

Problem 1. In microwave ovens the food is heated by standing waves of high-frequency electrical fields ($f = 2,45$ GHz, wavelength in air 12 cm).

a) What is the wave velocity in air? (1p)

Lösning:

b) In most of these ovens, the food is on a rotating tray, because standing waves give rise to "cold spots". Determine the shortest distance between such cold spots. (1p)

Lösning:

Problem 2. A few questions about sound. Motivate your answers.

a) The speed of sound in air depends on:

frequency, wavelength, temperature, all of these, none of these. (1p)

Lösning:

b) *Sonic booms are caused by airplanes accelerating to supersonic speeds* - true or false? (1p)

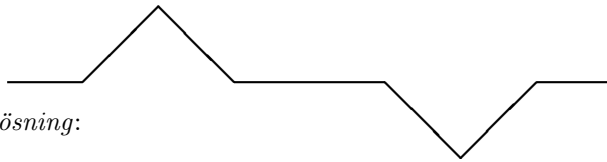
Lösning:

c) When a source of sound approaches, one measures a higher:

speed of sound, wavelength, frequency (mark all answers that apply). (1p)

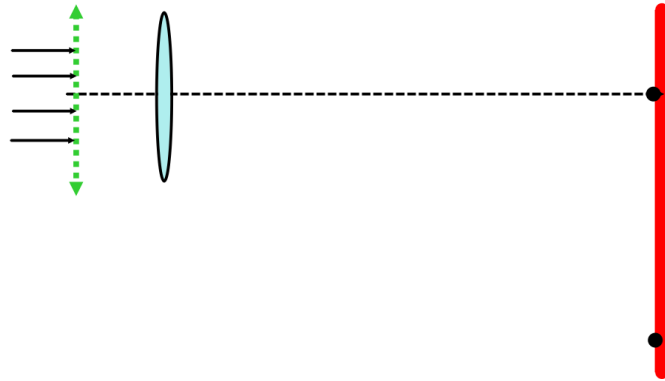
Lösning:

Problem 3. The figure shows a pair of pulses at $t = 0$ that travel toward each other at equal speeds of 1 cm/s. The string is 8 cm long. Sketch the shape of the string at $t = 1$ s, $t = 1,5$ s, $t = 2$ s, $t = 2,5$ s, $t = 3$ s and $t = 4$ s. (2p)



Lösning:

Problem 4. The figure below shows a diffraction grating in front of the eye lens. The retina is drawn schematically, a flat screen, 2 cm behind the lens. The light source is positioned at a large distance, straight away from the eye. It emits white light. Without a grating, a point image is formed on the retina in the point indicated on the optical axis. With a grating, 700 nm light gets focused in the lower spot indicated on the screen.



a) Determine the separation between the slits based on the dimensions in the figure. (1p)

Lösning:

b) Construct the rays towards the second point on the screen. (1p)

Lösning:

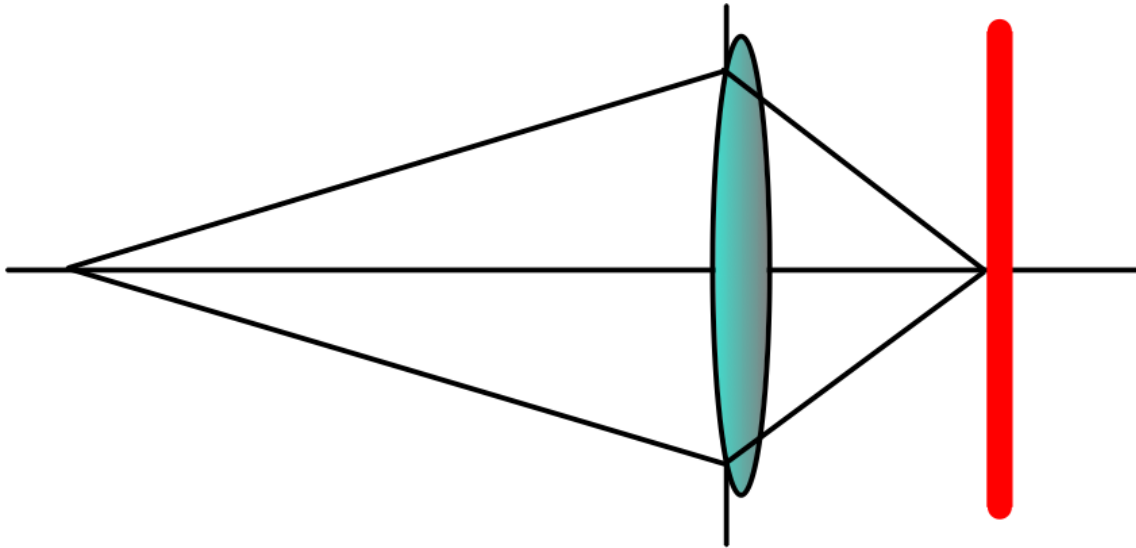
c) What distance should the eye focus on to see a clear spectrum? (1p)

Lösning:

d) Draw the image that one would see through the grating, indicate a scale. (1p)

Lösning:

Problem 5. The figure below shows the basics of a camera: a lens with an aperture (diaphragm) images an object on a screen (photographic emulsion or digital sensor). The figure also shows the marginal rays from a point on the optical axis that the camera is focused on.



a) Draw the marginal rays for a point that is closer and for a point that is further away. Describe what image quality objects at such positions give rise to. (2p)

Lösning:

b) What are the effects of a smaller aperture? Explain with a drawing. (1p)

Lösning: