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CTS PURE ARTISTS' PIGMENTS

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General information on pigments

The pigments are fine or very fine powders, colored, opaque, insoluble in water and in the main binders used in painting (oil, aqueous binders, etc..). The chemical inertness and non-solubility in the vehicle (binder or solvent) is their most important feature, which distinguishes them from coloring matter, which shall enter into solution by reacting with the support (paper, textiles, etc.) with which they come into contact and bind stably to it by means of stains (chemical action).

The main differences between pigment and colorant can be summarized in the following table:

	PIGMENTS	COLORANT
Solubility in water	No	Yes
Chemical inertness	Yes	No
Heat resistance	Good	Poor
Resistance to light	Usually good	Usually poor
Particle size	Medium to fine	Very fine
Chemical class	Mainly inorganic	Organics

Colorants can be made insoluble to equal a pigment by adsorption on an inorganic base white or colorless (eg alumina), obtaining an intermediate called lacquer. Today, the term lacquer is obsolete is preferred to call them "organic minerals", whose base is composed of inert materials such as carbonates and sulfates poorly soluble and organic synthesis colorants, much more resistant to environmental factors of ancient lakes. However, these modern lacquers are generally more sensitive than the purely inorganic pigments, to environmental factors and chemical agents, indication to consider for the application of these materials in exterior.

Classification and characteristics of the pigments

The subdivision of the pigments can be made depending on the color, origin (natural or synthetic), the chemical category (organic or inorganic), the period of use or composition. In this brochure, the typological subdivisions are (by origin and chemical class):
Inorganic synthetic;
Inorganic natural (land);
Organic Minerals.

To make it easier to read, the following table index:

	INORGANIC SYNTHETIC	INORGANIC NATURAL	ORGANIC MINERALS
WHITE	Titanium White 0241 Zinc White 0240		
YELLOW	Cadmium Yellow Light 0550 Cadmium Yellow Deep 0551	Oxide Yellow 0325 Yellow Earth 0269 Yellow Ochre 0324 Ocker Dunkel 0276 Havana Ochre 0275 Raw Sienna 0263	
RED	Cadmium Red light 0554 Cadmium Red Medium 0553 Cadmium Red Deep0555	Caput Mortum 0343 Red Earth 0270 Herculaneum Red 0316 Pozzuoli Red 0318 Venetian Red 0315 Burnt Sienna 0262	Cinnabar Red 0604 Lake Red Light 0307 Lake Red Deep 0308
GREEN	Chrome Oxide Green 0559 Emerald Green 0557	Green Earth 0264 Nicosia Green Earth0282	Lime Green 0286
BLUE	Prussian Blue 0340 Pure Ultramarine Blue 0561 Cobalt Blue 0558 Cerulean Blue 0602		Herculaneum Blue 0303
PURPLE	Pure Ultramarine Violet 0560		
BROWN		Raw Umber 0266 Burnt Umber 0261 Cyprus Raw Umber 0274 Cyprus Burnt Umber0272 Cassel Brown 0260	
BLACK		Rome Black 0268 Vine Black 0321 Ivory Black 0597 Lamp Black 0341	

In addition to the chemical composition and type, we can identify the following characteristics:

- **Color Index**: All pigments and colorants are classified in a database called Color Index International[(1)],in which each colored substance is marked by a distinctive code based on the chemical structure the color.
- **CIE L*a*b* data**: colorimetric parameters of the space CIE L*a*b*, which allow to define unambiguously the hue of a given material. This report shows the value of the pure pigment powder.
- **Shades apparent**: brief description indicative of the color, based on the interpretation of the CIE L*a*b* parameters.
- **Hiding power**: is the ability of a pigment to cover the underlying surface, imparting its color. The hiding power depends mainly on the refractive index, the particle size and the binder used.
- **Resistance to lime**: in the application *a fresco* or with basic mediums, it is important the choice of the pigment because the high pH can alter its structure and change their properties, especially with regard to the hue.
- **Resistance to moisture**: is a matter to be taken into consideration especially for paints in external or if the painting technique involves the use of a little of binder or "lean" binders.
- **Resistance to light**: it is known that many colors, if kept under direct sunlight, they tend to fade. This happens mainly because of the ultraviolet component of sunlight, which modifies the chemical structure of the compounds, particularly organic ones. In general, inorganic pigments are more lightfast organic colorants.

