Exam Papers Practice

Wave Phenomena

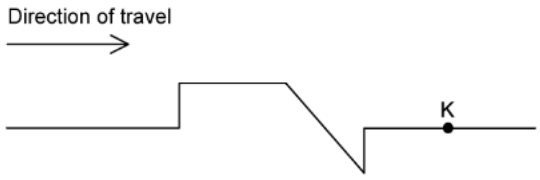
Question Paper

Course	HL IB Physics
Section	Wave Behaviour
Topic	Wave Phenomena
Difficulty	Medium

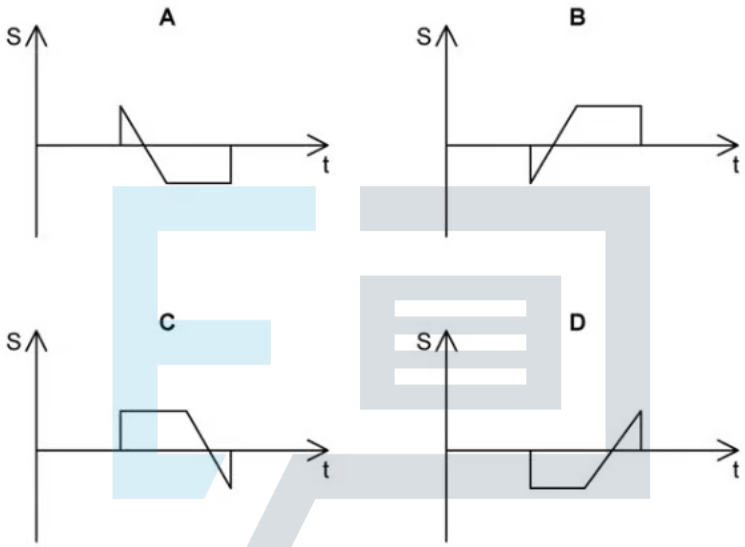
To be used by all students preparing for HL IB Physics
Students of other boards may also find this useful

Question 1

The diagram shows a wave moving along a rope under tension in the direction shown.



Which of the following graphs, **A** to **D,** correctly shows the variation of displacement *s* with time *t* of the particle K in the rope?



[1 mark]

Question 2

Two waves from individual point sources meet at a point X. Which of the following conditions is necessary for interference to be observed at point X?

A. Waves of equal amplitude

B. Waves of equal wavelength

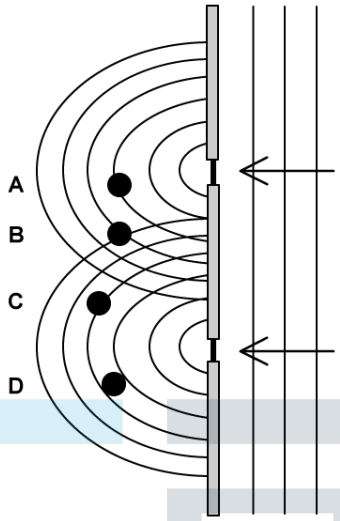
C. A constant phase difference between the waves

D. The waves must be electromagnetic

[1 mark]

Question 3

This diagram below shows two apertures through which planar waves are passed as they are moving to the left. The wavefronts show crests moving in phase. Given this information, at which point will the amplitude of the waves be a minimum?



[1 mark]

Question 4

A flat plate made of glass has a refractive index of $n = 1.52$. What is the speed of light within this material?

A. $1.36 \times 10^8 \text{ m s}^{-1}$

B. $1.67 \times 10^8 \text{ m s}^{-1}$

C. $1.97 \times 10^8 \text{ m s}^{-1}$

D. $2.66 \times 10^8 \text{ m s}^{-1}$

[1 mark]

Question 5

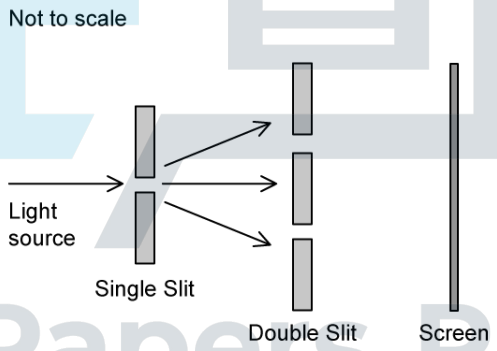
When a light ray enters a denser medium and refracts, some of the characteristics of the wave will change. Which of the following options is correct about this change?

