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PHY1106 Waves section

Syllabus outline:
full syllabus available at;
http://newton.ex.ac.uk/handbook/modules/PHY1106.html

IV. Introduction to Waves
V. Superposition of Waves
VI. Reflection and Transmission of Waves
VII. Waves on Periodic Structures
VIII. Other Examples of Waves

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Introduction to Waves

Dr. Pete Vukusic, Exeter University:
PHY 1106: Waves and Oscillators (Lecture 12)

Oscillation (vibration):

- ……..
- (e.g. mass on spring, simple pendulum, resonant circuit)

Wave:

- ……..
- (e.g. ripples on a pond, waves on a string, sound waves, electromagnetic waves, wave functions in Quantum Mechanics)
- ……..
……

Mathematical forms:

Oscillation	Wave

where *k* is the modulus of the ……. **k** (propagation constant) whose direction is the propagation direction and whose length is ____ .

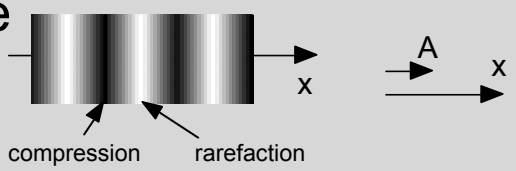
• exponential notation includes ……... in one expression.

• for classical waves we generally take ……... as final solution

Basic wave concepts (1)

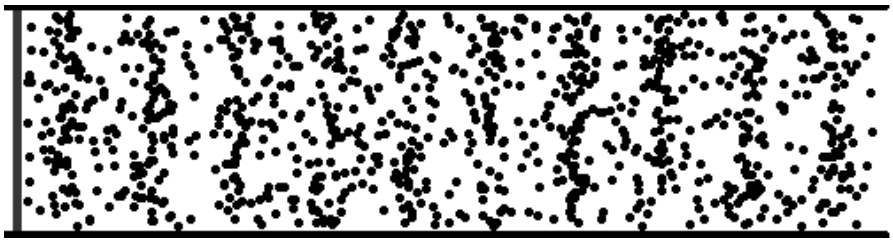
1) Longitudinal wave

e.g. ……..:



• ……

• *A*(*x*,*t*) is displacement of molecules at (*x*,*t*) (or pressure).

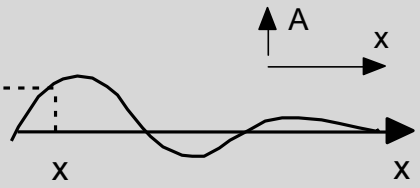


……. waves in a gas, (excited by the red piston).

Basic wave concepts (2)

2) Transverse wave

e.g. ……..: A(x,t) ---



• ……
……..

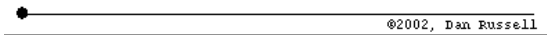
• $A(x,t)$ is displacement of molecules at (x,t).

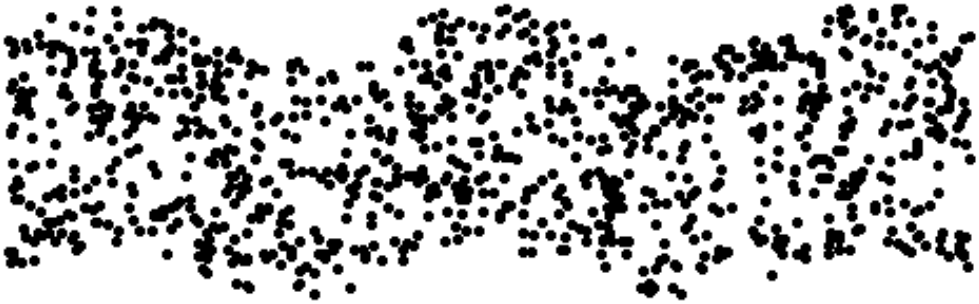
• transverse wave along a line of connected particles.

