THE SELF-TESTING ARITHMETIC, ON A NEW PLAN, SIMPLE AND SCIENTIFIC: CONTAINING THE LARGEST NUMBER OF EXERCISES EVER PUBLISHED

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JOHN HAY

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THE

SELF-TESTING ARITHMETIC,

ON A NEW PLAN, SIMPLE AND SCIENTIFIC,

CONTAINING THE

Largest Number of Exercises ever Published,

AND

METHODS BY WHICH THE TEACHER IS ENABLED TO CONSTRUCT
AN INFINITE NUMBER OF SELF-TESTING EXERCISES
IN THE SIMPLE AND COMPOUND RULES AND IN PRACTICE.

By JOHN HAY, F.E.I.S.,
RECTOR OF MUSSELBURGH GRAMMAR SCHOOL;
AND FORMERLY OF DUMBARTON BURGH ACADEMY.

GLASGOW:
WILLIAM HAMILTON, PRINTER AND PUBLISHER, 33 BATH STREET;
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MANCHESTER; AND SIMPKIN, MARSHALL, & Co., LONDON.

1863.

PREFACE.

THE elementary arithmetics at present in use in schools may be classed under three heads: *first*, those which contain answers to the exercises; *second*, those without answers; and *third*, those whose exercises are so constructed as to enable the teacher to test the answers. The objections to the first two are sufficiently illustrated by the many attempts to produce books of the third class, and by the evident satisfaction with which the announcement of every successive book is received by the teaching profession—yet, how few of these are now in general use! After trial they have been discarded as useless, either from the principle, if arbitrary and factitious, being easily detected by the pupil; or, if scientific, from its application requiring too much time and labour on the part of the Teacher. In both cases, too, the exercises have generally been limited in their range, and very unlike the requirements of actual business. The difficulty of constructing self-testing exercises entirely free from objections can hardly be over-stated: but from the present attempt having met with the cordial approbation of high educational authorities, the author ventures to hope that it will be found free from those just enumerated. The principle may be *explained* to the pupil without enabling him to "force" the answer, and by it his work can be tested at a glance. The only case in which the principle of the answer is not given in the text is in Addition, (Simple and Compound,) but the Teacher by taking unity for the first line, and proceeding as there explained will at once discover the multiplier for any number of lines, and the ratio of the third line to the sum of six lines, of the fourth line to the sum of seven lines, of the sixth line to the sum of nine lines, of the seventh line to the sum of ten lines, &c.

Those who agree with the author in thinking that practice in adding columns of money &c., much larger than those given in any School Arithmetic, is a useful exercise for senior pupils preparing for commercial situations, will at once appreciate the importance of the method in the text, and the reason for thus explaining the principle of the answers.

The exercises in application of the rules will be found no less suited for use in the class-room than for preparation for the work of the counting-house.

MUSSELBURGH GRAMMAR SCHOOL,
July, 1863.

TABLE OF WEIGHTS & MEASURES.

1.—Troy Weight.

24 grains	= 1 pennyweight (dwt.)
20 pennyweights	= 1 ounce (oz.)
12 ounces	= 1 pound (lb.)
5760 grains	= 1 pound.

2.—Avoirdupois Weight.

16 drams	= 1 ounce (oz.)
16 ounces	= 1 pound (lb.)
28 pounds	= 1 quarter (qr.)
4 quarters or 112 lb	= 1 hundredweight (cwt.)
20 hundredweights	= 1 ton (t.)

3.—Apothecaries Weight.

20 grains	= 1 scruple (scr.)
3 scruples	= 1 dram (dr.)
8 drams	= 1 ounce (oz.)
12 ounces	= 1 pound (lb.)

4.—Measure of Capacity.

4 gills	= 1 pint (pt.)
2 pints	= 1 quart (qt.)
4 quarts or 8 pints	= 1 gallon (gal.)
63 gallons	= 1 hogshead (hhd.)
2 gallons	= 1 peck (pk.)
4 pecks	= 1 bushel (bu.)
8 bushels	= 1 quarter (qr.)

5.—Lineal Measure.

12 lines	= 1 inch (in.)
12 inches	= 1 foot (ft.)
3 feet	= 1 yard (yd.)
5½ yards	= 1 pole (po.)
40 poles	= 1 furlong (fur.)
8 furlongs or 1760 yards	= 1 mile (m.)

6.—Square Measure.

144 square inches	= 1 square foot (sq. ft.)
9 square feet	= 1 square yard (sq. yd.)
30¼ square yards	= 1 square pole (sq. po.)
40 poles	= 1 rood (ro.)
4 roods	= 1 acre (ac.)

7.—Cubic or Solid Measure.

1728 cubic inches	= 1 cubic foot (c. ft.)
27 cubic feet	= 1 cubic yard (c. yd.)
42 cubic feet	= 1 ton of shipping.
40 cubic feet of round, or 50 cubic feet of hewn timber	= 1 ton or load.

8.—Cloth Measure.

