

Chemistry Investigatory Project



Preparation of Paint Pigments

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EDUCATION

Certificate

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Certified that Master.....

of Grade Section has carried out project work in
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Internal Examiner

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Acknowledgement

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Furthermore, I would like to thank Rushil Nagarsheth, for providing me the necessary details and helping me in carrying out the experiment.

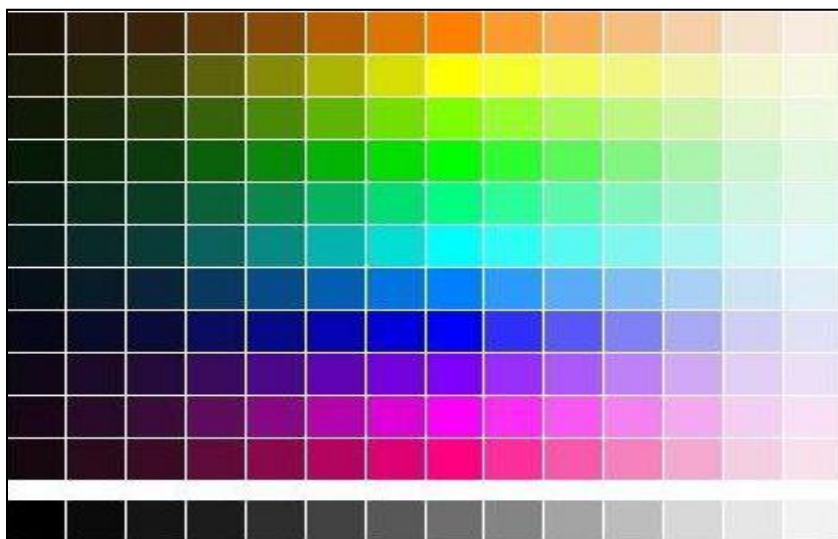
Thank You,

Taksh Anand

XII – A (2016-2017)

Abstract

This topic was chosen because of the fascination and the science behind the working of a pigment, and how the colour of each pigment is different and has different shades of the same colour.



We wanted to know how to prepare paint pigments using various chemicals and also record the efficiency in producing them.



What Are Pigments?

A pigment is a material that changes the colour of reflected or transmitted light as the result of wavelength-selective absorption. This physical process differs from fluorescence, phosphorescence, and other forms of luminescence, in which a material emits light.



Many materials selectively absorb certain wavelengths of light. Materials that humans have chosen and developed for use as pigments usually have special properties that make them ideal for colouring other materials. A pigment must have a high tinting strength relative to the materials it colours. It must be stable in solid form at ambient temperatures.

For industrial applications, as well as in the arts, permanence and stability are desirable properties. Pigments that are not permanent are called fugitive. Fugitive pigments fade over time, or with exposure to light, while some eventually blacken.

Pigments are used for colouring paint, ink, plastic, fabric, cosmetics, food and other materials. Most pigments used in manufacturing and the visual arts are dry colorants, usually ground into a fine powder. This powder is added to a binder (or vehicle), a relatively neutral or colourless material that suspends the pigment and gives the paint its adhesion.



A distinction is usually made between a pigment, which is insoluble in its vehicle (resulting in a suspension), and a dye, which either is itself a liquid or is soluble in its vehicle (resulting in a solution). A colorant can act as either a pigment or a dye depending on the vehicle involved. In some cases, a pigment can be manufactured from a dye by precipitating a soluble dye with a metallic salt. The resulting pigment is called a lake pigment. The term biological pigment is used for all coloured substances independent of their solubility.

Pigments appear the colours they are because they selectively reflect and absorb certain wavelengths of visible light. White light is a roughly equal mixture of the entire spectrum of visible light with a wavelength in a range from about 375 or 400 nanometres to about 760 or 780 nm.

