THE HANDBOOK

OF THE

BRITISH ASTRONOMICAL ASSOCIATION

1960

1959 NOVEMBER

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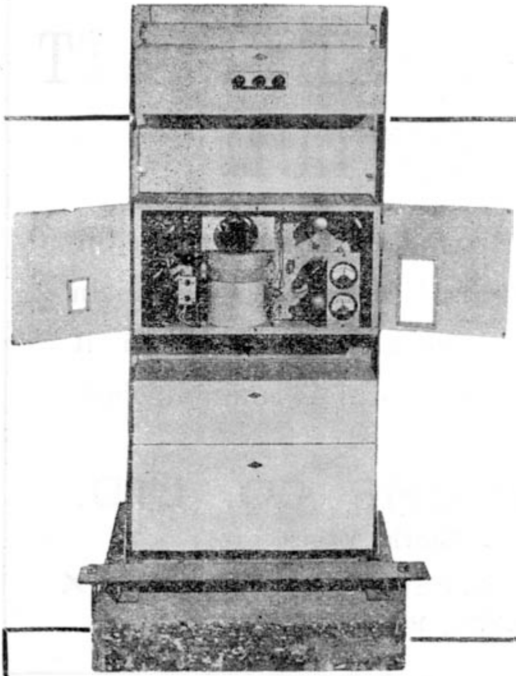
CONTENTS



British Astronomical Association

HANDBOOK FOR 1960

THIRTY-NINTH YEAR OF PUBLICATION

PREFACE

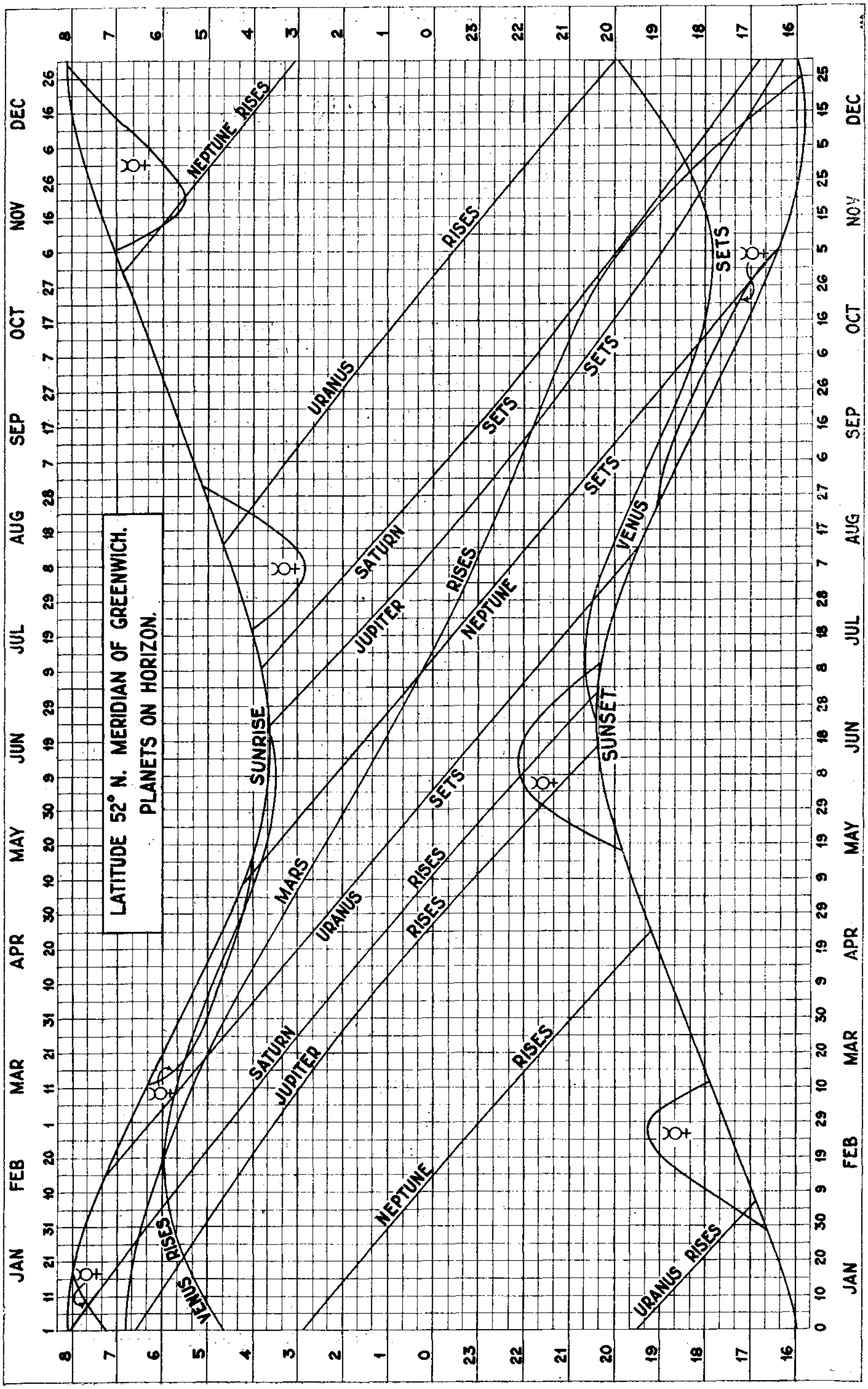
The unification of the *Nautical Almanac* and the *American Ephemeris* as from 1960 under the new title of the *Astronomical Ephemeris* has involved certain changes in the preparation and production of the *Handbook.* In particular, occultation predictions will no longer be given in the *Ephemeris*, although they will still be computed in the Nautical Almanac Office; and it has been agreed that the *Handbook* will in future be responsible for the publication of the predictions for the eight stations in Great Britain, South Africa, Australia and New Zealand.

Preparation of much of the remaining material in this issue has been organized by W. H. Julian and G. E. Taylor, and the names of contributors of cometary orbits are given under the individual comets. Ephemerides have been computed by D. A. Appleby, G. R. Alexander, T. P. Egerton, A. E. Ellin, G. Lea, S. Milbourn and B. O. Wheel. The diagrams have been prepared by A. K. Appleton, L. A. Carter, Mrs. J. G. Porter and S. H. C. Williams. Dr. R. H. Garstang has contributed the tables of Nearest and Brightest Stars as well as the ephemerides of Double Stars. The Meteor Diary has been provided by H. B. Ridley and the phenomena of Jupiter's Satellites by J. K. Openshaw. Other contributions have been made by C. M. Christison, H. B. Davey, G. P. Gilbert, R. E. Jerome, J. Kosniowski, B. G. Marsden and Mrs. D. Reynolds.

The thanks of the Association are due to all these members of the Computing Section and others who have assisted in the publication of the *Handbook.* Acknowledgements are also made to the Astronomer Royal and the Superintendent of the Nautical Almanac Office for advance information, and to Dr. Liisi Oterma, Dr. S. G. Makover, Dr. E. Rabe and Dr. Julie Vinter Hansen for the results of their cometary work. The astronomical data relating to the Sun Moon and planets are derived from the *Astronomical Ephemeris*, and are reproduced by permission of the Controller of H.M. Stationery Office.

J. G. PORTER
Director, Computing Section

HAILSHAM
SUSSEX


LATITUDE 52° N. MERIDIAN OF GREENWICH.
PLANETS ON HORIZON.
SUNRISE
SUNSET
NEPTUNE RISES
URANUS RISES
SATURN
JUPITER
MARS
VENUS
NEPTUNE
URANUS
RISES
SETS
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

VISIBILITY OF PLANETS

The diagram on the opposite page shows the times for the actual rising and setting of the Sun and planets.

Since dates change at midnight, the dates at the top of the diagram differ by one day from those at the foot; each vertical line followed upwards represents the succession of phenomena in the course of one night. The name of the planet is always written on the side of the curve on which observation is possible. Thus on the night of February 19–20, Mercury sets at $18^h\ 56^m$ and Neptune rises at $23^h\ 40^m$. Uranus is visible all night, setting just before sunrise. Jupiter rises at $4^h\ 05^m$, and Saturn at $5^h\ 08^m$, while Venus and Mars rise together at $5^h\ 58^m$.

The diagram has been drawn for a place on the meridian of Greenwich in latitude + 52°, but may be adapted for any place in the British Isles by applying two corrections as follows—

(1) *Add* the longitude, expressed in time measure, if *west* of Greenwich and *subtract* if *east*; this applies to both rising and setting times.

(2) *Add* the correction from the following table for *setting* times, and *subtract* this correction for *rising*.

Thus rising time = time from diagram ± longitude − correction.
setting time = time from diagram ± longitude + correction.

Example: Glasgow, $0^h\ 17^m$ W., 55° 53′ N. Date: June 12.

Mars rises at $01^h\ 20^m$ from the diagram.

Dec. of Mars (p. 28) = + 8°. Correction: $-\ 7^m$.

Mars rises at Glasgow at $01^h\ 20^m + 17^m + (-\ 7^m) = 01^h\ 30^m$.

CORRECTION TABLE

Dec. \ Lat. N.	50°	51°	52°	53°	54°	55°	56°	57°	58°
	m	m	m	m	m	m	m	m	m
+ 24°	− 12	− 6	0	+ 6	+ 12	+ 19	+ 27	+ 35	+ 44
+ 20	8	4	0	5	10	15	21	27	33
+ 16	6	3	0	3	7	11	15	20	24
+ 12	5	3	0	2	5	8	11	14	17
+ 8	3	− 2	0	2	4	5	7	9	11
+ 4	− 1	0	0	+ 1	+ 2	+ 3	+ 4	+ 5	+ 6
0	0	0	0	0	0	0	0	0	0
− 4	+ 1	0	0	− 1	− 2	− 3	− 4	− 4	− 5
− 8	2	+ 1	0	2	3	5	7	8	10
− 12	4	2	0	2	5	7	10	13	16
− 16	6	3	0	3	6	10	14	18	22
− 20	8	4	0	4	9	14	19	24	30
− 24	+ 11	+ 6	0	− 5	− 11	− 18	− 25	− 32	− 40

ECLIPSES, 1960

In 1960 there will be four eclipses, two of the Sun and two of the Moon. There are no penumbral lunar eclipses during the year.

1. *Total eclipse of the Moon*, March 13, invisible at Greenwich, but visible in New Zealand and generally in Australia.

	h m		h m
Moon enters penumbra	5 33·7	leaves	11 21·6
Moon enters umbra	6 37·8	leaves	10 17·7
Total eclipse begins	7 40·4	ends	9 15·1
Middle of eclipse	8 27·7	magnitude	1·520
First contact of umbra	$P = 97°$	last contact	$P = 298°$

2. *Partial eclipse of the Sun*, March 27, invisible at Greenwich, but visible generally in Australia and Antarctica. Maximum magnitude 0·705.

	Mag.	*Begins* h m	*P* °	*Middle* h m	*Ends* h m	*P* °
Melbourne	0·39	7 37	216	..	..	..
Perth	0·26	7 35	200	8 28	9 17	118
Sydney	0·11	7 48	210	..	..	..

At Melbourne and Sydney the Sun sets before the time of greatest phase; the magnitude given is that at sunset. This eclipse, which occurs at the Moon's descending node, belongs to a series which began in 1653, and which will become annular in 2014.

3. *Total eclipse of the Moon*, September 5, invisible at Greenwich, but visible in New Zealand and partly in Australia.

	h m		h m
Moon enters penumbra	8 36·4	leaves	14 06·1
Moon enters umbra	9 35·5	leaves	13 06·9
Total eclipse begins	10 37·5	ends	12 05·0
Middle of eclipse	11 21·2	magnitude	1·431
First contact of umbra	$P = 87°$	last contact	$P = 239°$

4. *Partial eclipse of the Sun*, September 20–21, invisible at Greenwich, but visible generally in North America and eastern Siberia, the maximum magnitude being 0·614.

This is the sixth eclipse of a series which began in 1870, and which will become annular in 2086.

TRANSIT OF MERCURY

There will be a transit of Mercury over the Sun's disk on November, 7 the ingress being visible at Greenwich. For details see page 25.

THE SUN

The tables on pages 6 and 7 give the values, **at mean noon** and at four-day intervals, of certain quantities which may be used in observations of the Sun.

The last three columns give

P = the position angle of the N. end of the axis of rotation, + if east of the north point of the disk, – if west.

B_0 = the heliographic latitude of the centre of the disk.

L_0 = the heliographic longitude of the centre of the disk.

The values of P and B_0 at any other time may be interpolated directly from the main table, while the value of L_0 may be obtained by use of the critical table below, bearing in mind the fact that L_0 *decreases* with time. The rate of decrease may be assumed to be 13°·2 per day, and although this is not strictly true, the resultant error should amount to less than 0°·2, which is less than the possible errors of measurement. Hence to obtain the value of L_0 at any other time, add 13°·2 for each day before, and subtract 13°·2 for each day after a date in the main table. Similarly add the appropriate angle from the critical table if before noon, and subtract if after noon.

Variation of L_0 with Time

h m	°	h m	°	h m	°	h m	°
0 00		1 43		3 32		5 21	
	0·0		1·0		2·0		3·0
05		54		43		32	
	0·1		1·1		2·1		3·1
16		2 05		54		43	
	0·2		1·2		2·2		3·2
27		16		4 05		54	
	0·3		1·3		2·3		3·3
38		27		16		6 05	
	0·4		1·4		2·4		3·4
49		38		27		16	
	0·5		1·5		2·5		3·5
1 00		49		38		27	
	0·6		1·6		2·6		3·6
10		3 00		49		38	
	0·7		1·7		2·7		3·7
21		10		5 00		49	
	0·8		1·8		2·8		3·8
32		21		10		7 00	
	0·9		1·9		2·9		3·9
43		32		21		10	
	1·0		2·0		3·0		4·0
1 54		3 43		5 32		7 21	

In critical cases ascend

The heliographic longitude and latitude of a spot may be conveniently estimated by the method described in *Journal*, 53, 63, 1943.

The dates of commencement of the synodic rotations, in continuation of Carrington's (Greenwich Photo-Heliographic) series, are as follows:—

Rotation No.	Commences	d	Rotation No.	Commences	d
1423	Jan.	19·40	1430	July	28·23
1424	Feb.	15·75	1431	Aug.	24·46
1425	Mar.	14·07	1432	Sept.	20·72
1426	Apr.	10·37	1433	Oct.	18·01
1427	May	7·62	1434	Nov.	14·31
1428	June	3·83	1435	Dec.	11·63
1429	July	1·03			

The sidereal period of rotation of the Sun used in physical ephemerides is 25·38 mean solar days, after Carrington; the mean synodic rotation period is $27^{d}\cdot2753$.

The Sun at *Noon*

Date	R.A.		Dec.	Diam.	Transit	P	B_0	L_0
	h m		° ′	′ ″	h m	°	°	°
Jan. 1	18 43·9	17·6	− 23 03	32 35	12 03·3	+ 2·2	− 3·0	235·8
5	19 01·5	17·5	22 41	35	05·1	+ 0·3	3·5	183·1
9	19 19·0	17·4	22 12	35	06·9	− 1·6	3·9	130·4
13	19 36·4	17·2	21 36	35	08·5	3·5	4·4	77·7
17	19 53·6	17·0	20 53	34	09·9	5·4	4·8	25·1
21	20 10·6	16·9	− 20 03	32 34	12 11·2	− 7·3	− 5·1	332·4
25	20 27·5	16·6	19 08	33	12·2	9·1	5·5	279·7
29	20 44·1	16·4	18 07	32	13·1	10·8	5·8	227·1
Feb. 2	21 00·5	16·2	17 01	31	13·7	12·5	6·1	174·4
6	21 16·7	15·9	15 50	29	14·1	14·0	6·4	121·7
10	21 32·6	15·8	− 14 34	32 28	12 14·3	− 15·5	− 6·6	69·1
14	21 48·4	15·5	13 15	27	14·3	17·0	6·8	16·4
18	22 03·9	15·4	11 53	25	14·1	18·3	7·0	323·7
22	22 19·3	15·2	10 27	23	13·7	19·6	7·1	271·1
26	22 34·5	15·1	8 59	21	13·1	20·7	7·2	218·4
Mar. 1	22 49·6	14·9	− 7 28	32 20	12 12·4	− 21·7	− 7·2	165·7
5	23 04·5	14·8	5 56	18	11·6	22·7	7·2	113·0
9	23 19·3	14·7	4 23	16	10·6	23·5	7·2	60·3
13	23 34·0	14·6	2 49	14	09·5	24·3	7·2	7·6
17	23 48·6	14·6	− 1 14	11	08·4	24·9	7·1	314·8
21	0 03·2	14·6	+ 0 21	32 09	12 07·2	− 25·4	− 7·0	262·1
25	0 17·8	14·5	1 56	07	06·0	25·8	6·8	209·4
29	0 32·3	14·6	3 29	05	04·8	26·1	6·6	156·6
Apr. 2	0 46·9	14·6	5 02	03	03·6	26·3	6·4	103·8
6	1 01·5	14·7	6 34	32 00	02·4	26·4	6·2	51·1
10	1 16·2	14·7	+ 8 03	31 58	12 01·3	− 26·3	− 5·9	358·3
14	1 30·9	14·8	9 31	56	12 00·3	26·1	5·6	305·4
18	1 45·7	15·0	10 55	54	11 59·3	25·8	5·3	252·6
22	2 00·7	15·0	12 17	52	58·5	25·4	4·9	199·8
26	2 15·7	15·2	13 36	50	57·8	24·9	4·6	146·9
30	2 30·9	15·3	+ 14 51	31 48	11 57·2	− 24·3	− 4·2	94·1
May 4	2 46·2	15·5	16 03	46	56·7	23·5	3·7	41·2
8	3 01·7	15·6	17 10	44	56·4	22·7	3·3	348·3
12	3 17·3	15·8	18 12	42	56·3	21·7	2·9	295·4
16	3 33·1	15·9	19 10	41	56·3	20·6	2·4	242·5
20	3 49·0	16·1	+ 20 02	31 39	11 56·4	− 19·4	− 2·0	189·6
24	4 05·1	16·2	20 49	38	56·7	18·1	1·5	136·7
28	4 21·3	16·3	21 30	36	57·2	16·7	1·0	83·8
June 1	4 37·6	16·5	22 05	35	57·7	15·3	0·5	30·8
5	4 54·1	16·5	22 35	34	58·4	13·7	− 0·1	337·9
9	5 10·6	16·5	+ 22 57	31 34	11 59·1	− 12·1	+ 0·4	285·0
13	5 27·1	16·7	23 14	33	11 59·9	10·4	0·9	232·0
17	5 43·8	16·6	23 23	32	12 00·8	8·7	1·4	179·1
21	6 00·4	16·6	23 26	31	01·7	7·0	1·9	126·1
25	6 17·0	16·6	23 23	31	02·5	5·2	2·3	73·2
29	6 33·6	16·6	+ 23 13	31 31	12 03·4	− 3·4	+ 2·8	20·2

The Sun at *Noon*

Date	R.A.		Dec.	Diam.	Transit	*P*	B_0	L_0
	h m		° ′	′ ″	h m	°	°	°
July 3	6 50·2	16·4	+ 22 56	31 31	12 04·1	− 1·6	+ 3·2	327·3
7	7 06·6	16·4	22 33	31	04·8	+ 0·3	3·6	274·3
11	7 23·0	16·2	22 04	31	05·4	2·1	4·0	221·4
15	7 39·2	16·1	21 29	31	05·9	3·9	4·4	168·5
19	7 55·3	16·0	20 48	32	06·2	5·6	4·8	115·5
23	8 11·3	15·8	+ 20 01	31 32	12 06·4	+ 7·3	+ 5·2	62·6
27	8 27·1	15·6	19 09	33	06·4	9·0	5·5	9·7
31	8 42·7	15·5	18 12	34	06·3	10·7	5·8	316·8
Aug. 4	8 58·2	15·3	17 10	35	06·0	12·2	6·1	263·9
8	9 13·5	15·2	16 04	36	05·5	13·7	6·3	211·0
12	9 28·7	15·0	+ 14 54	31 37	12 04·9	+ 15·2	+ 6·5	158·1
16	9 43·7	14·9	13 39	39	04·2	16·6	6·7	105·3
20	9 58·6	14·7	12 22	40	03·3	17·9	6·9	52·4
24	10 13·3	14·7	11 01	42	02·3	19·1	7·0	359·5
28	10 28·0	14·5	9 37	43	12 01·1	20·2	7·1	306·7
Sept. 1	10 42·5	14·5	+ 8 11	31 45	11 59·9	+ 21·3	+ 7·2	253·8
5	10 57·0	14·4	6 43	47	58·6	22·2	7·2	201·0
9	11 11·4	14·4	5 13	49	57·2	23·1	7·2	148·2
13	11 25·8	14·3	3 42	51	55·8	23·9	7·2	95·4
17	11 40·1	14·4	2 09	53	54·4	24·5	7·2	42·6
21	11 54·5	14·3	+ 0 36	31 55	11 53·0	+ 25·1	+ 7·1	349·8
25	12 08·8	14·5	− 0 57	31 57	51·6	25·6	6·9	297·0
29	12 23·3	14·5	2 31	32 00	50·3	25·9	6·8	244·2
Oct. 3	12 37·8	14·5	4 04	02	49·0	26·2	6·6	191·4
7	12 52·3	14·7	5 36	04	47·8	26·3	6·3	138·6
11	13 07·0	14·8	− 7 07	32 06	11 46·7	+ 26·4	+ 6·1	85·9
15	13 21·8	15·0	8 37	08	45·8	26·3	5·8	33·1
19	13 36·8	15·2	10 05	11	45·0	26·0	5·5	340·3
23	13 52·0	15·3	11 30	13	44·4	25·7	5·1	287·6
27	14 07·3	15·5	12 53	15	43·9	25·2	4·8	234·8
31	14 22·8	15·7	− 14 12	32 17	11 43·6	+ 24·6	+ 4·4	182·1
Nov. 4	14 38·5	16·0	15 28	19	43·6	23·9	4·0	129·3
8	14 54·5	16·2	16 39	21	43·8	23·1	3·5	76·6
12	15 10·7	16·4	17 46	23	44·2	22·1	3·1	23·9
16	15 27·1	16·6	18 48	24	44·8	21·0	2·6	331·1
20	15 43·7	16·8	− 19 45	32 26	11 45·7	+ 19·8	+ 2·1	278·4
24	16 00·5	17·1	20 36	28	46·8	18·5	1·6	225·7
28	16 17·6	17·2	21 21	29	48·0	17·1	1·1	173·0
Dec. 2	16 34·8	17·4	22 00	30	49·5	15·5	0·6	120·3
6	16 52·2	17·5	22 32	31	51·1	13·9	+ 0·1	67·6
10	17 09·7	17·7	− 22 56	32 32	11 52·9	+ 12·2	− 0·4	14·8
14	17 27·4	17·7	23 14	33	54·8	10·4	0·9	322·1
18	17 45·1	17·8	23 24	34	56·7	8·6	1·4	269·4
22	18 02·9	17·7	23 26	34	11 58·7	6·7	1·9	216·7
26	18 20·6	17·8	23 21	35	12 00·7	4·8	2·4	164·1
30	18 38·4		− 23 09	32 35	12 02·7	+ 2·9	− 2·9	111·4

TIME RECKONING

Universal Time (U.T., Greenwich Mean Time beginning at midnight) is used generally throughout the *Handbook*.

Ephemeris Time (E.T.) is the uniform time system which is used only in computing practice; in this system Newcomb's tables of the Sun agree with observation. E.T. is not subject to the fluctuations due to the variable rotation of the Earth, so that it is ahead of U.T. by a small amount ΔT which must be determined by observations; thus

$$\text{E.T.} = \text{U.T.} + \Delta T$$

The value of ΔT for 1960 is estimated to be about 35 seconds, but for the purposes of this *Handbook* the difference may be ignored.

Greenwich Mean Astronomical Time (G.M.A.T.) or Greenwich Mean Time beginning at noon, was in use before 1925 January 1, and all astronomical records prior to that date must be understood to refer to this system. This method of reckoning time has the advantage of avoiding the change of date at midnight, and is therefore used by observers of planets, meteors, etc. To convert U.T. to G.M.A.T., subtract twelve hours, and to convert G.M.A.T. to U.T. add twelve hours.

Sidereal Time is given in the table on the opposite page for every fourth day at noon. It may be obtained with sufficient accuracy for setting the circles of a telescope at any other time by adding $3^{m}.9$ for every complete day after a tabulated date, together with the correction for parts of a day from the critical table which follows:

h	m	m	h	m	m	h	m	m	h	m	m
0	00·0		5	46·9		11	52·2		17	57·4	
		0·0			1·0			2·0			3·0
0	18·2		6	23·5		12	28·7		18	33·9	
		0·1			1·1			2·1			3·1
0	54·7		7	00·0		13	05·2		19	10·5	
		0·2			1·2			2·2			3·2
1	31·3		7	36·5		13	41·7		19	47·0	
		0·3			1·3			2·3			3·3
2	07·8		8	13·0		14	18·3		20	23·5	
		0·4			1·4			2·4			3·4
2	44·3		8	49·6		14	54·8		21	00·0	
		0·5			1·5			2·5			3·5
3	20·8		9	26·1		15	31·3		21	36·6	
		0·6			1·6			2·6			3·6
3	57·4		10	02·6		16	07·8		22	13·1	
		0·7			1·7			2·7			3·7
4	33·9		10	39·1		16	44·4		22	49·6	
		0·8			1·8			2·8			3·8
5	10·4		11	15·6		17	20·9		23	26·1	
		0·9			1·9			2·9			3·9
5	46·9		11	52·2		17	57·4		24	02·7	
		1·0			2·0			3·0			4·0
6	23·5		12	28·7		18	33·9		24	39·2	

In critical cases ascend

The Julian Date, in which the day begins at noon, is used in accurate computing work. It is given in the table opposite for every fourth day, and is expressed at any other time as a decimal quantity.

The Sun's True Longitude is used as a measure of time in meteor work. It may be interpolated from the table on the opposite page.

Time Reckoning

Date	Julian Date	Sidereal Time	Sun's Long. 1950·0	
	243	h m	°	
Jan. 1·5	6935	18 40·6	279·95	4·08
5·5	6939	18 56·4	284·03	4·07
9·5	6943	19 12·2	288·10	4·08
13·5	6947	19 27·9	292·18	4·07
17·5	6951	19 43·7	296·25	4·07
21·5	6955	19 59·5	300·32	4·07
25·5	6959	20 15·2	304·39	4·07
29·5	6963	20 31·0	308·46	4·06
Feb. 2·5	6967	20 46·8	312·52	4·06
6·5	6971	21 02·5	316·58	4·05
10·5	6975	21 18·3	320·63	4·04
14·5	6979	21 34·1	324·67	4·04
18·5	6983	21 49·8	328·71	4·03
22·5	6987	22 05·6	332·74	4·03
26·5	6991	22 21·4	336·77	4·02
Mar. 1·5	6995	22 37·2	340·79	4·01
5·5	6999	22 52·9	344·80	4·00
9·5	7003	23 08·7	348·80	3·99
13·5	7007	23 24·5	352·79	3·98
17·5	7011	23 40·2	356·77	3·97
21·5	7015	23 56·0	0·74	3·97
25·5	7019	0 11·8	4·71	3·96
29·5	7023	0 27·6	8·67	3·95
Apr. 2·5	7027	0 43·3	12·62	3·94
6·5	7031	0 59·1	16·56	3·92
10·5	7035	1 14·9	20·48	3·92
14·5	7039	1 30·6	24·40	3·91
18·5	7043	1 46·4	28·31	3·90
22·5	7047	2 02·2	32·21	3·90
26·5	7051	2 17·9	36·11	3·89
30·5	7055	2 33·7	40·00	3·88
May 4·5	7059	2 49·5	43·88	3·87
8·5	7063	3 05·3	47·75	3·86
12·5	7067	3 21·0	51·61	3·86
16·5	7071	3 36·8	55·47	3·85
20·5	7075	3 52·6	59·32	3·84
24·5	7079	4 08·3	63·16	3·84
28·5	7083	4 24·1	67·00	3·84
June 1·5	7087	4 39·9	70·84	3·83
5·5	7091	4 55·7	74·67	3·82
9·5	7095	5 11·4	78·49	3·82
13·5	7099	5 27·2	82·31	3·82
17·5	7103	5 43·0	86·13	3·82
21·5	7107	5 58·7	89·95	3·82
25·5	7111	6 14·5	93·77	3·81
29·5	7115	6 30·3	97·58	3·82

Date	Julian Date	Sidereal Time	Sun's Long. 1950·0	
	243	h m	°	
July 3·5	7119	6 46·0	101·40	3·81
7·5	7123	7 01·8	105·21	3·81
11·5	7127	7 17·6	109·02	3·81
15·5	7131	7 33·4	112·83	3·82
19·5	7135	7 49·1	116·65	3·82
23·5	7139	8 04·9	120·47	3·82
27·5	7143	8 20·7	124·29	3·83
31·5	7147	8 36·4	128·12	3·83
Aug. 4·5	7151	8 52·2	131·95	3·83
8·5	7155	9 08·0	135·78	3·83
12·5	7159	9 23·7	139·61	3·85
16·5	7163	9 39·5	143·46	3·85
20·5	7167	9 55·3	147·31	3·85
24·5	7171	10 11·1	151·16	3·86
28·5	7175	10 26·8	155·02	3·87
Sept. 1·5	7179	10 42·6	158·89	3·88
5·5	7183	10 58·4	162·77	3·88
9·5	7187	11 14·1	166·65	3·89
13·5	7191	11 29·9	170·54	3·90
17·5	7195	11 45·7	174·44	3·91
21·5	7199	12 01·5	178·35	3·92
25·5	7203	12 17·2	182·27	3·92
29·5	7207	12 33·0	186·19	3·94
Oct. 3·5	7211	12 48·8	190·13	3·94
7·5	7215	13 04·5	194·07	3·95
11·5	7219	13 20·3	198·02	3·96
15·5	7223	13 36·1	201·98	3·98
19·5	7227	13 51·8	205·96	3·98
23·5	7231	14 07·6	209·94	3·99
27·5	7235	14 23·4	213·93	3·99
31·5	7239	14 39·2	217·92	4·01
Nov. 4·5	7243	14 54·9	221·93	4·01
8·5	7247	15 10·7	225·94	4·02
12·5	7251	15 26·4	229·96	4·03
16·5	7255	15 42·2	233·99	4·04
20·5	7259	15 58·0	238·03	4·04
24·5	7263	16 13·8	242·07	4·05
28·5	7267	16 29·6	246·12	4·06
Dec. 2·5	7271	16 45·3	250·18	4·06
6·5	7275	17 01·1	254·24	4·06
10·5	7279	17 16·9	258·30	4·07
14·5	7283	17 32·6	262·37	4·07
18·5	7287	17 48·4	266·44	4·07
22·5	7291	18 04·2	270·51	4·08
26·5	7295	18 19·9	274·59	4·08
30·5	7299	18 35·7	278·67	

EARTH

Perihelion Jan. 4 (91,400,000 miles); Aphelion July 2 (94,600,000 miles).