• notice the movement of an individual particle

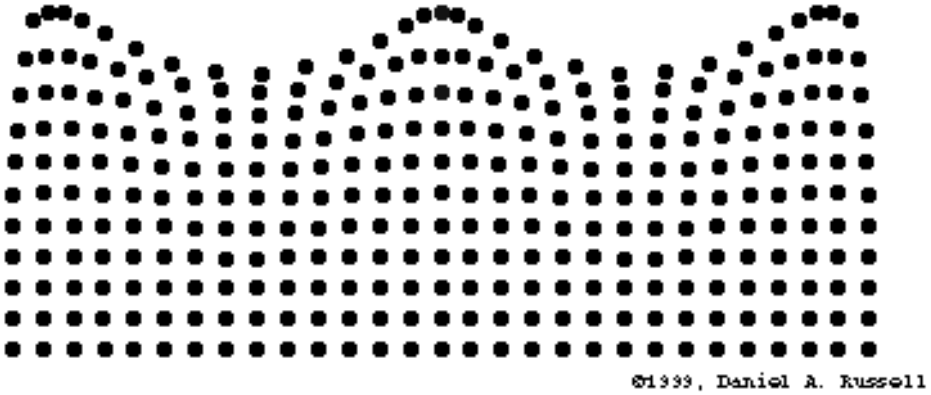
• ……..
……

Wave animations





Wave animations



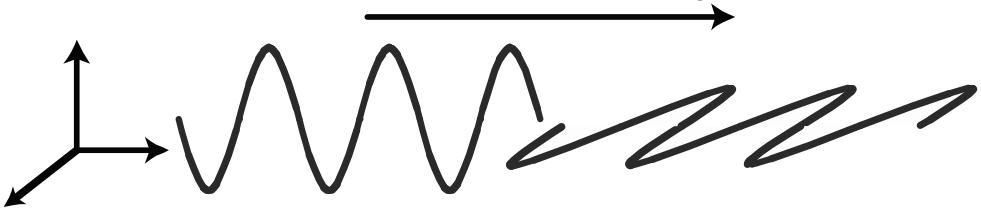
……. are an example of waves that involve a combination of both longitudinal and transverse motions. As a wave travels through the water, the particles travel in *clockwise circles*. The …….. ……. The movie shows a water wave traveling from left to right in a region where the depth of the water is greater than the wavelength of the waves.

Basic wave concepts (3)

Polarization:

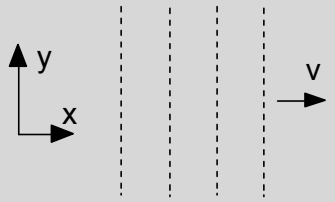
- ……..
  …….
- two possible linear polarizations

……. wave: direction of propagation

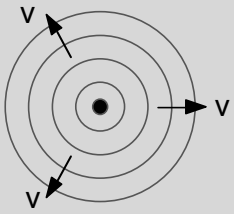


Basic wave concepts (3)

a) Plane wave



b) Circular wave



Basic wave concepts (4)

- Consider the sinusoidal wave
- The ..... . It is the maximum disturbance from equilibrium caused by the wave.

Basic wave concepts (5)

$A(x,t) = A_0 \sin(\omega t - kx)$

are waves travelling in which directions?

$A(x,t) = A_0 \sin(\omega t + kx)$

The displacement of a particle at *x=0* is given by;

$A = A_0 \sin(\omega t)$

……
……

So the motion of the point at any *x* position is the same as the motion of the at *x=0* at the earlier time of

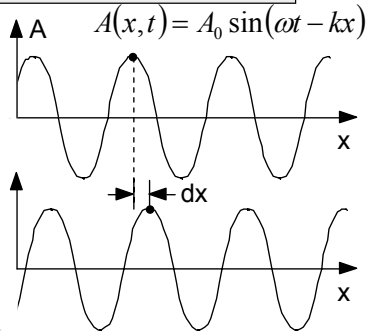
……
……

$A(x,t) = A_0 \sin(\omega t - kx)$ is a wave travelling to <u>right</u>

Basic wave concepts (6)

• The black dot marks the progress of a particular point on the wave

• This point has a specific phase ϕ.



• …….. i.e. it has a velocity

• The point also has a specific value of *A* (in this case $A = A_0$)

• For ϕ = *constant*, differentiating with respect to *t* gives…

Basic wave concepts (7)

Therefore the velocity of a "crest" of a wave as it moves along the x-direction is:

- …. ……
- It is the ……..
  ……..
- (strictly it should be multiplied by a unit vector in the direction of propagation)

Basic wave concepts (8)

Particle velocity

The velocity of a *particle* in the medium is *not* the phase velocity.

……..
……..

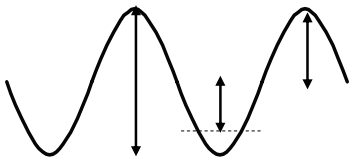
Particle transverse displacement $y(x,t) = y_0 \sin(\omega t - kx)$

differentiate w.r.t. time for velocity

this is different to

A quick test….

Which arrow indicates the wave amplitude?



The angular frequency, ω, is measured in Hertz – true or false?

A formula for phase velocity is $v = f\lambda$. Rewrite this in terms of ω and *k*.