EVALUATING ACADEMIC READINESS FOR APPRENTICESHIP TRAINING

Revised for

ACCESS TO APPRENTICESHIP

SCIENCE SKILLS LIGHT

AN ACADEMIC SKILLS MANUAL for The Hairstylist Trade

Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities

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In preparing these Academic Skills Manuals we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

SCIENCE SKILLS
LIGHT

An academic skill required for the study of the Hairstylist Trade

INTRODUCTION

One of the services a hairstylist provides is to lighten and colour a client's hair. To achieve the desired colour, you will have to analyse your client's needs and choose the right hair colour procedure. It will be helpful if you know how natural pigments colour the hair and how the eye sees colour. All colour perception comes from the light that is reflected to our eyes from an object such as hair. The colour we see depends on the nature of that light.

In this skills manual, we will look at light and colour theory, including the following:

- Basic properties of light
- How the eye sees colour
- Colour theory

BASIC PROPERTIES OF LIGHT

Definition of Light

Light is a form of energy. Light is the form of energy which we can see. Our eyes are intimately involved in what light is.

Light energy can travel through space without needing any matter to transmit it. It travels in a wave motion as small energy packets called ***photons***. When a photon of light hits a molecule of an object, its energy is transmitted to that object. A photon of light hitting our eyes transmits its energy to the nerves in the back of an eye, causing them to react.

Wavelengths of Light

Light travels in waves which can vary in size. We perceive the different sizes of wavelengths as different colours. The longer wavelengths are seen as red while the shorter lengths are seen as violet. The full spectrum of colours we see are the colours of the rainbow. The names of the colours and their order from long to short wavelength are listed below:

- red
- orange
- yellow
- green
- blue
- violet

The combination of all wavelengths of light is seen as white while the absence of any wavelengths of light is perceived as black.

Reflection of Light
When light shines on a surface, some of the light is reflected by the surface. When we see an object such as hair, it is the light reflected from the surface of the hair that stimulates our eyes. But, not all of the light hitting an object is reflected. Some of the light is absorbed by the object, and some may be transmitted through the object.

Transmission of light
When light is transmitted through certain objects, it travels through them instead of being reflected. Material which allows light to pass through it is called *transparent* or *translucent*. Clear glass is *transparent*, light can pass straight through it; we can see through it. A frosted window is *translucent*; some light is reflected from it so we see light through it but cannot clearly see objects on the other side clearly.

Refraction of light
Light travels in a straight line so it will continue travelling straight through material if the material is the same density as air.

Glass has a higher density than air and so the light rays slow down when passing from air to glass. This causes the light to bend where it enters the glass. This bending of light rays when they pass from one medium to another is called ***refraction***. This is the reason that a pencil in a glass of water appears bent.

Dispersion of Light
Light consists of different wavelengths that we see as colours.

- A ray of light consisting of a single colour, like green or red, is called *monochromatic light*.
- A ray of white light contains wavelengths of all the colours, so it is called *polychromatic light*.

Light of a longer wavelength is slowed down less than light of a shorter wavelength when it is transmitted from one medium into another, such as from air to a glass prism. Thus red light, which has a longer wavelength, will refract or bend less than violet light when it travels from air to water or glass. This causes the colours to separate from each other. The light is refracted into bands of colours. The process where polychromatic light bends into separate colours is called ***dispersion***. See Figure 1.

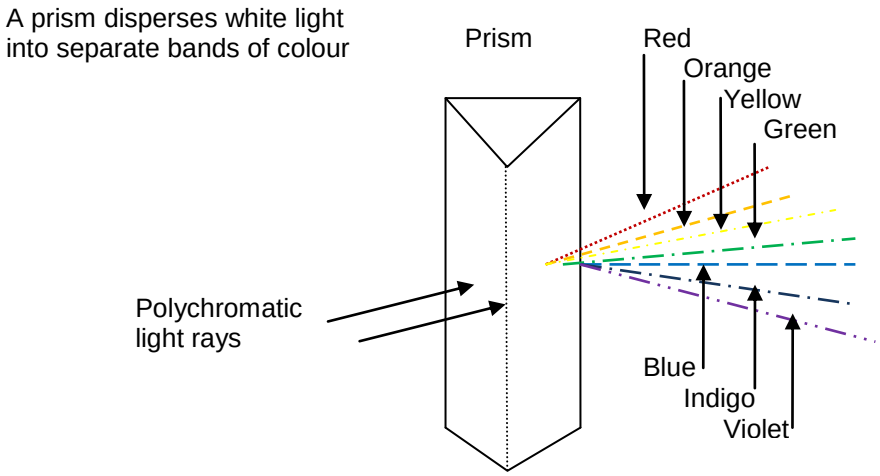


Figure 1: Dispersion of Light

In a prism, white light is dispersed or bent into separate colours, allowing us to see the colour spectrum. Red is refracted the least, followed by orange, yellow, green, blue and violet, which is refracted the most.