	Speed	Frequency	Wavelength
A	Increases	Decreases	Stays constant
B	Decreases	Stays constant	Decreases
C	Stays constant	Decreases	Increases
D	Increases	Increases	Stays constant

[1 mark]

Question 6

The effect of a double slit on monochromatic light is observed by the set up in the diagram below.



Interference fringes are seen on the screen.

Which of the following changes would increase the distance between the adjacent fringes?

A. Decrease the width of all the slits

B. Move the screen closer to the double-slit

C. Use light of a higher frequency

D. Decrease the distance between the two slits

[1 mark]

Question 7

Which of the following options will alter the frequency of a wave?

A. Reflection

B. Refraction

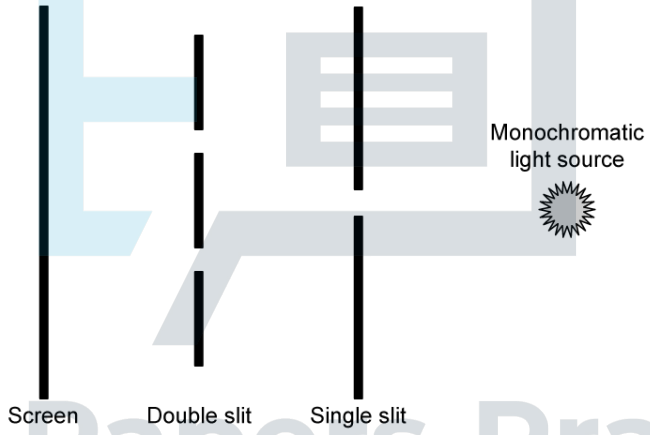
C. Diffraction

D. None of the above

[1 mark]

Question 8

Young's double-slit experiment is setup as shown, including a monochromatic source, a single slit, a double slit and a screen. What is the purpose of the double slit in this experiment?



A. To make sure there is equal intensity in the double-slits

B. To make sure the light is coherent upon the double-slits

C. To decrease intensity for the double-slits

D. To reduce the wavelength of the light

[1 mark]

Question 9

Identical waves that begin propagation at the same time leave from two different sources and arrive at the same point – point X. The first source is 18 m from point X. The second source is 10.5 m from point X. The waves of both sources have a wavelength of 3 m. What is observed at X?

A. Complete destructive interference

B. Partial destructive interference

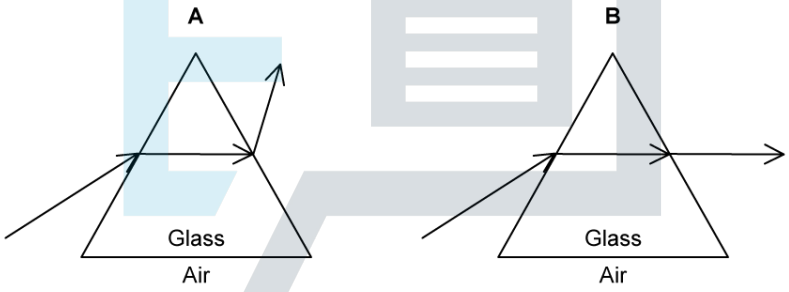
C. Partial constructive interference

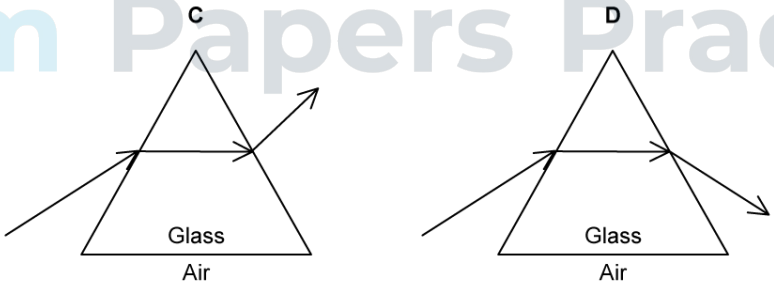
D. Complete constructive interference

[1 mark]

Question 10

Which of the following images shown below best represents the path of visible light traveling through a glass prism?





