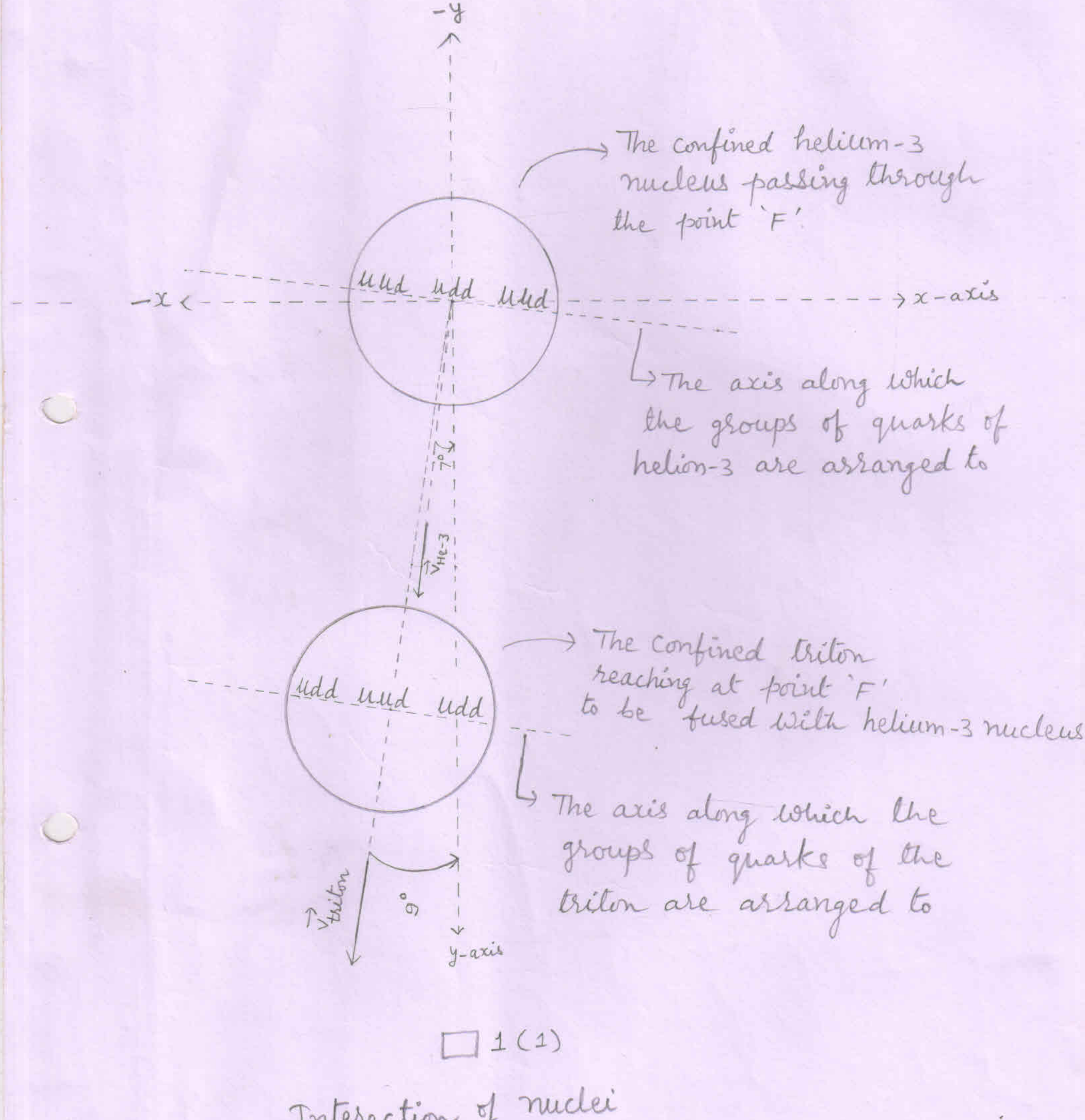
For fusion reaction 6(i) : ${}^{3}_{1}H + {}^{3}_{2}He \rightarrow {}^{5}_{3}Li + {}^{1}_{0}n$

1. Interaction of nuclei :-

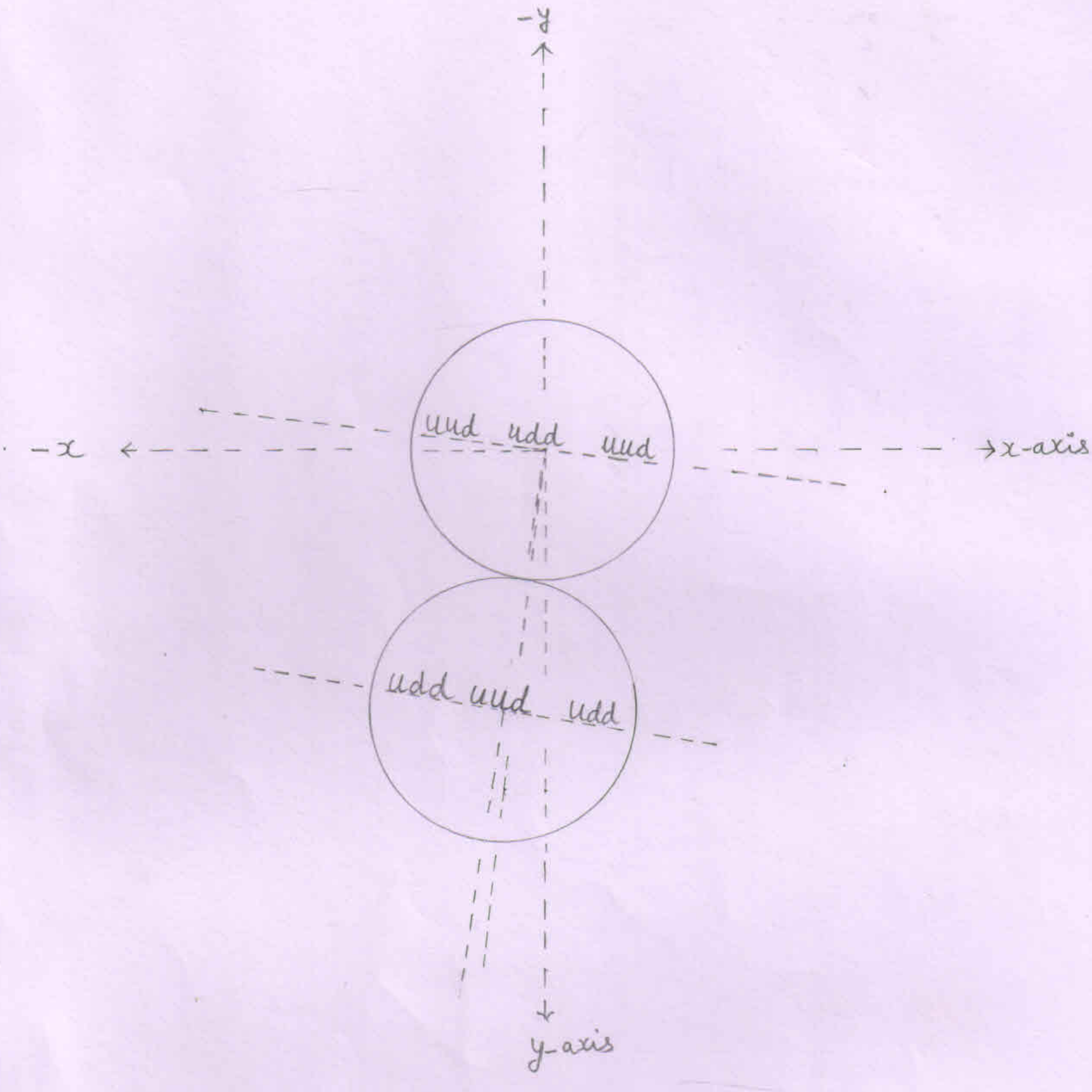
The confined triton reaches at point F and interacts [experiences a repulsive force due to confined helion-3 passing through the point `F'] with the confined helion-3 at point `F'. The confined triton overcomes the electrostatic repulsive force and - a like two solid spheres join - the confined triton dissimilarly joins with the confined helium-3 nucleus.