When this light encounters a pigment, parts of the spectrum are absorbed by the molecules or ions of the pigment. In organic pigments such as diazo or phthalocyanine compounds the light is absorbed by the conjugated systems of double bonds in the molecule. Some of the inorganic pigments such as vermilion (mercury sulphide) or Cadmium yellow (cadmium Sulphide) absorb light by transferring an electron from the negative ion (S^{2-}) to the positive ion (Hg^{2+} or Cd^{2+}). Such compounds are designated as charge-transfer complexes, with broad absorption bands that subtract most of the colours of the incident white light. The other wavelengths or parts of the spectrum are reflected or scattered. The new reflected light spectrum creates the appearance of a colour. Pigments can only subtract wavelengths from the source light, never add new ones.

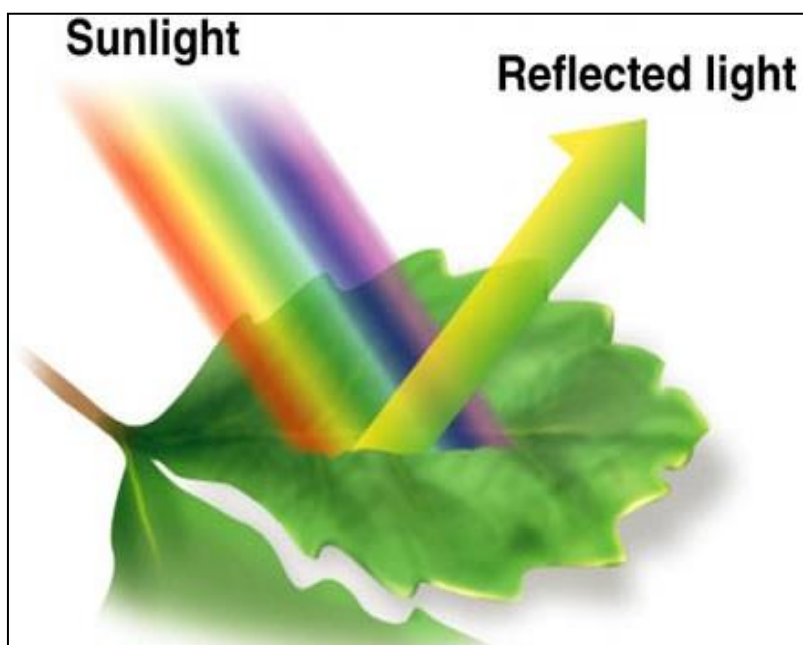


The appearance of pigments is intimately connected to the colour of the source light. Sunlight has a high colour temperature, and a fairly uniform spectrum, and is considered a standard for white light. Artificial light sources tend to have great peaks in some parts of their spectrum, and deep valleys in others. Viewed under these conditions, pigments will appear different colours.

Colour spaces used to represent colours numerically must specify their light source. Lab colour measurements, unless otherwise noted, assume that the measurement was taken under a D65 light source, or "Daylight 6500 K", which is roughly the colour temperature of sunlight.

Other properties of a colour, such as its saturation or lightness, may be determined by the other substances that accompany pigments. Binders and fillers added to pure pigment chemicals also have their own reflection and absorption patterns, which can affect the final spectrum. Likewise, in pigment mixtures, individual rays of light may not encounter pigment molecules, and may be reflected as is. These stray rays of source light contribute to a slightly less saturated colour. Pure pigment allows very little white light to escape, producing a highly saturated colour. A small quantity of pigment mixed with a lot of white binder, however, will appear desaturated and pale, due to the high quantity of escaping white light.

Selection of a pigment for a particular application is determined by cost, and by the physical properties and attributes of the pigment itself. For example, a pigment that is used to colour glass must have very high heat stability in order to survive the manufacturing process; but, suspended in the glass vehicle, its resistance to alkali or acidic materials is not an issue. In artistic paint, heat stability is less important, while light fastness and toxicity are of great concerns.



