MEP 2003

IODINE ($\lambda \approx 576$ nm)

Absorbing molecule $^{127}I_2$, a_1 component, P(62) 17-1 transition [1]

1.   CIPM recommended values

The values $f = 520\ 206\ 808.4$ MHz
$\lambda = 576\ 294\ 760.4$ fm

with a relative standard uncertainty of 4×10^{-10} apply to the radiation of a dye laser (or frequency-doubled He-Ne laser) stabilized with an iodine cell, within or external to the laser, having a cold-finger temperature of (6 ± 2) °C [2].

2.   Source data

Adopted value: $f = 520\ 206\ 808.4$ (2) MHz $u_c/y = 4 \times 10^{-10}$

for which:

$\lambda = 576\ 294\ 760.4$ (2) fm $u_c/y = 4 \times 10^{-10}$

calculated from

f / kHz	u_c/y	source data
520 206 808 491	1.5×10^{-10}	2.1
520 206 808 280	1×10^{-10}	2.2
Unweighted mean:	$f = 520\ 206\ 808\ 388$ kHz	

With this mean based on only two determinations, the CCL considered it prudent to assume an estimated relative standard uncertainty of 4×10^{-10}, closely equivalent to the difference between the two values.

Source data
2.1 Reference [1] gives $f_{a1} = 520\ 206\ 808\ 547$ kHz $u_c / y = 1.5 \times 10^{-10}$,

reduced by 12 kHz at the request of the NBS delegate at the CCDM meeting in 1982 [2, 3]. This value has been multiplied by the ratio (88 376 181 600.5/88 376 181 608) to account for the 1992 reference value of the methane frequency (see methane at $\lambda \approx 3.39$ μm, unresolved hyperfine structure) giving:
$f_{a1} = 520\ 206\ 808\ 491$ kHz $u_c/y = 1.5 \times 10^{-10}$.

2.2 Barwood et al. [4] give $f_{a1} / f_i = 1.098\ 381\ 317\ 29$ $u_c/y = 1 \times 10^{-10}$.

Using the recommended value of the absorbing molecule $^{127}I_2$, a_{16} or f component, R(127) 11-5 transition (see iodine at $\lambda \approx 633$ nm and frequency differences listed in corresponding Table 1) one obtains
$f_i = 473\ 612\ 214\ 712$ kHz $u_c/y = 2.2 \times 10^{-11}$,

one calculates $f_{a1} = 520\ 206\ 808\ 280$ kHz $u_c/y = 1 \times 10^{-10}$.

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[1]   All transitions in I_2 refer to the $B^3\Pi\, 0_u^+ - X^1\Sigma_g^+$ system.

[2]   For the specification of operating conditions, such as temperature, modulation width and laser power, the symbols ± refer to a tolerance, not an uncertainty.

3. Absolute frequency of the other transitions related to those adopted as recommended and frequency intervals between transitions and hyperfine components

This table replaces that published in BIPM Com. Cons. Long., 2001, **10**, 183 and Metrologia, 2003, **40**, 127.

The notation for the transitions and the components is that used in the source references. The values adopted for the frequency intervals are the weighted means of the values given in the references.

For the uncertainties, account has been taken of:

- the uncertainties given by the authors;
- the spread in the different determinations of a single component;
- the effect of any perturbing components;
- the difference between the calculated and the measured values.

In the tables, u_c represents the estimated combined standard uncertainty (1 σ).

All transitions in molecular iodine refer to the B-X system.

Table 1

$\lambda \approx 576$ nm $^{127}I_2$ P(62) 17-1

a_n	x	$[f(a_n) - f(a_1)]$/MHz	u_c/MHz	a_n	x	$[f(a_n) - f(a_1)]$/MHz	u_c/MHz
a_1	o	0	—	a_7	I	428.51	0.02
a_2	n	275.03	0.02	a_8	H	440.17	0.02
a_3	m	287.05	0.02	a_9	G	452.30	0.02
a_4	l	292.57	0.02	a_{10}	F	579.43	0.03
a_5	k	304.26	0.02	a_{15}	A	869.53	0.03
a_6	j	416.67	0.02				

Frequency referenced to a_1, P(62) 17-1, $^{127}I_2$: f = 520 206 808.4 MHz [5]

Ref. [4, 6]

4. References

[1] CCDM/82-30, NBS Measurement of Frequencies in the Visible and near I.R.

[2] Documents Concerning the New Definition of the Metre, *Metrologia*, 1984, **19**, 163-178.

[3] *BIPM Com. Cons. Déf. Mètre*, 1982, **7**, M 130–131.

[4] Barwood G.P., Rowley W.R.C., Characteristics of a $^{127}I_2$-Stabilized Dye Laser at 576 nm, *Metrologia*, 1984, **20**, 19-23.

[5] Recommendation CCL3 (*BIPM Com. Cons. Long.*, 10th Meeting, 2001) adopted by the Comité International des Poids et Mesures at its 91th Meeting as Recommendation 1 (CI-2002).

[6] Baird K.M., Evenson K.M., Hanes G.R., Jennings D.A., Petersen F.R., Extension of absolute-frequency measurements to the visible: frequencies of ten hyperfine components of iodine, *Opt. Lett.*, 1979, **4**, 263-264.