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THE WAVE COLLISION AND LAWS OF COLLISION

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***Abstract**:* This research on wave collision provide us a new laws of collision which will help us to find the formula of Elastic collision in two dimension which remained undiscovered yet. Till paper also deals with the change of the mass and energy of Electromagnetic waves in different mediums.It is took us to a new world of wave mechanics which is different of Schrodinger's wave equation.This paper will help physics to become more of itself and it will give a bridge between the undiscovered areas to discover in physics .

KEYWORDS = CLASSICAL MECHANICS AND WAVE MECHANICS

I. INTRODUCTION

Earlier, we have only known about matter collision and real life visible collision and had also learnt how to deal with them. But in the below topic we will learn about matter wave collision.

The theory of Electromagnetic mass also provides us details about mass and energy of Electromagnetic waves and how they are changing with respect to mediums.

The laws of collision will help us to learn the basics of collision and it will also help us to solve the problems and with the help of this law we can arrive at the formulae of Elastic Collision in 2-dimension which are yet to be discovered

1) **Collision between two matter waves in one dimension.**

Let us consider two particles A and B of masses m_1 and m_2 moving in same direction with velocities u_1 and u_2 collide each other.[1]

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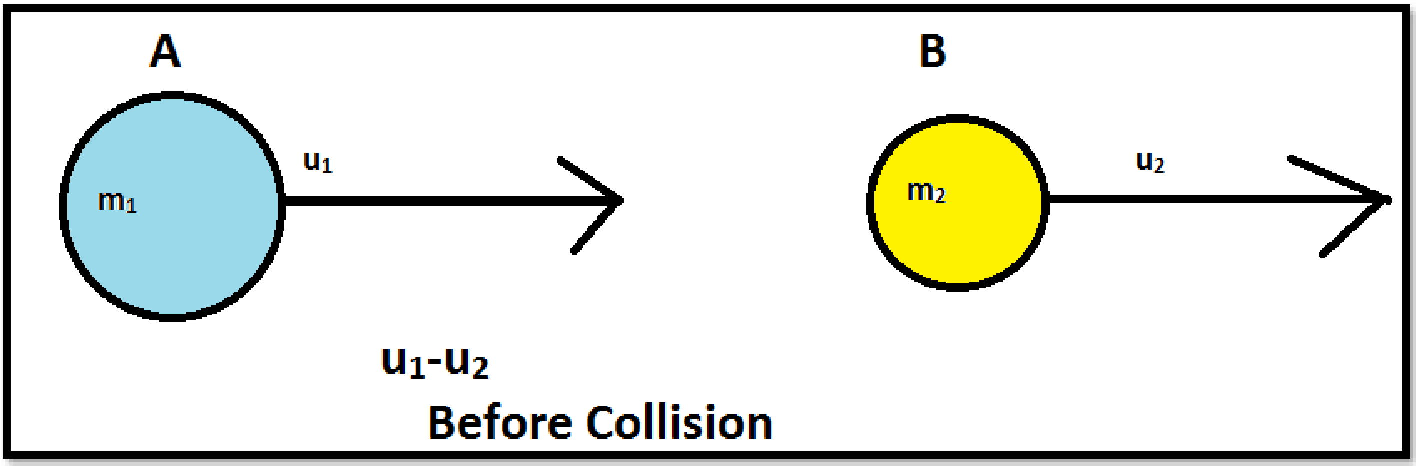

