A-Level Physics

Refraction, Diffraction and Interference (Multiple Choice)

Question Paper

Time available: 24 minutes
Marks available: 20 marks

1. Monochromatic visible light is incident normally on a plane transmission diffraction grating that has 4.8×10^5 lines m^{-1}.
First-order maxima are observed at angles of 16° to the central maximum.

How many maxima in total can be observed?

A 3 ⬭

B 4 ⬭

C 5 ⬭

D 7 ⬭

(Total 1 mark)

2. Which combination produces the smallest modal dispersion in an optical fibre?

	Refractive index of core	Refractive index of cladding	
A	1.5	1.4	⬭
B	1.4	1.5	⬭
C	1.5	1.3	⬭
D	1.3	1.5	⬭

(Total 1 mark)

3. Monochromatic light of wavelength 5.8×10^{-7} m is incident normally on a plane transmission diffraction grating that has a slit separation of 2.5×10^{-6} m.

How many maxima are produced by the grating?

A 4 ⬭

B 5 ⬭

C 8 ⬭

D 9 ⬭

(Total 1 mark)

4. In a Young's double-slit experiment, monochromatic light is incident on two narrow slits and the resulting interference pattern is observed on a screen.

Which change **decreases** the fringe separation?

A decreasing the separation between the two slits ⬭

B increasing the distance between the slits and the screen ⬭

C using monochromatic light of higher frequency ⬭

D using monochromatic light of longer wavelength ⬭

(Total 1 mark)

5. Light of wavelength λ is incident normally on two parallel slits of separation s. Fringes of spacing w are seen on a screen at a distance D from the slits.

Which row gives another arrangement that produces a fringe spacing of w?

	Wavelength	Slit separation	Distance between slits and screen	
A	2λ	$2s$	$2D$	⬭
B	2λ	$4s$	$2D$	⬭
C	2λ	$2s$	$4D$	⬭
D	4λ	$2s$	$2D$	⬭

(Total 1 mark)

6. The speed of light decreases by 40% when it travels from air into a transparent medium.

What is the refractive index of the medium?

A 0.6 ⬭

B 1.4 ⬭

C 1.7 ⬭

D 2.5 ⬭

(Total 1 mark)

7. A monochromatic light wave travels from glass into air.

Which row shows what happens to the wavelength, speed and photon energy?

	Wavelength	Speed	Photon energy	
A	increases	increases	increases	⬭
B	does not change	decreases	does not change	⬭
C	does not change	decreases	increases	⬭
D	increases	increases	does not change	⬭

(Total 1 mark)

8. In a Young's double-slit experiment, the spacing of the double slits is s and the distance between the slits and the screen on which fringes are formed is D. When monochromatic light of wavelength λ is incident on the slits the distance between adjacent fringes on the screen is w.

Which row shows another arrangement that produces a fringe spacing of w?

	Spacing of double slits	Distance between the slits and the screen	Wavelength of the light	
A	$4s$	$2D$	2λ	⬭
B	$2s$	$4D$	2λ	⬭
C	$2s$	$2D$	4λ	⬭
D	$2s$	$2D$	2λ	⬭

(Total 1 mark)

9. Which is a description of the pattern produced when monochromatic light passes through a very narrow slit?

A A series of equally-spaced light and dark fringes. ⬭

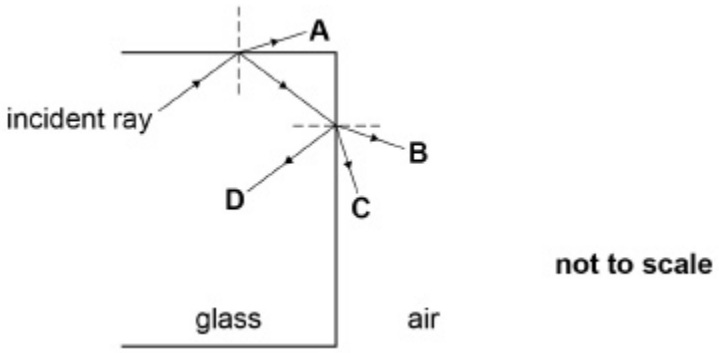
B A narrow central maximum with wider side fringes. ⬭

C A few bright fringes that are widely spaced. ⬭

D A wide central maximum with narrower side fringes. ⬭

(Total 1 mark)

10. A ray of light is incident on a glass–air boundary of a rectangular block as shown.



The refractive index of this glass is 1.5
The refractive index of air is 1.0
The angle of incidence of the light at the first glass–air boundary is 44°

What is the path of the ray of light?