In biology, a pigment is any coloured material of plant or animal cells. Many biological structures, such as skin, eyes, fur, and hair contain pigments (such as melanin). Animal skin coloration often comes about through specialized cells called chromatophores, which animals such as the octopus and chameleon can control to vary the animal's colour.

Many conditions affect the levels or nature of pigments in plant, animal, some protista, or fungus cells. For instance, the disorder called albinism affects the level of melanin production in animals.

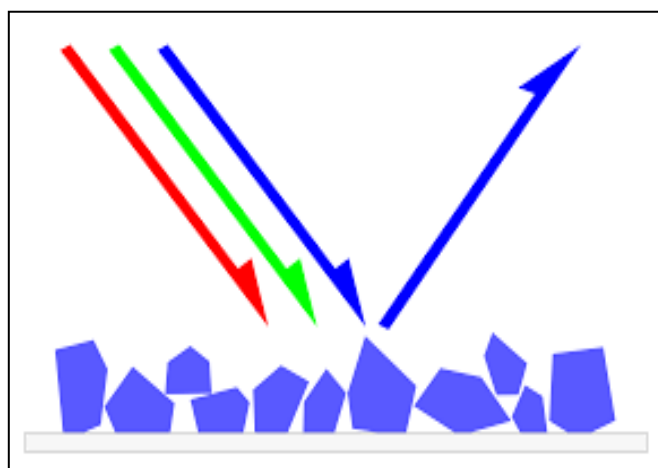
Pigmentation in organisms serves many biological purposes, including camouflage, mimicry, aposematism (warning), sexual selection and other forms of signalling, photosynthesis (in plants), as well as basic physical purposes such as protection from sunburn.

Pigment colour differs from structural colour in that pigment colour is the same for all viewing angles, whereas structural colour is the result of selective reflection or iridescence, usually because of multilayer structures. For example, butterfly wings typically contain structural colour, although many butterflies have cells that contain pigment as well



Principle

The principle behind the working of pigments is related with how different substances have the ability to selectively absorb and reflect different light rays corresponding to their different wavelengths in the visible spectrum. Pigments appear the colours they are because they selectively reflect and absorb certain wavelengths of visible light. White Light is a mixture of all light rays of wavelength 400 nm – 700 nm.



When this light encounters a pigment, parts of the spectrum are absorbed by the different components of the pigment. Some other wavelengths or parts of the spectrum are reflected and scattered. The new reflected light spectrum creates the appearance of a colour. When this reflected light comes in contact with a Human Eye, the Brain perceives the light as the colour corresponding to its Wavelength.

Pigments, unlike fluorescent substances can only subtract wavelengths from the source light, and can never add new ones.

Aim of Experiment

To prepare paint pigments using various chemicals and reagents.



Prussian Blue

Chrome Yellow



White

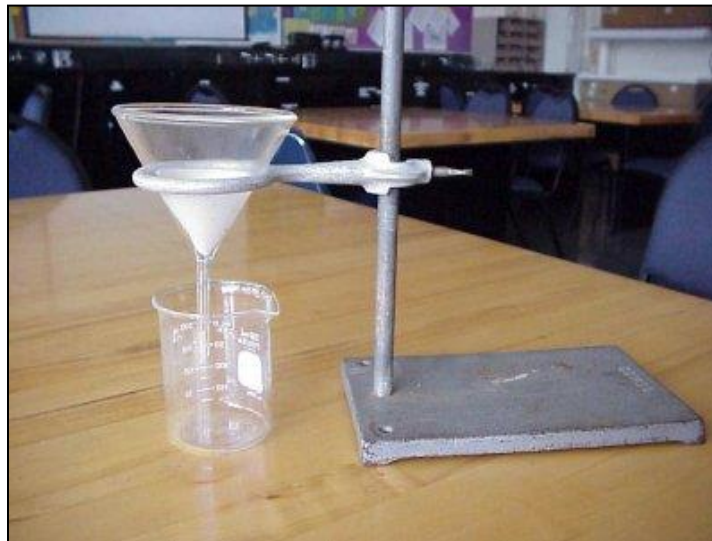
Malachite



Requirements

Apparatus Required:

1. Filter Paper
2. 250 MI Beaker
3. Conical Flask
4. Funnels
5. Distilled Water
6. Electronic Weighing Scale
7. Spatula
8. China Dish



Chemicals Required:

Experiment 1 : Prussian Blue

Ferric Chloride and Potassium Ferrocyanide

Experiment 2 : Chrome Yellow

Potassium Chromate and Lead Nitrate

Experiment 3 : White

Sodium Chloride and Lead Nitrate

Experiment 4 : Malachite

Copper Sulphate and Sodium Carbonate

Procedure

Experiment 1 : Preparation of Prussian Blue

- 1. Make a solution of hydrated iron (III) chloride by dissolving 5 grams of the salt in 50 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the water.**
- 2. Make a solution of potassium ferrocyanide by dissolving 10 grams of the salt in 75 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the water.**
- 3. Add iron chloride solution, slowly, into potassium ferrocyanide solution while stirring briskly.**
- 4. Leave the dark blue (prussian blue) mixture, so formed, undisturbed for 15 minutes.**
- 5. Prepare a gravity filter by setting a folded filter paper in the form of a cone, which is stuck to the inner edge of a funnel, which is then set on a conical flask**
- 6. Pour the mixture, slowly, over the gravity filter, and allow the powder to precipitate.**
- 7. Once the filter paper is dried up, carefully remove the filter paper and pour the powder in a china dish.**
- 8. Scrape the excess powder that is stuck on the filter paper, by using a spatula.**
- 9. The powder obtained, is the paint pigment of the shade prussian blue.**
- 10. Weigh the powder formed on an electronic weighing scale, and calculate the efficiency of formation.**