FIG 1

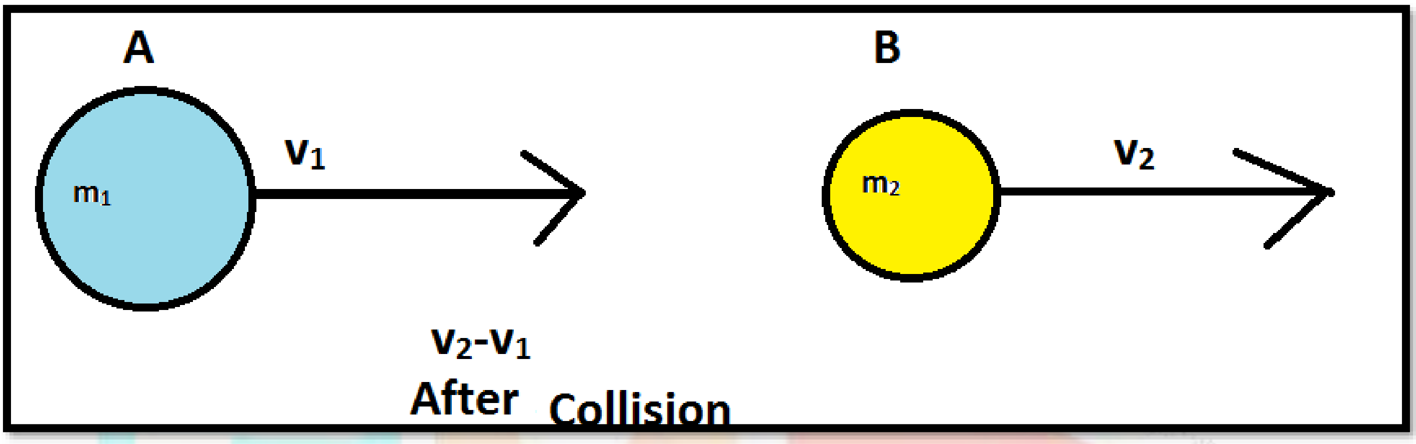

FIG 2

The particle A is called the incident particle particle and the particle B is called the target particle.
Let v_1 and v_2 be the final velocities of A and B .
According to De-Broglie's wavelength,
$\lambda_1=h/m_1u_1$ and $\lambda_2=h/m_2u_2$
where λ_1 and λ_2 are the initial wavelength of particles A and B. λ_1' and λ_2' be the final wavelength after collision of the particle A and B.
According to the law of Conservation of momentum,
$m_1u_1+m_2u_2 = m_1v_1+m_2v_2$
as the particles are matter waves .
So, we can write that
$h/\lambda_1+h/\lambda_2 = h/\lambda_1'+h/\lambda_2'$
hence,

$$\boxed{1/\lambda_1 + 1/\lambda_2 = 1/\lambda_1' + 1/\lambda_2' \text{ ------------------------(1)}}$$

Now, we know that relative velocity of approach is equal to relative velocity of Separation,

$(u_1-u_2)=v_2-v_1$

⇨ **$h/m_1\lambda_1 - h/m_2\lambda_2 = h/m_2\lambda_2' - h/m_1\lambda_1'$**

⇨ **$1/m_1\lambda_1 + 1/m_1\lambda_1' = 1/m_2\lambda_2' + 1/m_2\lambda_2$**

⇨ **$1/m_1(1/\lambda_1 + 1/\lambda_1') = 1/m_2(1/\lambda_2 + 1/\lambda_2')$**

⇨ **$(m_1/m_2)*(1/\lambda_2 + 1/\lambda_2')= (1/\lambda_1 + 1/\lambda_1')$**

⇨ **$(m_1/m_2)= (1/\lambda_1 + 1/\lambda_1')/(1/\lambda_2 + 1/\lambda_2')$**

⇨ $\boxed{(m_1/m_2)=[(\lambda_1'+\lambda_1)*(\lambda_2'\lambda_2)]/[(\lambda_2'+\lambda_2)*\lambda_1'\lambda_1]\text{---(2)}}$

⇨ **From equation (1) we get**

⇨ $(m_1/m_2)=[(\lambda_1'+\lambda_1)*(\lambda_2-\lambda_2')]/[(\lambda_1'^2-\lambda_1)*(\lambda_2'+\lambda_2)]$

⇨ **Again from equation 1 we solve for** λ_1' and we get

⇨ $\boxed{(\lambda_1'+\lambda_1)/(\lambda_1'-\lambda_1)=[2\lambda_2\lambda_2'+\lambda_1\lambda_2'-\lambda_1\lambda_2]/[(\lambda_2-\lambda_2')]\text{---(3)}}$

⇨ putting the above value in equation (2) , we obtained the result

⇨ $\lambda_2' = [\lambda_1 \lambda_2 * (m_1+m_2)]/[2m_2 \lambda_2 + m_2 \lambda_1 - m_1 \lambda_1]$---(4)

⇨ Similarly, solving for λ_2' from equation (1) and putting them in equation (2) we get

⇨ $\lambda_1' = [\lambda_1 \lambda_2 * (m_1+m_2)]/[2m_1 \lambda_1 + m_1 \lambda_2 - m_2 \lambda_2]$---(5)

2) THEORY OF ELECTROMAGNETIC MASS

- The frequency of an electromagnetic Wave is directly proportional to its moving mass.