□ 1 (1)

Interaction of nuclei

Interaction of nuclei



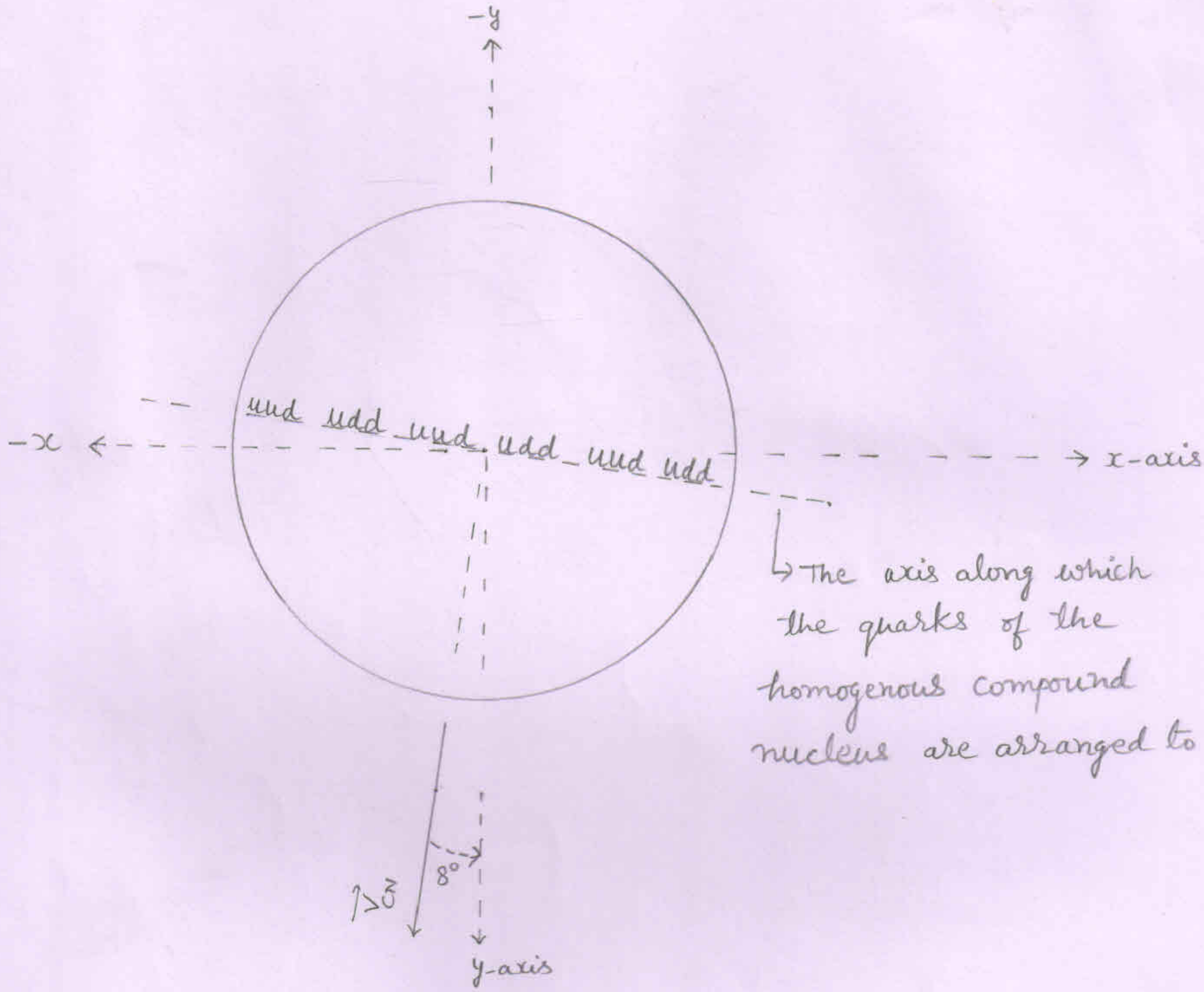
□ 1(2)

The dissimilarly joined nuclei

2. Formation of the homogenous compound nucleus :-
The constituents (quarks and gluons) of the dissimilarly joined nuclei (the triton and the helion-3) behave like a liquid and form the homogenous compound nucleus having similarly distributed groups of quarks with similarly distributed surrounding gluons.

Thus within the homogenous compound nucleus - each group of quarks is surrounded by gluons in equal proportion. So, within the homogenous compound nucleus there are 6 groups of quarks surrounded by the gluons.

The homogenous compound nucleus



2

The homogenous compound nucleus

⇒ The triton dissimilarly joined with the helium-3 nucleus and then their constituents form a homogenous compound nucleus. or the helium-3 nucleus dissimilarly joined with the triton and then their constituents form the homogenous compound nucleus. In both these above conditions, the number of groups of quarks that compose the homogenous compound nucleus remains same but the arrangement of groups of quarks on their own axis of the homogenous compound nucleus [that they compose] differs. That is why the compound nucleus splits into three ways – 1. Lithion-5 + Δm + neutron

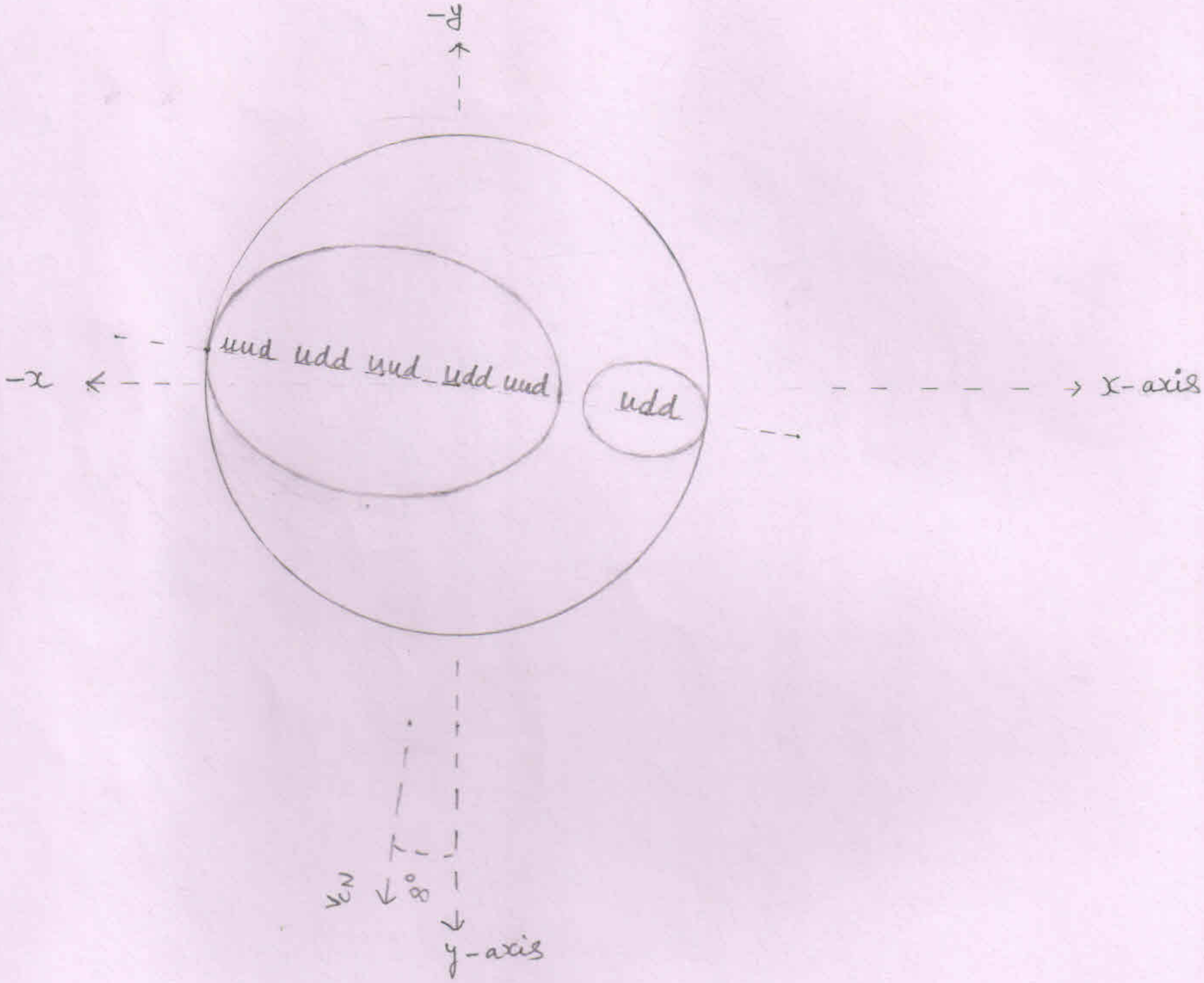
3. Formation of lobes within into the homogenous compound nucleus or the transformation of the homogenous compound nucleus into the heterogenous compound nucleus :-

The central group of quarks with its surrounding gluons to become a stable and the next higher nucleus (the lithion-5) than the reactant one (the helion-3) includes the other four (nearby located) groups of quarks with their surrounding gluons and rearrange to form the 'A' lobe of the heterogenous compound nucleus.

While the remaining group of quarks to become a stable nucleus (the neutron) includes its surrounding gluons or mass [out of the available mass (or gluons) that is not included in the formation of the lobe 'A'] and rearrange to form the 'B' lobe of the heterogenous compound nucleus.

Thus, due to formation of two dissimilar lobes within into the homogenous compound nucleus, the homogenous compound nucleus transforms into the heterogenous compound nucleus.

