Code No. 28–

EXERCISE BOOK

Narrow Ruling

School 77 OTU Course 6 *Standard* .....

Name NEALE F.T.H.

Subject NAVIGATION

Commenced 13-3-44 *Finished* .....

RULES FOR MENSURATION

a = Area. l = Length. b = Breadth. h = Height.
t = Thickness. v = volume. R and r = radius.
D = diameter. c = Circumference.

Area of rectangle = l × b. (N.B.—l × b must be in the same units, i.e., when l is in ft. b must be brought to ft.)

Area of parallelogram = b × h.

Area of triangle = $\frac{b \times h.}{2}$

Area of four walls of a room = 2 h (l + b).

Cubic contents of rectangular solid = l × b × h.
,, ,, cylinder or pipe = Base × h.

Sum of the three angles of a triangle = 180°.

Circle:
- circumference = 2 π r or π D (π = the constant $3\frac{1}{7}$)
- area = πr^2
- area of hollow ring = $\pi (R + r) (R - r)$
- surface area of cylinder (excluding area of two ends) = $2 \pi r h$
- volume of cylinder = $\pi r^2 h$
- volume of cone = $\frac{\pi r^2 h}{3}$
- truncated cone = $\frac{\pi h}{3} (R^2 + Rr + r^2)$ (R.r are radii of 2 ends).

MISCELLANEOUS

1 dozen = 12
1 score = 20
1 gross = 144

A cubic foot of fresh water weighs 62½ lbs.
,, ,, clay ,, 125 lbs.
,, ,, loose earth ,, 95 lbs.
,, ,, pine ,, 41 lbs.
,, ,, oak ,, 59 lbs.

A gallon of water weighs approx. 10 lbs.

A cubic yard of compressed hay weighs about 225 lbs.
,, ,, ,, straw ,, 145 lbs.
,, ,, coal (solid) weighs about 2,160 lbs.
,, ,, sand weighs about 1 ton (approx.)

A truss of straw should be 36 lbs.
,, ,, old hay should be 56 lbs.
,, ,, new hay should be 60 lbs.

36 trusses = a load.

5% Interest or Profit = $\frac{1}{20}$ = 1/- in the £.

Sound travels in air at approximately 1,100 ft. per second.

A halfpenny is 1 inch in diameter.

A noggin = 2 glasses. [4 noggins = 1 pint.]

Supplied for use in NAVAL & MILITARY SCHOOLS, etc., by His Majesty's Stationery Office

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MISS. N. PAXTON.

Training Scheme.

2 hr dry Swim
Map reading. Maps & charts. Types in use
Wind finding
Wireless aids.
Sextant calibration, calculation of errors, Watch rating.
Use of air plot.
Map reading 2. hints on map reading (Practical)
Astrograph. (1)
Sight Calculations.
Compass & Loop swinging.
Astro correction Sunrise etc.
Star recognition. day & night.
Pre flight planning.
Practical navigation.
Technique.
Astro compass & Air swinging.
Log analysis.
Astro theory.
D.R. Compass.
Bags of D.R.I.
Crew co operation.
Geography.
Position lines.
Time examples.
Log Keeping.

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Day. Flying Procedure.

Fly a screen do bombing practice.
2 trips so without screens. full crew. Bombing 3 hrs
Dual cross country with screens.
Series of cross countries. 4 hrs c. 5 hrs.
Test 1 hr
Cross country 5 hrs.
Fighter attacking 2 hrs.
Brew flying circuits.

Night.

Cross country with screens.
2 4 hrs 15 hrs 26 hrs as crew.
1 dual bombing at night 1½ hrs
2 solos 3 hrs.
1 trip with night fighters & searchlights.

Map Reading.

[redacted] of Long are chosen the [redacted] Cat being 1° the scale is correct at 2° on either side of the central meridian.

Position Errors for Wellington 3.

