Energy Levels of Light Nuclei
$A = 17$

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Abstract: An evaluation of $A = 16$–17 was published in *Nuclear Physics A*166 (1971), p. 1. This version of $A = 17$ differs from the published version in that we have corrected some errors discovered after the article went to press. Figures and introductory tables have been omitted from this manuscript. Reference key numbers have been changed to the NNDC/TUNL format.

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^{17}B

(Not illustrated)

^{17}B has not been observed. (1966GA25) predict that it is unbound with respect to decay into ^{15}B + 2n by 4.0 MeV. See also (1960ZE03).

^{17}C

(Not illustrated)

^{17}C has been observed in the 5.5 GeV proton bombardment of uranium: it is particle stable (1968PO04). (1966GA25) predict that it is bound, with respect to ^{16}C + n, by 0.6 ± 0.4 MeV: $M - A$ is then 22.4 ± 0.4 MeV. See also (1960ZE03, 1969AR13).

^{17}N

(Figs. 6 and 9)

GENERAL:

Theory and reviews: (1961BA1C, 1962GO1B, 1966MA12, 1970HI15).

Experimental papers: (1962VO01, 1965CI01, 1966PO08, 1967AU1B, 1967CA1J, 1968AR1F, 1968DO1C, 1969AR13).

1. (a) ^{17}N(β^-)^{17}O* → ^{16}O + n $\quad Q_{\rm m} = 4.536$
   (b) ^{17}N(β^-)^{17}O $\quad Q_{\rm m} = 8.679$

The half-life of ^{17}N is 4.14 ± 0.04 sec (1948KN1A), 4.20 ± 0.08 sec (1961HI01), 4.16 ± 0.01 sec (1965DO13), 4.17 ± 0.02 sec (1970ME1E): the mean of these values is 4.16 ± 0.01 sec. See also (1959AJ76).

The decay is primarily [≈ 95% (1964SI06)] to neutron unstable states of ^{17}O, principally ^{17}O*(4.55, 5.38, 5.94) [$J^\pi = \frac{3}{2}^-$, $\frac{3}{2}^-$ and $\frac{1}{2}^-$, respectively] (1961PE1A, 1963GI04). The ratio of the intensities of these delayed neutrons from ^{17}O*(5.38) and ^{17}O*(4.55) is 1.6 (1961PE1A). There are also weak branches to ^{17}O*(0, 0.87, 3.06): see Table 17.2 (1964SI06). The character of the decay indicates $J^\pi = \frac{1}{2}^-$ for ^{17}N(0). See also (1965MA16, 1970BE21, 1970HI15).

2. ^{11}B(^{7}Li, p)^{17}N $\quad Q_{\rm m} = 8.415$
   $Q_0 = 8.38 \pm 0.06$ (1959LI47).

Table 17.1: Energy levels of ^{17}N [a]

E_x in ^{17}N (MeV $\pm$ keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$	Decay	Reactions
0	$\frac{1}{2}^-; \frac{3}{2}$	$\tau_{1/2} = 4.16 \pm 0.01$ sec	β^-	1, 2, 3, 4, 5, 6, 9
1.3707 ± 0.8	$\leq \frac{3}{2}$	$\tau_m < 0.2$ psec	γ	2, 9
1.861 ± 10	$\frac{1}{2}^+$		γ	9
1.9080 ± 0.8	$\geq \frac{5}{2}$	$\tau_m > 0.5$ psec	γ	2, 9
2.5279 ± 3.6			γ	2, 9
3.1342 ± 4.6		$\tau_m < 0.3$ psec	γ	2, 9
3.220 ± 6		$\tau_m > 0.3$ psec	γ	2, 9
3.661 ± 6			γ	2, 9
3.684 ± 12				9
3.928 ± 12				9
4.023 ± 12			γ	2, 9
4.215 ± 25			γ	2, 9
4.470 ± 10			γ	2
5.176 ± 15			γ	2, 9
5.195 ± 15			γ	2, 9
5.523 ± 11	$(\frac{3}{2}^-)$		γ	2, 9
5.787 ± 15			γ	9
5.832 ± 11			γ	2, 9
6.08 ± 31				2
6.24 ± 24				2
6.43 ± 30				2
6.61 ± 24				2
6.99 ± 24				2
7.17 ± 40				2
7.37 ± 40				2
7.63 ± 40				2
7.78 ± 18				2
8.00 ± 24				2
8.14 ± 40				2
8.55 ± 40		broad		2
8.93 ± 40		broad		2
9.26 ± 40		broad		2
9.74 ± 40		broad		2

[a] See also Table 17.4.

Table 17.2: Beta decay of ^{17}N [a]

Decay to ^{17}O* (MeV)	J^π	Branch (%)	$\log ft$
0	$\frac{5}{2}^+$	1.6 ± 0.5	9.56 ± 0.13 [c]
0.87	$\frac{1}{2}^+$	2.6 ± 0.5	6.8 ± 0.1
3.06	$\frac{1}{2}^-$	0.46 ± 0.11	6.9 ± 0.1
3.84	$\frac{5}{2}^-$	< 0.1	> 7.4
> 3.84 [b]		≈ 95	

[a] (1964SI06) and J.C. Hopkins, private communication.
[b] See discussion in reaction 1 and (1961PE1A).
[c] $\log f_1 t$: E.K. Warburton, private communication and (1971TO08).

Proton groups have been observed to many states in ^{17}N: see Table 17.3 (1959LI47, 1965HA05, 1966MC05). See also (1963MO1B). Angular distributions have been measured at $E(^7\text{Li}) = 5$ MeV to most of the states with $E_\text{x} < 6.5$ MeV (1966MC05).

Observed γ-transitions are displayed in Tables 17.3 and 17.4 (1965HA05, 1969TH01). The mean lifetimes of ^{17}N*(1.37, 1.91, 3.13, 3.21) are, respectively, < 0.2, > 0.5, < 0.3 and > 0.3 psec, suggesting $J \leq \frac{3}{2}$ for ^{17}N*(1.37) and $J \geq \frac{5}{2}$ for ^{17}N*(1.91) (1969TH01). See also (1965CA05, 1967CA1D).

3. ^{14}C(α, p)^{17}N $\qquad Q_\text{m} = -9.715$

See (1961PE1A).

4. ^{15}N(t, p)^{17}N $\qquad Q_\text{m} = -0.110$

See (1963GI04, 1964SI06).

5. ^{17}O(n, p)^{17}N $\qquad Q_\text{m} = -7.896$

See ^{18}O in (1972AJ02).

6. ^{18}O(γ, p)^{17}N $\qquad Q_\text{m} = -15.942$

See ^{18}O in (1972AJ02).

Table 17.3: Levels of ^{17}N from ^{11}B(^{7}Li, p)^{17}N and ^{18}O(t, α)^{17}N

E_x (MeV ± keV)					
(1959LI47) [a]	(1965HA05) [a]	(1966MC05) [a]	(1969TH01) [b]	(1960JA13) [c]	A
0				0	0 [g]
1.32 ± 80			1.3707 ± 0.8	1.374 ± 18	1.381 ± 12
				1.851 ± 18	1.865 ± 12 [h]
1.89 ± 80			1.9080 ± 0.8	1.906 ± 18	1.921 ± 12
2.50 ± 80 [d]			2.5279 ± 3.6	2.536 ± 18	2.530 ± 15
2.82 ± 80					
			3.1342 ± 4.6	3.132 ± 18	3.138 ± 12
3.27 ± 90			3.2220 ± 7.1	3.212 ± 18	3.216 ± 12
3.57 ± 90			3.6656 ± 6.5	3.652 ± 25	3.650 ± 12
					3.684 ± 12
3.86 ± 90					3.928 ± 12
				4.010 ± 25	4.023 ± 12
4.18 ± 90				(4.215 ± 25) [f]	[i]
	4.47 ± 10	4.47 ± 40			[i]
					5.176 ± 15
	5.21 ± 20	5.23 ± 40			5.195 ± 15
	5.53 ± 20	5.51 ± 40			5.521 ± 15 [g]
					5.787 ± 15
	5.83 ± 20	5.83 ± 40			5.833 ± 15
	6.07 ± 50	6.09 ± 40			
	6.25 ± 30	6.23 ± 40			
	6.45 ± 40	6.41 ± 40			
	6.60 ± 30	6.62 ± 40			
	6.99 ± 30	6.99 ± 40			
	(7.26 ± 50)	7.17 ± 40			
		7.37 ± 40			
	(7.51 ± 70)				
		7.63 ± 40			
	7.79 ± 20	7.73 ± 40			
	8.00 ± 30	8.00 ± 40			

Table 17.3: Levels of ^{17}N from ^{11}B(^{7}Li, p)^{17}N and ^{18}O(t, α)^{17}N (continued)

E_x (MeV ± keV)					
(1959LI47) [a]	(1965HA05) [a]	(1966MC05) [a]	(1969TH01) [b]	(1960JA13) [c]	A
	(8.25 ± 30)	8.14 ± 40			
		8.55 ± 40 [e]			
		8.93 ± 40			
		9.26 ± 40			
		9.74 ± 40			

A: A.D.W. Jones, private communication: ^{18}O(t, α)^{17}N. See also (1968JO1G, 1969JO1L).

[a] Measurement of proton groups from ^{11}B(^{7}Li, p)^{17}N.

[b] Measurement of γ-ray from ^{11}B(^{7}Li, p)^{17}N.

[c] Measurement of alpha groups from ^{18}O(t, α)^{17}N.

[d] The proton groups to this level and the ones below are not completely resolved.

[e] This state and the ones below are broad.

[f] This may represent a doublet.

[g] $l = 1$.

[h] $l = 0$.

[i] States observed but E_x not determined.

7. ^{18}O(n, d)^{17}N $\qquad Q_m = -13.718$

See ^{19}O in (1972AJ02).

8. ^{18}O(d, ^{3}He)^{17}N $\qquad Q_m = -10.449$

Not reported.

9. ^{18}O(t, α)^{17}N $\qquad Q_m = 3.872$

$Q_0 = 3.872 \pm 0.015$ (1960JA13).

Alpha-particle groups corresponding to ^{17}N states with $E_x < 5.9$ MeV are displayed in Table 17.3 (1960JA13, A.D.W. Jones, private communication). Angular distributions to most of these have been measured at $E_t = 12.9$ MeV (1968JO1G, 1969JO1L): the spectroscopic strength of the transition to ^{17}N*(5.52) is equal to that of the ground state: it is probably the $p_{3/2}$ hole state.

Table 17.4: Radiative decays in ^{17}N [a] [†]

$E_{\rm i}$ (MeV)	$E_{\rm f}$ (MeV)	Branch (%)
1.37	0	100
$1.86 + 1.91$	0	75
	1.37	25
1.91	0	[b]
2.53	0	13
	1.37	30
	1.91	57
3.13	0	< 14
	1.91	[b]
3.22	0	50
3.66	$1.86 + 1.91$	[b]
	3.13	[b]
4.02	0	10
	$1.86 + 1.91$	40
	2.53	50
4.22	1.37	> 40
4.47	$1.86 + 1.91$	100
5.20	0	< 11
	$1.86 + 1.91$	[b]
	3.22	[b,c]
5.52	0	20
	1.37	30
	$1.86 + 1.91$	[b]
5.83	0	< 12
	1.37	[b]
	$3.13 + 3.22$	[b,c]

[†] Recent work (reaction 9, A.D.W. Jones, private communication) shows a number of states in ^{17}N addition to the ones listed below: see Table 17.1.

[a] (1965HA05, 1969TH01).

[b] Transition seen but branching ratio not measured.

[c] See, however, (1969TH01).

10. ^{19}F(n, ^{3}He)^{17}N $Q_{\mathrm{m}} = -16.217$

Not reported.

^{17}O
(Figs. 7 and 9)

GENERAL: (See also (1959AJ76).)

Shell model: (1957WI1E, 1959BR1E, 1959FE1B, 1959KH1A, 1959SA11, 1960AK1A, 1960TA1C, 1961BA1E, 1961NE1B, 1962BH09, 1962TA1B, 1962TA1E, 1963CO12, 1963HA05, 1963KU1B, 1963PA03, 1964BR1H, 1964RI1A, 1965GI1B, 1965LE1E, 1965MA16, 1965ZA1B, 1966AR10, 1966BO1R, 1966BR04, 1966BR1R, 1966BR1Q, 1966DE18, 1966LA1E, 1966MA12, 1966QU1A, 1966RI1F, 1966SO05, 1966ZA1E, 1967BO1T, 1967EL03, 1967EN01, 1967FE01, 1967GO04, 1967LY02, 1967NI1D, 1967PA05, 1967PF01, 1968BI07, 1968DE13, 1968EL1C, 1968EL1A, 1968HE1H, 1968HO1H, 1968KA1E, 1968MA2B, 1968NI1A, 1968SU1E, 1968ZU02, 1969BO37, 1969CH1R, 1969EL1D, 1969EL1B, 1969GI1B, 1969GU1M, 1969KA09, 1969KU1G, 1969MA38, 1969PI1D, 1969SA1J, 1969UL03, 1969ZU1D, 1970BO2B, 1970EL1G, 1970GU1E, 1970HI15, 1970WA01).

Collective model: (1959YU1A, 1960RA1A, 1960SH1A, 1961NE1B, 1962AR1C, 1962DA1B, 1962MA23, 1962MA1K, 1962MO1B, 1963CH02, 1964BA1L, 1964BR1H, 1965NE1C, 1966BR04, 1966BR1R, 1966BR1Q, 1967FE01, 1967GO04, 1967GR1D, 1968BI07, 1968EL1C, 1968MA2B, 1969BA2E, 1969MA38, 1970BA2B).

Electromagnetic transitions: (1959BA1C, 1959FA1C, 1960RA1A, 1962MA1K, 1963CH02, 1964BA1L, 1965GR1H, 1965KA1D, 1966MA12, 1966QU1A, 1967KA21, 1969KH1C, 1969MA38, 1970EL08, 1970GO1H, 1970SI1C).

Special levels: (1961WI1D, 1962IN02, 1963CO12, 1965EJ1A, 1965GI1B, 1965LE1E, 1965NE1C, 1966SO05, 1967BE02, 1967GR1D, 1967PF01, 1967PI01, 1968MA2B, 1969BA2E, 1969GI1B, 1969HA1G, 1970BA2B, 1970EL08, 1970RY02, 1970WA01).

Other topics: (1959FE1B, 1959KH1A, 1959SA11, 1960GO1C, 1963WA1E, 1964LI1B, 1964NI1A, 1965HU1D, 1965ZA1B, 1966MI1F, 1966WA1K, 1967EL03, 1967GR1H, 1967KA1G, 1967LY02, 1967NI1D, 1968KA1E, 1968NI1A, 1968SU1F, 1968SU1C, 1968SU1E, 1968WO1C, 1969DE16, 1969FO1G, 1969HE1N, 1969IW1B, 1969JA1P, 1969KA09, 1969NO03, 1969NO1E, 1969PA1G, 1969PI1D, 1969SA1J, 1969SC14, 1969SC1Q, 1970BA1M, 1970HA1T, 1970MC17, 1970SU1B).

Ground state:

$$\mu = -1.89371 \pm 0.00009 \text{ nm (1967SH14);}$$

$$Q = 26.5 \pm 3.0 \text{ mb (1964LI14).}$$

See also (1959FA1C, 1960RA1A, 1962BE1D, 1963BE36, 1964ST1B, 1965IC1A, 1966MA1V, 1966MA19, 1966MI1F, 1967CO1D, 1967GO1A, 1967GR1D, 1967SH05, 1968BE1X, 1968LE1L, 1968RO1E, 1969CH1R, 1969FU11, 1969PE1D, 1969SI1E, 1970EL08, 1970SI02, 1970SI1C).

