

Answer on the Question #66435, Chemistry / General chemistry

b) What is matter wave? What do you understand by in phase and out phase waves? (5)

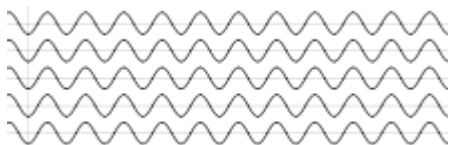
Calculate the wavelength associated with a body of mass 1.5 kg moving with a velocity of 100 m s⁻¹.

Solution:

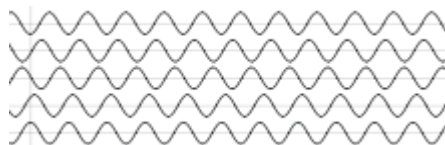
Wave is an oscillation which lead to the energy transfer through a medium. In common waves consist of oscillations or vibrations around almost fixed locations. The waves can be a mechanical like a sound and electromagnetic one like visible light, for instance.

Phase is the position of a point in time (an instant) on a wave cycle. Phase can also be an expression of relative displacement between two corresponding features (peak or zero crossing) of two waves with the same frequency.

Two waves that have the same frequency and phase are in phase. Two waves that have the same frequency but different phases are out of phase with each other.



In phase



Out of phase

Calculation of the wavelength:

1st step is the kinetic energy calculation:

$$E = \frac{1}{2}mv^2 = \frac{1}{2} \cdot 1.5 \text{ kg} \cdot (100\text{m/s})^2 = 7500 \frac{\text{kg} \cdot \text{m}^2}{\text{s}^2} = 7500 \text{ J}$$

2nd step is the calculation of the wavelength with the Broglie equation:

$$\lambda = \frac{h}{p}$$

where h is the Planck's constant and p is the moment of the body.

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2Em}} = \frac{6.626 \cdot 10^{-34} \text{ J} \cdot \text{s}}{\sqrt{2 \cdot 7500 \text{ J} \cdot \text{kg}}} = 4.4 \cdot 10^{-36} \text{ m}$$

Answer: the wavelength is $4.4 \cdot 10^{-36}$ m.