

## Metropolitan Museum of Art Gas Chromatography- Mass Spectrometry (GC-MS) Results from Material Analysis

This document includes (1) a mass spectrum and (2) the volatile organic compounds (VOCs) emitted from samples using GC-MS analysis. The data is not interpreted; however, several classes of chemicals are highlighted because they are potential risks for artwork in an enclosed environment. A basic key, provided below, indicates those classes. The amount of each chemical identified has not been determined; similarly, it is not known how much of each chemical is necessary to do damage to art. Finally, peaks may be present that are the result of the sample adsorbing chemicals from the air and reemitting them during testing rather than being inherent to the sample. Research is ongoing to determine specifically which chemicals and amounts are required to negatively affect artifacts.

### Highlighted data:

Pink – chemicals currently known to be hazardous to art

Green – amines; can raise the pH, are suspected to react with acids and may form crystals in an enclosed environment

Yellow – chemicals of the following type, which *may* be hazardous to art:

*Acids* – lower the pH, corrosive to metals, degrade organic materials

*Aldehydes* – can convert to acids with heat or exposure to UV light

*Esters* – can hydrolyze into acids with heat and humidity

*Sulfur-containing compounds* – known to tarnish and corrode some metals

*Halogenated compounds* – can become reactive with exposure to heat and UV light

*Nitrogen-containing, not amine* – can react with other off-gassed chemicals

*Alkynes* – can become reactive when exposed to heat or UV light



8.310	83.9	C11H24	156.2	937788	62016-19-7	Octane, 6-ethyl-2-methyl-
8.430	83.2	C11H22	154.2	1114746	4292-92-6	Cyclohexane, pentyl-
8.590	89.3	C22H42O4	370.3	1741785	999613-59-8	Oxalic acid, bis(6-ethyloct-3-yl) ester
8.660	95.6	C10H20O2	172.1	3623948	103-09-3	Acetic acid, 2-ethylhexyl ester
8.720	96.3	C10H30O5Si5	370.1	42877053	541-02-6	Cyclopentasiloxane, decamethyl-
8.950	93.9	C13H28	184.2	2340191	17312-77-5	Undecane, 2,3-dimethyl-
9.170	88.5	C12H24	168.2	1710060	74630-56-1	4-Undecene, 9-methyl-, (Z)-
9.380	95.2	C12H26	170.2	8503774	112-40-3	Dodecane
9.470	87.9	C10H20O	156.2	1122706	112-31-2	Decanal
9.710	80.4	C13H28	184.2	864809	62338-13-0	Decane, 3,3,5-trimethyl-
9.820	93.2	C11H20O2	184.1	3466751	103-11-7	2-Ethylhexyl acrylate
9.950	90.4	C11H22O2	186.2	2926323	999145-46-3	2-Ethyl-1-hexyl propionate
10.000	86.9	C10H20	140.2	2312433	3741-00-2	Cyclopentane, pentyl-
10.060	81.5	C20H42	282.3	1601927	56862-62-5	10-Methylnonadecane
10.220	83.8	C19H38	266.3	1773330	18435-45-5	1-Nonadecene
10.290	85.1	C13H28	184.2	933773	62238-14-6	Decane, 2,3,8-trimethyl-
10.680	95.8	C13H26	182.2	6886760	2437-56-1	1-Tridecene
10.790	94.7	C13H28	184.2	6259060	629-50-5	Tridecane
10.890	82.2	C13H28	184.2	2828842	17312-63-9	Nonane, 5-butyl-
10.960	82.2	C13H28	184.2	960081	1560-97-0	Dodecane, 2-methyl-
11.180	96.6	C12H36O6Si6	444.1	73067554	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.400	83.2	C12H22O	182.2	1169200	999136-28-0	Bis(cyclopentylmethyl) ether
11.440	80.9	C12H25Br	248.1	1519660	13187-99-0	2-Bromo dodecane
11.560	88.4	C12H24O3	216.2	2813970	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.740	90.5	C14H30	198.2	2731610	6418-41-3	Tridecane, 3-methyl-
11.840	93.7	C12H24O3	216.2	4983674	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
11.940	84.9	C20H42O	298.3	2028051	645-72-7	1-Hexadecanol, 3,7,11,15-tetramethyl-
12.030	87.6	C14H28	196.2	1471572	295-17-0	Cyclotetradecane
12.130	94.6	C14H30	198.2	7280419	629-59-4	Tetradecane
12.210	84.3	C16H34	226.3	2424217	55045-10-8	Tridecane, 6-propyl-
12.380	82.8	C19H38	266.3	969684	18435-45-5	1-Nonadecene
12.620	82.0	C19H40	268.3	759995	7225-66-3	Tridecane, 7-hexyl-
12.770	87.6	C14H30O	214.2	4726447	112-72-1	1-Tetradecanol
12.890	95.9	C10H10O4	194.1	1614601	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
13.070	82.5	C14H20O2	220.1	1190534	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
13.300	96.0	C15H30	210.2	3392422	13360-61-7	1-Pentadecene
13.400	82.6	C14H42O7Si7	518.1	45516713	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.620	98.3	C15H24O	220.2	6942056	128-37-0	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-
14.000	81.7	C16H34	226.3	914318	55045-14-2	Tetradecane, 4-ethyl-
14.050	91.6	C15H30	210.2	1236205	2883-02-5	n-Nonylcyclohexane
15.060	86.6	C16H24O	232.2	3017744	6738-27-8	2,5-Cyclohexadien-1-one, 2,6-bis(1,1-dimethylethyl)-4-ethylidene-
15.240	90.7	C16H32	224.3	796458	295-65-8	Cyclohexadecane
15.390	88.5	C16H48O8Si8	592.2	12826791	556-68-3	Cyclooctasiloxane, hexadecamethyl-
17.120	85.0	C18H54O9Si9	666.2	1887458	556-71-8	Cyclononasiloxane, octadecamethyl-