2¼ inches	= 1 nail (nl.)
4 nails	= 1 quarter (qr.)
4 quarters	= 1 yard (yd.)
5 quarters	= 1 English ell (E. ell.)
3 quarters	= 1 Flemish ell (Flem. ell.)
6 quarters	= 1 French ell (Fr. ell.)

9.—Time.

60 seconds	= 1 minute (min.)
60 minutes	= 1 hour (ho.)
24 hours	= 1 day (da.)
365¼ days	= 1 Julian year.
366 days	= 1 leap year.
365 days, 5 hours, 48 minutes, 48 seconds	= 1 solar year.

Thirty days are in September,
April, June, and dull November,
All the rest have thirty-one,
But February's month alone,
Which has but twenty-eight days clear,
And twenty-nine in each leap year.

MULTIPLICATION TABLE.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
14	28	42	56	70	84	98	112	126	140	154	168	182	196	210	224	238	252	266	280
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400

FORMS OF BILLS, RECEIPTS, &c.

INLAND BILL.

GLASGOW, *June 27th.* 1863.

£100.

Three months after date, pay to me or order, at the Union Bank of Scotland here, the sum of one hundred pounds sterling, for value received.

CHARLES DONALDSON
ALEXANDER BROWN.

To Mr. ALEXANDER BROWN,
Merchant, Glasgow.

FOREIGN BILL

DUNEDIN, OTAGO, N.Z.,
April 4th. 1863.

£1242 16*s.* 8*d.*

Two months after sight of this my first of exchange, (second and third of the same tenor and date unpaid) pay to the order of Messrs, Herbert, Haynes, and Hay, one thousand two hundred and forty-two pounds sixteen shillings and eightpence sterling, value of Edward Fotheringham, Esq., and place it to account of, as per advice from

GEORGE HENDERSON.
Accepted 10*th. June*, 1863.
JAMES KERR.

To Mr. JAMES KERR,
Merchant, London.

A PROMISSORY NOTE.

EDINBURGH, *July* 1*st.* 1863.

£24 10*s.* 6*d.*

Sixty days after date, I promise to pay to Mr. Matthew Norris or order, at my office here, the sum of twenty-four pounds ten shillings and sixpence sterling, value received.

OLIVER PATTESON.

RECEIPTS.

DUNBARTON, *June* 29*th.* 1863.

£27 5*s.* 4*d.*

Received from Quintin Robertson, Esq., the sum of twenty-seven pounds five shillings and fourpence, in full of his account to this date.

SAMUEL THOMSON.

MUSSELBURGH, *July* 2*nd.* 1863.

£148 10*s.*

Received from Mr. William Watson, the sum of one hundred and forty-eight pounds ten shillings sterling, in full for leather as per annexed account.

ADAM BERTRAM.

EDINBURGH, *November* 11*th.* 1862.

£60.

Received from Crawford Dunn, Esq., the sum of sixty pounds sterling, being the half-year's rent, ending at Martinmas, of that house, occupied by him, No. 391 Queen St., Edinburgh.

RICHARD TURNBULL.

THE

SELF-TESTING ARITHMETIC.

NOTATION.

I.

TABLE—*To be committed to memory.*

Roman.	Arabic.	Roman.	Arabic.	Roman.	Arabic.	Roman.	Arabic.
I.	= 1	XI.	= 11	XXX.	= 30	CD.	= 400
II.	„ 2	XII.	„ 12	XL.	„ 40	D.	„ 500
III.	„ 3	XIII.	„ 13	L.	„ 50	DC.	„ 600
IV.	„ 4	XIV.	„ 14	LX.	„ 60	DCC.	„ 700
V.	„ 5	XV.	„ 15	LXX.	„ 70	DCCC.	„ 800
VI.	„ 6	XVI.	„ 16	LXXX.	„ 80	CM.	„ 900
VII.	„ 7	XVII.	„ 17	XC.	„ 90	M.	„ 1000
VIII.	„ 8	XVIII.	„ 18	C.	„ 100	MD.	„ 1500
IX.	„ 9	XIX.	„ 19	CC.	„ 200	MDCCCLXIII.	
X.	„ 10	XX.	„ 20	CCC.	„ 300		= 1863

EXERCISES.

Express in Roman notation, and then in Arabic notation, the following numbers:—

(1) One, seventeen, eleven, twenty, two, nine.
(2) Three, fourteen, thirty-three, forty-seven, six.
(3) Forty-five, sixty-four, forty-six, seventy-two.
(4) Twenty-seven, ninety, fifty, sixty-one, sixteen.
(5) Seventy-four, forty-seven, seventy-nine, sixty.
(6) One hundred, four hundred, nine hundred, seven hundred.
(7) Three hundred, eight hundred and fifty, six hundred and ninety.
(8) Five hundred and twenty, two hundred and forty, eighty-nine.
(9) One hundred and thirty (and) four, two hundred and sixty (and) nine.
(10) Three hundred and ninety (and) five, three hundred and fifty-nine.

