

Aufgabe 2: Wasserwelle

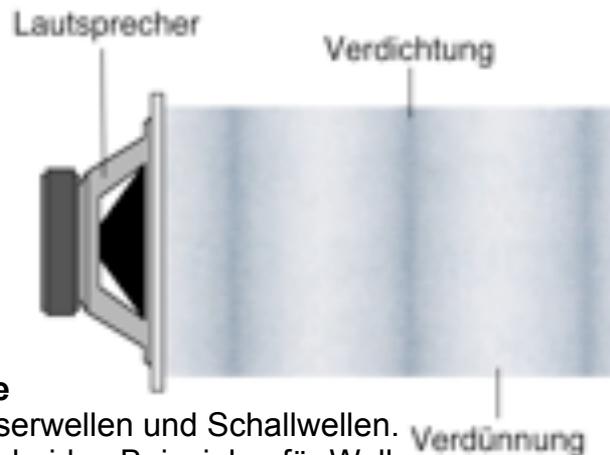
a) Eine Meereswelle besitzt eine Wellenlänge von 200 m und eine Schwingungsdauer von 10 s.

Wie groß ist ihre Ausbreitungsgeschwindigkeit?

b) Was geschieht, wenn die Meereswelle auf die seichte Uferzone bzw. das Ufer aufläuft?

$$c = \lambda \cdot f \quad f = \frac{1}{T} = \frac{1}{10} \frac{1}{s} \quad \lambda = 200 \text{ m}$$

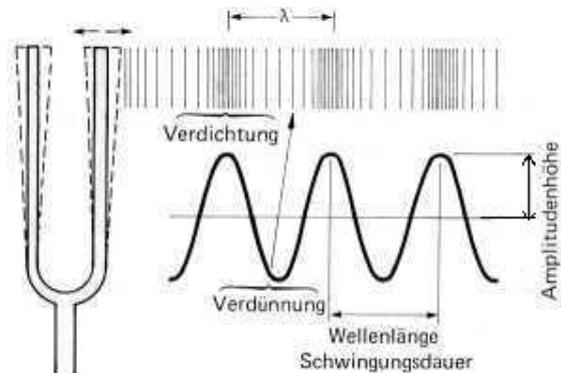
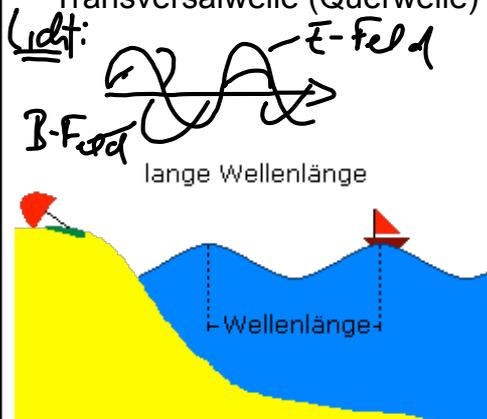
$$c = 200 \text{ m} \cdot \frac{1}{10} \frac{1}{s} = 20 \frac{\text{m}}{\text{s}}$$



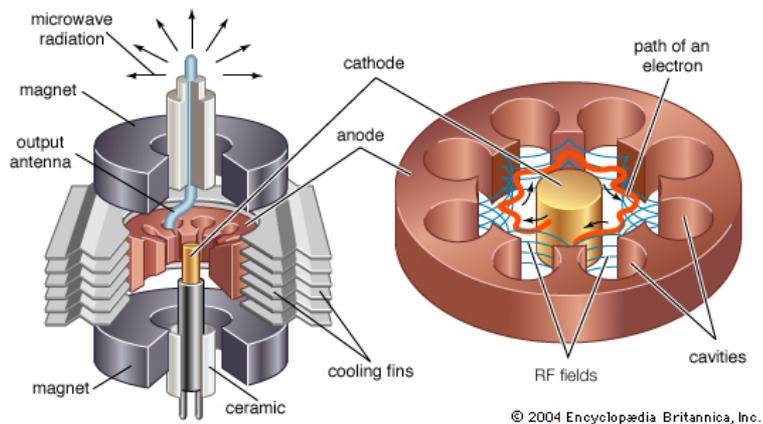
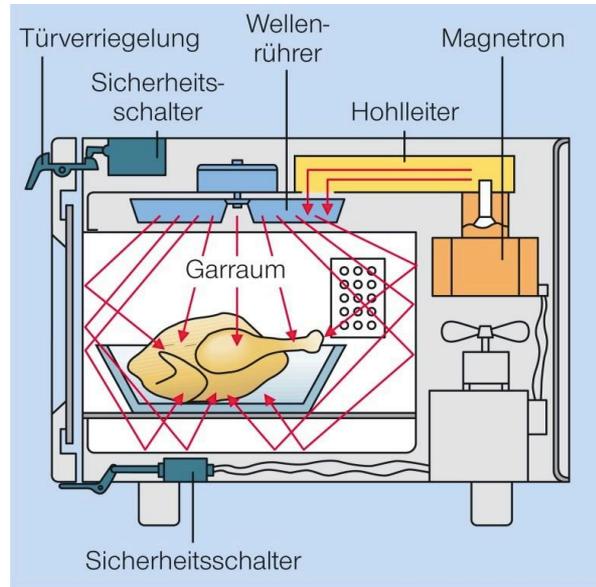
Aufgabe 3: Schallwelle