Spring Equinox	Mar.	20^d	15^h	Summer Solstice	June	21^d	10^h
Autumn Equinox	Sept.	23	01	Winter Solstice	Dec.	21	20

Obliquity of the Ecliptic

	1959·0	**1960·0**	1961·0
ϵ	23° 26′ 40″·62	**23° 26′ 40″·15**	23° 26′ 39″·68
sin ϵ	0·397 8624	**0·397 8603**	0·397 8583
cos ϵ	0·917 4451	**0·917 4460**	0·917 4469
log sin ϵ	9·599 7329	**9·599 7307**	9·599 7284
log cos ϵ	9·962 5801	**9·962 5805**	9·962 5809

PHASES OF THE MOON

Lunation	New Moon				First Quarter				Full Moon				Last Quarter			
		d	h	m		d	h	m		d	h	m		d	h	m
458	Dec.	29	19	09	Jan.	5	18	53	Jan.	13	23	51	Jan.	21	15	00
459	Jan.	28	06	15	Feb.	4	14	26	Feb.	12	17	24	Feb.	19	23	47
460	Feb.	26	18	23	Mar.	5	11	06	Mar.	13	08	26	Mar.	20	06	40
461	Mar.	27	07	37	Apr.	4	07	04	Apr.	11	20	27	Apr.	18	12	57
462	Apr.	25	21	44	May	4	01	00	May	11	05	42	May	17	19	54
463	May	25	12	26	June	2	16	01	June	9	13	02	June	16	04	35
464	June	24	03	27	July	2	03	48	July	8	19	37	July	15	15	43
465	July	23	18	31	July	31	12	38	Aug.	7	02	41	Aug.	14	05	37
466	Aug.	22	09	15	Aug.	29	19	22	Sept.	5	11	19	Sept.	12	22	19
467	Sept.	20	23	12	Sept.	28	01	13	Oct.	4	22	16	Oct.	12	17	25
468	Oct.	20	12	02	Oct.	27	07	34	Nov.	3	11	58	Nov.	11	13	47
469	Nov.	18	23	46	Nov.	25	15	42	Dec.	3	04	24	Dec.	11	09	38
470	Dec.	18	10	47	Dec.	25	02	30	Jan.	1	23	05	Jan.	10	03	02

The lunation numbers are a continuation of Brown's series (E. W. Brown, "The Motion of the Moon, 1923–1931", *M.N.*, **93**, 603), of which No. 1 commenced on 1923 January 16. These numbers are always quoted in any reference to occultation observations, and may be recommended as a convenient system of reference in any lunar observations.

Perigee				Apogee			
Date		Diam.	H.P.	Date		Diam.	H.P.
	d h	′ ″	′ ″		d h	′ ″	′ ″
Jan.	26 10	33 01	60 35	Jan.	10 13	29 26	54 01
Feb.	23 03	32 31	59 41	Feb.	7 06	29 30	54 08
Mar.	19 07	32 19	59 17	Mar.	6 02	29 33	54 13
Apr.	14 19	32 42	60 01	Apr.	2 22	29 32	54 13
May	12 18	33 09	60 50	Apr.	30 16	29 29	54 06
June	10 02	33 26	61 21	May	28 04	29 25	53 59
July	8 11	33 27	61 23	June	24 10	29 23	53 56
Aug.	5 20	33 13	60 58	July	21 14	29 24	53 58
Sept.	2 21	32 48	60 12	Aug.	18 01	29 28	54 05
Sept.	29 22	32 22	59 24	Sept.	14 18	29 32	54 12
Oct.	24 20	32 25	59 30	Oct.	12 13	29 33	54 14
Nov.	21 04	32 54	60 23	Nov.	9 09	29 31	54 10
Dec.	19 11	33 20	61 10	Dec.	7 03	29 27	54 03

H.P. = Horizontal Parallax

The distance of the Moon from the Earth in miles may be found by dividing 817,500,000 by the H.P. in seconds of arc.

LIBRATION

The table below gives the dates on which the libration of the Moon is a maximum in latitude and in longitude. The amount of the libration is given in degrees and the limb which is exposed to view is indicated.

Latitude			Longitude			Latitude			Longitude		
	d	°		d	°		d	°		d	°
Jan.	11·8	6·6 N	Jan.	3·7	7·6 W	July	20·1	6·7 N	July	2·4	7·7 E
	25·5	6·6 S		19·8	6·3 E	Aug.	3·2	6·7 S		14·3	7·6 W
Feb.	8·0	6·7 N	Feb.	1·0	6·6 W		16·3	6·8 N		30·3	6·9 E
	21·7	6·7 S		15·4	5·2 E		30·4	6·7 S	Aug.	11·6	7·1 W
Mar.	6·3	6·8 N		28·8	5·3 W	Sept.	12·5	6·8 N		26·6	5·7 E
	19·9	6·8 S	Mar.	12·8	5·2 E		26·6	6·7 S	Sept.	8·7	6·1 W
Apr.	2·6	6·8 N		26·8	4·7 W	Oct.	9·8	6·8 N		22·0	4·9 E
	16·1	6·7 S	Apr.	9·2	6·1 E		23·8	6·6 S	Oct.	6·3	5·2 W
	29·8	6·7 N		22·0	5·3 W	Nov.	6·1	6·6 N		18·9	5·3 E
May	13·4	6·5 S	May	7·1	7·1 E		20·0	6·5 S	Nov.	1·9	4·9 W
	26·9	6·6 N		19·2	6·5 W	Dec.	3·2	6·6 N		15·5	6·4 E
June	9·6	6·5 S	June	4·3	7·8 E		17·3	6·5 S		28·1	5·9 W
	23·0	6·6 N		16·1	7·5 W		30·2	6·6 N	Dec.	13·6	7·5 E
July	6·9	6·6 S								25·7	7·0 W

SUN'S SELENOGRAPHIC COLONGITUDE

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°
1	295·1	312·0	304·9	322·5	328·5	347·1	353·7	12·5	31·2	37·2	54·9	59·9
2	307·3	324·2	317·0	334·7	340·7	359·3	5·9	24·8	43·4	49·4	67·0	72·1
3	319·4	336·4	329·2	346·9	352·9	11·5	18·1	37·0	55·6	61·5	79·2	84·2
4	331·6	348·6	341·4	359·1	5·1	23·7	30·3	49·2	67·7	73·7	91·3	96·3
5	343·8	0·7	353·6	11·3	17·3	35·9	42·5	61·3	79·9	85·9	103·5	108·5
6	355·9	12·9	5·8	23·5	29·5	48·1	54·7	73·5	92·1	98·0	115·6	120·6
7	8·1	25·0	18·0	35·7	41·7	60·3	66·9	85·7	104·3	110·2	127·8	132·7
8	20·2	37·2	30·1	47·8	53·9	72·5	79·1	97·9	116·4	122·3	139·9	144·9
9	32·4	49·3	42·3	60·0	66·1	84·7	91·3	110·1	128·6	134·5	152·1	157·0
10	44·5	61·5	54·4	72·2	78·2	96·9	103·5	122·3	140·8	146·7	164·2	169·2
11	56·7	73·6	66·6	84·3	90·4	109·1	115·7	134·5	153·0	158·9	176·4	181·3
12	68·8	85·7	78·7	96·5	102·6	121·2	127·9	146·7	165·2	171·0	188·6	193·5
13	80·9	97·9	90·9	108·7	114·8	133·4	140·1	158·9	177·4	183·2	200·7	205·7
14	93·1	110·0	103·0	120·8	127·0	145·6	152·3	171·1	189·6	195·4	212·9	217·8
15	105·2	122·1	115·2	133·0	139·1	157·8	164·5	183·3	201·8	207·6	225·1	230·0
16	117·3	134·3	127·3	145·2	151·3	170·1	176·7	195·5	214·0	219·8	237·3	242·2
17	129·4	146·4	139·5	157·4	163·5	182·3	188·9	207·7	226·2	232·0	249·5	254·4
18	141·6	158·6	151·7	169·6	175·8	194·5	201·2	220·0	238·4	244·2	261·7	266·6
19	153·7	170·7	163·8	181·8	188·0	206·7	213·4	232·2	250·7	256·4	273·9	278·3
20	165·9	182·9	176·0	194·0	200·2	219·0	225·7	244·5	262·9	268·6	286·1	291·0
21	178·0	195·1	188·2	206·2	212·4	231·2	237·9	256·7	275·1	280·9	298·3	303·1
22	190·2	207·3	200·4	218·4	224·6	243·5	250·1	268·9	287·4	293·1	310·5	315·3
23	202·3	219·5	212·6	230·6	236·9	255·7	262·4	281·2	299·6	305·3	322·7	327·5
24	214·5	231·6	224·8	242·8	249·1	268·0	274·6	293·4	311·8	317·5	334·8	339·7
25	226·7	243·8	237·0	255·1	261·4	280·2	286·9	305·7	324·0	329·7	347·0	351·8
26	238·9	256·0	249·2	267·3	273·6	292·5	299·1	317·9	336·3	341·9	359·2	4·0
27	251·1	268·2	261·4	279·5	285·9	304·7	311·4	330·1	348·5	354·1	11·3	16·1
28	263·3	280·4	273·6	291·8	298·1	317·0	323·6	342·4	0·7	6·2	23·5	28·3
29	275·5	292·7	285·9	304·0	310·4	329·2	335·9	354·6	12·8	18·4	35·6	40·4
30	287·7		298·1	316·2	322·6	341·4	348·1	6·8	25·0	30·6	47·8	52·6
31	299·8		310·3		334·8		0·3	19·0		42·7		64·7

The Sun's selenographic colongitude, given here for each midnight, is numerically equal to the selenographic longitude of the morning terminator, measured eastward from the mean centre of the disk. Its value is approximately 270° at New Moon, 0° at First Quarter, 90° at Full Moon, and 180° at Last Quarter. Observers should always quote the *west* or *east longitude* of the *morning* or *evening* terminator, as appropriate. These values are obtained from the Sun's selenographic colongitude S as follows:

	Terminator	S	*Longitude*
New Moon to First Quarter	Morning	270° to 360°	360°−S West
First Quarter to Full Moon	Morning	0 to 90	S East
Full Moon to Last Quarter	Evening	90 to 180	180°−S West
Last Quarter to New Moon	Evening	180 to 270	S−180° East

The hourly increase in S may be taken as 0°·5.

LUNAR OCCULTATIONS

Occultations of all stars down to magnitude 7·5, visible from the eight stations whose coordinates are tabulated below, are given in the following lists. The stars are referred to by their numbers in the *Zodiacal Catalogue* (*Astr. Papers of the American Ephemeris*, X, part II, 1940), and an Index on page 22 gives the more familiar designations of the brighter stars.

	Long.	Lat.		Long.	Lat.
	h m	° ′		h m	° ′
Greenwich	0 00·0	51 29 N.	Wellington	11 39·1 E.	41 17 S.
Edinburgh	0 12·7 W.	55 55 N.	Dunedin	11 22·0 E.	45 52 S.
Cape	1 13·9 E.	33 56 S.	Melbourne	9 39·9 E.	37 50 S.
Johannesburg	1 52·3 E.	26 11 S.	Sydney	10 04·8 E.	33 52 S.

Ph. is the Phase—whether disappearance (D) or reappearance (R).

P is the position angle of the star, measured to the east from the north point of the Moon.

The time of occultation at a place $\Delta\lambda$ degrees *west* and $\Delta\phi$ degrees *north* of a place for which prediction is given may be found from

$$\text{predicted time} + a.\Delta\lambda + b.\Delta\phi$$

in which the coefficients a and b are given in the table in minutes. If the observer is *east* of the given place, then $\Delta\lambda$ is taken as negative; similarly $\Delta\phi$ is negative if the observer is *south* of a place for which a prediction is given.

For distances up to 300 miles the error will not usually exceed 2 minutes.

A better result is obtained by using values of a, b, for a latitude midway between the observer and the nearer station. If ϕ_1, a_1, b_1 apply to this station, and ϕ_2, a_2, b_2 to the other, then

$$a = a_1 + \frac{\Delta\phi}{2(\phi_2 - \phi_1)}(a_2 - a_1) \qquad b = b_1 + \frac{\Delta\phi}{2(\phi_2 - \phi_1)}(b_2 - b_1)$$

Example: Observer at Manchester, $\lambda + 2^\circ\ 14'$, $\phi\ 53^\circ\ 29'$ N.

Occultation of Z.C. 219 (μ Psc) on February 2.

$a_1 = -1·2$	$b_1 = -2·8$	$\phi_1 = 51^\circ\ 29'$
$a_2 = -1·1$	$b_2 = -1·7$	$\phi_2\ 55\ 55$
$\Delta\lambda = +2·2$	$\Delta\phi = +2·0$	

whence $a = -1·2 \quad b = -2·6$

Approximate time at Manchester $= 19^h\ 49^m·3 + 2·2\,(-1·2) + 2·0\,(-2·6)$
$= 19^h\ 41^m·5$

Occultations in 1960. The series of occultations of *Aldebaran* continues throughout the year. Mercury will be occulted on March 25 (America, Europe) and April 24 (Central Russia, North polar regions), Venus also on April 24 (South Africa, South America) and Mars on May 20 (East Indies, Northern Australia, Pacific region).

Date	Z.C.No.	Mag.	Ph.	Age of Moon	Greenwich U.T.	Greenwich *a*	Greenwich *b*	Greenwich *P*	Edinburgh U.T.	Edinburgh *a*	Edinburgh *b*	Edinburgh *P*
					h m	m	m	°	h m	m	m	°
Jan. 3	3431	6·6	D	5·0	19 27·0	−0·6	+0·3	39	19 27·7	−0·4	+0·9	21
6	269	7·3	D	8·1	No occn.	..	..	..	20 56·3	−1·6	−3·0	125
9	618	7·2	D	11·1	19 34·9	−1·3	+1·8	58	19 40·4	−0·9	+2·3	43
9	627	6·8	D	11·2	23 36·6	−1·3	0·0	57	23 34·1	−1·2	+0·7	42
10	741	5·7	D	12·0	17 39·7	−0·6	+1·9	72	17 47·4	−0·4	+2·2	60
11	878	5·5	D	13·0	17 41·9	−0·5	+1·4	95	17 47·9	−0·3	+1·7	84
12	1029	5·1	D	14·1	20 12·7	−1·0	+1·3	89	20 16·9	−0·8	+1·8	76
Feb. 2	219	5·1	D	5·5	19 49·3	−1·2	−2·8	117	19 36·1	−1·1	−1·7	99
3	352	7·3	D	6·7	23 10·0	−0·3	−0·4	51	23 07·8	−0·3	−0·1	37
4	464	6·4	D	7·7	22 35·7	−0·6	−0·9	67	22 30·4	−0·7	−0·5	54
6	692	1·1	D	9·4	14 26·0	+0·2	+2·8	30	14 41·4	—	—	12
6	692	1·1	R	9·4	15 10·0	−1·0	+0·6	305	15 07·9	—	—	324
8	878	5·5	D	10·8	Low	..	..	..	3 13·1	−0·4	−0·1	34
8	975	6·8	D	11·5	18 13·2	−1·3	+0·2	121	18 12·4	−1·0	+1·0	106
9	1003	7·2	D	11·7	0 27·9	−1·6	+0·7	43	0 29·5	—	—	23
9	1011	7·4	D	11·8	2 32·0	—	—	30	Graze	..	..	..
Mar. 4	659	6·4	D	7·0	18 37·1	−1·7	−1·7	115	Sun	..	..	..
4	669	4·0	D	7·1	20 40·6	−0·8	−3·5	135	20 24·7	−1·0	−2·4	119
4	667	5·3	D	7·1	20 44·2	−1·4	+1·7	29	No occn.	..	..	..
4	671	3·6	D	7·1	No occn.	..	..	..	20 44·7	—	—	154
4	672	6·6	D	7·1	20 44·9	−1·1	−1·2	86	20 36·9	−1·0	−0·8	74
4	677	4·8	D	7·1	21 40·3	−0·7	−1·4	84	21 32·4	−0·8	−1·1	74
4	680	6·7	D	7·1	21 47·7	−0·6	−1·7	95	21 38·6	−0·7	−1·4	85
4	685	6·5	D	7·2	23 22·2	−0·3	−0·9	62	23 17·5	−0·4	−0·7	53
5	806	5·1	D	8·2	24 00·2	−0·3	−1·0	66	23 54·7	−0·4	−0·9	57
6	938	7·2	D	9·2	22 50·9	—	—	158	22 33·2	−0·4	−3·2	142
11	1428	3·8	D	13·3	3 18·0	+0·3	−3·1	167	3 05·8	0·0	−2·7	160
25	Merc.	1·1	D	27·7	11 51·1	−1·2	+0·1	62	11 48·7	−1·0	+0·4	50
25	Merc.	1·1	R	27·7	13 03·6	−1·0	−0·5	248	12 57·3	−1·1	−0·8	262
Apr. 2	896	7·4	D	6·6	22 56·8	+0·2	−2·2	124	22 47·4	0·0	−2·1	116
5	1257	7·5	D	9·6	21 11·7	−1·7	−0·3	72	21 06·3	−1·6	+0·2	62
6	1271	5·9	D	9·7	1 00·8	−0·1	−1·6	94	0 52·9	−0·2	−1·6	90
7	1381	6·3	D	10·7	0 52·4	−0·2	−2·2	131	0 42·0	−0·3	−2·1	126
28	692	1·1	D	2·8	15 44·0	−1·5	−0·6	84	15 38·1	−1·3	0·0	70
28	692	1·1	R	2·8	17 03·0	−1·1	−1·1	264	16 53·8	−1·1	−1·5	276
May 1	1106	3·6	D	6·0	Low	..	..	..	22 50·4	+0·6	−2·9	159
June 3	1716	6·4	D	9·4	21 01·1	−1·4	−1·1	93	Sun	..	..	..
4	1830	6·8	D	10·4	21 25·8	−1·2	−1·3	119	Sun	..	..	..
6	2088	6·2	D	12·4	22 49·4	−1·3	−0·9	111	22 41·9	−1·2	−0·7	107
July 3	2033	4·3	D	9·8	21 44·0	−1·4	−0·7	68	21 36·9	−1·3	−0·6	63
17	401	6·3	R	23·0	1 49·1	−0·4	+1·2	294	Sun	..	..	..
19	692	1·1	D	25·3	10 20·3	−1·5	+0·3	61	10 18·8	−1·3	+1·0	45
19	692	1·1	R	25·3	11 34·1	−1·1	−1·9	286	11 21·2	−1·1	−2·4	300
29	1874	7·5	D	6·1	20 44·2	−0·5	−2·6	159	Sun	..	..	..
31	2110	6·4	D	8·1	20 45·5	—	—	174	Sun	..	..	..
Aug. 4	2733	6·4	D	12·1	20 44·6	−1·4	+0·7	77	Sun	..	..	..
8	3353	3·8	R	16·2	22 05·9	−0·8	+1·2	279	22 09·1	−0·7	+1·3	285
15	608	6·0	R	22·4	2 46·2	−1·0	+1·1	284	2 48·0	−0·9	+1·0	297
17	878	5·5	R	24·4	2 51·6	−0·5	+0·9	298	2 53·3	−0·6	+0·7	312
28	2208	7·4	D	6·4	19 46·1	−1·1	−2·1	146	Sun	..	..	..

Date	Z.C. No.	Mag.	Ph.	Age of Moon	Greenwich U.T.	Greenwich *a*	Greenwich *b*	Greenwich *P*	Edinburgh U.T.	Edinburgh *a*	Edinburgh *b*	Edinburgh *P*
					h m	m	m	°	h m	m	m	°
Sept. 1	2846	6·9	D	10·5	20 29·7	−1·4	+0·5	63	20 27·9	−1·2	+0·6	57
9	327	4·5	D	17·8	4 45·1	−0·8	+2·4	17	No occn.	..	..	..
12	699	5·8	R	20·7	1 14·3	−0·5	+2·1	240	1 21·9	−0·5	+1·9	251
12	704	4·8	R	20·7	1 21·3	—	—	180	1 41·0	−0·1	+3·2	205
13	820	6·0	R	21·7	1 05·0	−0·2	+2·0	249	1 12·7	−0·2	+1·8	259
14	970	6·5	R	22·8	2 53·9	−0·7	+1·6	268	2 58·1	−0·7	+1·3	281
28	2787	6·4	D	7·8	18 40·0	−1·4	+0·6	51	18 38·5	−1·2	+0·6	45
28	2794	6·7	D	7·9	19 25·8	−1·6	−0·7	108	19 18·9	−1·3	−0·4	101
30	3100	6·4	D	10·0	22 01·4	−1·7	−1·3	113	21 52·1	−1·3	−0·8	101
Oct. 2	3379	6·4	D	11·9	20 31·0	−1·4	+0·9	88	20 31·4	−1·1	+1·1	80
2	3383	6·5	D	11·9	21 51·3	—	—	2	No occn.	..	..	..
7	401	6·3	R	16·2	Sun	..	..	..	4 53·0	−0·9	−1·6	278
8	626	6·4	R	18·0	23 16·3	−0·7	+1·7	261	23 21·2	−0·6	+1·5	271
9	635	3·9	D	18·1	0 24·9	−1·0	+1·6	76	0 29·8	−0·8	+1·9	65
9	635	3·9	R	18·1	1 41·7	−1·4	+1·2	253	1 42·4	−1·3	+0·9	267
28	3186	6·7	D	8·3	17 18·4	−1·6	+0·1	127	Sun	..	..	..
29	3333	6·8	D	9·3	19 17·2	−1·1	+1·4	37	19 20·7	−0·8	+1·5	26
30	3472	7·0	D	10·3	17 42·8	−0·7	+2·0	43	17 49·6	−0·6	+2·0	36
31	3496	7·2	D	10·5	0 33·7	−0·6	0·0	43	0 33·4	−0·4	+0·6	26
31	55	6·4	D	11·3	18 23·8	−0·8	+1·7	66	18 29·4	−0·6	+1·8	59
Nov. 6	741	5·7	R	16·7	5 05·6	−0·9	−1·9	288	4 53·0	−0·9	−2·4	301
7	878	5·5	R	17·6	No occn.	..	..	..	3 59·8	−1·5	+1·9	217
14	1678	5·8	R	24·8	Sun	..	..	..	6 14·6	−1·0	0·0	305
15	1772	4·0	R	25·7	4 02·0	−0·4	+0·7	300	Low	..	..	..
23	2997	7·1	D	4·7	16 40·4	−1·3	+0·3	61	16 38·1	−1·1	+0·4	54
23	3005	6·2	D	4·8	18 14·8	−1·2	−0·8	85	18 08·4	−1·1	−0·5	75
26	3432	6·3	D	7·8	17 19·2	−1·6	+0·6	103	17 18·1	−1·3	+0·9	94
26	3461	6·4	D	7·9	23 12·7	−0·1	+1·1	19	Graze	..	..	..
27	22	7·3	D	8·8	17 55·3	−0·9	+1·9	34	18 01·7	−0·6	+2·1	23
29	298	7·2	D	11·0	23 33·5	−1·1	0·0	58	23 31·4	−1·0	+0·5	43
30	303	6·6	D	11·0	No occn.	..	..	..	1 22·1	—	—	144
30	308	6·7	D	11·1	2 09·1	−0·5	−0·4	52	2 06·7	−0·5	0·0	37
Dec. 3	692	1·1	D	14·1	0 57·2	−1·5	−0·2	77	0 53·3	−1·3	+0·4	63
3	692	1·1	R	14·1	2 16·3	−1·2	−1·0	266	2 07·1	−1·1	−1·4	279
5	1072	6·2	R	16·9	21 51·8	−0·3	+2·8	229	22 02·0	−0·4	+2·3	244
7	1198	6·2	R	18·1	1 42·7	−1·7	+2·7	231	1 47·2	−1·4	+1·6	248
7	1210	5·9	R	18·1	3 53·8	−1·8	+0·2	252	3 48·4	−1·5	−0·2	264
10	1525	5·9	R	21·2	3 25·7	−1·4	+0·3	287	3 22·6	−1·1	+0·1	298
13	1849	6·2	R	24·3	6 15·1	−1·7	+0·9	262	6 13·8	−1·4	+0·8	270
22	3253	5·4	D	4·3	No occn.	..	..	..	17 09·1	−1·8	−1·4	123
22	3255	7·4	D	4·3	18 11·0	−1·0	−0·3	61	18 07·5	−0·8	0·0	48
27	368	6·3	D	9·3	17 10·6	−0·6	+2·4	35	17 20·4	−0·3	+2·6	23
28	398	6·7	D	9·6	0 56·3	−0·5	−0·7	62	0 52·2	−0·5	−0·4	48
28	401	6·3	D	9·6	1 33·2	−0·6	+2·1	12	No occn.	..	..	..
29	516	7·3	D	10·6	2 04·0	−0·6	+0·6	30	2 08·3	—	—	7
29	626	6·4	D	11·5	21 04·7	—	—	132	20 54·1	−1·6	−0·3	112
29	635	3·9	D	11·5	23 43·4	−1·4	−2·9	127	23 29·2	−1·4	−1·6	110
30	659	6·4	D	11·6	2 57·4	−0·3	−1·6	91	2 49·5	−0·4	−1·4	81
30	669	4·0	D	11·7	Low	..	..	..	4 17·0	+0·1	−1·6	91
30	671	3·6	D	11·7	Low	..	..	..	4 21·9	+0·2	−2·0	114

