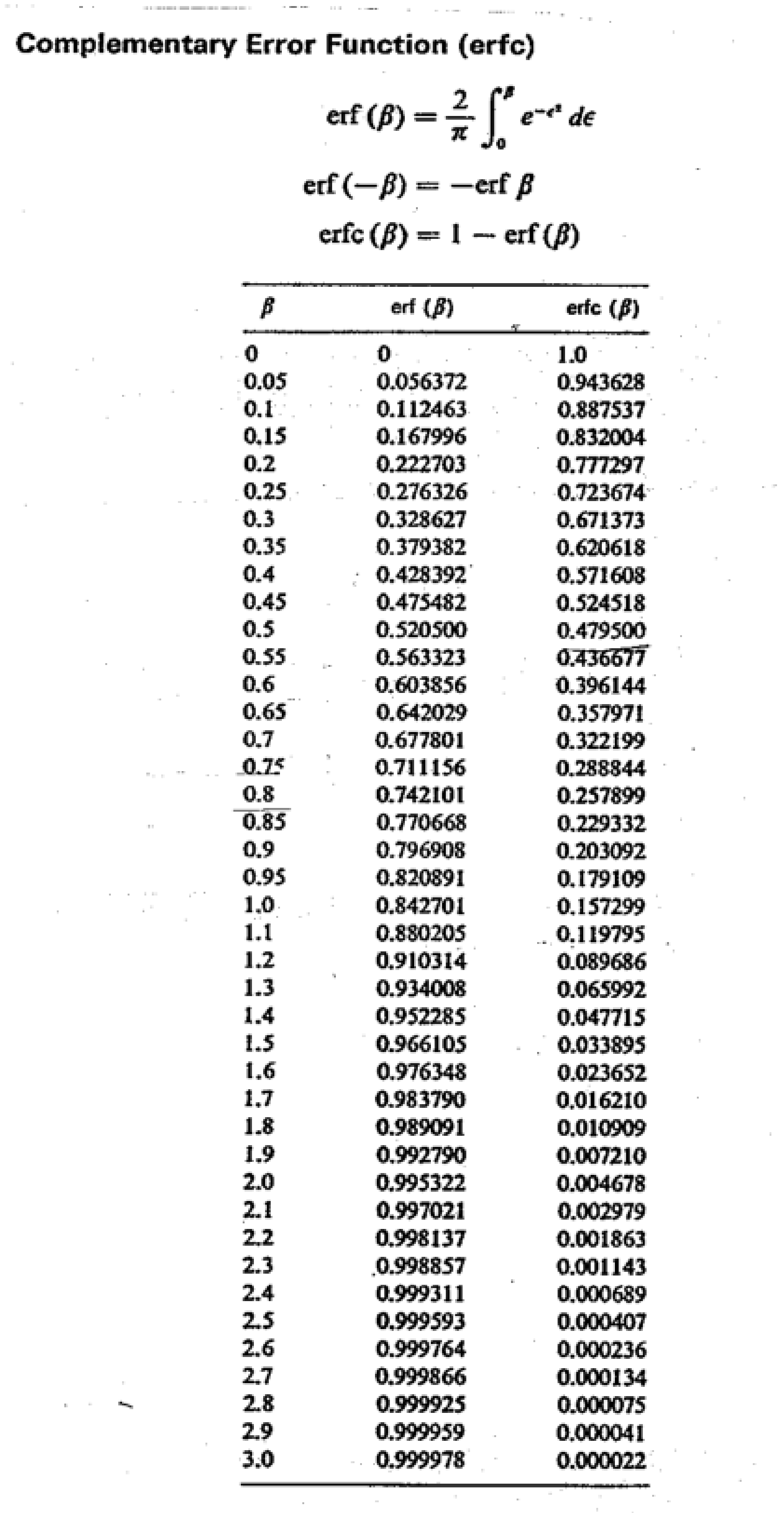
Element	H	C	N	O	Na	Mg	Al	S	Cl	K	Ca
Atomic weight	1	12	14	16	23	24	27	32	35.5	39	40

$$for\ L_w < h \quad \ln\left(\frac{R_e}{R}\right) = \left[\frac{1.1}{\ln\left(\frac{L_w}{R}\right)} + \frac{A + B\ln\left(\frac{(h-L_w)}{R}\right)}{\frac{L_e}{R}}\right]^{-1}$$

$$for\ L_w = h \quad \ln\left(\frac{R_e}{R}\right) = \left[\frac{1.1}{\ln\left(\frac{L_w}{R}\right)} + \frac{C}{\frac{L_e}{R}}\right]^{-1}$$