[3] Formation of lobes



Formation of lobes

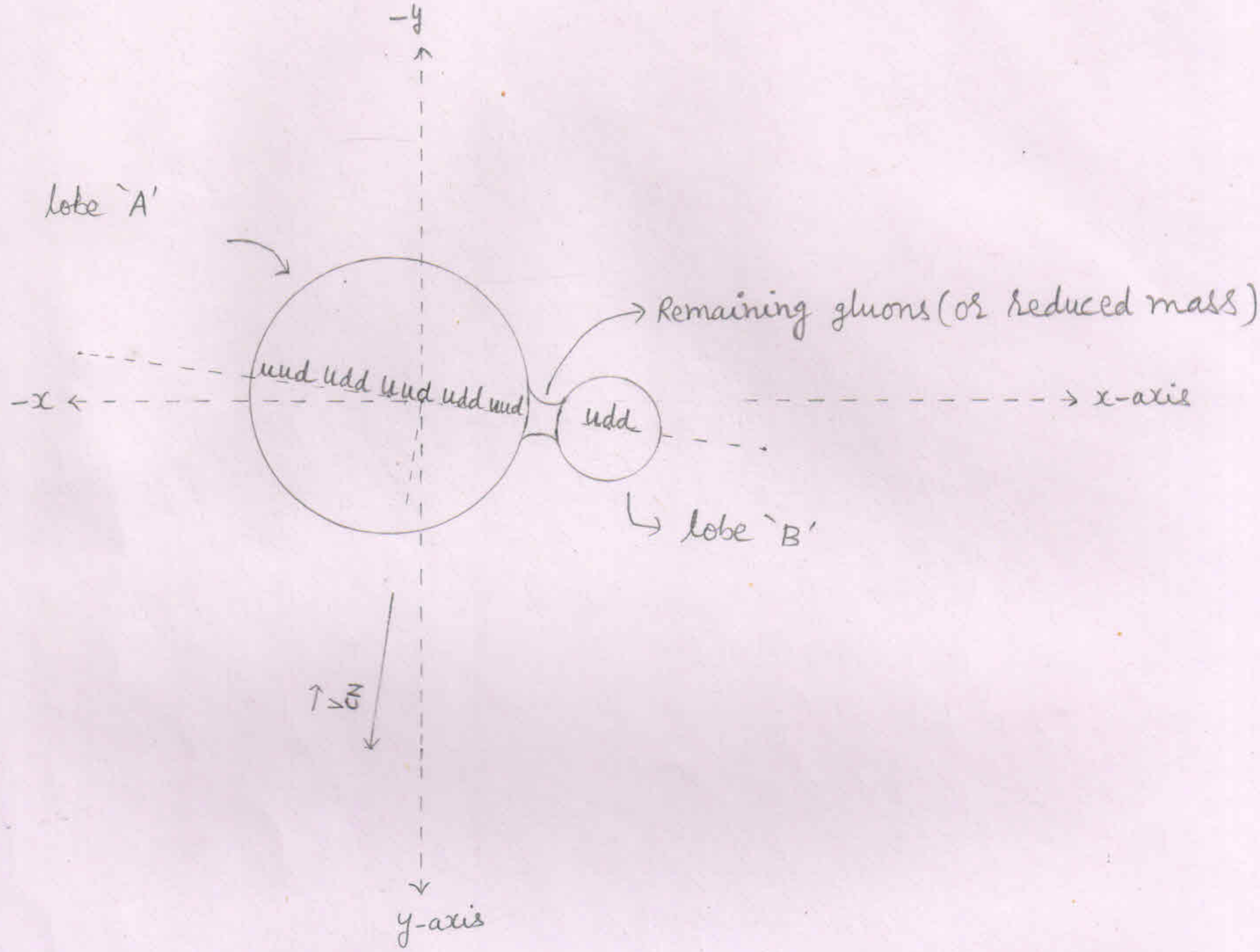
⇒ Within into the homogenous compound nucleus, the greater nucleus is the lithion-5 and the smaller nucleus is the neutron and the remaining space represents the remaining gluons.

⇒ Within into the homogenous compound nucleus, the greater nucleus is the lobe 'A' while the smaller nucleus is the lobe 'B'

4. Final Stage of the heterogenous compound nucleus:-
The process of formation of lobes creates voids between the lobes. So, the remaining gluons [or the mass that is not involved in the formation of any lobe] rearrange to fill the void(s) between the lobes and thus the remaining gluons form a node between the two dissimilar lobes of the heterogenous compound nucleus.

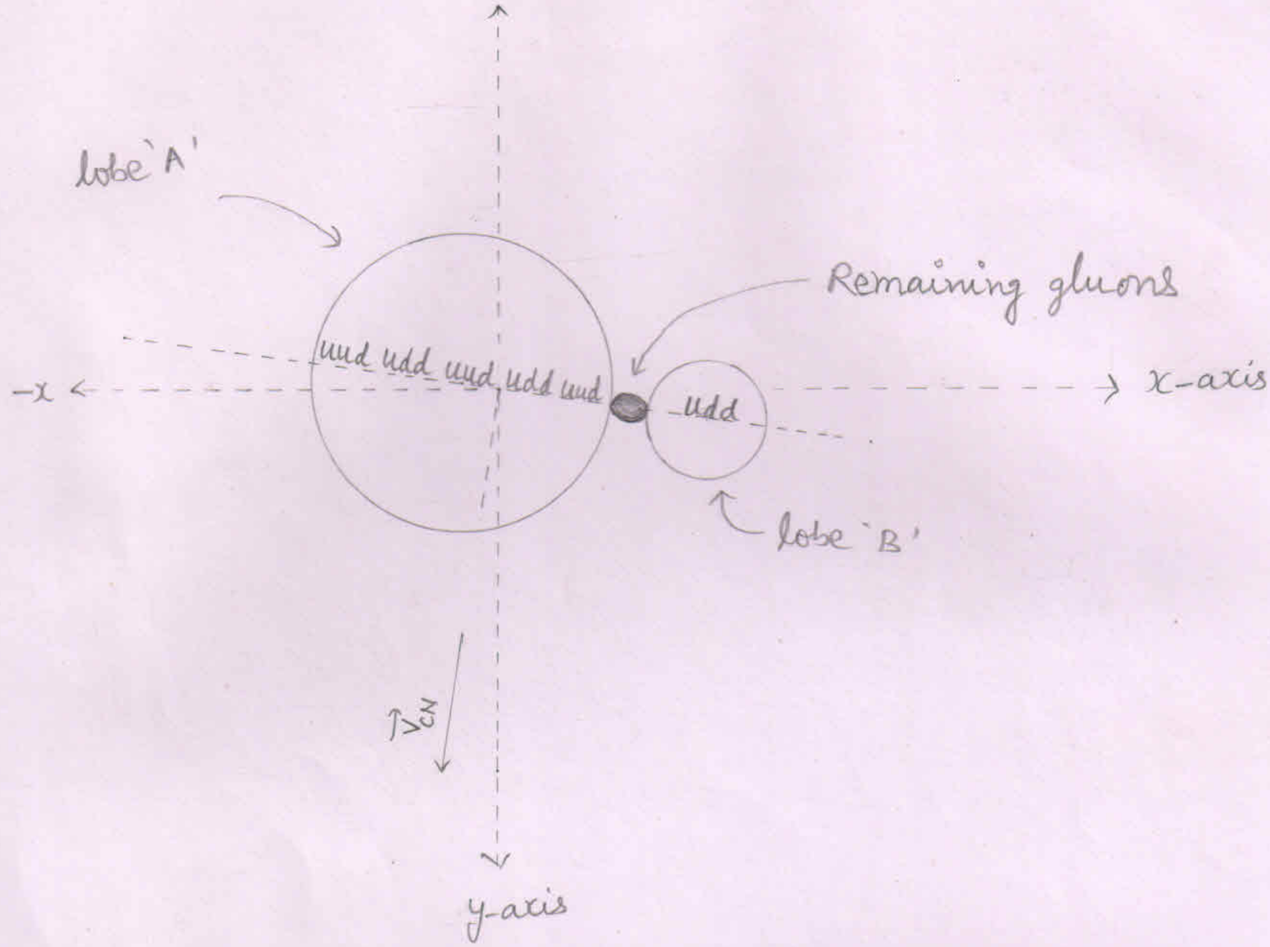
Thus, the reduced mass (or the remaining gluons) keeps both the dissimilar lobes - of the heterogenous compound nucleus - joined them together.

So, finally, the heterogenous compound nucleus becomes like an abnormal digit eight or becomes like a dumb-bell.



