

Contents

Preface	v
1 The object of practical physics	1
PART I STATISTICAL TREATMENT OF DATA	
2 Introduction to errors	7
2.1 The importance of estimating errors	7
2.2 Systematic and random errors	9
2.3 Systematic errors	10
3 Treatment of a single variable	12
3.1 Introduction	12
3.2 Distribution of measurements	13
3.3 The standard error in the mean	16
3.4 The Gaussian distribution	19
3.5 The integral function	23
3.6 The error in the error	25
3.7 Discussion of the Gaussian distribution	26
Summary of symbols, nomenclature, and important formulae	28
Exercises	29
4 Further topics in statistical theory	34
4.1 The treatment of functions	34
4.2 The straight line	37
4.3 Weighting of results	41
Summary of equations for the best straight line by the method of least squares	43
Exercises	44
5 Common sense in errors	46
5.1 Error calculations in practice	46

5.2	Complicated functions	50
5.3	Errors and experimental procedure	52
	Exercises	54
PART II EXPERIMENTAL METHODS		
6	Some laboratory instruments and methods	59
6.1	Introduction	59
6.2	Metre rule	59
6.3	Micrometer screw gauge	62
6.4	Measurement of length—choice of method	63
6.5	Measurement of length—temperature effect	65
6.6	The beat method of measuring frequency	67
6.7	Negative feedback amplifier	70
6.8	Servo systems	74
6.9	Natural limits of measurement	76
	Exercises	78
7	An analysis of some experiments	81
7.1	Comparison of low resistances by means of a potentiometer	81
7.2	Rayleigh refractometer	89
7.3	Measurement of the magnetic moment of the free electron	96
	Exercises	112
8	Experimental logic	113
8.1	Introduction	113
8.2	Apparent symmetry in apparatus	114
8.3	Sequence of measurements	115
8.4	Intentional and unintentional changes	116
8.5	Drift	117
8.6	Systematic variations	118
8.7	Calculated and empirical corrections	121
8.8	Relative methods	124
8.9	Why make accurate measurements?	127
	Exercises	129
9	Common sense in experiments	131
9.1	Preliminary experiment	131
9.2	Checking the obvious	132
9.3	Personal errors	133
9.4	Repetition of measurements	135

9.5	Working out results	137
9.6	Design of apparatus	137

PART III RECORD AND CALCULATIONS

10	Record of the experiment	141
10.1	Introduction	141
10.2	Bound notebook versus loose-leaf	141
10.3	Recording measurements	142
10.4	Down with copying	143
10.5	Diagrams	144
10.6	Tables	146
10.7	Aids to clarity	147
10.8	Some common faults—ambiguity and vagueness	147
11	Graphs	150
11.1	The use of graphs	150
11.2	Choice of ruling	154
11.3	Scale	154
11.4	Units	155
11.5	Some hints on drawing graphs	156
11.6	Indicating errors	158
11.7	Sensitivity	160
12	Arithmetic	162
12.1	Arithmetic is important	162
12.2	Ways of reducing arithmetical mistakes	162
12.3	Checking arithmetic	164
12.4	Orders of magnitude	166
12.5	Error calculations	166
12.6	Calculating devices	168
12.7	Some miscellaneous tips	169
12.8	Checking algebra	170
	Exercises	171
13	Writing a paper	174
13.1	Introduction	174
13.2	Title	174
13.3	Abstract	175
13.4	Plan of paper	175
13.5	Sections of paper	175
13.6	Diagrams, graphs, and tables	178
13.7	Instructions to authors	178

13.8	Clarity	178
13.9	Good English	179
13.10	Conclusion	181
	Solutions to exercises	182
Appendices		
A	Values of the Gaussian function and the Gaussian integral function	194
B	Evaluation of some integrals connected with the Gaussian function	195
C	The variance of s^2 for a Gaussian distribution	198
D	The binomial and Poisson distributions	200
	Binomial distribution	200
	Poisson distribution	202
E	The straight line—the standard error in the slope and intercept	205
F	SI units	211
	Names and symbols	212
	Decimal fractions and multiples	213
	Relation to c.g.s. units	213
	Definitions of the basic units	214
G	Values of constants	215
	Physical constants	215
	Energy relations	216
	Mathematical constants	216
	Some useful books	217
	References	218
	Index	220