Date	Z.C. No.	Mag.	Ph.	Age of Moon	Cape U.T.	Cape *a*	Cape *b*	Cape *P*	Johannesburg U.T.	Johannesburg *a*	Johannesburg *b*	Johannesburg *P*
					h m	m	m	°	h m	m	m	°
Jan. 2	3285	6·1	D	3·9	Sun	..	..	..	17 37·1	−0·7	+1·9	54
6	257	4·5	D	8·0	19 45·8	−1·5	+2·7	34	20 24·3	—	—	14
7	384	5·7	D	9·1	21 59·8	−1·2	+1·3	84	22 21·3	−0·8	+1·8	62
9	620	6·3	D	11·1	21 24·4	−2·3	+1·7	61	22 04·7	−2·3	+3·5	34
17	1486	4·6	R	18·2	0 16·2	−1·6	−2·4	330	No occn.	..	..	..
17	1589	6·0	R	19·2	23 29·6	−1·8	−1·1	275	23 38·0	−2·0	−1·8	302
19	1712	3·8	D	20·3	1 30·1	−2·3	−0·8	96	Graze	..	..	..
19	1712	3·8	R	20·3	2 50·7	−1·6	−1·8	320	Graze	..	..	..
21	1937	6·1	R	22·3	0 54·5	−1·5	−0·5	254	1 02·7	−1·6	−1·4	287
21	1941	4·8	R	22·3	1 29·1	−0·6	−3·0	337	No occn.	..	..	..
Feb. 7	832	4·7	D	10·5	Graze	..	..	..	18 55·1	−3·0	−1·7	127
7	836	5·5	D	10·6	No occn.	..	..	..	20 12·5	—	—	148
8	985	6·9	D	11·6	21 05·6	−2·1	−1·1	131	21 22·7	−2·2	+0·2	102
14	1658	6·4	R	17·6	Low	..	..	..	19 14·6	−0·7	−1·0	272
15	1678	5·8	R	17·8	0 58·1	−2·4	−0·3	279	1 11·3	−1·7	−1·6	317
15	1772	4·0	D	18·7	20 33·4	—	—	175	20 13·3	−0·5	−2·3	142
15	1772	4·0	R	18·7	21 01·6	—	—	227	21 13·4	−1·4	−0·7	263
29	153	6·2	D	2·9	Sun	..	..	..	17 37·3	−0·5	+2·5	35
Mar. 2	404	5·2	D	5·0	18 05·9	−1·4	−0·2	123	18 19·6	−1·0	+0·7	98
4	653	4·8	D	7·0	18 35·2	−2·2	+3·2	34	No occn.	..	..	..
5	787	7·5	D	8·0	20 12·2	−1·5	+0·9	96	20 36·1	−1·4	+1·9	65
9	1284	6·3	D	12·0	17 55·8	−2·0	−1·3	104	18 11·7	−2·7	−0·2	83
16	1994	6·5	R	18·2	0 25·9	−1·9	−1·3	296	0 26·7	−1·3	−3·2	336
17	2128	5·8	R	19·3	2 26·5	−1·6	−2·6	328	No occn.	..	..	..
Apr. 2	871	6·9	D	6·4	17 52·0	−1·7	−0·3	121	18 10·7	−1·7	+0·8	92
5	1247	6·8	D	9·5	20 04·4	−2·7	+1·9	66	No occn.	..	..	..
5	1246	6·6	D	9·5	No occn.	..	..	..	20 11·0	−0·7	−1·9	151
7	1467	7·3	D	11·5	19 19·0	−2·2	−1·0	114	19 43·2	−3·3	+0·9	79
7	1474	7·1	D	11·6	22 52·4	−1·1	+0·1	115	23 09·9	−1·3	+1·6	76
9	1589	6·0	D	12·7	0 01·8	−1·6	+2·3	68	No occn.	..	..	..
10	1712	3·8	D	13·7	1 58·6	−1·0	+3·8	51	No occn.	..	..	..
15	2372	4·4	D	18·7	0 05·5	−1·4	−2·3	132	0 12·6	−2·4	−0·5	96
15	2372	4·4	R	18·7	1 16·6	−2·4	+0·6	255	1 38·9	−2·4	−0·7	289
16	2674	6·0	R	20·6	22 15·2	−0·4	−0·6	254	22 11·9	−0·4	−1·4	288
20	3146	6·5	R	23·8	1 22·7	−0·5	−0·6	254	1 21·2	−0·8	−1·5	285
24	Venus	−3·3	D	28·2	13 24·0	−1·4	+1·4	88	13 46·1	−0·8	+1·6	71
24	Venus	−3·3	R	28·2	14 39·4	−0·6	+2·2	236	Low	..	..	..
May 2	1198	6·2	D	6·8	No occn.	..	..	..	18 56·0	—	—	173
5	1525	5·9	D	9·8	16 30·0	−2·0	−1·5	115	16 46·2	−3·0	−0·1	86
6	1658	6·4	D	11·0	23 54·3	−0·8	+2·2	69	No occn.	..	..	..
7	1746	7·1	D	11·9	17 32·1	−1·7	−1·3	105	17 50·5	−3·4	+0·8	68
8	1770	5·9	D	12·1	0 50·6	−0·4	−0·2	127	Low	..	..	..
8	1866	5·9	D	12·9	17 07·5	−0·6	−2·7	153	16 58·6	−1·2	−1·8	122
10	2022	5·5	D	14·1	0 30·4	−1·2	−1·6	146	0 36·9	−1·2	−0·1	113
14	2647	6·4	R	18·2	No occn.	..	..	..	3 39·5	—	—	187
31	1386	6·6	D	6·2	17 45·7	−1·6	+0·1	112	18 09·8	−2·0	+2·0	71
June 1	1486	4·6	D	7·2	16 38·1	−1·1	−2·7	160	16 41·0	−2·1	−0·9	121
2	1600	5·1	D	8·3	19 20·2	−1·7	+0·3	104	19 50·1	−2·3	+3·5	57
3	1712	3·8	D	9·3	20 05·9	−0·8	−2·1	157	20 08·6	−1·4	−0·3	117
4	1828	6·6	D	10·4	22 05·5	—	—	181	21 56·2	−0·8	−0·8	133

Date	Z.C. No.	Mag.	Ph.	Age of Moon	Cape U.T.	Cape a	Cape b	Cape P	Johannesburg U.T.	Johannesburg a	Johannesburg b	Johannesburg P
					h m	m	m	°	h m	m	m	°
June 5	1933	7·0	D	11·2	Sun	..	..	..	15 56·2	−1·5	−1·4	110
5	1937	6·1	D	11·2	No occn.	..	..	..	17 46·3	—	—	192
5	1941	4·8	D	11·3	17 47·2	−1·5	−1·9	130	17 56·6	−2·6	−0·4	94
7	2223	4·0	D	13·4	No occn.	..	..	..	23 49·8	—	—	169
14	3208	6·5	R	19·6	2 04·4	−2·2	0·0	261	2 27·3	−2·9	−0·4	277
14	3334	6·3	R	20·5	22 56·2	−0·5	+0·4	226	23 03·2	−0·9	−0·3	255
July 3	2020	6·6	D	9·6	18 42·8	−1·1	−3·3	162	18 43·9	−2·1	−1·0	120
4	2158	7·3	D	10·7	21 22·6	−1·4	−2·7	156	21 26·7	−1·5	−0·5	120
4	2167	7·5	D	10·8	23 38·5	−0·8	−0·3	129	23 44·8	−0·4	+0·3	106
11	3270	6·1	R	17·7	Low	..	..	..	19 55·9	−0·4	−0·9	272
19	650	5·7	R	25·0	3 05·3	0·0	−1·1	211	3 16·0	−0·7	+0·9	225
28	1746	7·1	D	4·9	No occn.	..	..	..	17 38·4	−0·7	−1·4	144
29	1866	5·9	D	6·0	No occn.	..	..	..	19 31·0	—	—	186
29	1869	6·1	D	6·0	19 07·9	−1·1	+1·3	86	19 36·2	—	—	40
30	1985	7·0	D	7·0	No occn.	..	..	..	19 27·7	−0·9	−2·9	161
Aug. 1	2231	6·9	D	9·0	No occn.	..	..	..	18 07·1	−2·0	−2·6	145
3	2548	7·5	D	11·1	20 35·1	—	—	25	No occn.	..	..	..
3	2555	7·5	D	11·1	22 06·8	−1·8	−0·2	114	22 24·0	−1·4	+0·6	95
11	219	5·1	R	19·2	Low	..	..	..	21 36·0	−0·4	+0·6	229
13	354	5·5	R	20·3	0 29·6	−1·6	−1·4	277	0 36·5	−2·8	−2·2	292
27	2072	6·7	D	5·3	17 28·6	−1·6	+0·2	108	17 49·6	−1·3	+1·6	76
29	2365	7·1	D	7·5	22 02·9	−0·5	+0·1	121	Low	..	..	..
30	2495	6·0	D	8·4	18 05·2	−2·1	−2·2	136	18 18·6	−2·3	−0·2	105
31	2647	6·4	D	9·3	No occn.	..	..	..	16 30·8	—	—	157
31	2674	6·0	D	9·5	22 00·7	−0·7	+2·2	54	22 23·5	0·0	+2·7	37
Sept. 1	2830	6·9	D	10·4	18 39·0	−2·1	+1·5	53	19 22·2	—	—	19
2	2995	6·2	D	11·5	22 02·7	−1·9	+0·8	85	22 27·3	−1·5	+1·3	74
13	832	4·7	R	21·8	3 39·9	−2·0	+0·9	232	Sun	..	..	..
16	1207	5·8	R	24·8	Low	..	..	..	2 22·3	−1·5	−2·5	309
17	1323	6·3	R	25·8	Low	..	..	..	2 34·9	—	—	342
26	2454	7·2	D	5·8	18 04·0	−2·1	−2·9	150	18 11·2	−1·6	−0·5	121
28	2808	7·4	D	8·0	23 03·2	−0·3	+0·7	103	Low	..	..	..
Oct. 12	1158	5·2	R	22·1	Low	..	..	..	23 55·7	−0·1	+1·4	219
24	2555	7·5	D	4·2	Sun	..	..	..	17 19·3	−1·1	+1·2	79
28	3188	5·4	D	8·3	18 32·0	—	—	125	18 52·9	−3·0	−0·6	110
28	3205	6·8	D	8·4	22 23·8	−0·8	+1·0	93	22 37·4	−0·4	+1·0	83
28	3208	6·5	D	8·4	22 48·3	−0·3	+1·9	54	23 04·0	+0·1	+2·0	42
29	3334	6·3	D	9·3	19 56·0	−1·6	+1·9	48	20 26·6	−1·2	+2·4	41
30	3470	7·0	D	10·3	17 55·4	—	—	5	No occn.	..	..	..
Nov. 21	2686	5·2	D	2·7	18 14·8	−1·0	−0·6	135	18 19·2	−0·4	0·0	118
21	2690	7·0	D	2·8	19 00·1	−0·8	−1·0	143	Low	..	..	..
23	3008	6·9	D	4·8	19 52·7	−1·0	+0·1	119	20 01·1	−0·4	+0·4	106
23	3015	5·3	D	4·8	20 41·6	−0·3	+0·6	106	Low	..	..	..
24	3155	6·8	D	5·8	18 16·5	−1·9	+0·7	93	18 38·9	−1·4	+1·0	85
Dec. 14	1950	5·8	R	25·1	Low	..	..	..	1 02·6	−0·2	−2·0	314
21	3109	6·5	D	3·3	19 32·7	−0·1	+1·1	84	Low	..	..	..
24	4	6·3	D	6·4	21 49·2	−0·2	+2·3	34	Low	..	..	..
25	109	6·5	D	7·3	19 12·0	−0·7	+3·7	10	19 52·0	—	—	351
30	764	5·0	D	12·5	22 10·7	−2·4	+1·0	73	22 46·8	−2·5	+2·3	52

Date	Z.C. No.	Mag.	Ph.	Age of Moon	Sydney				Melbourne			
					U.T.	*a*	*b*	*P*	U.T.	*a*	*b*	*P*
					h m	m	m	°	h m	m	m	°
Jan. 2	3247	7·0	D	3·6	Low	..	..	..	11 14·5	−0·2	+1·1	91
6	214	6·4	D	7·6	11 31·9	−1·0	+3·8	15	11 11·7	−1·1	+3·1	22
9	581	6·9	D	10·7	12 38·7	−2·1	+2·0	54	12 18·4	−2·2	+1·4	61
16	1441	6·4	R	17·8	No occn.	..	..	..	13 26·4	—	—	351
16	1442	Var.	R	17·8	13 57·4	−1·6	−2·5	324	13 56·3	−1·5	−2·1	311
18	1658	6·4	R	19·8	13 37·8	−1·0	−1·5	282	13 37·7	−0·8	−1·3	272
19	1772	4·0	D	20·9	14 55·7	−1·1	−1·8	119	14 58·0	−0·7	−2·1	131
19	1772	4·0	R	20·9	16 12·2	−1·7	−1·5	292	16 07·5	−1·5	−1·2	277
Feb. 5	523	6·5	D	8·2	11 51·2	−1·3	+0·4	111	11 41·3	−1·6	−0·1	123
6	648	3·9	D	9·1	9 16·7	—	—	19	Sun	..	..	..
6	653	4·8	D	9·2	9 44·3	−2·5	+1·1	64	Sun	..	..	..
7	787	7·5	D	10·2	12 03·2	−1·8	−1·0	133	11 58·6	—	—	152
16	1866	5·9	R	19·4	16 57·8	−1·7	−1·7	311	16 51·8	−1·9	−1·1	292
17	1994	6·5	R	20·5	18 29·3	−1·6	−2·1	323	18 25·1	−1·8	−1·3	302
Mar. 4	609	7·5	D	6·7	10 54·8	−1·0	+0·3	116	10 48·2	−1·1	−0·3	131
6	871	6·9	D	8·6	9 04·1	−2·6	−1·0	121	Sun	..	..	..
9	1247	6·8	D	11·7	10 21·6	−2·6	−0·2	87	10 09·0	−2·2	−0·8	98
15	1941	4·8	R	17·8	13 40·6	−1·5	−1·5	293	13 36·7	−1·4	−1·2	277
18	2372	4·4	D	21·0	17 43·5	−1·6	−2·8	141	17 52·7	—	—	172
18	2372	4·4	R	21·0	18 49·5	−2·6	+1·6	244	18 21·8	—	—	214
20	2674	6·0	R	23·0	16 52·9	−1·2	−0·6	257	16 46·8	−1·1	0·0	237
24	3278	5·4	R	27·1	18 47·5	−0·2	−2·3	299	Low	..	..	..
Apr. 5	1210	5·9	D	9·2	12 01·6	−0·7	−0·8	140	12 04·8	—	—	167
9	1658	6·4	D	13·2	13 20·8	−2·5	+0·6	88	13 06·8	−2·0	−0·4	108
10	1772	4·0	D	14·3	14 34·0	−2·2	+0·6	92	14 21·4	−1·8	−0·4	112
15	2460	6·1	R	19·3	15 09·0	—	—	213	No occn.	..	..	..
29	764	5·0	D	3·4	7 46·9	−2·2	+3·5	37	Sun	..	..	..
30	904	7·1	D	4·4	8 27·4	−0·9	−0·4	131	8 26·3	—	—	154
May 2	1158	5·2	D	6·4	8 31·0	−2·4	+1·0	81	8 14·0	−2·3	+0·2	97
4	1386	6·6	D	8·5	10 45·4	—	—	51	10 19·3	−2·4	+1·1	79
5	1486	4·6	D	9·5	8 23·2	−2·2	−1·1	113	8 16·3	−1·8	−1·7	128
5	1497	7·5	D	9·6	12 51·4	−0·5	−1·0	146	12 56·9	+0·2	−3·1	174
6	1600	5·1	D	10·5	10 41·9	−3·1	+1·2	74	10 23·9	−2·3	−0·2	96
7	1712	3·8	D	11·5	10 16·1	−1·4	−2·2	146	10 20·0	−0·7	−3·4	169
8	1849	6·2	D	12·7	16 33·5	−0·5	+0·4	111	16 29·3	−0·6	−0·1	126
17	3208	6·5	R	21·9	18 47·0	−1·4	+2·7	206	18 26·6	—	—	192
20	50	6·0	R	24·9	17 54·4	−0·9	−2·6	295	17 58·3	−0·5	−1·7	281
29	1114	6·8	D	3·8	7 38·6	−1·9	+1·5	77	Sun	..	..	..
29	1124	6·9	D	3·8	Low	..	..	..	9 13·5	−1·0	+1·4	85
30	1238	6·1	D	4·8	7 57·5	−1·5	0·0	116	7 50·0	−1·3	−0·7	135
June 3	1678	5·8	D	9·0	12 33·7	−0·5	−1·4	152	12 42·5	—	—	184

Date	Z.C. No.	Mag.	Ph.	Age of Moon	Sydney U.T.	Sydney a	Sydney b	Sydney P	Melbourne U.T.	Melbourne a	Melbourne b	Melbourne P
					h m	m	m	°	h m	m	m	°
June 6	2020	6·6	D	11·9	8 49·1	−0·8	−2·8	152	9 00·5	—	—	179
12	2995	6·2	R	18·1	15 39·2	−2·0	+0·1	256	15 26·9	−1·7	+0·3	243
29	1525	5·9	D	5·2	8 34·0	—	—	190	No occn.	..	..	..
July 1	1746	7·1	D	7·3	11 52·1	−0·6	0·0	121	11 49·3	−0·6	−0·6	139
2	1866	5·9	D	8·4	13 05·0	−0·4	−1·3	151	13 11·2	—	—	176
2	1869	6·1	D	8·4	No occn.	..	..	..	13 24·8	—	—	34
3	1985	7·0	D	9·3	12 32·0	−1·0	−1·0	140	12 32·2	−0·9	−2·5	161
3	1994	6·5	D	9·4	Low	..	..	..	14 38·9	−0·5	−1·0	149
4	2089	6·8	D	10·2	7 58·6	—	—	53	7 42·6	−1·8	−0·6	80
5	2231	6·9	D	11·3	9 21·9	−0·6	−4·3	166	No occn.	..	..	..
16	354	5·5	R	22·6	16 54·7	−0·9	−0·3	247	16 51·5	−0·5	−0·3	240
30	1933	7·0	D	6·6	8 43·0	—	—	185	No occn.	..	..	..
31	2072	6·7	D	7·7	12 21·9	−0·6	+1·4	83	12 12·5	−0·9	+0·9	97
Aug. 1	2184	7·0	D	8·6	8 10·1	−2·0	−1·2	114	8 05·4	−1·5	−2·1	134
2	2365	7·1	D	9·8	15 28·1	−0·2	+0·6	106	15 24·2	−0·4	+0·5	113
3	2495	6·0	D	10·7	10 42·9	−2·1	−1·0	115	10 36·7	−1·8	−2·1	133
3	2527	6·9	D	10·9	Low	..	..	..	16 59·8	+0·1	+1·5	70
4	2674	6·0	D	11·8	13 58·9	—	—	11	13 33·5	−1·2	+3·9	30
16	832	4·7	R	24·1	19 49·7	−1·6	+0·7	229	19 39·1	−1·1	+0·5	225
30	2433	6·5	D	8·0	8 09·7	—	—	41	Sun	..	..	..
Sept. 1	2789	7·3	D	10·1	13 49·1	—	—	8	13 30·0	−0·3	+4·3	21
1	2808	7·4	D	10·3	Low	..	..	..	16 41·9	−0·4	0·0	128
7	109	6·5	R	16·2	13 50·4	−1·9	−0·2	259	13 40·9	−1·5	−0·3	254
11	650	5·7	R	20·4	18 51·2	—	—	198	18 30·7	—	—	191
27	2548	7·5	D	6·4	10 09·3	−1·1	+2·3	56	9 52·9	−1·5	+1·8	66
30	3027	7·0	D	9·5	No occn.	..	..	..	10 47·3	—	—	8
Oct. 1	3208	6·5	D	10·7	Low	..	..	..	16 42·8	−0·4	+1·0	99
2	3334	6·3	D	11·6	13 35·7	−2·0	+0·9	84	13 20·1	−2·1	+0·6	86
7	454	5·8	R	16·7	14 53·6	−1·6	+1·2	224	14 40·6	−1·3	+0·9	222
23	2365	7·1	D	2·9	9 39·3	−0·2	+1·0	92	9 33·3	−0·5	+0·9	99
27	2995	6·2	D	6·9	11 13·0	−1·0	+1·6	67	10 59·5	−1·3	+1·6	70
28	3137	6·6	D	7·9	10 28·9	−0·5	+3·9	15	10 09·5	−0·9	+3·4	21
29	3280	7·4	D	8·9	9 18·5	−1·9	+1·2	57	Sun	..	..	..
30	3431	6·6	D	10·0	13 22·9	−1·1	+2·0	51	13 07·4	−1·3	+1·9	52
Nov. 7	947	5·2	R	18·2	16 31·2	−2·4	+2·0	220	16 11·1	—	—	210
22	2808	7·4	D	3·4	Low	..	..	..	11 08·0	+0·4	+2·5	32
24	3109	6·5	D	5·5	12 04·8	−1·3	−1·3	138	12 01·9	—	—	148
28	109	6·5	D	9·6	14 00·5	−1·1	+1·0	93	13 48·4	−1·5	+0·9	98
30	354	5·5	D	11·4	9 08·1	−1·1	+0·5	51	Sun	..	..	..
Dec. 7	1262	6·2	R	18·6	14 28·7	−1·9	−2·3	309	14 26·5	−1·6	−2·1	301
28	454	5·8	D	10·1	12 22·7	−2·4	+0·2	107	12 07·4	−2·6	−0·3	112

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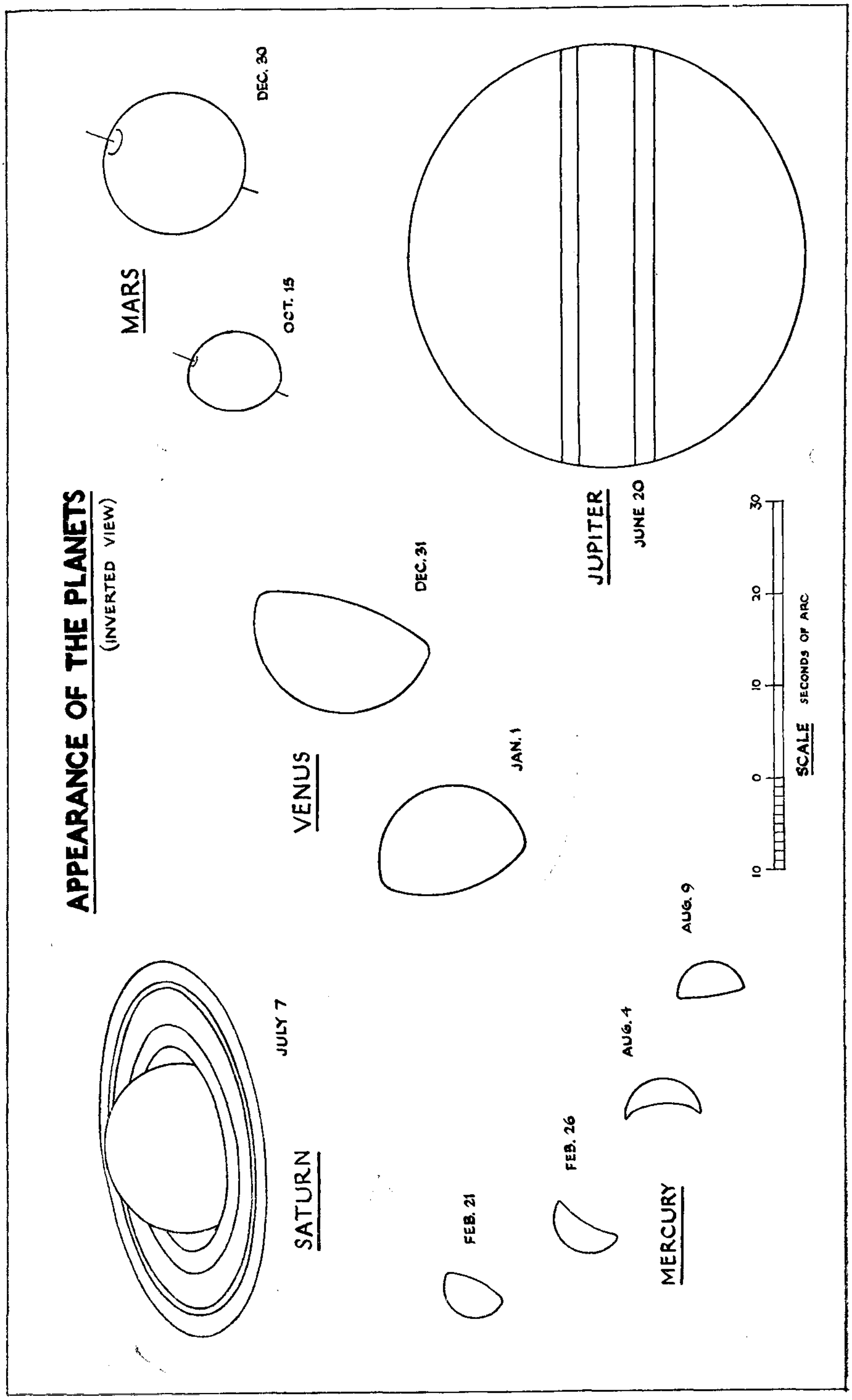
					h m	m	m	°	h m	m	m	°
Jan. 6	214	6·4	D	7·6	11 17·3	−0·7	+2·2	49	Low	..	..	..
9	581	6·9	D	10·7	12 48·1	−1·1	+1·7	74	13 01·3	−1·1	+2·0	63
16	1441	6·4	R	17·8	14 19·6	—	—	351	No occn.	..	..	..
16	1442	Var.	R	17·8	14 49·9	−1·4	−1·1	315	14 49·3	−1·2	−1·8	331
18	1658	6·4	R	19·8	14 19·8	−1·6	−1·0	272	14 22·3	−1·8	−1·2	285
19	1772	4·0	D	20·9	15 41·4	−1·4	−1·5	124	15 42·0	−1·8	−1·1	110
22	2128	5·8	R	23·8	14 01·4	−0·2	−1·3	271	13 55·9	−0·2	−1·5	282
23	2279	6·2	R	24·9	15 49·8	−0·1	−2·3	320	15 37·8	+0·2	−3·0	338
24	2433	6·5	R	25·9	15 36·6	0·0	−1·5	288	15 28·9	+0·1	−1·7	301
Feb. 1	35	6·4	D	4·1	No occn.	..	..	..	8 54·8	—	—	142
6	648	3·9	D	9·1	9 30·8	−1·8	+1·5	58	9 46·9	−1·9	+2·1	49
6	653	4·8	D	9·2	10 12·6	−1·6	+1·1	89	10 25·0	−1·6	+1·4	80
23	2876	5·4	R	26·4	16 02·2	−0·2	−0·4	235	16 00·4	−0·2	−0·7	252
23	2880	5·1	R	26·5	16 51·8	−0·3	−1·3	268	16 46·5	−0·2	−1·6	284
Mar. 6	862	7·5	D	8·6	Sun	..	..	..	7 52·7	−2·3	+1·2	63
6	863	6·7	D	8·6	7 57·1	−2·0	+0·7	74	8 10·3	−2·2	+1·2	65
6	871	6·9	D	8·6	9 48·4	−1·0	−0·6	144	9 51·7	−1·1	0·0	128
8	1124	6·9	D	10·6	9 30·5	—	—	45	No occn.	..	..	..
9	1247	6·8	D	11·7	11 03·4	−1·8	+0·5	96	11 15·2	−2·0	+1·1	81
15	1941	4·8	R	17·8	14 26·7	−1·6	−0·6	288	14 29·8	−1·6	−1·1	304
20	2674	6·0	R	23·0	17 22·1	−1·7	+1·1	229	Sun	..	..	..
22	2968	6·2	R	24·9	15 05·0	−0·2	−0·7	246	15 01·9	−0·2	−1·0	262
22	2969	3·2	R	24·9	15 11·0	−0·2	−0·7	245	15 08·0	−0·2	−1·0	262
Apr. 3	947	5·2	D	7·0	8 03·7	−2·1	+2·3	47	Graze	..	..	..
8	1525	5·9	D	12·0	7 22·7	−1·3	−1·6	114	7 22·1	−1·6	−1·3	104
9	1658	6·4	D	13·2	13 45·4	−1·1	+0·8	102	13 55·9	−1·2	+1·6	82
10	1772	4·0	D	14·3	14 56·0	−0·9	+0·5	112	15 03·8	−1·0	+1·1	94
14	2279	6·2	R	18·1	10 32·6	−0·4	−1·6	284	10 26·8	−0·4	−1·8	297
15	2433	6·5	R	19·1	10 08·7	−0·1	−1·1	260	10 03·9	−0·1	−1·2	273
May 1	1038	6·8	D	5·4	6 44·2	−1·6	+0·7	99	6 55·4	−1·7	+1·2	87
2	1158	5·2	D	6·4	8 50·2	−1·1	+1·3	90	9 02·6	−1·3	+1·9	73
4	1386	6·6	D	8·5	10 51·6	−1·2	+2·3	69	Low	..	..	..
5	1486	4·6	D	9·5	9 07·4	−1·5	−0·1	117	9 15·0	−1·8	+0·4	101
6	1589	6·0	D	10·5	No occn.	..	..	..	8 43·0	—	—	176
6	1600	5·1	D	10·5	11 09·8	−1·5	+1·3	85	11 26·2	−1·9	+2·9	61
7	1712	3·8	D	11·5	11 00·6	−0·9	−1·5	153	11 00·2	−1·2	−0·7	134
9	1941	4·8	D	13·5	7 41·0	−0·4	−2·5	153	7 32·7	−0·7	−2·2	138
15	2880	5·1	R	19·6	10 55·8	+0·4	−3·0	324	No occn.	..	..	..

