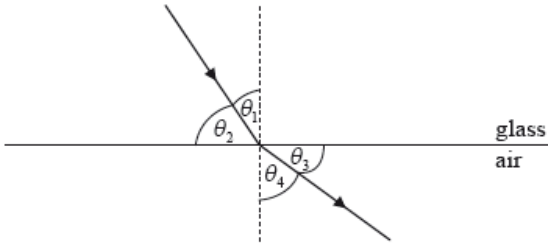
Topic 4 Review Packet B *[27 marks]*

1. A ray of light is incident on a boundary between glass and air. *[1 mark]*



Which of the following is the refractive index of glass?

A. $\frac{\sin\theta_1}{\sin\theta_3}$

B. $\frac{\sin\theta_1}{\sin\theta_4}$

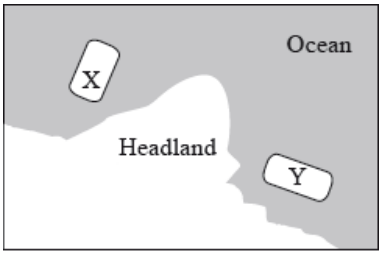
C. $\frac{\sin\theta_3}{\sin\theta_2}$

D. $\frac{\sin\theta_4}{\sin\theta_1}$

Markscheme

D

2. An orchestra playing on boat X can be heard by tourists on boat Y, which is situated out of sight of boat X around a headland. *[1 mark]*



The sound from X can be heard on Y due to

A. refraction.

B. reflection.

C. diffraction.

D. transmission.

Markscheme

C

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3. What is the best estimate for the refractive index of a medium in which light travels at a speed of $2.7 \times 10^8\ \mathrm{m\,s^{-1}}$? *[1 mark]*

A. 0.9

B. 1.0

C. 1.1

D. 2.7

Markscheme

C

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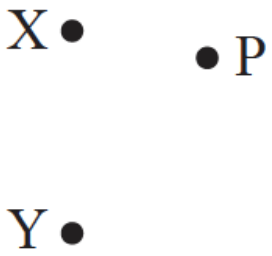
4. Monochromatic light travels from air into water. Which of the following describes the changes in wavelength and speed? *[1 mark]*

	Wavelength	Speed
A.	increases	decreases
B.	increases	increases
C.	decreases	increases
D.	decreases	decreases

Markscheme

D

5. Waves emitted from sources X and Y have equal wavelengths and are initially in phase. The waves interfere destructively at point P, where the path difference is 0.60m. *[1 mark]*



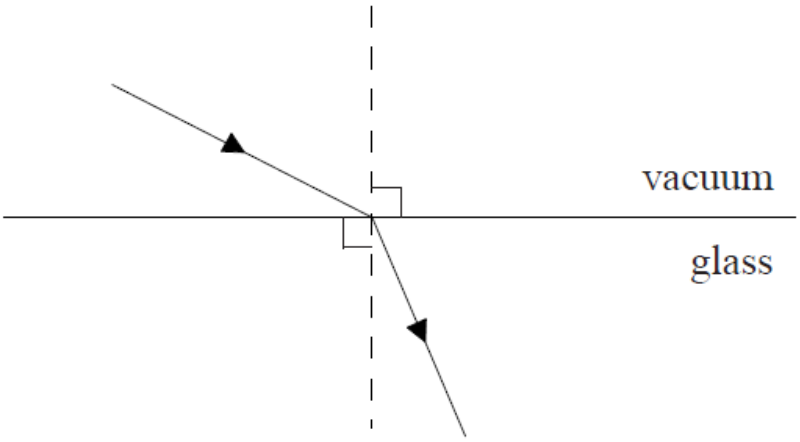
What is a possible value for the wavelength of the waves?

A. 0.20 m
B. 0.30 m
C. 0.40 m
D. 0.60 m

Markscheme

C

6. A ray of light travels from a vacuum into glass as shown below. *[1 mark]*



In glass, light has speed *v*. In a vacuum, light has speed *c*. Which of the following gives the refractive index of glass?