Table 17.5: Energy levels of ^{17}O

E_x in ^{17}O (MeV $\pm$ keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
0	$\frac{5}{2}^+; \frac{1}{2}$			1, 2, 5, 6, 8, 9, 10, 12, 14, 19, 20, 22, 29, 30, 31, 32, 33, 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48
0.87081 ± 0.22	$\frac{1}{2}^+$	$\tau_m = 258.6 \pm 2.6$ psec	γ	1, 2, 5, 6, 8, 9, 10, 14, 19, 20, 22, 29, 31, 32, 34, 41, 42, 43, 44, 45, 46, 47, 48
3.055 ± 2.5	$\frac{1}{2}^-$	$\tau_m = 120^{+80}_{-60}$ fsec	γ	5, 6, 8, 9, 12, 14, 22, 29, 31, 34, 41, 42, 45, 46
3.841 ± 3	$\frac{5}{2}^-$	$\tau_m \leq 25$ fsec	γ	5, 6, 8, 9, 12, 14, 19, 20, 29, 31, 37, 41, 42, 45, 46
4.554 ± 6	$\frac{3}{2}^-$	$\Gamma = 40 \pm 5$	n	5, 6, 8, 9, 14, 19, 20, 23, 29, 37, 41, 42, 46
5.083 ± 10	$\frac{3}{2}^+$	95 ± 5	n	8, 9, 14, 19, 23, 29, 41, 42
5.217 ± 5	$\frac{7}{2}^- \rightarrow \frac{11}{2}^-$	< 8		6, 8, 9, 14, 19, 20, 29, 37, 41, 46
5.377 ± 3	$\frac{3}{2}^-$	28 ± 7	n	6, 14, 19, 23, 29, 41, 42, 46
5.696 ± 3	$\frac{7}{2}^-$	3.4	n	6, 8, 9, 14, 19, 20, 23, 29, 37, 41, 46
5.731 ± 3	$\frac{1}{2}^+$	< 1	n	5, 6, 8, 9, 14, 23, 29, 46
5.867 ± 3	$\frac{3}{2}^+$	6.6	n	6, 8, 9, 14, 19, 23, 29, 46
5.935 ± 3	$\frac{1}{2}^-$	23 ± 10	n	5, 8, 9, 14, 19, 23, 29, 46
6.356 ± 8	$\frac{1}{2}^+$	135	n	5, 6, 14, 19, 23
6.859 ± 3		< 1	n	5, 6, 8, 9, 14, 19, 23, 29, 46

Table 17.5: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV ± keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
6.970 ± 3		< 1	n	8, 9, 14, 19, 23, 46
7.166 ± 2.4	$\frac{5}{2}^-$	2.7 ± 1	n, α	5, 7, 8, 9, 14, 19, 23, 28
7.29	$\frac{3}{2}^+$	500	n	23
7.378 ± 2.4	$\frac{5}{2}^+$	0.5	n, α	5, 6, 7, 8, 9, 14, 20, 23, 28, 46
7.379 ± 3	$\frac{5}{2}^-$	1.1	n	5, 6, 8, 9, 14, 19, 23, 28
(7.53)	$(\frac{3}{2})$	600	n	23
7.569 ± 7	$\frac{7}{2}^-$	≤ 4	n, α	5, 6, 7, 8, 9, 14, 19, 28
7.67	$\frac{3}{2}^-$	400	n	19, 23
7.684 ± 5	$\frac{7}{2}^-$	18	n, α	5, 7, 8, 9, 23, 28
(7.69)	$\frac{3}{2}^+$	3	n	8, 9, 23, 28
7.751 ± 14	$(\frac{11}{2}^-)$			6, 8, 19, 20, 21, 37, 46
7.947 ± 20	$\frac{1}{2}^-$	79 ± 10	n, α	7, 23, 28
8.090 ± 9	$\frac{3}{2}^+$	71 ± 8	n, α	7, 19, 20, 23, 28
8.213 ± 9	$\frac{3}{2}^-$	71 ± 5	n, α	7, 19, 20, 23, 28, 29
8.347 ± 5	$\frac{1}{2}^+$	9 ± 3	n, α	7, 23, 28, 29
8.402 ± 5	$\frac{5}{2}^+$	4 ± 3	n, α	7, 23, 28
8.467 ± 5	$\frac{7}{2}^+$	7 ± 3	n, α	5, 7, 8, 9, 20, 23, 28
8.502 ± 5	$\frac{5}{2}^-$	5 ± 3	n, α	7, 8, 9, 19, 23, 28
(8.568 ± 10)			n	23
8.703 ± 8	$\frac{3}{2}^-$	50 ± 3	n, α	6, 7, 8, 9, 19, 23, 28
8.87 ± 20	$\frac{7}{2}^-$	6	n, α	7, 8, 9, 19, 20, 23
8.90 ± 15	$\frac{3}{2}^+$	101 ± 3	n, α	6, 7, 8, 9, 19, 20, 28
8.961 ± 4	$\frac{7}{2}^-$	21 ± 3	n, α	6, 7, 8, 9, 19, 20, 23, 28
9.14 ± 30	$(\frac{9}{2}^-)$			6, 19, 20, 21
9.16 ± 15	$\frac{1}{2}^-$	4 ± 3	n, α	7, 28
9.18	$\frac{7}{2}^-$	3	α	7
9.19	$\frac{5}{2}^+$	5.5 ± 1	n, α	7, 23, 28

Table 17.5: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV $\pm$ keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
9.45	$\geq \frac{3}{2}$	140	n	23
9.50	$\frac{5}{2}^-$	15 ± 1	n, α	5, 7, 19, 28
9.705 ± 5	$\frac{7}{2}^+$	16 ± 1	n, α	6, 7, 19, 23
9.78	$\frac{3}{2}^+$	45	n, α	7, 19, 20, 23
9.88	$\frac{9}{2}^+$	12 ± 1	n, α	6, 7, 19, 20, 23, 28
9.95	$\frac{5}{2}^+$	107	n, α	7, 28
10.13	$\frac{5}{2}^+$	138	n, α	7
10.157 ± 7	$\frac{7}{2}^-$	42	n, α	7, 19, 23, 28
10.24	$\frac{7}{2}^+$	122	n, α	7, 28
10.32	$(\frac{5}{2}^+, \frac{7}{2}^-)$		n, α	7
10.422 ± 10		14 ± 3	n, α	7
10.49	$(\frac{5}{2}^+, \frac{7}{2}^-)$	75 ± 30	n, α	7
10.549 ± 6	$(\frac{7}{2}^-, \frac{9}{2}^+)$	47 ± 15	n, α	7, 19, 23, 24, 28
10.70	$(\frac{7}{2}^+)$	≤ 25	α	6, 7
10.769 ± 10	$(\frac{1}{2}^+, \frac{7}{2}^-)$	80 ± 20	n, α	7, 24, 28
10.909 ± 7	$\frac{5}{2}$	57 ± 15	n, α	7, 19, 23, 24, 28
11.026 ± 10	$T = \frac{1}{2}$	45 ± 10	n, α	7, 19, 24, 28
11.082 ± 6	$(\frac{1}{2})^-; \frac{3}{2}$	< 20		6, 19, 24, 41, 43
11.225 ± 10		100 ± 30	n, α	5, 7, 19, 28
11.51	$\geq \frac{3}{2}$	190	n, (α)	19, 23, 24, 28
11.615 ± 10		120 ± 30	n, α	7, 19, 24, 28
11.748 ± 10		40 ± 25	n, α	7, 28
11.813 ± 15		12 ± 3	n, α	6, 7, 28
11.97	$\geq \frac{3}{2}$	270	n	23
12.002 ± 15			n, α	6, 7, 24, 28
12.11 ± 20		150 ± 50	n, α	6, 7, 24
12.271 ± 15		100 ± 30	n, α	6, 7, 28
12.38 ± 20	$\geq \frac{1}{2}$	130	n, α	7, 23
12.417 ± 15			n, α	7
12.471 ± 5	$(\frac{3}{2})^-; \frac{3}{2}$		n	6, 24, 43

Table 17.5: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV ± keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
12.592 ± 15		75 ± 30	n, α	7, 23
12.666 ± 15		≈ 75	n, α	7, 23, 24
12.81 ± 25			n, α	7
12.92 ± 20		$\gtrsim 150$	n, α	7
12.950 ± 8	$\frac{1}{2}^+; \frac{3}{2}$			6, 24, 43
12.994 ± 8	$T = \frac{3}{2}$		n, α	6, 7, 43
13.073 ± 15		16 ± 4	n, α	7
13.481 ± 15		≈ 120	n, α	7
13.606 ± 15		250 ± 100	n, α	7, 23
13.640 ± 5	$(\frac{5}{2})^+; \frac{3}{2}$			6, 43
14.219 ± 8	$T = \frac{3}{2}$			29, 43
14.282 ± 12	$T = \frac{3}{2}$			6, 29, 43
14.62	$(\geq \frac{3}{2})$	340	n	6, 23
14.80	$(T = \frac{3}{2})$			6
14.99	$(\frac{5}{2}^+)$	≈ 150	n, d, α	17, 23
15.101 ± 8	$T = \frac{3}{2}$		p, d, α	16, 17, 43
15.6		≈ 200	p, d, α	16, 17
20.5	$(\frac{1}{2}^+)$		n, ^{3}He	11, 23
21.1			n, ^{3}He	11
21.7	$(\frac{5}{2}^+)$		^{3}He, α	11
22.1	$(\frac{1}{2}^-, \frac{3}{2}^-, \frac{7}{2}^-)$		n, ^{3}He, α	11
23.0	$(\frac{1}{2}^+)$		^{3}He	11

1. ^{7}Li(^{14}N, α)^{17}O $\qquad Q_m = 16.154$

The angular distribution of the α-particles corresponding to ^{17}O*(0, 0.87) (unresolved) has been measured at $E(^{14}\text{N}) = 27.6$ MeV (1964WA1B).

2. ^{9}Be(^{16}O, ^{8}Be)^{17}O $\qquad Q_m = 2.477$

The lifetime of ^{17}O*(0.87), $\tau_{\rm m}$, is 253 ± 6 psec (1969NI09): see Table 17.7. At $E(^{16}{\rm O}) = 15$ and 18 MeV, the transitions to ^{17}O*(0, 0.87) have been studied (1970BA1J). The excitation curve for the one-neutron transfer to ^{17}O*(0.87) has been measured for $E(^{16}{\rm O}) = 6$ to 22 MeV (1970BA55). See also (1968KN1A).

3. (a) ^{10}B(^{7}Li, p)^{16}N — $Q_{\rm m} = 13.985$ — $E_{\rm b} = 27.767$
   (b) ^{10}B(^{7}Li, d)^{15}N — $Q_{\rm m} = 13.723$
   (c) ^{10}B(^{7}Li, t)^{14}N — $Q_{\rm m} = 9.146$
   (d) ^{10}B(^{7}Li, α)^{13}C — $Q_{\rm m} = 21.410$

Cross sections to various of the final states have been measured at $E(^{7}{\rm Li}) = 5.20$ MeV (1966MC05). See also (1963MO1B).

4. (a) ^{11}B(^{6}Li, p)^{16}N — $Q_{\rm m} = 9.782$ — $E_{\rm b} = 23.564$
   (b) ^{11}B(^{6}Li, d)^{15}N — $Q_{\rm m} = 9.520$
   (c) ^{11}B(^{6}Li, t)^{14}N — $Q_{\rm m} = 4.942$
   (d) ^{11}B(^{6}Li, α)^{13}C — $Q_{\rm m} = 17.207$

Cross sections to various of the final states have been measured at $E(^{6}{\rm Li}) = 4.72$ MeV (1966MC05). See also (1963MO1B).

5. ^{12}C(^{6}Li, p)^{17}O — $Q_{\rm m} = 7.607$

Angular distributions have been reported at $E(^{6}{\rm Li}) = 3$ MeV (1963BA08; p_2, p_3, p_4), 3.4 to 4.0 MeV (1962BL13; $p_0 \rightarrow p_3$), 4.5 to 5.5 MeV (1966HE05; $p_0 \rightarrow p_4$), 5.6 to 6.6 MeV (1970JO09; $p_0 \rightarrow p_3$), 9.0 to 14.0 MeV (1970JO09; $p_0 \rightarrow p_4$) and 20 MeV (1968ME10; p to ^{17}O*(8.47)). Neither the direct reaction model nor the statistical compound nucleus model alone is adequate to describe the data (1970JO09). Proton groups to various states of ^{17}O with $E_{\rm x} \leq 15.8$ MeV have been identified by (1966HE05, 1968ME10, 1970JO09). See also (1960SH05, 1967DZ01), (1967CA1D), (1968GA1J, 1969GI1B; theor.) and ^{18}F in (1972AJ02).

6. ^{12}C(^{7}Li, d)^{17}O — $Q_{\rm m} = 2.579$

Angular distributions of the d_0 and d_1 groups have been measured at $E(^{7}{\rm Li}) = 3.24$ to 3.64 MeV (1967MO23). At $E(^{7}{\rm Li}) = 20$ and 24.4 MeV, deuteron groups are observed to many states of ^{17}O with $E_{\rm x} < 15$ MeV, including states at $E_{\rm x} = 8.50$ and 11.85 MeV and probable $T = \frac{3}{2}$ states at 11.08, 12.47, 12.99, 13.64, 14.28 and 14.80 MeV (1969BA2U, 1970COZA). See also (1970CA1N) and ^{19}F in (1972AJ02).

Table 17.6: Resonances in ^{13}C(α, α_0)^{13}C, ^{13}C(α, n)^{16}O and ^{16}O(n, α)^{13}C

E_α (MeV ± keV)	E_n (MeV)	Γ_α/Γ	$\Gamma_{c.m.}$ (keV)	J^π	E_x [a] (MeV)	Refs.
1.063 ± 4			2.7 ± 1	$\frac{5}{2}$	7.170	A
1.340 ± 4			≤ 2	$\frac{5}{2}^+$	7.382	(A, 1969SC04)
1.585 ± 7			≤ 4	$\frac{7}{2}^-$	7.569	(1956RU1A, 1957WA1C, 1969SC04)
1.736 ± 5			22	$\frac{5}{2}^+$	7.684	(1956RU1A, 1957WA1C, 1969SC04)
2.080 ± 20	4.0	0.03	79 ± 10	$\frac{1}{2}^-$	7.947	(B, 1965BA32, 1967SE07)
2.250 ± 20	4.15	0.05	71 ± 8	$\frac{3}{2}^+$	8.077	(C, 1965BA32, 1967SE07)
2.420 ± 20	4.25	0.11	71 ± 5	$\frac{3}{2}^-$	8.207	(C, 1965BA32, 1967SE07)
2.603 ± 5	4.46	0.44	9 ± 3	$\frac{1}{2}^+$	8.347	(D, 1965BA32, 1967SE07)
2.675 ± 5	4.53	0.08	4 ± 3	$\frac{5}{2}^+$	8.402	(D, 1965BA32, 1967SE07)
2.760 ± 5	4.59	0.97	7 ± 3	$\frac{7}{2}^+$	8.467	(D, 1965BA32, 1967SE07)
2.805 ± 5	4.62	0.26	5 ± 3	$\frac{5}{2}^-$	8.502	(D, 1965BA32, 1967SE07)
3.08 ± 15	4.85	0.06	50 ± 3	$\frac{3}{2}^-$	8.71	(D, 1963DA12, 1965BA32, 1967SE07, 1971BA06)
(3.1)			broad	$\frac{1}{2}^-$	8.7	(1971BA06)
3.305		1.00	6	$\frac{7}{2}^-$	8.884	(1965BA32)
3.33 ± 15	5.05	0.50	101 ± 3	$\frac{3}{2}^+$	8.90	(D, 1963DA12, 1965BA32, 1967SE07, 1971BA06)
3.42 ± 15	5.12	0.04	21 ± 3	$\frac{7}{2}^-$	8.97	(D, 1963DA12, 1965BA32, 1967SE07, 1971BA06)
3.67 ± 15	5.32	0.45	4 ± 3	$\frac{1}{2}^-$	9.16	(1956BO61, 1963DA12, 1967SE07, 1968KE02)
3.69		1.00	3	$\frac{7}{2}^-$	9.18	(1968KE02)
3.72	5.37	0.20	5.5 ± 1	$\frac{5}{2}^+$	9.20	(1956BO61, 1956SC1C, 1963DA12, 1967SE07, 1968KE02)
4.11	5.68	0.85	15 ± 1	$\frac{5}{2}^-$	9.50	(1956BO61, 1956SC1C, 1963DA12, 1967SE07, 1968KE02)
(4.3)			broad	$\frac{3}{2}^-$	(9.6)	(1971BA06)
4.40		0.70	16 ± 1	$\frac{7}{2}^+$	9.72	(1956BO61, 1956SC1C, 1967SE07, 1968KE02, 1971BA06)
	5.92					(1963DA12)
4.42		0.90	61	$\frac{3}{2}^+$	9.74	(1968KE02, 1971BA06)
4.58	6.08	0.18	12 ± 1	$\frac{9}{2}^+$	9.86	(1963DA12, 1967SE07, 1968KE02, 1971BA06)
4.70	6.22	0.78	107	$\frac{5}{2}^+$	9.95	(1963DA12, 1968KE02, 1971BA06)
4.94		0.85	138	$\frac{5}{2}^+$	10.13	(1968KE02)