a) Vergleichen Sie Wasserwellen und Schallwellen.

b) Stellen Sie an diesen beiden Beispielen für Wellen mit Hilfe von Skizzen den Unterschied zwischen Transversalwelle (Querwelle) und Longitudinalwelle (Längswelle) dar.



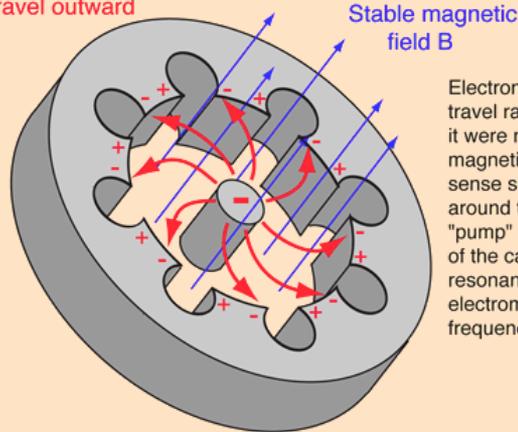
Darstellung eines einfachen Schwingungsvorgangs



The Magnetron

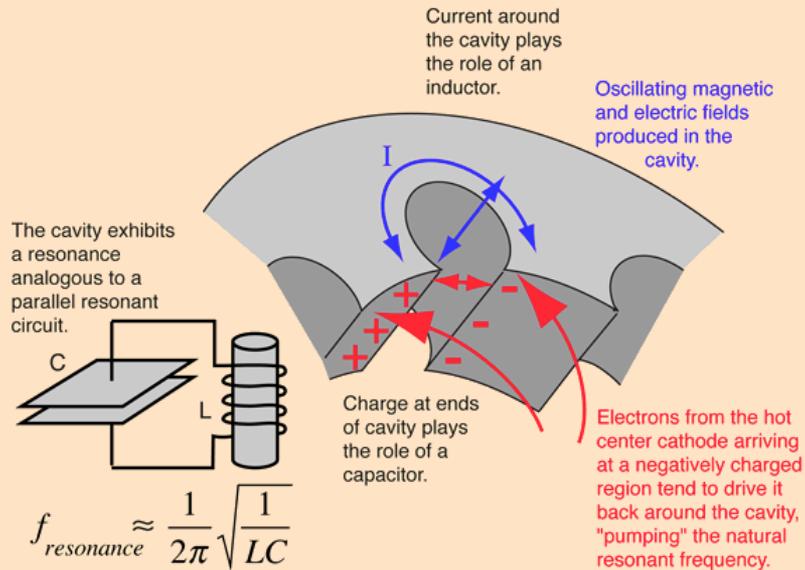
The [microwave radiation](#) of microwave ovens and some radar applications is produced by a device called a magnetron.

Hot cathode emits electrons which travel outward



Electrons from a hot filament would travel radially to the outside ring if it were not for the magnetic field. The magnetic force deflects them in the sense shown and they tend to sweep around the circle. In so doing, they "pump" the natural resonant frequency of the cavities. The currents around the resonant cavities cause them to radiate electromagnetic energy at that resonant frequency.