4(1)

Final stage of the heterogenous compound nucleus



4(2)
Final stage of the heterogenous compound nucleus

Minimum kinetic energy (E_m) required by the triton for $^3_1T - ^3_2He$ fusion is -

$$E_m = \frac{2 k^2 z_1^2 z_2^2 q^4 m}{h^2}$$

$z_1 = 1$ and $z_2 = 2$

$m = m_t = 5.0072 \times 10^{-27}$ kg

$$\Rightarrow E_m = \frac{2 \times (9 \times 10^9)^2 \times 1^2 \times 2^2 \times (1.6 \times 10^{-19})^4 \times 5.0072 \times 10^{-27}}{(6.62 \times 10^{-34})^2} \text{ J}$$

$$\Rightarrow E_m = \frac{21264.2404761 \times 10^{18} \times 10^{-76} \times 10^{-27}}{43.8244 \times 10^{-68}} \text{ J}$$

$$\Rightarrow E_m = 485.2146 \times 10^{-17} \text{ J}$$

$$\Rightarrow E_m = 303.2591 \times 10^2 \text{ eV}$$

$$= 30.32591 \times 10^3 \text{ eV}$$

$$= 0.0303 \text{ MeV}$$

Formation of Compound nucleus

1. As the confined triton reaches at point 'F', it fuses with the confined helion-3 [passing through the point 'F'] to form the Compound nucleus.

2. Just before fusion, to overcome the electrostatic repulsive force, the triton loses energy equal to 0.0303 Mev.

S So, just before fusion, the kinetic energy of the triton is –

$$E_b = [1.1583 \text{ Mev}] - [0.0303 \text{ Mev}]$$

$$= 1.128 \text{ Mev}$$

3. Momentum of the triton (just before fusion)

$$P_b = [2 m_t E_b]^{\frac{1}{2}}$$

$$E_b = 1.128 \times 1.6 \times 10^{-13} \text{ J}$$

$$\Rightarrow P_b = [2 \times 5.0072 \times 10^{-27} \times 1.128 \times 1.6 \times 10^{-13}]^{\frac{1}{2}} \text{ kgm/s}$$

$$\Rightarrow P_b = [18.07398912 \times 10^{-40}]^{\frac{1}{2}} \text{ kgm/s}$$

$$\Rightarrow P_b = 4.2513 \times 10^{-20} \text{ kgm/s}$$

Components of the momentum of the triton just before fusion :-

If α, β and γ are the angles made by the triton with respect to positive x, y and z axes respectively. Then

1. $\vec{P}_x = P_b \cos\alpha$

$P_b = 4.2513 \times 10^{-20}$ kg m/s

$\cos\alpha = \cos 99^\circ \simeq -0.1556$

$\Rightarrow \vec{P}_x = 4.2513 \times 10^{-20} \times (-0.1556)$ kg m/s

$= -0.6615 \times 10^{-20}$ kg m/s

2. $\vec{P}_y = P_b \cos\beta$

$\cos\beta = \cos 9^\circ \simeq 0.9879$

$\Rightarrow \vec{P}_y = 4.2513 \times 10^{-20} \times 0.9879$ kg m/s

$= 4.1998 \times 10^{-20}$ kg m/s

3. $\vec{P}_z = \vec{P}_b \cos\gamma$

$\cos\gamma = \cos 90^\circ = 0$

$\Rightarrow \vec{P}_z = 4.2513 \times 10^{-20} \times 0$ kg m/s

$= 0$ kg m/s

Components of momentum of the compound nucleus :-

1. X- Component of momentum of Compound nucleus =

[X - Component of momentum of the Confined triton just before fusion at point F] + [X - Component of the momentum of the Confined helion-3 at point F]

$$\vec{P}_x = [-0.6615 \times 10^{-20}] + [-0.4710 \times 10^{-20}] \; kg\,m/s$$

$$= -1.1325 \times 10^{-20} \; kg\,m/s$$

2. Y-Component of momentum of compound nucleus =

[Y-Component of momentum of the Confined triton just before fusion at point F] + [Y-Component of the momentum of the Confined helion-3 at point F]

$$\vec{P}_y = [4.1998 \times 10^{-20}] + [3.9094 \times 10^{-20}] \; kg\,m/s$$

$$= 8.1092 \times 10^{-20} \; kg\,m/s$$

3. z-component of momentum of compound nucleus =

[z-component of momentum of the confined triton just before fusion at point F] + [z-component of the momentum of the confined helion-3 at point F]

$$\Rightarrow \vec{P}_z = [0] + [0] \quad kg\,m/s$$
$$= 0 \quad kg\,m/s$$

4. Mass of the compound nucleus (M) :

$$M = m_t + m_{He-3}$$
$$= (5.0072 \times 10^{-27}) + (5.00629 \times 10^{-27}) \quad kg$$
$$= 10.01349 \times 10^{-27} \quad kg$$

Components of the velocity of the compound nucleus: ⇒

1. X - Component of the velocity of the Compound nucleus:-

$$\Rightarrow \vec{V}_x = V_{CN} \cos\alpha = \frac{\vec{P}_x}{M} = \frac{P_{CN}\cos\alpha}{M}$$

$$\Rightarrow \vec{V}_x = V_{CN} \cos\alpha = \frac{-1.1325 \times 10^{-20} \ \text{kg m/s}}{10.01349 \times 10^{-27} \ \text{kg}}$$

$$\Rightarrow \vec{V}_x = V_{CN} \cos\alpha = -0.1130 \times 10^{7} \ \text{m/s}$$

2. y-component of the velocity of the Compound nucleus :-

$$\Rightarrow \vec{V}_y = V_{CN} \cos\beta = \frac{\vec{P}_y}{M} = \frac{P_{CN}\cos\beta}{M}$$

$$\Rightarrow \vec{V}_y = V_{CN} \cos\beta = \frac{8.1092 \times 10^{-20} \ \text{kg m/s}}{10.01349 \times 10^{-27} \ \text{kg}}$$

$$\Rightarrow \vec{V}_y = V_{CN} \cos\beta = 0.8098 \times 10^{7} \ \text{m/s}$$

3. z-component of the velocity of the Compound nucleus -

$$\Rightarrow \vec{V}_z = V_{CN} \cos\gamma = \frac{\vec{P}_z}{M} = \frac{P_{CN}\cos\gamma}{M}$$

$$\Rightarrow \vec{V}_z = V_{CN} \cos\gamma = \frac{0 \ \text{kg m/s}}{\ldots} = 0 \ \text{m/s}$$

Velocity of the compound nucleus ($\vec{V}_{CN}$) :-

$$V_{CN}^2 = V_x^2 + V_y^2 + V_z^2$$

$$\vec{V}_x = V_{CN} \cos\alpha = -0.1130 \times 10^7 \ m/s$$

$$\vec{V}_y = V_{CN} \cos\alpha = 0.8098 \times 10^7 \ m/s$$

$$\vec{V}_z = V_{CN} \cos\gamma = 0 \ m/s$$

$$\Rightarrow V_{CN}^2 = (0.1130 \times 10^7)^2 + (0.8098 \times 10^7)^2 + (0)^2 \ m^2/s^2$$

$$= (0.012769 \times 10^{14}) + (0.65577604 \times 10^{14}) + 0 \ m^2/s^2$$

$$V_{CN}^2 = 0.66854504 \times 10^{14} \ m^2/s^2$$

$$\Rightarrow V_{CN} = 0.8176 \times 10^7 \ m/s$$

Angle made by the velocity of the Compound nucleus ($\vec{V}_{CN}$):-

⇒ If α, β and γ are the angles made by the velocity of the compound nucleus with respect to the x, y and z axes respectively. Then

1. $$\cos\alpha = \frac{V_{CN}\cos\alpha}{V_{CN}}$$

$$V_{CN}\cos\alpha = -0.1130\times10^{7}\ m/s$$
$$V_{CN} = 0.8176\times10^{7}\ m/s$$

$$\cos\alpha = \frac{-0.1130\times10^{7}}{0.8176\times10^{7}}\ \frac{m/s}{m/s} = -0.1382$$

$$\alpha \simeq 98^{\circ}$$

2. $$\cos\beta = \frac{V_{CN}\cos\beta}{V_{CN}}$$

$$V_{CN}\cos\beta = 0.8098\times10^{7}\ m/s$$

$$\Rightarrow \cos\beta = \frac{0.8098\times10^{7}}{0.8176\times10^{7}}\ \frac{m/s}{m/s} = 0.9904$$

$$\beta \simeq 8^{\circ}$$

3. $$\cos\gamma = \frac{V_{CN}\cos\gamma}{V_{CN}}$$

$$V_{CN}\cos\gamma = 0\ m/s$$

$$\Rightarrow \cos\gamma = \frac{0}{0.8176\times10^{7}}\ \frac{m/s}{m/s} = 0$$

The splitting of the heterogonous compound nucleus:-

⇒ The heterogenous compound nucleus, due to its instability, splits according to the lines parallel to the direction of the velocity of the compound nucleus ($\vec{V}_{CN}$) into three particles - the lithion-5, the neutron and the reduced mass (Δm).

out of them, the two particles (the lithion-5 and the neutron) are stable while the third one (reduced mass) is unstable.