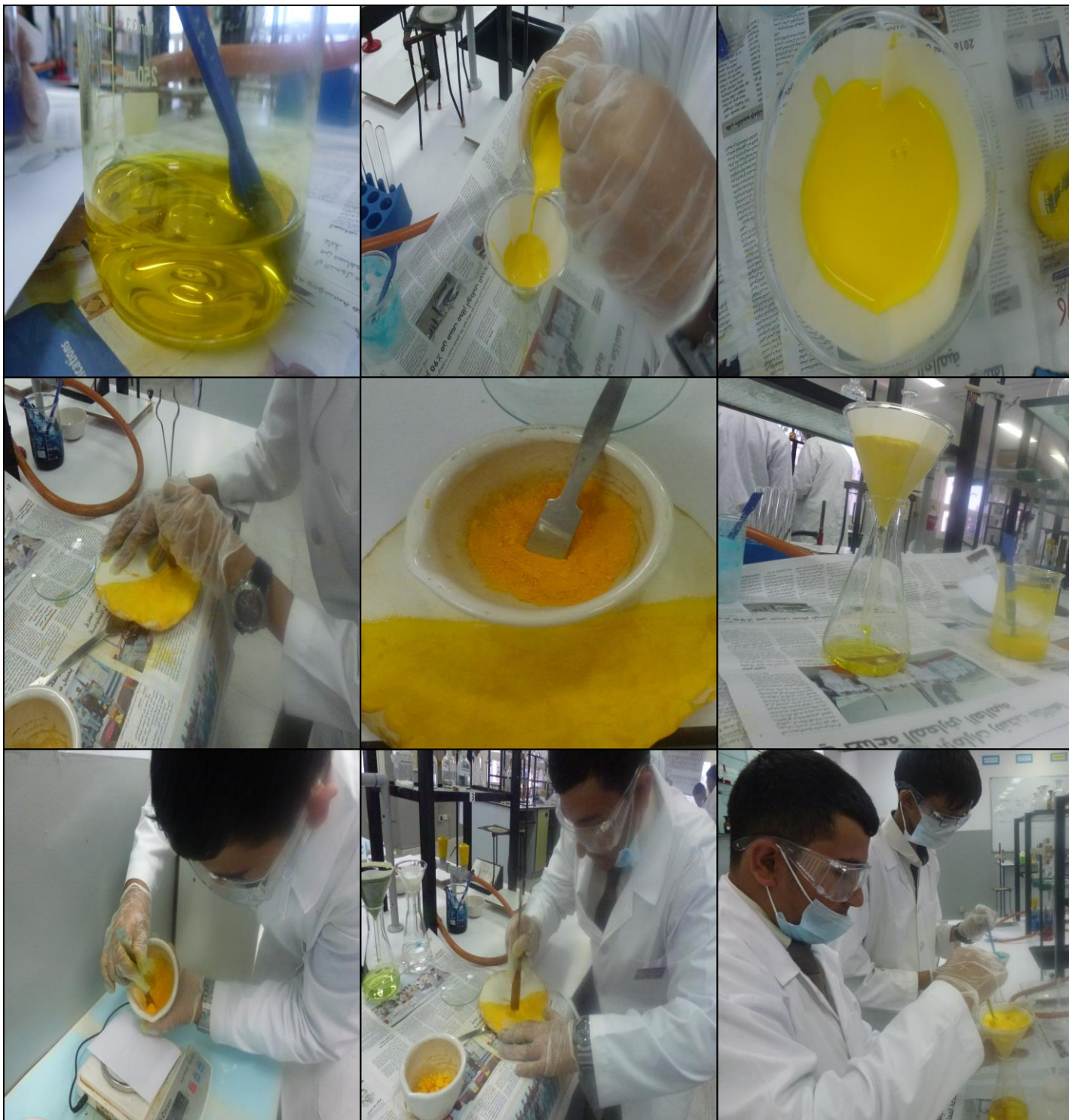
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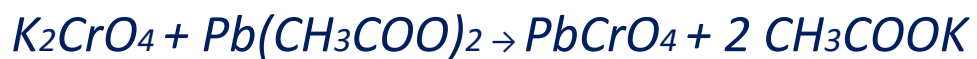
SAMPLE OF PRUSSIAN BLUE

Experiment 2 : Preparation of Chrome Yellow

- 1. Make a solution of potassium chromate by dissolving 7 grams of the salt in 50 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the water.**
- 2. Make a solution of lead nitrate by dissolving 10 grams of the salt in 100 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the water.**
- 3. Add potassium chromate solution, slowly, into lead nitrate solution while stirring briskly.**
- 4. Leave the yellow (chrome yellow) mixture, so formed, undisturbed for 15 minutes.**
- 5. Prepare a gravity filter by setting a folded filter paper in the form of a cone, which is stuck to the inner edge of a funnel, which is then set on a conical flask**
- 6. Pour the mixture, slowly, over the gravity filter, and allow the powder to precipitate.**
- 7. Once the filter paper is dried up, carefully remove the filter paper and pour the powder in a china dish.**
- 8. Scrape the excess powder that is stuck on the filter paper, by using a spatula.**
- 9. The powder obtained, is the paint pigment of the shade chrome yellow.**
- 10. Weigh the powder formed on an electronic weighing scale, and calculate the efficiency of formation.**