[1 mark]

Question 11

The **angle of incidence** should always be measured between:

A. The normal and the reflected ray

B. The incident ray and the normal

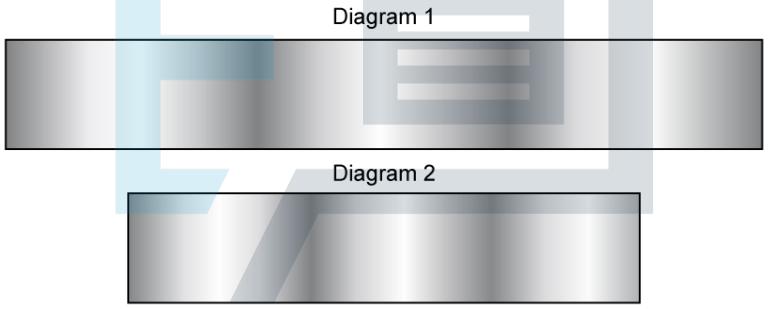
C. The incident ray and the reflected ray

D. The incident ray and the surface of the second medium

[1 mark]

Question 12

In two separate experiments, monochromatic light is incident on a single slit. The diagrams show the interference patterns obtained on a screen far from the slit. In diagram 1, the wavelength of light is λ_1 and the slit width is b_1. In diagram 2, the wavelength of light is λ_2 and the slit width is b_2.



What is the correct expression linking wavelength and slit width of the two interference patterns?

A. $\lambda_2 < \lambda_1$

B. $b_2 < b_1$

C. $\frac{\lambda_1}{b_1} > \frac{\lambda_2}{b_2}$

D. $\frac{\lambda_1}{b_1} < \frac{\lambda_2}{b_2}$

[1 mark]

Question 13

Which of the statements are true for single-slit interference?

I. Blue light produces a larger angle of diffraction than red light
II. The smaller the slit width, the larger the angle of diffraction for a constant wavelength

A. Neither

B. I only

C. II only

D. Both

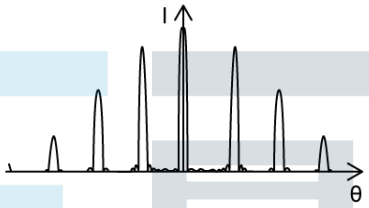
[1 mark]

Question 14

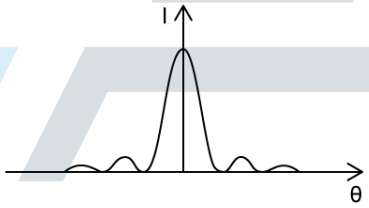
Several diffraction experiments are performed with light diffracted through different numbers of slits. Which row. in the table below, correctly matches the number of slits and the intensity pattern observed on the screen?

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
A.	5–slit diffraction grating	Single Slit	Double Slit	10–slit diffraction grating
B.	10–slit diffraction grating	Single Slit	Double Slit	5–slit diffraction grating
C.	10–slit diffraction grating	Double Slit	Single Slit	5–slit diffraction grating
D.	5–slit diffraction grating	Double Slit	Single Slit	10–slit diffraction grating

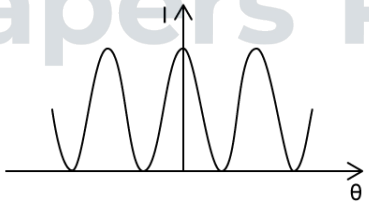
1.



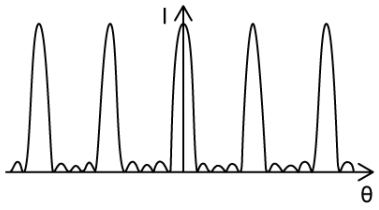
2.



3.



