Ultrasonics 2017
Exercise 2

Bring your solutions to this and the first exercise to the exercise session on Thu 26.1.

1. Acoustic intensity is defined as the average energy flow per unit area. The unit is Joule/s/m^2 = W /m^2. A sound source emitting a "plane wave" is placed under water. The acoustic intensity of the emitted sound is 200 W/m^2 and the frequency 15 kHz. Assume that the plane wave travels through a circular ring with a radius of 50 cm.
   Calculate:
   a. Acoustic power through the ring
   b. The pressure amplitude of the plane wave
   c. The amplitude of the particle speed
   d. The amplitude of the particle displacement
   e. Compression amplitude
   f. Root mean square of the pressure
   g. Static radiation pressure

   (ρ_{water} = 1000kg/m^3 and c_{water} = 1500m/s)

2. Calculate the speed of sound in air that has the temperature:
   a. -25°C
   b. 0°C
   c. +25°C
   d. +100°C

   What is the sensitivity of a US based thermometer?

3. A wave propagating on the surface of a solid object (Rayleigh wave) is a superposition of two inhomogeneous waves, longitudinal and shear, propagating at identical velocities on the interface. A surface wave propagates with a phase velocity approximately given by

$$\frac{c_R}{c_t} = \frac{0{,}87 + 1{,}12\nu}{1+\nu}$$

   Where c_R = phase velocity of the surface wave, c_t = velocity of a transverse wave in the material and ν= Poisson's ratio. Show that the phase velocity can be presented in the form:

$$c_R = \alpha\sqrt{\frac{G}{\rho}}$$

where α = constant, G = shear modulus and ρ= density. What is the velocity of the surface wave on aluminium? What is the Rayleigh c and why is it important in ultrasound microscopy?

4. Explain briefly:
    a. Sonoluminescence
    b. Piezoelectric effect
    c. Dispersion
    d. Cavitation

    (What are the physical quantities and units describing these?)

5. You are driving around in your old Corolla. At what distance is the lowest bass frequencies of your stereo system heard effectively? The lowest effective frequency is 50 Hz and after attenuating 3dB the bass will no longer rouse respect. The attenuation of 100Hz sound in air is 0,05dB/m and grows in respect to the square of the frequency. How accurately can one determine the location of the car from the -3dB distance?