REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF MINERALS AND ENERGY
EXAMINATION FOR THE MINE SURVEYOR'S CERTIFICATE OF COMPETENCY

DATE: 16 April 2009 (Thursday) TOTAL MARKS: 100
TIME: 12:30 – 15:30 (3 Hours) TO PASS: 50

MINING ECONOMICS II

NOTE:

1. Any pocket calculator may be used and intermediate results need not be shown. The make and model number of the calculator used must be noted on the front cover of the answer book.
2. Tables that may be used are attached hereto.
3. Graph, Probability and Log paper will be supplied if required
4. Your examination number must be written on all graph paper and loose sheets that are handed in with your examination script.

Question 1:

a) Explain what is meant by the following terms:
i) Ordinary Kriging
ii) Point Kriging
iii) Simple Kriging
iv) Skewness
v) Kurtosis
vi) Coefficient of Variation
vii) Anisotrophy

b) Draw an annotated sketch of a Spherical Semi-variogram illustrating your understanding of the function of the following components:
i) Nugget
ii) Sill
iii) Range

[20 Marks]

Question 2:

The following values are available for a block of ground on a gold mine.

Upper sampling value (cm.g/t)	Cumulative frequency (%)
4	5
7	6
12	8
29	12
46	18
80	25
120	35
180	50
280	68
450	82
800	93
1200	98
∞	100

a) Determine, by means of a graph, whether the distribution is a normal or a log normal distribution.
b) Determine, by means of a graph, whether this is a two or a three parameter distribution.
c) Determine the parameters of the distribution from the graphs.

[30 Marks]

Question 3:

The results of an exploration programme based on 240 samples of approximately 3 tons each, show that the values are normally and randomly distributed with a mean value of 33% MgO and a standard deviation of 10.6% MgO. It is estimated that 30 000 000 tons would be payable with a pay value of 37.9% MgO for a mining pay limit of 26.8% MgO. However, the minimum quantity that can be allocated to either the mill or waste dump is a truck load of 30 tons.

a) Calculate the total tons in the deposit.
b) Determine the payable tons and pay value for the given mining conditions.
c) Determine the 90% confidence limits for the mean value.

[20 Marks]

Question 4:

The following cash flow is anticipated for a mining project.

Year	0 (Initial Investment)	1	2	3
Cash Flows	R -100 000	R50 000	R80 000	R30 000

Should the mining company invest in the mining project if the discount rate is 29%?

[5 Marks]

Question 5:

A project is expected to generate the following cash flow stream.

Year	Cash Flow
0 (Initial Investment)	R -1 500
1	R 900
2	R 800
3	R 500

a) Determine the internal rate of return for the project.
b) Is the project acceptable if the hurdle rate 17%?

[15 Marks]

Question 6:

Develop a cash flow schedule for a small high capacity mine based on the following information:

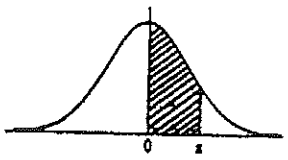
Development Period	2 years
Production Period	10 Years
Capital Expenditure (CAPEX) millions	R6m in first year R8m in second year
Annual Revenue millions	R5m in the first year of production R9m thereafter
Annual operating expenditure (OPEX) millions	R2m in the first year of production R3m thereafter
Tax Rate	40%

[10 Marks]

Total Marks [100]

