Phys106, II-Semester 2018/19, Tutorial 2, Fri 18.1.

Work in teams of three. Do"Stages" in the order below. When all teams finished a stage, make sure all students at your table understand the solution and agree on one by using the board (in Studio-Air), or paper sheets (in L1).

Stage 1 (i) Draw the following wave forms accurately into a the same co-ordinate system: $y(x) = A\cos\left(\frac{2\pi}{\lambda}x + \varphi\right) + B$.

- $A = 1$, $\lambda = 2$, $\varphi = 0$, $B = 0$
- $A = 1$, $\lambda = 3$, $\varphi = 0$, $B = 0.5$
- $A = 0.5$, $\lambda = 2$, $\varphi = -\pi/2$, $B = 0$

(ii) For the following waves, determine amplitude, frequency and phase velocity. What can you say about the units of these? (space is in meters (m) and time in seconds (s)).

- $y(x,t) = \frac{A}{2}\cos\left(\frac{2\pi}{\lambda}x - rt + \pi/2\right) + B$
- $y(x,t) = [B\cos\left(\frac{2\pi}{\lambda}x - 2\pi ft + \varphi\right) + A]C$
- $y(x,t) = 2D\cos\left[\frac{2\pi}{\lambda}(x - \lambda mt) - qt - 3\right] - A$

(iii) A function has the following form at three time points $t = 0, 1, 2$.

- $y(x, t = 0) = A\cos\left(\frac{2\pi}{\lambda}x\right)$
- $y(x, t = 1) = A\cos\left(\frac{2\pi}{\lambda}x - \frac{\pi}{3}\right)$
- $y(x, t = 2) = A\cos\left(\frac{2\pi}{\lambda}x - \frac{2\pi}{3}\right)$

Can you use this information to infer the travel direction, velocity and frequency of the wave? If yes what are they?

Stage 2 (i) For the following electro-magnetic waves, calculate the missing variable (wave-length λ or frequency ν): $\lambda = 1900$ nm, $\lambda = 550$ nm, $\nu = 10^{20}$ Hz, $\nu = 1$ GHz. What name do waves from that part of the electro-magnetic spectrum have? Discuss where they are used/ where they occur in nature.

(ii) For the following waves, calculate the phase velocity and guess which type of wave it might be: $\lambda = 1$ mm and $\nu = 5$ MHz, $\lambda = 20$ cm and $\nu = 1650$ Hz, $\lambda = 1000$ km and $\nu = 300$ Hz (based on the speeds of waves given in the lecture or the internet).

Stage 3 (i) Consider the following functional shape: $y_{tot}(x,t) = y_1(x,t) + y_2(x,t)$ with $y_1(x,t) = A\sin\left(\frac{2\pi}{\lambda_1}(x - Vt)\right)$ and $y_2(x,t) = A\sin\left(\frac{2\pi}{\lambda_2}(x - Vt)\right)$, with almost but not quite equal wavelengths $\lambda_1 \approx \lambda_2$. Is this a solution to the wave equation for velocity V?

(ii) Make a drawing of $y_1(x,t)$ and $y_2(x,t)$ at $t = 0$ for some $\lambda_1 \approx \lambda_2$ of your choice. Make sure to draw it for *many* wavelengths. Using only your drawing "add" them together to form $y_{tot}(x,t)$. How does the result look? Does the pattern have a name?

(iii) Now lets do the same with math, at $t = 0$ using the trigonometric identity: $\sin(a) + \sin(b) = 2\sin\left(\frac{a+b}{2}\right)\cos\left(\frac{a-b}{2}\right)$. Compare with your drawing.

Stage 4 (i) In the lecture we discussed double slit interference as arising from the superposition of waves coming from the two different slits. We can also treat a single slit as an infinitely dense collection of single point "emitters" as sketched in the figures below. On your table, discuss qualitatively how you would expect based on these pictures that waves passing through this single slit behave when they reach the far right side. How does this differ from a stream of particles? Does the effect depend on wave-length? Did you experience this in your lives already?

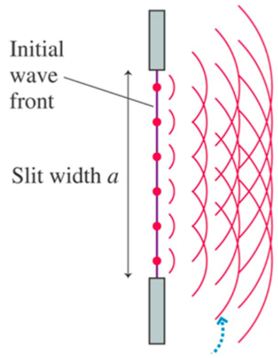

Fig. A

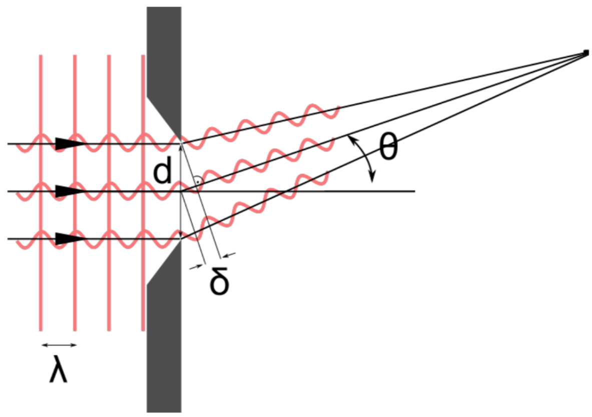

Fig. B