# Things to remember in the last hour before the exam: Level 1 Wave behaviour

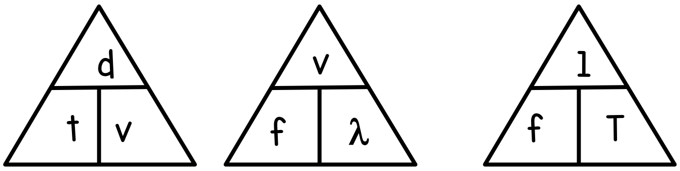
(This is not a revision sheet – you've done that by now - it's a list of things you might want to remind yourself about …)

Formula you are given:

$$v = \frac{d}{t} \qquad v = f\lambda \qquad f = \frac{1}{T}$$

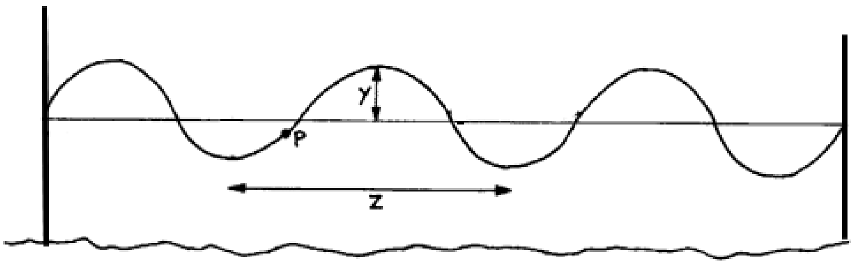
You often want to rearrange this into T = 1/f but make sure you know the difference between frequency and period!

If you are nervous about rearranging formulae then memorise these triangles!




d – distance (m), t – time (s), v - speed ($ms^{-1}$), f – frequency (Hz or $s^{-1}$), λ (m), T – period (s)
Note: kilo means x 1000, 1 km = 1000 m, 1 kHz = 1000 Hz

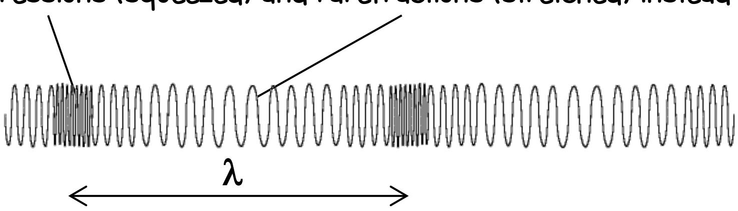
1. Waves transfer energy.
2. Transverse waves
   - Definition: involves particles vibrating at right angles to the wave direction
   - Examples: light, water, vibrating guitar string
   - Light travels in straight lines – also known as "rectilinear propagation"
   - Wave features



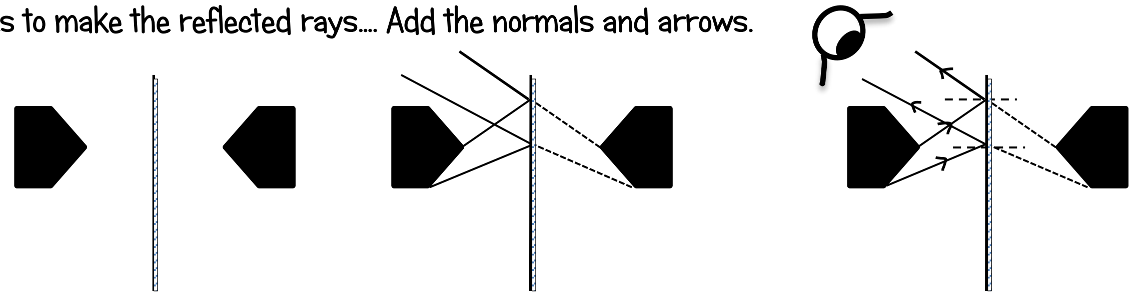

The picture shows three complete wavelengths. Z is the wavelength of the wave. Y is the amplitude of the wave. A very small piece or particle of the wave marked with a letter P is moving up.

If you were counting and timing the waves as they went past a pole and found that 4 waves went past in 2 seconds the frequency of the waves would be 4/2 = 2 Hz .The period (time for one wavelength to pass a point) of the wave would be 0.5s. (T=1/f so T = 1/2).

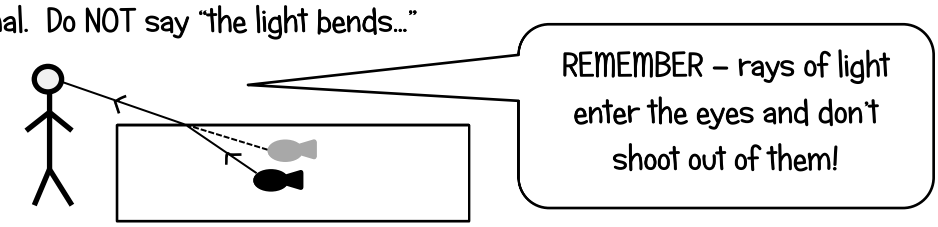
3. Longitudinal waves
   1. Definition - are waves that have vibrations along or parallel to their direction of travel.
   2. Examples – sound waves and P-waves (earthquakes)
   3. Have compressions (squeezed) and rarefractions (stretched) instead of peaks and troughs