Date	Z.C. No.	Mag.	Ph.	Age of Moon	Dunedin U.T.	Dunedin *a*	Dunedin *b*	Dunedin *P*	Wellington U.T.	Wellington *a*	Wellington *b*	Wellington *P*
					h m	m	m	°	h m	m	m	°
May 20	50	6·0	R	24·9	18 28·0	−1·1	0·0	236	Sun	..	..	..
June 1	1441	6·4	D	6·7	6 17·2	−1·3	−1·2	144	6 18·8	−1·6	−0·7	128
1	1442	Var.	D	6·8	Graze	..	..	..	6 44·3	−0·8	−1·9	158
6	2008	6·6	D	11·8	5 49·3	−0·4	−2·3	142	5 41·5	−0·6	−2·0	129
6	2020	6·6	D	11·9	9 39·3	−0·8	−2·8	161	9 33·9	−1·4	−1·8	140
12	2995	6·2	R	18·1	15 50·9	—	—	195	16 10·4	−1·2	+2·8	212
13	3145	6·5	R	19·1	15 02·4	−2·0	−3·4	311	No occn.	..	..	..
28	1413	6·7	D	4·1	6 31·3	−1·2	+0·9	100	6 42·6	−1·4	+1·6	82
29	1525	5·9	D	5·2	No occn.	..	..	..	8 51·0	—	—	189
July 1	1732	7·0	D	7·1	6 13·4	−1·9	−0·2	101	6 23·3	−2·4	+0·7	83
4	2089	6·8	D	10·2	8 35·9	−2·1	+1·0	70	8 59·0	—	—	38
5	2231	6·9	D	11·3	No occn.	..	..	..	10 16·4	—	—	173
11	3208	6·5	R	17·3	10 27·0	−0·4	−1·4	270	10 21·7	−0·5	−1·9	288
16	354	5·5	R	22·6	Graze	..	..	..	17 05·8	—	—	187
Aug. 1	2184	7·0	D	8·6	8 57·2	−1·3	−1·3	140	8 59·6	−1·5	−0·4	122
3	2495	6·0	D	10·7	No occn.	..	..	..	11 40·4	—	—	156
4	2674	6·0	D	11·8	13 42·2	−0·8	+1·4	81	13 52·3	−0·6	+1·6	72
29	2279	6·2	D	6·9	7 50·1	−1·5	−0·1	114	7 57·8	−1·6	+0·6	99
30	2433	6·5	D	8·0	8 29·8	−1·6	+0·9	86	8 42·4	−1·6	+1·7	70
31	2606	7·1	D	9·1	12 13·6	−0·4	+2·2	57	12 25·3	−0·1	+2·5	46
Sept. 1	2789	7·3	D	10·1	13 24·2	−0·4	+1·6	75	13 33·2	−0·2	+1·7	68
7	109	6·5	R	16·2	14 06·2	−0·8	+2·2	198	14 20·2	−1·0	+2·2	205
25	2240	6·8	D	4·3	Sun	..	..	..	7 11·9	−1·0	+2·4	62
27	2548	7·5	D	6·4	10 10·6	−0·8	+0·8	108	10 17·6	−0·6	+1·0	99
28	2722	7·1	D	7·5	10 57·2	−0·5	+1·9	65	11 08·0	−0·2	+2·1	56
29	2871	7·1	D	8·4	7 27·1	−1·8	−0·9	108	7 33·1	−2·0	−0·1	94
30	3027	7·0	D	9·5	10 56·9	−1·2	+1·5	69	11 09·3	−1·0	+1·8	62
Oct. 25	2674	6·0	D	4·9	9 20·0	−0·3	+1·9	65	9 29·9	−0·1	+2·0	57
27	2995	6·2	D	6·9	11 17·5	−0·9	+0·6	120	11 23·7	−0·6	+0·7	112
28	3137	6·6	D	7·9	10 22·0	−1·1	+1·5	75	10 33·5	−0·9	+1·7	69
29	3280	7·4	D	8·9	9 55·1	−2·4	−0·7	120	10 03·3	−2·2	0·0	111
30	3431	6·6	D	10·0	13 22·6	−0·8	+1·4	91	13 31·9	−0·6	+1·4	86
31	4	6·3	D	10·9	8 39·1	−1·9	−1·0	97	8 44·3	−2·0	−0·4	88
Nov. 5	653	4·8	R	16·0	11 48·4	−2·3	−2·7	309	11 45·1	—	—	321
30	354	5·5	D	11·4	9 47·7	−2·4	−1·1	110	9 54·2	−2·5	−0·6	104
Dec. 8	1371	6·4	R	19·6	13 41·8	−1·3	−2·5	324	13 35·0	−1·6	−3·2	336
28	454	5·8	D	10·1	12 57·8	—	—	151	12 58·1	−0·7	−0·0	131

Index of Occulted Stars, 1960

Z.C.		Z.C.		Z.C.		Z.C.	
4	80 B. Psc	787	+ 18° 812 *m.*	1658	80 Leo	2690	− 18° 4994
22	− 2° 19	806	111 Tau	1678	89 Leo	2722	− 17° 5310
35	98 B. Psc	820	117 Tau	1712	β Vir	2733	− 19° 5182
50	44 Psc	832	119 Tau	1716	+ 1° 2624	2787	187 B. Sgr
55	10 Cet	836	120 Tau	1732	+ 2° 2499	2789	− 17° 5478
109	155 B. Psc	862	+ 18° 920	1746	52 B. Vir	2794	− 19° 5317
153	73 Psc	863	127 Tau	1770	13 Vir	2808	− 17° 5535
214	263 B. Psc	871	+ 18° 950	1772	η Vir	2830	− 17° 5611
219	μ Psc	878	130 Tau	1828	298 B. Vir	2846	246 B. Sgr
257	*o* Psc	896	+ 17° 1051	1830	− 3° 3349	2871	− 17° 5699 *f.*
269	+ 6° 275	904	+ 18° 1040	1849	38 Vir	2876	54 Sgr
298	136 G. Psc.	938	+ 17° 1154 *p.*	1866	44 Vir	2880	55 Sgr
303	39 B. (Ari)	947	71 Ori	1869	46 Vir	2968	16 B. Cap
308	+ 7° 324	970	292 B. (Ori)	1874	− 4° 3408	2969	β Cap
327	ξ^1 Cet	975	+ 17° 1224 *m.*	1933	519 B. Vir	2995	27 G. Cap
352	+ 9° 313	985	+ 18° 1214	1937	72 Vir	2997	41 B. Cap *m.*
354	ξ Ari	1003	21 Gem. *f.*	1941	74 Vir	3005	47 B. Cap
368	389 B. Cet	1011	+ 17° 1306	1950	80 Vir	3008	13 Cap
384	31 Ari	1029	26 Gem	1985	− 7° 3712	3015	τ Cap *m.*
398	434 B. (Cet)	1038	+ 18° 1338	1994	598 B. Vir *p.*	3027	− 14° 5839
401	85 (Cet)	1072	110 B. Gem	2008	614 B. Vir	3100	− 15° 5908
404	38 Ari	1106	λ Gem	2020	94 Vir	3109	53 B. Aqr
454	147 B. Ari	1114	143 B. Gem	2022	95 Vir	3137	− 12° 5994
464	3 B. (Tau)	1124	+ 18° 1610	2033	κ Vir	3146	72 B. (Aqr)
516	+ 13° 568	1158	74 Gem	2072	8 G. Lib	3155	75 B. (Aqr)
523	30 B. Tau	1198	2 B. Cnc	2088	6 B. Lib	3186	− 13° 6008
581	150 B. Tau	1207	3 Cnc	2089	8 B. Lib	3188	λ Cap
608	179 B. Tau	1210	5 Cnc	2110	22 B. Lib	3205	129 G. Cap
609	+ 16° 559	1238	+ 16° 1662	2128	13 Lib	3208	96 B. (Aqr)
618	+ 15° 592	1246	23 H^1. Cnc	2158	− 12° 4198	3247	36 Aqr
620	193 B. Tau	1247	+ 16° 1687	2167	− 12° 4214	3253	38 Aqr
626	48 Tau	1257	+ 15° 1805	2184	− 12° 4227	3255	135 B. Aqr
627	+ 15° 607	1262	25 Cnc	2208	− 14° 4208	3270	150 B. Aqr
635	γ Tau	1271	29 Cnc	2223	γ Lib	3278	ρ Aqr
648	δ Tau	1284	90 B. Cnc	2231	175 B. Lib	3280	− 9° 5963
650	63 Tau	1323	54 Cnc	2240	182 B. Lib	3285	170 B. Aqr
653	64 Tau	1371	81 Cnc	2279	203 B. Lib	3333	213 B. Aqr *f.*
659	70 Tau	1381	222 B. Cnc	2365	− 15° 4324	3334	67 Aqr
667	75 Tau	1386	+ 13° 2074	2372	ϕ Oph	3353	λ Aqr
669	θ^1 Tau	1413	35 B. Leo	2433	78 B. Oph	3379	81 Aqr
671	θ^2 Tau	1428	*o* Leo	2454	108 B. Oph	3383	82 Aqr
672	+ 15° 633 *m.*	1441	19 Leo	2460	125 B. Oph	3431	316 B. Aqr
677	264 B. Tau	1442	*R* Leo	2495	164 B. Oph *m.*	3432	317 B. Aqr
680	269 B. Tau	1467	+ 11° 2136	2527	226 B. Oph	3461	337 B. Aqr
685	275 B. Tau	1474	+ 10° 2100	2548	− 17° 4903	3470	34 G. Psc
692	α Tau	1486	*A* Leo	2555	− 18° 4645 *m.*	3472	− 5° 6011
699	89 Tau	1497	+ 9° 2317	2606	− 17° 5001	3496	− 3° 5697
704	σ^2 Tau	1525	44 Leo	2647	52 G. Sgr		
741	318 B. Tau	1589	56 Leo	2674	85 B. Sgr		
764	104 Tau *m.*	1600	59 Leo	2686	100 B. Sgr		


APPEARANCE OF THE PLANETS
(INVERTED VIEW)
MARS
DEC. 30
OCT. 15
JUPITER
JUNE 20
VENUS
DEC. 31
JAN. 1
SATURN
JULY 7
MERCURY
FEB. 21
FEB. 26
AUG. 4
AUG. 9
SCALE
SECONDS OF ARC
10
0
10
20
30

Planetary Appulses and Occultations

1. The following appulses may be of interest to observers:—

Planet	*Date*	*Time of conjunction*	*Star*	*Mag.*	*Geocentric separation*	*Horizontal Parallax*
		h m			″	″
Venus	Apr. 23	13 11	80 Piscium	5·7	12	5
	Apr. 28	23 51	269B. Piscium	6·6	21	5
	Nov. 26	15 15	172B. Sagittarii	5·7	7	8
Mars	Jan. 29	03 08	C.D. − 23° 14758	8·7	5	4
	Mar. 15	18 53	B.D. − 17° 6237	9·0	19	4
	Apr. 3	00 12	B.D. − 12° 6218	8·3	9	4
	May 3	22 18	B.D. − 4° 5939	8·5	5	5
	May 4	22 42	B.D. − 3° 5702	9·0	4	5
	May 14	18 58	B.D. − 0° 21	8·6	5	5
	May 16	03 53	B.D. − 0° 35	8·6	3	5
	May 16	15 46	B.D. − 0° 42	7·9	20	5
	June 1	15 00	B.D. + 4° 166	7·7	20	5
	June 9	03 06	B.D. + 6° 216	9·0	6	5
Jupiter	Jan. 10	16 14	C.D. − 22° 12008	8·7	4	1
	Feb. 9	07 39	C.D. − 22° 12237	8·4	0	2
	June 21	23 26	C.D. − 23° 13662	9·0	11	2
	July 2	04 54	C.D. − 23° 13598	8·4	27	2
	Oct. 6	09 37	C.D. − 23° 13589	8·3	3	2
	Nov. 5	04 38	C.D. − 23° 14011	9·0	8	2
	Dec. 7	03 21	C.D. − 23° 14580	6·8	21	1
	Dec. 10	09 43	C.D. − 23° 14633	9·0	48	1
Saturn	Apr. 24	01 57	B.D. − 21° 5359	9·0	14	1
	May 1	01 11	B.D. − 21° 5359	9·0	1	1
	June 17	21 42	C.D. − 22° 13730	8·8	46	1
	Sept. 4	05 23	C.D. − 22° 13397	8·0	17	1

2. The following occultations by **Mars** have been predicted:—

Date	*Star*	*Area of Visibility*	*Station*	*Disappearance* U.T.	*P*	*Reappearance* U.T.	*P*
				h m	°	h m	°
May 4	B.D. − 3° 5702 (9ᵐ·0)	S. Asia	Hyderabad	22 38	87	22 41	227
May 16	B.D. − 0° 35 (8ᵐ·6)	Iberia	Madrid	03 50	38	03 53	276
June 9	B.D. + 6° 216 (9ᵐ·0)	Iberia N.W. Africa	Madrid	03 02	82	03 05	234

3. The following occultations by **Jupiter** have been predicted:—

Date	*Star*	*Area of Visibility*	*Station*	*Disappearance* U.T.	*P*	*Reappearance* U.T.	*P*
Feb. 9	C.D. − 22° 12237 (8ᵐ·4)	Central and S. America	La Plata	06 59	94	08 15	270
June 21	C.D. − 23° 13662 (9ᵐ·0)	Central and S. America	La Plata	22 35	237	24 29	121
		Europe	Helwan	22 23	244	24 26	115
		S. Asia	Greenwich	22 24	245	24 30	113
		Africa	Cape	22 29	238	24 24	120
			Hyderabad	22 20	243	LOW	
Oct. 6	C.D. − 23° 13589 (8ᵐ·3)	Australasia	Sydney	8 45	102	10 35	261
		E. Asia	Wellington	8 46	103	10 35	260
			Tokyo	SUN		10 35	267

4. **Saturn** and its rings will occult the star B.D. – 21° 5359 ($9^m.0$) between April 30 and May 1. As Saturn is then near its stationary point (its motion is only 1″ per hour), any accurate form of prediction is impossible, and only approximate times are given.

	Disappearance U.T.	Disappearance P	Reappearance U.T.	Reappearance P
	d h	°	d h	°
Outer edge of Rings	Apr. 30 04	258	May 1 18	75
Limb of Saturn	Apr. 30 15	261	May 1 11	71

5. No passages of planets in front of radio sources are predicted.

Occultations of Stars by Minor Planets

No actual occultations by minor planets have been predicted for established observatories in 1960, but the following appulses may be of interest to observers:

Mag.	Date	Time of Conjunction	Star	Mag.	Geocentric Separation*	Horizontal Parallax
Ceres		h m			″	″
9·0	Mar. 17	08 03	C.D. – 23° 16549	8·7	– 1·8	2·5
8·9	Apr. 2	11 52	C.D. – 22° 15275	9·3	– 5·3	2·6
8·9	Apr. 2	15 33	C.D. – 22° 15279	7·5	+ 0·7	2·6
8·1	July 8	12 41	C.D. – 23° 17399	9·6	– 10·0	4·1
Pallas						
9·5	Sept. 15	05 33	B.D. + 10° 3599	8·6	– 14·9	2·9
9·9	Oct. 26	05 19	B.D. + 3° 3879	8·3	– 8·0	2·5
Juno						
10·8	Feb. 29	16 52	B.D. – 10° 4507	7·4	+ 2·3	2·6
Vesta						
7·2	Mar. 21	01 58	B.D. – 18° 4938	8·9	+ 7·1	4·4

* The geocentric separation is here given in the sense $\delta_p - \delta_s$.

Transit of Mercury, November 7

The whole of or parts of the transit may be seen generally in western and central parts of Europe, Africa (except the very extreme east), the Atlantic Ocean, America, the Pacific Ocean (except the extreme west), Antarctica, New Zealand and the extreme east of Australia. The geocentric least angular distance between the centres of Mercury and the Sun is 8′ 48″ occurring at $16^h\ 53^m.0$.

Ingress (P= 148°)	Exterior contact	Interior contact	Egress (P= 262°)	Interior contact	Exterior contact
	h m	h m		h m	h m
Cape	14 33·3	14 35·3	Sydney	19 10·8	19 12·8
Greenwich	14 34·4	14 36·4	Wellington	19 10·7	19 12·7

MERCURY

Superior Conjunction	Greatest Elongation E.	Inferior Conjunction	Greatest Elongation W.
Jan. 26	Feb. 23 (18°)	Mar. 10	Apr. 7 (28°)
May 17	June 19 (25°)	July 17	Aug. 5 (19°)
Aug. 30	Oct. 15 (25°)	Nov. 7	Nov. 24 (20°)

Mercury will be best placed for observation in these latitudes in mid-February as an evening star and the second week of August as a morning star. For observers in the southern hemisphere the corresponding dates are the second week of October and the second week of April.

Mercury will be occulted by the Moon on March 25 as seen from America, Europe and N. Africa and on April 24 from Central Russia.

Mercury will be only 0°·2 S. of Venus on May 6^d 02^h. There will be a transit of Mercury on Nov. 7 (see p. 00).

Date	R.A.	Dec.	Ph.	Elong.
	Evening Star			
	h m	° ′		°
Feb. 11	22 20·9	− 11 38	91	12
16	22 52·3	7 41	80	15
21	23 18·5	3 47	62	18
26	23 35·7	− 0 36	39	18
Mar. 2	23 40·1	+ 1 06	18	15
May 26	4 53·1	+ 24 06	91	10
31	5 36·8	25 20	80	15
June 5	6 16·4	25 31	68	19
10	6 50·9	24 53	57	23
15	7 19·7	23 39	47	24
20	7 42·2	+ 22 04	38	25
25	7 57·9	20 21	29	24
30	8 06·3	18 42	20	22
July 5	8 06·9	17 21	12	17
10	7 59·8	+ 16 31	5	12
Sept. 13	12 05·7	+ 0 12	95	11
18	12 35·2	− 3 36	92	14
23	13 03·2	7 12	88	17
28	13 30·1	10 34	84	20
Oct. 3	13 56·0	13 38	80	22
8	14 20·6	− 16 22	74	24
13	14 43·5	18 40	67	25
18	15 03·4	20 25	58	25
23	15 18·0	21 28	45	23
28	15 23·6	21 30	29	20
Nov. 2	15 15·6	− 20 05	11	12

Date	R.A.	Dec.	Ph.	Elong.
	Morning Star			
	h m	° ′		°
Mar. 17	23 00·0	− 3 37	7	12
22	22 52·9	5 41	17	19
27	22 55·0	6 47	28	24
Apr. 1	23 04·9	6 53	38	27
6	23 20·5	6 07	46	28
11	23 40·5	− 4 35	54	28
16	0 03·7	− 2 26	61	26
21	0 29·5	+ 0 16	68	24
26	0 58·0	3 26	74	21
May 1	1 29·2	6 59	81	18
6	2 03·5	+ 10 48	89	13
July 25	7 25·2	+ 17 34	8	13
30	7 25·4	18 37	19	17
Aug. 4	7 36·5	19 31	34	19
9	7 58·5	19 54	52	19
14	8 29·7	19 24	71	16
19	9 07·1	+ 17 48	86	12
Nov. 17	14 25·5	− 12 05	29	17
22	14 34·3	12 33	52	20
27	14 53·8	14 18	69	20
Dec. 2	15 19·2	16 32	81	18
7	15 47·9	18 48	88	16
12	16 18·5	− 20 51	92	14
17	16 50·6	− 22 33	95	11

VENUS

Superior Conjunction June 22

In northern latitudes Venus will not be very conspicuous in 1960. It is a morning star at the beginning of the year and becomes an evening star after conjunction.

Venus is occulted by the Moon on Apr. 24 as seen from S. America and S. Africa and on Aug. 23 as seen from Antarctica.

It passes 1°·1 N. of Jupiter on Jan. 21^d 11^h, only 0°·2 N. of Saturn on Feb. 7^d 11^h, 1°·1 N. of Mars on Feb. 17^d 03^h and only 0°·2 N. of Mercury on May 6^d 02^h. It passes 1° N. of *Regulus* on Aug. 8^d 14^h.

Date		R.A.	Dec.	Mag.	Diam.	Ph.	Distance
		h m	° ′		″		
Jan.	2	15 51·5	− 17 50	− 3·6	15·9	72	1·059
	12	16 41·3	20 14	3·6	14·9	75	1·125
	22	17 32·7	21 45	3·5	14·1	78	1·190
Feb.	1	18 25·3	22 16	3·5	13·4	81	1·251
	11	19 18·1	21 42	3·4	12·8	83	1·310
	21	20 10·2	− 20 04	− 3·4	12·3	86	1·365
Mar.	2	21 01·1	17 27	3·4	11·9	88	1·418
	12	21 50·2	14 01	3·3	11·5	90	1·467
	22	22 37·8	9 57	3·3	11·1	92	1·513
Apr.	1	23 24·0	− 5 25	− 3·3	10·8	93	1·556
Sept.	3	12 02·7	+ 0 58	− 3·3	10·6	94	1·586
	13	12 47·4	− 4 11	3·3	10·9	92	1·545
	23	13 32·6	9 12	3·3	11·2	91	1·500
Oct.	3	14 19·0	13 53	3·3	11·6	89	1·451
	13	15 07·0	18 02	3·4	12·0	87	1·400
	23	15 57·0	− 21 25	− 3·4	12·5	85	1·345
Nov.	2	16 48·8	23 51	3·4	13·1	82	1·288
	12	17 41·9	25 10	3·5	13·7	80	1·229
	22	18 35·4	25 16	3·5	14·4	77	1·167
Dec.	2	19 28·1	24 09	3·6	15·3	74	1·102
	12	20 19·0	− 21 54	− 3·6	16·2	71	1·036
	22	21 07·2	− 18 40	− 3·7	17·4	68	0·967

The Phase (Ph.) in these tables is the fraction of the area of the disk which is illuminated. It is also the fraction of the diameter, perpendicular to the line of cusps, lying in the visible portion of the disk. For convenience, it is given in these tables as a percentage. The elongation (Elong.) of a planet from the Sun is given in the case of Mercury only. The distance, where given, is expressed in astronomical units of 93,000,000 miles.

MARS

Opposition December 30

Mars will remain a morning star throughout the year, passing from the southern constellations of Scorpio and Sagittarius to reach a stationary point (November 21) and opposition in Gemini. The planet passes 5° north of *Aldebaran* on August 17. Mars will be closest to the Earth on December 25.

Mars will be occulted by the Moon on May 20 (East Indies, Northern Australia and the Pacific), and will be 1°·2 S. of Saturn on January 31^{d} 11^{h}, and 1°·1 S. of Venus on February 17^{d} 03^{h}.

Date	R.A.	Dec.	Mag.	Diam.	*P*	Q	Ph.	Tilt	Distance
	h m	° ′		″	°	°		°	
May 6	23 47·4	− 2 55	+ 1·2	5·2	337	245	92	− 24	1·807
16	0 15·4	+ 0 06	1·2	5·3	333	245	91	24	1·762
26	0 43·2	3 05	1·1	5·5	330	246	90	23	1·716
June 5	1 11·0	6 00	1·1	5·6	327	247	90	22	1·671
15	1 38·7	8 46	1·0	5·8	325	248	89	20	1·625
25	2 06·4	+ 11 23	+ 1·0	5·9	324	249	89	− 19	1·579
July 5	2 34·2	13 47	0·9	6·1	323	251	88	17	1·532
15	3 01·9	15 57	0·9	6·3	323	253	88	14	1·484
25	3 29·6	17 51	0·8	6·5	324	255	87	12	1·434
Aug. 4	3 57·1	19 28	0·8	6·8	325	258	87	9	1·383
14	4 24·3	+ 20 47	+ 0·7	7·0	326	260	87	− 7	1·329
24	4 50·8	21 49	0·6	7·4	328	263	86	4	1·273
Sept. 3	5 16·5	22 35	0·6	7·7	330	266	86	− 2	1·215
13	5 41·0	23 05	0·5	8·1	333	268	86	0	1·154
23	6 04·1	23 23	0·4	8·6	335	270	86	+ 2	1·091
Oct. 3	6 25·2	+ 23 31	+ 0·2	9·1	337	272	87	+ 4	1·026
13	6 43·9	23 33	+ 0·1	9·8	340	274	88	6	0·959
23	6 59·7	23 33	− 0·1	10·5	342	276	89	7	0·892
Nov. 2	7 11·8	23 36	0·3	11·3	343	277	90	8	0·827
12	7 19·6	23 48	0·5	12·2	344	277	92	8	0·764
22	7 22·0	+ 24 11	− 0·6	13·2	344	276	94	+ 8	0·707
Dec. 2	7 18·4	24 47	0·9	14·2	344	274	96	7	0·659
12	7 08·7	25 33	1·1	15·0	343	270	98	6	0·625
22	6 53·8	26 19	1·3	15·4	341	259	99	4	0·608
32	6 36·4	26 54	− 1·3	15·3	339	153	100	+ 2	0·612

P = Position angle of the axis of rotation, measured eastwards from the north point.

Q = Position angle of the point of greatest defect of illumination. The position angle of the line of cusps is Q ± 90°.

Tilt = the tilt of the north pole of Mars towards (+) or away from (−) the Earth. These quantities will enable the disk to be sketched before observing.

JUPITER

Opposition June 20

Jupiter passes from Ophiuchus into Sagittarius during the early months of the year, but its retrograde motion carries it back again; the stationary points occur on April 20 and August 20.

Jupiter will be 1°·1 S. of Venus on January 21^{d} 11^{h}.

Date		R.A.	Dec.	Mag.	Polar Diam.	Equat. Diam.	Distance
		h m	° ′		″	″	
Feb.	16	17 50·4	− 22 59	− 1·5	32·0	34·3	5·747
	26	17 57·2	23 00	1·6	32·8	35·2	5·602
Mar.	7	18 03·1	23 01	1·6	33·7	36·1	5·449
	17	18 08·0	23 00	1·7	34·7	37·2	5·289
	27	18 11·8	23 00	1·8	35·8	38·4	5·127
Apr.	6	18 14·3	− 22 59	− 1·8	37·0	39·6	4·967
	16	18 15·6	22 59	1·9	38·2	40·9	4·813
	26	18 15·5	23 00	2·0	39·4	42·2	4·669
May	6	18 14·0	23 01	2·0	40·5	43·4	4·540
	16	18 11·3	23 02	2·1	41·5	44·5	4·429
	26	18 07·4	− 23 04	− 2·1	42·3	45·4	4·341
June	5	18 02·7	23 05	2·2	42·9	46·0	4·279
	15	17 57·3	23 07	2·2	43·3	46·4	4·245
	25	17 51·8	23 07	2·2	43·3	46·4	4·241
July	5	17 46·4	23 07	2·2	43·1	46·2	4·266
	15	17 41·6	− 23 07	− 2·1	42·6	45·6	4·319
	25	17 37·6	23 07	2·1	41·8	44·8	4·398
Aug.	4	17 34·8	23 07	2·1	40·9	43·8	4·499
	14	17 33·2	23 07	2·0	39·8	42·6	4·619
	24	17 33·0	23 09	1·9	38·7	41·4	4·754
Sept.	3	17 34·1	− 23 11	− 1·9	37·5	40·2	4·899
	13	17 36·6	23 14	1·8	36·4	39·0	5·050
	23	17 40·2	23 17	1·8	35·3	37·9	5·203
Oct.	3	17 45·1	23 20	1·7	34·3	36·8	5·354
	13	17 50·9	− 23 23	− 1·6	33·4	35·8	5·500

The tables of longitudes on the following pages refer to the central meridian of the illuminated disk, the correction for phase having been applied. For the convenience of observers, alternative headings using G.M.A.T. beginning at noon are given. The brief tables of movement of the central meridian are based on mean daily synodic rotations of 877°·95 for System I, and 870°·30 for System II. More extended tables are given in the *Astronomical Ephemeris* each year, and were also published in the *Handbook* for 1931, 1932 and 1933.

LONGITUDE OF CENTRAL MERIDIAN OF JUPITER

SYSTEM I

Month U.T. G.M.A.T.	Feb. 24^h 12	Mar. 24^h 12	Apr. 24^h 12	May 22^h 10	June 20^h 8	July 20^h 8	Aug. 20^h 8	Sept. 19^h 7	Oct. 17^h 5
Day	°	°	°	°	°	°	°	°	°
1	204·9	101·5	315·9	301·4	86·9	147·7	4·2	180·5	159·6
2	2·7	259·3	113·8	99·4	244·9	305·7	162·1	338·3	317·3
3	160·4	57·2	271·7	257·4	43·0	103·7	319·9	136·0	115·0
4	318·2	215·0	69·7	55·4	201·0	261·7	117·8	293·8	272·7
5	116·0	12·9	227·6	213·4	259·0	59·7	275·7	91·6	70·4
6	273·8	170·7	25·5	11·4	257·1	217·7	73·6	249·4	228·1
7	71·6	328·6	183·4	169·4	315·1	15·7	231·5	47·1	25·8
8	229·4	126·4	341·4	327·4	113·2	173·7	29·3	204·9	183·5
9	27·2	284·3	139·3	125·4	271·2	331·6	187·2	2·6	341·2
10	185·0	82·2	297·3	283·5	69·2	129·6	345·0	160·4	138·8
11	342·8	240·1	95·2	81·5	227·3	287·6	142·9	318·2	296·5
12	140·6	37·9	253·2	239·5	25·3	85·6	300·8	115·9	94·2
13	298·4	195·8	51·1	37·5	183·3	243·5	98·6	273·7	251·9
14	96·2	353·7	209·1	195·5	341·4	41·5	256·5	71·4	49·6
15	254·0	151·5	7·0	353·5	139·4	199·4	54·3	229·2	207·3
16	51·8	309·4	165·0	151·5	297·4	357·4	212·1	26·9	5·0
17	209·7	107·3	323·0	309·6	95·5	155·3	10·0	184·6	162·6
18	7·5	265·2	120·9	107·6	253·5	313·3	167·8	342·3	320·3
19	165·3	63·1	278·9	265·6	51·5	111·2	325·6	140·1	118·0
20	323·1	221·0	76·9	63·6	209·6	269·2	123·5	297·8	275·7
21	120·9	18·9	234·8	221·7	7·6	67·1	281·3	95·6	73·4
22	278·8	176·8	32·8	19·7	165·6	225·0	79·1	253·3	231·0
23	76·6	334·7	190·8	177·7	323·6	23·0	236·9	51·0	28·7
24	234·4	132·6	348·7	335·7	121·7	180·9	34·7	208·7	186·4
25	32·3	290·5	146·7	133·8	279·7	338·8	192·5	6·5	344·1
26	190·1	88·4	304·7	291·8	77·7	136·7	350·3	164·2	141·7
27	347·9	246·3	102·7	89·8	235·7	294·7	148·1	321·9	299·4
28	145·8	44·2	260·7	247·9	33·7	92·6	305·9	119·6	97·1
29	303·6	202·1	58·7	45·9	191·7	250·5	103·7	277·3	254·7
30		0·0	216·6	203·9	349·7	48·4	261·5	75·1	52·4
31		158·0		2·0		206·3	59·3		210·1

Change of Longitude in Intervals of Mean Time

h	°	h	°	m	°	m	°	m	°
1	36·6	6	219·5	10	6·1	1	0·6	6	3·7
2	73·2	7	256·1	20	12·2	2	1·2	7	4·3
3	109·7	8	292·7	30	18·3	3	1·8	8	4·9
4	146·3	9	329·2	40	24·4	4	2·4	9	5·5
5	182·9	10	5·8	50	30·5	5	3·0	10	6·1

System I applies to all objects situated on or between the north component of the south equatorial belt and the south component of the north equatorial belt.