$f \propto m$

where,

f=frequency

m=moving mass

- Moving mass of an Electromagnetic wave is different in different media.

Proof: The speed of electromagnetic wave in any medium is

$$\boxed{C = (1/u\varepsilon)^{1/2} \text{ -----------------------------(6)}}$$

Where,

C=velocity of electromagnetic wave

u=permeability[3] of the medium

ε=permittivity of the same medium

We know that,

$C = f\lambda$ where λ=wavelength

Putting the value of c from equation (6) we get

$$(1/u\varepsilon)^{1/2} = f\lambda$$

- ⇨ $1/\lambda = f(u\varepsilon)^{1/2}$
- ⇨ **But,** $\lambda = h/mc$ where h = planck's constant
- ⇨ $mc/h = f(u\varepsilon)^{1/2}$
- ⇨ $m = hf(u\varepsilon)^{1/2}/c$
- ⇨ **putting the value of c from equation 6 we get,**
- ⇨ $m = hf[(u\varepsilon)^{1/2}]^2$

⇨ $m = hfu\varepsilon$--(7)

- ⇨ **since, h, u, ε are constants for a particular medium**
- ⇨ **hence,**
- ⇨ $f \propto m$**[proved]**

The equation (7) shows that an Electromagnetic wave which exerts pressure and have momentum should have mass.

(3.1) ENERGY OF AN ELECTROMAGNETIC WAVE

Energy of an electromagnetic wave is different in different medium

We know,

Momentum(p) = Energy(e)/velocity(c)-----------(8)

- ⇨ $C = e/p$
- ⇨ **Now,**
- ⇨ $m = hfu\varepsilon$
- ⇨ $m = hf(u\varepsilon)^{1/2}/c$
- ⇨ **putting the value of c from equation (8) we get**
- ⇨ $m = hfp(u\varepsilon)^{1/2}/e$

⇨ $e = hfp(u\varepsilon)^{1/2}/m$------------------------------------(9)

- ⇨ **According to de-Broglie's wave equation**
- ⇨ $\lambda = h/p$

⇨ $p = h/\lambda$---(10)

- ⇨ **putting the value of equation (10) in equation (9) we get**

⇨ $E = (h^2 f) * (u\varepsilon)^{1/2}/(m\lambda)$--------------------------------(11)

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3) LAWS OF COLLISION

The following are the basic laws of collision:-

- When a incident particle collides with a targeted particle, the targeted particle starts moving with a uniform velocity in the line which joins the centre of masses of both the particle during collision.(The mass of targeted particle should be very large in comparision to the incident particle)