⇒ According to the law of inertia, each particle that has separated from the compound nucleus has an inherited velocity ($\vec{V}_{inh}$) equal to the velocity of the compound nucleus ($\vec{V}_{CN}$).

⇒ So, for conservation of momentum

$$M\vec{V}_{CN} = (m_{Li-5} + \Delta m + m_n)\vec{V}_{CN}$$

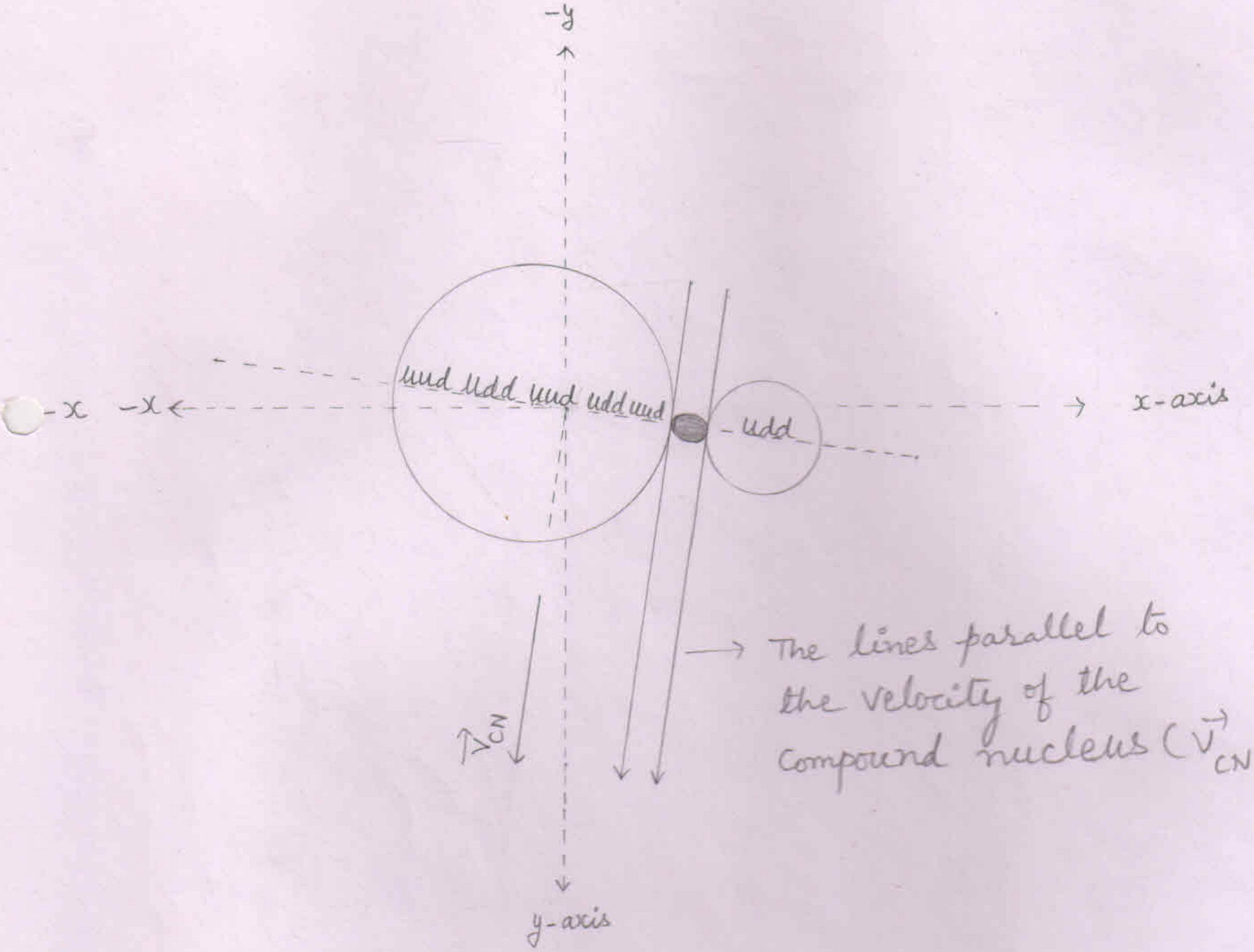
Where,

M = mass of the compound nucleus
$\vec{V}_{CN}$ = velocity of the compound nucleus

m_{Li-5} = mass of the lithion-5

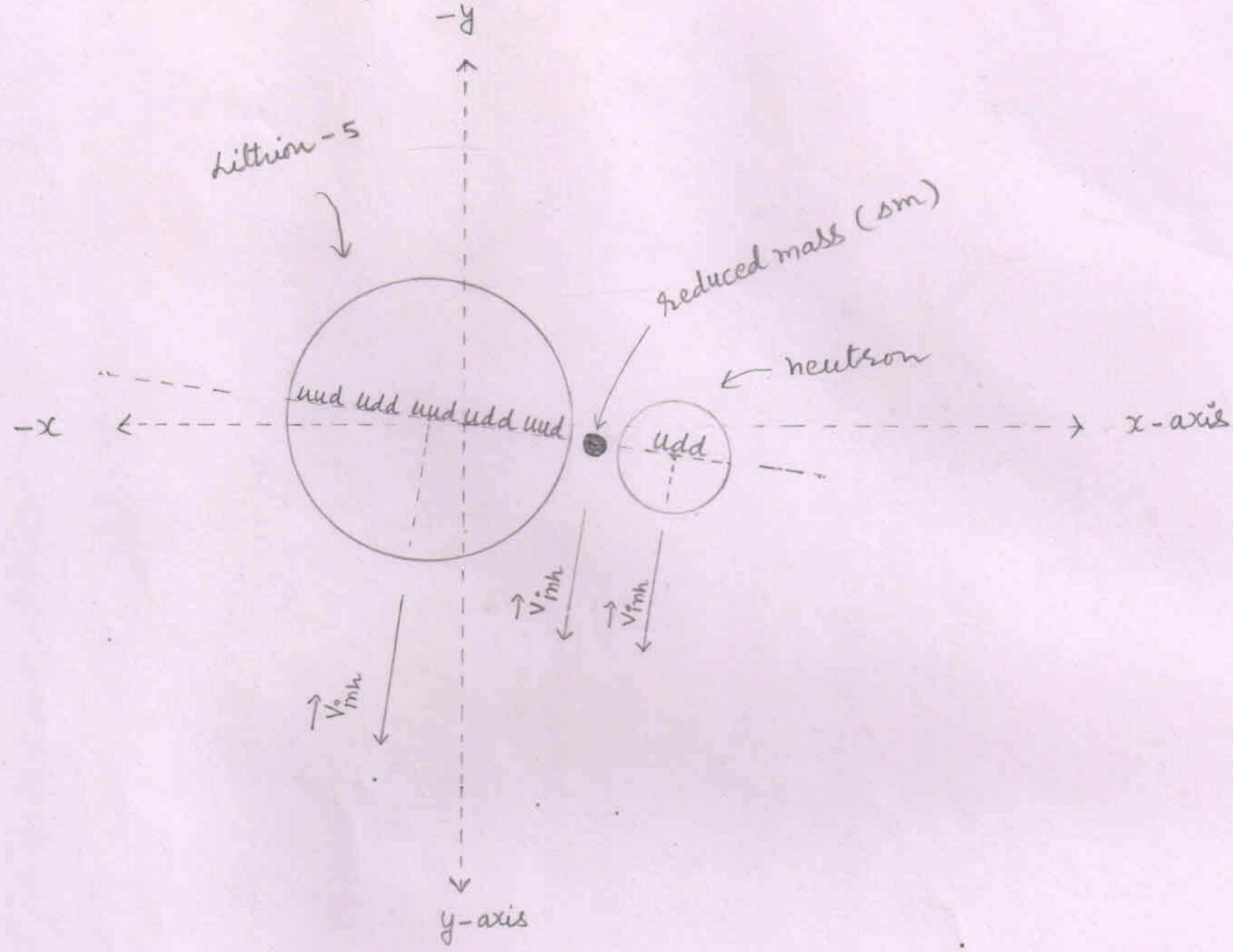
Δm = reduced mass

m_n = mass of the neutron



The Splitting of the heterogenous compound nucleus

The splitting of the heterogenous compound nucleus



⇒ The heterogenous compound nucleus splits into three particles - Lithion-5, reduced mass and the neutron.

Inhereted velocity of the particles

⇒ Each particle that has separated from the compound nucleus has an inhereted velocity ($\vec{V}_{inh}$) is equal to the velocity of the compound nucleus ($\vec{V}_{CN}$).

1. Inhereted velocity of the lithion-5.

$$V_{inh} = V_{CN} = 0.8176 \times 10^7 \text{ m/s}$$

⇒ Components of the inhereted velocity ($\vec{V}_{inh}$) of the lithion-5.

