# Physics 131 – Test 1 – Fall 2007

One-page reminder sheet allowed. *Show all work – no credit given if work not shown!*

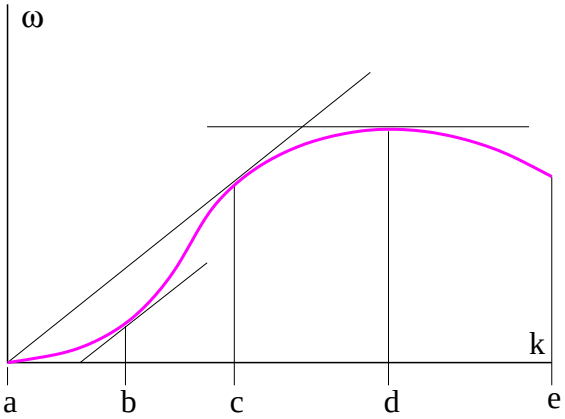
1. Two sine waves of equal amplitude produce a sequence of wave packets of length $L$ containing waves with wavenumber $k$. Find the wavenumbers of the two original sine waves in terms of $L$ and $k$.

2. Given the dispersion relation for the wave shown graphically below, indicate the ranges of $k$ for which

   (a) the group velocity is greater than the phase speed;

   (b) the group velocity is positive, but less than the phase speed;

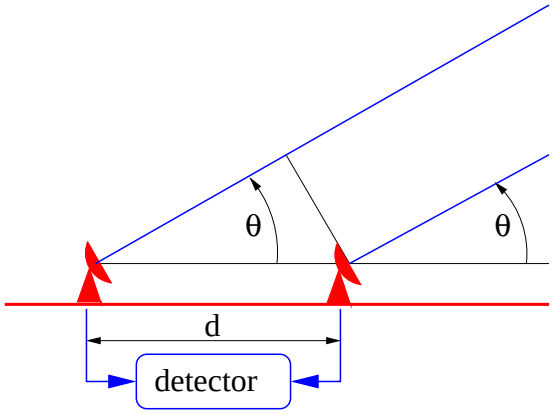
   (c) the group velocity is negative.




3. Two radio telescopes aligned east-west along the earth's equator with separation $d$ receive radio signals of wavelength $\lambda$ from a quasar rising in the east. The signals from the telescopes are compared in a detector which determines whether they are in phase or out of phase.

   (a) Determine the quasar elevation angles $\theta$ for which constructive interference occurs between the signals from the two telescopes.

   (b) How many cycles of constructive-destructive-constructive interference occur from the time the quasar rises above the horizon to the time it is directly overhead?

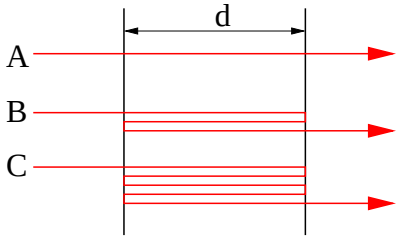


4. Consider the Fabry-Perot interferometer below with half-silvered mirrors separated by distance $d$. Light with wavelength $\lambda$ is passing through the interferometer.

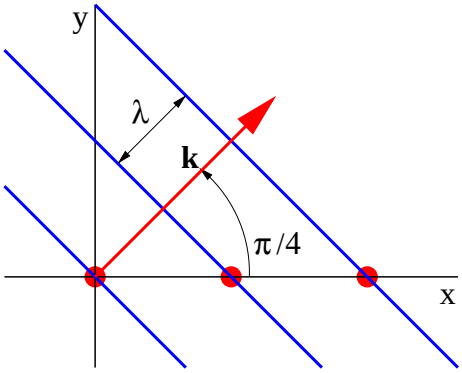
   (a) Find the values of $d$ which result in constructive interference between the beam passing straight through (A) and the beam that makes one round trip (B).

   (b) Do the same for constructive interference between beam A and beam C which makes two round trips.

   (c) For what values of $d$ do all three beams interfere constructively?




5. A plane wave in two dimensions in the $x-y$ plane moves in the direction 45° counterclockwise from the $x$-axis as shown below. Determine how fast the intersection between a wavefront and the $x$-axis moves to the right in terms of the phase speed $c$ and wavelength $\lambda$ of the wave.




6. In the sketch below the superposition of two plane waves results in wavefronts given by the thin lines while the thick lines show where destructive interference occurs between the waves.

   (a) Sketch a possible central wave vector $\mathbf{k}_0$.

   (b) Sketch a possible half-difference $\Delta\mathbf{k}$ between the wave vectors of the two waves.

   (c) From the above sketches, draw the corresponding wave vectors $\mathbf{k}_1$ and $\mathbf{k}_2$ of the superposed waves.