TABLE 1

AREAS under the STANDARD NORMAL CURVE from 0 to z

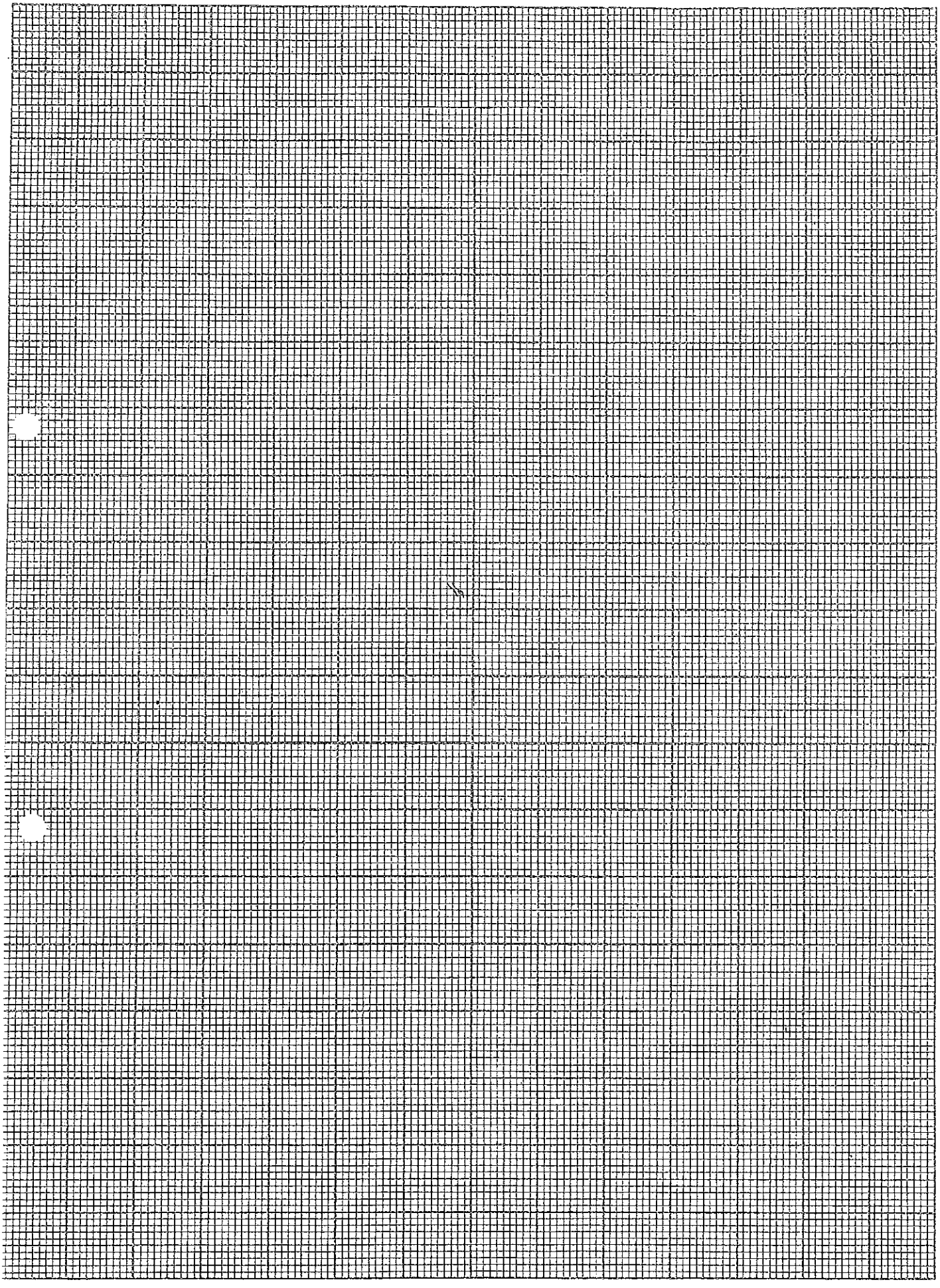


z	0	1	2	3	4	5	6	7	8	9
0·0	0·0000	0·0040	0·0080	0·0120	0·0160	0·0199	0·0239	0·0279	0·0319	0·0359
0·1	0·0398	0·0438	0·0478	0·0517	0·0557	0·0596	0·0636	0·0675	0·0714	0·0754
0·2	0·0793	0·0832	0·0871	0·0910	0·0948	0·0987	0·1026	0·1064	0·1103	0·1141
0·3	0·1179	0·1217	0·1255	0·1293	0·1331	0·1368	0·1406	0·1443	0·1480	0·1517
0·4	0·1554	0·1591	0·1628	0·1664	0·1700	0·1736	0·1772	0·1808	0·1844	0·1879
0·5	0·1915	0·1950	0·1985	0·2019	0·2054	0·2088	0·2123	0·2157	0·2190	0·2224
0·6	0·2258	0·2291	0·2324	0·2357	0·2389	0·2422	0·2454	0·2486	0·2518	0·2549
0·7	0·2580	0·2612	0·2642	0·2673	0·2704	0·2734	0·2764	0·2794	0·2823	0·2852
0·8	0·2881	0·2910	0·2939	0·2967	0·2996	0·3023	0·3051	0·3078	0·3106	0·3133
0·9	0·3159	0·3186	0·3212	0·3238	0·3264	0·3289	0·3315	0·3340	0·3365	0·3389
1·0	0·3413	0·3438	0·3461	0·3485	0·3508	0·3531	0·3554	0·3577	0·3599	0·3621
1·1	0·3643	0·3665	0·3686	0·3708	0·3729	0·3749	0·3770	0·3790	0·3810	0·3830
1·2	0·3849	0·3869	0·3888	0·3907	0·3925	0·3944	0·3962	0·3980	0·3997	0·4015
1·3	0·4032	0·4049	0·4066	0·4082	0·4099	0·4115	0·4131	0·4147	0·4162	0·4177
1·4	0·4192	0·4207	0·4222	0·4236	0·4251	0·4265	0·4279	0·4292	0·4306	0·4319
1·5	0·4332	0·4345	0·4357	0·4370	0·4382	0·4394	0·4406	0·4418	0·4429	0·4441
1·6	0·4452	0·4463	0·4474	0·4484	0·4495	0·4505	0·4515	0·4525	0·4535	0·4545
1·7	0·4554	0·4564	0·4573	0·4582	0·4591	0·4599	0·4608	0·4616	0·4625	0·4633
1·8	0·4641	0·4649	0·4656	0·4664	0·4671	0·4678	0·4686	0·4693	0·4699	0·4706
