

## Grade 9 Natural Sciences Worksheet

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### Pigments

Ndebele art is world famous for its bright colours and detailed patterns. The women paint the outside walls of their houses in this way. Zulu women make ordinary objects into works of art with beautiful beading. What is similar about these two traditional decorative displays? The fact that colour is important is central to Ndebele and Zulu artwork. The patterns on the wall and the beaded objects would not mean as much if different colours were not used. All coloured objects, including the paints and dyes that make walls and beaded objects so attractive, contain different **pigments**. These pigments are responsible for colouring things in our world. Pigments are also responsible for the colouration of living organisms.

#### Part One: Write an explanatory paragraph

What is a pigment? How do we see different colours?

Answer these questions in an explanatory paragraph.

[10 marks]

#### Part Two: The importance of chlorophyll

It could be argued that the most important pigment on earth is chlorophyll. What is chlorophyll and why is it so important?

Write a paragraph explaining your answer. Use evidence to justify any claims you make.

[12 marks]

#### Part Three: Practical investigation

Practical investigation into pigments in your koki pens (felt tipped markers).

You will need:

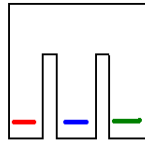
- Some water soluble (non-permanent) felt tipped pens (kokis)
- A beaker of water
- Some filter paper

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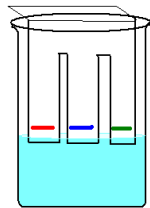
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You are going to find out more about the pigments making up the inks in your coloured pens.

Take a square piece of filter paper which is wider than the top of your beaker. Cut it into the following shape:



Take 3 different felt-tipped pens and make a thick stripe close to the bottom of each of the 'arms' on your filter paper. While the colours are drying, put some water in your beaker and bend the filter. Hang it in the beaker so that just the bottoms of the 'arms' are in the water. Do not let the ink stripe touch the water. Watch what happens over the next few minutes.



Write your observations in your workbook.

Find out what this process is called.

[15 marks]

### Part Four: Chromatography exercise

In this activity, you are going to perform another chromatography exercise. This time you are going to separate the pigments making up chlorophyll. You are also going to set up your experiment as a scientific investigation. Copy the investigation sheet into your book, completing it as you perform the experiment.

#### *Investigation sheet*

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### **Research question:**

Is chlorophyll one pigment or are there a few pigments making up the green we see?

### **Hypothesis:**

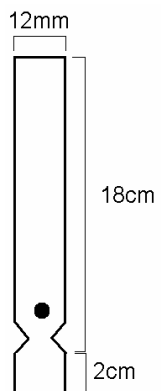
Fill in a statement which you think could be an answer to the research question. You are going to test your statement.

### **Apparatus:**

Read through the METHOD below and identify the apparatus you will need. Write it in here.

### **Method:**

Trim the filter paper provided so that it has the dimensions of the paper in the diagram shown here.



1. Using the pestle, grind the leaves in a mortar with about 50 ml ethyl alcohol. Allow the solution to stand a while, then grind further. A dark green liquid should result.
2. Place a dot of the green extract in the place indicated by the dot in the diagram. Wave the paper to dry the dot. Reapply green liquid a few times to ensure that you have a concentrated sample. Make sure the dot is completely dry.
3. Pour 5 ml alcohol into a test tube.
4. Hang the filter paper carefully so that only the section below the notch is in the alcohol. Do not let the dot touch the alcohol. Secure the filter paper with a peg and place in a test tube rack.
5. Leave for 5 – 10 minutes. Remove the filter paper. Carefully discard the alcohol and clean up your apparatus and work area while the filter paper dries.

### **Results:**

Write in what you observe. It should be a full description. You could draw a diagram.

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**Conclusion:**

*Did you prove your hypothesis and answer the research question? What do your results tell you?*

[20 marks]

**Part Five: Research how humans use pigments**

Research at least four ways in which humans use pigments in their lives. Write up your findings in a detailed paragraph.

[12 marks]

**Part Six: Animals with colouration**

You and your partner must look at the list of animals which have some form of colouration. You will decide the reason why the animal has this colouration.

Spots on leopards.

Red and black ladybird beetles.

Yellow and black striped flies.

Emperor moths with 'eyes' on their wings.

Coloured feathers of the peacock.

Humans – white and black ethnic colouration.

Write a short paragraph entitled 'Reasons why animals are pigmented'. Your paragraph must argue for your reasoning. You need to convince the reader that your points are valid.

