Chapter 21 – Colours

(A) Dispersion

1. Define dispersion.

- Dispersion is the splitting of white light into its colour components.

2. What is the colour that sunlight appears to be?

- White

3. State the seven colours in sunlight / white light.

- Red
- Orange
- Yellow
- Green
- Blue
- Indigo
- Violet

Memory Help (just remember one of the following sentences):

- √ ***R**ichard **o**f **Y**ork **g**ains **b**attle **i**n **v**ain*
- √ ***Roy g**ives **b**irth **i**n **V**ietnam*

Comment:

√ *The exact sequence is important and must be followed. I.e. you must give red first, followed by orange, then yellow… and finally violet.*

4. Describe how the dispersion of sunlight results in a rainbow.

- When sunlight enters water droplets in air, the different colour components of white light slow down by different amounts.
- As a result, the seven different colours bend towards the normal through different angles.
- On leaving the droplet, the separated colours will bend again but now away from the normal to produce the rainbow colours.

5. State whether red or violet light bends the most when made to undergo refraction.

- Violet.

Memory Help:

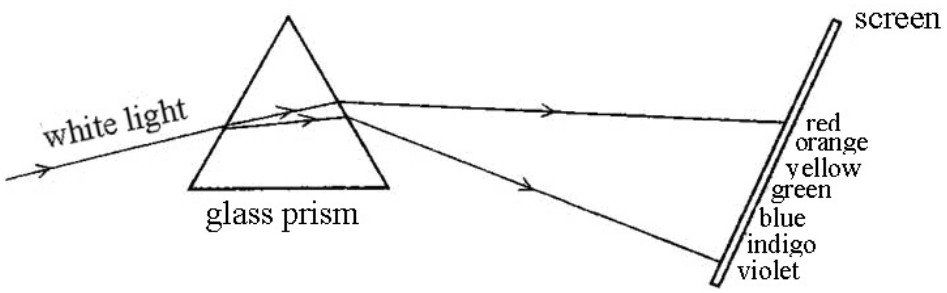
- √ *"V" for victory. Hence, violet light bends the most.*

Comment:

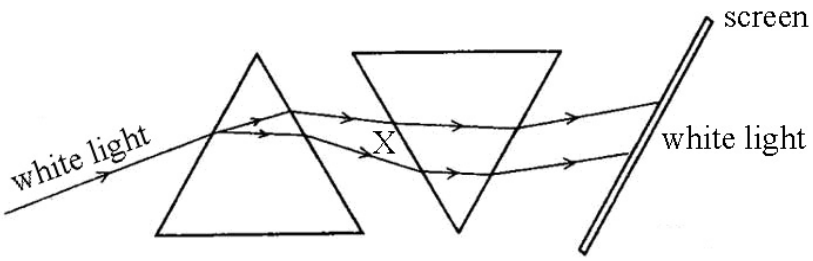
√ *The reason for the bending of white light is that its seven component colours each has a different wavelength. Red light has the longest wavelength, while violet has the shortest wavelength. As such, the speed of light is slowest for red light, and fastest for violet. This results in the smallest angle of refraction for red light, and largest angle of refraction for violet.*

6. Draw a diagram to show:

(a) The dispersion of white light by a prism,



(b) The combining of the different colours of a spectrum by two inverted prisms.



Comments:

- √ *If you pass white light through one prism, you will see the seven colours of the spectrum. If, however, you use two prisms, the spectrum will merge to produce white light again.*
- √ *Note that there will be a spectrum at point X in the diagram above. The spectrum will recombine to form white light after passing through the second prism.*

7. Other than using two inverted prisms, state another way of combining the different colours of a spectrum.

- ❖ Spinning Newton's disc (this disc consists of the seven rainbow colours).
- ❖ When the disc is spinning very fast, all seven colours will combine to form white light.

(B) Primary and Secondary Colours

8. State the three primary colours.

- ❖ Red
- ❖ Blue
- ❖ Green

9. What coloured light is produced when the three primary colours are mixed in equal proportion?

- ❖ White light

Comment:

√ *Thus, we can obtain white light by either mixing the seven rainbow colours, or by simply mixing the three primary colours.*

10. State the three secondary colours.

- ❖ Magenta
- ❖ Cyan
- ❖ Yellow

11. Secondary colours are produced by mixing any two of the three primary colours. State the colours that must be mixed to produce:

(a) Magenta	**(b) Cyan**	**(c) Yellow**
❖ Red and blue	❖ Blue and green	❖ Green and red

Memory Help:

√ *Try to think of a story to memorise the above colour changes. For example, consider the following sentence:*

"Red is stronger than Blue, and Blue is stronger than Green."