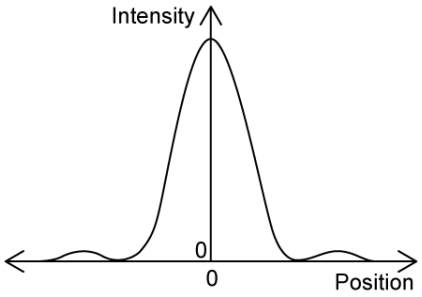
4.



[1 mark]

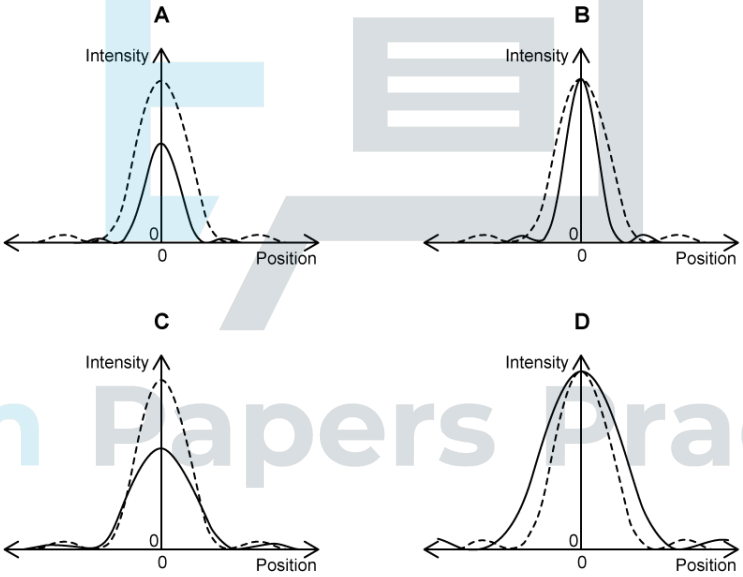
Question 15

Monochromatic light is incident on a narrow rectangular slit in an optical experiment. The diffracted light is observed on a distant screen. The graph below shows how the intensity of light varies with position on the screen.



The width of the slit is increased. The original diffraction pattern is shown by the solid line.

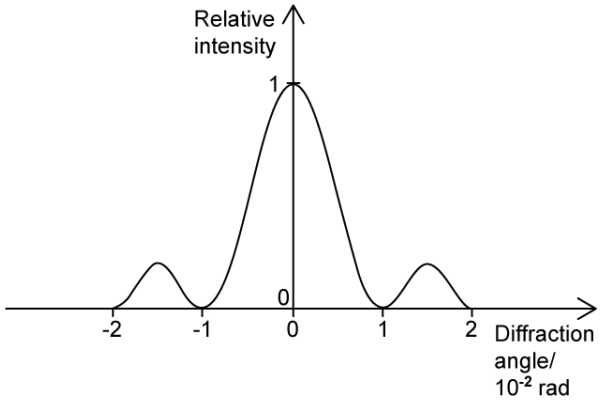
Which graph shows how the intensity of light observed varies with position on the screen?



[1 mark]

Question 16

The diagram shows the diffraction pattern for light travelling through a single slit of width 2.0 mm.



What is the wavelength of the light used?

A. 2.0 cm

B. 2.0 mm

C. 20 μm

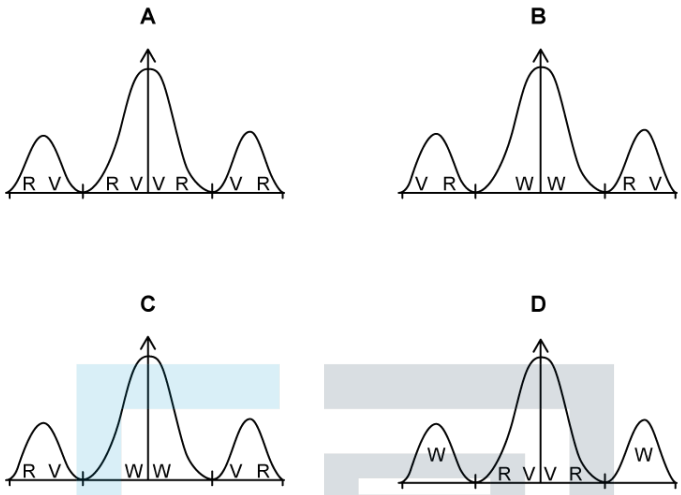
D. 20 nm

[1 mark]

Question 17

White light is diffracted through a single slit.