HOW THE EYE SEES COLOUR

When light hits an object, some of the wavelengths are reflected but some are absorbed. Usually all but one wavelength is absorbed. The one wavelength that isn't absorbed is reflected.

- This is the wavelength that hits our eye after being reflected.
- The eye sends a message to the brain indicating the wavelength of light it has received.
- The brain interprets this information as colour.

When we see in colour, we are actually seeing the wavelengths that haven't been absorbed.

- A leaf absorbs all colours except green. That is the only colour that is reflected to our eye. So we see the leaf as green.
- If an object absorbs all colours, we see that object as black.
- If an object reflects all colours, we see that object as white.

The amount of absorbed light gives different qualities to the colour we perceive. A material that absorbs more light has a richer, darker colour while a material that absorbs less light has a shinier, lighter colour.

COLOUR THEORY

Although there are only seven defined colours, these can be mixed in endless combinations. The colours we apply to hair consist of different pigments mixed to give us the required shade. When two colour pigments are combined in the same ratio, the resulting colour will be the same.

- When blue and yellow are combined, they always make green. The shade of green can be varied by adding more blue or more yellow.

Primary Colours

The primary colours are pure colours that can't be produced by mixing other colours together. Blue, red and yellow are the primary pigment colours. You cannot mix any other colours and get yellow. However, you can mix yellow with other colours such as red to get orange. You might think that except for yellow, these primary colours aren't very important in hair colouring. However, all the other colours are actually produced by mixing these three colours in various amounts along with white and black. If all the primary colours are mixed in equal amounts, the resulting colour will be black

Pigments

When we talk of mixing the primary colours together, we are talking about pigments of these colours. When you mix pure light rays of these colours, the results are somewhat different. Hair colouring is concerned with pigments, so we will look at colours resulting from colour pigments, not pure light.

We said earlier that a combination of all wavelengths of light is perceived as white light. A combination of primary pigments is obviously different from a combination of light wavelengths. The difference occurs because of the different ways our eye perceives colour from pigments and from pure light.

Blue: When you add blue to a colour, you make the colour darker and cooler. It is a dominant colour, so when it is added to another colour, the coolness and darkness from the blue will predominate.

- Blue pigment is closest to the outer part of the hair shaft.
- It is the first colour to be lifted out when hair is coloured. The depth and coolness are lost, leaving the warm pigments of yellow and red.

Red: When you add red to a colour, the colour becomes richer and warmer.

- Red is found in the middle of the hair shaft.
- It takes longer to lift the red pigment from the hair. When it is removed, the hair loses its warmth and becomes lighter.

Yellow: When yellow is added to a colour, it gives lightness and brightness. Yellow is the lightest primary colour.

- Because the yellow pigment is found in the deepest part of the hair, it takes the longest time and the most strength to lift it from the hair.