Besides these features, it must take into account the chemical compatibility between different pigments with various binders, as well as the toxicity of the compounds. Another important fact of modern pigments, held in little consideration, is the correspondence between name and type of compound. Many of the pigments on the market today retain the historic name, although they often have been made in the composition of the improvements for increased covering power and resistance to various factors and / or decrease toxicity while maintaining a tone similar to the original pigment.
The above guidance also affect the CTS PURE ARTISTS' PIGMENTS that, therefore, are comparable only with pigments of similar composition and non analogous nomenclature.

SYNTHETIC INORGANIC PIGMENTS

WHITE PIGMENTS

	TITANIUM WHITE 0241	ZINC WHITE 0240
Chemical composition	TiO_2 (minimum 95%) and aluminum hydroxide.	ZnO high purity
Color Index	PW6-77891	PW4-77947
CIE L*a*b* data	L 80.32 a -0.17 b -0.67	L 89.58 a -0.19 b 2.8
Tonality	Cool white, opaque	Neutral white, semi-transparent
Resistance to lime	Average	Poor
Resistance to moisture	Average	Average
Resistance to light	High	High
Hiding power	High	Average

Titanium White is a white pigment very hiding, composed of titanium dioxide anhydrous high purity. It can be used in any painting technique and is also used as a basis for the preparation of opaque fillers of various types (plaster, epoxy, etc..).
It remains virtually unaffected by acids and bases, and is not subject to particular effects due to the heat. No particular chemical incompatibilities with other pigments. In oil gives films that tend to not dry well, especially if used pure and it is advisable to add the appropriate amount of white zinc to prevent the formation of spongy film.
White Zinc is mainly composed of zinc oxide, anhydrous. Especially suitable for glazes, especially in aqueous medium (gouache, watercolor, acrylic, etc..). Sensitive to both acid and bases, the use in fresco is not recommended.
Drying is slow in oils, especially in the poppy oil, so we recommend the addition of a small amount of resin dammar or mastic. The zinc oxide absorbs ultraviolet radiation below 370 nm and has anti-yellowing, but creates films with tendency to crack, especially if used pure, since it reacts with the acids contained in the oil (saponification process).
No particular chemical incompatibilities with other pigments; however, being a UV absorber, can accelerate the action of degradation in the light of the colors with which it is mixed, especially in watercolor and in the presence of pigments poor resistant to light, as many organic compounds and Prussian Blue. Due to the humidity, tends to turn into zinc carbonate, with minimum coverage and should therefore be used with caution in outside, especially with low-fat binders. A strong heat can make it turn yellow, but it returns to white for cooling.

(1) held by two American Associations Society of Dyers and Colourists and the American Association of Textile Chemists and colorists.

BLUE AND PURPLE PIGMENTS

	PRUSSIAN BLUE 0340	PURE ULTRAMARINE BLUE 0561	PURE ULTRAMARINE PURPLE 0560	COBALT BLUE 0558	CERULEAN BLUE 0602
Chemical composition	$Fe(CN_6)NH_4M+$ (M=Na, K)	approximately $(Na,Ca)_4(Al,SiO_4)_3(SO_4,S,Cl)$	approximately $(Na,Ca)_4(Al,SiO_4)_3(SO_4,S,Cl)$	$CoO*Al_2O_3$, $(Na,Ca)_4(Al,SiO_4)_3(SO_4,S,Cl)$ and TiO_2	Cr_2O_3*CoO, chromium and cobalt oxide
Color Index	PB27-77510/77520	PB29-77007	PV15-77007	PB28–77346 / PW6–77891 / PB29-77007	PB36-77343
CIE L*a*b* data	L 4.69 a 9.95 b -21.82	L 35.52 a 18.91 b -53.84	L 50.3 a 18.88 b -28.73	L 52.02 a 4.58 b -42.25	L 41.48 a -23.19 b -28.48
Tonality	Dark blue tending to purple	Deep blue pure, cold	Purple medium, tending to lilac	Medium blue, cold	Blue color with greenish undertones
Resistance to lime	Insufficient	Good	Good	Good	High
Resistance to moisture	Poor	Good	Good	Good	High
Resistance to light	High	High	Good	Good	High
Hiding power	Average	Good	Average	Good	High