Which row in the table indicates the correct positions of red (R), violet (V) and white (W) light on the intensity pattern seen on a screen?



[1 mark]

Question 18

A single slit diffraction pattern is performed several times using light of different colours, slits of different widths and different distances to the screen. Which change will decrease the width of the central peak?

A. Change the light source from red to blue

B. Change the light source from blue to red

C. Make the slit width narrower

D. Move the screen further away

[1 mark]

Question 19

A parallel beam of coherent light of wavelength λ is incident on a rectangular slit of width b. After passing through the slit the light is incident on a screen a distance D from the slit where D is much greater than b.

What is the width of the central maximum of the diffraction pattern as measured on the screen?

A. $\frac{b}{D\lambda}$

B. $\frac{D\lambda}{b}$

C. $\frac{2b}{D\lambda}$

D. $\frac{2\lambda D}{b}$

[1 mark]

Question 20

In a diffraction experiment with a single slit, the first minimum is observed at a diffraction angle θ. The intensity of the central maximum of the diffraction pattern is I. The light source stays the same. What is the effect on I and θ of reducing the slit width?

	θ	I
A.	decreases	increases
B.	increases	decreases
C.	decreases	decreases
D.	increases	increases

[1 mark]

Question 21

A single slit produces a diffraction pattern. The angle from the centre of the pattern to the first minimum point is *Y*. The slit width is then halved and the frequency of light is doubled.

What is the new angle from the centre of the pattern to the first minimum point?

A. $4Y$

B. $\frac{1}{2}Y$

C. Y

D. $\frac{1}{4}Y$

[1 mark]

Question 22

Waves emitted from sources V and W are initially in phase and have equal wavelengths. Point A is not equidistant between V and W. The waves interfere destructively at point A, where the path difference is 0.30 m.

What is the maximum possible value of the wavelength of the waves?

A. 0.60 m

B. 0.30 m

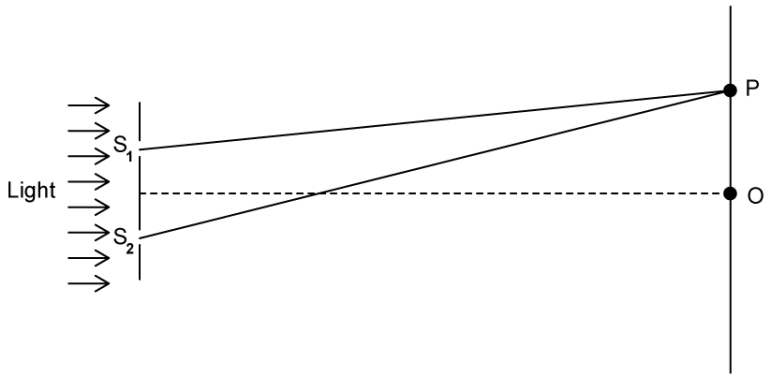
C. 0.20 m

D. 0.12 m

[1 mark]

Question 23

The diagram below shows an arrangement for a two-slit interference experiment. Coherent light of frequency *f* is incident on two narrow parallel slits S_1 and S_2. An interference pattern is observed on a screen a distance away. The central bright fringe is at O and the next bright fringe is at P. The speed of light is c.