1. $\vec{V}_x = V_{inh} \cos\alpha = V_{CN} \cos\alpha = -0.1130 \times 10^7 \text{ m/s}$

2. $\vec{V}_y = V_{inh} \cos\beta = V_{CN} \cos\beta = 0.8098 \times 10^7 \text{ m/s}$

3. $\vec{V}_z = V_{inh} \cos\gamma = V_{CN} \cos\gamma = 0 \text{ m/s}$

2. Inhereted velocity of the neutron

$$V_{inh} = V_{CN} = 0.8176 \times 10^7 \text{ m/s}$$

⇒ Components of inhereted velocity ($\vec{V}_{inh}$) of the neutron :-

1. $\vec{V}_x = V_{inh} \cos\alpha = V_{CN} \cos\alpha = -0.1130 \times 10^7 \text{ m/s}$

2. $\vec{V}_y = V_{inh} \cos\beta = V_{CN} \cos\beta = 0.8098 \times 10^7 \text{ m/s}$

3. $\vec{V}_z = V_{inh} \cos\gamma = V_{CN} \cos\gamma = 0 \text{ m/s}$

3. Inhereted velocity of the reduced mass(sm) :-

Propellation of the particles.

1. Reduced mass

$$\Delta m = [m_t + m_{He-3}] - [m_{Li-5} + m_n]$$

$$= [3.0155 + 3.0149] - [5.0109 + 1.0086] \text{ amu}$$

$$= [6.0304] - [6.0195] \text{ amu}$$

$$= 0.0109 \text{ amu}$$

$$= 0.0109 \times 1.6605 \times 10^{-27} \text{ kg}$$

$$= 0.01809945 \times 10^{-27} \text{ kg}$$

2. Inhereted kinetic energy of the reduced mass :

$$E_{inh} = \frac{1}{2} \Delta m V_{inh}^2 = \frac{1}{2} \Delta m V_{CN}^2$$

$$V_{CN}^2 = 0.66854504 \times 10^{14} \text{ m}^2/\text{s}^2$$

$$\Rightarrow E_{inh} = \frac{1}{2} \times 0.01809945 \times 10^{-27} \times 0.66854504 \times 10^{14} \text{ J}$$

$$= 0.00605014876 \times 10^{-13} \text{ J}$$

$$= 0.0037 \text{ MeV}$$

3. Released energy (E_R) :

$$E_R = \Delta m c^2$$

$$= 0.0109 \times 931 \text{ MeV}$$

$$= 10.1479 \text{ MeV}$$

4. Total energy (E_T) :

$$E_T = E_{inh} + E_R$$

$$= [0.0037] + [10.1479] \quad Mev$$

$$= 10.1516 \quad Mev$$

Increased kinetic energy of the neutron

$$E_{inc} = \frac{m_{Li-5}}{m_{Li-5} + m_n} \times E_T$$

$$= \frac{5.0109}{5.0109 + 1.0086} \times 10.1516 \text{ Mev}$$

$$= 0.83244455519 \times 10.1516 \text{ Mev}$$

$$\Rightarrow E_{inc} = 8.4506 \text{ Mev}$$

Increased kinetic energy of the lithion-5 [$^{5}_{3}Li$]

E_{inc} = [E_T - Increased kinetic energy of the neutron]

$$= [10.1516 - 8.4506] \text{ Mev}$$

$$= 1.701 \text{ Mev}$$

Increased velocity of the neutron

$$V_{inc} = \sqrt{\frac{2 E_{inc}}{m_n}}$$

$$= \left[\frac{2 \times 8.4506 \times 1.6 \times 10^{-13}}{1.6749 \times 10^{-27}}\right]^{\frac{1}{2}} \quad m/s$$

$$= \left[\frac{27.04192}{1.6749} \times 10^{14}\right]^{\frac{1}{2}} \quad m/s$$

$$= \left[16.1453937548 \times 10^{14}\right]^{\frac{1}{2}} \quad m/s$$

$$= 4.0181 \times 10^{7} \quad m/s$$

Increased velocity (V_{inc}) of the lithium-5

$$V_{inc} = \sqrt{\frac{2 E_{inc}}{m_{Li-5}}}$$

$$= \left[\frac{2 \times 1.701 \times 1.6 \times 10^{-13}}{8.3205 \times 10^{-27}}\right]^{\frac{1}{2}} \quad m/s$$

$$= \left[\frac{5.4432}{8.3205} \times 10^{14}\right]^{\frac{1}{2}} \quad m/s$$

$$= \left[0.6541914548.4 \times 10^{14}\right]^{\frac{1}{2}} \quad m/s$$

$$= 0.8088 \times 10^{7} \quad m/s$$

Angle of propellation

1. As the reduced mass converts into energy, the total energy (E_T) propell both the particles with equal and opposite momentum according to a ray (line) perpendicular to the direction (line) of the velocity of the compound nucleus ($\vec{V}_{CN}$).

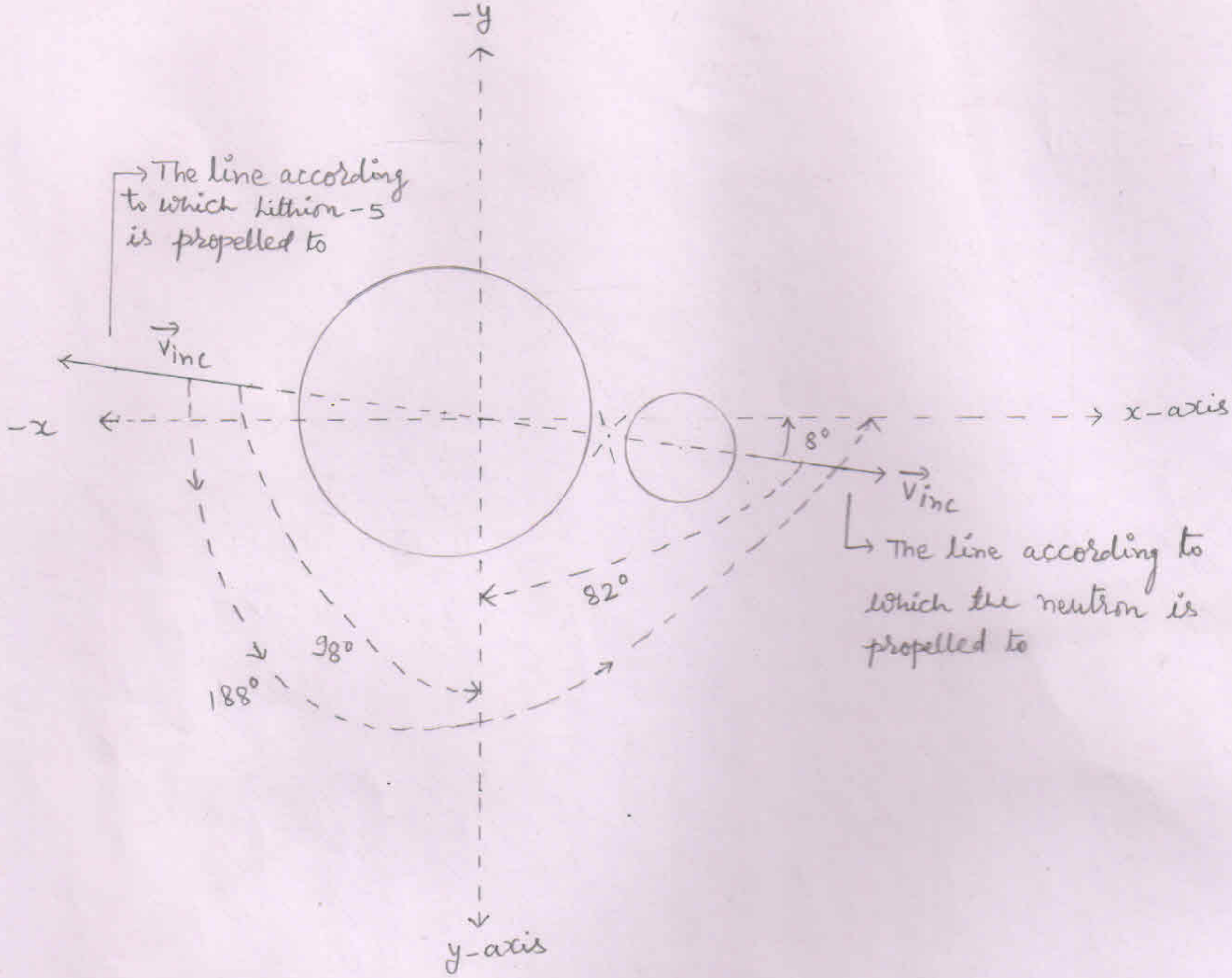
2. We know that when there a fusion process occures, then we find the lighter nucleus in the forward direction [or in the direction of ion beam or in the direction of the velocity of the compound nucleus ($\vec{V}_{CN}$)].

