Table 1. Common traditional inorganic and organic pigments [1–8].

Pigment name (C.I. Name*)	Chemical composition	In use	Refractive index (n_D)	Comments
WHITE PIGMENTS				
Lead white (PW 1)	$2PbCO_3 \cdot Pb(OH)_2$	Antiquity –20th c.	1.94–2.09	One of the first synthetic pigments. Toxic was replaced by TiO_2.
Barium white (Barium Sulphate) (PW 21; PW 22)	$BaSO_4$	Nat: since antiquity; Synthetic: since 1830	1.62–1.64	Natural: barytes (barites). Synthetic: Blanc fixe.
Bone white	$Ca_3(PO_4)_2 + CaCO_3$	Since antiquity		Made from Bone ash.
Chalk (PW 18)	$CaCO_3$	Since antiquity	1.49–1.66	The mineral is calcite. Important filler and primer components.
Gypsum (PW 25)	$CaSO_4 \cdot 2H_2O$	Since antiquity	1.520–1.530	Important filler and primer (ground) components.
Zinc white (PW 4)	ZnO	Since 1834	2.00–2.02	It is synthetic, non-toxic opaque, permanent, has good hiding power.
Lithopone (PW 5)	$BaSO_4 + ZnS$	Since 1874	$BaSO_4$: 1.64; ZnS: 2.3	Synthetically made. ZnS (28-30%), $BaSO_4$ (72-70%).
Titanium white (PW 6)	TiO_2	Since the 1920s	2.5–2.9	Minerals: rutile and anatase. Has good whiteness and hiding power.
Antimony white (PW 11)	Sb_2O_3	Since 1920	2.20	Synthetic inorganic pigment.
YELLOW PIGMENTS				
Yellow Ochre (PY 43)	α-FeOOH + clay, quartz	Since antiquity	2.36 (av.)	A mineral is a goethite.
Massicot (PY 46)	PbO	Since antiquity	2.51–2.71	Synthetic inorganic pigment.
Orpiment (PY 39)	As_2S_3	BC until the end of the 19th c.	2.40–3.02	Natural inorganic toxic pigment. The mineral is orpiment.
Naples yellow (PY 41)	$Pb_3(SbO_4)_2$ or $Pb(SbO_3)_2$	16th c. BC	2.01–2.28	Synthetic pigment. Known under the name lead antimonate yellow.
Lead-Tin-Yellow type I; Lead-Tin-Yellow type II	Pb_2SnO_4 (type I); $Pb(Sn,Si)O_3$ (type II)	13th c.–1750; rediscovered in 1941	2.29–2.31	Synthetic inorganic pigment.
Chrome yellow (PY 34)	$PbCrO_4$; $PbCrO_4 \cdot PbSO_4$	Since 1814	2.31–2.49	Synthetic inorganic pigment.
Barium yellow (PY 31)	$BaCrO_4$	Since 1809	1.94–1.98	Synthetic inorganic pigment.
Strontium yellow (PY 32)	$SrCrO_4$	Since the 1800s	1.92–2.01	Synthetic inorganic pigment.
Zinc yellow (PY 36)	$K_2O \cdot 4ZnCrO_4 \cdot 3H_2O$	Since 1847	1.84-1.9	Synthetic inorganic pigment.
Cadmium yellow (PY 35/37)	CdS	Since the early 20th c.	2.35–2.48	Synthetic inorganic pigment.
Cobalt yellow (aureolin) (PY 40)	$K_3[Co(NO_2)_6] \cdot 3H_2O$	1861	1.72-1.76	Synthetic inorganic pigment.
Gamboge (NY 24)	Gambogic acid ($C_{38}H_{44}O_8$)	In Asia: since 8th c.; In Europe: since 17th c.	1.582-1.586	The natural gum resin is produced by several species of *Garcinia* trees.
Indian Yellow (NY 20)	$C_{19}H_{16}O_{11}Mg \cdot 5H_2O$ (magnesium salt of euxanthic acid)	15th c. until the beginning of 20th c.	1.67	It was originally made from the urine of cows fed on mango leaves (*Mangifera indica Linn.*).
Arylide (Hansa) yellows (PY 1-6; PY65; PY 73-75; PY 97; PY 98)	azo dye family	Since 1910		More than 20 pigments of arylide type have been developed. Hansa Yellow G (PY 1) and Hansa yellow 10G (PY 3) have been commonly used as artists' pigments.
RED PIGMENTS				
Cinnabar (Vermilion) (PR 106)	HgS	Since antiquity	3.146–2.819	Natural inorganic pigment. The mineral is cinnabar.
Red lead (PR 105)	Pb_3O_4	Since antiquity	2.42	Synthetic inorganic pigment.
Red ochre (or natural red earth (PR 102)	Fe_2O_3 + clay	Since antiquity	2.87 (av.)	Natural inorganic pigment. The mineral is hematite.
Cadmium red (PR 198)	CdS+CdSe [or CdS(Se)]	about 1910	2.64–2.77	Synthetic inorganic pigment.
Realgar	As_4S_4	BC–19th c.	2.46–2.61	Natural inorganic pigment. The mineral is realgar.
Chrome red (PR 103)	$PbO \cdot PbCrO_4$	Since 1809	2.42-2.7	Synthetic inorganic pigment.
Carmine [Cochineal carmine (NR 4) and Kermes Carmine)]	Carminic acid ($C_{22}H_{20}O_{13}$); Kermesic acid ($C_{16}H_{10}O_8$)	Since antiquity		Dye and also lake pigment that is prepared from two scale insects: cochineal and kermes.