The distance $S_2P - S_1P$ is equal to

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

B. $\frac{c}{2f}$

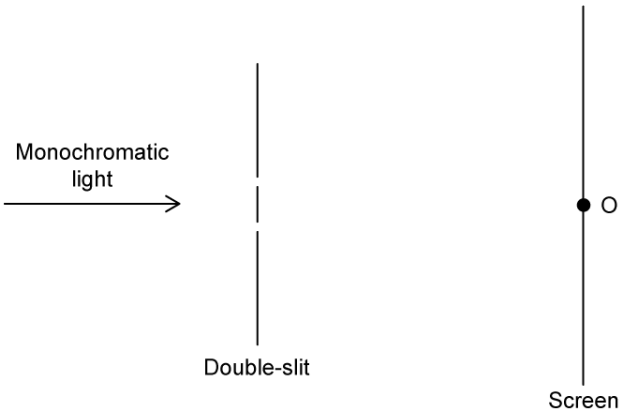
C. $\frac{c}{f}$

D. $\frac{f}{2c}$

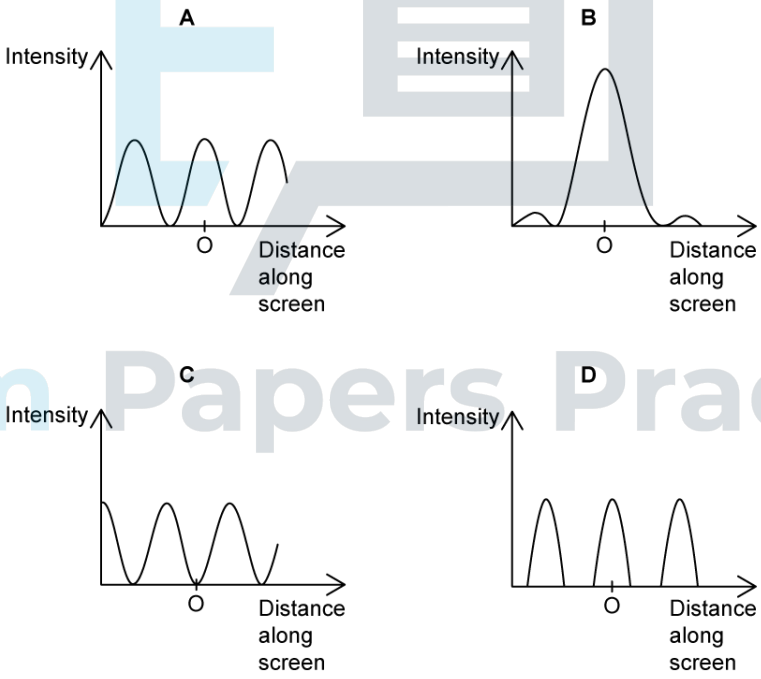
[1 mark]

Question 24

The interference of light waves is observed using a double-slit arrangement as shown below.



Which of the following best shows the intensity distribution of light at point O on the screen?



[1 mark]

Question 25

In an experiment, light incident on a diffraction grating has a first maximum of the second order in the same location as the first minimum of a single slit diffraction pattern. The light source and the distance from the slits to the screen are kept the same.

What is the relationship between the slit separation d and the slit width b?

A. $d = 2b$

B. $d = \frac{b}{4}$

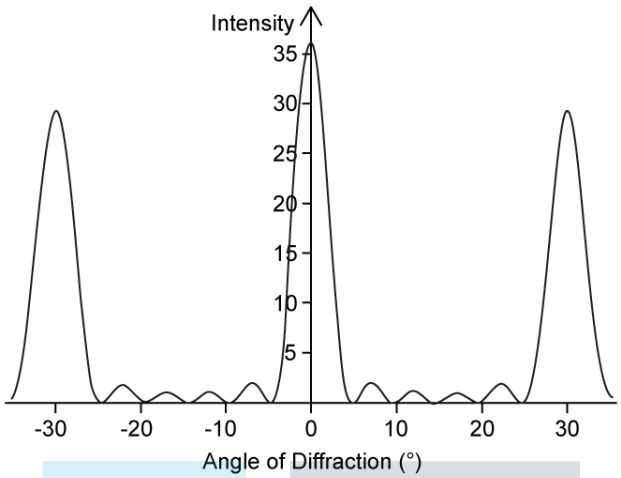
C. $d = 4b$

D. $d = \frac{b}{2}$

[1 mark]

Question 26

The graph shows the intensity pattern from the interference of monochromatic light passing through *N* slits.