LONGITUDE OF CENTRAL MERIDIAN OF JUPITER

SYSTEM II

Month	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
U.T.	24^h	24^h	24^h	22^h	20^h	20^h	20^h	19^h	17^h
G.M.A.T.	12	12	12	10	8	8	8	7	5
Day	°	°	°	°	°	°	°	°	°
1	175·4	210·6	188·5	305·8	215·3	47·2	27·1	327·3	78·2
2	325·5	0·8	338·8	96·2	5·7	197·6	177·4	117·5	228·3
3	115·6	151·1	129·1	246·6	156·1	347·9	327·6	267·6	18·3
4	265·8	301·3	279·4	36·9	306·5	138·3	117·9	57·8	168·4
5	56·0	91·5	69·7	187·3	96·9	288·7	268·2	207·9	318·5
6	206·1	241·7	220·0	337·7	247·3	79·0	58·4	358·1	108·6
7	356·3	32·0	10·3	128·1	37·7	229·4	208·6	148·2	258·6
8	146·5	182·2	160·6	278·4	188·1	19·7	358·9	298·3	48·7
9	296·6	332·4	310·9	68·8	338·5	170·1	149·1	88·4	198·8
10	86·8	122·7	101·2	219·2	128·9	320·4	299·3	238·6	348·8
11	236·9	272·9	251·5	9·6	279·3	110·8	89·6	28·7	138·9
12	27·1	63·2	41·9	159·9	69·7	261·1	239·8	178·8	288·9
13	177·3	213·4	192·2	310·3	220·1	51·4	30·0	328·9	79·0
14	327·5	3·6	342·5	100·7	10·5	201·8	180·2	119·1	229·1
15	117·7	153·9	132·8	251·1	160·9	352·1	330·4	269·2	19·1
16	267·9	304·2	283·2	41·5	311·3	142·4	120·6	59·3	169·2
17	58·0	94·4	73·5	191·9	101·7	292·7	270·9	209·4	319·2
18	208·2	244·7	223·8	342·3	252·1	83·1	61·0	359·5	109·3
19	358·4	34·9	14·1	132·7	42·5	233·4	211·2	149·6	259·3
20	148·6	185·2	164·5	283·1	192·9	23·7	1·4	299·7	49·4
21	298·8	335·4	314·8	73·4	343·3	174·0	151·7	89·8	199·4
22	89·0	125·7	105·2	228·9	133·7	324·3	301·8	239·9	349·5
23	239·2	276·0	255·5	14·2	284·1	114·6	92·0	30·0	139·5
24	29·4	66·2	45·9	164·6	74·5	264·9	242·2	180·1	289·6
25	179·6	216·5	196·2	315·0	224·9	55·2	32·4	330·2	79·6
26	329·8	6·8	346·6	105·4	15·3	205·5	182·5	120·3	229·6
27	120·0	157·1	136·9	255·8	165·7	355·8	332·7	270·4	19·7
28	270·2	307·4	287·3	46·3	316·1	146·0	122·9	60·5	169·7
29	60·4	97·6	77·6	196·7	106·4	296·3	273·1	210·5	319·8
30		247·9	228·0	347·0	256·8	86·6	63·2	0·6	109·8
31		38·2		137·5		236·8	213·4		259·8

Change in Longitude in Intervals of Mean Time

h	°	h	°	m	°	m	°	m	°
1	36·3	6	217·6	10	6·0	1	0·6	6	3·6
2	72·5	7	253·8	20	12·1	2	1·2	7	4·2
3	108·8	8	290·1	30	18·1	3	1·8	8	4·8
4	145·1	9	326·4	40	24·2	4	2·4	9	5·4
5	181·3	10	2·6	50	30·2	5	3·0	10	6·0

System II applies to all objects situated north of the south component of the north equatorial belt or south of the north component of the south equatorial belt.

SATELLITES OF JUPITER

The following pages give the configurations of the four great satellites of Jupiter, as seen in an inverting telescope in the northern hemisphere. The column headed ♃ between heavy lines represents the body of the planet, and the figures 1 to 4 represent the satellites. A number between the heavy lines thus represents a transit of that satellite, and shadow transits are similarly represented by the letters *a*, *b*, *c* or *d* for the shadows of satellites 1, 2, 3 or 4 respectively. A missing number shows that a satellite is in eclipse or occulted. The aim has been to give the times of all visible eclipses, together with sufficient other information to enable the observer to identify the satellites and their shadows.

The column headed *Time* gives the time of eclipse (and certain other phenomena) to the nearest minute, but where the minutes are omitted, the configuration is merely intended as a general guide at about that hour. The times have been chosen to suit observers in S. Africa, Australia and New Zealand, as well as in this country. Observers in the southern hemisphere will have to invert these diagrams to obtain the correct orientation.

The column *Phen.* gives the phenomenon which occurs at the time stated. The configuration given then shows the position of the satellites immediately afterwards. The abbreviations used are

E = eclipse commences F = eclipse finishes

D = disappearance by occultation R = reappearance from occultation

Observers should have no difficulty in identifying the satellites at any particular time, and the movements are clearly shown in the changes from line to line. Thus the identification of a missing satellite is made by glancing at the preceding and following lines, where the beginning or end of an eclipse or occultation will generally be found. At times near conjunction this may be more difficult, as fewer phenomena are given during such restricted hours.

The satellites move from east to west (i.e. from the *f* to the *p* side) across the face of the planet, and from west to east behind it. Before opposition the shadows fall to the west, and after opposition to the east. To make this clear the word *Shadow* is printed at the foot of the appropriate column.

Detailed notes on these phenomena will be found in the 1944 *Handbook*.

There is a curious relationship between the mean daily motions of satellites I, II and II such that

$$3n_2 = 2n_3 + n_1$$

This implies that these three satellites cannot all undergo the same phenomenon at the same time. Thus I and III may be in transit, and II in eclipse, or I in transit, II and III occulted, and so on; but the three are never eclipsed together, and can never be seen together in transit.

Phenomena of Satellite IV commence again in 1960 with an eclipse on September 7 and a shadow-transit on September 15; these are followed by a transit on October 18 and an occultation on October 27. The shadow transit on September 15 commences at $17^h\ 31^m$ and lasts for 41^m; the others are less readily observable.

Time d	h	m	Phen.	*p* West	♃	*f* East
February						
1	7			4		123
	16			4 1	2	3
2	4	56	E 1	24		3
	18			2 4		1 3
3	6			12		4 3
	17			1		234
4	6			3		12 4
5	6			31	2	4
	17	53	E 1	3 2		4
6	6			32		1 4
	17			32	*a*1	4
7	6			13		2 4
	17					3124
8	6					1234
	17			1	*b*	2 34
9	6	49	E 1	2		34
	17			2		1 34
10	6			2	*a*1	34
	18			1		324
11	1	18	E 1		*c*	342
	6					412
	18			34		12
12	6			341	*b*	2
	18			3421		
13	6			432		1
	18			43 2	*a*1	
	23	38	E 2	43 1		
14	6			4 31		2
	13	59	E 3	4 1		2
	14	14	E 1	4		2
	16	41	F 3	4 3		2
15	6			4		312
	18			4 1		23
16	6			4 21		3
	18			4 2		1 3
17	17			4 1		23
18	3	11	E 1	4		32
	17			4 3		12
19	5			341		2
	17			3124		
20	5			3 2		14
21	2	11	E 2	31		4
	16	08	E 1	3		2 4
	17	57	E 3			2 4
22	5					3124
	16				1	23 4
23	5			12		34
				Shadow		

Time d	h	m	Phen.	*p* West	♃	*f* East
February						
23	17			2		1 34
24	15	28	E 2	1		3 4
25	5	05	E 1			32 4
	17			3		12 4
26	5			3	1	2 4
	17			312		4
27	5			32		14
28	4	45	E 2	3 1		4
	18	02	E 1	34		2
29	0	39	F 3	43		12
	5			4		12
	17			4	*a*1	23
March						
1	4			4 1	2	3
	16			4 2		1 3
2	18	02	E 2	4 1		3
3	4			4 1		23
	16			4		312
4	5			4 3	*a*	12
	16			4 31	2	
5	1	27	E 1	43 2		
	5			432		1
6	4			4321		
	16			4 31		2
7	1	53	E 3	4		12
	4	37	F 3	43		12
	16			4		312
8	4			1	*b*	243
	14	23	E 1	2		43
9	4			2		143
	16			21		34
10	4			1		23 4
	16				*c*	3124
11	4			3		12 4
	16			31	*b*	2 4
12	3	20	E 1	3 2		4
	16			32		1 4
13	4			321		4
	16			31		2 4
14	5	50	E 3			124
	16					3124
15	4			1		234
	16	17	E 1	2		4 3
16	4			24		1 3
	16			24	1	3
	23	10	E 2	41		3
				Shadow		

Time	Phen.	*p* West	♃	*f* East
March				
d h m				
17 5		4 1		2 3
16		4		132
18 3		4	3	12
16		4 31		2
19 5 13	E 1	43 2		
16		432		1
20 4		43 2	*a*1	
12 27	E 2	43 1		
15 00	F 2	4312		
23 42	E 1	4 3		2
21 4		4 3		12
12 34	F 3	4 3		12
22 4		4 1		23
16		4 21		3
18 10	E 1	4 2		3
23 4		42		1 3
16		24	*a*	1 3
24 1 44	E 2	14		3
4 17	F 2	142		3
12 38	E 1			423
25 4				3142
15		31		2 4
26 3		312		4
15		32		1 4
27 15 02	E 2	3 1		4
17 34	F 2	312		4
28 1 35	E 2	3		2 4
13 45	E 3			12 4
16 32	F 3	3		12 4
29 3		1		32 4
15		1	2	3 4
30 3		2		1 34
31 4 19	E 2	1		34
14 32	E 1			23 4
April				
1 3				3142
15		3	1	42
2 3		314	2	
15		342		1
3 17 36	E 2	4 31		
4 3 28	E 1	4 3		2
17 43	E 3	4		12
5 3		4	1	32
15		4 1	*b*	23
21 57	E 1	4 2		3
6 3		4 2		1 3
		Shadow		

Time	Phen.	*p* West	♃	*f* East
April				
d h m				
7 3		4 12		3
16 25	E 1	4		23
8 3		4		312
15		4	3 *a* 1	2
9 3		431	*b*	2
10 53	E 1	342		
10 3		324		1
20 11	E 2	3 1		4
11 3		31		24
21 41	E 3			124
12 0 30	F 3	3		12 4
3			*a*	12 4
15		1		23 4
23 50	E 1	2		34
13 15		2		1 34
14 3		21		34
18 18	E 1			2 34
15 3				1234
15				3124
16 3		13		2 4
12 46	E 1	32		4
17 3		32		1 4
22 46	E 2	3 1		4
18 15		34		12
19 1 39	E 3	4		12
4 29	F 3	4 3	*a*	12
15		4 1		32
20 1 43	E 1	4 2		3
15		4 2		1 3
21 2		4 2	*a* 1	3
12 03	E 2	4 1		3
20 11	E 1	4		2 3
22 3		4		123
16		4	*c*	132
23 3		4 13		2
14 40	E 1	4 32		
24 3		432		1
15		43 2	1	
25 1 21	E 2	43 1		
14		43		12
26 14		14		32
27 3 36	E 1	2		43
14		2		143
28 2		2	*a*1	43
14 38	E 2	1		34
22 05	E 1			2 34
29 2				1234
		Shadow		

Time			Phen.		*p* West	♃	*f* East
April							
d	h	m					
29	14						1324
30	2				1	3	2 4
	16	33	E	1	32		4
May							
1	2				32		1 4
2	2				312		4
	3	56	E	2	3 1		4
	11	01	E	1	3		2 4
3	1				3		12 4
	9	34	E	3		*a*1	2 4
	12	26	F	3	13		2 4
4	1				1	*b*2	3 4
	13				2		143
5	1				2		413
	17	14	E	2	41		3
	23	58	E	1	4		2 3
6	13				4		132
7	1				4 1	*c*	32
	13				4 13	*b*	2
	18	26	E	1	4 32		
8	1				432		1
9	1				4321		
	12	55	E	1	43		2
10	1				4 3		12
	13	32	E	3	4 1		2
	16	24	F	3	4 13		2
11	2				4 1	*b*	23
	13				4 2		1 3
12	13				4 21		3
	19	49	E	2	4 1		3
13	1	51	E	1	4		2 3
	13				4		123
14	1					*a*1	342
	13				13		2 4
	20	20	E	1	32		4
15	1				32		1 4
16	1				321		4
	9	08	E	2	3 1		4
	14	48	E	1	3		2 4
17	1				3		12 4
	17	29	E	3	1		2 4
	20	23	F	3	13		2 4
18	1				1		32 4
	9	16	E	1	2		3 4
19	1				2		1 34
	22	25	E	2			1 34
					Shadow		
May							
d	h	m					
20	3	45	E	1			2 34
	13						1234
21	2					*b*1	342
	13				1	3	42
	22	13	E	1	342		
22	2				3 42		1
	13				324		1
23	1				3421		
	11	44	E	2	43 1		
	16	42	E	1	43		2
24	1				4 3		12
	21	28	E	3	4 1		32
25	11	10	E	1	4 2		3
26	1				4 2		13
27	1	01	E	2	4 1		3
	13				4		123
28	1				4		132
	14				4 1	*c*3	2
29	0	07	E	1	432		
	13				324		1
30	1				3214		
	14	20	E	2	3 1		4
	18	35	E	1	3		24
31	1				3		124
June							
1	0				13		2 4
	1	26	E	3	1		2 4
	13	04	E	1	2		3 4
2	0				2		13 4
	12				2	*a*1	34
3	0				12		34
	3	38	E	2	1		34
	7	32	E	1			2 34
	12						1234
4	12				1		32 4
5	2	00	E	1	32		4
	12				32		1 4
6	0				3 2	*a*1	4
	16	56	E	2	3 1		4
	20	29	E	1	3		2 4
7	0				3		124
	13				3 4		12
8	0				431		2
	14	57	E	1	4	2	3
9	0				4 2		13
10	0				4 12		3
					Shadow		

Time	Phen.	*p* West	♃	*f* East
June				
d h m				
10 9 26	E 1	4		2 3
13		4		123
11 13		4 1		32
23		4 1	3	2
12 3 54	E 1	4 3	2	
11		4 32		1
13 11		4321		
19 33	E 2	43 1		
22 23	E 1	43		
14 11		43		12
23		431		2
15 9 23	E 3	14		2
16 51	E 1	4	*b*2	3
23		2		413
16 11		2		143
23		21		43
17 8 51	E 2	1		34
11 19	E 1			34
23				1234
18 10			*a*1	32 4
19 0		1	*c*3	2 4
13		32		1 4
20 11		321		4
		Shadow		

Opposition. After this date satellites are occulted on the "*p*" side and reappear from eclipse on the "*f*" side.

Time	Phen.	*p* West	♃	*f* East
20 23		312		4
21 0 48	F 2	3		2 4
2 29	F 1	3		12 4
23		3	1*a*	2 4
22 16 19	F 3	1		23 4
20 58	F 1	2		1 34
23 11		2		143
23		21		4 3
24 14 06	F 2	4		2 3
15 26	F 1	4		123
25 11		4	1*a*	23
23		4 1		32
26 9 55	F 1	4 32		1
27 11		4321		
23		4312		
28 3 26	F 2	43		2
4 24	F 1	43		12
29 0		4 3	1*a*	2
20 19	F 3	4 13	2*b*	
22 52	F 1	4 2		13
				Shadow

Time	Phen.	*p* West	♃	*f* East
June				
d h m				
30 23		421		3
July				
1 16 44	F 2	4		2 3
17 21	F 1	4		12 3
2 11				1423
23		1		342
3 11 49	F 1	32		1 4
4 11		321		4
23		312		4
5 6 03	F 2	3		2 4
6 18	F 1	3		12 4
6 1		3	1	2 4
12		13		2 4
7 0 18	F 3	2	*b*	3 4
0 46	F 1	2		13 4
23		21		34
8 19 15	F 1			1 34
19 22	F 2			2134
9 13				1234
23		1		342
10 13 43	F 1		*bc*	41
23		324		1
11 11		3241		
23		3421		
12 8 12	F 1	43		1
8 41	F 2	43		21
23		43		12
13 11		4 31		2
14 0		4	2	
12		4 2		31
23		4 2	1*a*	3
15 11		4 21		3
21 09	F 1	4		1 3
21 59	F 2	4		213
16 11		4		123
23		4 1		23
17 15 38	F 1	4 2	3*bc*	1
23		423		1
18 11		324	1*a*	
23		321		4
19 10 07	F 1	3		14
11 19	F 2	3		214
23		3		12 4
20 23		31		2 4
21 8 19	F 3	2		31 4
23		2	1	3 4
				Shadow

Time d	h m	Phen.	*p* West	♃	*f* East
July					
22	11		21		34
	23 04	F 1			1 34
23	0 37	F 2			2134
	11				1234
	23		1		234
24	17 32	F 1		23*b*	1 4
	22		23	*c*	1 4
25	22		321		4
26	12 01	F 1	3		1 4
	13 57	F 2	3		214
	23		3		412
27	11		314		2
	22		431		2
28	6 30	F 1	4	2*b*	1
	9 17	E 3	4 2		1
	12 19	F 3	4 2		31
	23		4 2		13
29	21		4 21		3
30	0 58	F 1	4		1 3
	3 15	F 2	4		213
	22		4 1	*a*	23
31	19 27	F 1	4	2*b*	31
	22		4 2	3	1
August					
1	22		4321		
2	13 56	F 1	43		1
	16 30	F 2	43		21
	22		43		12
3	22		431		2
4	13 16	E 3	24		1
	16 19	F 3	2		431
	22		2		143
5	22		21		43
6	12				1234
	22			1*a*	23 4
7	21 22	F 1		2	31 4
8	22		321		4
9	15 50	F 1	3		1 4
	19 13	F 2	3		21 4
10	22		31		2 4
11	10 19	F 1	3	2	1 4
	17 15	E 3	2		1 4
	20 19	F 3	2		314
12	22		21		43
18	8 31	F 2	4		213
	22		4		123
					Shadow

Time d	h m	Phen.	*p* West	♃	*f* East
August					
14	12		4 1		2 3
	23 17	F 1	4	2	13
15	12		4 23		1
	22		4321		
16	17 45	F 1	43		1
	21 51	F 2	43		21
17	22		43 1		2
18	12 14	F 1	4 3	2	1
	21 14	E 3	4 2		1
19	12		4 21		3
20	6 43	F 1	4		13
	11 09	F 2	4		213
	22		4		123
21	21		1		234
22	12		23	*c*	1 4
	22		231	*a*	4
23	19 40	F 1	3		1 4
24	12		3		12 4
	21		31		2 4
25	14 09	F 1	3	2	1 4
	21		2		1 4
26	21		21		3 4
27	8 38	F 1			13 4
	13 47	F 2			2134
	21				1234
28	21		1		243
29	11		2	3	41
	21		234	1	
30	11		3241		
	21 35	F 1	34 2		1
31	21		43 1		2
September					
1	20		4 32	*b*	1
2	8 21	F 3	4 2		13
	20		4 21		3
3	10 33	F 1	4 2		1 3
	20		4		213
4	20		4 1		23
5	20		423	*c*	1
6	10		3214		
	20		324		
7	9 52	E 4	3		12
	10 41	F 4	3		142
	20		3 1	*a*	42
8	17 59	F 1	3		214
	20		3	2	1 4
					Shadow

SATURN

Opposition July 7

Saturn remains in Sagittarius throughout the year. The rings are now beginning to close again, and the planet is slightly less bright than in 1959.

Saturn will be only 0°·2 S. of Venus on February 7^d 11^h, and 1°·2 N. of Mars on January 31^d 11^h; an occultation of a 9th magnitude star by Saturn is predicted on page 25.

Date	R.A.	Dec.	Mag.	Polar Diam.	Rings Major Axis	Rings Minor Axis	Distance
	h m	° ′		″	″	″	
Feb. 26	19 07·1	− 22 03	+ 0·8	14·0	35·2	14·6	10·655
Mar. 17	19 13·7	21 52	0·8	14·4	36·2	14·8	10·367
Apr. 6	19 17·9	21 45	0·8	14·9	37·4	15·1	10·041
26	19 19·6	21 43	0·7	15·4	38·6	15·6	9·711
May 16	19 18·4	21 46	0·6	15·8	39·9	16·1	9·416
June 5	19 14·8	− 21 54	+ 0·5	16·2	40·8	16·6	9·189
25	19 09·3	22 04	0·3	16·5	41·4	17·1	9·059
July 15	19 03·0	22 16	0·3	16·5	41·5	17·4	9·045
Aug. 4	18 57·3	22 26	0·4	16·3	41·0	17·4	9·147
24	18 53·1	22 34	0·5	15·9	40·1	17·1	9·352
Sept. 13	18 51·3	− 22 38	+ 0·6	15·5	39·0	16·7	9·634
Oct. 3	18 52·3	22 39	0·7	15·0	37·7	16·2	9·957
23	18 56·1	22 36	0·8	14·5	36·5	15·6	10·285
Nov. 12	19 02·3	22 29	0·8	14·1	35·5	15·0	10·582
Dec. 2	19 10·4	− 22 18	+ 0·8	13·8	34·7	14·4	10·817

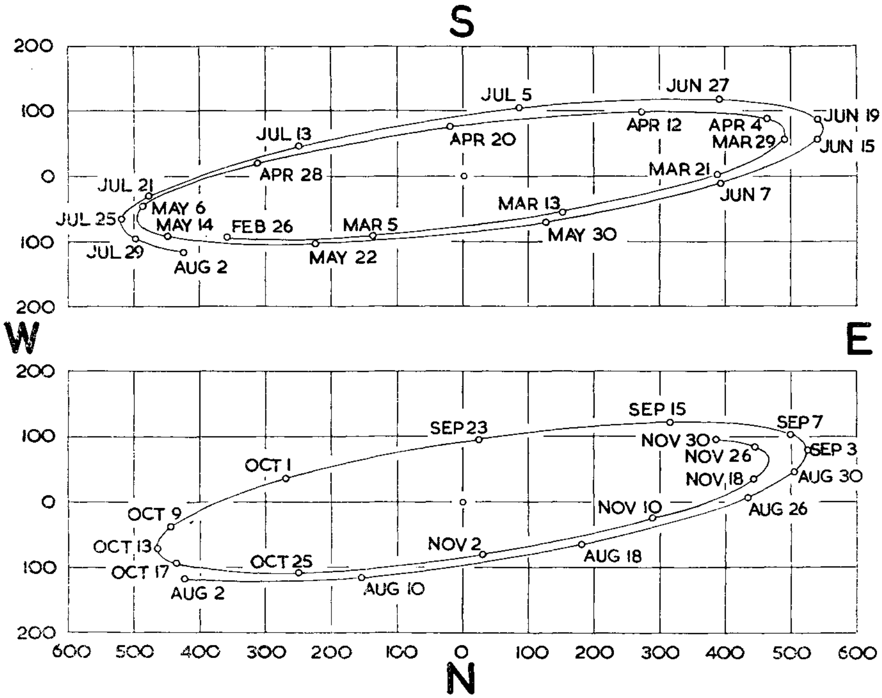
Satellites of Saturn

For details of these satellites see 1948 *Handbook*.

Titan. Diagrams are given on page 40 to show the position of Titan, as seen in an inverting telescope, at each successive midnight.

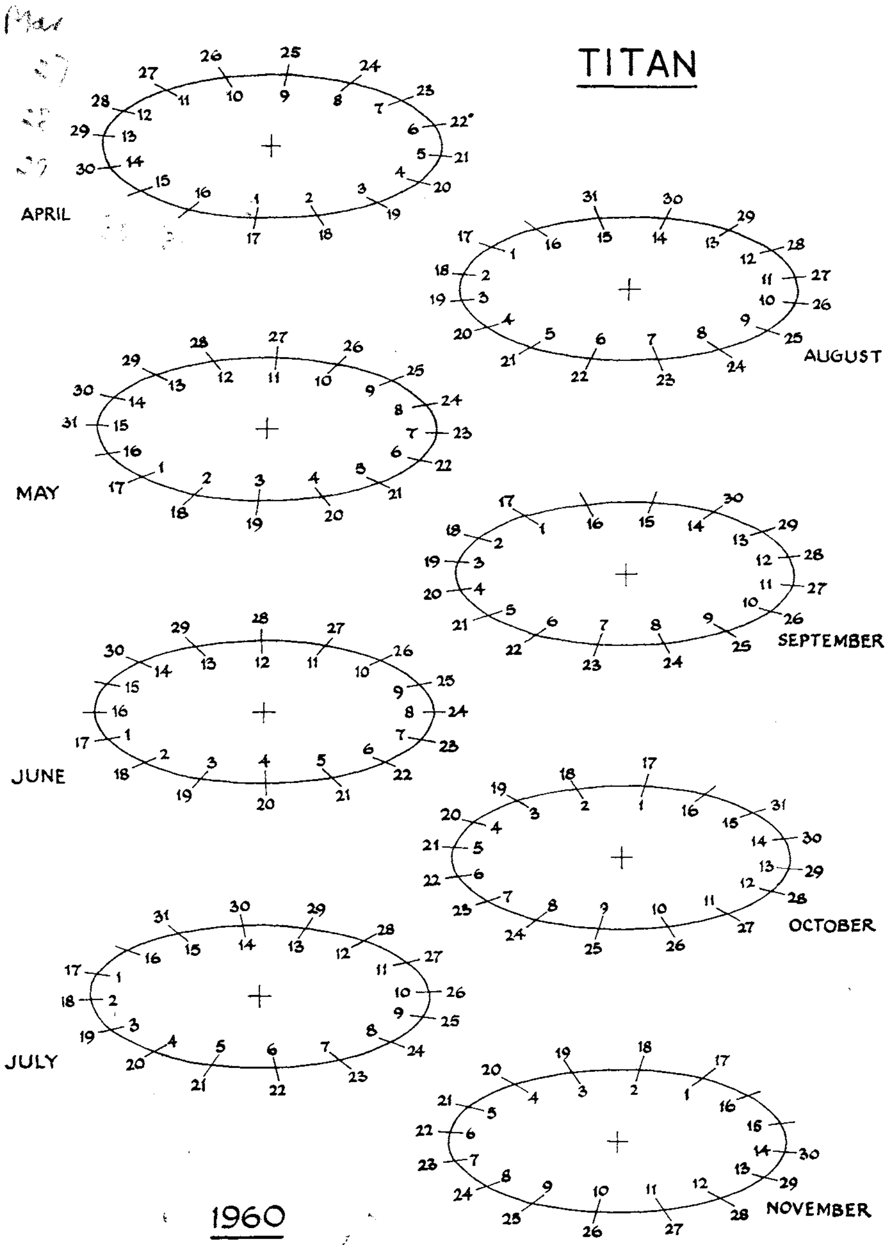
Hyperion. This satellite may be seen most easily when near conjunction with Titan. The most favourable dates occur just after the western elongations of March 28, May 31, August 3 and October 5.

Iapetus. The diagrams on p. 39 show the path of this satellite to scale, the measurements being in seconds of arc. Iapetus is interesting because it is much brighter at western elongation (March 30, June 17, September 3, November 22).