Prussian Blue is a synthetic pigment very fine-graded, which makes it usable as a dye for leather, textiles, plastics, paper, etc. It can be used with oily or aqueous medium. Specifically suitable for watercolor technique and techniques on paper. Not suitable for fresco techniques, preparation of mortars, marbles and lime-based stucco.
Despite the presence of cyanides, Prussian Blue has a high toxicity, due to the strong bond of the Fe-CN. However, in an acidic environment, the influence of heat or UV radiation can give off strong fumes of hydrogen cyanide, highly toxic; therefore it is not recommended to use in exterior paints. Ultramarine Blue and Purple can be used in the field of fine arts in both aqueous and oily medium. In strong alkali (PH12-14) do not decompose, but they tend to turn gray in excess of lime or in contact with acids (even weak); are therefore inadvisable in fresco and in exterior environments. They can be used as a coloring agent in the preparation of stucco plaster, epoxy, etc.. Are altered in contact with pigments containing lead, for the formation of blacks sulphides. Cobalt Blue and Cerulean Blue pigments are synthetic imitation of historical pigments. They have high chemical-physical features that allow its use in any painting technique and environment. In particular, the Cobalt Blue 0558 can replace the Cobalt Blue in the production of ceramics in the cold, but does not resist the firing at 1000 °C . Can also be used as coloring agents in the preparation of mortars, marbles, fillers of various types. In the technique of oil painting, the pigments containing cobalt catalyze the drying oil.

CADMIUM RED AND YELLOW PIGMENTS

	CADMIUM YELLOW LIGHT 0550	CADMIUM YELLOW DEEP 0551	CADMIUM RED LIGHT 0554	CADMIUM RED MEDIUM 0553	CADMIUM RED DEEP 0555
Chemical composition	$CdS*ZnS+BaSO_4$	$CdS*ZnS+BaSO_4$	$CdS*CdSe+BaSO_4$	$CdS*CdSe+BaSO_4$	$CdS*CdSe+BaSO_4$
Color Index	PY35 - 77205 / PW21 - 77120	PY35 - 77205 / PW21 - 77120	PO20 - 77202 / PW21 - 77120	PR108 - 77202 / PW21 - 77120	PR108 - 77202 / PW21 - 77120
CIE L*a*b* data	L 85.61 a -11.23 b 75.37	L 77.49 a 9.24 b 95.19	L 48.89 a 57.98 b 46.95	L 41.9 a 55.14 b 37.47	L 34.49 a 43.1 b 23.49
Tonality	Very intense light yellow, with greenish undertones	Intense golden yellow, warm	Bright red, very intense	Medium red, intense	Medium deep red
Resistance to lime	Medium	Medium	Medium	Medium	Medium
Resistance to moisture	High	High	High	High	High
Resistance to light	High	High	High	High	High
Hiding power	High	High	High	High	High

Cadmium yellow and red are the variety of cadmium lithopone, cadmium sulfide and zinc, with the addition of barium sulphate.

The orange and red tones are obtained by increasing inclusion of selenium, which replaces the cadmium in the crystal structure, to give mixed compounds (sulphoselenide cadmium, CdS*CdSe). Given their high covering power, the very fine-graded and vibrancy of color, are ideal means for imparting a background color, in the case of stucco, marbles, etc. Cadmium pigments are unaffected by both strong acids and strong bases, but react with concentrated nitric acid (strong oxidant) developing red vapors and discoloring. When heated above 300 ° C, change their color, but they return to the original color on cooling. The interaction with pigments based on iron, copper, arsenic or lead can give rise to blacks sulfides, resulting in blackening. The exposure to the elements (air, moisture and ultraviolet rays) can cause bleaching for the formation of cadmium sulfate (CdSO4, colorless). The sulphoselenides are more resistant to weathering than the yellows, especially the darker tones.