Table 17.6: Resonances in ^{13}C(α, α_0)^{13}C, ^{13}C(α, n)^{16}O and ^{16}O(n, α)^{13}C (continued)

E_α (MeV $\pm$ keV)	E_n (MeV)	Γ_α/Γ	$\Gamma_{c.m.}$ (keV)	J^π	E_x [a] (MeV)	Refs.
4.995	6.41	0.15	46	$\frac{7}{2}^-$	10.176	(1963DA12, 1968KE02, 1970RO08, 1971BA06)
5.08	6.59	0.60	122	$\frac{7}{2}^+$	10.24	(1963DA12, 1967SE07, 1968KE02)
5.185				$\frac{5}{2}^+, \frac{7}{2}^-$	10.321	(1968KE02, 1970RO08)
5.317 ± 10			14 ± 3		10.422	(1963SP02, 1967SE07, 1968KE02)
5.40			75 ± 30	$\frac{5}{2}^+, \frac{7}{2}^-$	10.49	(1967SE07, 1968KE02)
5.496 ± 10	6.81		47 ± 15	$\frac{7}{2}^-, \frac{9}{2}^+$	10.559	(1963DA12, 1963SP02, 1968KE02, 1970RO08)
5.68		1.00	≤ 25	$(\frac{7}{2}^+)$	10.70	(1968KE02)
5.771 ± 10	7.04		80 ± 20	$\frac{1}{2}^+, \frac{7}{2}^-$	10.769	(1963DA12, 1963SP02, 1968KE02, 1970RO08)
5.945 ± 10	7.20		57 ± 15	$\frac{5}{2}$	10.902	(1963DA12, 1963SP02, 1968KE02, 1970RO08)
6.107 ± 10	7.32		45 ± 10		11.026	(1963DA12, 1963SP02, 1968KE02)
6.367 ± 10	7.59		100 ± 30		11.225	(1963DA12, 1963SP02)
	(7.79)				(11.47)	(1963DA12)
6.878 ± 10	7.90		120 ± 30		11.615	(1963DA12, 1963SP02)
7.051 ± 10	(8.06)		40 ± 25		11.748	(1963DA12, 1963SP02)
7.136 ± 15	8.22		12 ± 3		11.813	(1963DA12, 1963SP02)
7.384 ± 15	8.38				12.002	(1963DA12, 1963SP02)
7.52 ± 20			150 ± 50		12.11	(1963SP02)
7.736 ± 15	8.66		100 ± 30		12.271	(1963DA12, 1963SP02)
7.88 ± 20					12.38	(1963SP02)
7.927 ± 15					12.417	(1963SP02)
8.156 ± 15			75 ± 30		12.592	(1963SP02)
8.253 ± 15			≈ 5		12.666	(1963SP02)
8.44 ± 25					12.81	(1963SP02)
8.59 ± 20			$\gtrsim 150$		12.92	(1963SP02)
8.72 ± 20					13.02	(1963SP02)
8.785 ± 15			16 ± 4		13.073	(1963SP02)
9.319 ± 15			≈ 120		13.481	(1963SP02)

Table 17.6: Resonances in ^{13}C(α, α_0)^{13}C, ^{13}C(α, n)^{16}O and ^{16}O(n, α)^{13}C (continued)

E_α (MeV $\pm$ keV)	E_n (MeV)	Γ_α/Γ	$\Gamma_{c.m.}$ (keV)	J^π	E_x [a] (MeV)	Refs.
9.483 ± 15			250 ± 100		13.606	(1963SP02)

A: (1953JO1A, 1956RU1A, 1957WA1C).

B: (1955SE1A, 1956BO61, 1956RU1A, 1956SC1C, 1957WA1C).

C: (1955SE1A, 1956BE1D, 1956BO61, 1956RU1A, 1956SC1C, 1957WA1C).

D: (1956BE1D, 1956BO61, 1956SC1C, 1957WA1C).

[a] I am indebted to Dr. C.H. Johnson for a discussion of the nature of many of these states.

Table 17.7: Lifetime of ^{17}O*(0.87) [a]

τ_m (psec)	Refs.
255 ± 13	(1960KA10)
263 ± 8	(1963LO03)
258.7 ± 4.2	(1964BE15)
233 ± 27	(1965AL14)
263 ± 7	(1965MC10)
232 ± 8	(1967BI05)
261 ± 7	(1969GO04)
253 ± 6	(1969NI09)
258.6 ± 2.6	mean [b]

[a] See also (1953TH14, 1962GA15, 1967WA1C, 1968SC1E).
[b] Mean does not include value of (1967BI05).

7. (a) ^{13}C(α, n)^{16}O $\qquad Q_m = 2.215 \qquad E_b = 6.357$
   (b) ^{13}C(α, α)^{13}C

The yield of neutrons (reaction (a)) increases monotonically for $E_\alpha = 0.475$ to 0.700 MeV: $S(E) = [(5.48 \pm 1.77) + (12.05 \pm 3.91)E] \times 10^5$ MeV · b (1968DA05). The astrophysical considerations are discussed by (1968DA1D). See also (1959AJ76).

Elastic scattering studies (reaction (b)) have been carried out for $E_\alpha = 2.0$ to 3.5 MeV (1965BA32) and 3.5 to 6.5 MeV (1968KE02). Recent measurements of yield curves for reaction (a) have been made at $E_\alpha = 2.0$ to 3.5 MeV (1965BA32), 2.0 to 5.6 MeV (1967SE07; σ_t), 3.5 to 6.5 MeV (1968KE02), 4.5 to 10.5 MeV (1970RO08; n_0), 5 to 10 MeV (1963SP02: 6.13 and 7 MeV γ) and 17.4 to 22.5 MeV (1963DE27; n_0). Angular distributions have been measured at many energies.

A number of resonances in the neutron yield and of anomalies in the elastic scattering have been observed: see Table 17.6 (1953JO1A, 1956BE1D, 1956BO61, 1956RU1A, 1957WA1C, 1963SP02, 1965BA32, 1967SE07, 1968KE02, 1970RO08). See also (1960ST02). Table 17.6 also shows the results from the inverse reaction ^{16}O(n, α)^{13}C. The study of the n_0 yield by (1970RO08) indicates more structure than is displayed in Table 17.6. In the range $E_n = 17.4$ to 22.4 MeV the n_0 cross section does not show any appreciable variation with energy. See also (1968LE1N) and (1963KE1A; theor.).

Table 17.8: ^{17}O levels from the study of ^{13}C(^{6}Li, d)^{17}O and ^{13}C(^{7}Li, t)^{17}O (1970BE31)

E_x [a] (MeV)	J^π	$d\sigma/d\omega$ in (μb/sr) [b] (^{6}Li, d)	(^{7}Li, t)
0 [b]	$\frac{5}{2}^+$	105	75
0.87 [b]	$\frac{1}{2}^+$	180	92
3.06 [b]	$\frac{1}{2}^-$	560	750
3.84 [b]	$\frac{5}{2}^-$	340	1400
4.55 [b]	$\frac{3}{2}^-$	285	1350
5.08 [b]	$\frac{3}{2}^+$	180	250
5.22 [b]	$\frac{7}{2}^- \rightarrow \frac{11}{2}^-$	245	230
5.38	$\frac{3}{2}^-$	c	c
5.70 [b]	$\frac{7}{2}^-$	230 (5.70 + 5.73)	530 (5.70 + 5.73)
5.73 [b]	$\frac{1}{2}^+$		
5.87	$\frac{3}{2}^+$	90 (5.87 + 5.94)	150 (5.87 + 5.94)
5.94	$\frac{1}{2}^-$		
6.24		c	c
6.36	$\frac{1}{2}^+$	c	c
6.86 [b]		92	125
6.97 [b]		200	320
7.17 [b]	$\frac{5}{2}^-$	350	1050
7.29	$\frac{3}{2}^+$	d	d
7.38 [b]	$\frac{5}{2}^+$	720	2000
7.57 [b]	$\frac{7}{2}^-$	98	310
7.68 [b]	$\frac{7}{2}^-$	620	1100
7.76 ± 0.02 [a,b]	$(\frac{11}{2}^-)$		
7.95	$\frac{1}{2}^-$	d	d
8.09	$\frac{3}{2}^+$	c	c
8.21	$\frac{3}{2}^-$	d	d
8.35	$\frac{1}{2}^+$	d	d
8.40	$\frac{5}{2}^+$	d	d
8.47 [b]	$\frac{7}{2}^+$	940 (8.47 + 8.50)	2400 (8.47 + 8.50)
8.50 [b]	$\frac{5}{2}^-$		

Table 17.8: ^{17}O levels from the study of ^{13}C(^{6}Li, d)^{17}O and ^{13}C(^{7}Li, t)^{17}O (1970BE31) (continued)

E_x [a] (MeV)	J^π	$d\sigma/d\omega$ in (μb/sr) [b]	
		(^{6}Li, d)	(^{7}Li, t)
8.70	$\frac{3}{2}^-$	50	200
8.88	$\frac{7}{2}^-$ }	1400	2000
8.96	$\frac{7}{2}^-$ }		

[a] These energies were not determined in this experiment, except for that of ^{17}O*(7.76).
[b] Angular distributions were obtained for these states. For these $d\sigma/d\omega$ were taken at the maximum of the distribution. For the other states $d\sigma/d\omega$ is the 30° value.
[c] Group not seen: obscured by contaminant.
[d] This level was not observed.

J^π assignments derived from polarization measurements at $E_\alpha = 3.36$ to 4.80 MeV are displayed in Table 17.6 (1971BA06). See also (1969SC04).

8. ^{13}C(^{6}Li, d)^{17}O $\qquad Q_m = 4.885$

At $E(^{6}\mathrm{Li}) = 18$ MeV, deuteron groups have been seen corresponding to many ^{17}O states with $E_x < 9$ MeV: see Table 17.8 (1970BE31). See also (1968OG1A, 1970OG1A).

9. ^{13}C(^{7}Li, t)^{17}O $\qquad Q_m = 3.890$

This reaction has been studied at $E(^{7}\mathrm{Li}) = 17$ MeV: see reaction 8 and Table 17.8 (1970BE31). See also (1968OG1A).

10. ^{13}C(^{16}O, ^{12}C)^{17}O $\qquad Q_m = -0.804$

At $E(^{16}\mathrm{O}) = 17$ and 20 MeV, the transitions to ^{17}O*(0, 0.87) have been studied (1968KN1A, 1970BA1J). The excitation curve for the one-neutron transfer to ^{17}O*(0.87) has been measured for $E(^{16}\mathrm{O}) = 12$ to 25 MeV (1970BA55).

11. (a) $^{14}C(^{3}He, n)^{16}O$ $Q_m = 14.616$ $E_b = 18.759$

(b) $^{14}C(^{3}He, ^{3}He)^{14}C$

(c) $^{14}C(^{3}He, \alpha)^{13}C$ $Q_m = 12.402$

The n_0 yield (reaction (a)) for $E(^{3}He) = 1.6$ to 3.25 MeV indicates two resonances at $E(^{3}He) = 2.1$ and 2.8 MeV, corresponding to $^{17}O^*(20.5, 21.1)$ (1961JO24). The excitation function shows a resonance in the n_0 and n_{3+4} yields at $E(^{3}He) = 4.1$ MeV [$^{17}O^*(22.1)$], but not in the n_{1+2} yield: $J^\pi = \frac{1}{2}^-$ or $\frac{3}{2}^-$ is suggested (1970HO08).

Resonances are observed in the α-yield (reaction (c)) at $E(^{3}He) = 3.6$ and 4.1 MeV [$^{17}O^*(21.7, 22.1)$] and in the ^{3}He yield (reaction (b)) at 5.1 MeV [$^{17}O^*(23.0)$], with $J^\pi = (\frac{5}{2}^+)$, $(\frac{7}{2}^-)$ and $(\frac{1}{2}^+)$, respectively (1970KE1D). The variation of the ^{3}He optical parameters has been studied for $E(^{3}He) = 10$ to 18 MeV (1970DU07).

12. $^{14}C(\alpha, n)^{17}O$ $Q_m = -1.819$

A study of n-γ correlations leads to $J^\pi = \frac{1}{2}^-$ for $^{17}O^*(3.06)$ and probably to $J^\pi = \frac{5}{2}^-$ for $^{17}O^*(3.84)$. The upper limits to the decays $3.06 \rightarrow 0$ and $3.84 \rightarrow 0.87$ are, respectively, 2 and 5%. The lifetimes of $^{17}O^*(3.06, 3.84)$ are 120^{+80}_{-60} and < 25 fsec, respectively (1964AL11).

13. (a) $^{14}N(t, p)^{16}N$ $Q_m = 4.840$ $E_b = 18.621$

(b) $^{14}N(t, d)^{15}N$ $Q_m = 4.577$

(c) $^{14}N(t, t)^{14}N$

(d) $^{14}N(t, \alpha)^{13}C$ $Q_m = 12.264$

Excitation functions have been measured in the range $E_t = 1.0$ to 2.0 MeV for the p_0, p_1, p_2, p_3 groups, the d_0 and t_0 groups and the α_0 and α_1 groups: the reactions appear to proceed primarily via a direct interaction mechanism (1964SC09). See also ^{16}N, and ^{13}C and ^{15}N in (1970AJ04).

14. (a) $^{14}N(\alpha, p)^{17}O$ $Q_m = -1.193$

(b) $^{14}N(\alpha, p\alpha)^{13}C$ $Q_m = -7.546$

$Q_0 = -1.200 \pm 0.017$ (1967SP09).

Differential cross sections have been measured at $E_\alpha = 8.12$ to 11.52 MeV (1969SC21; $p\gamma_1$), 12.9 to 24.9 MeV (1970ZE01; p_0, p_1), 13.0, 13.4, 14.25, 14.5 and 18.1 MeV (1969RO07: states with $E_x < 7.6$ MeV), 17.3 to 24.9 MeV (1970ZE01; p_2), 22.3 MeV (1963YA1C; p_0, p_1), 22.5

to 24.9 MeV (1970ZE01; p_3), and 26.8, 28.1 and 33.3 MeV (1961YA02; $p_0 \rightarrow p_3$). Using the $(2J+1)$ rule, $J = \frac{7}{2}$, $\frac{9}{2}$ or $\frac{11}{2}$ for ^{17}O*(5.22). The previously reported states at $E_x = 6.24$ and 7.29 MeV were not excited, but ^{17}O*(6.97) is confirmed by the work of (1969RO07). The lifetime of ^{17}O*(0.87), measured by this reaction and by reaction 29, $\tau_m = (4.30 \pm 0.21) \times 10^{-10}$ sec (1962GA15): see Table 17.7. See also (1959AJ76) and ^{18}F in (1972AJ02).

At $E_\alpha = 22.9$ MeV, the sequential decay (reaction (b)) appears to take place via a number of ^{17}O states with $8.46 \le E_x \le 13.57$ MeV. Those involved are believed to have $J \ge \frac{5}{2}$, $\Gamma_\alpha/\Gamma \ge 0.6$ (1969BA17). See also (1968KU1C).

15. ^{15}N(d, n)^{16}O $\qquad Q_m = 9.901 \qquad E_b = 14.044$

The excitation function has been measured for $E_d = 0.5$ to 5.3 MeV. Above $E_d = 1.0$ MeV, pronounced peaks are observed, presumably to be ascribed to numerous overlapping resonances (1958WE31). See also (1970MU1H). Polarization measurements (n_0 group) are reported at $E_n = 1.6$ to 3.0 MeV (1966BR12), 2.65 MeV (1966BU09), 2.75 MeV (1969BU19), 3.09 to 3.83 MeV (1968ME15) and 4.35 and 5.50 MeV (1967BU16). See also (1966BR1E). See also ^{16}O.