A ⬭

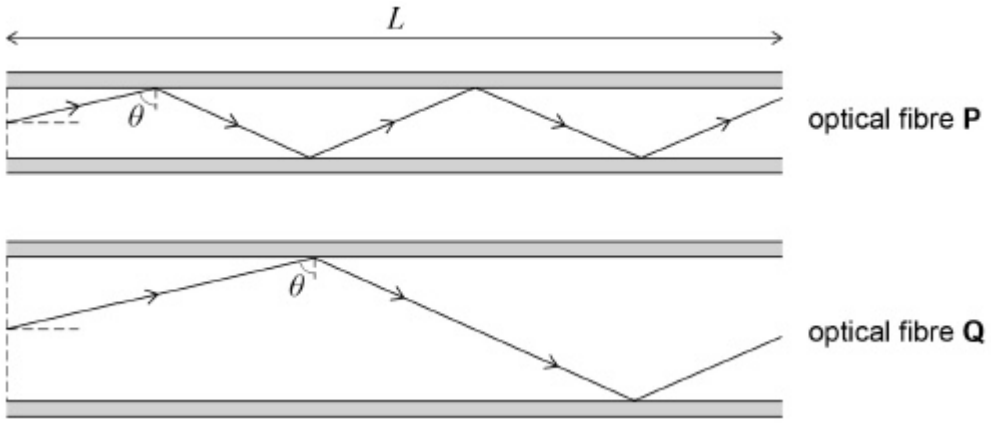
B ⬭

C ⬭

D ⬭

(Total 1 mark)

11. Rays of light are incident at the same angle θ on the core–cladding boundary of optical fibres **P** and **Q**.
The cores of **P** and **Q** have the same refractive index n.
P and **Q** are the same length L.
The core diameter of **P** is half that of **Q**.



The time for the ray to travel along optical fibre **P** is

$$\frac{nL}{c\sin\theta}$$

where c is the speed of light in a vacuum.

What is the time for the ray to travel along optical fibre **Q**?

A $\frac{nL}{c\sin\theta}$ ⬭

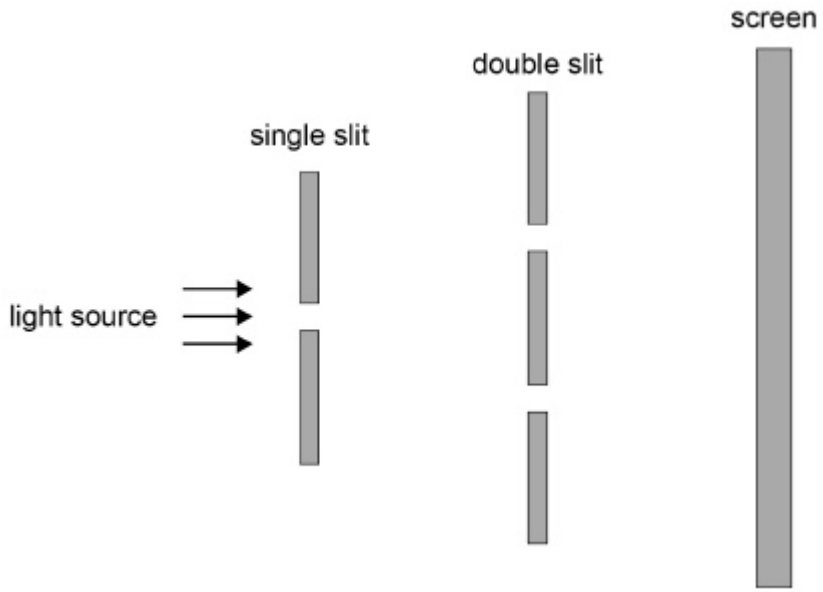
B $\frac{nL}{2c\sin\theta}$ ⬭

C $\frac{2nL}{c\sin\theta}$ ⬭

D $\frac{4nL}{c\sin\theta}$ ⬭

(Total 1 mark)

12. Light from a point source passes through a single slit and is then incident on a double-slit arrangement. An interference pattern is observed on the screen.



What will increase the fringe spacing?

