Unit 18 · Dispersion

WORKSHEET

Full marks 37

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 37

1 Key words [4]

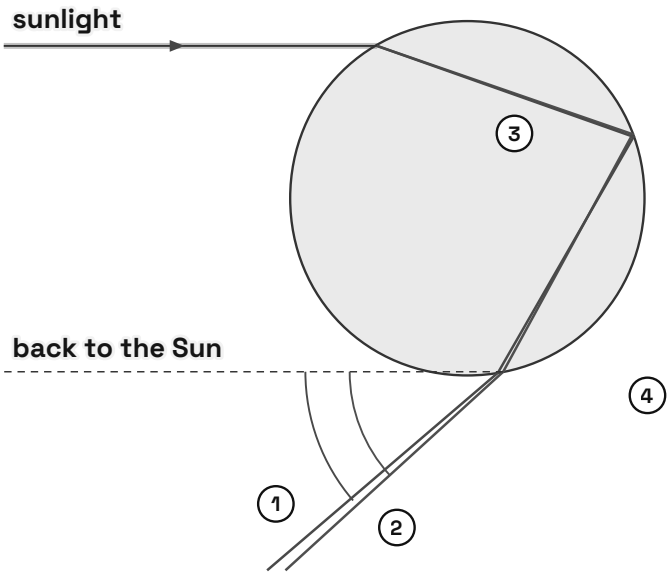
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

achromatic doublet	**angular dispersion**	**chromatic aberration**	**dispersion**	**lateral shift**
pure	**spectrum**	**spherical aberration**	**total internal reflection**	**violet**

The splitting of white light into its colors is called _____. It happens because the refractive index of glass is larger for _____ light than for red. The band of colors on a screen is a _____; when its colors do not overlap it is a _____ spectrum. The difference between the deviations of violet and red light is the _____. A lens that cannot bring all colors to one focus shows _____; one that cannot bring paraxial and marginal rays to one focus shows _____. A convex crown lens cemented to a concave flint lens, free from color fringes, is an _____.

2 Label the diagram [2]

The diagram shows how a raindrop makes the colors of a rainbow. Write the words that belong in place of 1 to 4. Each carries 0.5 mark.



1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. White light passes through a glass prism. Which color is deviated most? [1]

a. red
b. yellow
c. green
d. violet

ii. The sky looks blue because: [1]

a. raindrops disperse sunlight
b. air molecules scatter blue light much more than red
c. the ozone layer is blue
d. the air refracts blue light most

iii. In a rainbow, red is seen on the outside of the bow because red light reaches the eye from drops at about: [1]

a. 42° from the point opposite the Sun, violet at 40°
b. 40° from the point opposite the Sun, violet at 42°
c. 51° from the point opposite the Sun, violet at 42°
d. 90° from the Sun

iv. The dispersive power of a prism depends on: [1]

a. its refracting angle only
b. its material only (for the two colors compared)
c. both its material and its angle
d. the angle of incidence

v. An achromatic doublet must be made of: [1]

a. two convex lenses of the same glass
b. a convex and a concave lens of the same glass
c. a convex and a concave lens of different glasses
d. two concave lenses of different glasses

4 Very short answers [3]

Write very short answers to the following questions.

a. Define the dispersive power of a material. [1]

b. Write Cauchy's relation for the refractive index of a material. [1]

c. Why is yellow taken as the mean color of the spectrum? [1]

5 Short answers [6]

Write short answers to the following questions.

a. Write any two ways of reducing the spherical aberration of a lens. [2]

b. Blue light (about 450 nm) is scattered about 6 times as strongly as red light (about 700 nm). Show this, and say why the sky isn't violet, though violet is scattered even more. [2]

c. Write two conditions for getting a pure spectrum with a prism. [2]

6 Long answer [4]

Write a long answer to the following question.

Show that the chromatic aberration of a thin lens is $f_r - f_v = \omega f$, where ω is the dispersive power of its glass and f its mean focal length.

7 Numerical problems [10]

Solve the following problems. Show your working.

a. A small-angled prism of angle 6° is made of crown glass whose refractive indices are 1.514 for red, 1.517 for yellow and 1.530 for violet. Find the angular dispersion and the dispersive power of the glass. **[3]**

Answer: _____

b. A convex lens of mean focal length 40 cm is made of glass of dispersive power 0.031 (between violet and red). Find its chromatic aberration, and say which color is focused nearer the lens. **[3]**

Answer: _____

c. An achromatic doublet of focal length +50 cm is to be made from crown glass ($\omega = 0.016$) and flint glass ($\omega = 0.039$). Find the focal length of each lens, and say which is convex. **[4]**

Answer: _____

8 Think [3]

A rainbow is seen only when the Sun is behind you and lower than about 42° in the sky. Why can't you see a rainbow at noon on a summer day, when the Sun is high? And why is a rainbow seen from an aeroplane sometimes a full circle?

9 Activity: A spectrum from a glass of water (not marked)

On a sunny morning, put a glass full of water on a window sill in the sun, with a sheet of white paper on the floor where the light from the glass falls. Move the paper until a band of colors appears. (You can also use a glass prism.)

What I looked at	What I saw
The order of the colors on the paper	
Which color is bent farthest from the straight path?	
What happens to the band as the paper moves farther away?	
Are the edges between the colors sharp?	

Is this a pure or an impure spectrum? Why?