A. $\frac{c}{v}$

B. $\frac{v}{c}$

C. $\frac{\sin c}{\sin v}$

D. $\frac{\sin v}{\sin c}$

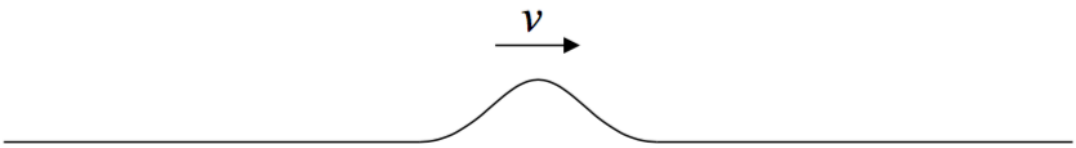
Markscheme

A

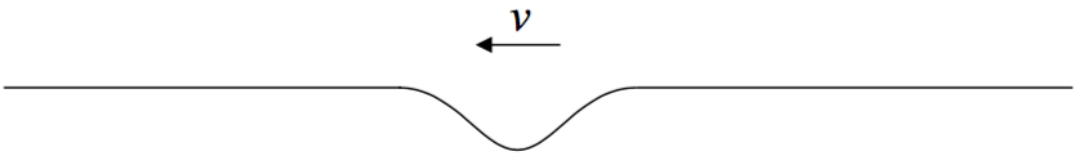
7. Two wave pulses travel along a string towards each other. The diagram shows their positions at a moment in time. *[1 mark]*

Which of the following shows a possible configuration of the pulses at a later time?

A.



B.



C.

D.

Markscheme

C

8. Two identical waves of wavelength λ leave two sources in phase. The waves meet and superpose after travelling different distances. Which path difference will result in destructive interference? *[1 mark]*

A. $\frac{\lambda}{4}$

B. $\frac{\lambda}{2}$

C. $\frac{3\lambda}{4}$

D. λ

Markscheme

B

9. Light of wavelength 600 nm travels from air to glass at normal incidence. *[1 mark]*
The refractive index of the glass is 1.5. The speed of light in air is c.
Which of the following correctly identifies the speed of the waves and their wavelength in the glass?

	Speed	Wavelength
A.	$\frac{2c}{3}$	900 nm
B.	c	900 nm
C.	c	400 nm
D.	$\frac{2c}{3}$	400 nm

Markscheme

D

10. Which of the following correctly describes the direction of a ray drawn relative to a wavefront for longitudinal and transverse waves? *[1 mark]*

	Longitudinal wave	Transverse wave
A.	parallel	parallel
B.	parallel	perpendicular
C.	perpendicular	parallel
D.	perpendicular	perpendicular

Markscheme

D

This question is about lasers.

With reference to the light waves emitted by a laser, state what is meant by the terms

11. *[2 marks]*

(i) monochromatic.

(ii) coherent.

Markscheme

(i) (the waves) all have the same frequency/wavelength;

Do not accept "one colour".

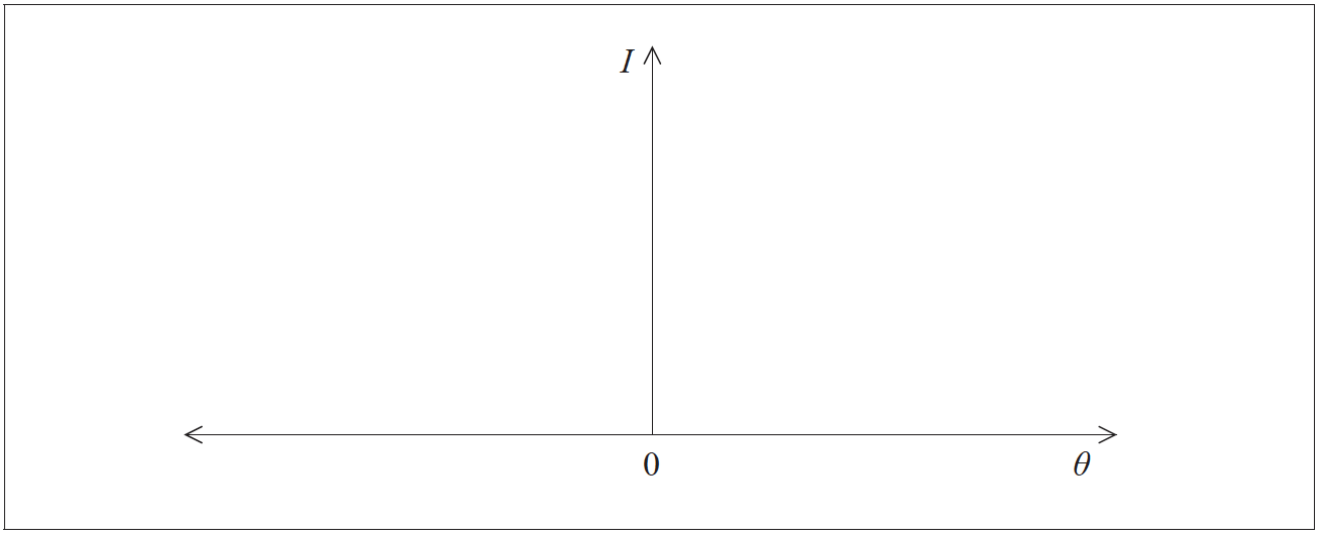
(ii) (the waves) are all in phase with each other / the phase difference between the waves is constant;