II.

Write in Arabic notation, and put in the proper columns on your slate thus ruled and headed—

	Thousands.	Hundreds.	Tens.	Units.
Example—Two thousand five hundred and sixty-nine, ...	2	5	6	9

(1) Four hundred and sixty-four.
(2) Six hundred and seventy-three.
(3) Eight hundred and ninety-nine.
(4) Six thousand, nine hundred and ninety-two.
(5) Nine thousand, four hundred and forty-four.
(6) Three thousand, five hundred and sixty-eight.
(7) Eight thousand.
(8) Eight hundred.
(9) Eighty.
(10) Eight.
(11) One thousand four hundred.
(12) Three thousand six hundred.
(13) Nine thousand, nine hundred and one.
(14) Seventeen thousand, six hundred and thirty-seven.
(15) Two thousand and forty-two.
(16) Three thousand and ninety-nine.
(17) Eight thousand and eighty-eight.
(18) Twenty-seven thousand and five.
(19) Forty-four thousand and forty-four.
(20) Sixty-eight thousand, three hundred and three.
(21) One score.
(22) One dozen.
(23) Nine and twenty.
(24) Seven hundred and thirty-six.
(25) Three score and ten.
(26) Two thousand, two hundred and twenty-two.
(27) Forty-four thousand, four hundred and forty-four.
(28) Six hundred and sixty-six thousand, six hundred and sixty-six.
(29) Seven hundred and seventy-seven thousand, seven hundred and seventy.
(30) Ninety-nine thousand, nine hundred and nineteen.

Write the following numbers:—

11	101	111	900	1234	87654	879080
234	342	432	990	5678	345678	9200301
871	589	985	909	25780	505050	9999999

SIMPLE ADDITION.

TABLE I.—*For daily use in the class.*

(1)	1	2	3	4	5	6	7	8	9
(2)	9	8	7	6	5	4	3	2	1
(3)	2	4	6	8	1	3	5	7	9
(4)	7	10	1	4	7	2	6	8	7
(5)	1	3	5	7	9	2	4	6	8
(6)	9	1	8	2	7	3	6	4	5

(1) Add 2, *viva voce*, to each of the figures in cols. 1, 2, 3, 4, 5—thus, 2 and 1 are 3, 2 and 2 are 4, 2 and 3 are 5, &c. (2) 2 and 9 are 11, 2 and 8 are 10, &c., and so with 3, 4, 5, 6.

(2) Add, *viva voce*, 3 to each of the figures in cols. 1, 2, 3, 4, 5, 6.

(3) Add, *viva voce*, 4, 5, &c., to each figure in each column.

(4) Add as before, naming aloud the result thus—col. 4, adding by 2. Results, 9, 12, 3, 6, &c.

(5) Take col. headed 1, going downwards, and add 7 to each figure. The results are 8, 16, 9, 14, &c.

TABLE II.—*For daily use in the class.*

1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9

Take a number and add to it successively all the digits in any column. *Example* 1—Take 8 and col. 4; the results are 12, 16, 20, 24, 28, 32, &c. *Example* 2—Take 3 and col. 9; results are 12, 21, 30, 39, &c.

This table may be used in a variety of ways. *Example*—Add col. 1 to col. 9, col. 2 to col. 8, 3 to 7, 4 to 6. Add col. 1 to col. 2, 4 to 5, 8 to 9, &c. Add diagonally 1, 1 2, 1 2 3, &c. Add together the alternate columns, 1, 3, 5, 7, &c., or 2, 4, 6, 8, &c.

Add any number—say 7, and the alternate columns together, thus—beginning with col. 1. The results are 8, 11, 16, 23, &c.

These preliminary exercises should be practised at least for ten minutes at the beginning of each arithmetical lesson, the class pointing to the figures with their pencils, and answering first simultaneously and then individually.

The following sums are to be worked first *vivâ voce* in the class and then on slates.

III.

(1)	(2)	(3)
1234567891234	22222222222	234234234234567
2222222202222	61715246351	123453714565322

(4)	(5)	(6)
345345345345481	6051423678094	802978654302244
683362821414333	3333373221905	187020134134134

IV.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	2	7	3	2	5	6	1	2	4	8	8
2	3	0	0	4	1	0	1	1	1	6	3
2	1	1	5	1	0	1	4	3	1	3	7
4	2	1	1	2	3	1	3	2	3	2	4

V.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
24	36	47	95	86	53	40	89
49	75	58	78	69	99	76	90

(9)	(10)	(11)	(12)	(13)	(14)
1234567	123	357	579	747	909
1932322	679	298	319	558	111

VI.

(1)	(2)	(3)	(4)	(5)	(6)
1094	1379	1111	1404	7850	8034
2689	1046	1909	1509	6032	9659

(7)	(8)	(9)	(10)	(11)	(12)
9004	3033	3456	3257	4989	9999
7899	7707	3089	9989	3707	8909