16. ^{15}N(d, p)^{16}N $\qquad Q_m = 0.262 \qquad E_b = 14.044$

The excitation curve has been obtained for $E_d = 0.3$ to 2.7 MeV. There is some resonance structure at $E_d = 1.3$ and 1.9 MeV [^{17}O*(15.2, 15.7)] (1957BO04). See also ^{16}N.

17. ^{15}N(d, α)^{13}C $\qquad Q_m = 7.687 \qquad E_b = 14.044$

The α_0 yield curve for $E_d = 0.8$ to 1.8 MeV indicates two resonances at $E_d = 1.06$ and 1.25 MeV [$\Gamma \approx 100$ and 200 keV, respectively], attributed to an ^{17}O state at $E_x = 14.98$ MeV [$J^\pi = \frac{5}{2}^+$] and to one or more ^{17}O states at $E_x = 15.15$ MeV [$J^\pi = \frac{5}{2}^-$ or $\frac{7}{2}^-$] (1966TI03). In the range $E_d = 1.2$ to 2.5 MeV a broad maximum is observed in both the α_0 and α_1 yields at $E_d \approx 1.7$ MeV (1965MA1A). See also (1959FI30).

18. ^{15}N(t, n)^{17}O $\qquad Q_m = 7.787$

Not reported.

19. ^{15}N(^{3}He, p)^{17}O $\qquad Q_m = 8.550$

Table 17.9: Decay properties of the lowest $T = \frac{3}{2}$ states in $A = 17$

	^{17}O*(11.08)	^{17}F*(11.20)
$\Gamma_{\rm c.m.}$	< 20 keV [a]	< 600 eV [b]
Branching ratios (%):		
^{16}O(g.s.)	91 ± 5 [c]	8.8 ± 1.6 [c]
		12 ± 4 [d]
^{16}O*(6.05)	5 ± 2 [c]	23 ± 5 [c]
		26 ± 8 [d]
^{16}O*(6.92)		28 ± 13 [d]
^{16}O*(7.12)		34 ± 14 [d]
θ^2(g.s.)/θ^2(6.05)	3.4 ± 1.4 [c]	0.16 ± 0.05 [c]

[a] D.C. Hensley, quoted in (1970MC02).
[b] (1967PA17).
[c] (1970MC02).
[d] (1969HA2B).

At $E(^3$He$) = 18$ MeV, many ^{17}O states with $E_{\rm x} < 11.6$ MeV have been observed. The levels at 5.70 MeV ($\frac{7}{2}^-$), 7.38 MeV ($\frac{5}{2}^-$) and 11.08 MeV ($\frac{1}{2}^-$; $T = \frac{3}{2}$) are particularly strongly populated (1969ME1K). See also (1965SE01, 1968BE1Y, 1968SE1C). At $E(^3$He$) = 8.4$ MeV a $T = \frac{1}{2}$ state at $E_{\rm x} = 11.02$ MeV is excited (1970MC02): see also reaction 43 and Table 17.9. See also (1963PA01) and (1969BA1Z).

20. ^{15}N(α, d)^{17}O $\qquad Q_{\rm m} = -9.803$

At $E_\alpha = 45.4$ MeV, the deuteron spectrum is dominated by the groups corresponding to states with $E_{\rm x} = 7.742 \pm 0.020$ and 9.137 ± 0.030 MeV. These states are assigned $J^\pi = (\frac{11}{2}^-)$ and $(\frac{9}{2}^-)$, respectively and arise from a dominant $({\rm d}_{5/2})^2_5{\rm p}^{-1}_{1/2}$ configuration. Angular distributions were measured as well for the deuterons corresponding to ^{17}O(0) and to states with $E_{\rm x} = 0.87 \pm 0.05$, 5.208 ± 0.030, 5.690 ± 0.030, 7.367 ± 0.030, 8.459 ± 0.030, 8.890 ± 0.030 and 9.814 ± 0.030 MeV. In addition the excitation of states with $E_{\rm x} = 3.85 \pm 0.05$, 4.57 ± 0.05 and 8.147 ± 0.030 MeV is also reported (1969LU07). See also (1962HA40, 1966RI04) and (1963GL1C; theor.).

21. ^{15}N(^{11}B, ^{9}Be)^{17}O $\qquad Q_{\rm m} = -1.775$

Table 17.10: Recent angular distribution, total cross-section and polarization measurements in ^{16}O(n, n)^{16}O [a]

(a) *Angular distribution studies*

E_n (MeV)	Group	Refs.
$0.3 - 1.7$	n_0	(1961LA1A)
0.9	n_0	(1962LO09)
$1.12 - 1.16$, $1.64 - 1.70$, $1.77 - 3.67$	n_0	(1968JO1F)
$1.51 - 2.25$	n_0	(1962MA05)
1.96, $3.21 - 3.44$	n_0	(1970FO03)
$2.0 - 4.1$	n_0	(1962HU07)
$2.2 - 4.2$	n_0	(1967JO12)
$3.1 - 4.7$	n_0	(1966LI03)
$5.0 - 6.5$	n_0	(1960SM02)
13.9	n_0, $n_{1+2+3+4}$	(1963BA46)
14	n_0	(1967BE2B)
14.1	n_0, n_{1+2}, n_{3+4}	(1969ME15)
14.8	n_0	(1967LU1B)
15	n_0	(1959BE1B)

(b) *Cross-section measurements*

E_n (MeV)	Type	Refs.
$0.003 - 10.0$ eV	σ_t	(1960WA07)
1.44 eV	σ_{sc}	(1965RA1B)
$10 - 500$ keV	σ_t	(1966MO09)
$1.77 - 3.67$ MeV	σ_t	(1968JO1F)
$3 - 8$	σ_t	(1969DA13)
$3.3 - 5.1$	σ_t	(1960TS02)
$3.3 - 5.2$	σ_t	(1968MA2D)
$3.33 - 3.87$	σ_t	(1967JO12)
$3.4 - 16$	σ_t	(1961FO07)
$14 - 19$	σ_{el}	(1970BO30)
14.1	σ_t, σ_{el}	(1969ME15)
$18 - 27.6$	σ_t	(1960PE1B)

Table 17.10: Recent angular distribution, total cross-section and polarization measurements in $^{16}O(n, n)^{16}O$ [a] (continued)

(b) *Cross-section measurements* (continued)

E_n (MeV)	Type	Refs.
88 – 150	σ_t	(1966ME14)
13.9	σ_{el}, σ_{ne}	(1963BA46)
14.8	σ_{ne}	(1967CH1P)
15	σ_{ne}	(1969NY1A)
6.4 – 9.8	$\sigma_{n,\ n'\gamma_{6.1}}$	(1959HA13)
6.72 – 11.0	$\sigma_{n,\ n'\gamma_{6.1}}$, $\sigma_{n,\ n'\gamma_{6.9}}$	(1970DI1C)
7.50 – 11.0	$\sigma_{n,\ n'\gamma_{7.1}}$	(1970DI1C)
7.7 – 9.4	$\sigma_{n,\ n'\gamma_{6.9+7.1}}$	(1959HA13)
9.0 – 14	$\sigma_{n,\ n'\gamma_{8.9}}$	(1970DI1C)
14.6	$\sigma_{n,\ n'\gamma_{6.1}}$, $\sigma_{n,\ n'\gamma_{6.9+7.1}}$	(1969BU08)
15	$\sigma_{n,\ n'\gamma}$	(1969NY1A)
17 – 37	$\sigma_{n,\ 2n}$	(1961BR1A)
11.08 – 19.04	$\sigma_{n,\ p}$	(1962DE13)
12.6 – 16.3	$\sigma_{n,\ p}$	(1961SE02, 1962SE1F)
14.7	$\sigma_{n,\ p}$	(1960DE19, 1962KA1A)
14.8	$\sigma_{n,\ p}$	(1966MI1J, 1966PR1A)
3.77 – 4.67	$(\sigma_{n,\ \alpha})_t$	(1966LI03)
5.0 – 8.8	$\sigma_{n,\ \alpha_0}$	(1963DA12)
7.13 – 12.03	$\sigma_{n,\ \alpha_0}$, $\sigma_{n,\ \alpha_1}$	(1968DA1E)
7.6 – 8.7	$\sigma_{n,\ \alpha_1}$	(1963DA12)
8.1 – 8.5	$\sigma_{n,\ \alpha_{2+3}}$	(1963DA12)
7.1 – 12.0	$\sigma_{n,\ \alpha_0}$, $\sigma_{n,\ \alpha_t}$	(1968PA1X)
12 – 20	$\sigma_{n,\ \alpha_0}$	(1963BO1E)
14.8 – 18.8	$\sigma_{n,\ \alpha_0}$, $\sigma_{n,\ \alpha_{1+2+3}}$	(1968SI06)
15	$\sigma_{n,\ \alpha\gamma}$	(1969NY1A)

(c) *Polarization measurements*

E_n (MeV)	Group	Refs.
0.2 – 2.2	n_0	(1962EL01)

Table 17.10: Recent angular distribution, total cross-section and polarization measurements in ^{16}O(n, n)^{16}O [a] (continued)

(c) *Polarization measurements* (continued)

E_n (MeV)	Group	Refs.
0.84	n_0	(1962BE1C)
$1.51 - 2.03$	n_0	(1962MA05)
2.84, 2.98	n_0	(1963GL1D)
3.5	n_0	(1962OT01)

[a] See also (1959AJ76), (1964ST25, 1970GA1A).

At $E(^{11}\text{B}) = 115$ MeV, the states at $E_x = 7.7$ and 9.1 MeV [$J^\pi = \frac{11}{2}^-$ and $\frac{9}{2}^-$, respectively] are strongly populated. as in the ^{15}N(α, d)^{17}O reaction (1967PO1E). See also (1966PO1E, 1967VO1A).

22. ^{16}O(n, γ)^{17}O $\qquad$ $Q_m = 4.143$

$$\sigma_{\text{capt.}} = 0.178 \pm 0.025 \text{ mb (1964JU05).}$$

Capture γ-rays with $E_\gamma = 870{\pm}5, 1088{\pm}5, 2180{\pm}25$ and $3271{\pm}15$ keV, from the transitions to and decay of ^{17}O*(0.87, 3.06), are reported by (1964JU05). See also (1969HO1X). Astrophysical considerations are discussed by (1968FO1A).

23. ^{16}O(n, n)^{16}O $\qquad$ $E_b = 4.143$

The scattering amplitude (bound) is $a = 5.80 \pm 0.05$ fm (1965DO1B). The coherent scattering cross section is 4.23 ± 0.07 b (1964ST25). See also (1961WI1A, 1965RA1B, 1969BA1P).

Recent cross section and angular distribution measurements are listed in Table 17.10. Cross section data are summarized in (1964ST25), while angular distribution data are displayed in (1970GA1A). See also (1968AL1G).

A large number of resonances have been observed for $E_n \leq 11.5$ MeV: these are displayed in Table 17.11 (1960TS02, 1961FO07, 1967JO12, 1968DA1F, 1968JO1F, 1969DA13, 1970BO30, 1970FO03) and (1959AJ76, 1964ST25). See also (1966LI03). Recent high-resolution cross section measurements and phase-shift analyses have led to a much better understanding of the ^{17}O level structure: see (1967JO12, 1970FO03) for a general review of the work on this reaction. See also (1960PE02, 1961GO1H, 1963KU1F), (1968AL1G) and (1959AU1A, 1960CO1A,

1960FO14, 1960MI1B, 1963JO1D, 1963KA27, 1963LU10, 1963PI03, 1965GA1F, 1965SL1B, 1966AG1A, 1966GA1L, 1967GR1J, 1967RE1C, 1967SC1E, 1967SC1H, 1967UN1A, 1968FO1D, 1969IW1A, 1969IW1C, 1969MA2B, 1970CO1U, 1970MU1C, 1970WA1J; theor.).

Polarization measurements have been carried out for $E_n = 0.2$ to 3.5 MeV: see Table 17.10 (1962BE1C, 1962EL01, 1962MA05, 1962OT01, 1963GL1D). See also the reviews by (1963HA1G, 1963PI03, 1966DA1B, 1966RO1B) and (1967BE1F; theor.)

24. ^{16}O(n, n′)^{16}O* $E_b = 4.143$

Recent cross section measurements are listed in Table 17.10. The cross sections for production of 6.13 and $(6.92 + 7.12)$ γ-rays in the range $E_n = 6.5$ to 10 MeV show a number of resonances: see Table 17.12 (1969HA2B). See also (1970SU01).

25. ^{16}O(n, 2n)^{15}O $Q_m = -15.668$ $E_b = 4.143$

The cross section has been measured for $E_n = 17$ to 37 MeV (1961BR1A). See also (1964HE18).

26. ^{16}O(n, p)^{16}N $Q_m = -9.639$ $E_b = 4.143$

Recent cross-section measurements are listed in Table 17.10. Resonances are reported at 11.8 and (15.2) MeV (1962DE13) and at 13.50 ± 0.01, 14.10 ± 0.01 and 15.10 ± 0.05 MeV (1961SE02, 1962SE1F). See also (1958RO1A, 1969BR1F), (1959AJ76, 1960BU1C, 1963LE1D, 1963SH1C, 1966JE1B, 1968AL1G) and (1964DU1B; theor.).

27. ^{16}O(n, d)^{15}N $Q_m = -9.901$ $E_b = 4.143$

See (1967VA12) and ^{15}N in (1970AJ04).

28. ^{16}O(n, α)^{13}C $Q_m = -2.215$ $E_b = 4.143$

The cross section has been measured from threshold to 20 MeV: see (1959AJ76) and Table 17.10. All of the ^{17}O levels observed in the inverse reaction ^{13}C(α, n)^{16}O from ^{17}O* $= 7.95$ to 9.95 are also observed in this reaction: see Table 17.6 (1955SE1A, 1957WA1C, 1963DA12). (1963BO1E) also report a broad maximum at $E_n \approx 16$ MeV. See also (1965FU1E), (1960BU1C, 1963CH1C, 1966JE1B) and (1964GA1A; theor.).

Table 17.11: Resonances in ^{16}O(n, n)^{16}O [a]

E_n (keV)	$\Gamma_{c.m.}$ (keV)	$\frac{\gamma^2}{\hbar^2/\mu a^2}$ [b]	J^π	E_x (MeV)	Refs.
442	45	0.06	$\frac{3}{2}^-$	4.558	(1964ST25, 1970FO03)
1000	94	0.45	$\frac{3}{2}^+$	5.084	(1964ST25)
1312 ± 3.5	41	0.02	$\frac{3}{2}^-$	5.377	(1968DA1F, 1970FO03)
1651 ± 3	3.4	0.09	$\frac{7}{2}^-$	5.696	(1968JO1F, 1970FO03)
1689 ± 3	< 1			5.731	(1968JO1F, 1970FO03)
1833 ± 3	6.6	0.009	$\frac{3}{2}^+$	5.867	(1968JO1F, 1970FO03)
1906 ± 3	24.5	0.01	$\frac{1}{2}^-$	5.935	(1970FO03)
2353 ± 8	135	0.02	$\frac{1}{2}^+$	6.356	(1970FO03)
2888 ± 3	< 1			6.859	(1968JO1F, 1970FO03)
3006 ± 3	< 1			6.970	(1970FO03)
3212 ± 3	1.4	0.005	$\frac{5}{2}^-$	7.164	(1968JO1F, 1970FO03)
3350	500	0.23	$\frac{3}{2}^+$	7.294	(1967JO12)
3438 ± 3	0.5	0.0002	$\frac{5}{2}^+$	7.376	(1970FO03)
3441 ± 3	1.1	0.003	$\frac{5}{2}^-$	7.379	(1961FO07, 1970FO03)
(3600)	600		$(\frac{3}{2})$	(7.53)	(1961FO07)
3750	405		$\frac{3}{2}^-$	7.670	(1967JO12)
3769	14		$\frac{7}{2}^-$	7.688	(1967JO12)
3772	3		$\frac{3}{2}^+$	7.690	(1967JO12)
4000 ± 50			$\frac{1}{2}^-$	7.91	(1961FO07, 1967JO12) [c]
4200 ± 10	80		$\frac{3}{2}^+$	8.093	(1960TS02, 1961FO07, 1967JO12)
4330 ± 10	70		$\frac{3}{2}^-$	8.215	(1960TS02, 1961FO07, 1967JO12)
(4460)				(8.34)	(1960TS02, 1961FO07)
4540	≤ 10		$\geq \frac{5}{2}$	8.41	(1961FO07) [c]
4610	≤ 11		$\geq \frac{3}{2}$	8.48	(1961FO07) [c]
4650	≤ 13		$\geq \frac{3}{2}$	8.52	(1961FO07) [c]
4705 ± 10				8.568	(1960TS02)
4845 ± 10	55		$\frac{3}{2}$	8.700	(1960TS02, 1961FO07)
5010 ± 10	< 20			8.855	(1960TS02)
5122 ± 4	28		$\frac{7}{2}$	8.960	(1961FO07, 1969DA13)
5360	≤ 17		$\geq \frac{3}{2}$	9.18	(1961FO07) [c]

Table 17.11: Resonances in ^{16}O(n, n)^{16}O [a] (continued)

E_n (keV)	$\Gamma_{c.m.}$ (keV)	$\frac{\gamma^2}{\hbar^2/\mu a^2}$ [b]	J^π	E_x (MeV)	Refs.
5640	140		$\geq \frac{3}{2}$	9.45	(1961FO07) [c]
5914 ± 5	28		$\geq \frac{5}{2}$	9.705	(1961FO07, 1969DA13)
6010	28		$\geq \frac{3}{2}$	9.80	(1961FO07) [c]
6100	25		$\geq \frac{1}{2}$	9.88	(1961FO07) [c]
6395 ± 7	38		$\geq \frac{3}{2}$	10.157	(1961FO07, 1969DA13)
6807 ± 7	40		$\geq \frac{3}{2}$	10.545	(1961FO07, 1969DA13)
7200 ± 8	70		$\geq \frac{3}{2}$	10.914	(1961FO07, 1969DA13)
7830	190		$\geq \frac{3}{2}$	11.51	(1961FO07) [c]
8320	270		$\geq \frac{3}{2}$	11.97	(1961FO07) [c]
8740	130		$\geq \frac{1}{2}$	12.36	(1961FO07) [c]
9050	95		$\geq \frac{1}{2}$	12.65	(1961FO07) [c]
10130	400		$(\geq \frac{1}{2})$	13.67	(1961FO07) [c]
11140	340		$(\geq \frac{3}{2})$	14.62	(1961FO07) [c]
11540	180		$(\geq \frac{1}{2})$	14.99	(1961FO07) [c]
17300			$(\frac{1}{2}^+)$	20.4	(1970BO30)

[a] See also (1959AJ76).