1·9	0·4713	0·4719	0·4726	0·4732	0·4738	0·4744	0·4750	0·4756	0·4761	0·4767
2·0	0·4772	0·4778	0·4783	0·4788	0·4793	0·4798	0·4803	0·4808	0·4812	0·4817
2·1	0·4821	0·4826	0·4830	0·4834	0·4838	0·4842	0·4846	0·4850	0·4854	0·4857
2·2	0·4861	0·4864	0·4868	0·4871	0·4875	0·4878	0·4881	0·4884	0·4887	0·4890
2·3	0·4893	0·4896	0·4898	0·4901	0·4904	0·4906	0·4909	0·4911	0·4913	0·4916
2·4	0·4918	0·4920	0·4922	0·4925	0·4927	0·4929	0·4931	0·4932	0·4934	0·4936
2·5	0·4938	0·4940	0·4941	0·4943	0·4945	0·4946	0·4948	0·4949	0·4951	0·4952
2·6	0·4953	0·4955	0·4956	0·4957	0·4959	0·4960	0·4961	0·4962	0·4963	0·4964
2·7	0·4965	0·4966	0·4967	0·4968	0·4969	0·4970	0·4971	0·4972	0·4973	0·4974
2·8	0·4974	0·4975	0·4976	0·4977	0·4977	0·4978	0·4979	0·4979	0·4980	0·4981
2·9	0·4981	0·4982	0·4982	0·4983	0·4984	0·4984	0·4985	0·4985	0·4986	0·4986
3·0	0·4987	0·4987	0·4987	0·4988	0·4988	0·4989	0·4989	0·4989	0·4990	0·4990
3·1	0·4990	0·4991	0·4991	0·4991	0·4992	0·4992	0·4992	0·4992	0·4993	0·4993
3·2	0·4993	0·4993	0·4994	0·4994	0·4994	0·4994	0·4994	0·4995	0·4995	0·4995
3·3	0·4995	0·4995	0·4995	0·4996	0·4996	0·4996	0·4996	0·4996	0·4996	0·4997
3·4	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4998
3·5	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998
3·6	0·4998	0·4998	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999
3·7	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999
3·8	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999
3·9	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000