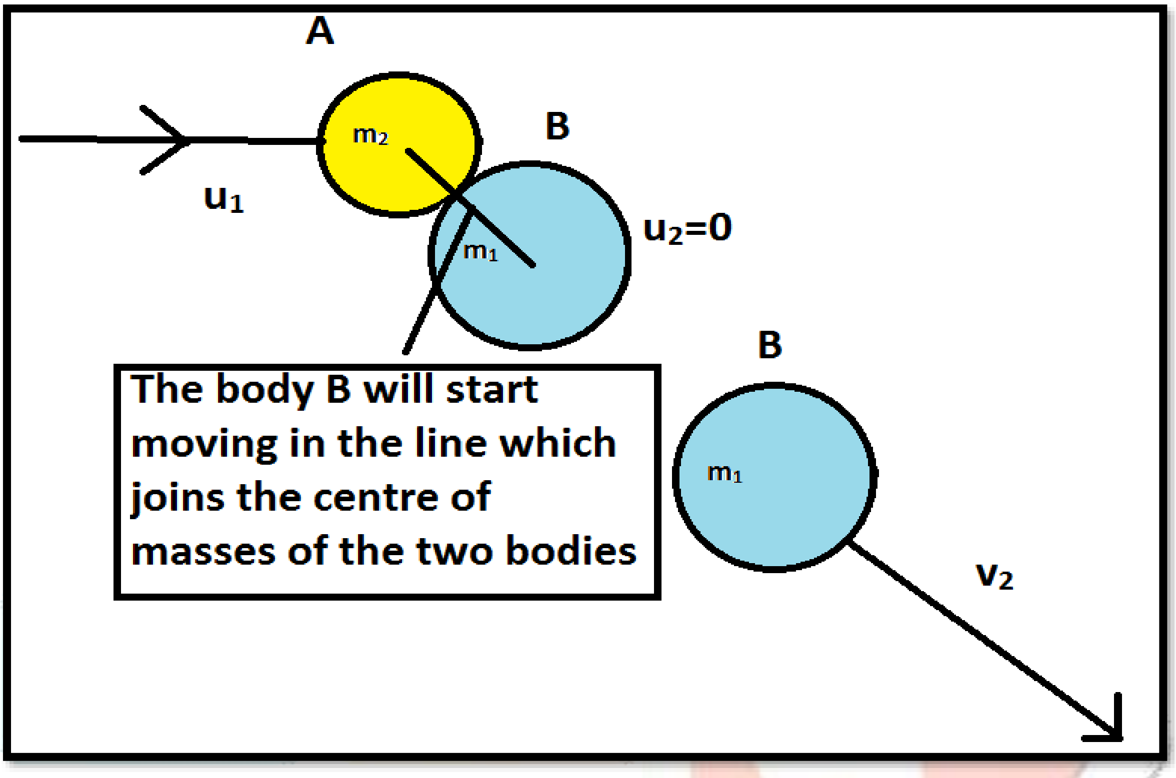

FIG 3

- If the mass and velocity of the inclined particle is very large than the mass and velocity of the target particle then, the incident particle will continue to move in the same direction but with different velocity.
- If the collision between incident particle and Target particle is not head-on and both the masses of incident and target particle are same then the two identical particles move at right angles after elastic collision in 2-dimension.
- If the mass of a target particle is very large in comparison to the incident particle then the particle bounces back with almost same speed.

(4.1) ELASTIC COLLISION IN TWO DIMENSIONS

Let A and B be two particles which hav[4]e an elastic (non-head on) collision with each other, the particle B being at rest. The particle A is called the incident particle and B is the target particle.

Let m_1 , m_2 = masses of the particles A and B

u_1 = velocity of the particle A along x-axis before collision.

v_1 , v_2 = velocity of the particle A and B after collision.

Since, the collision is non-head . Let v_1 and v_2 make angles θ and ϕ respectively along axis. According to the figure 4 below:-

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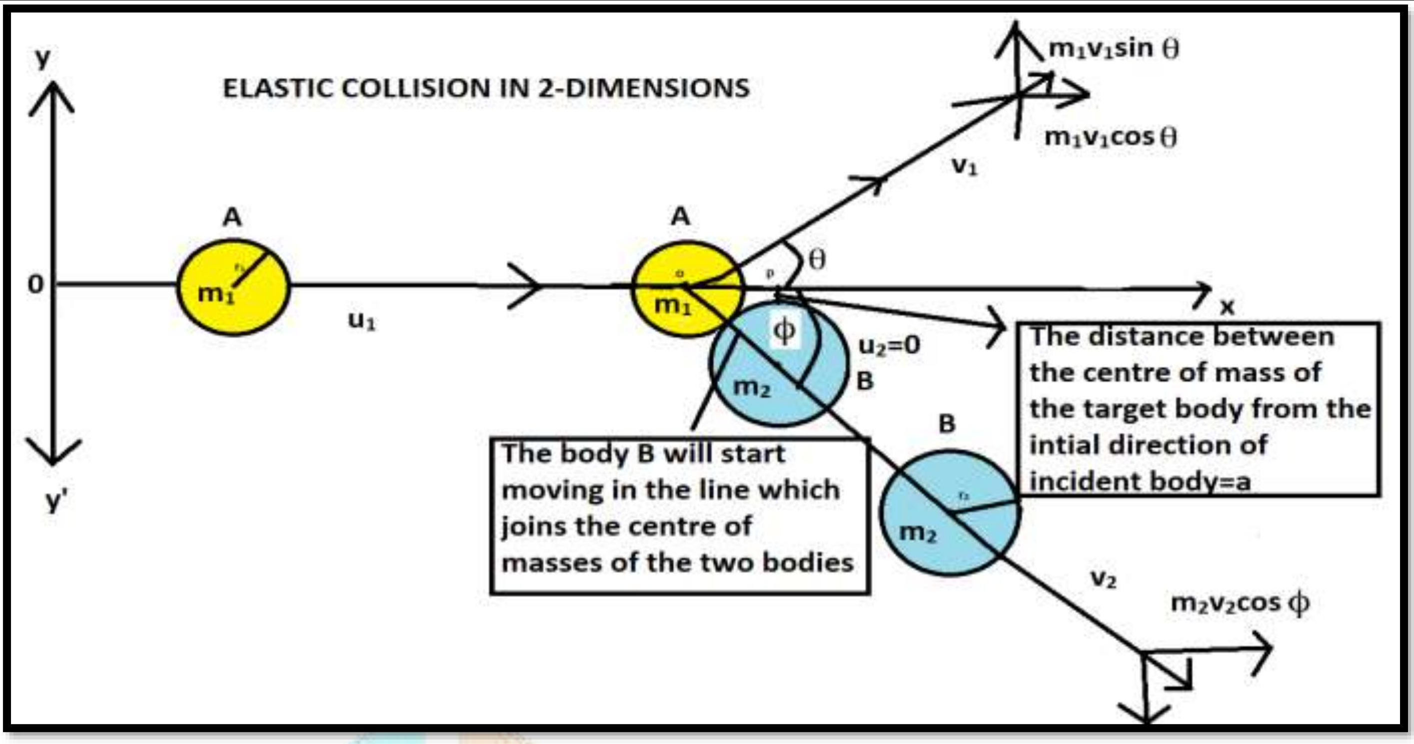