GREEN PIGMENTS

	CHROME OXIDE GREEN 0559	EMERALD GREEN 0557
Chemical composition	anhydrous chromium sesquioxide (Cr_2O_3)	$CoO*Al_2O_3$, TiO_2 e Cr_2O_3, phthalocyanine blue and green
Color Index	PG17 - 77288	PB28 – 77346 / PW6 – 77891 / PG17 – 77288 / PB15 – 74160 / PG7 - 74260
CIE L*a*b* data	L 43.48 a -13.58 b 14.01	L 53.89 a -28.24 b 2.52
Tonality	Medium green, olive	Medium green, bright
Resistance to lime	High	Good
Resistance to moisture	High	High
Resistance to light	High	Good
Hiding power	High	Good

Chromium Oxide Green has a dull green color and is very opaque. It is a color very stable, in any condition and can therefore be used in any technique (fresco, oil, tempera, etc..) And environment.
The Emerald Green, as the Cerulean Blue, is an imitation of the historic color with the same nomenclature. It can be used in any pictorial technique, both in interior and exterior environments. Accelerates the drying of the oil for the presence of cobalt.

INORGANIC NATURAL PIGMENTS

In general, all the earths described below, as well as blacks and browns natural, can be used in any technique of painting (oil, tempera, fresco, encaustic, etc.) because it is extremely stable. For the same reason it can also be used as a coloring agent in the preparation of mortars, marbles, fillers of various types, even in the exterior.

YELLOW EARTHS

	Oxide Yellow 0325	Yellow Earth 0269	Yellow Ochre 0324	Ocker Dunkel 0276	Havana Ochre 0275
Chemical composition	α-FeO(OH)	α-FeO(OH), $CaCO_3$,$CaSO_4$	α-FeO(OH), $CaCO_3$,$CaSO_4$	α-FeO(OH), MnO_2,$CaCO_3$, $CaSO_4$	α-FeO(OH), MnO_2,$CaCO_3$, $CaSO_4$
Color Index	PY42 - 77492	PY42 - 77492	PY42 - 77492	PY42 – 77492 / PBr7 - 77491	PY42 – 77492 / PBr7 - 77491
CIE L*a*b* data	L 61 a 13.05 b 45.07	L 64.61 a 11.58 b 46.02	L 67.8 a 12.7 b 49.04	L 53.9 a 14.48 b 31.72	L 51.99 a 9.33 b 30.82
Tonality	Light yellow, golden	Light yellow, golden	Bright yellow, golden	Medium yellow, golden	Medium yellow, golden
Resistance to lime	High	High	High	High	High
Resistance to moisture	High	High	High	High	High
Resistance to light	High	High	High	High	High
Hiding power	Good	Good	Good	Good	Good

Yellow earths are the well known Ochre, natural compounds more or less impure, that can also contain organic compounds such as bitumen and humic substances. The color of the yellow earths is due to the presence of ferric hydroxide (α-FeO (OH)), known as goethite in mineralogy, clay minerals associated with between 15-20% and 60-70%; this variable composition makes possible the existence of numerous yellow ocher, more or less with golden hues. Unlike the Sienna raw, sometimes have a greenish tinge. By heating at around 300°C, is obtained iron sesquioxide colored orange-red (see red earth). Earths are insoluble in alkali and partially soluble in acid, releasing the clay as background body.

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RED EARTHS

	CAPUT MORTUM 0343	RED EARTH 0270	HERCULANEUM RED 0316	POZZUOLI RED 0318	VENETIAN RED 0315
Chemical composition	Mixture of iron oxides	Fe_2O_3	Fe_2O_3	Fe_2O_3	Fe_2O_3
Color Index	PR101 - 77491	PR101- 77491	PR101 - 77491	PR101- 77491	PR101- 77491
CIE L*a*b* data	L 26.47 a 9.02 b 7.07	L 33.99 a 21.52 b 24.24	L 41.46 a 36.4 b 36.32	L 41.72 a 31.66 b 33.15	L 36.04 a 20.81 b 22.65
Tonality	Dark red-orange, warm	Medium Red-Orange, opaque	Medium Red-Orange, warm	Medium Red-Orange, warm	Medium Red-Orange, opaque
Resistance to lime	High	High	High	High	High
Resistance to moisture	High	High	High	High	High
Resistance to light	High	High	High	High	High
Hiding power	High	High	High	High	High