3. At point 'F', as $\vec{V}_{CN}$ make 98° angle with x-axis, 8° angle with y-axis and 90° angle with z-axis.

4. So, the neutron is propelled making 8° angle with x-axis, 82° angle with y-axis and 90° angle with z-axis.

5. While the lithion-5 is propelled making 188° angle with x-axis, 98° angle with y-axis and 90° angle with z-axis.

Propellation of the particles



Components of the increased velocity ($\vec{V}_{inc}$) of the particles

I. For neutron

1. $\vec{V}_x = V_{inc} \cos\alpha$

$V_{inc} = 4.0181 \times 10^7$ m/s

$\cos\alpha = \cos(8) = 0.99$

$\Rightarrow \vec{V}_x = 4.0181 \times 10^7 \times 0.99$ m/s

$= 3.9779 \times 10^7$ m/s

2. $\vec{V}_y = V_{inc} \cos\beta$

$\cos\beta = \cos(82) = 0.13$

$\Rightarrow \vec{V}_y = 4.0181 \times 10^7 \times 0.13$ m/s

$= 0.5223 \times 10^7$ m/s

3. $\vec{V}_z = V_{inc} \cos\gamma$

$\cos\gamma = \cos 90^\circ = 0$

$\Rightarrow \vec{V}_z = 4.0181 \times 10^7 \times 0$ m/s $= 0$ m/s

II. For lithion -5

1. $\vec{V}_x = V_{inc} \cos\alpha$

$V_{inc} = 0.8088 \times 10^7$ m/s

$\cos\alpha = \cos(188) = -\cos(8) = -0.99$

$\Rightarrow \vec{V}_x = 0.8088 \times 10^7 \times (-0.99)$ m/s

$= -0.8007 \times 10^7$ m/s

2. $\vec{V}_y = V_{inc} \cos\beta$

$\cos\beta = \cos(98) = -\cos(82) = -0.13$

$\Rightarrow \vec{V}_y = 0.8088 \times 10^7 \times (-0.13)$ m/s

$= -0.1051 \times 10^7$ m/s

3. $\vec{V}_z = V_{inc} \cos\gamma$

$\cos\gamma = \cos 90^\circ = 0$

$\Rightarrow \vec{V}_z = 0.8088 \times 10^7 \times 0$ m/s $= 0$ m/s

Components of the final velocity ($\vec{v}_f$) of the particles

I. For neutron

According to	Inhereted velocity ($\vec{v}_{inh}$)	Increased velocity ($\vec{v}_{inc}$)	Final velocity ($\vec{v}_f$) $\vec{v}_f = \vec{v}_{inh} + \vec{v}_{inc}$
x-axis	$\vec{v}_x = -0.1130 \times 10^7$ m/s	$\vec{v}_x = 3.9779 \times 10^7$ m/s	$\vec{v}_x = 3.8649 \times 10^7$ m/s
y-axis	$\vec{v}_y = 0.8098 \times 10^7$ m/s	$\vec{v}_y = 0.5223 \times 10^7$ m/s	$\vec{v}_y = 1.3321 \times 10^7$ m/s
z-axis	$\vec{v}_z = 0$ m/s	$\vec{v}_z = 0$ m/s	$\vec{v}_z = 0$ m/s

II. For lithium-5

According to	Inhereted velocity ($\vec{v}_{inh}$)	Increased velocity ($\vec{v}_{inc}$)	Final velocity ($\vec{v}_f$) $\vec{v}_f = \vec{v}_{inh} + \vec{v}_{inc}$
x-axis	$\vec{v}_x = -0.1130 \times 10^7$ m/s	$\vec{v}_x = -0.8007 \times 10^7$ m/s	$\vec{v}_x = -0.9137 \times 10^7$ m/s
y-axis	$\vec{v}_y = 0.8098 \times 10^7$ m/s	$\vec{v}_y = -0.1051 \times 10^7$ m/s	$\vec{v}_y = 0.7047 \times 10^7$ m/s
z-axis	$\vec{v}_z = 0$ m/s	$\vec{v}_z = 0$ m/s	$\vec{v}_z = 0$ m/s

Final velocity (v_f) of the neutron

$$v_f^2 = v_x^2 + v_y^2 + v_z^2$$

$v_x = 3.8649 \times 10^7$ m/s
$v_y = 1.3321 \times 10^7$ m/s
$v_z = 0$ m/s

$$\Rightarrow v_f^2 = (3.8649 \times 10^7)^2 + (1.3321 \times 10^7)^2 + (0)^2 \ m^2/s^2$$

$$\Rightarrow v_f^2 = (14.93745201 \times 10^{14}) + (1.77449041 \times 10^{14}) + 0 \ m^2/s^2$$

$$\Rightarrow v_f^2 = 16.71194242 \times 10^{14} \ m^2/s^2$$

$$\Rightarrow v_f = 4.0880 \times 10^7 \ m/s$$

Final kinetic energy of the neutron

$$E = \frac{1}{2} m_n v_f^2$$

$v_f^2 = 16.71194242 \times 10^{14}$ m²/s²

$$\Rightarrow E = \frac{1}{2} \times 1.6749 \times 10^{-27} \times 16.71194242 \times 10^{14} \ J$$

$$= 13.9954161796 \times 10^{-13} \ J$$

$$= 8.7471 \ MeV$$

Angles that make the final velocity ($\vec{v}_f$) of the neutron with axes at point F.

1. With x-axis

$$\cos\alpha = \frac{\vec{v}_x}{v_f}$$

$$\vec{v}_x = 3.8649 \times 10^7 \text{ m/s}$$
$$v_f = 4.0880 \times 10^7 \text{ m/s}$$

$$\Rightarrow \cos\alpha = \frac{3.8649 \times 10^7}{4.0880 \times 10^7} \frac{\text{m/s}}{\text{m/s}} = 0.9454$$

$$\Rightarrow \alpha \simeq 19^\circ$$

2. With y-axis

$$\cos\beta = \frac{\vec{v}_y}{v_f}$$

$$\vec{v}_y = 1.3321 \times 10^7 \text{ m/s}$$

$$\Rightarrow \cos\beta = \frac{1.3321 \times 10^7}{4.0880 \times 10^7} \frac{\text{m/s}}{\text{m/s}} = 0.3258$$