Madder, Madder lake (PR 83 ja NR 9)	Alizarin $C_{14}H_8O_4$, purpurin $C_{14}H_8O_5$	plant root: 3000 BC synthetic alizarin: 1868		Dyestuff from the root of *Rubia tinctorium* plant. Also, organic artists' pigment (lake pigment).
Permanent red	Quinacridone family	After 1856		Synthetic organic pigment.
GREEN PIGMENTS				
Malachite (PG 39)	$CuCO_3 \cdot Cu(OH)_2$	Since antiquity	1.655–1.909	Mineral is malachite
Green earth (PG 23)	Iron-rich clay	Since antiquity	1.62	Main minerals: glauconite and/or celadonite.
Verdigris (PG 20)	$Cu(CH_3COO)_2 \cdot 2Cu(OH)_2$	Since antiquity	1.53–1.56	Synthetic pigment. The most reactive and unstable of all the Cu-pigments.
Atacamite	$Cu_2Cl(OH)_3$		1.831-1.880	Mineral.
Chromium oxide (PG 17)	Cr_2O_3	Known since 1809; available since 1862	2.5	Synthetic pigment. The most stable of green pigments.
Cobalt green (PG 19)	$CoO \cdot ZnO$	Since 1780	1.94–2.0	Synthetic inorganic pigment.
Emerald green (PG 21)	$3Cu(AsO_2)_2 \cdot Cu(CH_3COO)_2$	Discovered 1800–1814	1.71–1.78	Synthetic, extremely toxic.
Viridian green (PG 18)	$Cr_2O_3 \cdot 2H_2O$	Discovered 1838	1.62–2.12	Synthetic inorganic pigment. Replaced Emerald green.
Chrome green (PG 15)	$Fe_4[Fe(CN)_6]_3 + PbCrO_4$	Since the beginning of the 19th c.	2.4	Synthetic inorganic pigment.
Phthalocyanine green (Phthalo Green) (PG 7)	$Cu(C_{32}H_{16-n}Cl_nN_8)$	1938	1.40	Synthetic organic pigment.
BLUE PIGMENTS				
Azurite (PB 30)	$2CuCO_3 \cdot Cu(OH)_2$	Antiquity until the beginning of 18th c.	1.730–1.838	Mineral is azurite.
Blue Verditer (PB 30)	$2CuCO_3 \cdot Cu(OH)_2$	17th c.	1.72-1.74	Synthetically made azure blue pigment.
Egyptian blue (PB 31)	$CaCuSi_4O_{10}$	ca 3100 B.C.	1.59–1.63	One of the oldest synthetically made pigments.
Indigo (NB 1)	$C_{16}H_{10}N_2O_2$ (indigotin)	Plant leaf: BC; synthetic: ca 1880	>1.662	Organic pigment.
Vivianite	$Fe_3(PO_4)_2 \cdot 8H_2O$		1.60-1.65	Mineral
Ultramarine blue (PB 29)	the approximate formula: $3Na_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2Na_2S$	natural: 13th –19th; artificial: since 1828	1.5	Mineral is lapis lazuli.
Smalt (PG 32)	potash silicate glass with cobalt oxide	16th–19th c.	1.46–1.55	The earliest of the cobalt pigments. The only amorphous blue pigment.
Prussian blue (PB 27)	$Fe_4[Fe(CN)_6]_3$	Since 1704	1.56	Well-documented synthetic pigment.
Cobalt blue (PB 28)	$CoO \cdot Al_2O_3$	Discovered in 1802	1.74	Synthetic inorganic pigment.
Cerulean blue (PB 35)	$CoO \cdot nSnO_2$	Since 1860	1.84	Synthetic inorganic pigment.
Manganese blue (PB 33)	$BaMnO_4 + BaSO_4$	Patented 1935	1.65	
Phthalocyanine blue (Phthalo Blue) (PB 15)	$Cu(C_{32}H_{16}N_8)$	1935	1.38	Synthetic organic pigment.
BROWN PIGMENTS				
Brown ochre (PBr 6)	$Fe_2O_3 \cdot nH_2O$, silica, clay	Since antiquity	1.8–2.2	Natural inorganic pigment
Burnt umber (PBr 7)	$Fe_2O_3 + MnO_2$ + clay	Since antiquity	2.2–2.3	Natural inorganic pigment
Raw umber (PBr 8)	$Fe_2O_3 \cdot H_2O + MnO_2$ + clay	Since antiquity	1.87–2.17	Natural inorganic pigment
Sepia	Melanin (mixture of polyacid polymers of the indole type)	End of 18th c.	Opaque	Ink of cuttlefish; organic pigment.
BLACK PIGMENTS				
Vine black (pure plant black) (PBk 8)	C	Since antiquity	Opaque	Natural pigment
Bone black/ Ivory black (PBk 9)	$C + Ca_3(PO_4)_2$	Since antiquity	1.65–1.70	Natural inorganic pigment
Charcoal black (PBk 10)	C	Since antiquity	Opaque	Natural pigment
Lamp black	C	Since antiquity	Opaque	Amorphous carbon
Magnetite	Fe_3O_4			Mineral
Asphaltum (Bitumen)	mixture of hydrocarbons	Since antiquity	1.64-1.66	Organic pigment

[*] The C.I. (Colour Index) Name is an internationally recognized name assigned to a particular colourant. The C.I. Name consists of the category (type of dye or pigment), general hue and serial number assigned, based on its chemical composition. The paint industry uses such information to identify ingredients and is often added on the labels of artists´ paints or associated product information [1].

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