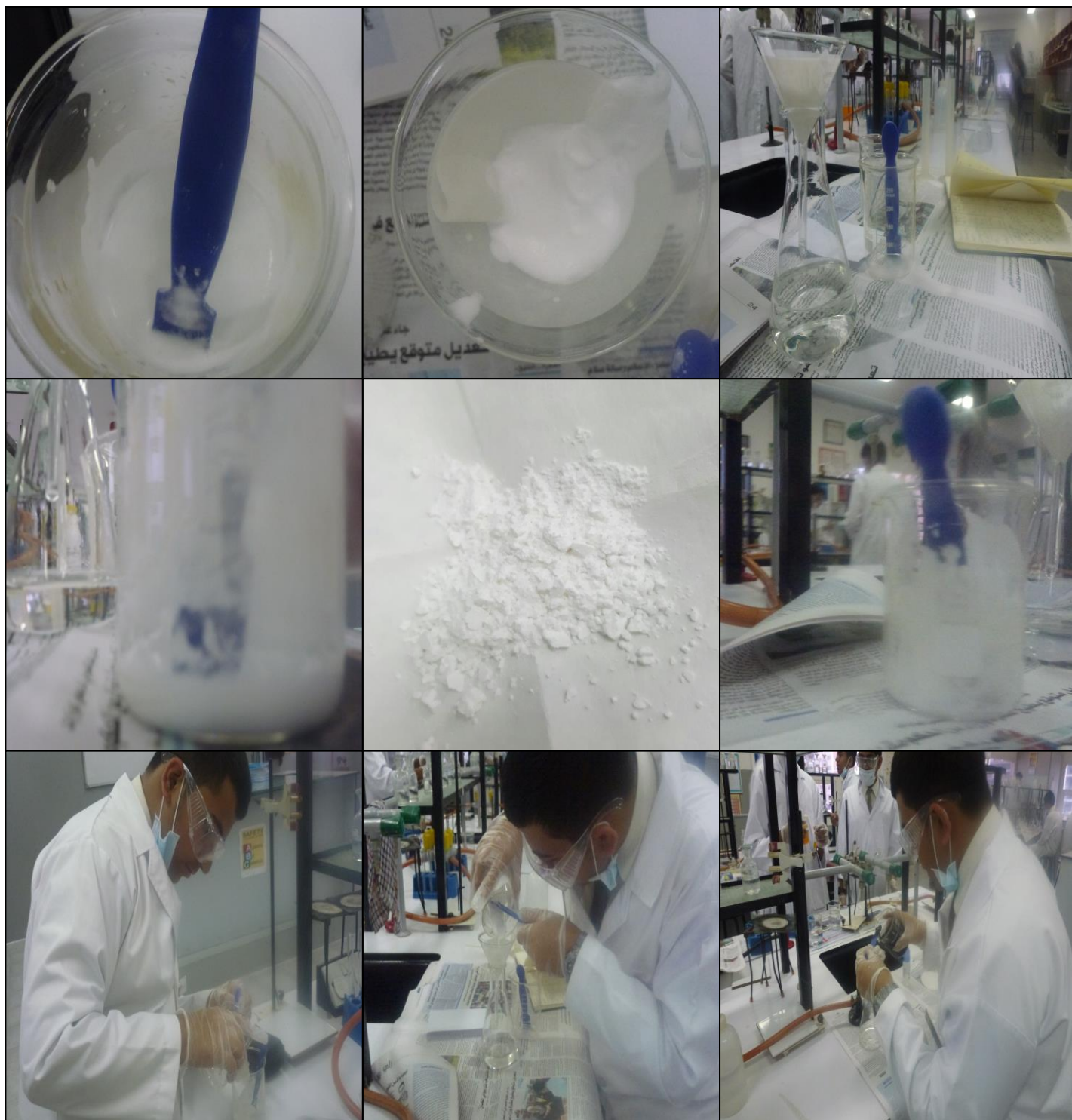
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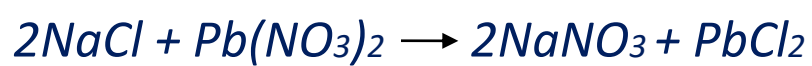
SAMPLE OF CHROME YELLOW

