2 7 Light of wavelength $500\ \text{nm}$ is passed through a diffraction grating which has 400 lines per mm.

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

[1 mark]

A 11.5° ⬭

B 23.1° ⬭

C 23.6° ⬭

D 47.2° ⬭

2 5 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?

[1 mark]

	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	⬭

Section B

Answer **all** questions in this section.

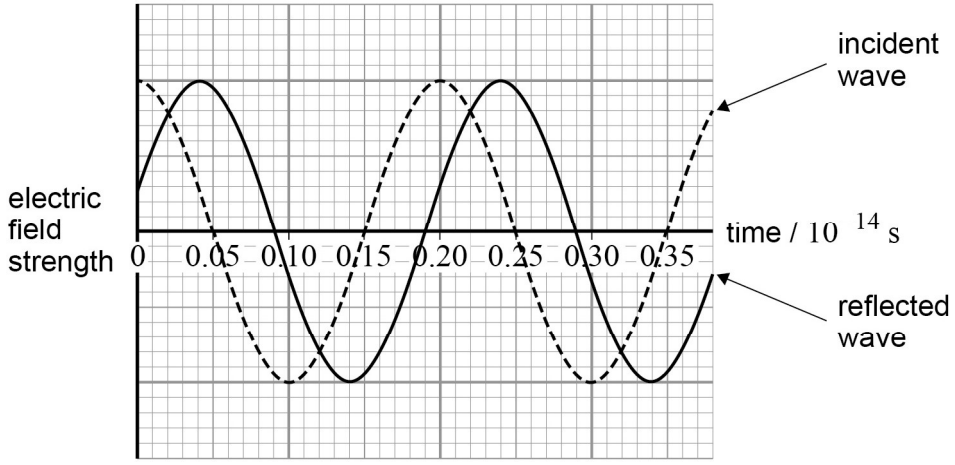
0 3 A gravimeter is an instrument used to measure the acceleration due to gravity. The gravimeter measures the distance fallen by a free-falling mirror in a known time.

To do this, monochromatic light is reflected normally off the mirror, creating interference between the incident and reflected waves. The mirror is released from rest and falls, causing a change in the phase difference between the incident and reflected waves at a detector.

At the point of release of the mirror, the waves are in phase, resulting in a maximum intensity at the detector. The next maximum is produced at the detector when the mirror has fallen through a distance equal to half a wavelength of the light. The gravimeter records the number of maxima detected in a known time as the mirror falls. These data are used by the gravimeter to compute the acceleration of the free-falling mirror.

Figure 9 illustrates the phase relationship between the incident and reflected waves at the detector for one position of the mirror.

Figure 9



0 3 . 1 Show that the wavelength of the light is 600 nm.

[3 marks]

0 3 . 2 Determine the phase difference, in rad, between the incident and reflected waves shown in **Figure 9**.

[2 marks]

phase difference = _____ rad

Question 3 continues on the next page

0 3 . 3 A maximum is detected each time the mirror travels a distance equal to half a wavelength of the light.

In one measurement 2.37×10^5 maxima are recorded as the mirror is released from rest and falls for 0.120 s.

Using an appropriate equation of motion, calculate the acceleration due to gravity that the gravimeter computes from these data.

State your answer to 3 significant figures.