Rhea. The following table gives eastern elongations and position angles at multiples of six hours after eastern elongation:

Rhea at Eastern Elongation						Time after E. Elong.	*P*
	d h		d h		d h	d h	°
Feb.	9 13·2	May	18 23·6	Aug.	26 07·0	0 00	97
	14 01·8		23 12·0		30 19·3	06	106
	18 14·3		28 00·3	Sept.	4 07·7	12	116
	23 02·9	June	1 12·6		8 20·1	18	133
	27 15·4		6 01·0		13 08·6	1 00	164
Mar.	3 04·0		10 13·3		17 21·0	06	209
	7 16·5		15 01·6		22 09·4	12	240
	12 05·0		19 14·0		26 21·9	18	257
	16 17·5		24 02·3	Oct.	1 10·3	2 00	268
	21 06·0		28 14·6		5 22·8	06	277
	25 18·5	July	3 02·9		10 11·3	12	285
	30 07·0		7 15·2		14 23·8	18	296
Apr.	3 19·5		12 03·5		19 12·3	3 00	312
	8 07·9		16 15·9		24 00·8	06	342
	12 20·4		21 04·2		28 13·3	12	27
	17 08·8		25 16·5	Nov.	2 01·9	18	60
	21 21·2		30 04·8		6 14·4	4 00	77
	26 09·6	Aug.	3 17·2		11 03·0	06	88
	30 22·1		8 05·5		15 15·5		
May	5 10·5		12 17·8		20 04·1		
	9 22·8		17 06·2		24 16·6		
	14 11·2		21 18·6		29 05·2		


TITAN
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
1960

Scale ?

URANUS

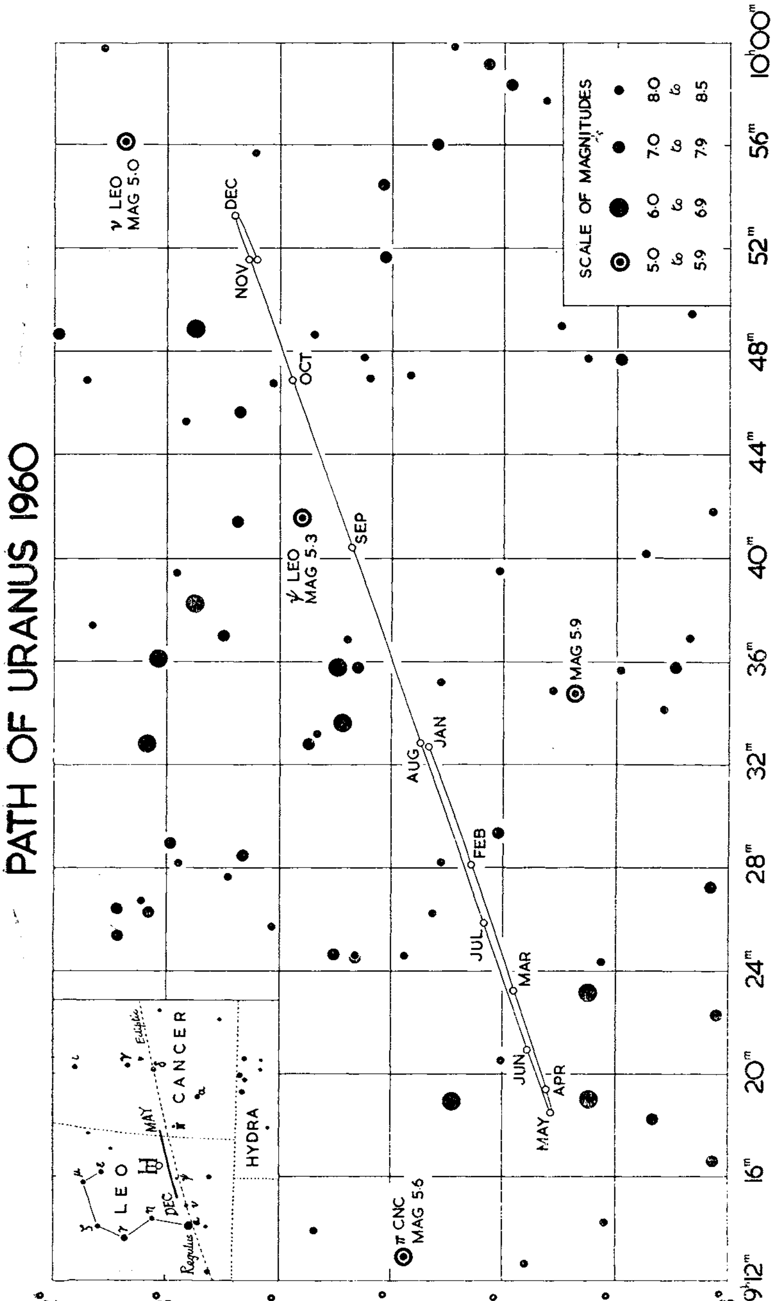
Uranus will be seen on the borders of Cancer and Leo. At opposition on Feb. 8, its geocentric distance will be 17·41 units and its apparent diameter 3″·9. Uranus is bright enough to be found without difficulty (magnitude 5·7) and the diagram on page 42 shows only stars brighter than 8^{m}·5. The small circles indicate the position on the first day of each month.

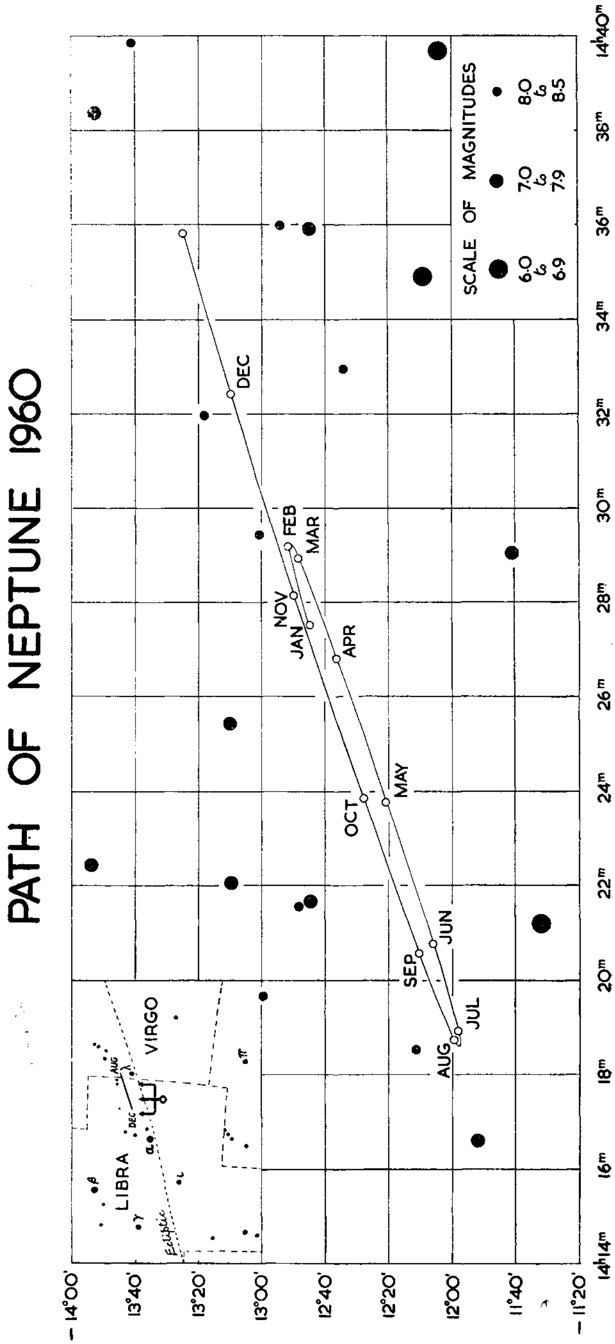
To facilitate further observations of its magnitude a list of suitable comparison stars is given below. The magnitudes are taken from the Harvard Photometry, as given in the *Zodiacal Catalogue*, and the list contains no stars of a later spectral class than G.

Name		*Mag.*	*R.A.* (1950·0) h m	*Dec.* ° ′
B.D.+ 18° 2090		6·56	8 55·5	+ 18 30
80	Cnc	6·75	9 09·1	18 15
81	Cnc	6·40	9 09·6	15 12
B.D.+ 19° 2187		6·87	9 13·6	19 01
83	Cnc	6·60	9 16·2	17 55
227 B.	Cnc	6·49	9 18·5	+ 15 35
B.D.+ 13° 2074		6·58	9 18·6	13 20
B.D.+ 17° 2065		6·79	9 18·6	16 49
35 B.	Leo	6·66	9 32·3	12 53
7	Leo	6·21	9 33·2	14 36
11	Leo	6·60	9 35·3	+ 14 34
B.D.+ 13° 2128		6·80	9 35·6	12 58
47 B.	Leo	6·77	9 37·9	13 17
19	Leo	6·37	9 44·7	11 48
21	Leo	6·66	9 48·1	12 05
ν	Leo	5·18	9 55·5	+ 12 41
107 B.	Leo	6·28	10 03·0	16 00
34	Leo	6·41	10 08·9	+ 13 36

NEPTUNE

Neptune (page 43) remains in Libra throughout the year; it is at opposition on April 28, when the apparent diameter will be 2″·5 and the geocentric distance 29·32 units. As in the case of Uranus the path of Neptune is illustrated by a diagram showing the field as seen in an inverting telescope. The magnitude of Neptune is 7·7, and the diagram shows stars down to magnitude 8·5.


PATH OF URANUS 1960
ν LEO
MAG 5.0
ψ LEO
MAG 5.3
π CNC
MAG 5.6
MAG 5.9
DEC
NOV
OCT
SEP
AUG
JAN
FEB
JUL
MAR
JUN
APR
MAY
SCALE OF MAGNITUDES
5.0 to 5.9
6.0 to 6.9
7.0 to 7.9
8.0 to 8.5
LEO
CANCER
HYDRA
Regulus
Ecliptic
MAY
DEC
+12°
13°
14°
15°
16°
17°
+18°
9h12m
16m
20m
24m
28m
32m
36m
40m
44m
48m
52m
56m
10h00m


PATH OF NEPTUNE 1960
SCALE OF MAGNITUDES
6.0 to 6.9
7.0 to 7.9
8.0 to 8.5
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
LIBRA
VIRGO
Ecliptic
14h14m
16m
18m
20m
22m
24m
26m
28m
30m
32m
34m
36m
38m
14h40m
– 14°00′
13°40′
13°20′
13°00′
12°40′
12°20′
12°00′
11°40′
– 11°20′

MINOR PLANETS

Dates of opposition and corresponding magnitudes are:—

Ceres	Aug.	14,	7·8	Juno	June	10,	9·9
Pallas	July	11,	9·1	Vesta	July	2,	6·0

Ceres

Date	R.A. h m	Dec. ° ′	H.P. ″
July 5	22 20·7	− 22 55	4·03
15	22 18·1	23 59	4·19
25	22 13·1	25 09	4·32
Aug. 4	22 06·2	26 20	4·41
14	21 58·0	27 25	4·43
24	21 49·2	− 28 17	4·40
Sept. 3	21 40·9	28 52	4·31
13	21 34·0	29 08	4·17
23	21 29·1	29 06	4·01
Oct. 3	21 26·5	28 47	3·82
13	21 26·4	− 28 14	3·63
23	21 28·8	27 31	3·45
Nov. 2	21 33·3	26 37	3·28
12	21 39·7	25 36	3·12
22	21 47·7	− 24 28	2·97

Pallas

Date	R.A. h m	Dec. ° ′	H.P. ″
May 26	19 30·1	+ 20 21	3·19
June 5	19 25·9	21 19	3·28
15	19 20·0	21 57	3·35
25	19 12·7	22 11	3·40
July 5	19 04·6	21 57	3·43
15	18 56·4	+ 21 15	3·43
25	18 48·7	20 07	3·40
Aug. 4	18 42·3	18 38	3·35
14	18 37·6	16 52	3·27
24	18 34·8	14 56	3·17
Sept. 3	18 34·0	+ 12 56	3·07
13	18 35·3	10 56	2·96
23	18 38·5	9 02	2·84
Oct. 3	18 43·4	7 15	2·73
13	18 49·9	+ 5 37	2·63

Juno

Date	R.A. h m	Dec. ° ′	H.P. ″
Apr. 26	17 48·5	− 7 00	3·37
May 6	17 45·5	6 14	3·52
16	17 40·4	5 33	3·65
26	17 33·7	4 58	3·76
June 5	17 25·7	4 34	3·82
15	17 17·1	− 4 21	3·85
25	17 08·7	4 22	3·82
July 5	17 01·2	4 35	3·76
15	16 55·2	5 01	3·66
25	16 51·0	− 5 36	3·54

Vesta

Date	R.A. h m	Dec. ° ′	H.P. ″
Apr. 6	18 41·8	− 18 38	4·89
16	18 53·2	18 34	5·22
26	19 02·2	18 32	5·58
May 6	19 08·6	18 38	5·97
16	19 11·9	18 52	6·38
26	19 11·9	− 19 17	6·78
June 5	19 08·6	19 53	7·15
15	19 02·1	20 40	7·44
25	18 53·2	21 35	7·60
July 5	18 43·1	22 31	7·61
15	18 33·4	− 23 24	7·47
25	18 25·4	24 12	7·19
Aug. 4	18 20·3	24 52	6·82
14	18 18·5	25 24	6·40
24	18 20·2	25 50	5·98
Sept. 3	18 25·2	− 26 09	5·57
13	18 33·1	26 21	5·18
23	18 43·5	26 26	4·83
Oct. 3	18 56·0	26 23	4·52
13	19 10·3	− 26 11	4·24

PLUTO

Pluto is in Leo, opposition occurring on February 24. The magnitude of the planet is about 14·5.

			R.A.	Dec.				R.A.	Dec.
			h m	° ′				h m	° ′
1959	Dec.	18	10 50·5	+ 20 46	1960	Aug.	14	10 47·2	+ 20 52
1960	Jan.	27	10 48·8	21 12		Sept.	23	10 52·4	20 25
	Mar.	7	10 45·1	21 40		Nov.	2	10 56·8	20 13
	Apr.	16	10 41·8	21 53		Dec.	12	10 58·7	20 20
	May	26	10 40·8	+ 21 46	1961	Jan.	21	10 57·5	+ 20 45

ALGOL (β Persei)

Mean Place: R.A. $3^h\ 05^m{\cdot}6$, Dec. + 40° 48′

The following table of approximate U.T. of primary minima is based on the period of $2^d{\cdot}867318$ derived by Smart (*M.N.*, **97**, 402), which has been used in previous numbers of the *Handbook*. An empirical correction of $-0^h{\cdot}8$ has been applied to bring the times into better agreement with recent observations.

The total variation in brightness is from $2^m{\cdot}2$ to $3^m{\cdot}5$.

	d	h		d	h		d	h		d	h
Jan.	2	19·4	Mar.	14	11·9	Aug.	13	11·1	Oct.	24	3·4
	5	16·2		17	8·7		16	7·9		27	0·2
	8	13·0		20	5·6		19	4·7		29	21·0
	11	9·8		23	2·4		22	1·5	Nov.	1	17·8
	14	6·7		25	23·2		24	22·3		4	14·6
	17	3·5		28	20·0		27	19·1		7	11·4
	20	0·3		31	16·8		30	15·9		10	8·2
	22	21·1	Apr.	3	13·7	Sept.	2	12·8		13	5·0
	25	17·9					5	9·6		16	1·9
	28	14·8					8	6·4		18	22·7
	31	11·6	July	1	10·9		11	3·2		21	19·5
Feb.	3	8·4		4	7·8		14	00·0		24	16·3
	6	5·2		7	3·6		16	20·8		27	13·1
	9	2·1		10	1·4		19	17·6		30	9·9
	11	22·9		12	22·2		22	14·4	Dec.	3	6·8
	14	19·7		15	19·0		25	11·2		6	3·6
	17	16·5		18	15·8		28	8·0		9	0·4
	20	13·3		21	12·6	Oct.	1	4·9		11	21·2
	23	10·2		24	9·4		4	1·7		14	18·0
	26	7·0		27	6·2		6	22·5		17	14·9
	29	3·8		30	3·0		9	19·3		20	11·7
Mar.	3	0·6	Aug.	1	23·9		12	16·1		23	8·5
	5	21·4		4	21·7		15	12·9		26	5·3
	8	18·3		7	17·5		18	9·7		29	2·1
	11	15·1		10	14·3		21	6·5		31	23·0

EPHEMERIDES OF DOUBLE STARS

The position angles and distances are interpolated for 1960·0 from published ephemerides. For additional stars not included in the list see *B.A.A. Handbooks* 1958 and 1959 and references 1 and 2.

Star Name		ADS	Position 1950·0 R.A.	Dec.	Mags.		P.A.	Dist.	Refs.
			h m	° ′			°	″	
η	Cas	671	0 46·1	+ 57 33	3·7	7·4	295·2	10·93	2
α	Psc	1615	1 59·4	+ 2 31	4·3	5·3	294·1	1·99	1
Σ	367	2416	3 11·5	+ 0 33	8·0	8·0	152·1	0·77	2
OΣ	77	3082	4 12·8	+ 31 34	7·5	7·5	266·0	0·75	1
40	Eri BC	3093	4 13·2	− 7 41	9·2	11·0	347·1	7·41	1, 4
α	Gem	6175	7 31·4	+ 32 00	2·0	2·9	164·8	2·02	1
ζ	Cnc AB	6650	8 09·3	+ 17 48	5·6	5·9	4·6	1·16	3
ζ	Cnc AC	6650	8 09·3	+ 17 48	5·6	6·1	84·0	6·02	3
γ	Leo	7724	10 17·2	+ 20 06	2·6	3·9	121·6	4·30	1
Σ	1639	8539	12 21·9	+ 25 52	6·7	7·7	328·7	1·28	1
γ	Vir	8630	12 39·1	− 1 11	3·6	3·7	308·3	5·08	1
35	Com	8695	12 50·8	+ 21 31	5·3	7·3	142·6	0·93	2
Σ	1785	9031	13 46·8	+ 27 14	7·8	8·3	143·2	2·92	5
ξ	Boo	9413	14 49·1	+ 19 19	4·8	6·9	347·7	6·77	1
44	Boo	9494	15 02·2	+ 47 51	5·2	6·1	272·4	0·81	1
σ	CrB	9979	16 12·8	+ 33 59	5·7	6·7	230·0	6·20	1
Σ	2026	9982	16 13·5	+ 7 30	8·6	9·1	31·2	2·29	1
Σ	2398	11632	18 42·5	+ 59 30	8·2	8·7	161·8	15·15	1
β	648	11871	18 55·2	+ 32 50	5·3	7·7	227·4	1·21	2
δ	Cyg	12880	19 43·4	+ 45 00	3·0	6·5	243·6	2·09	1
61	Cyg	14636	21 04·4	+ 38 28	5·6	6·3	142·2	27·65	1
ζ	Aqr	15971	22 26·2	− 0 17	4·4	4·6	262·5	1·98	2
Kr	60	15972	22 26·3	+ 57 27	9·3	10·8	71·0	2·57	2
A	632	16326	22 50·0	+ 57 27	8·2	9·0	179·9	0·98	1
Hol	60	17178	23 59·8	+ 39 22	8·5	8·9	192·2	0·74	1

(1) P. Muller, *Journal des Observateurs*, **36**, 61, 1953.
(2) P. Muller, *Journal des Observateurs*, **37**, 153, 1954.
(3) C. Gasteyer, *A.J.*, **59**, 243, 1954.
(4) The brighter component is a white dwarf.
(5) K. A. Strand, *A.J.*, **60**, 42, 1955.

METEOR DIARY, 1960

This Diary is intended primarily for observers in England, and is based on the meridian of Greenwich and latitude 52° N. All times are in U.T.—the use of G.M.A.T. in Meteor Section publications is to cease as from 1960, Jan. 1.

Normal Limits—The dates between which an observer may expect to obtain a radiant for the stream in five or six hours watching.

Zenithal Hourly Rate (*Z.H.R.*)—The probable hourly rate for an observer watching under good conditions with the radiant in the zenith. The actual rate observed will depend on the state of the sky, the altitude of the radiant and the inherent variability of meteor rates. The following table gives the corrections for altitude, and is based on a formula derived by J. P. M. Prentice. It shows clearly that it is useless to expect a high rate when the radiant altitude is low.

Altitude °	*Factor*	*Altitude* °	*Factor*
0		27·4	
	0·1		0·6
2·6		34·5	
	0·2		0·7
8·6		42·5	
	0·3		0·8
14·5		52·2	
	0·4		0·9
20·7		65·8	
	0·5		1·0
27·4		90·0	

In critical cases ascend

Moonlight—In general, effective visual or photographic work on meteors is only possible in the absence of moonlight, and observing is therefore restricted to the period from the Third Quarter of one lunation to the First Quarter of the next.

Twilight—This has been assumed to start and end when the centre of the Sun is 12° below the horizon.

Quadrantids.—The epoch of maximum of this shower is variable to the extent of about six hours either way, and since the period of strong activity is of the same order, a late arrival of the shower may result in the richest part of the display occurring in daylight.

Giacobinids.—Even in the unlikely event of a great shower being seen in 1959, there is no reason to expect any appreciable activity in 1960, but watch should be kept in order to complete the three-year series of observations begun in 1958.

Taurids.—This is a long-enduring system of streams with a much dispersed pattern of radiants; the centre given is usually the most active, and although moonlight will spoil the period of maximum, observations should be possible towards the end of the apparition.

Bielids.—This famous shower, considered to be virtually defunct in recent years, has been recovered photographically by Hawkins, Southworth and Stienon at Harvard Observatory. The photographic rate of one per hour is sufficiently high to justify the hope that the shower may be detected visually.

Shower	Epoch (U.T.) ☉ (1950)	Epoch (U.T.) Maximum	Epoch (U.T.) Normal limits	Z.H.R. at Max.	Radiant R.A.	Radiant Dec.	Radiant Altitude
	° ′				°	°	d h °
Quadrantids	282 43	Jan. 4^d 05^h	Jan. 3–4	45	232	+ 50	Jan. 3 18 17 20 12 22 13 4 00 21 02 33 04 48 06 66
Lyrids	32	Apr. 22	Apr. 20-22	6	271	+ 33	Apr. 21 21 17 23 34 22 01 52 03 68
Perseids	139	Aug. 11	July 27–Aug. 17	50	46	+ 58	Aug. 11 21 27 23 37 12 01 51 03 66
Giacobinids	196 01	Oct. 9^d 12^h	Oct. 9	1?	262	+ 54	Oct. 9 20 58 22 43 10 00 30 02 21 04 18
Orionids	207	Oct. 20-21	Oct. 15-25	10	96	+ 15	Oct. 20 23 17 21 01 35 03 49 05 53
Taurids	225	Nov. 1-7	Oct. 26–Nov. 16	6	54	+ 14	Nov. 1 19 12 21 31 23 47 2 01 52 03 44 05 28
Bielids	232	Nov. 14	?	5?	23	+ 43	Nov. 14 19 59 22 81 15 01 59 04 33
Leonids	234	Nov. 16-17	Nov. 15-17	4	152	+ 22	Nov. 17 00 14 02 32 04 49 06 60
Geminids	261	Dec. 12-13	Dec. 9-14	60	112	+ 32	Dec. 12 20 25 22 43 13 00 60 02 70 04 60 06 43
Ursids	270	Dec. 21	Dec. 20-22	5	217	+ 76	Dec. 21 18 41 20 38 22 39 22 00 42 02 48 04 56 06 62

Date	Moon: Age	Moon: In	Moon: Rises		Moon: Sets		Twilight: Dusk		Twilight: Dawn		Remarks
	d		h	m	h	m	h	m	h	m	
Jan. 3	4·2	Aqr	10	39	22	18	17	24	06	44	Favourable (See Notes)
4	5·2	Psc	11	05	23	28					
Apr. 20	23·7	Aqr	02	38	13	00					
21	24·7	Aqr	03	09	14	12	20	30	03	25	Fairly Favourable
22	25·7	Aqr	03	36	15	22					
Aug. 7	14·2	Aqr	19	43	04	55					
9	16·2	Aqr	20	44	07	32	21	04	03	09	Unfavourable
11	18·2	Cet	21	36	10	00					
13	20·2	Cet	22	31	12	17					
Oct. 8	17·0	Tau	19	32	09	54					
9	18·0	Tau	20	09	10	55	18	34	05	02	Unfavourable (See Notes)
10	19·0	Tau	20	51	11	51					
Oct. 15	24·0	Cnc	00	29	15	07					
20	29·0	Vir	06	11	17	18	18	11	05	20	Favourable
21	0·5	Vir	07	25	17	49					
25	4·5	Sgr	12	01	20	58					
Oct. 26	5·5	Sgr	12	53	22	05					
Nov. 2	12·5	Psc	16	29	05	22	17	49	05	41	Unfavourable
9	19·5	Gem	21	15	12	03					
16	26·5	Vir	03	47	15	17					
Nov. 14	24·5	Leo	01	27	14	26	17	29	06	02	Favourable (See Notes)
Nov. 15	25·5	Vir	02	36	14	51					
16	26·5	Vir	03	47	15	17	17	27	06	04	Favourable
17	27·5	Vir	05	01	15	45					
Dec. 9	20·0	Leo	22	05	11	40					
11	22·0	Leo	—	—	12	29	17	13	06	36	Rather unfavourable
13	24·0	Vir	01	24	13	17					
15	26·0	Lib	03	49	14	13					
Dec. 20	1·6	Sgr	09	31	18	44					
21	2·6	Cap	10	15	20	01	17	15	06	41	Favourable
22	3·6	Cap	10	52	21	19					

PERIODIC COMETS IN 1960

Comet Gale

By C. Dinwoodie

This comet was not seen in 1949, and the perturbation scheme for that year has been continued, using the barycentric form of the Cowell method. Perturbations by all the planets have been included where appreciable.

The comet is not a bright one, and is badly placed at perihelion in 1960.

T 1960 January 30·35235 U.T.			Epoch 1960 January 27·0 U.T.	
	°			
ω	209·8125	1950·0	a	4·8889906
☊	66·0474	1950·0	e	0·7647501
i	11·4397	1950·0	n°	0·09117490
q	1·1501345		P	10·810 years

Equatorial constants (1950·0):

$$x = +0\cdot4550223\,(\cos E - e) + 3\cdot0840269 \sin E$$
$$y = -4\cdot2521072 \qquad\qquad + 0\cdot5309754$$
$$z = -2\cdot3695515 \qquad\qquad - 0\cdot3606014$$

Magnitudes derived from $m = 12\cdot0 + 15 \log r + 5 \log \Delta$

1960		R.A. 1950·0	R.A. 1950·0	r	Δ	Variation $\Delta\alpha$	Variation $\Delta\delta$	Mag.
		h m	° ′			m	′	
Apr.	16	0 08·8	− 7 08	1·547	2·364	− 1·17	− 8·0	16·2
	26	0 33·2	4 39	1·633	2·415	1·03	7·5	
May	6	0 55·6	2 22	1·721	2·459	0·91	7·1	17·0
	16	1 16·2	− 0 18	1·812	2·495	0·80	6·6	
	26	1 35·1	+ 1 32	1·904	2·521	0·71	6·1	17·7
June	5	1 52·4	+ 3 08	1·996	2·537	− 0·64	− 5·7	
	15	2 08·2	4 31	2·088	2·541	0·58	5·4	18·3
	25	2 22·5	5 41	2·180	2·533	0·52	5·2	
July	5	2 35·1	6 38	2·272	2·515	0·49	5·0	18·8
	15	2 46·0	7 23	2·363	2·485	0·46	4·9	
	25	2 54·9	+ 7 56	2·453	2·447	− 0·44	− 4·8	19·3
Aug.	4	3 01·9	8 18	2·543	2·402	0·44	4·9	
	14	3 06·6	8 29	2·632	2·353	0·44	5·0	19·7
	24	3 08·8	8 30	2·719	2·301	0·45	5·2	
Sept.	3	3 08·6	+ 8 21	2·806	2·254	− 0·48	− 5·4	20·0

Comet Schaumasse

By M. G. Sumner

Ephemeris continued from the 1959 *Handbook.*

1960		R.A. 1950·0	Dec. 1950·0	r	Δ	Variation $\Delta\alpha$	Variation $\Delta\delta$	Mag.
		h m	° ′			m	′	
Jan.	7	1 58·8	+ 4 35	1·741	1·224	− 1·07	− 10·4	14·1
	17	2 03·7	6 59	1·660	1·246	1·02	11·1	
	27	2 12·7	9 35	1·581	1·267	1·02	12·0	13·5
Feb.	6	2 25·5	12 24	1·505	1·282	1·05	13·0	
	16	2 42·1	15 25	1·435	1·292	1·12	14·0	12·9
	26	3 02·5	+ 18 34	1·370	1·296	− 1·23	− 15·0	
Mar.	7	3 26·9	21 46	1·313	1·295	1·39	15·9	12·3
	17	3 55·6	24 54	1·265	1·289	1·60	16·5	
	27	4 28·9	27 48	1·229	1·282	1·88	16·4	11·9
Apr.	6	5 06·7	30 17	1·205	1·275	2·19	15·6	
	16	5 49·0	+ 32 08	1·196	1·271	− 2·53	− 13·9	11·7
	26	6 34·8	33 03	1·201	1·275	2·85	10·9	
May	6	7 22·7	32 51	1·221	1·290	3·09	6·6	11·9
	16	8 10·6	31 32	1·253	1·318	3·20	− 1·8	
	26	8 56·6	29 12	1·298	1·362	3·16	+ 2·8	12·4
June	5	9 39·3	+ 26 01	1·352	1·424	− 3·00	+ 6·9	
	15	10 18·3	22 21	1·415	1·503	2·77	9·8	13·1
	25	10 53·5	18 24	1·485	1·599	2·51	11·7	
July	5	11 25·3	14 25	1·559	1·711	2·24	12·5	14·0
	15	11 54·3	10 33	1·637	1·836	2·00	12·5	
	25	12 20·9	+ 6 52	1·718	1·973	− 1·78	+ 12·0	15·0
Aug.	4	12 45·7	3 25	1·801	2·119	1·59	11·3	
	14	13 08·9	+ 0 14	1·885	2·272	1·43	10·4	15·9
	24	13 31·0	− 2 41	1·969	2·430	1·29	9·4	
Sept.	3	13 52·1	5 21	2·054	2·590	1·17	8·4	16·8
	13	14 12·4	− 7 46	2·139	2·750	− 1·06	+ 7·5	
	23	14 32·1	9 58	2·224	2·907	0·96	6·7	17·5
Oct.	3	14 51·3	− 11 55	2·308	3·061	− 0·88	+ 5·8	

Comet Väisälä (1), 1939 IV

By L. Oterma

Ephemeris continued from the 1959 *Handbook.*

1960		R.A. 1950·0	Dec. 1950·0	r	Δ	Variation Δα	Δδ	Mag.
		h m	° ′			m	′	
Jan.	7	8 57·3	+ 12 03					
	17	8 54·8	13 18					
	27	8 50·1	14 57	2·041	1·059	+ 3·19	− 4·2	15·4
Feb.	6	8 44·3	16 54					
	16	8 38·8	18 58					
	26	8 35·0	+ 20 57					
Mar.	7	8 34·3	22 39	1·865	1·000	+ 3·40	+ 0·3	14·9
	17	8 37·4	23 59					
	27	8 44·7	24 52					
Apr.	6	8 55·9	25 17					
	16	9 10·6	+ 25 14	1·761	1·190	+ 2·85	+ 0·4	15·0
	26	9 28·0	24 44					
May	6	9 47·7	23 48					
	16	10 08·9	22 28					
	26	10 31·1	20 46	1·749	1·476	+ 2·35	− 3·8	15·5
June	5	10 53·9	+ 18 45					
	15	11 16·9	16 30					
	25	11 39·9	14 02					
July	5	12 02·8	11 28	1·832	1·840	+ 1·87	− 6·9	16·2
	15	12 25·4	8 49					
	25	12 47·8	+ 6 09					
Aug.	4	13 09·9	3 31					
	14	13 31·7	+ 0 57	1·993	2·291	+ 1·45	− 6·7	17·0
	24	13 53·2	− 1 30					
Sept.	3	14 14·5	3 49					
	13	14 35·6	− 5 58					
	23	14 56·6	7 57	2·206	2·800	+ 1·14	− 5·0	17·9
Oct.	3	15 17·3	9 46					
	13	15 37·8	11 22					
	23	15 58·1	12 47					
Nov.	2	16 18·2	− 14 00	2·448	3·293	+ 0·89	− 2·9	18·7
	12	16 38·0	15 01					
	22	16 57·4	15 51					
Dec.	2	17 16·5	16 29					
	12	17 35·1	− 16 57	2·703	3·675	+ 0·70	− 1·4	19·3

Comet Reinmuth (2)

By E. Rabe

The following ephemeris is based on improved elements obtained from numerous observations at the 1947-48 and 1953-54 apparitions. Accurate perturbations (Venus to Neptune) have been included, and were computed on NORC by Musen's method.