120 mph	+ 10
130 "	+ 9
140 "	+ 8
150 "	+ 7
160 "	+ 6
170 "	+ 5
180 "	+ 4
190 "	+ 3
200 "	+ 2

IAS 140 PE + 8 = 152
B to 10,000
4000 + 8 6000 + 4.
5000 + 6°

RAS 157 6,000 = 174 157 ⟩ 7 1099
10.50 1.75 for 167 400 800

16.2
27
408 1099
800
2990

160

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$\frac{7}{400} \times \frac{68}{1} \times \frac{157}{1} = \frac{6594}{400}$ $\quad 942 \times 7 = 6594$

400) 6594

400

2594

2400

1940

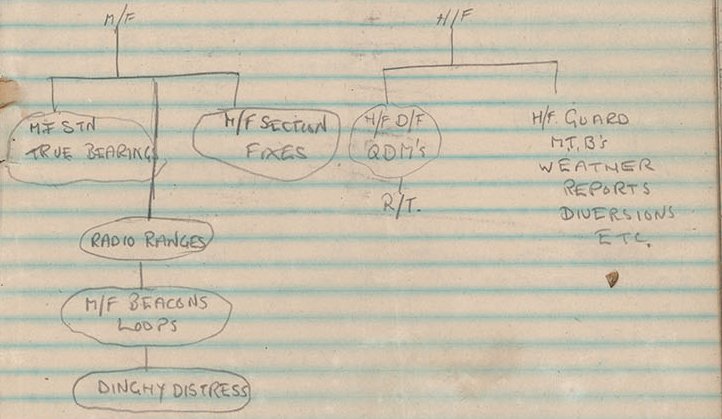
1600

3400

173°

Right

W/T ORGANISATION.



M/F STATIONS.
WYDDA.
HABBANIA.
EL HAZA.

M/F Range 200-300 miles

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Radio Range. (U.S.A.)

not made clear.

Range of M/F 200-300 miles.
W/T Beacons.
Visual indicators, if needles turn to right then turn to port is executed.
this is bearings not recip.

Ditching.
Wop transmitts between 1 hr to 10 past 30 mins to 40 mins.

Priorities.
SOS or Mayday (distress).
O Have operational message of vital importance
OP Immediate is to be used for (A) operation messages of less importance (B) messages of extreme importance not amounting to immediate danger of crashing.

ie.
Lost with good deal of petrol, used to prefix QPM. some mechanical mishap requiring return to base. Injury of one of the crew or severe illness.

P Important.

H/F D/F 0-100 miles.
Q.D.M. Q.D.L.E series of QDM's.

MIDDLE EAST Distress frequency } 4575 Ks day
Inter command H/F D/F } 3105 night

In distress. hand WOP PSN Co HT Speed minutes of flying time left.

H/F GUARD.
Broadcast every ½ hr wop must pick them up. diversion signals, met requests also time signals. All messages to ~~base~~ H/F guard.

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Local R/T procedure.

QASTINA ground control, Callword "Digest"
QASTINA satellite "Digest 2"
Bombing range "Digest Range"

"A" Flight "Drastic Red"
"B" " "Drastic White"
"C" " "Drastic Blue"
"D" " "Drastic Green"
"T T" " "Drastic Grey"

"Ground Testing"

A/c calls ground station
"Drastic Red D. Dog calling digest ground testing over".
Answer: "Drastic Red D. Dog. loud e clear over."
"Drastic Red D. Dog. answering loud e clear also out."

Taxying Up.

"Drastic Red D Dog calling Digest taxiing out over."
"Drastic Red D. Dog Roger out."

After each landing or Circuit & bumps.

"Drastic Red D Dog calling digest landed e clear of runway over."
"Drastic Red D. Dog Roger out."

After completing a detail.

"Drastic Red D Dog calling digest landed e clear of runway, detail completed (or not completed) over"
"Drastic Red D Dog Roger out"

Asking for Q.F.E. prior to landing.

M. "Drastic Red D Dog calling Digest Q F E over"
Answer. "Drastic Red D Dog Q.F.E. 1016 over."
M. "Drastic Red D. Dog Q F E 1016 out."

R/T Procedure at Bombing Range.

M. "Drastic Red D. Dog calling digest Range may I commence bombing over"
Answer "Drastic Red D Dog carry on for bombing over"
M. Drastic Red D Dog Wilco out.

after each bomb
DDog
"Drastic Red calling Digest Range
No 1 bomb gone over
Drastic Red D Dog Roger out.

