

Contents

Chapter 1	Introduction	1
1.1	Jenkins versus Robinson	1
1.2	The infinite experiment	3
1.2.1	Relative frequency distribution: normalization	4
1.2.2	Limiting frequency distribution	5
1.2.3	Discrete value distribution	7
1.2.4	Histogram	7
1.2.5	Continuous distribution	9
1.3	True value: mean, mode and median	10
1.4	Precision of the apparatus: standard deviation	14
1.5	Comments and worked examples	18
1.6	Problems	22
Chapter 2	Interpretation of Results	25
2.1	Best estimate of the true value	25
2.2	Best estimate of precision	26
2.3	Combinations of measurements: true value and precision	29
2.3.1	Scale factor ($z = ax$)	30
2.3.2	Sum ($z = x + y$)	31
2.3.3	Linear combination ($z = \alpha + ax + by + \dots$)	32
2.3.4	Logarithmic function ($z = \log x$)	32
2.3.5	General product ($z = \alpha x^a y^b$)	33
2.3.6	General function ($z = f(x)$)	34
2.4	Accuracy of the mean value: standard error	35
2.5	Accuracy of the standard deviation: number of significant figures	37
2.6	Combinations of measurements: standard error	40
2.6.1	Linear combination ($z = \alpha + ax + by + \dots$)	40
2.6.2	General product ($z = \alpha x^a y^b \dots$)	40
2.6.3	General function ($z = f(x)$)	41
2.7	Discussion of Jenkins' and Robinson's experiments	41
2.8	Comments and worked examples	42
2.9	Problems	53

Chapter 3	Least Squares	56
3.1	Mean as best estimate of true value	56
3.2	Sum of two quantities ($z = x + y$)	57
3.3	Best straight line	57
3.4	Combined experiments: least error	62
3.5	Combined Jenkins and Robinson experiment	64
3.6	Comments and worked examples	65
3.7	Problems	69
Chapter 4	Causes of Error	72
4.1	Systematic errors	72
4.2	Random errors	73
4.3	Combination of two random errors	73
4.3.1	Matching errors	76
4.3.2	Number of significant figures	77
4.4	Comments and worked example	78
4.5	Problems	79
Chapter 5	Elementary Theory of Errors	81
5.1	Permutations and combinations	81
5.2	Binomial distribution	83
5.3	Gaussian distribution	86
5.4	Poisson distribution	91
5.5	Comments and worked examples	99
5.6	Problems	101
Chapter 6	Likelihood, Confidence and Truth	103
6.1	Maximum likelihood—Gaussian distribution	104
6.2	Maximum likelihood—Poisson distribution	107
6.3	Confidence	108
6.4	Best combined estimates	110
6.4.1	Consistent experiments	111
6.4.2	Inconsistent experiments	113
6.5	Truth of a hypothesis: the χ^2 test	114
6.6	Return of Jenkins and Robinson	119
6.7	Comments and worked examples	120
6.8	Problems	122
	Summary	124
	Notation	124
	Chapter 1. Introduction	125
	Chapter 2. Interpretation of results	126

Chapter 3. Least squares	127
Chapter 4. Causes of error	128
Chapter 5. Elementary theory of errors	129
Chapter 6. Likelihood, confidence and truth	129
Appendix 1. The Gaussian or normal distribution function . . .	131
Appendix 2. The integral Gaussian probability	132
Appendix 3. The Poisson distribution function	133
Appendix 4. Hypothesis test, $P_n(>\chi^2)$	136
Further Reading	140
Index	141