[b] See discussion in (1970FO03).

[c] I am indebted to Dr. J.C. Davis for sending me revised energy values due to a recalibration of the analyzing magnet used by (1961FO07).

29. ^{16}O(d, p)^{17}O $\quad Q_m = 1.918$

$Q_0 = 1.920 \pm 0.003$ (1967SP09).

Angular distributions of the protons to many ^{17}O states have been studied for $E_d = 0.3$ to 26.3 MeV: see Table 17.13 (1959HA29, 1961HA19, 1961KE01, 1962MA25, 1963AL04, 1963AM1A, 1963YA03, 1964AM1A, 1964SC12, 1964TE1C, 1965DE1N, 1965GA1A, 1965LO02, 1965MO16, 1966AL09, 1966GA09, 1966SC09, 1967AL06, 1967OG1A, 1968DI06, 1968HO23, 1968NA06, 1968NG1B, 1969TH04, 1970DA14). See also (1969CO12, 1970CO1P) and ^{18}F in (1972AJ02).

(1970VI03) report a DWBA calculation to the unbound $\frac{3}{2}^+$ state at $E_x = 5.08$ MeV. The width of the corresponding neutron resonance [$E_n = 1.00$ MeV: see reaction 23] is determined to be 67 keV from the magnitude of the cross section.

Table 17.12: Resonances in ^{16}O(n, n$'\gamma$)^{16}O (1959HA13)

E_n (MeV)	E_x (MeV)
6.83	10.57
7.07	10.79
7.24	10.95
7.40	11.10
7.87	11.55
8.35	12.00
8.50	12.14
8.84	12.46
9.10	12.70
9.34	12.93

^{17}O levels derived from proton spectra measurements are displayed in Table 17.14 (1951BU1A, 1957BR82, 1965GA1A). The lifetime of ^{17}O*(0.87) is 258.6 ± 2.6 psec: see Table 17.7 (1960KA10, 1963LO03, 1964BE15, 1965AL14, 1965MC10, 1967BI05, 1969GO04). $E_\gamma = 870.81 \pm 0.22$ keV (1966WI01), 870.5 ± 2.0 keV (1952TH24); the internal conversion coefficient is consistent with E2 (1952TH24). See also (1959LO59, 1960AL35, 1960GO20, 1961JA23, 1961LO1C, 1961PU1B, 1963DO1B, 1965HE1B, 1966BE1E, 1967LA1M, 1968GO1N), (1959AJ76) and (1960BE1B, 1960BI1B, 1960NA1A, 1961BU16, 1961WI1D, 1963GL1C, 1963LE1E, 1963SA1B, 1963SM05, 1963TA1A, 1965BU1G, 1965HU1E, 1965SI1D, 1965SM1A, 1967BA1R, 1967BA2E, 1967SC16, 1967SH1J, 1967SH1K, 1968EL1G, 1968PE1E, 1969HA1V, 1969IC02, 1969MA2C, 1969MC1G, 1969PE1K, 1969PE1L, 1970BU16, 1970OH06, 1970PE14, 1970PE1B; theor.).

30. ^{16}O(t, d)^{17}O $\qquad Q_m = -2.115$

The angular distribution of the d_0 groups has been studied at $E_t = 5.5$ MeV (1961BA10). See also (1960MU07) and (1964EL1B; theor.).

31. ^{16}O(α, ^{3}He)^{17}O $\qquad Q_m = -16.435$

Angular distributions of the ^{3}He particles corresponding to ^{17}O*(0, 0.87, 3.06, 3.84) have been measured at $E_\alpha = 46$ MeV (1968PR1C).

Table 17.13: Recent $^{16}O(d, p)^{17}O$ angular distribution studies [a]

E_d (MeV)	Distribution of proton groups	Refs.
0.32 – 1.07	p_1	(1968NG1B)
0.33 – 0.45	p_1	(1965LO02)
0.75 – 1.50	p_0, p_1	(1963AL04)
0.90 – 1.39	p_0, p_1	(1963AM1A, 1964AM1A)
1.3, 4.0	p_0, p_1	(1966GA09)
1.9 – 3.6	p_0, p_1	(1968DI06)
4.0 – 6.0	p_0, p_1, p_3	(1970DA14)
5.56	p_0, p_1	(1965MO16)
6.00 – 8.55	$p_0 \rightarrow p_8$	(1965DE1N, 1969TH04)
6.0 – 11.0	p_0, p_1	(1968NA06)
7.73	p_0, p_1	(1967OG1A)
10	$p_0 \rightarrow p_3$	(1965GA1A)
10.2, 12.4, 14.8	p_0, p_1	(1959HA29, 1961HA19)
11, 13	p_0	(1966SC09)
11.8	$p_0 \rightarrow p_3$	(1964SC12)
12	p_0, p_1, p_5	(1966AL09, 1967AL06)
14.3	$p_0 \rightarrow p_8$, p_{10}, p_{13}, $p_{15} \rightarrow p_{18}$, p_{20}, p_{22+23}	(1968HO23)
14.95	$p_0 \rightarrow p_5$, p_7, p_8	(1963YA03)
15	$p_0 \rightarrow p_5$	(1961KE01)
26.3	p_0, p_1	(1962MA25, 1964TE1C)

[a] See also (1959AJ76).

Table 17.14: States of ^{17}O from ^{16}O(d, p)^{17}O and ^{19}F(d, α)^{17}O

E_x [a] (MeV ± keV)	$\Gamma_{c.m.}$ [a] (keV)	E_x [b] (MeV ± keV)	E_x [c] (MeV ± keV)	S [d]	$\theta^2_{abs.}$ [e]	J^π [f]
0	< 8	0	0	0.81	0.045	$\frac{5}{2}^+$
0.871 ± 4 [g]	< 8	0.870 ± 20	0.883 ± 11	0.71	0.16	$\frac{1}{2}^+$
3.055 ± 4 [g]	< 8	3.060 ± 30	3.069 ± 10	0.032	0.0024	$\frac{1}{2}^-$
3.846 ± 5 [g]	< 8	3.850 ± 30	3.856 ± 11	0.028	0.0022	$\frac{7}{2}^-$ [i]
4.553 ± 6	40 ± 5	4.580 ± 20	4.567 ± 14		0.0071	$\frac{3}{2}^-$
5.083 ± 10	95 ± 5	5.070 ± 20			0.047	$\frac{3}{2}^+$
5.215 ± 5	< 8		5.229 ± 13			
5.378 ± 7	28 ± 7	5.310 ± 20	5.397 ± 14			$\frac{3}{2}^-$
5.695 ± 5 [h]	< 8				0.013	$\frac{7}{2}^-$
5.731 ± 5 [h]	< 8	5.760 ± 20	5.723 ± 14			
5.866 ± 5	< 8		5.875 ± 15			
5.940 ± 15	23 ± 10		5.957 ± 15			
		6.240 ± 20				
		6.890 ± 30	6.869 ± 14			
			(6.986 ± 15)			
			(7.371 ± 15)			
		7.510 ± 30				
		8.270 ± 40				
		(8.590 ± 40)				
		9.060 ± 40				

[a] ^{16}O(d, p)^{17}O: (1957BR82).
[b] ^{16}O(d, p)^{17}O and ^{19}F(d, α)^{17}O: (1951BU1A).
[c] ^{19}F(d, α)^{17}O: (1952WA1A).
[d] ^{16}O(d, p)^{17}O: (1970DA14).
[e] ^{16}O(d, p)^{17}O: (1961KE01, 1963YA03).
[f] Assignments from (1955AJ61, 1956GR37, 1958RI1A, 1961KE01, 1963YA03, 1964SC12).
[g] (1965GA1A) report $E_x = 873 \pm 5$, 3056 ± 4 and 3838 ± 4 keV.
[h] ΔE_x between ^{17}O*(5.73, 5.70) $= 34 \pm 2$ keV (1968BI1A).
[i] $J^\pi = \frac{5}{2}^-$: see, for instance, reaction 46.

32. ^{16}O(^{11}B, ^{10}B)^{17}O $Q_m = -7.313$

The excitation of ^{17}O*(0, 0.87) is reported at $E(^{11}\text{B}) = 113.1$ MeV (1967PO13). See also (1969BR1D).

33. ^{16}O(^{14}N, ^{13}N)^{17}O $Q_m = -6.410$

See (1965GA1B).

34. ^{17}N(β^-)^{17}O $Q_m = 8.679$

See ^{17}N.

35. ^{17}O(γ, α)^{13}C $Q_m = -6.357$

See (1964GR08).

36. ^{17}O(e, e)^{17}O

The ^{17}O charge radius, $r_{\text{rms}} = 2.662 \pm 0.026$ (using a distorted wave approximation), 2.700 ± 0.026 fm (using a Born approximation) (1970SI02). See also (1966DE1K, 1970TI1C).

37. ^{17}O(p, p)^{17}O

The angular distribution of elastically scattered protons has been studied at $E_p = 11$ MeV (1967AL06). At $E_p = 29$ MeV, the odd parity states ^{17}O*(3.84, 4.55, 5.22, 5.70, 7.75) are strongly populated (R. Mendelson, private communication). See also ^{18}F in (1972AJ02) and (1969IC02; theor.).

38. ^{17}O(^{3}He, ^{3}He)^{17}O

The elastic angular distribution has been measured at $E(^3\text{He}) = 17.3$ MeV (1968HA30). See also (1969HA1U, 1969MA1G).

39. ^{17}F(β^+)^{17}O $\qquad Q_m = 2.760$

See ^{17}F.

40. ^{18}O(γ, n)^{17}O $\qquad Q_m = -8.046$

See (1963FU06).

41. ^{18}O(p, d)^{17}O $\qquad Q_m = -5.822$

Angular distributions have been measured at $E_p = 17.6$ MeV (1961LE1A, 1963LE03; d_0, d_1, d_2), 18.2 MeV (1967LU05; d_0, d_1, d_2, d_3) and at 27 and 31 MeV (R. Mendelson, private communication; $d_0 \rightarrow d_8$ and ^{17}O*(11.08)). ^{17}O*(3.06, 5.38) contain most (> 80%) of the $p_{1/2}$ and $p_{3/2}$ hole strength respectively (R. Mendelson). See also (1969IG1A, 1970BO1K, 1970HI15; theor.).

42. ^{18}O(d, t)^{17}O $\qquad Q_m = -1.789$

Angular distributions of the tritons corresponding to ^{17}O*(0, 0.87, 3.84, 4.55, 5.08, 5.38) have been studied at $E_d = 15$ MeV (1961AR06). See also (1961VL02) and (1963OG1A, 1963RO12, 1968KA1E, 1970BO1K; theor.).

43. ^{18}O(^{3}He, α)^{17}O $\qquad Q_m = 12.532$

Angular distributions of alpha particles are reported by (1965WA1D; α_0, α_1) at $E(^3\text{He}) = 2.68$ to 6.47 MeV and by (1969DE06: see Table 17.15) at $E(^3\text{He}) = 16$ MeV. The $T = \frac{3}{2}$ states reported by (1969DE06) are displayed in Table 17.15 [the isospin identification is based on the enhanced excitation and the narrow widths of these states]. The branching ratios for transitions to ^{16}O*(0, 6.05) for ^{17}O*(11.08) [the first $T = \frac{3}{2}$ state in ^{17}O] and for the analog state in ^{17}F are displayed in Table 17.9: the ratios of the reduced widths are quite different in the two mirror nuclei (1970MC02). See also (1969BA1Z).

44. ^{19}F(n, t)^{17}O $\qquad Q_m = -7.557$

Table 17.15: $T = \frac{3}{2}$ states of ^{17}O from ^{18}O(^{3}He, α)^{17}O [a,b]

E_x (MeV ± keV)	l_n	J^π	C^2S [c]
11.082 ± 6	1	$(\frac{1}{2})^-$	0.49
12.471 ± 5	1	$(\frac{3}{2})^-$	0.27
12.950 ± 8	0	$\frac{1}{2}^+$	0.096
12.994 ± 8			
13.640 ± 5	2	$(\frac{5}{2})^+$	0.39
14.219 ± 8			
14.282 ± 12			
15.101 ± 8			

[a] See also Table 17.9.
[b] (1969DE06).
[c] Calculated assuming $C^2S = 4$ for ^{15}O*(6.18).

Angular distributions of the t_0 and t_1 groups are reported at $E_n = 14.4$ MeV by (1968AN1F, 1968RE07). See also (1964VA1E).

45. ^{19}F(p, ^{3}He)^{17}O $\quad Q_m = -8.321$

Angular distributions have been measured at $E_p = 30.5$ MeV (1967CO05, 1968CO1U: to ^{17}O*(0, 0.87)), 40 MeV (1966BR1X, 1966HO1F: to ^{17}O*(0, 0.87, 3.06, 3.84)) and 46 MeV (1969HU1H, 1970HU1J: to ^{17}O*(0, 0.87, 3.06)). The $E_p = 30.5$ MeV distributions have been compared by (1968CO1U) with those from the mirror (p, t) reaction.

46. ^{19}F(d, α)^{17}O $\quad Q_m = 10.033$

$Q_0 = 10.060 \pm 0.010$ (1967SP09).

Observed alpha groups are displayed in Table 17.14 (1951BU1A, 1952WA1A, 1968BI1A). Angular distributions have been measured at many energies in the range $E_d = 0.3$ to 27.5 MeV: see Table 17.16 (1960HU10, 1961CI02, 1962FO02, 1962TA07, 1963HO1F, 1964JA08, 1964MA04, 1965CO07, 1965CO09, 1965ST14, 1966WE04, 1968BI1A, 1968PR04, 1968TA02, 1969ME07, 1970BE68). The cross sections for formation of the low-lying states of ^{17}O obey the $2J + 1$ rule, when it is cautiously applied: see (1965CO07, 1965CO09, 1968TA1N). Application of this rule, together with the results of reaction 29, leads to $J^\pi = \frac{5}{2}^-$ for ^{17}O*(3.84) (1965CO07, 1965CO09).