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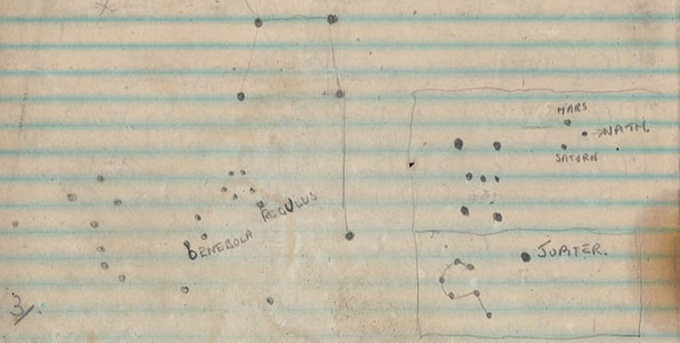
R/T Call signs around CASTINA.

AQUIA.	"DEVONT"
LYDDA	"BAGSHOT"
CAIRO WEST	"STOCKYARD"
BEIRUT	"ECHELON"
MALBRANIA.	"CYCLOPS"
G H 3	"RAMPAGE"
ZERKA	"LARRY"

1 2



3.

1st leg. LOOP. BASE for T.M.G. to 33°

LOOP BEIRUT. Check on G/s. 33° to 34° 20'.

Cyprus leg.
Loop at Paphos check on G/s. to 33°40'
Loop on BALTIM. to check turning point.

3rd leg.
Loop BALTIM for Homing.

4th leg.
QDM. from GIANICLIS. for check on G/s.
Loop on Base to check turning point.

5th leg.
Loop from SHALLUFA for check on G/s.
Then later Loop Base & SHALLUFA for fix.
Loop on Base get Turning point. Then homing on to BASE.

BASE CAIRO.

Co 050 T TAS 150 kph.

1220 Loop BALTIM. 270° + 050 = 320 − 180 = 140.
270 + 052 = 322 47

1230 Loop BASE 091° + 050 = 057 + 180 = 237°
091 + 052 = 045 243

291/54. 30°35'N 32°40'E

1220 052 QC +5
30 41 N 32 18½ E
308/15 (13)

T. Port needles right True bearing.

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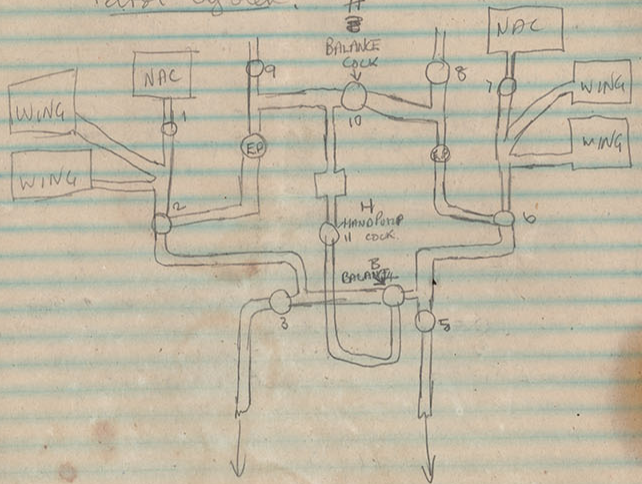
Astrograph.

Ensure that correct land fortune & latitude involved is used.
Select setting longe instal astrograph.
Line up chart.

Petrol System.



OVERLOADS

A/1134.

	W.O.P.			CREW.		
	G.P.	V/c	T.R.9.	G.P.	V/c	T.R.9.
A	W/T G.P.	—	—	—	V/c	T.R.9.
B	W/T G.P.	V/c	T.R.9.	—	V/c	T.R.9.
C	R/T W/T G.P.	V/c	T.R.9.	W/T R/T G.P.	V/c	T.R.9.

T.R.1196. used instead of T.R.9.
Emergency Codes with lights.
E/A. sighted series of A's.
Turn to Port = dots; abbrev to be taken on last dot.
Turn to STB = dashes " " a " " " dash.
at shooting down of E/A = XX. or all clear.
If gunner catches packet = NNN —

R stack landing.
P. for ditching.
L for baling out.
Length of trailing aerial 50 ft.