A increasing the separation of the single slit and the double slit ⬭

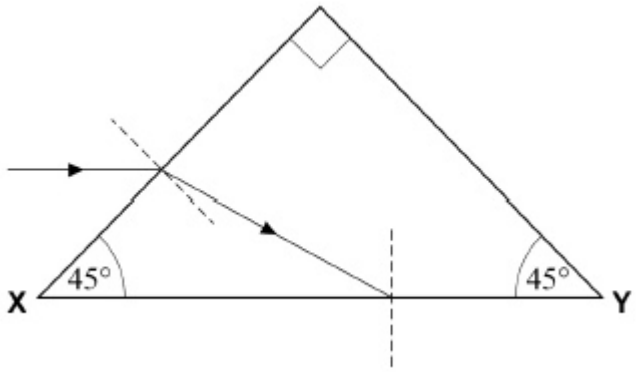
B increasing the width of the single slit ⬭

C decreasing the distance between the double slits and the screen ⬭

D decreasing the separation of the double slits ⬭

(Total 1 mark)

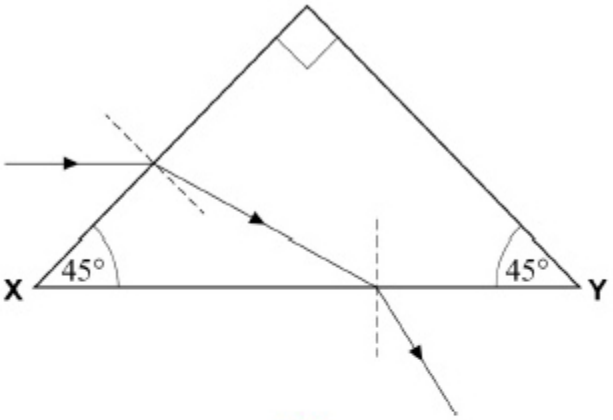
13. The diagram shows part of the path of a ray of light through a right-angled prism.



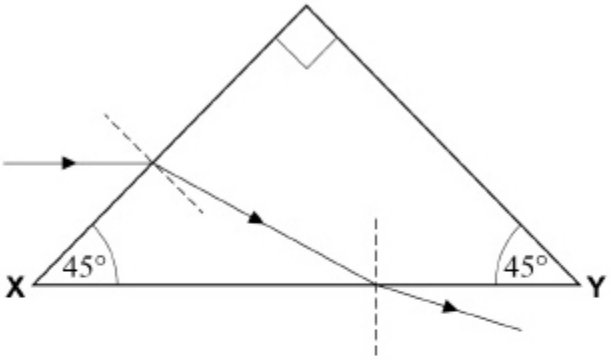
The prism is made of glass of refractive index 1.5
The incident light ray is parallel to the face **XY**. The ray is refracted towards the face **XY**.

What is the path of the ray after it is incident on face **XY**?

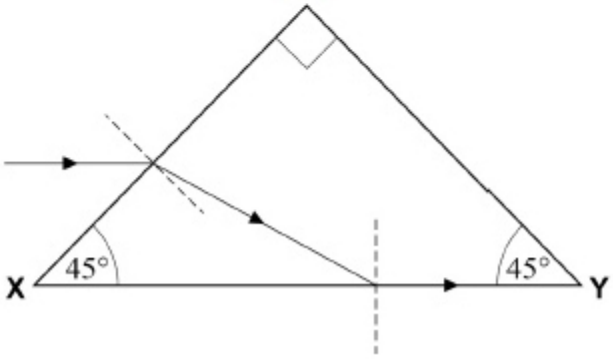
A



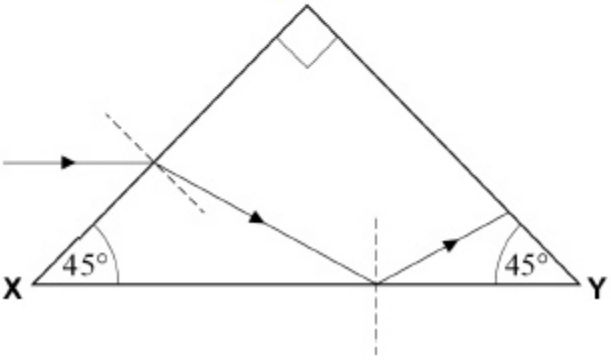
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

14. Which row shows the change in velocity, frequency and wavelength of an electromagnetic wave as it travels from an optically less dense to an optically more dense medium?

	Velocity	Frequency	Wavelength	
A	decreases	decreases	unchanged	⬭
B	increases	unchanged	increases	⬭
C	decreases	unchanged	decreases	⬭
D	increases	increases	unchanged	⬭

(Total 1 mark)

15. Light of wavelength 500 nm is passed through a diffraction grating which has 400 lines per mm.

What is the angular separation between the two second-order maxima?