- ⇨ *Since red is stronger than blue, it will produce a pinkish colour of magenta (close to red colour) when the two colours are mixed.*
- ⇨ *Since blue is stronger than green, it will produce a light-bluish colour of cyan (close to blue colour) when the two colours are mixed*
- ⇨ *Hence, the remaining colour – yellow – must be produced by mixing red and green.*

(C) Seeing Colours

12. Fill in the blanks:

We see objects because they _____ or _____ light into our eyes. This in turn depends on whether the objects are _____ or _____.

- emit
- reflect
- luminous
- non-luminous

(C1) Luminous Vs Non-luminous Objects

13. Explain the difference between luminous and non-luminous objects.

- Luminous objects emit light.
- In contrast, non-luminous objects reflect light (i.e. they do not emit light.)

Comment:

√ *Luminous objects glow in the dark, but non-luminous objects. This is because luminous objects generate light themselves.*

14. Give three examples each of:

(a) Luminous objects

- Fire
- Lamp
- Sun

(b) Non-luminous objects

- Chair
- Pencil
- Moon

15. What factor determines the colour that the following types of objects appear in:

(a) Luminous objects

- The colour of luminous objects depends on the colour that the luminous object emits.

(b) Non-luminous objects

- The colour of non-luminous objects depends on the colour that the non-luminous objects absorb and then reflect.

(C2) Colour of Objects

Comments:

√ *The colour of luminous objects is straightforward – their colours are simply the colours that they give out. E.g. a luminous light-stick is green in colour because it gives off green light.*

√ *The concept on the colour of non-luminous objects is slightly more difficult to understand. We will look into this through the following example.*

16. State (and explain your answer) the colour of the following coloured shirts under the different lighting indicated below:

(a) White light:

(i) Red shirt

- Red.
- Because the red shirt reflects the red colour in white light and absorbs all the other colours.

(ii) Green shirt

- Green.
- Because the green shirt reflects the green colour in white light and absorbs all the other colours.

(iii) Yellow shirt

- Yellow.
- Because the yellow shirt reflects the red and green colours in white light, and absorbs all the other colours. The red and green colours reflected appear as yellow to our eyes.

(iv) White shirt

- White.
- Because the white shirt reflects all seven colours in white light.

(b) Red light:

(i) Red shirt

- Red.
- Because the red shirt reflects the red light.

(ii) Green shirt

- Black.
- Because the green shirt does not reflect any light after absorbing the red light.

Comment:

√ *The green shirt can only reflect green light. However, the only coloured light available is red. Thus, no light will be reflected, and the green shirt appears as black.*

(iii) Yellow shirt

- Red.
- Because the yellow shirt reflects the red light.

Comment:

√ *Yellow is made up of red and green colours. Thus, the yellow shirt can reflect both red and green light. However, the only coloured light available here is red. Hence, it will reflect only red light.*

(iv) White shirt

- Red.
- Because the red shirt reflects the red light.

Comment:

√ *White is made up of seven colours. Thus, the white shirt can reflect all seven colours. However, the only coloured light available here is red. Hence, it will reflect only red light.*

(c) Blue light:

(i) Red shirt

- Black.
- Because the red shirt does not reflect any light after absorbing the blue light.

(ii) Green shirt

- Black.
- Because the green shirt does not reflect any light after absorbing the blue light.

(iii) Yellow shirt

- Black.
- Because the yellow shirt does not reflect any light after absorbing the blue light.

(iv) White shirt

- Blue.
- Because the white shirt reflects the blue light.

(d) Cyan light:

(i) Red shirt

- Black.
- Because the red shirt does not reflect any light after absorbing the cyan light.

Comment:

√ *The red shirt can only reflect red light. However, the only coloured light available in cyan are blue and green. Thus, no light will be reflected, and the red shirt appears as black.*

(ii) Green shirt

- Green.
- Because the green shirt reflects the green colour in cyan light and absorbs the blue colour.

Comment:

√ *The green shirt can only reflect green light. Cyan light consists of two colours – green and blue. Thus, green light will be reflected, and the green shirt appears as green.*

(iii) Yellow shirt

- Green.
- Because the yellow shirt reflects the green colour in cyan light and absorbs the blue colour.

Comment:

√ *The yellow shirt can reflect both red and green light. Cyan light consists of two colours – green and blue. Since green is the common light, the yellow shirt will reflect the green colour and absorb the blue colour.*

(iv) White shirt

- Cyan.
- Because the white shirt reflects the cyan light.

Comment:

√ *White is made up of seven colours. Thus, the white shirt can reflect all seven colours. However, the only coloured light available here are green and blue. Hence, it will reflect both green and blue light, and appear as cyan.*