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$\frac{N-S}{2} = \frac{+4}{2} + 2. \quad \frac{-8-13}{2} = -11$

	L/C	A/C	DEV
N	360	356	+4
	090	098	-8
	180	180	-
	270	257	+13

		A			A.
N	+2	+2	= 0	0	-1
NE	+1	+2	= -1	+1	0
E	+3	+2	= +1	0	-1
SE	+1	+2	= -1	+1	0
S	+2	+2	= 0	+3	+2
SW	+1	+2	= -1	+1	0
W	+2	+2	= 0	+2	+1
NW	+1	+2	= -1	+1	0

$A = +\frac{13}{8}$ $\quad A = \frac{9}{8}$

MK 14 Bomb Sight.

Services.

1. Electricity. 12 or 24 volts to servo motors.
2. Suction 4½ inches of mercury to pitch & roll gyros.
3. Air pressure 5 lbs ☐ in for pneumatic servos.
4. Static vent for A S I & altimeter.
5. Pitot vent for A S I.
6. Course control D.R compass or manual.

Settings for Bombing.

Before flight.

1. Met wind speed.
2. Met wind direction
3. Bomb T.V
4. Target height against M S L press at Target.
5. Levelling scale for all up wt at target.

Approaching Target.

1. Bomb sight air cock on.
2. Computor switch on.
3. Graticule on.
4. Reset wind speed & direction & check course dial reading.

On Bombing Run.

If no D.R.C sgotem in A/c course

N-S +4

must be fed in to computator by any crew member ie NAV. give usual instructions to pilot to bring target down drift line release bombs when graticule covers target.

N.B. before releasing bombs perimeter collimator to return to neutral.

After Bombing

1. Graticule off
2. Computator off.
3. Air off.

in this order only.

BETLE 19-4-44 CAP ALPHARD.

17 56 50
115°12'
1 47
116°55' 7°24 N
27°58'
32
388 53
35 07
64°00'
3402 +33
13
3415
2543
10
2556
26 18
27T.
5 TH.

17 59 30
115°12'
2 23
117 35 4557
281°52'
399 27
34 33
74 00 360
162
48 24-58
24. 360
48 00 53
3256 307
18A
1 Lov.

18 03 50
117°42'
0 58 S
118°40' 8.25
218 47
334 27
34 33
12 00
198
48°00'
48 11
11T

18 52 42-20"+4hrs. 2252 22
2 44 T' CAP = 5 H.

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N-S = +4 +2. -8-13. -11 11

end of shot - 1° 33' 39"

25 secs fast

20-4-44

1130

06 43 10
28016
048
28104
3456 107
31600
4426 34
17
4443
44 32

06 56 02
28246
1 31
28417
3443
31900
4651 34
17
4708
4704

1130.

06 52 20
28246
035
28321
3439
31800
4603 34
17
4620
4621

05 51 41
s
05 55 45
5 34 25 end

06 01 55
35 47
106 09 30
109 37 27
06 13 11
38 11
16 50
38 05
19 54
39 33
23 10
40 15
27 15
41 04
32 00
42 08
35 46
42 45
40 08
5H43 41
44 35
44 37
53 45
46 01
57 21
47 04

110

2H 3H
18A 22A 9T 4T
2H 2H 11H
3T 7T 15A 27T
10L 1L
27T 13A 20A 7A
9L 9L
6A 1T 4A

1129°N'

05 50 16
26746
04
26750
3510
30300 98
3342+31
15
3357
3339

06 11 46
272/46
27
273 13
7447
30800 102
3152 32
10
3808
3811

06 25 50
27516
128
27644
3411
31110 104
4021 32
16
4037
4104

1129

05 54 20
26746
105
26851
3509
30400 99
3432+31
15
3447
3425

06 15 25
272/46
136
274 22
3438
30900 102
3842 32
16
3858
3865

06 31 35
27746
2H
27810
3450
31300 105
4200 32
16
4216
4208

1130

06 00 30
27046
08
27024
3436
30500 100
3522 31
16
3538
3547

06 18 29
272/46
207
274 53
3507
31000 103
3932 32
16
3948
3933

06 34 15
27746
1104
27860
3510
31400 106
4249 33
16
4305
4245

1130

06 08 05
27046
207
27217
3443
30800 101
3702 32
16
3718
3722

06 21 45
275 16
11
27527
3433
31000 103
3932 32
16
3948
4005

06 38 43
27746
211
27957
3503
31500 107
4338 33
16
43 54
43 47

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N-S = +4 +2. -8=13 " "

20 secs slow 24-4.