1960		R.A. 1950·0	Dec. 1950·0	r	Δ	Mag.
		h m	° ′			
Mar.	27	18 42·4	− 27 42	2·693	2·557	20·1
Apr.	6	18 54·8	27 28			
	16	19 05·8	27 12	2·600	2·211	19·3
	26	19 15·2	26 55			
May	6	19 22·7	26 38	2·509	1·886	18·6
	16	19 27·9	− 26 21			
	26	19 30·5	26 05	2·420	1·602	17·8
June	5	19 30·3	25 50			
	15	19 27·1	25 34	2·334	1·378	17·0
	25	19 21·2	25 16			
July	5	19 13·4	− 24 54	2·253	1·238	16·3
	15	19 04·6	24 25			
	25	18 56·2	23 51	2·177	1·192	15·8
Aug.	4	18 49·7	23 11			
	14	18 45·9	22 29	2·109	1·234	15·5
	24	18 45·6	− 21 46			
Sept.	3	18 49·0	21 04	2·050	1·339	15·4
	13	18 55·8	20 21			
	23	19 05·8	19 36	2·002	1·483	15·3
Oct.	3	19 18·4	18 48			
	13	19 33·4	− 17 55	1·965	1·647	15·3
	23	19 50·3	16 54			
Nov.	2	20 08·8	15 45	1·942	1·822	15·4
	12	20 28·4	14 26			
	22	20 48·9	12 56	1·933	2·002	15·5
Dec.	2	21 10·0	− 11 16			
	12	21 31·6	9 27	1·938	2·186	15·7
	22	21 53·4	7 29			
	32	22 15·4	− 5 23	1·957	2·371	16·0

Comet Comas Solá

By H. Q. Rasmusen and Julie M. Vinter Hansen

This comet has been observed at all four apparitions since its discovery in 1926. The following ephemeris is based on elements derived from observations of the three first apparitions and revised by using the observations from the fourth. The ephemeris has been computed by Julie Vinter Hansen, and Encke-perturbations including all major planets, except Pluto, from 1951 to date, computed by H. Q. Rasmusen, have been applied. Although the comet will not pass its perihelion until 1961 it is hoped that it will be recovered long before that.

1960		R.A. 1950·0	Dec. 1950·0	r	Δ	Mag.
		m h	° ′			
July	5	1 56·3	+ 0 20	2·984	3·064	18·0
	15	2 06·8	1 05	2·925	2·878	
	25	2 16·7	1 44	2·866	2·691	17·5
Aug.	4	2 25·7	2 15	2·807	2·505	
	14	2 33·5	2 38	2·748	2·323	16·9
	24	2 39·9	+ 2 54	2·689	2·146	
Sept.	3	2 44·6	3 03	2·630	1·977	16·3
	13	2 47·2	3 04	2·571	1·820	
	23	2 47·3	3 00	2·513	1·676	15·6
Oct.	3	2 44·7	2 53	2·455	1·551	
	13	2 39·4	+ 2 47	2·398	1·445	15·0
	23	2 31·6	2 45	2·342	1·363	
Nov.	2	2 22·2	2 54	2·287	1·307	14·5
	12	2 12·2	3 18	2·233	1·276	
	22	2 03·1	4 01	2·181	1·271	14·1
Dec.	2	1 56·1	+ 5 04	2·130	1·288	
	12	1 52·1	6 26	2·081	1·322	13·9
	22	1 51·7	8 06	2·035	1·370	
	32	1 54·8	+ 9 59	1·992	1·428	13·8

Magnitudes have been added from

$$m = 8{\cdot}5 + 15 \log r + 5 \log \Delta.$$

Comet Encke

By S. G. Makover

The following elements have been computed from the elements of the 1957 *Handbook* by applying perturbations by six planets (Mercury to Saturn).

T 1961 February 5·583 U.T. Epoch 1960 December 12·0 U.T.

M	343·39985°		ϕ	57·89292°
ω	185·22706	1950·0	e	0·8470563
☊	334·72145	1950·0	a	2·2166100
i	12·35967	1950·0	$n°$	0·29865525
q	0·3390165		P	3·300 years

Magnitudes computed from $m = 11{\cdot}5 + 15 \log r + 5 \log \Delta$

1960	R.A. 1950·0 (h m)	Dec. 1950·0 (° ′)	r	Δ	Mag.
Sept. 3	1 24·4	+ 20 20			
8	1 20·3	20 38	2·329	1·483	17·9
13	1 14·8	20 50			
18	1 08·2	20 58	2·234	1·313	17·3
23	1 00·1	20 58			
28	0 50·7	+ 20 50	2·134	1·167	16·8
Oct. 3	0 40·0	20 32			
8	0 28·1	20 03	2·030	1·050	16·2
13	0 15·3	19 22			
18	0 01·9	18 29	1·921	0·966	15·7
23	23 48·3	+ 17 26			
28	23 35·0	16 14	1·807	0·914	15·2
Nov. 2	23 22·2	14 55			
7	23 10·4	13 35	1·687	0·889	14·7
12	22 59·8	12 14			
17	22 50·5	+ 10 55	1·560	0·884	14·1
22	22 42·6	9 42			
27	22 36·1	8 35	1·426	0·887	13·5
Dec. 2	22 30·9	7 34			
7	22 26·9	6 39	1·284	0·888	12·9
12	22 23·8	+ 5 51			
17	22 21·5	5 08	1·132	0·877	12·0
22	22 19·8	4 28			
27	22 18·3	3 49	0·971	0·846	10·9
32	22 16·7	+ 3 06			

Comet Forbes

By B. G. Marsden

This comet was discovered in 1929, and seen again in 1942 and 1948. It was badly placed at its 1955 perihelion-passage and was not observed. Perturbations by Jupiter and Saturn, and the inner planets where appreciable, have been computed by a combination of the Encke and Cowell methods for the two revolutions 1948-61, starting from the elements in *M.N.* 119, (in press. The comet is well placed for recovery at this return, particularly in the Southern Hemisphere.

T 1961 July 24·2944 E.T. Epoch 1961 August 9·0 E.T.

	°			
ω	259·7276	1950·0	e	0·552985
☊	25·3891		a	3·455621
i	4·6199		n°	0·1534317
q	1·544715		P	6·424 years

Magnitudes computed from $m = 11{\cdot}3 + 15 \log r + 5 \log \Delta$

1960		R.A. 1950·0	Dec. 1950·0	r	Δ	Variation $\Delta\alpha$	Variation $\Delta\delta$	Mag.
		h m	° ′			m	′	
Nov.	2	12 38·3	− 2 26	2·814	3·633	− 0·59	+ 4·5	20·8
	12	12 53·0	4 05			0·62	4·8	
	22	13 07·9	5 44	2·695	3·351	0·66	5·1	20·4
Dec.	2	13 23·0	7 22			0·72	5·4	
	12	13 38·4	8 59	2·574	3·030	0·79	5·7	19·9
	22	13 54·0	− 10 35			− 0·87	+ 6·1	
	32	14 09·8	− 12 08	2·452	2·684	− 0·97	+ 6·4	19·3

Comet Borrelly

By M. G. Sumner and M. P. Candy

Ephemeris continued from the 1959 *Handbook*

1960		R.A. 1950·0	Dec. 1950·0	r	Δ	Variation $\Delta\alpha$	Variation $\Delta\delta$	Mag.
		h m	° ′			m	′	
Jan.	7	22 23·6	− 35 50	2·177	2·769	− 0·90	− 3·3	17·3
	17	22 44·2	33 12	2·110	2·765	0·92	4·5	
	27	23 05·3	30 20	2·043	2·752	0·92	5·7	16·8
Feb.	6	23 27·0	27 18	1·977	2·733	0·94	6·9	
	16	23 49·0	24 04	1·913	2·710	0·95	8·2	16·4
	26	0 11·5	− 20 39	1·850	2·683	− 0·97	− 9·4	
Mar.	7	0 34·3	− 17 04	1·790	2·653	− 0·98	−10·7	15·9

Comet Borrelly

1960	R.A. 1950·0	Dec. 1950·0	r	Δ	Variation $\Delta\alpha$	$\Delta\delta$	Mag.
	h m	° ′			m	′	
Sept. 3	9 17·7	+ 30 31	1·705	2·488	− 1·50	− 2·7	15·5
13	9 47·7	+ 30 07	1·760	2·493	− 1·43	− 1·2	
23	10 16·2	29 32	1·819	2·496	1·33	+ 0·2	15·9
Oct. 3	10 43·3	28 51	1·881	2·496	1·24	1·3	
13	11 08·8	28 07	1·944	2·491	1·15	2·3	16·3
23	11 32·7	27 24	2·009	2·482	1·05	3·2	
Nov. 2	11 55·1	+ 26 47	2·075	2·467	− 0·96	+ 3·9	16·7
12	12 15·8	26 18	2·142	2·447	0·87	4·6	
22	12 35·1	26 00	2·210	2·421	0·80	5·3	17·1
Dec. 2	12 52·6	25 56	2·278	2·389	0·74	6·0	
12	13 08·2	26 08	2·346	2·354	0·67	6·7	17·4
22	13 22·0	+ 26 38	2·414	2·314	− 0·63	+ 7·3	
32	13 33·7	+ 27 25	2·482	2·273	− 0·60	+ 8·1	17·7

Comet Finlay

By M. P. Candy

Since 1926 this comet has been observed at only one apparition, that of 1953-54. All the observations at that apparition have been used to correct the orbit, which has been linked to that of 1926 by approximate Jupiter and Saturn perturbations.

T 1953 December 25·87253 E.T.		Epoch 1953 December 29·0 E.T.	
ω	321°·08361 (1950·0)	e	0·7080454
☊	45·38965 (1950·0)	a	3·5928248
i	3·44005 (1950·0)	n°	0·14472716
q	1·048942	P	6·810 years

Perturbations by the planets Venus to Saturn have been applied using the Encke and Cowell methods:

T 1960 September 2·28630 E.T.		Epoch 1959 November 28·0 E.T.	
ω	321°·61346 (1950·0)	e	0·7030289
☊	42·07919 (1950·0)	a	3·6240797
i	3·64487 (1950·0)	n°	0·14285895
q	1·076247	P	6·899 years

Magnitudes derived from $m = 11{\cdot}5 + 15 \log r + 5 \log \Delta$

1960		R.A. 1950·0	Dec. 1950·0	*r*	Δ	Variation Δα	Δδ	Mag.
		h m	° ′			m	′	
Jan.	7	16 47·5	− 23 25	2·863	3·647	− 0·57	+ 3·0	21·2
	17	17 04·1	23 56					
	27	17 21·1	24 22	2·707	3·316	− 0·76	+ 1·2	20·6
Feb.	6	17 38·5	24 42					
	16	17 56·3	24 56	2·546	2·945	− 0·95	+ 0·7	19·9
	26	18 14·5	− 25 03					
Mar.	7	18 32·9	25 04	2·380	2·550	− 1·18	− 0·2	19·2
	17	18 51·8	24 58					
	27	19 11·0	24 45	2·208	2·149	− 1·52	− 1·7	18·3
Apr.	6	19 30·7	24 25					
	16	19 50·9	− 23 58	2·033	1·756	− 1·98	− 4·1	17·3
	26	20 11·8	23 23					
May	6	20 33·6	22 40	1·855	1·388	− 2·65	− 8·1	16·2
	16	20 56·6	21 47					
	26	21 21·4	20 42	1·677	1·056	− 3·63	− 15·0	15·0
June	5	21 48·6	− 19 20					
	15	22 19·0	17 36	1·503	0·776	− 5·13	− 27·7	13·6
	25	22 53·6	15 18					
July	5	23 34·5	12 13	1·341	0·561	− 7·29	− 50·6	12·1
	15	0 21·8	8 06					
	25	1 15·7	− 2 54	1·203	0·431	− 9·37	− 83·6	10·9
Aug.	4	2 13·8	+ 3 00					
	14	3 11·9	8 44	1·109	0·401	− 9·68	− 91·4	10·2
	24	4 05·8	13 33					
Sept.	3	4 53·1	17 08	1·076	0·444	− 5·49	− 53·6	10·2
	13	5 32·9	+ 19 38					
	23	6 05·5	21 22	1·114	0·510	− 3·74	− 22·3	10·7
Oct.	3	6 31·2	22 37					
	13	6 50·3	23 36	1·212	0·564	− 3·58	− 6·7	11·5
	23	7 02·6	24 32					
Nov.	2	7 08·0	+ 25 31	1·352	0·599	− 4·22	+ 2·1	12·3
	12	7 06·3	26 35					
	22	6 58·0	27 41	1·515	0·638	− 5·05	+ 4·3	13·2
Dec.	2	6 44·4	28 38					
	12	6 28·0	29 17	1·690	0·724	− 5·13	+ 0·5	14·2
	22	6 11·8	+ 29 34					
	32	5 58·2	+ 29 33	1·868	0·895	− 4·24	− 3·1	15·3

THE BRIGHTEST AND NEAREST STARS

The ' Brightest Stars ' Table contains data for the thirty stars of brightest apparent magnitude. The columns *V*, *B–V* and *U–B* contain, respectively, the visual magnitude, blue minus visual colour index, and ultraviolet minus blue colour index, all on the system of Johnson and Morgan, or reduced to it as accurately as possible. The annual proper motions μ_α and μ_δ are in seconds of time and seconds of arc, respectively. The radial velocity (R.V.) is in kilometres per second. *Sp* is the spectral type and luminosity class (Ia, Iab, Ib are supergiants, II and III are giants, IV are subgiants and V are dwarfs), and M_{sp} is the spectroscopic visual absolute magnitude according to the calibration of Keenan and Morgan. π_{tr} is the trigonometrical parallax. *D* is the distance in light years, based on trigonometrical parallaxes for stars within 100 l.y. and on spectroscopic absolute magnitudes for more distant stars.

The ' Nearest Stars ' Table contains those stars with $\pi_{tr} \geqslant 0''\cdot252$, selected from the Yale Parallax Catalogue (1952), with the addition of UV Ceti; the tabulated parallaxes are taken from the Catalogue except for UV Ceti and L 789-6, for which the values are based on more recent data. Visual double stars are included separately; invisible companions are ignored. The proper motions in this table are both in seconds of arc [the quantity tabulated under μ_α is 15 μ_α cos δ if μ_α is in seconds of time] and are copied from the Parallax Catalogue. Positions (including galactic latitudes *b* and longitudes *l*) are taken from Luyten's 1955 Catalogue. The photometric data are on Johnson and Morgan's system (*B*, *V*) when available (these are given to two decimal places); if *B*, *V* values are not available, rough estimates are given based on visual and photographic magnitudes. The distance *D*, in light years, and M_V, the visual absolute magnitude, are based on the tabulated trigonometrical parallax. Luminosity classes are not tabulated; all the stars are dwarfs except Sirius B and Procyon B, which are white dwarfs, and Procyon A, which is F5 IV–V.

Sources of Data

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R. E. Wilson, *General Catalogue of Stellar Radial Velocities*, Carnegie Pub. No. 601, 1953.

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M. L. Woods, *Comm. Obs. Memoir*, No. 12, 1955.

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A large number of other papers have been consulted in checking and in compiling the Notes to the Tables.

THE BRIGHTEST STARS

No.	Star	Name	HD	R.A. (1950·0)	Dec. (1950·0)	V	$B-V$	$U-B$	μ_α	μ_δ	R.V.	*Sp.*	M_{sp}	π_{tr}	D
				h m	° ′				s	″	km/sec				l.y.
1	α Eri	Achernar	10144	1 35·9	−57 29	0·49	− 0·17	− 0·67	+ 0·011	− 0·03	+ 19	B5 V	− 1·3	0·023	75
2	α Tau	Aldebaran	29139	4 33·0	+16 25	0·78	+ 1·51	+ 1·81	+ 0·005	− 0·19	+ 54	K5 III	− 0·2	0·048	65
3	β Ori	Rigel	34085	5 12·2	− 8 15	0·08	− 0·03	− 0·69	0·000	0·00	+ 21	B8 Ia	− 7·0	− 0·003	850
4	α Aur	Capella	34029	5 13·0	+45 57	0·09	+ 0·80	+ 0·43	+ 0·008	− 0·43	+ 30	*	*	0·073	45
5	γ Ori	Bellatrix	35468	5 22·5	+ 6 18	1·61	− 0·21	− 0·86	0·000	− 0·01	+ 18	B2 III	− 4·1	0·026	450
6	β Tau	El Nath	35497	5 23·1	+28 34	1·64	− 0·13	− 0·48	+ 0·002	− 0·18	+ 8	B7 III	− 3·0	0·018	270
7	ε Ori	Alnilam	37128	5 33·7	− 1 14	1·71	− 0·20	− 1·06	0·000	0·00	+ 26	B0 Ia	− 6·7	− 0·007	1600
8	ζ Ori	Alnitak	37742	5 38·2	− 1 58	1·73	− 0·20	− 1·06	0·000	0·00	+ 18	O9·5 Ib	− 6·0	0·022	1100
9	α Ori	Betelgeuse	39801	5 52·5	+ 7 24	*	*	*	+ 0·002	+ 0·01	+ 21	M2 Iab	− 5·5	0·005	650
10	α Car	Canopus	45348	6 22·8	−52 40	− 0·71	+ 0·16	+ 0·04	+ 0·002	+ 0·02	+ 21	F0 Iab	− 5·5	0·018	300
11	α CMa	Sirius	48915	6 42·9	−16 39	− 1·47	+ 0·01	− 0·08	− 0·037	− 1·21	− 8	A1 V	+ 0·7	0·375	8·7
12	ε CMa	Adhara	52089	6 56·7	−28 54	1·42	− 0·16	*	0·000	0·00	+ 27	B2 II	− 5·0	—	620
13	α CMi	Procyon	61421	7 36·7	+ 5 21	0·34	+ 0·40	− 0·01	− 0·047	− 1·03	− 3	F5 IV-V	+ 2·8	0·288	11
14	β Gem	Pollux	62509	7 42·3	+28 09	1·15	+ 1·00	+ 0·84	− 0·047	− 0·05	+ 3	K0 III	+ 0·7	0·093	35
15	β Car	Miaplacidus	80007	9 12·7	−69 31	1·70	− 0·02	0·00	− 0·029	+ 0·10	− 5	A1 IV	− 0·1	0·038	85
16	α Leo	Regulus	87901	10 05·7	+12 14	1·33	− 0·12	− 0·38	− 0·017	0·00	+ 4	B7 V	− 1·0	0·039	85
17	α Cru	Acrux	108248	12 23·8	−62 49	0·80	− 0·25	− 0·96	− 0·005	− 0·02	− 11	B1 IV	− 3·8	—	270
18	γ Cru	(Gacrux)	108903	12 28·4	−56 50	1·74	+ 1·63	+ 1·74	+ 0·003	− 0·27	+ 21	M3 II	− 2·4	—	220
19	β Cru	(Mimosa)	111123	12 44·8	−59 25	1·28	− 0·25	− 1·03	− 0·005	− 0·03	+ 20	B0·5 IV	− 4·0	—	370
20	α Vir	Spica	116658	13 22·6	−10 54	0·98	− 0·26	− 0·94	− 0·003	− 0·04	+ 1	B1 V	− 3·2	0·021	220
21	β Cen	Hadar(Agena)	122451	14 00·3	−60 08	0·61	− 0·22	− 0·98	− 0·003	− 0·03	− 12	B1 III	− 4·3	0·016	300
22	α Boo	Arcturus	124897	14 13·4	+19 26	− 0·06	+ 1·23	+ 1·26	− 0·078	+ 2·00	− 5	K2 IIIp	*	0·090	36
23	α Cen	Rigil Kent.	128620	14 36·2	−60 38	− 0·27	+ 0·70	*	− 0·490	+ 0·71	− 22	G2 V	+ 4·6	0·751	4·0
24	α Sco	Antares	148478	16 26·4	−26 19	0·92	+ 1·84	+ 1·30	0·000	− 0·03	− 3	M1 Ib	− 4·5	0·019	400
25	λ Sco	Shaula	158926	17 30·2	−37 04	1·61	− 0·22	− 0·91	0·000	− 0·03	0	B2 IV	− 3·3	—	300
26	α Lyr	Vega	172167	18 35·2	+38 44	0·03	0·00	− 0·01	+ 0·017	+ 0·28	− 14	A0 V	+ 0·3	0·123	26
27	α Aql	Altair	187642	19 48·3	+ 8 44	0·75	+ 0·23	+ 0·07	+ 0·036	+ 0·38	− 26	A7 IV,V	+ 2·1	0·198	16
28	α Cyg	Deneb	197345	20 39·7	+45 06	1·26	+ 0·09	− 0·25	0·000	0·00	− 5	A2 Ia	− 7·0	− 0·013	1500
29	α Gru	Al Na'ir	209952	22 05·1	−47 12	1·77	− 0·14	− 0·46	+ 0·012	− 0·15	+ 12	B5 V	− 1·3	0·051	64
30	α PsA	Fomalhaut	216956	22 54·9	−29 53	1·16	+ 0·08	+ 0·03	+ 0·025	− 0·16	+ 7	A3 V	+ 1·8	0·144	23

* See Notes to Table

Notes to Table

2. α Tau = ADS 3321. B is 13^m at 31″, 110°. Radius by Interferometer 36 ⊙. Slightly variable.

3. β Ori = ADS 3823. B is 8^m at 9″·5, 202°. A is a spectroscopic binary, period 22^d. B is itself a visual binary, separation about 0″·2.

4. α Aur = ADS 3841. Spectroscopic and visual binary, period 104 days. Orbit obtained also by interferometer. Semimajor axis 0″·05. Wright (*Pub. D.A.O. Victoria*, **10**, 1, 1954) gives spectral types G8 III and G0 III with masses 3·03 ⊙, 2·91 ⊙ and visual absolute magnitudes 0·12, 0·37 respectively,

8. ζ Ori = ADS 4263. Magnitudes refer to AB. B is 5^m at 2″·6, 158°.

9. α Ori = ADS 4506. B is 14^m at 40″, 110°. A is variable, semiregular, period about 6 years, range V = 0·4 to about 1·3. $B - V$ is about + 2. Radius by interferometer varies from 300 ⊙ to 420 ⊙.

11. α CMa = ADS 5423. A is the brightest star in the sky, B is a white dwarf. B is $8^m·4$ at 9″, 90° (1960). AB has period 50 years, a = 7″·6, e = 0·59. Masses 2·35 ⊙, 0·99 ⊙ and radii 1·8 ⊙, 0·022 ⊙ respectively for A and B. See also 'The Nearest Stars' Table.

12. ε CMa = ADS 5654. B is 8^m at 7″·5, 160°. No $U - B$ measure available.

13. α CMi = ADS 6251. B is a white dwarf, 11^m at 4″·4, 81° (1960). AB has period 41 years, a = 4″·6, e = 0·40. Masses 1·74 ⊙, 0·63 ⊙ and radii 1·7 ⊙, 0·01 ⊙ respectively for A and B. See also 'The Nearest Stars' Table.

14. β Gem = ADS 6335. B is 14^m at 41″, 275°, but is not physically connected to Pollux. Pollux is the nearest giant star to the Sun.

16. α Leo = ADS 7654. B is $7^m·6$ at 176″, 307°, type K2.

17. α Cru. Magnitudes refer to AB. A is $1^m·6$, B is $2^m·1$, AB is 5″, 118°. Both are spectroscopic binaries.

19. β Cru. Probably β Canis Majoris type variable, amplitude $0^m·04$.

20. α Vir. Spectroscopic binary, period 4 days.

22. α Boo. High-velocity giant star, showing spectral peculiarities. Absolute magnitude − 0·3 (based on parallax). Radius by interferometer 23 ⊙.

23. α Cen. Magnitudes refer to AB. A is $0^m·0$, B is $1^m·4$. B has spectral type K1. No $U–B$ measure available. AB has period 80 years, a = 17″·7, e = 0·52. Masses 1·10 ⊙, 0·89 ⊙ and radii 1·23 ⊙, 0·87 ⊙, respectively for A and B. See also 'The Nearest Stars' Table.

24. α Sco = ADS 10074. B is $6^m·8$ at 3″·2, 275°, and is a peculiar hot star. A is variable; approximate radius by interferometer 285 ⊙.

25. λ Sco. Spectroscopic binary.

26. α Lyr = ADS 11510. Optical companion.

27. α Aql = ADS 13009. Optical companion. Luminosity class of A uncertain.

28. α Cyg = ADS 14172. B is 11^m at 75″, 106°.