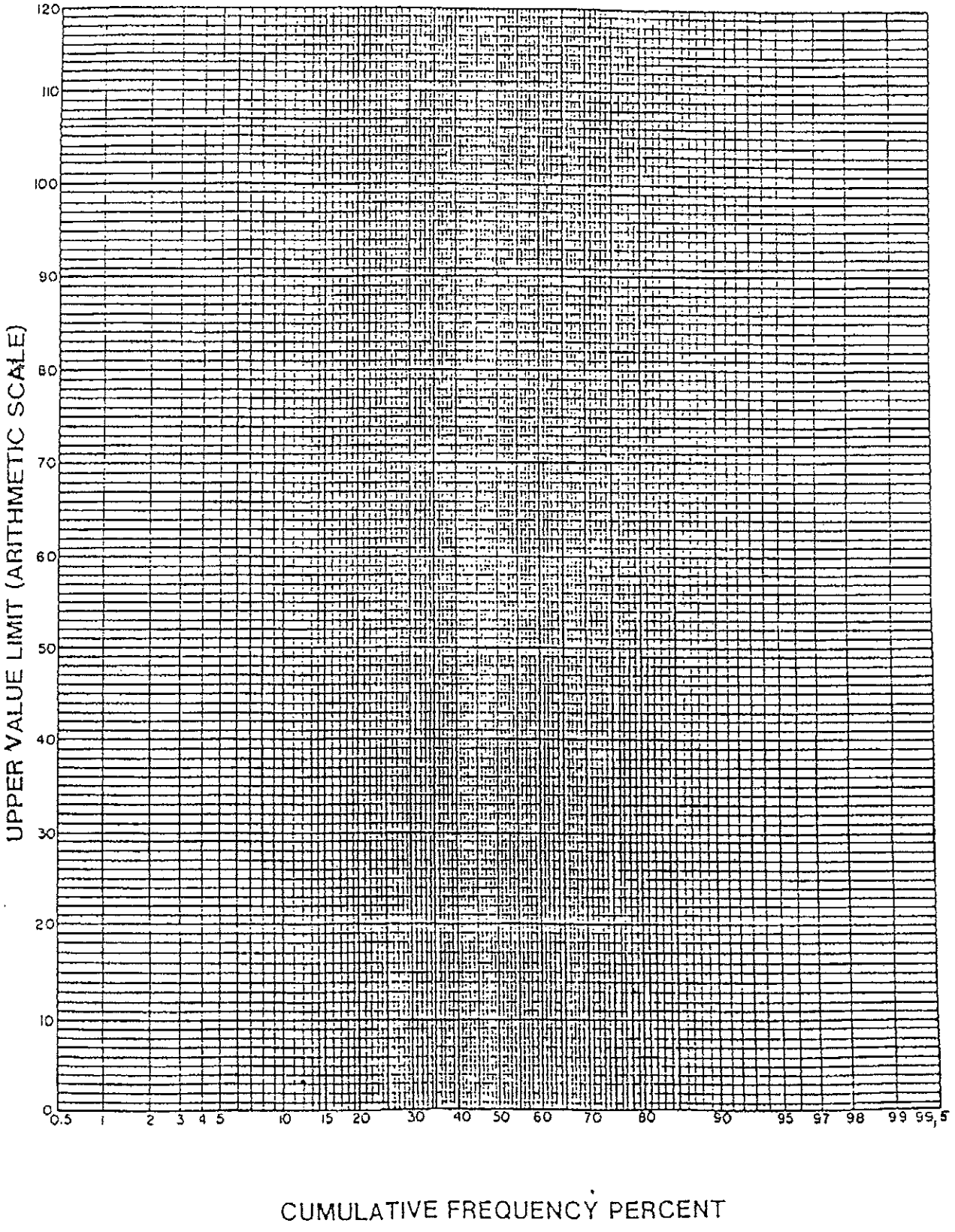
TABLE 5

TABLE FOR THE COMPUTATION OF TONNAGE AND GRADE ABOVE CUTT-OFF FOR THE NORMAL DISTRIBUTION

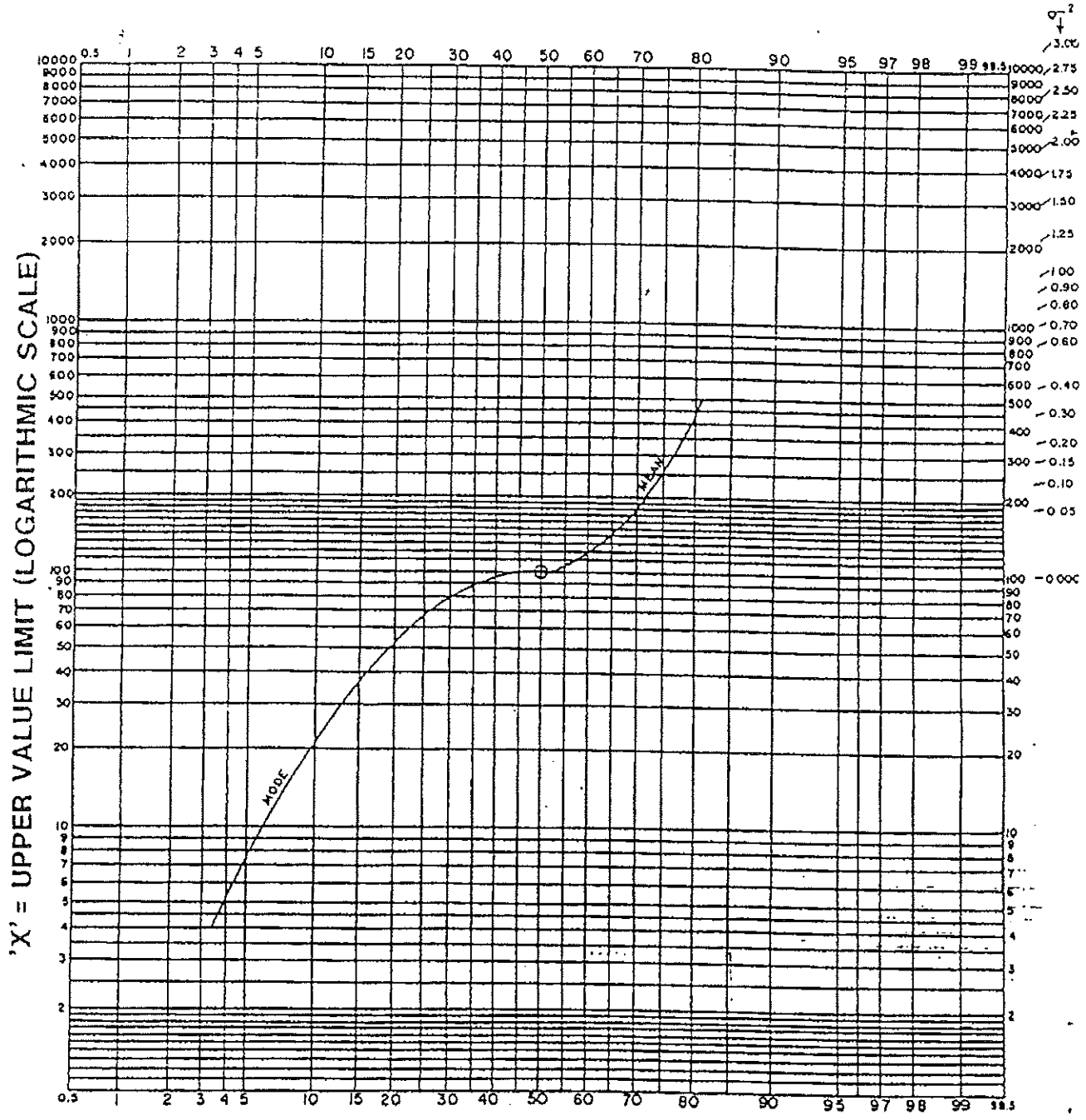
Cut-off below the mean		Reduced cut-off = Z PV = MV + ωσ	Cut-off above the mean	
Tonnage proportion	ω-factor		ω-factor	Tonnage proportion
50.00	0.798	0.00	0.798	50.00
51.99	0.766	0.05	0.830	48.01
53.98	0.735	0.10	0.863	46.02
55.96	0.705	0.15	0.896	44.04
57.93	0.675	0.20	0.929	42.07
59.87	0.646	0.25	0.964	40.13
61.79	0.617	0.30	0.998	38.21
63.68	0.589	0.35	1.034	36.32
65.54	0.562	0.40	1.069	34.45
67.36	0.535	0.45	1.106	32.64
69.15	0.509	0.50	1.142	30.85
70.88	0.484	0.55	1.180	29.12
72.57	0.459	0.60	1.217	27.43
74.22	0.435	0.65	1.256	25.78
75.80	0.411	0.70	1.295	24.20
77.34	0.389	0.75	1.334	22.66
78.81	0.367	0.80	1.375	21.19