0500 23 } SH
27 07 }

0504 06 } SH
26 37 } 2
37

0507 16 } 2L
2612

0512 16 } 3H
2511

3H → 0516 18 24 38

2H 20 32 40
33 44

SH. 20 34 35
33 33

17 35 45
2190

SH 20 36 45
31 19

ARC 20 37 40
38 58

2H 20 41 20
58 48

20 43 15
32 34

N 1928

SIR.

14643
26350
3310
29700
32 41 86
33 49
6841

DUB 41

19456
31233
3422
34800
5858
10A

POL

ARC 17 38 00

11507
200
11707
3453
15200

1H

10 41 40 5848
11737
025
11762
3458
15300

2H.

POL 17 37 05 3119
34
3153

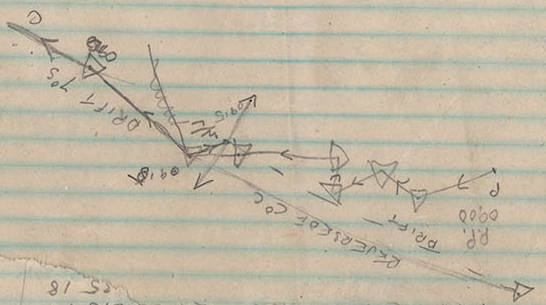
11507
147
11654
3443
15137

SH

N 0203
19456

10-4-44 SUN

-1 min +19 secs



Brit & Pan Amer Treaty

100's C	1000's H	C	M	C	
06 11 39	06 IV 09	06 30 46	06 36 38	06 38 36	
372 32		31502	27502	27702	
0		12	140	2	
			276 42	277 39	
			55 18	3491	

06 12 20 37 11
06 17 50 38 19
06 21 27 39 07
06 27 19 40 16
06 31 07 41 03
06 40 20 42 56
06 44 01 43 40
06 49 47 44 48
06 53 41 45 30
06 59 07 46 51

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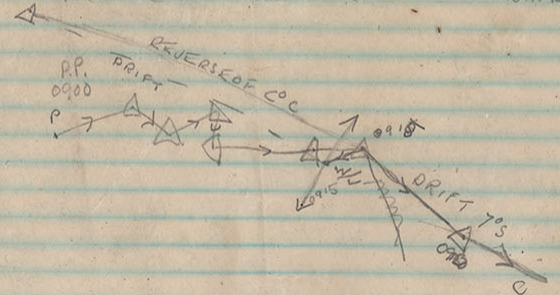
S/C	A/Compass	090°	34990 H
288°	290°		
303°	306°		
310°	313°		
329°	331°		
343°	345°		
	360°	N	
	017°		
044	043°		

	S.I.R.D.	A.C. Course
A/C	0.22	032°
	-11½	122

DRIFT & PIN LINE METHOD OF WIND FINDING



A-B : Courses flown.
at time of position line draw in Air pos'n A/C latest to course approx at right angles to pos'n line. from Air pos'n at time of pos'n line draw in reverse of this last course (at Rt Angle to pos'n line) for time flown at Air speed. from pos'n obtained draw off line representing drift, where this cuts pos'n line draw in line to A. Pos'n at time of pos'n line, this will be wind up to time of

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MARINE SEXTANT.

①. S.D.—. HT 2,500.

MOON 13/3/44. OBS ALT. 21°26' S.D.R.

~~T~~= 21°26'
D.R. -7
S.R. 0
P.A. +51
Dip. -49

19°39' ~ 20 15

POLARIS.

17.2.44.

17 24 36.
46°34'
1 09
47°43'
LONG E 36 04
LHA ~~11°39~~
83°47 Q = -33'

3205'
SD.R -5
S.C -3
Q= -33'
31° 24' ✓

22nd April. 3310E 3100N.

02 32 16 GMT.
24 32
0 34
GHA ♈ 24 06. 28°47'N
SHA. ☆ 358 38 2' Starboard of track
GHA ☆ 246 44'
3316 ✓ 31 00N INT 10 TOW.
LHA. 280 00
22 16
2236 ~~T~~ 069 TRUE 7 = 069° ✓

22°13'
SD.R -7
22°26'

4. STAR

	STAR	POLAR. 30N
	93 44	93 44
	1 16	2 16
3443	95 00	96 00

ASS PSNS. 3105 3102.