This question is about diffraction and polarization.

12a. Light from a monochromatic point source S_1 is incident on a narrow, rectangular slit. *[5 marks]*

After passing through the slit the light is incident on a screen. The distance between the slit and screen is very large compared with the width of the slit.

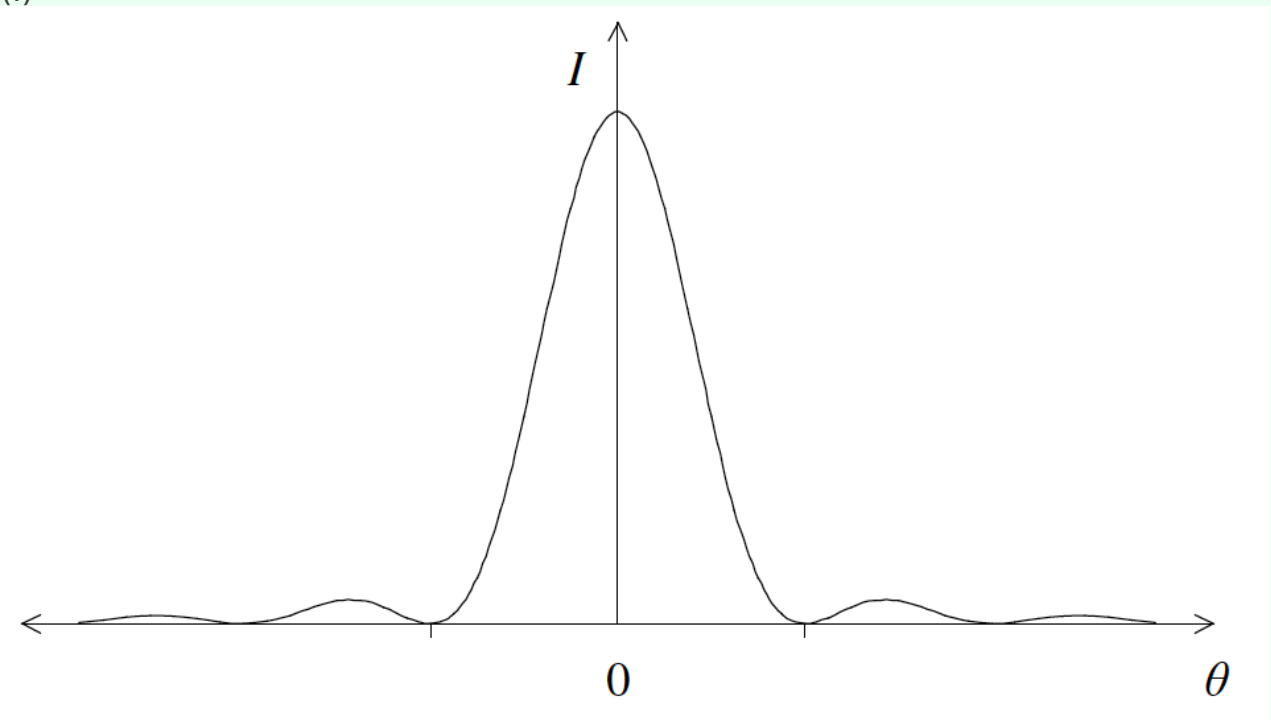
(i) On the axes below, sketch the variation with angle of diffraction θ of the relative intensity I of the light diffracted at the slit.