J for ^{17}O*(5.22) is found to be $\frac{3}{2}$ (1968BI1A). At $E_d = 1.2$ MeV, the γ-transition ($3.06 \to 0.87$) and ($3.84 \to 0$) are observed: the absence of ($3.06 \to 0$) is consistent with $J = \frac{1}{2}$ for ^{17}O*(3.06) (1957MU1A). See also (1960KR02, 1960RI05, 1969LI22, 1970BI1D), (1969DA1L) and (1963MI1E; theor.).

Table 17.16: ^{19}F(d, α)^{17}O angular distribution studies

E_d (MeV)	Distribution of alpha groups	Refs.
$0.30 - 0.65$	$\alpha_0 \to \alpha_3$	(1969ME07)
$0.9 - 4.0$	$\alpha_0 \to \alpha_4$	(1968TA02)
$0.95 - 1.25$	$\alpha_0 \to \alpha_3$	(1965ST14)
$1.35 - 2.00$	$\alpha_0 \to \alpha_3$	(1969BA2T)
$1.5 - 2.5$	$\alpha_0 \to \alpha_3$	(1963HO1F)
2.0, 2.2	$\alpha_0 \to \alpha_4$, α_6, α_7, α_{8+9}	(1968BI1A)
$2.0 - 4.6$	$\alpha_0 \to \alpha_2$	(1970BE68)
2.24, 2.33	$\alpha_0 \to \alpha_3$	(1964JA08)
$5.5 - 11.5$	$\alpha_0 \to \alpha_4$	(1966WE04)
9.2	$\alpha_0 \to \alpha_4$	(1965CO07, 1965CO09)
10	$\alpha_0 \to \alpha_3$	(1962FO02)
11.1, 11.4	α_0, α_1	(1960HU10)
13	α_0, α_1	(1961CI02)
14.7	$\alpha_0 \to \alpha_4$	(1962TA07)
20.9	$\alpha_0 \to \alpha_2$	(1968PR04)
27.5	α_0, α_1	(1964MA04)

47. ^{19}F(α, ^{6}Li)^{17}O $\qquad Q_m = -12.342$

At $E_\alpha = 42$ MeV, angular distributions are reported for the ^{6}Li ions corresponding to ^{17}O*(0, 0.87) (1968MI05).

48. ^{20}Ne(n, α)^{17}O $\qquad Q_m = -0.587$

At $E_n = 14.1$ MeV, angular distributions are reported for the α-particles, corresponding to ^{17}O*(0, 0.87) (1966MC14). See also (1959BE66, 1966CE03, 1969KA1D).

^{17}F
(Figs. 8 and 9)

GENERAL:

Shell model: (1957WI1E, 1960TA1C, 1962BH09, 1962TA1E, 1963KU1B, 1965LE1E, 1965MA16, 1966DE18, 1966MA12, 1966SO05, 1967EL03, 1968BI07, 1968EL1A, 1968HO1H, 1968MA2B, 1969EL1B, 1969KU1G, 1969MA38, 1970WA01).

Collective model: (1959FA1C, 1960RA1A, 1962AR1C, 1962MA23, 1962MA1K, 1964BA1L, 1968BI07, 1968MA2B, 1969MA38).

Electromagnetic transitions: (1959BA1C, 1959FA1C, 1960RA1A, 1964BA1L, 1965GR1H, 1965KA1D, 1966MA12, 1967KA21, 1969KH1C, 1969MA38, 1970EL08, 1970GO1H, 1970SI1C).

Special levels: (1960EV1A, 1961WI1D, 1962BA1C, 1962IN02, 1965EJ1A, 1965LE1E, 1966SO05, 1967BE02, 1969HA1G, 1970EL08, 1970WA01).

Other topics: (1960GO1C, 1964LI1B, 1967NE1D, 1969HE1N, 1969NO1E, 1969SC14, 1969SC1Q, 1969TE1A, 1970BA1M).

Ground state:

$$\mu = 4.7224 \pm 0.0012 \text{ nm (1965SU02, 1966SU01).}$$

See also (1964ST1B, 1966MA1V, 1967CO1D, 1967SH14, 1968LE1L, 1968RO1E, 1969FU11, 1969PE1D).

1. ^{17}F(β^+)^{17}O $\qquad Q_{\rm m} = 2.760$

The decay is to the ground state of ^{17}O. The spectrum has the allowed shape down to 150 keV (1962VA27). The upper limit for the transition to ^{17}O*(0.87) is $< 3.4 \times 10^{-4}$ per decay (1969GA05), 4×10^{-4} per decay (1963AR1B) [$\log ft > 5.6$]. The half-life of ^{17}F is 66.0 ± 0.2 sec: see Table 17.18 and (1959KI99) $\log ft = 3.36$. See also (1970ST04). See also (1958VA31, 1959VA10, 1966SU01) and (1965GA1D, 1965HA31, 1965MI1B, 1966MI1F, 1967AM1H, 1969LE1D, 1969SU15; theor.).

2. ^{12}C(^{12}C, ^{7}Li)^{17}F $\qquad Q_{\rm m} = -16.859$

See (1962CH01).

Table 17.17: Energy levels of ^{17}F [a]

E_x in ^{17}F (MeV ± keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
0	$\frac{5}{2}^+; \frac{1}{2}$	$\tau_{1/2} = 66.0 \pm 0.2$ sec	β^+	1, 2, 4, 6, 13, 14, 15, 16, 17, 18, 19, 20, 21
0.49533 ± 0.10	$\frac{1}{2}^+$	$\tau_m = 412 \pm 9$ psec	γ	4, 6, 13, 15, 16, 17, 18, 20
3.105 ± 7	$\frac{1}{2}^-$	$\Gamma = 19 \pm 1$	p	6, 7, 13, 15, 20
3.86	$\frac{5}{2}^-$	$\tau_m = 6 \pm 1$ fsec	γ, p	6, 7, 13, 14, 15, 20
4.696 ± 10	$\frac{3}{2}^-$	$\Gamma = 230$	p	7, 13, 20
5.103 ± 10	$\frac{3}{2}^+$	1530	p	7
5.521 ± 10	$\frac{3}{2}^-$	69	p	7, 14
5.672 ± 10	$\frac{7}{2}^-$	40	p	7, 14
5.681 ± 10	$\frac{1}{2}^+$	< 0.6	p	7
5.817 ± 10	$\frac{3}{2}^+$	180	p	7
6.036 ± 10	$\frac{1}{2}^-$	28	p	7
6.556 ± 10	$\frac{1}{2}^+$	203	p	7
6.699 ± 10	$\frac{3}{2}^-$	< 3	p	7
6.774 ± 10	$\frac{3}{2}^+$	4.5	p	7
7.027 ± 10	$\frac{3}{2}^-$	3.8	p	7
7.356 ± 10	$\frac{3}{2}^+$	10 ± 2	p, α	7, 8
7.448 ± 7		≤ 5	p	7
7.454 ± 7		7 ± 2	p, α	7, 8
7.471 ± 7		5 ± 2	p	7
7.478 ± 10	$\frac{3}{2}^+$	795	p	7
7.546 ± 10	$\frac{7}{2}^-$	28	p	7
7.75 ± 20	$\frac{1}{2}^+$	179 ± 3	p, α	7, 8
7.95 ± 15		10 ± 3	p	7
8.01 ± 20		47 ± 20	p, α	7, 8
8.07 ± 15	$\frac{5}{2}^+$	100 ± 20	p, α	7, 8
8.2	$\frac{3}{2}^-$	700 ± 240	p, α	7, 8
8.383 ± 5	$\frac{5}{2}^-$	11 ± 5	p, α	7, 8
8.416 ± 10	$\frac{7}{2}^+$	42 ± 10	p, α	7, 8
8.75 ± 30	$\frac{5}{2}^+$	170 ± 30	p, α	7, 8

Table 17.17: Energy levels of ^{17}F [a] (continued)

E_x in ^{17}F (MeV $\pm$ keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
8.95 ± 20	$\frac{5}{2}^-$	120 ± 20	p, α	7, 8
9.3 ± 150	$\frac{3}{2}^+$	210 ± 40	p, α	7, 8
9.62 ± 20		310 ± 70	p	7
9.88 ± 20		130 ± 20	p, α	7, 8
9.93 ± 20		420 ± 90	p	7
10.04 ± 20	$\frac{7}{2}$	280 ± 90	p	7
10.22 ± 20		250 ± 80	α	8
10.40 ± 20		160 ± 40	p	7
10.49 ± 20	$\frac{7}{2}^-$	140 ± 30	p, α	7, 8
(10.70 ± 20)		140 ± 30	p, α	7, 8
10.79 ± 20		120 ± 40	p, α	7, 8
10.95 ± 20		190 ± 50	p, α	7, 8
11.204 ± 5	$\frac{1}{2}^-; \frac{3}{2}$	< 2	p, α	5, 7, 8
11.43 ± 20		240 ± 60	p, α	7, 8
11.57 ± 40		160 ± 30	p	7
(11.78 ± 20)		190 ± 90	p	7
(11.87 ± 20)		40 ± 20	α	8
12.00 ± 20		120 ± 40	p, α	7, 8
(12.19 ± 20)		160 ± 60	p, α	7, 8
12.25 ± 20	$\frac{3}{2}^-$	190 ± 50	p	7
12.35 ± 20		260 ± 50	p	7
12.556 ± 7	$\frac{3}{2}^-; \frac{3}{2}$	≤ 3	p, α	5, 7, 8
(12.8)		≈ 3800	p	7
13.060 ± 4	$(\frac{3}{2}, \frac{5}{2})^-; \frac{3}{2}$	≤ 4	p, α	5, 7, 8
13.082 ± 5	$T = \frac{3}{2}$	≤ 5	p, α	7, 8
(13.15)		≈ 400	p	7
(13.7)		≈ 300	p	7
13.779 ± 5	$T = \frac{3}{2}$	≈ 10	p, α	7, 8
14.310 ± 5	$T = \frac{3}{2}$	≈ 14	p, α	7, 8
14.5		≈ 700	p	7

Table 17.17: Energy levels of ^{17}F [a] (continued)

E_x in ^{17}F (MeV ± keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
14.8		≈ 600	p	7
(15.2)		≈ 500	p	7
15.6		≈ 500	p	7
(16.0)		≈ 400	p	7
(16.5)		≈ 500	p	7
(16.7)		≈ 400	p	7
(17.02)		≈ 400	p	7
17.2	$\frac{5}{2}^-$	≈ 450	p	7
17.4		≈ 400	p	7
(17.67)		≈ 400	p	7
(17.9)		≈ 450	p	7
(18.5)		≈ 400	p	7
19.8	$\frac{3}{2}$		p	7
20.7		≈ 400	p	7
21.6		≈ 400	p	7
22.4		≈ 400	p	7
25.7	$\frac{3}{2}^-$	broad	p	7
27.3	$\frac{5}{2}^-$		p	7

[a] See also Table 17.20.

3. (a) ^{14}N(^{3}He, n)^{16}F $\quad Q_m = -0.969 \quad E_b = 15.843$
   (b) ^{14}N(^{3}He, p)^{16}O $\quad Q_m = 15.243$
   (c) ^{14}N(^{3}He, d)^{15}O $\quad Q_m = 1.799$
   (d) ^{14}N(^{3}He, α)^{13}N $\quad Q_m = 10.025$
   (e) ^{14}N(^{3}He, 2α)^{11}C $\quad Q_m = 2.297$

The p_0 yield (reaction (b)) does not show the presence of any resonances for $E(^3\mathrm{He}) = 2.5$ to 5.5 MeV (1963GO09). See also (1962BI01, 1965BR1B) and ^{16}O. The yields of α_0, α_1 and $\alpha_2 + \alpha_3$ (reaction (d)) in the range $E(^3\mathrm{He}) = 2.5$ to 8.5 MeV show broad uncorrelated fluctuations, except

Table 17.18: The half-life of ^{17}F

$\tau_{1/2}$ (sec)	Refs. [a]
66.0 ± 0.5	(1958AR15)
66 ± 1	(1949BR27)
66.3 ± 1	(1951LA1A)
66.0 ± 0.5	(1954KO54)
66.0 ± 1.8	(1954WO20)
66.0 ± 0.2	(1960JA12)
66.0 ± 0.2	mean

[a] See also (1952AJ38, 1954WA1A, 1962VA27).

for a structure at $E(^3\text{He}) = 4.5$ MeV (1970KN01). See also (1964BR1G, 1965BR1B, 1966GO1E, 1967BE22, 1967HA20) and ^{13}N in (1970AJ04). For reaction (a) see (1966MA1R) and ^{16}F. For reaction (c) see (1967HA20) and ^{15}O in (1970AJ04). For reaction (e), see (1965BR1B).

4. ^{14}N(α, n)^{17}F $\qquad Q_{\text{m}} = -4.735$

See (1956DO1C, 1969SC21) and ^{18}F in (1972AJ02).

5. ^{15}N(^{3}He, n)^{17}F $\qquad Q_{\text{m}} = 5.008$

Neutron groups have been observed corresponding to ^{17}F states at $E_{\text{x}} = 11.195 \pm 0.007$, 12.540 ± 0.010 and 13.059 ± 0.009 MeV, with $\Gamma < 20$, < 25 and < 25 keV, respectively. Angular distributions at $E(^3\text{He}) = 10.36$ and 11.88 MeV lead to $J^\pi = \frac{1}{2}^-$ for ^{17}F*(11.20) [$L = 0$], $\frac{3}{2}^-$ or $\frac{5}{2}^-$ for ^{17}F*(12.54) and $(\frac{3}{2}^-, \frac{5}{2}^-)$ for ^{17}F*(13.06). These three states are probably the first three $T = \frac{3}{2}$ states in ^{17}F (1966AD07, 1969AD02). See also (1969BA1Z, 1969GA1P). The branching ratios for transitions to ^{16}O*(0, 6.05, 6.13) for ^{17}F*(11.20) and for the analog $T = \frac{3}{2}$ state in ^{17}O are displayed in Table 17.9: the ratios of the reduced widths are quite different in the two mirror nuclei (1970MC02).

6. ^{16}O(p, γ)^{17}F $\qquad Q_{\text{m}} = 0.601$

Table 17.19: Recent ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N yield curves and polarization studies [a]

(a) *Yield curves*

E_p (MeV)	Particles	Refs.
2.5 – 2.8	p_0	(1965GO08)
3.43 – 3.52	p_0	(1964SI04)
3.5 – 5.75	p_0	(1962HA37)
4.25 – 8.6	p_0	(1962SA11, 1962SA1C)
6.7 – 10.6	$\gamma_{6.13}$, $\gamma_{6.92}$	(1961ST17, 1962ST1A)
6.9 – 15.6	p_0	(1960KO09)
7.2 – 12.9	p_1, p_2, p_3, p_4	(1964DA02)
10.2 – 18	p_0	(1961MA15)
$\approx$ 11 – 15	$p_0 \rightarrow p_5$	(1967VA1H, 1968TE1C)
$\approx$ 11.2, 12.7	p_0, p_2, p_4	(1967PA17)
12 – 19	p_2, p_{3+4}	(1960KO09)
12.7 – 19.2	p_0	(1964DA07)
13.2 – 14.6	p_0, p_1, p_2, p_3, p_4	(1969SK1B)
13.5 – 19	p_0	(1964KE01)
14.6 – 19.2	p_2, p_{3+4}, p_5	(1964DA07)
16.0 – 30.6	p_0	(1969KA14)
18.5 – 30	p_0, p_{1+2}, p_{3+4}, p_5	(1970GU04)
20 – 30	p_0	(1968AP1A)
21 – 40	p_0, p_{1+2}, p_5	(1969BU1J)
23.4 – 46.1	p_{1+2}, p_5	(1970AU1C)
7.2 – 12.8	α_0	(1964DA02)
9.6 – 15	α	(1960FU1A)
10.5 – 19	α_0	(1961MA15)
$\approx$ 11 – 15	α_0	(1967VA1H, 1968TE1C)
12 – 18	$\sigma_{act.}$	(1961HI09)
13.20 – 14.08	α_0	(1969SK1B)
15.6 – 18.3	α_1	(1961MA15)
16.2 – 18.3	$\alpha_2 + \alpha_3$	(1961MA15)
21 – 40	α	(1969BU1J)

Table 17.19: Recent ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N yield curves and polarization studies [a] (continued)

(b) *Polarization measurements*

E_p (MeV)	Particles	Refs.
$1.51 - 2.99$	p_0	(1967TR08)
$2 - 12$	p_0	(1965BL02)
$3.76 - 4.65$	p_0	(1962GO26, 1965BE1K)
$4.27 - 4.84$	p_0	(1964MA34, 1964MA43, 1965DR01)
4.5	p_0	(1965BO29)
7.9	p_0	(1961RO13)
$8.5 - 11.9$	p_0	(1962BL15)
8.7, 8.9	p_0	(1959AL08)
10	p_0	(1961RO05)
14.5	p_0	(1965RO22, 1966RO1R)
$19.8 - 30.3$	p_0	(1969KA14)
20.3	p_0, p_2, p_3, p_4, p_5	(1970BL03)
$21.0 - 52.5$	p_0	(1966BE1M, 1966BO1Q, 1966BO1T)
$24.5 - 39.7$	p_0	(1968EL1F)

[a] See also (1959AJ76).