FIG 4

Let,

- OP=b
- The line joining two centre of masses=$(r_1+r_2)=h$
- The line joining centre of mass of the target body to the initial direction of incident body along the x axis $=(r_2+a)=p$

From the above figure we get

$\cos\phi = b/(r_1+r_2) = b/h$--(12)

$\sin\phi = p/(r_1+r_2) = p/h$--(13)

and

$m_1v_1\sin\theta = m_2v_2\sin\phi$ --(14)

- **putting the value [5]of sin ϕ from equation (13) we get,**
- $m_1v_1\sin\theta = m_2v_2(p/h)$
- $m_2v_2 = m_1v_1\sin\theta\,(h/p)$
- **According to law of conservation of momentum,**
- $m_1u_1 = m_1v_1\cos\theta + m_2v_2\cos\phi$--------------------------(15)
- $m_1u_1 = m_1v_1\cos\theta + m_1v_1\sin\theta*(h/p)*(b/h)$
- $u_1 = v_1\cos\theta + v_1\sin\theta\,(b/p)$
- $v_1p\cos\theta + v_1\sin\theta = u_1p$
- $v_1 = (u_1p)/(p\cos\theta + b\sin\theta)$
- $v_1 = (u_1[r_2+a])/([r_2+a]\cos\theta + b\sin\theta)$----------------(16)
- **now, again from equation (14) we get,**
- $m_1v_1 = [(m_2v_2)/\sin\theta]*(p/h)$-------------------------(17)

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- **putting the value of equation (17) in equation (15) we get,**
- **$m_1u_1 = m_2v_2\cos\theta/\sin\theta*(p/h) + m_2v_2(b/h)$**
- **$m_1u_1h = m_2v_2\cot\theta p+m_2v_2b$**
- **$v_2(m_2\cot\theta p+m_2b)=m_1u_1h$**
- **$v_2=(m_1u_1h)/(m_2\cot\theta p+m_2b)$**
- **$v_2=(m_1u_1h)/[m_2(p\cot\theta+b)]$**
- **$v_2=(m_1u_1h\sin\theta)/[m_2(p\cos\theta+b\sin\theta)]$**
- **$v_2=(m_1u_1(r_1+r_2)\sin\theta)/[m_2(\{r_2+a\}\cos\theta+b\sin\theta)]$---- ----------------------- ----------------------- (18)**
- **According to conservation of kinetic energy**
- **$(1/2)m_1u_1^2=(1/2)m_1v_1^2+(1/2)m_2v^2{}_2$----------(19)**
- **Now squaring equations (18) and (17) and then putting it to the equation (19) and calculating we get**
- **$\theta = \cot^{-1}([2m_2pb]/[m_2p^2-m_2b^2+m_1h^2])$**
- **$\theta = \cot^{-1}([2m_2(r_2+a)b]/[m_2(r_2+a)^2-m_2b^2+m_1(r_1+r_2)^2])$**

-------------------(20)

4) CONCLUSION

- Equations (4) and (5) are used to find the final wavelengths of two waves after head- on collision
- Equations (7) and (11) are used to find the mass and energy of electromagnetic waves in different mediums.
- Equations (20), (18) and (16) are used to[6] find the angles, and the final velocities of the bodies after elastic collision in two dimensions or non-head-on collisions.

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[3] LEONARD I. SCHIFF QUANTUM MECHANICS

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