Dec 0°14'N

①	303 41	305 41	305 41	305 11
	1 15	1 24	2 18	0 45
GHA	304 26 C	307 05	307 59	308 56
LONG+	34 34 32N	34 55	35 01	35 04
LHA	339 00	342 00	343 00	344 00
	52 21 + 52	53 46 54	54 12	54 37 55
	12 144	13 148	13 54	13 152.
	52 33	53 59	54 25 150	54 50
	52 45	54 04	54 36	54 51
	12 TOW	6 TOW	1 TOW	1 TOW.
	4 low	2 low	3 low	3 low.
32041	318 11	318 11		32041
205	0 02	1 27		044
32246	318 13.	319 38		32123
3414	3447	3422		3437
35700	174 353 00	35400		35600
5753		5731 169		5747 172
15				15
5808	57 20 167	14		5802
5824	14	5745.		5819
16 T.	5734.	5801		17
	57 48 T.	16 TOW.		Nil Error
1 low.	13 TOW.			
	~~22~~ high	4 low		
	8 low			
	2			

S—N

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① PERPENDICULAR ERROR. Mirror corkayed.
Not experienced

② SIDE ERROR
~~Mirror~~ Displacement of Prisme bubble chamber offset.

③ INDEX ERROR.
ERRORS IN MECHANISM.

④ SHADE ERROR.
Dirty or bad shade causes refraction.

⑤ WEAR & TEAR.
Old age.

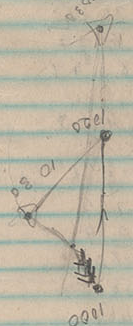
⑥ PERSONAL ERROR.

Sight REFRACTION. TABLE "A" applies to us.

DOME REFRACTION.
SEMI DIAMETER. Sun & Moon
DIP
PARALLAX IN ALTITUDE.

CORRECTIONS.

HT OBSERVED
± SEXTANT CORRN
−DIP
− REFRACTION
− DOME REFRACTION
± S. DIAMETER.
+ PINA
± O CRN
= CALCULATED ALT.



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N-S +4 a

WATCH READING 215806 10 secs fast = 215756.

GHA ☉ 82°43'
2 00
GHA ☉ 84°43' 215756
SHA ✱ 281°52' Dec N 45°57'
GHA ✱ 366 35
Long E 34 25 Lat 32 N.
LHA 41 00
Hc 55°41' AZ 054°
Ho 55 21 TR AZ = 306°
INT. 20' AWAY.

CAPELLA Hs 55°25'
D.R-4' = 55°21'
Ho = 55°21'

31 45. N
34 42 E

W.R. 23 41 11. + 10 23 41 01

346 44. N 20 00 6706.
0 15 + 21.
GHA ☉ 346. 59 - 3
Long 35 01 6724
LHA 382 00 360
022 00 AZ 111
~~77 52~~ 460 T.A ~~184~~
66 57 116
67 24 244°
27 AWAY 5½ high.

METRIC MEASURES

Kilo-	Hecto-	Deka-	Gramme (g)	Deci-	Centi-	Milli-
(1,000)	(100)	(10)	Metre (m)	1/10	1/100	1/1,000
Kg. Km. Kl.	Hg. Hm. Hl.	Dg. Dm. Dl.	Litre (l)	dg. dm. dl.	cg. cm. cl.	mg. mm. ml.

(*Note.*—dm. with a small "d" is a *deci*metre = 1/10 of a metre.
Dm. with a capital "D" is a *Deca*metre = 10 metres.)

There are certain connections between the metric system and the British measures.
(They are only approximate.)

1 cm. = rather less than 2/5 in.
1 m. = 39·37 ins. (rather more than a yd.)
1 g. (·032 oz.) is the weight of 1 cc. of water.
1 cu. ft. of water = 6¼ galls. (approx.)