Experiment 3 : Preparation of White

- 1. Make a solution of sodium chloride by dissolving 2.5 grams of the salt in 10 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the Water.**
- 2. Make a solution of lead nitrate by dissolving 6 grams of the salt in 10 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the water.**
- 3. Add sodium chloride solution, slowly, into lead nitrate solution while stirring briskly.**
- 4. Leave the white mixture, so formed, undisturbed for 15 minutes.**
- 5. Prepare a gravity filter by setting a folded filter paper in the form of a cone, which is stuck to the inner edge of a funnel, which is then set on a conical flask**
- 6. Pour the mixture, slowly, over the gravity filter, and allow the powder to precipitate.**
- 7. Once the filter paper is dried up, carefully remove the filter paper and pour the powder in a china dish.**
- 8. Scrape the excess powder that is stuck on the filter paper, by using a spatula.**
- 9. The powder obtained, is the paint pigment of the shade white.**
- 10. Weigh the powder formed on an electronic weighing scale, and calculate the efficiency of formation.**



Reaction Involved:



SAMPLE OF WHITE

Experiment 4 : Preparation of Malachite

- 1. Make a solution of sodium carbonate by dissolving 5.8 grams of the salt in 55 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the water.**
- 2. Make a solution of copper sulphate by dissolving 12.5 grams of the salt in 50 mL of water. Stir the solution briskly, using a spatula, until the salt particles are properly dissolved in the water.**
- 3. Add sodium carbonate solution, slowly, into copper sulphate solution while stirring briskly.**
- 4. Leave the greenish (malachite) mixture, so formed, undisturbed for 15 minutes.**
- 5. Prepare a gravity filter by setting a folded filter paper in the form of a cone, which is stuck to the inner edge of a funnel, which is then set on a conical flask**
- 6. Pour the mixture, slowly, over the gravity filter, and allow the powder to precipitate.**
- 7. Once the filter paper is dried up, carefully remove the filter paper and pour the powder in a china dish.**
- 8. Scrape the excess powder that is stuck on the filter paper, by using a spatula.**
- 9. The powder obtained, is the paint pigment of the Shade malachite.**
- 10. Weigh the Powder Formed on an Electronic Weighing Scale, and calculate the efficiency of formation.**



Reaction Involved:



SAMPLE OF MALACHITE

Results

Experiment 1: Prussian Blue

Amount of Reactants = ____ g

Amount of Pigment formed = ____ g

Efficiency = ____ %



Experiment 2: Chrome Yellow

Amount of Reactants = ____ g

Amount of Pigment formed = ____ g

Efficiency = ____ %

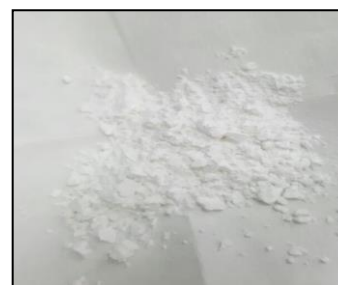


Experiment 3: White

Amount of Reactants = ____ g

Amount of Pigment formed = ____ g

Efficiency = ____ %



Experiment 4: Malachite

Amount of Reactants = ____ g

Amount of Pigment formed = ____ g

Efficiency = ____ %



Precautions



- 1. All apparatuses used for the experiment should be properly cleaned before use so as to prevent any unnecessary addition of impurities.**
- 2. All chemicals used should be accurately measured. If more or less than the required amount is used, then the pigment may not be formed efficiently.**
- 3. Make sure the right chemicals are used else an unwanted reaction may take place, which may thus lead to incorrect results.**
- 4. Filtration of the pigment should be done carefully so as to get maximum amount of pigment.**

Future Scope

- 1. There is tremendous scope for paint pigments in the future.*
- 2. Increasing experimental methods and newer technologies in preparation of pigments has increased the quality and quantity of pigments obtained.*
- 3. Scientists are trying to increase the efficiency of the various paint pigments by newer experimental methods.*
- 4. New shades of colours have been developed in laboratories.*
- 5. Industries have increased their production of pigments and dyes through scientific technology.*
- 6. Pigments are now being used more widely.*
- 7. Natural pigments / non – toxic pigments are being synthesized to avoid any health hazards due to the dangerous chemicals contained in them.*

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