Non-resonant capture has been studied for $E_p = 0.8$ to 2.1 MeV by (1954WA1A): three γ-rays are observed – γ_1 to the ground state, γ_2 to ^{17}F*(0.50) and γ_3 from the $(0.50 \rightarrow 0)$ transition. The ratio of γ_2 to γ_1 is ≈ 10 over the above energy region. For $E_p = 2.56$ to 2.76 MeV, a study of the γ_1 and γ_2 yield shows an anomaly in the γ_2 yield [as predicted by (1961CH1C)]: it is deduced from it that $\Gamma_\gamma < 0.03$ eV for the capture transition $(3.10 \rightarrow 0.50)$, and that $\theta^2 = 0.38 \pm 0.08$ and 0.57 ± 0.10, respectively, for ^{17}F*(0, 0.50) (1965DO1G). The yield of 3.86 MeV γ-rays has been measured in the vicinity of the $E_p = 3.47$ MeV resonance, previously discussed by (1951LA1A, 1951LA1B). The angular distribution of the γ-rays is characteristic of an almost pure dipole transition. The data lead to $J^\pi = \frac{5}{2}^-$ for ^{17}F*(3.86), $\Gamma < 1.5$ keV, $\Gamma_\gamma = 0.11 \pm 0.02$ eV, $\tau_m = 6 \pm 1$ fsec (1963SE14). See also (1970AB1D).

For $E_p = 140$ to 170 keV, the cross section varies from 0.46 to 2.34×10^{-10} b (1958HE57). Astrophysical considerations are discussed by (1961CH1C, 1962GR1C, 1965DO1G).

The mean lifetime of ^{17}F*(0.50) is 445 ± 22 psec (1960KA10). See also (1957LE28, 1958HO97). (1963TH1A) have calculated a single-particle lifetime of 320 ± 80 psec for this state.

See also (1959GR1A, 1965ZO1A, 1966ED1A, 1968RI1P) and (1959AJ76).

Table 17.20: Resonances in ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N

E_p (MeV $\pm$ keV)	Γ_{lab} (keV)	Particles out	^{17}F* (MeV)	$J^\pi; T$	Refs.
2.663 ± 7 [a]	20 ± 1	p_0	3.105	$\frac{1}{2}^-$	(A, 1962SA1C, 1965BL02, 1965GO08)
3.47	1.63 ± 0.2	p_0	3.86	$\frac{5}{2}^-$	(A, 1962SA1C, 1964SI04, 1965BL02)
4.354 ± 10	240	p_0	4.696	$\frac{3}{2}^-$	(A, 1962HA37, 1962SA11, 1962SA1C, 1965BL02)
4.787 ± 10	1630	p_0	5.103	$\frac{3}{2}^+$	(A, 1962HA37, 1962SA11, 1962SA1C, 1965BL02)
5.231 ± 10	72.5	p_0	5.521	$\frac{3}{2}^-$	(A, 1962HA37, 1962SA11, 1962SA1C, 1965BL02)
5.392 ± 10	42.9	p_0	5.672	$\frac{7}{2}^-$	(A, 1962HA37, 1962SA11, 1962SA1C)
5.402 ± 10	< 0.6	p_0	5.681	$\frac{1}{2}^+$	(A, 1962SA11, 1962SA1C)
5.546 ± 10	191	p_0	5.817	$\frac{3}{2}^+$	(A, 1962HA37, 1962SA11, 1962SA1C, 1965BL02)
5.779 ± 10	30	p_0	6.036	$\frac{1}{2}^-$	(A, 1962SA11, 1962SA1C)
6.332 ± 10	216	p_0	6.556	$\frac{1}{2}^+$	(1962SA11, 1962SA1C)
6.484 ± 10	< 3	p_0	6.699	$\frac{3}{2}^-$	(A, 1962SA11, 1962SA1C)
6.564 ± 10	4.8	p_0	6.774	$\frac{3}{2}^+$	(A, 1962SA11, 1962SA1C, 1965BL02)
6.833 ± 10	4.0	p_0, $\gamma_{6.13}$	7.027	$\frac{3}{2}^-$	(1961ST17, 1962SA11, 1962SA1C, 1962ST1A, 1965BL02)
7.183 ± 10	10 ± 2	p_0, p_2, α_0	7.356	$\frac{3}{2}^+$	(1960KO09, 1962SA11, 1962SA1C, 1964DA02, 1965BL02)
7.280 ± 7	≤ 5	p_0	7.448		(1962SA11, 1962SA1C, 1964DA02)
7.287 ± 7	7 ± 2	p_0, p_1, p_2, α	7.454		(1962SA11, 1962SA1C, 1964DA02)
7.305 ± 7	5 ± 2	p_0, p_2	7.471		(1962SA11, 1962SA1C, 1964DA02)
7.313 ± 10	845	p_0	7.478	$\frac{3}{2}^+$	(1962SA11, 1962SA1C, 1964DA02)
7.385 ± 10	30	p_0, p_2, $\gamma_{6.13}$	7.546	$\frac{7}{2}^-$	(1961ST17, 1962SA11, 1962SA1C, 1962ST1A, 1964DA02)
7.60 ± 20	190 ± 3	p_0, p_1, α_0	7.75	$\frac{1}{2}^+$	(1962SA11, 1962SA1C, 1964DA02)
7.81 ± 15	10 ± 3	p_2	7.95		(1964DA02)
7.88 ± 20	50 ± 20	p_0, $\gamma_{6.13}$, $\gamma_{6.92}$, α_0	8.01		(1961ST17, 1962SA11, 1962SA1C, 1962ST1A, 1964DA02)
7.94 ± 15	110 ± 20	p_0, p_1, α_0	8.07	$\frac{5}{2}^+$	(1962SA11, 1962SA1C, 1964DA02)
8.1	750 ± 250	(p_0), p_1, α_0	8.2	$\frac{3}{2}^-$	(1964DA02)
8.275 ± 5	12 ± 5	p_0, p_1, p_2, p_3, α_0	8.383	$\frac{5}{2}^-$	(1962SA11, 1962SA1C, 1964DA02)
8.310 ± 10	45 ± 10	p_0, p_1, p_2, p_3, $\gamma_{6.13}$, $\gamma_{6.92}$, α_0	8.416	$\frac{7}{2}^+$	(1961ST17, 1962SA11, 1962SA1C, 1962ST1A, 1964DA02, 1965BL02)
8.66 ± 30 [b]	180 ± 30	p_2, p_3, p_4, α_0	8.75	$\frac{5}{2}^+$	(1963HA04, 1964DA02)

Table 17.20: Resonances in ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N (continued)

E_p (MeV $\pm$ keV)	Γ_{lab} (keV)	Particles out	^{17}F* (MeV)	$J^\pi; T$	Refs.
8.88 ± 20	130 ± 20	$p_0 \rightarrow p_4, \alpha_0, \gamma_{6.13}, \gamma_{6.92}$	8.95	$\frac{5}{2}^-$	(1961ST17, 1962ST1A, 1963HA04, 1964DA02)
9.2 ± 150 [b]	220 ± 40	$p_0 \rightarrow p_4, \alpha_0, \gamma_{6.13}, \gamma_{6.92}$	9.3	$\frac{3}{2}^+$	(1961ST17, 1962ST1A, 1963HA04, 1964DA02)
9.59 ± 20	330 ± 75	p_0, p_1, p_4	9.62		(1964DA02)
9.87 ± 20	140 ± 20	p_0, p_2, α_0	9.88		(1964DA02)
9.92 ± 20	450 ± 100	p_3	9.93		(1964DA02)
10.04 ± 20	300 ± 100	p_0, p_1	10.04	$\frac{7}{2}$	(1963HA04, 1964DA02)
10.23 ± 20	270 ± 85	α_0	10.22		(1964DA02)
10.42 ± 20	170 ± 40	p_1, p_3	10.40		(1964DA02)
10.52 ± 20	150 ± 30	p_0, p_2, α_0	10.49	$\frac{7}{2}^-$	(1963HA04, 1964DA02, 1965TO03)
(10.74 ± 20)	150 ± 30	p_1, α_0	(10.70)		(1964DA02)
10.83 ± 20	130 ± 40	$p_0, p_2, (p_3), (\alpha_0)$	10.79		(1963HA04, 1964DA02)
11.00 ± 20	200 ± 50	$(p_2), p_3, (\alpha_0)$	10.95		(1963HA04, 1964DA02)
11.276 ± 8 [c]	< 2	$p_0 \rightarrow p_5, \alpha_0$	11.204	$\frac{1}{2}^-; \frac{3}{2}$	(1967PA17, 1967VA1H, 1968TE1C) [d]
11.52 ± 20	260 ± 60	p_2, α_0	11.43		(1963HA04, 1964DA02)
11.67 ± 40 [b]	170 ± 30	p_0, p_3	11.57		(1963HA04, 1964DA02)
(11.89 ± 20)	200 ± 100	p_2	(11.78)		(1964DA02)
(11.98 ± 20)	40 ± 20	α_0	(11.87)		(1964DA02)
12.12 ± 20	130 ± 40	p_2, α_0	12.00		(1963HA04, 1964DA02)
(12.32 ± 20)	170 ± 60	$(p_2), \alpha_0$	(12.19)		(1964DA02)
12.39 ± 20	200 ± 50	p_0, p_2	12.25	$\frac{3}{2}^-$	(1963HA04, 1964DA02, 1965TO03)
12.49 ± 20	280 ± 50	p_1, p_4	12.35		(1963HA04, 1964DA02)
12.714 ± 8	≤ 3	$p_0, p_1, p_2, p_4, p_5, \alpha_0$	12.556	$\frac{3}{2}^-; \frac{3}{2}$	(1963HA04, 1964DA02, 1967PA17, 1967VA1H, 1968TE1C)
$(\approx 13.)$	≈ 4000	p_0	(12.8)		(1960KO09)
13.250 ± 4	≤ 4	$p_0 \rightarrow p_5, \alpha_0$	13.060	$T = \frac{3}{2}$	(1963HA04, 1964DA02, 1967VA1H, 1968TE1C, 1969SK1B) [e]
13.273 ± 5	≤ 5	$p_0 \rightarrow p_4, \alpha_0$	13.082	$T = \frac{3}{2}$	(1969SK1B)
(13.35)	≈ 450	p_0	(13.15)		(1964DA07)
(13.9)	≈ 350	p_0	(13.7)		(1964DA07, 1964KE01)

Table 17.20: Resonances in ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N (continued)

E_p (MeV $\pm$ keV)	Γ_{lab} (keV)	Particles out	^{17}F* (MeV)	$J^\pi; T$	Refs.
14.015 ± 5	≈ 11	$p_0 \rightarrow p_4, \alpha_0$	13.779	$T = \frac{3}{2}$	(1969SK1B)
14.579 ± 7	≈ 15	$p_0 \rightarrow p_5, \alpha_0$	14.310	$T = \frac{3}{2}$	(1961HI09, 1967VA1H, 1968TE1C, 1969SK1B) [e]
14.8	≈ 700	p_0, p_{1+2}	14.5		(1960KO09, 1964DA07, 1964KE01)
15.1	≈ 600	p_{1+2}	14.8		(1964DA07)
(15.5)	≈ 550	$p_0, p_{1+2}, p_{3+4}, p_5$	(15.2)		(1964DA07)
15.9	≈ 550	p_0, p_{1+2}	15.6		(1964DA07, 1964KE01)
(16.4)	≈ 400	$p_0, p_{1+2}, p_{3+4}, p_5$	(16.0)		(1964DA07)
(16.9)	≈ 550	p_0	(16.5)		(1964DA07)
(17.1)	≈ 450	p_{1+2}	(16.7)		(1964DA07)
(17.45)	≈ 450	p_0, p_{3+4}	(17.02)		(1964DA07)
17.6	≈ 500	p_0, p_{3+4}	17.2	$\frac{5}{2}^-$	(1964DA07, 1969KA14)
17.9	≈ 450	p_0, p_{3+4}, p_5	17.4		(1964DA07, 1964KE01)
(18.15)	≈ 450	p_0, p_{1+2}	(17.67)		(1964DA07)
(18.4)	≈ 500	p_{3+4}, p_5	(17.9)		(1964DA07)
(19.0)	≈ 400	p_0, p_{1+2}, p_5	(18.5)		(1964DA07) [f]
20.4		p_0	19.8	$\frac{3}{2}$	(1969KA14)
21.4	≈ 400	p_0	20.7		(1968AP1A, 1969KA14)
22.3	≈ 400	p_0	21.6		(1968AP1A, 1969KA14)
23.2	≈ 400	p_0, p_5	22.4		(1968AP1A, 1969KA14)
26.7	broad	p_0	25.7	$\frac{3}{2}^-$	(1968AP1A, 1969KA14)
28.4		p_0	27.3	$\frac{5}{2}^-$	(1969KA14)

A: (1951LA1A, 1951LA1B, 1953EP1A, 1954SE1A, 1954SE1B): see (1959AJ76).

[a] A search for fine structure near this resonance was unsuccessful: (1968SE1D).

[b] This may correspond to more than one state: see (1964DA02).

[c] $\Gamma_{p_0} = 40^{+10}_{-20}$ eV (1967PA17). [d] And C.A. Barnes, private communication. [e] And P.D. Parker, private communication.

[f] Structures in the yields of p_0, p_{1+2}, p_{3+4}, p_5 for $19 < E_p < 28$ MeV are also reported by (1970GU04).

7. (a) ^{16}O(p, p)^{16}O $E_b = 0.601$

(b) ^{16}O(p, pα)^{12}C $Q_m = -7.161$

(c) ^{16}O(p, pn)^{15}O $Q_m = -15.668$

Yield curves for elastic protons, protons scattered to ^{16}O*(6.05, 6.13, 6.92, 7.12, 8.87) and for γ-rays from ^{16}O*(6.13, 6.92) have been studied at many energies up to $E_p = 46$ MeV: see Table 17.19 for a summary of the measurements and Table 17.20 for a display of the observed resonances (1960KO09, 1961MA15, 1961ST17, 1962HA37, 1962SA11, 1962SA1C, 1962ST1A, 1964DA02, 1964DA07, 1964KE01, 1964SI04, 1965GO08, 1967PA17, 1967VA1H, 1968AP1A, 1968SE1D, 1968TE1C, 1969BU1J, 1969KA14, 1969SK1B, 1970AU1C, 1970GU04). See also (1965TO03, 1967CA1Q, 1970AB1D). See also (1966DA1B), (1968CA1D) and (1963CR10, 1963OP02, 1964VO1A, 1965HA28, 1966GA1L, 1969BO2A, 1969HA2C, 1969SO1A, 1969WA11, 1970SH14; theor.).

Total reaction cross sections have been measured at $E_p = 24.5$ to 45.9 MeV by (1967CA1R, 1969MC1A) and at 142 MeV by (1961TA06). At $E_p = 13.1$ MeV, cross sections for production of the p_{1+2} and p_{3+4} groups, as well as for the α_0 and α_1 groups (reaction (b)) have been measured by (1967CH1N). At $E_p = 150$ MeV, cross sections for formation of ^{16}O*(6.05, 6.13, 6.92) are reported by (1962RO25). See also (1962AL16). For a summary of angular distribution measurements, see Table 16.27 in ^{16}O.