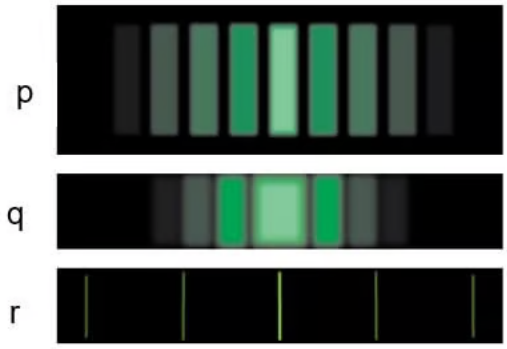
Which row gives the correct value of *N* and the correct relationship between the slit separation *d* and the wavelength λ?

	N	Relationship
A.	6	$d = \frac{\lambda}{2}$
B.	6	$d = 2\lambda$
C.	4	$d = 2\lambda$
D.	4	$d = \frac{\lambda}{2}$

[1 mark]

Question 27

Red light is incident on a diffraction grating, a double-slit and a single-slit. The patterns produced on a screen some distance away are shown below.



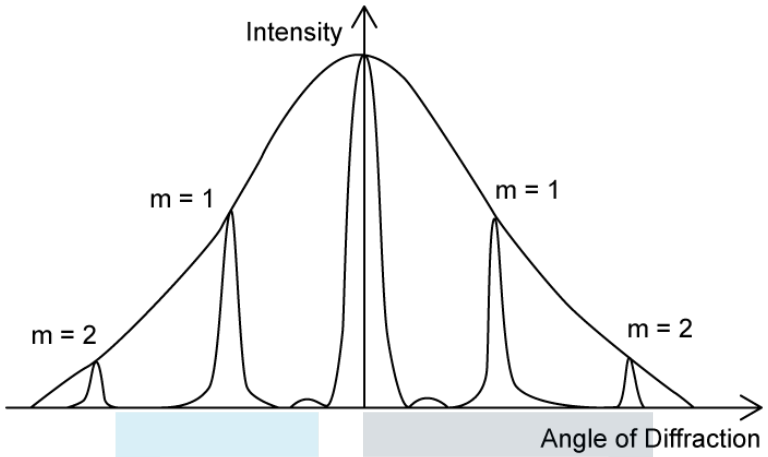
Which row in the table correctly identifies patterns p, q and r?

	p	q	r
A.	Diffraction Grating	Double Slit	Single Slit
B.	Double Slit	Single Slit	Diffraction Grating
C.	Single Slit	Double Slit	Diffraction Grating
D.	Diffraction Grating	Single Slit	Double Slit

[1 mark]

Question 28

The graph shows the variation with diffraction angle of the intensity of light when monochromatic light is incident on a diffraction grating.



The number of slits is reduced to less than 20. The width and the separation of the slits remain the same.

Three possible changes to the pattern are:

I. The intensity of the primary maxima increases

II. The width of the primary maxima increases

III. Secondary maxima are seen between the primary maxima

Which of the possible changes are correct?

A. I and II only

B. I and III only

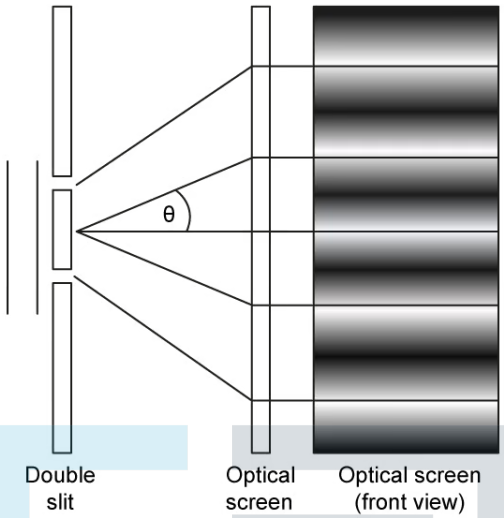
C. II and III only

D. I, II and III only

[1 mark]

Question 29

A beam of monochromatic light is incident normally on a double slit. The slit spacing is *d*. The angles between the different orders are shown on the diagram.



What is the expression for the wavelength of light used?

A. $\lambda = sD$

B. $\lambda = s\theta$

C. $\lambda = \theta D$

D. $\lambda = \theta d$

[1 mark]