The red earths are often found in volcanic regions, produced by heating of earths containing iron hydroxides. The color of red earth (red ocher) is essentially due to the presence of sesquioxide of iron (III) (Fe2O3), normally associated with minerals of the group of the clay and partly amorphous silicate compounds. In this sesquioxide mineralogy is identified as hematite

GREEN EARTHS

	GREEN EARTH 0264	NICOSIA GREEN EARTH0282
Chemical composition	Ferrous and ferric silicates of potassium, manganese and aluminum	Ferrous and ferric silicates of potassium, manganese and aluminum
Color Index	PG23 - 77009	PG23 - 77009
CIE L*a*b* data	L 58.03 a -9.83 b 13.05	L 61.63 a -13.21 b 2.23
Tonality	Medium green, opaque and olive	Medium green, opaque bluish
Resistance to lime	Good	Good
Resistance to moisture	Good	Good
Resistance to light	Good	Good
Hiding power	Medium	Medium

The green earths vary greatly depending on the genesis and origin. The mineralogical species that determine the color of these earths are mainly of hydrated silicates of iron (II), magnesium and alkali. Contain silica acid. The mineral glauconite ((K, Na) (Fe (III), Al, Mg) 2 (Si, Al) 4O10 (OH) 2), for example, is the main colorant factor of the green earths Nice and Nicosia, with hues slightly more bluish than the classic green earths, which owe their color to iron and magnesium silicates (mainly celadonite, K (Mg, Fe (II)) (Fe (III), Al) [Si4O10] (OH) 2) generally present in products derived from alteration of volcanic rocks (green earths of Brentonico and Verona), with shades olive scales.

SIENNA EARTHS

	RAW SIENNA 0263	BURNT SIENNA 0262
Chemical composition	α-FeO(OH), Al_2O_3·MnO_2, SiO_2·H_2O	Fe_2O_3, Al_2O_3·MnO_2, SiO_2
Color Index	PY42 - 77492	PBr7 - 77491
CIE L*a*b* data	L 51.74 a 13.68 b 37.39	L 38.6 a 23.55 b 31.71
Tonality	Deep yellow, golden	Golden brown, opaque
Resistance to lime	High	High
Resistance to moisture	Good	Good
Resistance to light	High	High
Hiding power	Good	Good

Sienna earths are special kinds of ochre, containing up to 50-60% of goethite (α-FeO (OH)) or hematite (Fe2O3) and up to 1% of a dark mineral consisting of manganese dioxide (MnO2) , called pyrolusite. There is also silica acid (SiO2 * H2O). The chemical and physical characteristics are similar to the yellow and red ochre. The drying oil is accelerated by the presence of manganese. This feature, together with the high oil absorption, means that films tend to be fragile and their use in oil is therefore limited.

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RAW UMBER

	RAW UMBER 0266	BURNT UMBER 0261	CYPRUS RAW UMBER 0274	CYPRUS BURNT UMBER 0272
Chemical composition	$Fe(OH)_3 + Al_2O_3 + SiO_2*2H_2O + MnO_2$ + clays and impurities	$Fe(OH)_3 + Al_2O_3 + SiO_2*2H_2O + MnO_2$ + clays and impurities	$Fe(OH)_3 + Al_2O_3 + SiO_2*2H_2O + MnO_2$ + clays and impurities	$Fe(OH)_3 + Al_2O_3 + SiO_2*2H_2O + MnO_2$ + clays and impurities
Color Index	PBr7 - 77491	PBr7 - 77491	PBr7 - 77491	PBr7 - 77491
CIE L*a*b* data	L 35.13 a 4.21 b 14.01	L 39.21 a 13.84 b 23.11	L 32.64 a 9 b 24.07	L 21.95 a 7.21 b 13.05
Tonality	Matt brown, olive	Matt brown, golden	Yellowish brown, opaque	Dark brown, opaque
Resistance to lime	Good	High	Good	High
Resistance to moisture	Good	High	Good	High
Resistance to light	High	High	High	High
Hiding power	Good	Good	Good	Good

The umber raw have a high content of manganese dioxide and, if calcined, give reddish hues (burnt umber), with chemical and physical properties similar to natural earths.
The color is mainly due to the presence of oxides of manganese and iron (III), finely dispersed within a clay matrix. In oil techniques is better to know that the presence of manganese promotes oil drying and the film will be fragile.