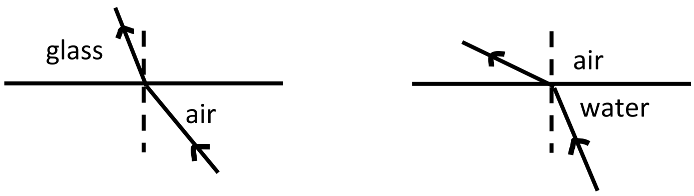
4. Converting transverse waves to longitudinal waves: A vibrating guitar string (transverse wave) causes air molecules near the string to vibrate back and forth with the same frequency and create compressions and rarefactions in air (longitudinal wave) which spread out as sound waves.
5. Reflection in plane mirrors
   - i° = r° for all mirrors using the normal – line drawn at 90° to surface of plane mirror; use dotted line
   - Properties of image – same size as object, appears same distance behind mirror as object is in front, laterally inverted e.g. , plane ɘnslq virtual (light rays don't actually go there), upright.
   - How to draw (cheat!) – draw mirror image same size and height as object "behind" the mirror, laterally inverting it. Draw line from object to mirror – any angle, then a dotted line to corresponding part of image. Repeat for another part or another angle. Now continue dotted lines back as solid lines to make the reflected rays.... Add the normals and arrows.



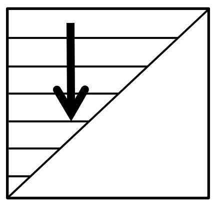
6. Refraction: Light changes direction as it passes from one medium to another because its speed changes.
7. If light travels into a more dense medium (e.g. air to glass), the light changes direction (is refracted) towards the normal. If it travels into a less dense medium (e.g. water to air), the light changes direction is (refracted) away from the normal. Do NOT say "the light bends..."

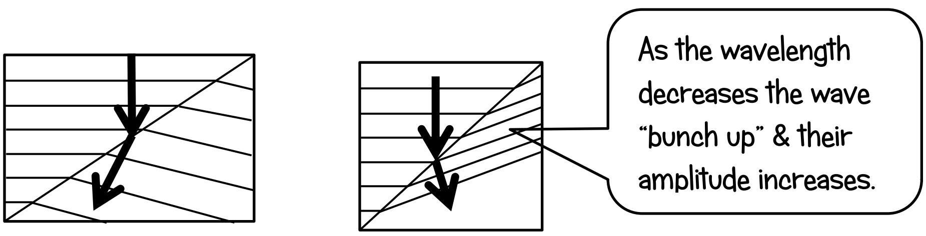



Waves have the same frequency during refraction (if they slow down or speed up, their wavelength decreases or increases but f stays the same)
8. Different media: air is less optically dense than water..... water is less optically dense than glass
Examples



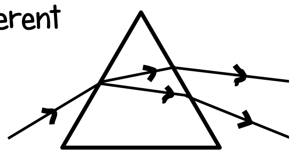

- If you get a wave front question (hopefully not) draw the refracted ray and then the wave fronts at 90° to the ray





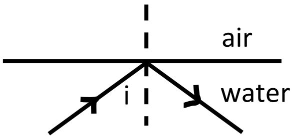

From shallow to deeper water From deeper to shallower water

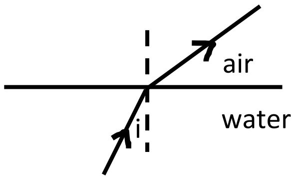
9. Prisms disperse light into ROYGBIV because the different colours have different changes in speed as they go through the prism – blue (violet) light travels slower through glass than red light (so changes direction more violently).



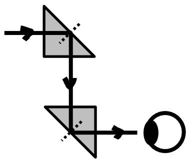

10. White light is a mixture of colours, light of different wavelengths / frequencies. This is why they refract differently (see 9.)

11. Critical angle determines whether incident rays are totally internally reflected or refracted. If angle of incidence > critical angle then total internal reflection will occur. (Total Internal reflection only happens when trying to leave optically denser materials).
If it less, refraction will occur.

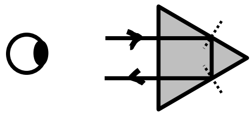


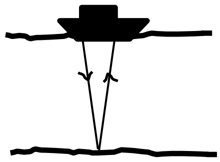

12. Prisms
Uses: periscopes,



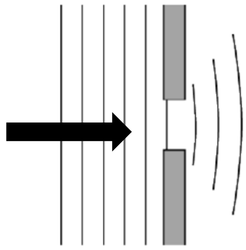
bicycle reflectors

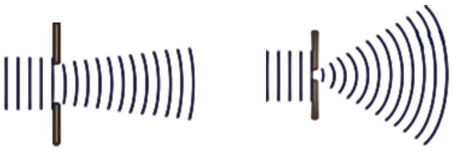


13. Echo = reflected sound. Remember to hear an echo the sound wave travels there AND BACK. If the distance travelled by a sound wave from ship to ocean floor to ship is 300 m, the sea floor is 150 m below the ship!

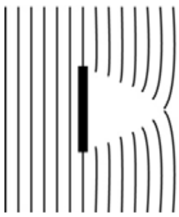


14. Diffraction = apparent bending of waves when a wave meets an obstacle (or passes through a gap). A smaller gap makes diffraction greater (more curve) but has <u>no effect</u> on λ, f and v. NCEA shouldn't examine gaps but should examine barrier such as (harbour) walls (see 15.)





15. Diffraction also makes waves bend around objects



16. Electromagnetic waves (radio (longest λ, smallest f),microwave, IR, visible, UV, x-ray, gamma (shortest λ, largest f) – all travel at the same speed (in a vacuum) – about 300,000,000 $ms^{-1}$.

17. Sound (a mechanical wave involving oscillation of matter) travels much slower than electromagnetic waves – about 343 $ms^{-1}$ in dry air @ 20°C - but sound travels at different speeds depending on what it is traveling through. Of the three mediums (gas, liquid, and solid) sound waves travel the slowest through gases, faster through liquids, and fastest through solids.