The magnetron is called a "crossed-field" device in the industry because both [magnetic](#) and [electric](#) fields are employed in its operation, and they are produced in perpendicular directions so that they cross. The applied magnetic field is constant and applied along the axis of the circular device illustrated. The power to the device is applied to the center cathode which is heated to supply energetic electrons which would, in the absence of the magnetic field, tend to move radially outward to the ring anode which surrounds it.



$$f_{\text{resonance}} \approx \frac{1}{2\pi} \sqrt{\frac{1}{LC}}$$

Electrons are released at the center hot cathode by the process of thermionic emission and have an accelerating field which moves them outward toward the anode. The axial magnetic field exerts a [magnetic force](#) on these charges which is perpendicular to their initially radial motion, and they tend to be swept around the circle. In this way, work is done on the charges and therefore energy from the power supply is given to them. As these electrons sweep toward a point where there is excess negative charge, that charge tends to be pushed back around the cavity, imparting energy to the oscillation at the natural frequency of the cavity. This driven oscillation of the charges around the cavities leads to radiation of electromagnetic waves, the output of the magnetron.

Energie der Mikrowelle

$$P = 600 \text{ W} \quad t = 6 \text{ min}$$

$$W = ?$$

$$\boxed{W_s = J = V \cdot A \cdot s}$$

$$W = P \cdot t$$

$$= 600 \cdot 6 \cdot 60 \text{ Ws}$$

$$= 216\,000 \text{ J}$$

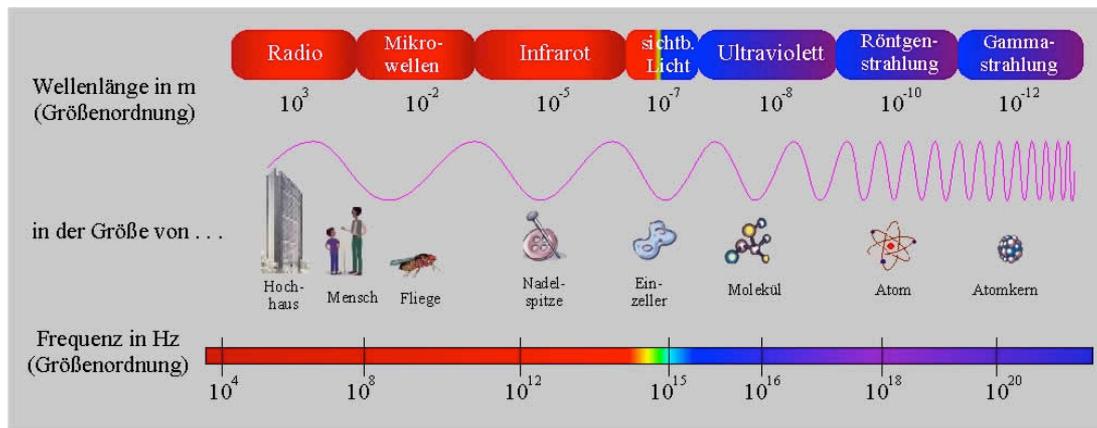
Handy: SAR-Wert $0,6 \frac{\text{W}}{\text{kg}}$

$$\text{Ohr: } m = 100 \text{ g} = 0,1 \text{ kg}$$

6 min telefonieren

$$W = 0,6 \frac{\text{W}}{\text{kg}} \cdot 0,1 \text{ kg} \cdot 6 \cdot 60 \text{ s}$$

$$= 21,6 \text{ J}$$

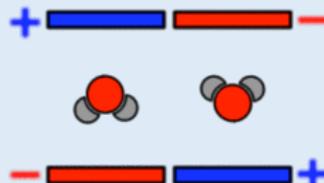


Erwärmung mit Mikrowellen

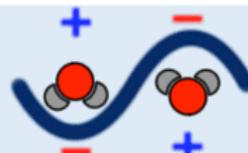
Wassermoleküle sind elektrisch unausgewogen: Das Sauerstoffatom bindet die Elektronen stärker an sich als die beiden Wasserstoffatome. Die Seite des Sauerstoffatoms ist daher elektrisch negativ geladen.



Die elektrische Unausgewogenheit der Wassermoleküle sorgt dafür, dass sich die Teilchen in einem elektrischen Feld ausrichten.



Elektromagnetische Wellen wie Mikrowellen sind elektrische Wechselfelder, in denen die Wassermoleküle hin- und hergedreht werden. Durch Reibung der Wassermoleküle an ihren Nachbarn entsteht Wärme.



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Ein Mikrowellenherd erhitzt zunächst die Wassermoleküle im Essen.

Quelle: Dirk Rathje/Welt der Physik