Basic Waves and Diffraction

Definitions

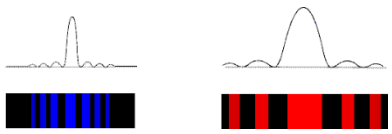
Waves carry energy. The greater the amplitude of a wave then the more energy it is carrying.

Electromagnetic waves:

- Can travel through a vacuum
- Maximum speed: **3 × 10^8 m s^{-1}**
- **R**adio, **m**icro, **i**nfra-red, **v**isible, **u**ltra-violet, **X** rays, **g**amma (**R**emember **M**y **I**nstructions **V**isible **U**nder **X** ray **G**lasses)

Mechanical waves:

- Need a medium
- Waves made on ropes/strings/springs/in water/Earthquakes
- Sound waves **speed: 330 m s^{-1}** in air



Diffraction occurs when a wave passes through around an object or through a gap (called a **slit** or an **aperture**). When a wave passes through a gap the diffraction effect is greatest when the width of the gap is about the same size as the wavelength of the wave. Smaller obstacles and smaller gaps lead to more diffraction or bending of waves than larger obstacles or gaps, when you are comparing waves with the same wavelength. There is more diffraction or bending of waves with larger wavelength than of waves with smaller wavelength. The same happens with sound waves. Diffraction of light using blue and red light.

Equations/Diagrams

$v = f\lambda$	Velocity of wave	v	m s^{-1}
	frequency	f	Hz
	wavelength	λ	m
$f = \frac{1}{T}$	Frequency	f	Hz
	Time period	T	s

Diffraction

Questions

INTERFERENCE (2022;2)

Vincent is studying interference patterns formed by diffraction gratings. He has a set of diffraction gratings with different slit spacings. Vincent shines a red laser through the gratings, and observes the pattern formed on a screen that is some distance away.

(a) Vincent uses the diffraction grating to study blue light from his new laser. He uses a grating with 6.00 x 10^5 lines per metre. Calculate the value of d, the spacing between each slit.

Terms

Diffraction: Bending of waves around a barrier/through a gap
Diffraction grating: Series of fine slits or lines used to deviate waves (e.g. Light)
Frequency: The number of waves which reach an observer in one second
Longitudinal waves: The wave in which the particles oscillate in the same direction as the direction of propagation of wave e.g. sound waves
Transverse waves: A wave in which the particles of the medium oscillate in a direction perpendicular of the direction of propagation of wave
Wave velocity: The distance travelled by a wave in one second
Wavelength: The distance between the two nearest points on a waves (two adjacent crests or two adjacent troughs)

Tips

- There are very rarely any questions on basic waves and diffraction at Level 3 except for diffraction grating calculations. Use d = 1/N (where N is the number of lines per meter) to solve this.

Answers

(a) $d = \frac{1}{N}$

$d = \frac{1}{6.00 \times 10^5}$

$d = 1.6667 \times 10^{-6}$