A 11.5° ⬭

B 23.1° ⬭

C 23.6° ⬭

D 47.2° ⬭

(Total 1 mark)

16. Intensity maxima are produced on a screen when a parallel beam of monochromatic light is incident on a diffraction grating. Light of a longer wavelength can be used or the distance from the diffraction grating to the screen can be increased.

Which row gives the change in appearance of the maxima when these changes are made independently?

	Longer wavelength	**Distance from grating to screen increased**	
A	closer together	more widely spaced	⬭
B	more widely spaced	more widely spaced	⬭
C	more widely spaced	closer together	⬭
D	closer together	closer together	⬭

(Total 1 mark)

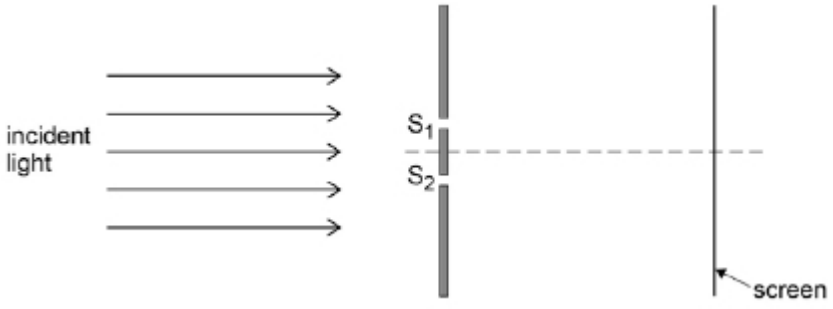
17. Two loudspeakers emit sound waves.

Which line in the table gives the correct frequency condition and the correct phase condition for the waves from the loudspeakers to be coherent?

	Frequency condition	**Phase condition**	
A	same frequency	variable phase difference	⬭
B	constant frequency difference	constant phase difference	⬭
C	constant frequency difference	in phase	⬭
D	same frequency	constant phase difference	⬭

(Total 1 mark)

18. When a parallel beam of monochromatic light is directed at two narrow slits, S_1 and S_2, interference fringes are observed on a screen.

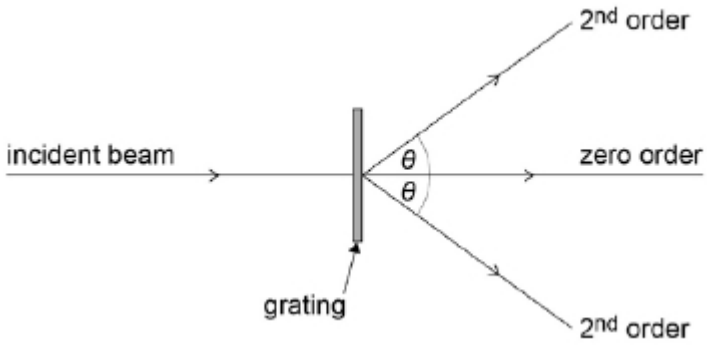


Which line in the table gives the changes that will increase the spacing of the fringes?

	Slit spacing	Distance from slits to screen	
A	halved	halved	⬭
B	halved	doubled	⬭
C	doubled	halved	⬭
D	doubled	doubled	⬭

(Total 1 mark)

19. A parallel beam of monochromatic light is directed normally at a plane transmission grating which has N slits per metre. The second order diffracted beam is at angle θ to the zero order transmitted beam.



The grating is then replaced by a plane transmission grating which has $2N$ slits per metre.

Which one of the following statements is correct?

A With the first grating, the first order beam is at angle 0.5θ to the zero order transmitted beam. ⬭

B With the second grating, the first order beam is at angle 0.5θ to the zero order transmitted beam. ⬭

C With the second grating, the first order beam is at angle θ to the zero order transmitted beam. ⬭

D With the second grating, the second order beam is at angle θ to the zero order transmitted beam. ⬭

(Total 1 mark)

20. A layer of liquid of refractive index 1.6 covers the horizontal flat surface of a glass block of refractive index 1.5. A ray of light strikes the boundary between them at an angle such that it travels along the boundary afterwards.

How does the ray strike the boundary?

A it travels in glass at an angle of 70° to the boundary ⬭

B it travels in glass at an angle of 20° to the boundary ⬭

C it travels in the liquid at an angle of 70° to the boundary ⬭

D it travels in the liquid at an angle of 20° to the boundary ⬭

(Total 1 mark)