80.23	0.346	0.85	1.415	19.77
81.59	0.326	0.90	1.457	18.41
82.89	0.306	0.95	1.499	17.11
84.13	0.287	1.00	1.542	15.87
85.31	0.269	1.05	1.586	14.69
86.43	0.251	1.10	1.631	13.57
87.49	0.235	1.15	1.677	12.51
88.49	0.219	1.20	1.724	11.51
89.44	0.204	1.25	1.772	10.56
90.32	0.189	1.30	1.821	9.68
91.15	0.175	1.35	1.872	8.85
91.92	0.162	1.40	1.923	8.08
92.65	0.150	1.45	1.977	7.35
93.32	0.138	1.50	2.033	6.68
93.94	0.127	1.55	2.098	6.06
94.52	0.117	1.60	2.147	5.48
95.05	0.107	1.65	2.208	4.95
95.54	0.098	1.70	2.270	4.46
95.99	0.090	1.75	2.335	4.01
96.41	0.082	1.80	2.403	3.59
96.78	0.074	1.85	2.473	3.22
97.13	0.067	1.90	2.546	2.87
97.44	0.061	1.95	2.622	2.56
97.72	0.055	2.00	2.701	2.28
97.98	0.050	2.05	2.784	2.02
98.21	0.045	2.10	2.870	1.79
98.42	0.040	2.15	2.961	1.58
98.61	0.036	2.20	3.055	1.39
98.78	0.032	2.25	3.155	1.22



