Unit 10 · Nature and Propagation of Light

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

1 Key words [4]

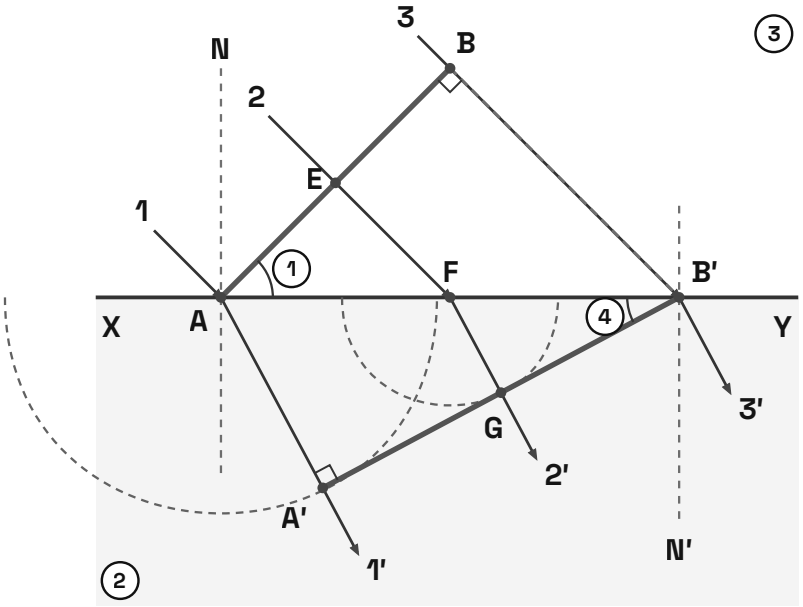
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

corpuscles	envelope	ether	phase	photon	plane wavefront	polarization
rectilinear propagation	secondary wavelets	wavefront				

Newton said light is a stream of tiny particles, which he called _____. Huygens said it is a wave, spreading through an all-filling medium his followers called the _____. The stage a vibrating particle has reached in its vibration is its _____. A surface joining all the points of a wave that are in the same phase is a _____; far from a source it is practically a _____. In Huygens' principle every point on a wavefront sends out _____, and the new wavefront is their _____ in the forward direction. A wide wavefront rebuilding itself step after step explains the _____ of light.

2 Label the diagram [2]

The diagram shows a plane wavefront refracted from air into glass by Huygens' construction. Write the label that belongs 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. A long, lit tube light sends out wavefronts that are: [1]

a. spherical **b.** cylindrical
c. plane **d.** converging

ii. Light travels through a glass of refractive index 1.6 at a speed of: [1]

a. 4.8×10^8 m/s **b.** 3.0×10^8 m/s
c. 1.9×10^8 m/s **d.** 1.6×10^8 m/s

iii. The phase difference between any two points on the same wavefront is: [1]

a. zero **b.** $\pi/2$
c. π **d.** 2π divided by their distance apart

iv. Light of wavelength 600 nm in air enters water ($\mu = 1.33$). Its wavelength in water is: [1]

a. 798 nm **b.** 600 nm
c. 451 nm **d.** 267 nm

v. In a uniform medium, the rays of a wave and its wavefronts are: [1]

a. parallel to each other **b.** perpendicular to each other
c. at 45° to each other **d.** at an angle that depends on the source

4 Short answers [7]

Write short answers to the following questions.

a. Write any two differences between Newton's corpuscular theory and Huygens' wave theory of light. [2]

b. In Huygens' construction, why is there no wavefront traveling backwards? [2]

c. Light of frequency 4.5×10^{14} Hz passes from air into glass of refractive index 1.5. Find its speed in the glass, and its wavelength in air and in the glass. ($c = 3.0 \times 10^8$ m/s) [3]

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5 Long answer [4]

Write a long answer to the following question.

Using Huygens' principle, prove Snell's law of refraction for a plane wavefront passing from a medium where light's speed is c into one where it is v, and show that $\mu = c/v$.

6 Numerical problems [8]

Solve the following problems. Show your working. Take $c = 3.0 \times 10^8$ m/s.

a. A plane wavefront in air meets a water surface ($\mu = 1.33$) at an angle of incidence of 50°. Its first point A reaches the water; its other end B reaches the water at B′, 8.0 cm from A, a time t later. Find i. the distance BB′, ii. the radius of the wavelet from A in the water by then, and iii. the angle of refraction. [4]

Answer:

b. Light of wavelength 500 nm (in air) crosses a glass slab 2.0 cm thick ($\mu = 1.5$) at right angles to its faces. Find i. the time it takes to cross the slab, ii. how much longer that is than for 2.0 cm of air, iii. how many wavelengths fit in the slab's thickness, and in 2.0 cm of air. [4]

Answer:

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7 Think [3]

Using Huygens' wavelets, explain why light from a window throws a fairly sharp shadow, while you can hear a person talking round the corner of an open door.

8 Activity: Check Snell's law with a glass block (not marked)

Put a rectangular glass block on paper and trace its outline. Send a ray in at different angles (with pins or a narrow beam of light), and draw the ray inside the block. Measure the angles from the normal.

Angle of incidence i (°)	Angle of refraction r (°)	sin i ÷ sin r
20		
40		
60		

Is sin i ÷ sin r the same each time? What does it tell you about light's speed in glass?