NATURAL BROWNS AND BLACKS

	CASSEL BROWN 0260	ROME BLACK 0268	VINE BLACK 0321	IVORY BLACK 0597	LAMP BLACK 0341
Chemical composition	Mixed oxides of iron and manganese $Fe(OH)_3*Mn$	Mixture of carbonates of calcium, manganese and iron	Mixture of natural carbon and oxides	Ash of animal bones and phosphates	Amorphous carbon up to 99%
Color Index	PBr7 - 77491	-	PBk8 - 77268	PBk9 - 77269	PBk6 - 77266
CIE L*a*b* data	L 22.88 a 3.49 b 5.79	L 27 a 1.14 b 4.69	L 18.89 a 0.69 b 2.55	L 12.56 a 0.54 b 2.45	L 9.98 a -0.45 b -0.49
Tonality	Deep brown, neutral	Brownish black, neutral	Neutral black	Deep black neutral	Deep black, cold
Resistance to lime	Good	High	High	High	Good
Resistance to moisture	Good	Good	Good	High	High
Resistance to light	High	High	High	High	Good
Hiding power	Good	Good	Good	Good	Good

The browns and blacks are natural pigments derived from the carbonization of materials such as animal bones, ivory, vine branches, or lignite and natural bituminous substances. They have a predominantly amorphous structure and contain impurities which vary according to the material from which they are produced. The impurities also determine the various properties such as transparency, compatibility with oily medium and the hue. Pigments containing manganese, are more opaque and facilitate oil drying.

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ORGANIC MINERALS

	CINNABAR RED 0604	LAKE RED LIGHT 0307	LAKE RED DEEP 0308	HERCULANEUM BLUE 0303	LIME GREEN 0286
Chemical composition	organic colorant (naftholo) fixed on mineral base	organic colorant (naftholo) fixed on mineral base	organic colorants (naftols) fixed on mineral base	organic colorant (blue phthalocyanine) fixed on mineral base	organic colorants (monoazo and phthalocyanine green) fixed on mineral base
Color Index	PR170 - 12475	PR112 - 12370	PR112 – 12370 / PR12 - 12385	PB15 - 74160	PY74 – 11741 / PG7 - 74260
CIE L*a*b* data	L 42.94 a 55.42 b 26.94	L 49.72 a 56.05 b 30.97	L 43.25 a 47.46 b 13.05	L 53.16 a -20.66 b -31.74	L 56.2 a - 41.98 b 24.23
Tonality	Medium intense red	Medium red, bright	Deep intense red	Medium intense blue, with greenish undertones	Brilliant light green
Resistance to lime	Good	Poor	Poor	Poor	Poor
Resistance to moisture	Good	Good	Good	Good	Good
Resistance to light	Medium	Medium	Medium	Good	Medium
Hiding power	Good	Good	Good	Good	Good

The category of organic minerals determines a boundary line between the pigment in the strict sense (inorganic mineral) and organic coloring. These compounds are obtained by a dry dispersion of the organic colorant on a inorganic base. The inorganic base on which the colorant is dispersed is mainly composed of carbonates and sulfates of calcium, with the addition of wetting agents and anionic dispersants, to increase the contact surface between the organic molecules and the inorganic support.
This treatment makes insoluble the organic colorant and gives a higher opacity. The organic compounds present in the CTS pure artists' pigments belong to three families: naphthols, phthalocyanines and monoazo. They can be used in all pictorial techniques both aqueous (tempera, acrylic, vinyl, etc..) and oil-based. They are not recommended in the fresco techniques and exterior environments, with the exception of Red Cinnabar.

The information contained in this sheet is based on our knowledge and laboratory tests at the date of the last version. Users must verify the suitability of the product in relation to the specific use by preliminary tests, and is obliged to observe the laws and regulations in force regarding hygiene and safety.
C.T.S. S.r.l. ensures the consistent quality of the product but is not liable for any damage caused by improper use of the material, since it is designed for professional use. Moreover, they can change at any time components and packaging without prior notice at any time.