(ii) The wavelength of the light is 480 nm. The slit width is 0.1 mm and its distance from the screen is 1.2 m. Determine the width of the central diffraction maximum observed on the screen.

Markscheme

(i)



overall correct shape with central maxima at θ=0; { *(only one secondary maximum required each side of θ=0)*
secondary maximum no greater than ¼ intensity of central maximum; { *(judge by eye)*

(ii) $\theta = \frac{\lambda}{b} = \frac{x}{D}$ (where x is the half width of central maximum);
$2x = 2\frac{D\lambda}{b}$;
$\left(\frac{2\times1.2\times4.8\times10^{-7}}{10^{-4}}\right) = 12\text{mm}$;

12b. Judy looks at two point sources identical to the source S_1 in (a). The distance between the sources is 8.0 mm and Judy's eye is at a distance d from the sources. *[3 marks]*

Estimate the value of d for which the images of the two sources formed on the retina of Judy's eye are just resolved.

Markscheme

diameter of pupil =3.0 mm; *(accept answers in the range of 2.0 mm to 5.0 mm)*

$\theta = \left(1.22 \times \frac{\lambda}{b} = 1.22 \times \frac{4.8\times10^{-7}}{3.0\times10^{-3}} =\right) 1.95 \times 10^{-4}\,(\text{rad})$;

$d = \frac{8.0\times10^{-3}}{1.95\times10^{-4}} = 41\text{m}$; *(accept answer in the range of 20m to 70m)*

12c. The light from a point source is unpolarized. The light can be polarized by passing it through a polarizer. *[3 marks]*

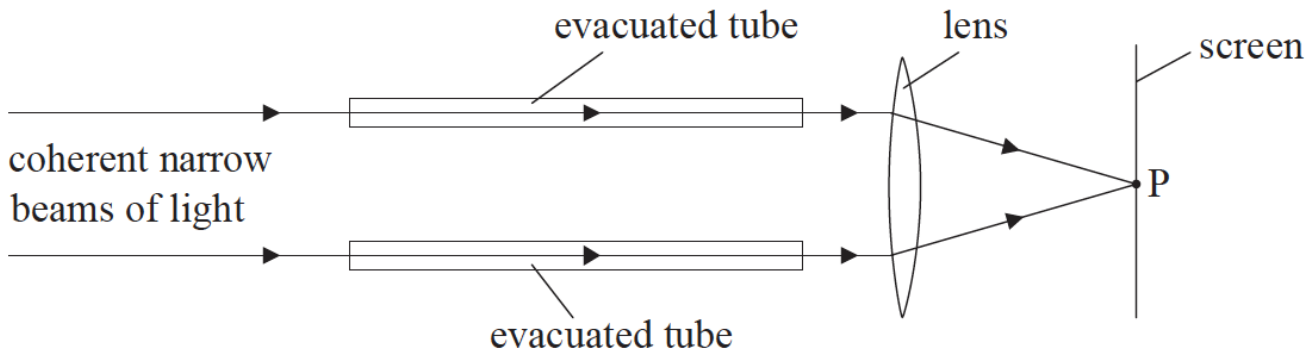
Explain, with reference to the electric (field) vector of unpolarized light and polarized light, the term polarizer.

Markscheme

in unpolarized light the plane of vibration of the electric (field) vector is continually changing / *OWTTE*;
in polarized light the electric vector vibrates in one plane only;
a polarizer is made of material that absorbs/transmits either the horizontal or vertical component/only one component of the electric vector;

This question is about interference of light.

Two coherent narrow beams of light pass through two identical evacuated tubes, as shown below.



The two coherent narrow beams are brought to a focus at point P on a screen.

13a. State what is meant by coherence. *[1 mark]*

Markscheme

constant phase difference;

13b. State, with reference to the wavelength, the condition that must be satisfied for a bright fringe to be formed on the screen at point P. *[1 mark]*

Markscheme

path difference between beams=$n\lambda$, where n is an integer/is one wavelength;

13c. Air is allowed to enter gradually into one of the evacuated tubes. The brightness of the light at point P is seen to decrease and then increase again repeatedly. *[2 marks]*

(i) State the effect on the wavelength of the light in the evacuated tube as the air is introduced.

(ii) Suggest why there is a variation in the brightness of the light at point P.

Markscheme

(i) wavelength decreases;
(ii) (effective/optical) path/phase difference changes;