Complementary Error Function (erfc)

$$\text{erf}\,(\beta) = \frac{2}{\pi}\int_0^{\beta} e^{-\epsilon^2}\,d\epsilon$$

$$\text{erf}\,(-\beta) = -\text{erf}\,\beta$$

$$\text{erfc}\,(\beta) = 1 - \text{erf}\,(\beta)$$

β	erf (β)	erfc (β)
0	0	1.0
0.05	0.056372	0.943628
0.1	0.112463	0.887537
0.15	0.167996	0.832004
0.2	0.222703	0.777297
0.25	0.276326	0.723674
0.3	0.328627	0.671373
0.35	0.379382	0.620618
0.4	0.428392	0.571608
0.45	0.475482	0.524518
0.5	0.520500	0.479500
0.55	0.563323	0.436677
0.6	0.603856	0.396144
0.65	0.642029	0.357971
0.7	0.677801	0.322199
0.75	0.711156	0.288844
0.8	0.742101	0.257899
0.85	0.770668	0.229332
0.9	0.796908	0.203092
0.95	0.820891	0.179109
1.0	0.842701	0.157299
1.1	0.880205	0.119795
1.2	0.910314	0.089686
1.3	0.934008	0.065992
1.4	0.952285	0.047715
1.5	0.966105	0.033895
1.6	0.976348	0.023652
1.7	0.983790	0.016210
1.8	0.989091	0.010909
1.9	0.992790	0.007210
2.0	0.995322	0.004678
2.1	0.997021	0.002979
2.2	0.998137	0.001863
2.3	0.998857	0.001143
2.4	0.999311	0.000689
2.5	0.999593	0.000407
2.6	0.999764	0.000236
2.7	0.999866	0.000134
2.8	0.999925	0.000075
2.9	0.999959	0.000041
3.0	0.999978	0.000022

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u	$W(u)$	u	$W(u)$	u	$W(u)$	u	$W(u)$
1×10^{-10}	22.45	7×10^{-8}	15.90	4×10^{-5}	9.55	1×10^{-2}	4.04
2	21.76	8	15.76	5	9.33	2	3.35
3	21.35	9	15.65	6	9.14	3	2.96
4	21.06	1×10^{-7}	15.54	7	8.99	4	2.68
5	20.84	2	14.85	8	8.86	5	2.47
6	20.66	3	14.44	9	8.74	6	2.30
7	20.50	4	14.15	1×10^{-4}	8.63	7	2.15
8	20.37	5	13.93	2	7.94	8	2.03
9	20.25	6	13.75	3	7.53	9	1.92
1×10^{-9}	20.15	7	13.60	4	7.25	1×10^{-1}	1.823
2	19.45	8	13.46	5	7.02	2	1.223
3	19.05	9	13.34	6	6.84	3	0.906
4	18.76	1×10^{-6}	13.24	7	6.69	4	0.702
5	18.54	2	12.55	8	6.55	5	0.560
6	18.35	3	12.14	9	6.44	6	0.454
7	18.20	4	11.85	1×10^{-3}	6.33	7	0.374
8	18.07	5	11.63	2	5.64	8	0.311
9	17.95	6	11.45	3	5.23	9	0.260
1×10^{-8}	17.84	7	11.29	4	4.95	1×10^{0}	0.219
2	17.15	8	11.16	5	4.73	2	0.049
3	16.74	9	11.04	6	4.54	3	0.013
4	16.46	1×10^{-5}	10.94	7	4.39	4	0.004
5	16.23	2	10.24	8	4.26	5	0.001
6	16.05	3	9.84	9	4.14		

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Carbonate Equilibrium Constants as a Function of Temperature

T, °C	K_m	K_1	K_2	K_{sp}
5		3.02×10^{-7}	2.75×10^{-11}	8.13×10^{-9}
10		3.46×10^{-7}	3.24×10^{-11}	7.08×10^{-9}
15		3.80×10^{-7}	3.72×10^{-11}	6.03×10^{-9}
20		4.17×10^{-7}	4.17×10^{-11}	5.25×10^{-9}
25	1.58×10^{-3}	4.47×10^{-7}	4.68×10^{-11}	4.57×10^{-9}
40		5.07×10^{-7}	6.03×10^{-11}	3.09×10^{-9}
60		5.07×10^{-7}	7.24×10^{-11}	1.82×10^{-9}

$$K_m = \frac{[H_2CO_3]}{[CO_2]_{aq}} \qquad K_1 = \frac{[H^+][HCO_3^-]}{[H_2CO_3]} \qquad K_2 = \frac{[H^+][CO_3^{-2}]}{[HCO_3^-]}$$

K_{sp} = Solubility product for $CaCO_3$