Polarization measurements have been carried out for $E_p = 1.5$ to 52.5 MeV: see Table 17.19 (1959AL08, 1961RO05, 1962BL15, 1962GO26, 1964MA34, 1964MA43, 1965BE1K, 1965BL02, 1965BO29, 1965DR01, 1965RO22, 1966BE1M, 1966BO1Q, 1966BO1T, 1966RO1R, 1967TR08, 1968EL1F, 1969KA14, 1970BL03). Below $E_p = 5$ MeV two very broad resonances give rise to polarizations which change slowly with energy except near the 2.66 and 3.47 MeV resonances (1965BL02). (1968EL1F) report a drastic variation in the polarization angular distribution between $E_p = 21$ and 27 MeV, suggesting strong resonances in that region. See also (1967FA06), (1966DA1B, 1966RO1B) and (1959KE1A, 1960KA1E, 1963DU1B, 1963HO1D, 1965BA1M, 1965HA28, 1967LE13, 1968CH35, 1968RE03, 1969BO2A, 1969VA18; theor.).

For reaction (b) see also (1962AL16, 1962RO25); for reaction (c), see (1965VA1E).

For discussions of spallation measurements, see (1967BE2D) and (1960GR1A, 1961TA10, 1962AL16, 1963AL1G, 1963VA1C, 1965ZO1A, 1967AU1A, 1967EP1A, 1967GR1K, 1967LI1B, 1968JA1M, 1968PA1J, 1968YI1B, 1969AB1A, 1969DU10, 1969EP1B, 1970KO25). Astrophysical implications are considered by (1967BE2D) and (1966RE1D, 1967AU1A, 1967GR1K, 1967LI1B, 1968YI1B). See also reaction 57 in ^{16}O.

8. ^{16}O(p, α)^{13}N $Q_m = -5.218$ $E_b = 0.601$

Excitation functions of various α-groups and activation functions have been measured for $E_p = 7.2$ to 40 MeV: see Table 17.19 (1960FU1A, 1961HI09, 1961MA15, 1964DA02, 1967VA1H, 1968TE1C, 1969BU1J, 1969SK1B). Observed resonances are displayed in Table 17.20 (1961HI09, 1964DA02, 1967VA1H, 1968TE1C, 1969SK1B). In addition to the sharp resonances reported by (1961HI09, 1967VA1H, 1968TE1C, 1969SK1B) a number of broad structures are observed above $E_p \approx 15$ MeV (1961HI09, 1961MA15, 1970GU04). Cross sections for formation of ^{13}N*(0, 2.37, $3.51 + 3.55$) have been measured at $E_p = 13.1$ MeV (1967CH1N). See also ^{13}N in (1970AJ04).

9. ^{16}O(p, n)^{16}F $\qquad Q_m = -16.212 \qquad E_b = 0.601$

See ^{16}F.

10. ^{16}O(p, d)^{15}O $\qquad Q_m = -13.443 \qquad E_b = 0.601$

Excitation functions have been measured for $E_p = 21$ to 33 MeV (1969BU1J). At $E_p = 30.3$ MeV, polarization measurements have been made for the deuterons corresponding to ^{15}O*(0, 6.18) (1967CH15). See also ^{15}O in (1970AJ04).

11. ^{16}O(p, t)^{14}O $\qquad Q_m = -20.406 \qquad E_b = 0.601$

Excitation functions have been measured for $E_p = 30$ to 33 MeV (1969BU1J). Polarization measurements for the tritons corresponding to ^{14}O(0) and the ^{3}He particles corresponding to the analog state, ^{14}N*(2.31), have been carried out at $E_p = 49.5$ MeV: the analyzing powers of the two reactions are closely the same (1970NE1B). Asymmetry measurements are also reported at $E_p = 43.8$ MeV for the tritons corresponding to ^{14}O*(0, 7.78, 9.74) and to ^{14}O*(6.59). The latter disagree with DWBA predictions (1970HA23). See also ^{14}O in (1970AJ04).

12. ^{16}O(p, ^{3}He)^{14}N $\qquad Q_m = -15.243 \qquad E_b = 0.601$

Polarization measurements have been reported at $E_p = 43.8$ MeV for the ^{3}He particles corresponding to ^{14}N*(7.03) (1970HA23). See also reaction 11 (1970NE1B) and ^{14}N in (1970AJ04).

13. ^{16}O(d, n)^{17}F $\qquad Q_m = -1.624$

$$E_{\text{thresh.}} = 1.8292 \pm 0.0006;\ Q_0 = -1.6246 \pm 0.0005 \text{ (1960BO21)};$$
$$E_{\text{thresh.}} = 1.830 \pm 0.004 \text{ (1955MA85)};$$
$$E_{\text{thresh.}} = 1.832 \pm 0.003 \text{ (1961CH14)}.$$

Table 17.21: ^{16}O(d, n)^{17}F angular distribution studies [a]

E_d (MeV)	Angular distributions of groups	Refs.
$1.93 - 2.39$	n_0	(1961DI06)
$2.20 - 3.30$	n_0	(1968DI06)
$2.70 - 3.30$	n_1	(1968DI06)
$3.00 - 5.50$	n_0, n_1	(1970LO01)
$4.75 - 6.0$	n_0, n_1	(1970DA14)
5.02	n_0, n_1	(1961YA05)
7.73, 11, 12	n_0, n_1	(1969OL02)
8.0, 9.3	n_0, n_1	(1969TH04)

[a] See also (1959AJ76).

Slow-neutron thresholds have been observed corresponding to the ground state and to the first excited state. For the latter, $Q_1 = -2.125 \pm 0.004$ MeV (1955MA85), -2.125 ± 0.003 MeV (1961CH14), leading to $E_x = 499 \pm 3$ keV (1955MA85), 498 ± 2 keV (1961CH14). See also (1965MA1K). (1966AL10) report $E_x = 495.33 \pm 0.10$ keV from the measurement of the corresponding E_γ. The lifetime for ^{17}F*(0.50) is 406.8 ± 8.7 psec (1964BE15). See also (1967BI05, 1967WA1C, 1968SC1E).

Neutron groups have been observed corresponding to ^{17}F*(0, 0.50), to states at 3.03 ± 0.06 and 4.74 ± 0.07 MeV ($\Gamma < 90$ keV) (1957GR1A), and to ^{17}F*(3.86) (1969TH04). See also (1969OL02). Angular distributions have been measured for $E_d \leq 12$ MeV for the n_0 and n_1 groups: see Table 17.21 (1961DI06, 1961YA05, 1968DI06, 1969OL02, 1969TH04, 1970DA14, 1970LO01) and (1959AJ76). $l_p = 2$ and 0, respectively for the transitions to ^{17}F*(0, 0.5), in agreement with their assignments $J^\pi = \frac{5}{2}^+$ and $\frac{1}{2}^+$, respectively. Spectroscopic factors have been extracted and compared with those from ^{16}O(d, p)^{17}O: see (1969OL02, 1969TH04, 1970DA14) and (1970LO01). See also (1960MA21, 1962VA27, 1963KN04, 1963SA1C, 1965SU02, 1966AL12, 1966SU01, 1969OV01), (1963TA1A, 1963TR1A, 1969HA1V, 1970TE1B; theor.) and ^{18}F in (1972AJ02).

14. (a) ^{16}O(^{3}He, d)^{17}F $\quad Q_m = -4.893$

(b) ^{16}O(^{3}He, dp)^{16}O $\quad Q_m = -5.494$

$Q_0 = -4.90 \pm 0.09$ (1960WE04).

The angular distribution of the d_0 group has been measured at $E(^3\text{He}) = 9.16$ MeV: it is consistent with $l = 2$ (1959HI73). See also (1966AG1B, 1966EC1B). Reaction (b) appears to proceed in part via excited states of ^{17}F at $E_x = 3.86$ and 5.6 MeV (1967HO14).

15. ^{16}O(α, t)^{17}F $\qquad Q_m = -19.214$

At $E_\alpha = 46$ MeV, angular distributions of triton groups to the first four states of ^{17}F have been measured (1968PR1C). See also (1963TR1A; theor.).

16. ^{16}O(^{11}B, ^{10}Be)^{17}F $\qquad Q_m = -10.628$

At $E(^{11}$B$) = 113$ MeV, the ^{10}Be spectrum shows the strong excitation of ^{17}F*($0 + 0.5$), in addition to some unidentified weaker groups (1967PO13). See also (1967VO1A, 1969BR1D).

17. ^{17}O(p, n)^{17}F $\qquad Q_m = -3.542$

Angular distributions of the n_0 and n_1 groups have been obtained for $E_p = 6.95$ to 13.50 MeV (n_0) and 6.95 to 12.45 MeV (n_1). There appears to be collective enhancement in the $L = 2$ transition to ^{17}F*(0.5). A large spin-flip term in the effective two-body force is necessary to account for the strength of the ground state transition (1969AN06). See also (1966AN1A) and (1969SC1H).

18. ^{17}O(^{3}He, t)^{17}F $\qquad Q_m = -2.778$

At $E(^3$He$) = 17.3$ MeV, angular distributions have been obtained for the tritons corresponding to ^{17}F*(0, 0.50). The data have been analyzed using DWBA and a two-body interaction between the incident and target nucleons. An exact coupled-channel-equation calculation was also made for the ground state transition (1968HA30, 1969HA1U, 1969MA1G). See also (1966EC1B).

19. ^{19}F(γ, 2n)^{17}F $\qquad Q_m = -19.581$

See (1959OC07).

20. ^{19}F(p, t)^{17}F $\qquad Q_m = -11.099$

Table 17.22: Energy levels of ^{17}Ne

E_x in ^{17}Ne (MeV $\pm$ keV)	$J^\pi; T$	$\tau_{1/2}$ (msec)	Decay	Reactions
0	$\frac{1}{2}^-; \frac{3}{2}$	108.0 ± 2.7	β^+	1, 2
1.35 ± 70				2
1.84 ± 70				2
2.77 ± 70				2
5.28 ± 70				2

Angular distributions of the triton groups corresponding to ^{17}F*(0, 0.50) have been measured at $E_p = 16.4 - 18.0$ MeV (1963KA13), 17.5 MeV (1969HA1T), 22.8 MeV (1963HO24), 30.3 MeV (1967DI1C, 1968CO1U) and 46 MeV (1969HU1H, 1970HU1J). Angular distributions are also reported for the t_2 group (1963HO24, 1969HU1H) and for the t_3 and t_4 groups (1963HO24: partial distribution). See also (1962CO17, 1965RE1A, 1967AN1B, 1969AN1L).

21. ^{20}Ne(p, α)^{17}F $\qquad Q_m = -4.129$

At $E_p = 43$ MeV, the angular distribution of the α_0 group is reported by (1968FA1G). Some indication of a state at $E_x = 5.28$ MeV is reported by (1965PE1E).

^{17}Ne
(Fig. 9)

GENERAL:

Theory: (1964WI1B, 1965MA16, 1966MA12).

Reviews: (1960BA1F, 1960GO1B, 1961BA1C, 1962GO1B, 1964GO1G, 1966GO1B, 1966GO1K, 1966MC1C, 1968CE1A, 1969GA1P).

Mass of ^{17}Ne: $M - A$, determined from the Q-value of the ^{20}Ne(^{3}He, ^{6}He)^{17}Ne reaction, is 16.479 ± 0.050 MeV (1970ME11). See also (1967ES02). Then ^{17}Ne $-$ ^{17}F $= 14.53$ MeV and E_b for p, ^{3}He and α are, respectively, 1.50, 6.46 and 9.05 MeV. [E_b for an α-particle is calculated using the mass of (1970ME11) for ^{13}O.] The mass of ^{17}Ne predicted from mass formulae are $M - A = 16.508 \pm 0.023$ MeV (1970ME11), 16.517 ± 0.026 MeV (1968CE1A), 16.63 MeV (1966KE16). See also (1964WI1B, 1965JA1C).

1. ^{17}Ne(β^+)^{17}F* $\rightarrow$ ^{16}O + p

Table 17.23: Decay of ^{17}Ne †

Decay to ^{17}F* (MeV)	J^π	Decay [a] (%) (1967ES02)	Decay [a] (%) (1969HA2B)	log ft [b] (1969HA2B)	Decay to ^{16}O* (MeV)	J^π	Decay (%) (1969HA2B)
0	$\frac{5}{2}^+$	0.2 [c]		7.3 [c]			
0.50	$\frac{1}{2}^+$	0.6 [c]		6.8 [c]			
3.11	$\frac{1}{2}^-$	< 1.0	0.49	6.50 ± 0.07	0	0^+	100
4.32 [e]		2.0 ± 0.5					
4.70	$\frac{3}{2}^-$	19.2 ± 1.0	16.5	4.59 ± 0.02	0	0^+	100
5.52	$\frac{3}{2}^-$	56.2 ± 1.8	54.9	3.86 ± 0.01	0	0^+	100
6.04	$\frac{1}{2}^-$	12.4 ± 0.7	10.8	4.44 ± 0.02	0	0^+	100
6.43 [e]		0.9 ± 0.3	0.36	5.82 ± 0.10	0	0^+	100
6.70	$\frac{3}{2}^-$	0.4 ± 0.2					
7.03	$\frac{3}{2}^-$	≤ 0.5					
7.36 → 7.48		≤ 0.7					
7.75	$\frac{1}{2}^+$		0.18	5.70 ± 0.20	0	0^+	
8.01 }		4.5 ± 0.4 (8.01, 8.07)					
8.07 }	$\frac{5}{2}^+$		6.9	4.00 ± 0.01	0	0^+	
					6.05	0^+	
8.39 }		0.8 ± 0.1 (8.39, 8.42)					
8.42 }			6.6	3.85 ± 0.03	0	0^+	
					6.05	0^+	
8.85			1.9	4.20 ± 0.03	0	0^+	
					6.05	0^+	
11.20 [d]	$\frac{1}{2}^-; T = \frac{3}{2}$	0.04 ± 0.01	0.61	3.35 ± 0.10	0	0^+	12 ± 4
					6.05	0^+	26 ± 8
					6.92	2^+	28 ± 13
					7.12	1^-	34 ± 14

† *Note added in proof*: For latest results, see (1971HA05).

[a] See also (1964MC16, 1965HA20, 1965MA16).

[b] Based on $\tau_{1/2} = 109 \pm 3$ msec.

[c] From mirror log ft values (1967ES02).

[d] No decay was observed to ^{16}O*(6.13) [3^-] nor to ^{13}N (O) [by α-emission]: upper limit is 10% of the observed proton decays (1969HA2B).

[e] Proposed on the basis of the work of (1967ES02).

The half-life of ^{17}Ne is 102 ± 7 msec (1964MC16), 105 ± 5 msec (1967ES02), 107 ± 5 msec (1967FI10), 115 ± 5 msec (1969HA2B): the mean value is 108.0 ± 2.7 msec. See also (1964FL03, 1964FL05, 1965HA20). The decay is primarily to proton unstable states of ^{17}F at $E_x = 4.69$, 5.52 and 6.04 MeV, with $J^\pi = \frac{3}{2}^-$, $\frac{3}{2}^-$ and $\frac{1}{2}^-$, respectively: see Table 17.23 (1967ES02, 1969HA2B). The super-allowed decay to the analog state [^{17}F*(11.20)] has $\log ft = 3.35 \pm 0.10$ (1969HA2B). The character of the decay leads to $J^\pi = \frac{1}{2}^-$ for ^{17}Ne(0). See also (1963BA63, 1963VL1B, 1964DA13, 1965HA31, 1965MA16, 1965MI1B, 1966HA22).

2. ^{20}Ne(^{3}He, ^{6}He)^{17}Ne $\qquad Q_m = -26.187$

At $E(^3\text{He}) = 62$ MeV, ^{6}He groups are observed to five states of ^{17}Ne: see Table 17.22 (R. Mendelson, J.M. Loiseaux, G. Wozniak and J. Cerny, private communication).

^{17}Na

(Not illustrated)

^{17}Na has not been observed: its mass excess is predicted to be 35.61 MeV by (1966KE16). It is then unbound with respect to breakup into ^{16}Ne + p by 3.2 MeV and with respect to breakup into ^{14}O + 3p by 5.8 MeV.

References

(Closed 30 November 1970)

References are arranged and designated by the year of publication followed by the first two letters of the first-mentioned author's name and then by two additional characters. Most of the references appear in the National Nuclear Data Center files (Nuclear Science References Database) and have NNDC key numbers. Otherwise, TUNL key numbers were assigned with the last two characters of the form 1A, 1B, etc. In response to many requests for more informative citations, we have, when possible, included up to ten authors per paper and added the authors' initials.

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