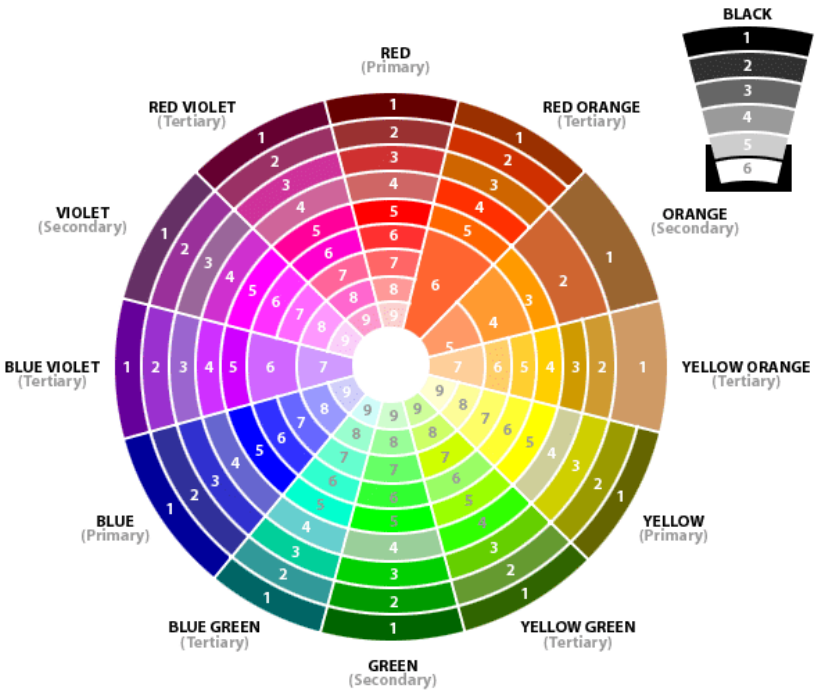
Mixing colours

If the primary colours are mixed so that blue predominates, the result will be a dark brown. If red predominates, the result will be a reddish brown. If yellow predominates, the result will be a golden brown.

Secondary and Tertiary Colours: If you combine two of the primary colours in equal amounts, you get the *secondary colours*.

- Blue and yellow create green
- Red and yellow create orange
- Blue and red create violet

These colours are often arranged on a colour wheel (see below) that consists of red, orange, yellow, green, blue and violet, which brings the colour circle back to red. Between these colours are the *tertiary colours* of red-orange, yellow-orange, yellow-green, blue-green, blue-violet and red-violet. Natural hair colour is a complex mix of many of these pigments.



Complementary Colours: Complementary colours are opposite each other on the colour wheel.

- Violet is opposite yellow on the wheel and blue is opposite orange.
- When complementary colours are mixed together, they neutralize each other and create a brown tone.
  - If there is too much yellow in the hair tone, you can add violet pigment, the complementary colour to yellow. This will tone down the yellow.
  - Orange in the hair can be toned down by adding its complimentary colour, blue.

CONCLUSION

Choosing the right method of lightening or colouring hair is a complex process. Hair colouring is based on the science of colour theory. The more you know about how colours work together, the better you will be able to create a pleasing hair tone. Applying hair colouring products to produce the desired result is also the art of putting together all you know about how we perceive colour.

Choosing the right blend of pigments depends on whether the new hair colour is going to be lighter or darker than the natural colour. The natural hair pigmentation has to be lightened to the right stage. You have to know when the colour a client wants will be too light. Then you have to add the correct amount of tint to the pigment in the hair to produce the final colour.

An understanding of light and colour theory, along with an understanding of how the colouring techniques actually work, will give you skills you need to be an effective hair colourist.

Answer the following questions about light and colour by placing the correct word in the blank space. The answers are on the last page.

1. Light travels in a wave motion as small energy packets called _____ .

2. The wavelength of light can vary. The different wavelengths are perceived as the different _____ we see.

3. The colours of the full spectrum or of the rainbow are:
   _____
   _____
   _____
   _____
   _____
   _____

4. The longest wavelength of light is seen as the colour _____ .

5. The shortest wavelength is seen as the colour _____ .

6. When light hits an object, some of the light is absorbed and some is _____ .

7. When light shines on a person's hair, most of the light is absorbed; the wavelengths that aren't absorbed are reflected to our eye, which sends a message to the brain. The brain interprets this information as _____ .

8. A leaf absorbs all colour wavelengths except that of the colour _____ .

9. _____ , _____ and _____ are called the primary colours.

10. All other colours are created by mixing the _____ colours in varying proportions.

11. Blue is the darkest and _____ colour.

12. Red is found in the _____ of the hair shaft.

13. Yellow is the _____ colour.

14. If the three primary colours are mixed in the same proportions, the resulting colour will be _____ .

15. If you combine two primary colours in the same proportion, you get a _____ colour.

16. The secondary colours are _____ , _____ and _____ .

17. The primary, secondary and tertiary colours can be arranged in a circle called a colour _____ .

18. Colours opposite each other on the colour wheel are called _____ colours.

19. Complementary colours _____ each other.

20. A hair product with blue pigment will tone down a hair colour with too much _____ in it.

ANSWERS

1. photons

2. colour

3. red
   orange
   yellow
   green
   blue
   violet

4. red

5. violet

6. reflected

7. colour

8. green

9. Blue, red, yellow

10. primary

11. coolest

12. middle

13. lightest

14. black

15. secondary

16. orange, green, violet

17. wheel

18. complementary

19. neutralize

20. orange