PROBABILITY PAPER



LOGARITHMIC PROBABILITY PAPER



CUMULATIVE FREQUENCY PERCENT UP TO 'X' VALUE

SOME USEFUL FORMULAE

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - u)^2 \qquad \sigma^2 = \frac{1}{N}\sum_{i=1}^{N}x_i^2 - u^2$$

$$s^2 = \frac{1}{n-1}\sum(x-\bar{x})^2 \qquad \gamma(h) = C(\frac{3h}{2a} - \frac{h^3}{2a^3})$$

$$s^2 = \frac{1}{n-1}[\sum x^2 - n\bar{x}^2] \qquad \gamma(h) = C(1 - \exp(\frac{-h}{a}))$$

$$T = \frac{\bar{x}-\mu}{s\sqrt{n}} \qquad T = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

$$P = PV\frac{i}{1-(1+i)^n} \qquad PV = A/(1+r)^n$$

$$PV = P(1-(1+i)^n)/i \qquad PV = \frac{P[(1+r)^n - 1]}{r(1+r)^n}$$

$$\theta = \frac{Mx^2 - x_p x_{1-p}}{x_p + x_{1-p} - 2Mx} \qquad b = \frac{n\sum xy - \sum x\sum y}{n\sum x^2 - (\sum x)^2}$$

$$2\gamma(h) = \frac{1}{n}\sum[g(x) - g(x+h)]$$

$$r = \frac{\sum xy - \sum x\sum y/n}{[\sum x^2 - (\sum x)^2/n][\sum y^2 - (\sum y)^2/n]} \qquad \sigma^e = \hat{s}_y\sqrt{1-r^2}$$

additive constant (a) = $\frac{m^2 - f1 * f2}{f1 + f2 - 2m}$