[21 marks]

[Total: 90 marks]

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### Suggested Solutions

Question number	Possible marks	Solution
1	10	Pigments are substances that absorb ✓ certain colours and reflect others. ✓ You can see the colour of a certain object because the pigment reflects ✓ the light of that particular colour only. ✓ If an object appears blue, ✓ it is because the pigment in the object absorbs red and yellow and green and all the other colours, but reflects blue. ✓ So we see the object as blue. The pigment is the dye in the object. ✓ It is a chemical substance ✓ that has the special characteristic of reflecting and absorbing different colours. ✓ Pigments are a form of matter. ✓
2	12	Chlorophyll is the green pigment ✓ found in green plants ✓ and some algae. ✓ The chlorophyll is packed into special organelles in the plant cells. These organelles are called chloroplasts. ✓ Chlorophyll is very important because it is the pigment that absorbs the light ✓ that starts the reactions making up photosynthesis. ✓ Photosynthesis means 'making with light'. The plant makes food using sunlight. ✓ But how does the plant absorb the sunlight? The pigment chlorophyll absorbs the right part of the sunlight to start the photosynthetic reactions. ✓ Not only is chlorophyll important to plants because it makes food for the plant, ✓ it is also important to animals. ✓ Animals eat plants ✓ or other animals that originally ate plants. ✓ So even spiders, that eat other insects, rely on chlorophyll in plants!
3	10 + 5 marks for learners' practical skills and manipulating materials and apparatus = 15	Almost immediately, you should observe the water being absorbed by the filter paper. ✓ The water travels up the filter paper ✓ and touches the coloured stripes. ✓ As it does so, the pigments in the stripes start to 'separate out'. ✓ You find that different colours start moving up the filter paper with the water. ✓ You should discover some interesting things about the different colours. What looks like green ink, for example, is actually a mixture of blues and yellows. ✓ The particles of matter making up the different dyes are different sizes. ✓ They move different distances along the filter paper, depending on their size. ✓ This process of separating pigments is called <b>chromatography</b> . ✓✓
4	15 + 5 marks for learners practical skills and manipulating materials and	RESEARCH QUESTION: Is chlorophyll one pigment or are there a few pigments making up the green we see? ✓✓ HYPOTHESIS: <i>Either</i> : Many pigments make up what we see as chlorophyll <i>or</i> : Chlorophyll is one pigment. ✓✓ APPARATUS: Filter paper, leaves (dark green spinach leaves work well), mortar and pestle, ethyl alcohol, dropper, test tube, peg, test tube rack. ✓✓✓✓ METHOD:

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	apparatus = 20	<p>RESULTS: The green dot splits up into different pigments which travel up the filter paper. ✓✓ Depending on the leaf used, green, yellow and orange pigments emerge. ✓✓</p> <p>CONCLUSION: Your results should indicate that what we see as chlorophyll is actually a number of pigments. ✓✓ Depending on what you stated for your hypothesis, you would have either proved it or disproved it. ✓ Remember that it doesn't matter if your hypothesis was proved incorrect. You have simply shown what is NOT the case! You have still done science!</p>
5	12	<p>Pigments are found in animals and plants, as well as in minerals. Since earliest times, humans have developed ways of extracting the various different pigments. The pigments are then used to colour fabrics, ✓ clay ✓ and other objects, make paints for artwork ✓ and even colour and dye the human body! ✓</p> <p>Until the mid-19th century all dyes were made from natural materials, ✓ mainly vegetable and animal matter. Ancient dyes include madder, a red dye made from the roots of the Ruba plant, ✓ blue indigo from leaves of the Indigo plant, ✓ and yellow from the stigmas of the saffron plant. A bright red called cochineal was obtained from an insect from Mexico. ✓ A beautiful purple called Tyrian purple was obtained from a snail-like creature found near the island of Tyre. ✓ Natural dyes are used today mainly in handicrafts. ✓ Some craft spinners, weavers, and knitters use natural dyes as a particular feature of their work.</p> <p>Mineral ores and oxides have also been used from ancient times to make dyes such as red ochre, cobalt blue, manganese purple, antimony yellow and chromium green. Xhosa women used to dye their clothes with red ochre. Ancient humans also used pigments and dyes to colour their bodies. ✓</p> <p>We still do this today! The cosmetics industry makes use of pigments to colour our faces and bodies. This is done to beautify and enhance the face and body. ✓</p>
6	21	<p>Animals are pigmented for the following reasons:</p> <ul style="list-style-type: none"> <li>• Camouflage: to hide their presence from other animals, the animal is coloured to blend in with its surroundings to make it difficult to see – spots on leopards. ✓✓✓</li> <li>• Poisonous or taste bad: Very often red, yellow and black combinations advertise to a predator that the animal is poisonous or tastes bad; applies predominantly to insects – red and black ladybird beetles. ✓✓✓</li> <li>• Mimicry: Sometimes insects that are not dangerous or poisonous copy or mimic the colouration of dangerous insects so that predators will be fooled and leave them alone – yellow and black striped flies. ✓✓✓</li> </ul>

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		<ul style="list-style-type: none"><li>• Frighten predators: Sometimes colouration will be used to make an animal look bigger than it is to frighten away predators – emperor moths with ‘eyes’ on their wings. ✓✓✓</li><li>• Mating: Colour plays an important role in attraction of mates – coloured feathers of the peacock. ✓✓✓</li><li>• Protection from the sun’s rays: Dark pigmentation in humans protects them from UV radiation from the sun – humans – white and black ethnic colouration. ✓✓✓</li></ul> <p>Plus 3 marks for argument and convincing the reader.</p>
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