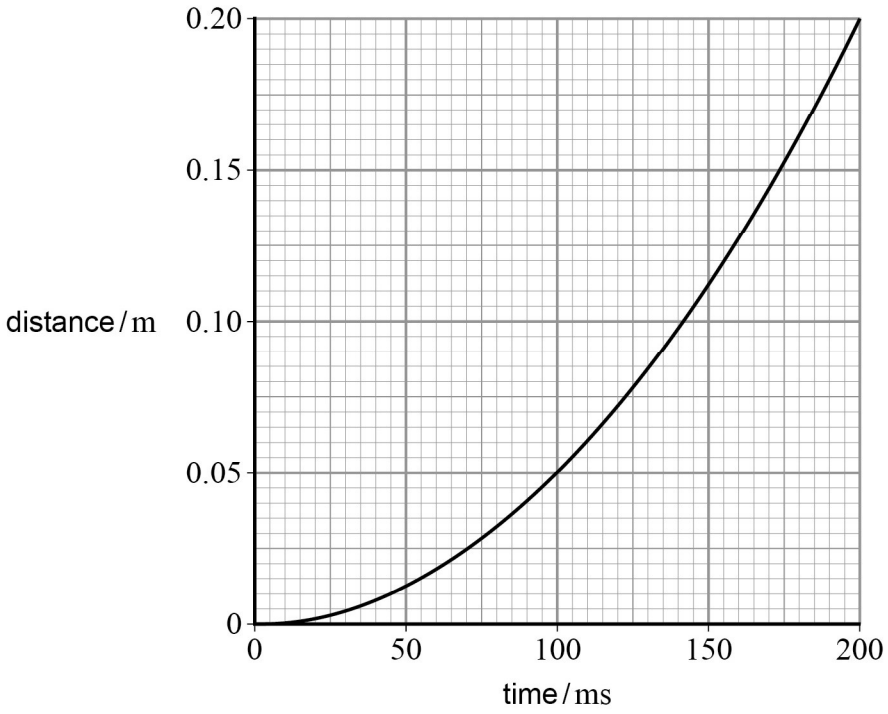
wavelength of the light = 600 nm

[3 marks]

acceleration due to gravity = _____ m s^{-2}

0 3 . 4 **Figure 10** is a graph that the gravimeter could produce to show how the distance travelled by the mirror varies with time as it falls.

Figure 10



Determine the gradient of the line when the time is 0.12 s.

[2 marks]

gradient = _____

0 3 . 5 State what this gradient represents.

[1 mark]

_____

11

Do not write outside the box

1 9 Two points on a progressive wave have a phase difference of $\frac{\pi}{6}$ rad
The speed of the wave is $340\ \text{m s}^{-1}$

What is the frequency of the wave when the minimum distance between the two points is $0.12\ \text{m}$?

[1 mark]

A 240 Hz ⬭

B 470 Hz ⬭

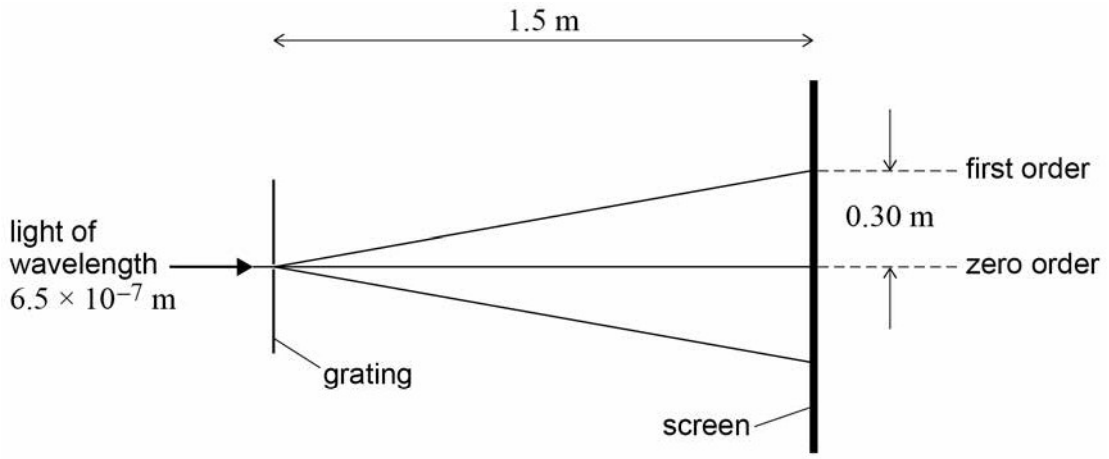
C 1400 Hz ⬭

D 2800 Hz ⬭

[1 mark]

Do not write outside the box

1 8 A diffraction grating is illuminated normally with light of wavelength 6.5×10^{-7} m
When a screen is 1.5 m from the grating, the distance between the zero and first-order maxima on the screen is 0.30 m



What is the number of lines per mm of the diffraction grating?

[1 mark]

A 3.3×10^{-6} ○

B 3.3×10^{-3} ○

C 3.0×10^{2} ○

D 3.0×10^{5} ○

Do not write outside the box

1 7 The fundamental frequency f is the lowest frequency heard when a stretched string is vibrating.

The string is now lightly touched one third of the way along its length.

What is the lowest frequency heard?

[1 mark]

A $\frac{f}{3}$ ⬭

B $\frac{2f}{3}$ ⬭

C f ⬭

D $3f$ ⬭

Turn over for the next question