THE NEAREST STARS

No.	Star	R.A. (1950·0)	Dec.	l	b	V	B-V	Sp	μ_α	μ_δ	π	D	R.V.	M_V
		h m	° ′	°	°				″	″	″	l.y.	km/sec	
1	Gr 34 A	0 15·5	+ 43 44	85	− 18	8·07	1·56	M1	+ 2·872	+ 0·400	0·278	11·7	+ 14	10·3
2	Gr 34 B	0 15·6	+ 43 44	85	− 18	11·04	1·80	M6	+ 2·872	+ 0·400	0·278	11·7	+ 21	13·3
3	UV Cet A	1 36·4	− 18 13	145	− 74	12·5	1·7	M6e	+ 0·58	+ 3·31	0·36:	10:	+ 29	15·3:
4	UV Cet B	1 36·4	− 18 13	145	− 74	13·0	1·7	M6e	+ 0·58	+ 3·31	0·36:	10:	+ 29	15·8:
5	τ Cet	1 41·7	− 16 12	143	− 72	3·49	0·72	G8	− 1·718	+ 0·860	0·275	11·9	− 16	5·7
6	ε Eri	3 30·6	− 9 38	164	− 46	3·68	0·89	K2	− 0·975	+ 0·022	0·303	10·8	+ 15	6·1
7	Sirius A	6 42·9	− 16 39	195	− 8	− 1·47	0·01	A1	− 0·537	− 1·210	0·375	8·7	− 8	1·4
8	Sirius B	6 42·9	− 16 39	195	− 8	8·5	—	DA	− 0·537	− 1·210	0·375	8·7	—	11·4
9	+ 5° 1668	7 24·7	+ 5 29	180	+ 12	10·91	1·65	M5	+ 0·59	− 3·71	0·263	12·4	+ 26	13·0
10	Procyon A	7 36·7	+ 5 21	181	+ 14	0·34	0·40	F5	− 0·707	− 1·032	0·288	11·3	− 3	2·6
11	Procyon B	7 36·7	+ 5 21	181	+ 14	10·8	—	—	− 0·707	− 1·032	0·288	11·3	—	13·1
12	Wolf 359	10 54·1	+ 7 20	214	+ 57	13·5	2·2	M8	− 3·83	− 2·68	0·402	8·1	+ 13	16·5
13	Lal 21185	11 00·7	+ 36 18	152	+ 67	7·48	1·52	M2	− 0·565	− 4·745	0·398	8·2	− 87	10·5
14	Ross 128	11 45·3	+ 1 06	240	+ 60	11·13	1·59	M5	+ 0·621	− 1·214	0·294	11·1	− 13	13·5
15	Proxima	14 26·3	− 62 28	282	− 2	10·7:	—	Me	− 3·75	+ 0·87	0·762	4·3	—	15·1
16	α Cen A	14 36·2	− 60 38	283	− 1	0·00	0·64	G2	− 3·606	+ 0·705	0·751	4·3	− 25	4·4
17	α Cen B	14 36·2	− 60 38	283	− 1	1·4	0·9	K1	− 3·606	+ 0·705	0·751	4·3	− 21	5·8
18	Barnard	17 55·4	+ 4 24	358	+ 13	9·53	1·74	M5	− 0·72	+10·27	0·545	6·0	−108	13·2
19	Σ 2398 A	18 42·2	+ 59 33	56	+ 24	8·90	1·54	M4	− 1·328	+ 1·866	0·280	11·6	+ 1	11·1
20	Σ 2398 B	18 42·2	+ 59 33	56	+ 24	9·69	1·59	M5	− 1·360	+ 1·815	0·280	11·6	+ 14	11·9
21	Ross 154	18 46·7	− 23 53	339	− 12	10·6	1·8	M6	+ 0·72	− 0·18	0·351	9·3	− 4	13·3
22	61 Cyg A	21 04·7	+ 38 30	50	− 6	5·19	1·19	K5	+ 4·120	+ 3·179	0·292	11·2	− 64	7·5
23	61 Cyg B	21 04·7	+ 38 30	50	− 6	6·02	1·38	K7	+ 4·120	+ 3·179	0·292	11·2	− 64	8·4
24	Lac 8760	21 14·3	− 39 04	331	− 46	6·76	1·42	M1	− 3·269	− 1·154	0·255	12·8	+ 23	8·8
25	ε Ind	21 59·6	− 57 00	303	− 49	4·71	1·04	K3	+ 3·934	− 2·558	0·285	11·4	− 40	7·0
26	Kr 60 A	22 26·3	+ 57 27	72	0	9·85	1·62	M4	− 0·80	− 0·34	0·252	12·9	− 24	11·9
27	Kr 60 B	22 26·3	+ 57 27	72	0	11·3	1·8	M6	− 0·80	− 0·34	0·252	12·9	− 28	13·3
28	L 789–6	22 35·7	− 15 36	16	− 58	12·2	2·1	M7	+ 2·35	+ 2·27	0·295	11·1	− 60	14·6
29	Lac 9352	23 02·6	− 36 09	332	− 67	7·43	1·50	M2	+ 6·773	+ 1·308	0·273	11·9	+ 10	9·6
30	Ross 248	23 39·5	+ 43 56	78	− 17	12·2	1·6	M6	+ 0·13	− 1·82	0·316	10·3	− 81	14·7

Notes to Table

1, 2. Groombridge 34 = + 43° 44 = ADS 246. AB is 38″, 60°. A is a spectroscopic binary.

3, 4. UV Ceti = Luyten L 726-8. B is a flare star. AB has a period of about 40 years (± 10) and $a = 2''\cdot0$ (± 0.4). Combined mass 0·11 ☉. The mass of B is probably 0·05 ☉. The parallax is still uncertain.

7, 8. Sirius = α CMa = ADS 5423. A is the brightest star in the sky, B is a white dwarf. See 'The Brightest Stars' Table.

9. Luyten's star.

10, 11. Procyon = α CMi = ADS 6251. B is a white dwàrf. See 'The Brightest Stars' Table.

13. Unresolved astrometric binary. Perturbation has period 1·14 years, e = 0·75, $a = 0''\cdot03$. Masses probably about 0·35 ☉ and 0·03 ☉.

15. Proxima Centauri. The nearest star. Flare star.

16. α Centauri. See 'The Brightest Stars' Table.

18. Barnard's star = + 4° 3561. The star of largest proper motion. Possibly unresolved binary, period about one year.

19, 20. Σ 2398 = + 59° 1915 = ADS 11632. AB is 17″, 155°.

21. Flare star.

22, 23. 61 Cygni = ADS 14636. AB is 27″·7, 142° (1960). AB has period 720 years, $a = 24''\cdot6$. Masses 0·58 ☉ (A), 0·54 ☉ (B). There is a third body present, causing a perturbation with period 4·8 years, $a = 0''\cdot01$, and having a mass 0·008 ☉ (according to Strand).

24. Lacaille 8760 = − 39° 14192 = GC 29761.

26, 27. Krüger 60 = ADS 15972. AB is 2″·6, 71° (1960). AB has period 44·5 years, $a = 2''\cdot41$, $e = 0\cdot41$. Masses 0·27 ☉ (A), 0·16 ☉ (B). B is a flare star, and it is one of the least massive stars known with certainty.

28. Luyten L 789–6 = Luyten LPM 837.

29. Lacaille 9352 = GC 32159.

Added in proof:

3, 4. UV Ceti = Luyten L726-8. A paper by P. van de Kamp (*A.J.*, **64**, 236, 1959) gives a new parallax determination, $\pi = 0''\cdot369 \pm 0''\cdot010$, and new orbital elements P = 200 years, $a = 5''\cdot57$. On this basis the masses of A and B are 0·044 ☉ and 0·035 ☉. These are the least massive stars known.

ELEMENTS OF THE PLANETARY ORBITS

Elements for the Epoch 1960, Jan. 1·5 E.T.

Planet	Mean Longitude at the Epoch *L*			Mean Longitude of the perihelion ϖ			Mean Longitude of the Ascending Node Ω			Inclination to the Ecliptic *i*			Eccentricity *e*
	°	′	″	°	′	″	°	′	″	°	′	″	
Mercury	222	37	17·95	76	49	59·1	47	51	25·7	7	00	14·3	0·205 6265
Venus	174	17	39·51	131	00	29·9	76	19	11·0	3	23	39·2	0·006 7932
Earth	100	09	29·31	102	15	09·1	..	..	..	..	..	..	0·016 7259
Mars	258	46	02·26	335	19	21·7	49	14	56·5	1	50	59·7	0·093 3682
Jupiter	259	49	52·05	13	40	41·6	100	02	40·0	1	18	19·3	0·048 4354
Saturn	280	40	16·88	92	15	52·1	113	18	26·9	2	29	23·7	0·055 6818
Uranus	141	18	17·85	170	00	39·0	73	47	46·7	0	46	23·0	0·047 2094
Neptune	216	56	27·24	44	16	26·2	131	20	23·3	1	46	25·5	0·008 5748
Pluto	157	19	23·1	224	09	35	109	53	08	17	10	12	0·250 2376

The mean elements of the four inner planets and of Uranus and Neptune are from Newcomb's Tables (with Ross's corrections for Mars); those of Jupiter and Saturn are based on Hill's values, to which the variations of Le Verrier and Gaillot have been applied. The mean distance is the theoretical value of the semi-major axis, freed from perturbations, as adopted in the tables. The sidereal period and mean motion are drived from observations, and not from the mean distance by Kepler's third law. The angular elements are referred to the mean equinox and ecliptic of epoch.

The elements of Pluto are not mean elements, but are osculating values for the epoch 1960 September 23·0 E.T.

Planet	Mean Distance: Astronomical Units *a*	Mean Distance: Millions of Miles	Sidereal Period in Tropical Years *P*	Sidereal Mean Daily Motion *n*	Mean Synodic Period	Orbital Velocity mls/sec
				°	d	
Mercury	0·387099	36·0	0·24085	4·092339	115·88	29·77
Venus	0·723332	67·2	0·61521	1·602131	583·92	21·77
Earth	1·000000	92·9	1·00004	0·985609	..	18·52
Mars	1·523691	141·5	1·88089	0·524033	779·94	15·01
Jupiter	5·202803	483·3	11·86223	0·083091	398·88	8·12
Saturn	9·538843	886·1	29·45772	0·033460	378·09	6·00
Uranus	19·181946	1782	84·01331	0·011732	369·66	4·22
Neptune	30·057779	2792	164·79345	0·005981	367·48	3·37
Pluto	39·43886	3664	248·4302	0·003968	366·73	2·94

Elements of Minor Planets: Equinox 1950·0

Planet	ϖ	Ω	*i*	*e*	*n*	*a*
	°	°	°		°	
Ceres	152·367	80·514	10·607	0·07590	0·214082	2·7675
Pallas	122·734	172·975	34·798	0·23402	0·213579	2·7718
Juno	56·571	170·438	12·993	0·25848	0·226124	2·6683
Vesta	253·236	104·102	7·132	0·08887	0·271568	2·3617

SUN, MOON AND PLANETS

Name	Semi-diameter at: Unit Dist.	Semi-diameter at: Mean Opp'n Dist.*	Diameter in: Kilo-metres	Diameter in: Miles	Period of Axial Rotation	Inclin-tion ‡	Reciprocal Mass Sun= 1 §	Dens-ity Water = 1	Escape Velocity mls./sec	On scale Earth= 1: Dia-meter	On scale Earth= 1: Mass	On scale Earth= 1: Volume	On scale Earth= 1: Surface Grav.**
	″	″				° ′							
Sun	959·63	..	1,391,000	864,000	25ᵈ·380	7 15	..	1·41	384	109	333,434	1,300,000	28·0
Moon	2·40	932·58	3,476	2,160	27ᵈ·3217	1 32	27,158,000	3·34	1·5	0·272	0·0123	0·0203	0·16
Mercury .	3·44	5·61	4,990	3,100	88ᵈ	?	6,000,000	5·13	2·6	0·39	0·056	0·060	0·36
Venus	8·[illegible]2	31·44	12,400	7,700	?	32	408,000	4·97	6·4	0·97	0·817	0·910	0·87
Earth (Eql.) ..	8·80	..	12,757	7,927	$23^h\ 56^m\ 04^s{\cdot}100$	23 27	329,400	5·52	6·9	1·000	1·000	1·000	1·00
Earth (Polar) ..	8·77	..	12,714	7,900	..					0·997			1·00
Mars	4·68	8·94	6,800	4,200	$24^h\ 37^m\ 22^s{\cdot}689$	23 59	3,093,500	3·94	3·1	0·53	0·108	0·151	0·38
Jupiter (Eql.) ..	98·47	23·43	142,700	88,700	$9^h\ 50^m\ 30^s{\cdot}003$†	3 04	1047·35	1·34	37	11·2	318·4	1312	2·64
Jupiter (Polar) ..	91·91	21·87	133,200	82,800	..					10·4			2·67
Saturn (Eql.) ..	83·33	9·76	120,800	75,100	$10^h\ 14^m$	26 44	3501·6	0·69	22	9·5	95·2	763	1·13
Saturn (Polar) ..	74·57	8·73	108,100	67,200	..					8·5			1·15
Uranus	32·5	1·79	47,100	29,300	$10^h\ 49^m$	97 53	22,869	1·60	14	3·7	14·6	50	1·07
Neptune	30·8	1·06	44,600	27,700	14^h?	28 48	19,314	2·23	15	3·5	17·3	43	1·41
Pluto	4·1	0·11	7,900	4,900	$6^d{\cdot}39$	?	360,000	4 ?	?	0·6	0·9 ?	0·2	?

NOTES.—The values for Uranus and Neptune are based on recent data published by Kuiper and Camichel respectively; those for Pluto are tentative, and are derived from measures by the same observers.

* The values for Mercury and Venus are those at mean inferior conjunction.

† The rotation period for Jupiter is for System I; for System II the value is $9^h\ 55^m\ 40^s{\cdot}632$.

‡ This column give the inclination of the equator of the body to its mean orbit, except in the cases of the Sun and Moon. For these two bodies, the inclination of the equator to the ecliptic is given.

§ These include the mass of the satellite system, if any.

** The values here compared are those of the planets' attractions and not the resultant of gravity and centrifugal force; the latter would diminish the result given for the equator of Jupiter by 9 per cent, and that for the equator of Saturn by 16 per cent, but does not affect the attraction at the poles.

Planet and Satellite	Mean Distance from Primary: Astronomical Units	Mean Distance from Primary: Angular at Mean Opposition Distance	Sidereal Period	Synodic Period
		° ′ ″	d	d h m s
EARTH				
Moon	0·002 571	..	27·321 661	29 12 44 02·8
MARS				
I Phobos	0·000 062 725	24·7	0·318 910	7 39 26·65
II Deimos	0·000 156 95	1 1·8	1·262 441	1 6 21 15·68
JUPITER				
V	0·001 207	59·2	0·498 179	11 57 27·6
I Io	0·002 819 56	2 18·4	1·769 138	1 18 28 35·95
II Europa	0·004 486 20	3 40·2	3·551 181	3 13 17 53·74
III Ganymede	0·007 155 90	5 51·2	7·154 553	7 3 59 35·86
IV Callisto	0·012 586 5	10 17·7	16·689 018	16 18 5 06·92
VI	0·076 723	1 2 45	250·57	266
VII	0·078 455	1 4 10	259·65	276 05
X	0·079 217	1 4 48	263·55	—
XII	0·141 773	1 55 58	631·1	—
XI	0·150 833 6	2 3 24	692·5	—
VIII	0·157 20	2 8 35	738·9	—
IX	0·158 5	2 9 39	758	—
SATURN				
I Mimas	0·001 240 1	30·0	0·942 422	22 37 12·4
II Enceladus	0·001 590 9	38·4	1·370 218	1 08 53 21·9
III Tethys	0·001 969 4	47·6	1·887 802	1 21 18 54·8
IV Dione	0·002 522 4	1 0·9	2·736 916	2 17 42 09·7
V Rhea	0·003 522 6	1 25·1	4·517 503	4 12 27 56·2
VI Titan	0·008 166 0	3 17·3	15·945 452	15 23 15 25
VII Hyperion	0·009 892 8	3 59·0	21·276 665	21 07 39 06
VIII Iapetus	0·023 797 6	9 34·9	79·330 82	79 22 04 56
IX Phoebe	0·086 575 2	34 56	550·45	523 16
URANUS				
V Miranda*	0·000 825	9·3	1·414	—
I Ariel	0·001 282 0	14·2	2·520 383	2 12 29 40
II Umbriel	0·001 785 9	20·2	4·144 183	4 03 28 25
III Titania	0·002 930 3	33·2	8·705 876	8 17 00 00
IV Oberon	0·003 918 7	44·4	13·463 262	13 11 15 36
NEPTUNE				
I Triton	0·002 363 5	16·8	5·876 833	5 21 03 27
II Nereid	0·037 255	4 24	359·4	—

NOTES.—The elements of the satellite orbits are all subject to considerable variations, particularly in regard to inclination and eccentricity; the orbits of the outer satellites are not even approximately elliptic. The values given should be regarded as means. The masses of the satellites are in most cases unknown, and the diameters are mostly rough estimates.

The inclinations of the orbits are referred to the plane of the planet's equator, except in the case of the Moon, whose orbit has a mean inclination of 5° 08′ to the ecliptic. Inclinations greater than 90° indicate retrograde motion with respect to the rotation of the planet.

Commensurabilities: If n_i is the mean motion of satellite i the following rules can be stated:

Jupiter: $n_1 - 3n_2 + 2n_3 = 0$

Saturn: $5n_1 - 10n_2 + n_3 + 4n_4 = 0$

Uranus: $n_5 - 3n_1 + 2n_2 = 0$

$n_1 + n_2 + 2n_3 + n_4 = 0$

Orbit inclination	Orbit eccentricity	Satellite diameter (miles)	Reciprocal mass Planet ÷	Stellar Magnitude at Mean Opposition Distance	
					EARTH
See notes	0·05490	2160	81·271	− 12·5	Moon
° ′					MARS
0 57	0·0210	10?		10—12	I
1 18	0·0028	5?		11—12	II
					JUPITER
0 24	0·003	100		13	V
0	0	2000	26 200	5·3—5·8	I
0	0	1750	40 300	5·7—6·4	II
0	0	3000	12 200	4·9—5·3	III
0	0	2800	19 600	6·1—6·4	IV
27 38	0·15798	80		14·7	VI
24 46	0·20719	25		17·5—18	VII
29 01	0·13029	12		19	X
147	0·16870	12		18	XII
164	0·20678	15		19	XI
145	0·378	25		17·0	VIII
153	0·275	12		18·6	IX
					SATURN
1 31	0·0201	300	15 000 000	12·1	I
0 01	0·00444	400	8 000 000	11·7	II
1 06	0	600	870 000	10·6	III
0 01	0·00221	600	550 000	10·7	IV
0 21	0·00098	850	250 000	10·0	V
0 20	0·0289	3000	4 150	8·3	VI
0 26	0·104	250		15	VII
14 43	0·02828	750		10·8	VIII
150	0·16326	150		14	IX
					URANUS
0	< 0·01	100?	1 000 000	16·8	V
0	0·0028	400	70 000	13·7	I
0	0·0035	300	170 000	14·5	II
0	0·0024	600	20 000	13·7	III
0	0·0007	500	34 000	13·8	IV
					NEPTUNE
159 57	0	2500	750	13·6	I
27 27	0·76	200?		19·5	II

Dimensions of Saturn's Ring-System

Diameter		At Unit Distance	At Mean Opposition Distance	Miles	Ratio
		″	″		
Ring A	outer	375·4	43·96	169,300	1·0000
	inner	330·4	38·69	149,000	0·8801
Ring B	outer	322·8	37·80	145,500	0·8599
	inner	249·6	29·24	112,600	0·6650
Ring C	inner	205·9	24·12	92,900	0·5486
Saturn	equat.	166·7	19·52	75,100	0·4440
	polar	149·1	17·46	67,200	0·3973

ASTRONOMICAL AND PHYSICAL CONSTANTS

Solar parallax (Paris Conference, 1896)	8″·80
Constant of nutation (Paris Conference, 1896)	9″·21
Constant of aberration (Paris Conference, 1896)	20″·47
Moon's equatorial horizontal parallax (*Brown*)	3422″·70
Annual general precession (*Newcomb*)	$p = 50''\cdot2564 + 0''\cdot0222T$*
Annual precession in R.A. (*Newcomb*)	$m = 3^s\cdot07234 + 0^s\cdot00186T$
Annual precession in Dec. (*Newcomb*)	$n = 20''\cdot0468 - 0''\cdot0085T$
Obliquity of ecliptic (*Newcomb*)	$\epsilon = 23°\ 27'\ 08''\cdot26 - 46''\cdot85T$
Node of moving on fixed ecliptic (*Newcomb*)	$\Pi = 173°\ 57'\cdot06 + 54'\cdot77T$
Speed of rotation of ecliptic (*Newcomb*)	$\pi = 0''\cdot4711 - 0''\cdot0007T$
Mean distance Earth to Sun†	149,500,000 km = 92,900,000 miles
Mean distance Earth to Moon	384,040 km = 238,900 miles

Length of the Year (*Newcomb*)	d d
Tropical (equinox to equinox)	365·24219 879 − 0·00000 614T
Sidereal‡	365·25636 042 + 0·00000 011T
Anomalistic (perihelion to perihelion)	365·25964 134 + 0·00000 304T
Eclipse§ (*Brown*)	346·62003 1 + 0·00003 2 T
Julian	365·25

Length of the month (*Brown*)	d d
Synodical (New Moon to New Moon)	29·53058 82 − 0·00000 02T
Sidereal‡	27·32166 10 − 0·00000 02T
Tropical (equinox to equinox)	27·32158 17 − 0·00000 02T
Anomalistic (perigee to perigee)	27·55455 05 − 0·00000 14T
Nodical (node to node)	27·21222 0 + 0·00000 00T

Length of day (*Newcomb*)	
Mean solar	$24^h\ 03^m\ 56^s\cdot555 = 1^d\cdot00273\ 791$ sidereal time
Sidereal	$23^h\ 56^m\ 04^s\cdot091 = 0^d\cdot99726\ 957$ mean solar time

Dimensions of the Earth (*Hayford's Spheroid*, as adopted at Madrid, 1924)

Equatorial radius	a = 6378·388 km = 3963·35 miles
Polar radius	b = 6356·912 km = 3950·01 miles
Flattening or ellipticity	$c = (a-b)/a = 1/297$
Eccentricity of meridian	$e = \sqrt{2c - c^2} = 0\cdot08199\ 189$

$\rho \sin \phi' = S \sin \phi$ $\rho \cos \phi' = C \cos \phi$ where

$S = 0\cdot994953 - 0\cdot001678 \cos 2\phi + 10^{-6}(2 \cos 4\phi + 0\cdot0478H)$*

$C = 1\cdot001687 - 0\cdot001689 \cos 2\phi + 10^{-6}(2 \cos 4\phi + 0\cdot0478H)$

$\tan \phi' = (0\cdot993277 + 10^{-6}\ 0\cdot0003H) \tan \phi$

$\rho = 0\cdot998320 + 0\cdot001684 \cos 2\phi + 10^{-6}(4 \cos 4\phi - 0\cdot0478H)$

$\phi - \phi' = 695''\cdot65 \sin 2\phi - 1''\cdot17 \sin 4\phi$

1° of latitude	111·133 − 0·562 cos 2ϕ km
1° of longitude	111·414 cos ϕ − 0·094 cos 3ϕ km

Acceleration due to gravity, in cm per second per second

$g = 980\cdot618 - 2\cdot5865 \cos 2\phi + 0\cdot0058 \cos^2 2\phi - 0\cdot000308\, h$

Gaussian gravitation constant	$k = 0\cdot01720\ 209895 = 0°\cdot98560\ 76686$
Period of a comet or asteroid	$1\cdot00004\ 027\ a^{3/2}$ tropical years = $365\cdot256898\ a^{3/2}$ mean solar days
Earth's mean orbital speed	29·8 km = 18·5 miles per second
Constant of gravitation (*Heyl*)	$G = 6\cdot670 \times 10^{-8}$ c.g.s. units
Mass of the Earth (*derived from above*)	$5\cdot98 \times 10^{27}$ grams
Mean density of the Earth (*derived from above*)	5·517 (water = 1)
Mass of the Sun (*derived from above*)	$2\cdot00 \times 10^{33}$ grams
Invariable plane of the solar system (*Innes*)	$\Omega = 106°\ 35'\ 01'' + 3452''T$
	$i = 1°\ 34'\ 59'' - 18''T$

* T = time measured in Julian centuries from 1900·0; ϕ = geographical latitude; h = height above sea level in metres and H = same in feet.

† Corresponding to the value of the Solar Parallax given above. The more recent value of 8″·79 (*Handbook*, 1942) would give a distance of 149,700,000 km = 93,000,000 miles.

‡ The sidereal year (or month) is the interval between successive returns of the Sun (or Moon) to the same point among the stars.

§ The interval between successive returns of the Sun to the Moon's node.

Galactic plane, equinox 1950·0 (*I.A.U.*, 1959)
Pole .. .. R.A. $12^h 49^m$ Dec. + 27°·4
Node on equator .. .. R.A. $18^h 49^m$
Inclination to equator .. .. 62°·6
Point of zero longitude .. .. R.A. 17^h 42·4 Dec. − 28° 55′

Centre of galaxy* .. .. R.A. 265° Dec. − 29°
Distance to centre of galaxy* .. .. 8200 parsecs
Mass of galactic system* .. .. .. $1·6 \times 10^{11} \times$ mass of Sun = 3×10^{44} grams
Period of rotation* (for stars in vicinity of Sun) .. .. .. $2·2 \times 10^8$ years
Vertex of star streaming† (*Eddington*) .. .. .. R.A. 94° Dec. + 12°
Solar apex† .. .. R.A. 271° Dec. + 30°
Solar motion† .. .. 19·4 km = 12·2 miles per second

Solar constant (*Abbott*) .. .. .. 1·97 gram-calories per square cm per minute
Sun's emission of energy (*derived from above*) .. .. $3·9 \times 10^{33}$ ergs per second
Sun's emission of energy per cm^2 of surface .. .. .. $6·35 \times 10^{10}$ ergs per second

Velocity of light in vacuo .. .. 299,791 km = 186,282 miles per second
Light travels unit distance in‡ .. .. $498^s·38 = 8^m·306 = 0^h·1384 = 0^d·005768$

Light ratio for one magnitude 2·512 .. .. .. Logarithm of ratio 0·400
Sun's stellar magnitude (*mean of various observers*) .. .. .. −26·6
Sun's absolute magnitude (at distance of 10 parsecs) .. .. .. 5·0
Magnitude of Full Moon (*mean of various observers*) .. .. .. −12·5
Total light of all stars (*Van Rhijn*) = 1440 first mag. stars

Light-year .. .. $9·463 \times 10^{12}$ km = $5·880 \times 10^{12}$ miles
= 63,290 astronomical units = 0·3069 parsecs
Parsec.. .. .. $30·84 \times 10^{12}$ km = $19·16 \times 10^{12}$ miles
= 206,265 astronomical units = 3·259 light years
Number of square degrees in the sky 41,253

MISCELLANEOUS DATA

		Logarithm
π	3·14159 26536	0·497 1499
e	2·71828 18285	0·434 2945
$M = \log_{10} e$	0·43429 44819	$\bar{1}$·637 7843
$1/M = \log_e 10$	2·30258 50930	0·362 2157
1 radian	57°·29577 95131	1·758 1226
	= 3437′·74677 078	3·536 2739
	= 206264″·80625	5·314 4251
1″ in radians	0·00000 4848137 = arc 1″	$\bar{6}$·685 5749
1′ in radians	0·00029 08882 = arc 1′	$\bar{4}$·463 7261
1° in radians	0·01745 32925 = arc 1°	$\bar{2}$·241 8774
1 metre =	3·28084 27 feet	0·515 9855
1 foot =	0·30479 973 metres	$\bar{1}$·484 0145
1 km =	0·621372 miles	$\bar{1}$·793 3516
1 mile =	1·609342 km	0·206 6484
miles/hour =	1·4667 ft./sec.	0·166 33
ft./sec. =	0·68182 miles/hr.	$\bar{1}$·833 67
Seconds in a day	86,400	4·936 5137
Seconds in a Julian year	31,557,600	7·499 1040
$\sqrt{2}$	1·41421 35624	0·150 5150
$\sqrt{3}$	1·73205 08076	0·238 5606

* Combined from all published data.
† From bright stars.
‡ Corresponding to a constant of aberration of 20″·47, not to the measured velocity of light in the previous line. In ephemerides it is more usual to take a value of $498^s·58 = 0^d·005770$.

MEAN MAGNETIC ELEMENTS

	Declination West	Horizontal Intensity	Vertical Intensity	Inclination (Dip)
	° ′	c.g.s. units	c.g.s. units	° ′
1953	8 57·5	0·18695	0·43321	66 39·5
1954	8 50·9	0·18720	0·43332	66 38·1
1955	8 43·6	0·18738	0·43348	66 37·3
1956	8 36·8	0·18750	0·43376	66 37·4
*1957	10 17·2	0·18627	0·43451	66 47·8
1958	10 11·0	0·18655	0·43465	66 46·3
1959 (provisional)	10 04·8	0·1868	0·4347	66 45
1960 (inferred)	9 59	0·1871	0·4348	66 43

The values given in the table for the years 1953—1956 refer to Abinger (Lat. 51° 11′ N., Long. 0° 23′ W.) but those for 1957 *et seq.* refer to Hartland (Lat. 51° 00′ N., Long. 4° 29′ W.). The observed differences Hartland *minus* Abinger for the epoch 1957·0 were:—

*Declination West	+ 1° 46′·6	Horizontal Intensity,	− 0·00146 c.g.s. units
Inclination	+ 0 11·4	Vertical Intensity,	+ 0·00056 ,, ,,

At other parts of the British Isles, the value of Declination West may be very roughly inferred by taking a value of 2°·5 less than that at Hartland and then allowing an increase of 0°·5 per degree of longitude west of Greenwich and 0°·3 per degree of latitude north of 50° North. Local deviations of the isogonals are, however, considerable, and the above rule may give a result as much as 1° in error in places.

* Revised values

Errata, 1959 *Handbook*

page 14, Jan. 1; *for* ε Leo *read* υ Leo.
page 26, foot; the equation should read $3n_2 = 2n_3 + n_1$.
page 54, Pluto *L*; *for* 37° *read* 137°.
page 56, Nereid; the angular distance should be 4′ 24″.
page 57, Titania, reciprocal mass; *for* 30000 *read* 20000.
page 59, footnote; *for* 489·48 *read* 498·58.

NOTES

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