1 KM. = 5/8 mile or 5 furlongs.
1 l. = 1¾ pt. (rather less than 1 quart).
1 Kg. = 2⅕ lb.
1 Hl. = 22 galls. (approx.)

WEIGHT

16 ounces (*oz.*) = 1 pound (*lb.*)
14 lb. = 1 stone
28 lb. = 1 quarter (*qr.*)
4 qrs. or 112 lb. = 1 hundredweight (*cwt.*)
20 cwt. or 2240 lb. or 160 stone = 1 ton
(Meat—14 lb. live: 8 lb. dead = 1 stone)

INDIAN WEIGHT

5 Tolas = 1 Chittack (2 oz. approx.)
16 Chittacks = 1 Seer (2 lb. approx.)
40 Seer = 1 Maund (80 lb. approx.)

LENGTH

12 inches (*in.*) = 1 foot (*ft.*)
3 ft. = 1 yard (*yd.*)
22 yds. = 1 chain (*ch.*) (length of cricket pitch).
10 chs. or 220 yds. = 1 furlong (*fur.*)
8 fur. or 1760 yds. or 5280 ft. or 63360 ins. = 1 mile.
3 miles = 1 league.
6 ft. = 1 fathom.
1 nautical mile = 2026⅔ yds.
1 cable's length = 1/10 nautical mile (taken as 200 yds.)

LIQUID MEASURE

4 gills = 1 pint (*pt.*)
2 pts. = 1 quart (*qt.*) (it is a *quarter* of a gallon).
4 qts. = 1 gallon (*gall.*)
36 galls. (beer) = 1 barrel.

DRY MEASURE

(Corn, etc.)

2 galls. = 1 peck (*pk.*)
4 pks. = 1 bushel (*bush.*)
8 bush. = 1 quarter (2 sacks).
1 bush. (oats) weighs 40 lbs. (average)
1 ,, (barley) ,, 50 lbs. ,,
1 ,, (wheat) ,, 60 lbs. ,,
1 sack flour weighs 280 lb. (approx.)

SQUARE OR AREA MEASURE

(used to measure surfaces)

144 sq. in. = 1 sq. ft.
9 sq. ft. = 1 sq. yd.
484 sq. yd. = 1 sq. ch.
1210 sq. yd. = 1 rood.
4840 sq. yd. or 4 roods or 10 sq. ch. = 1 acre.
640 acres = 1 sq. mile.

(*N.B.*—Six square feet must not be confused with six feet square.)

1 Hectare (*Ha.*) = 100 ares = 2½ acres (approx.)
100 Ha. = 1 Sq. Km.

A football pitch is 1¾ acres (approx.)

To measure the surface of a rectangular shape it is necessary to multiply length by breadth (*expressed in the same unit*).

CUBIC MEASURE

(used to measure solids or volumes).

1728 cubic inches = 1 cu. foot.
27 cu. ft. = 1 cu. yard.
128 cu. ft. (a heap approx. 6′ × 4′ × 5′) = 1 cord of wood.

To measure the volume of a solid it is necessary to multiply together length and breadth and thickness (*expressed in the same unit*).

TROY WEIGHT

(For Gold, Silver and Jewels)

24 Grains = 1 Pennyweight (*dwt.*)
20 Pennyweights = 1 ounce (*oz.*)
12 ounces = 1 Pound (*lb.*)

MONEY

12 pence = 1 shilling (1/-).
100 pence = 8/4.
240 pence = 1 pound (£1).
1000 pence = £4.3.4.
10/- = ½£ or ·5 of £1.
5/- (crown) = ¼ or ·25 of £1.
4/- = ⅕ or ·2 of £1.
2/6 (half a crown) = ⅛ or ·125 of £1.
2/- (florin) = 1/10 or ·1 of £1.
1/4 = 1/15 or ·06 of £1.
1/3 = 1/16 or ·0625 of £1.
1/- = 1/20 or ·05 of £1.
6d. = 1/40 or ·025 of £1.

To convert shillings to decimal of £ *multiply* by 5 and *divide* by 100.
To convert decimal of £ to shillings *divide* by 5 and *multiply* by 100.

French 100 centimes = 1 franc (124·25 to the £ roughly)
American 100 cents = 1 dollar (4·86 to the £ roughly)
Indian: 3 Pies = 1 Pice. 12 Pies or 4 Pice = 1 Anna. 16 Annas = 1 Rupee (= 1/6).
German 100 Pfennige = 1 Mark (20·43 to the £ roughly)

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