$$\Rightarrow \beta \simeq 71^\circ$$

3. With z-axis

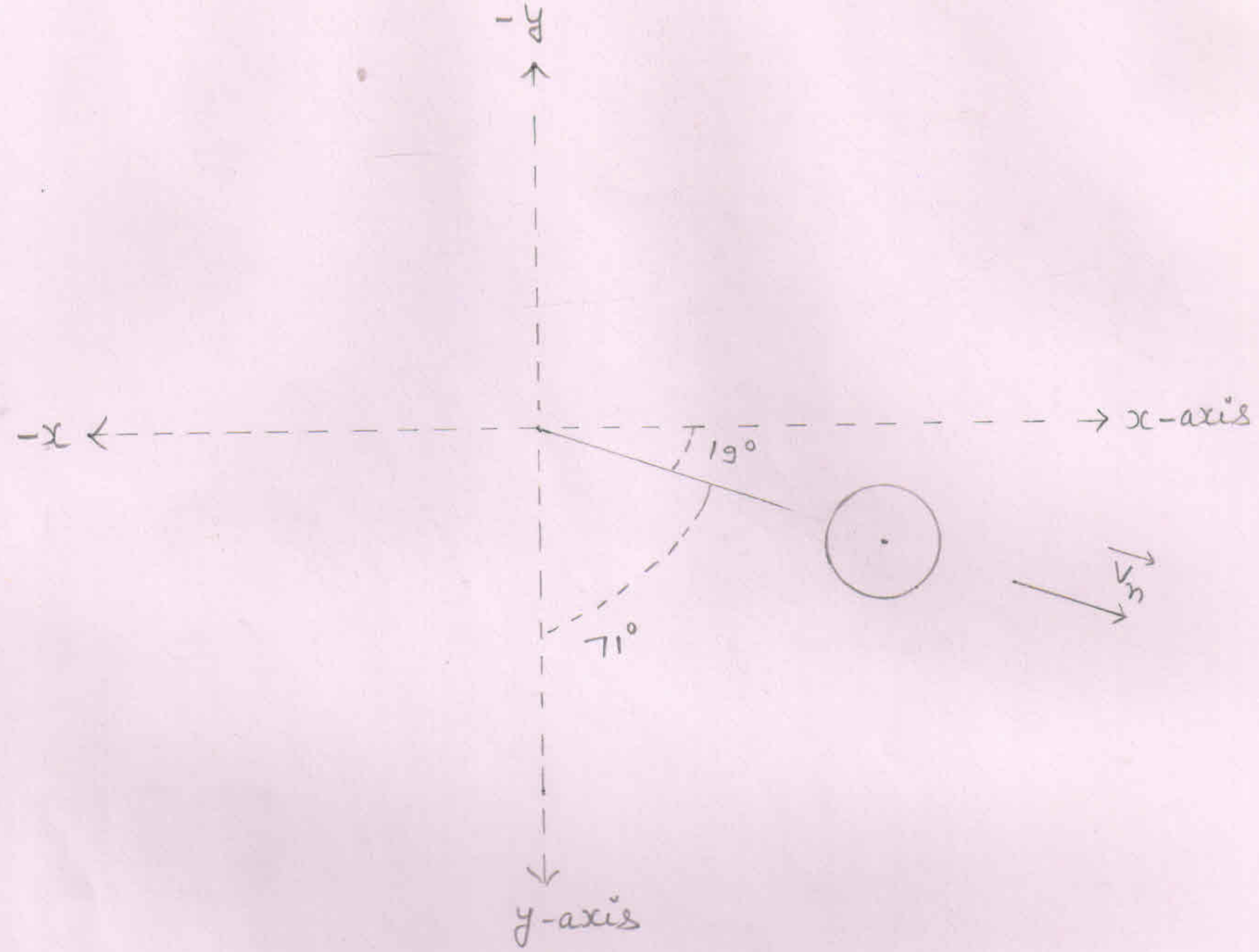
$$\cos\gamma = \frac{\vec{v}_z}{v_f}$$

$$\vec{v}_z = 0 \text{ m/s}$$

$$\Rightarrow \cos\gamma = \frac{0 \times}{4.0880 \times 10^7} \frac{\text{m/s}}{\text{m/s}} = 0$$

$$\Rightarrow \gamma = 90^\circ$$

The angles that make the final velocity ($\vec{V}_f$) of the neutron :-



Final velocity of the lithion-5

$$v_f^2 = v_x^2 + v_y^2 + v_z^2$$

$v_x = 0.9137 \times 10^7$ m/s
$v_y = 0.7047 \times 10^7$ m/s
$v_z = 0$ m/s

$$\Rightarrow v_f^2 = (0.9137 \times 10^7)^2 + (0.7047 \times 10^7)^2 + (0)^2 \quad m^2/s^2$$

$$\Rightarrow v_f^2 = (0.83484769 \times 10^{14}) + (0.49660209 \times 10^{14}) + 0 \quad m^2/s^2$$

$$\Rightarrow v_f^2 = 1.33144978 \times 10^{14} \quad m^2/s^2$$

$$\Rightarrow v_f = 1.1538 \times 10^7 \quad m/s$$

Final velocity of the lithion - 5

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Angles that make the final velocity ($\vec{v}_f$) of the lithion-5 with axes at F point F.

1. With x-axis

$$\cos\alpha = \frac{\vec{v}_x}{v_f}$$

$$\vec{v}_x = -0.9137 \times 10^7 \text{ m/s}$$
$$v_f = 1.1538 \times 10^7 \text{ m/s}$$

$$\Rightarrow \cos\alpha = \frac{-0.9137 \times 10^7}{1.1538 \times 10^7} \frac{\text{m/s}}{\text{m/s}} = -0.7919$$

$$\Rightarrow \alpha \simeq 142.3$$

$$[\because \cos(142.3) = -\cos(37.7) = -0.7912]$$

2. With y-axis

$$\cos\beta = \frac{\vec{v}_y}{v_f}$$

$$\vec{v}_y = 0.7047 \times 10^7 \text{ m/s}$$

$$\Rightarrow \cos\beta = \frac{0.7047 \times 10^7}{1.1538 \times 10^7} \frac{\text{m/s}}{\text{m/s}} = 0.6107$$

$$\Rightarrow \beta \simeq 52.3 \qquad [\because \cos(52.3) = 0.6115]$$

3. With z-axis

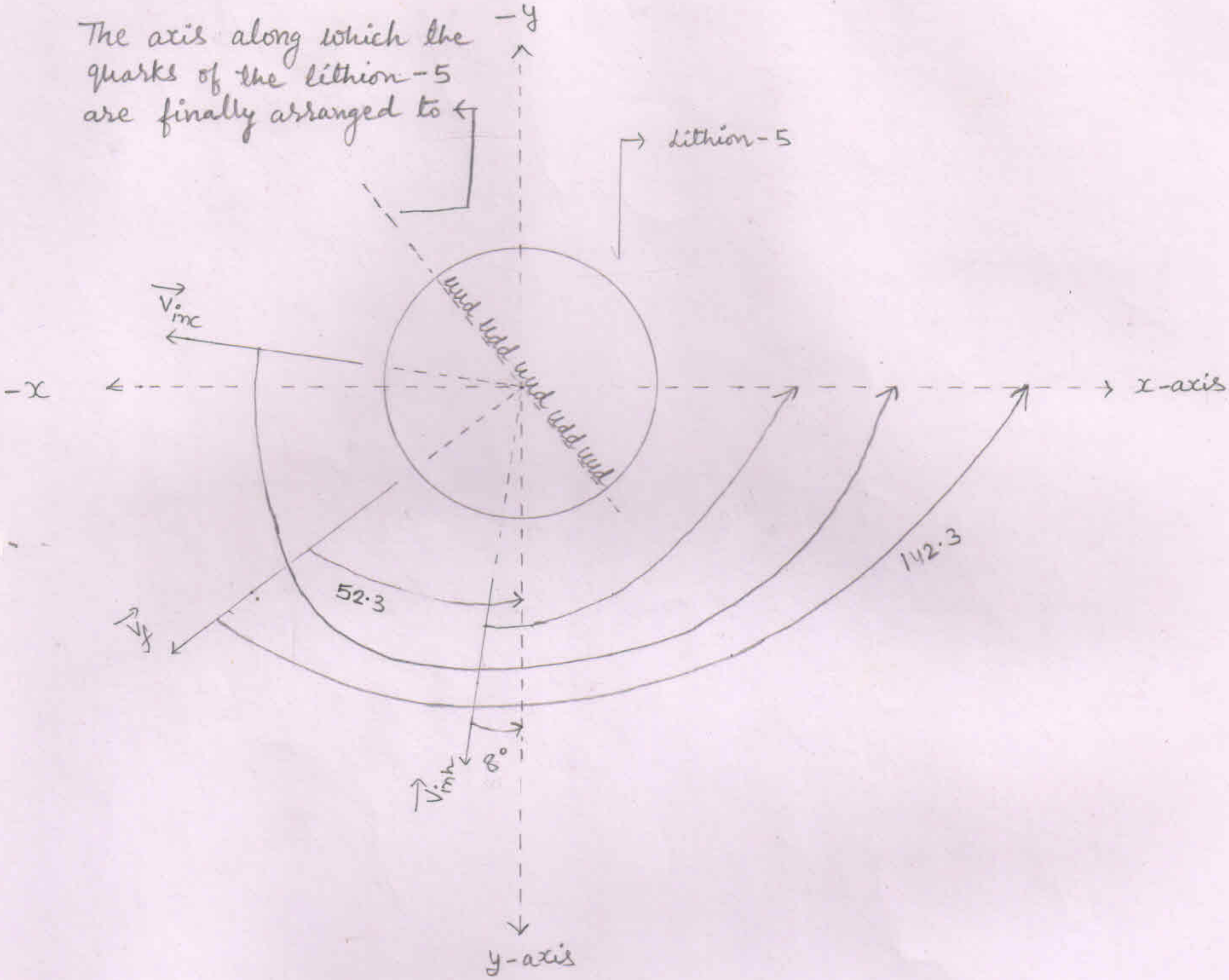
$$\cos\gamma = \frac{\vec{v}_z}{v_f}$$

$$\vec{v}_z = 0 \text{ m/s}$$

$$\Rightarrow \cos\gamma = \frac{0}{1.1538 \times 10^7} \frac{\text{m/s}}{\text{m/s}} = 0$$

$$\Rightarrow \gamma = 90^\circ$$

Angles that make the final velocity ($\vec{v}_f$) of the lithion-5 at point 'F.'



⇒ lithion-5 is an unstable homogenous nucleus. So, the lithion-5 again behave as a homogenous compound nucleus.

So, for stability, the groups of quarks that compose the lithion-5 again rearrange with the surrounding gluons and forms the lobes 'A' and 'B' within into the homogenous compound nucleus [the lithion-5] and thus turns the lithion-5 into a heterogenous

For the fusion reaction :-

$$^{5}_{3}Li \longrightarrow {}^{4}_{2}He + \Delta m + {}^{1}_{1}H$$

⇒ The lithion-5 is an unstable homogenous nucleus. So, the lithion-5 again behave as a homogenous compound nucleus.

So, for stability, the groups of quarks that compose the lithion-5 again rearrange with the surrounding gluons and form the lobes 'A' and 'B' within into the homogenous compound nucleus [the lithion-5] and thus turns the lithion-5 into a heterogenous compound nucleus.

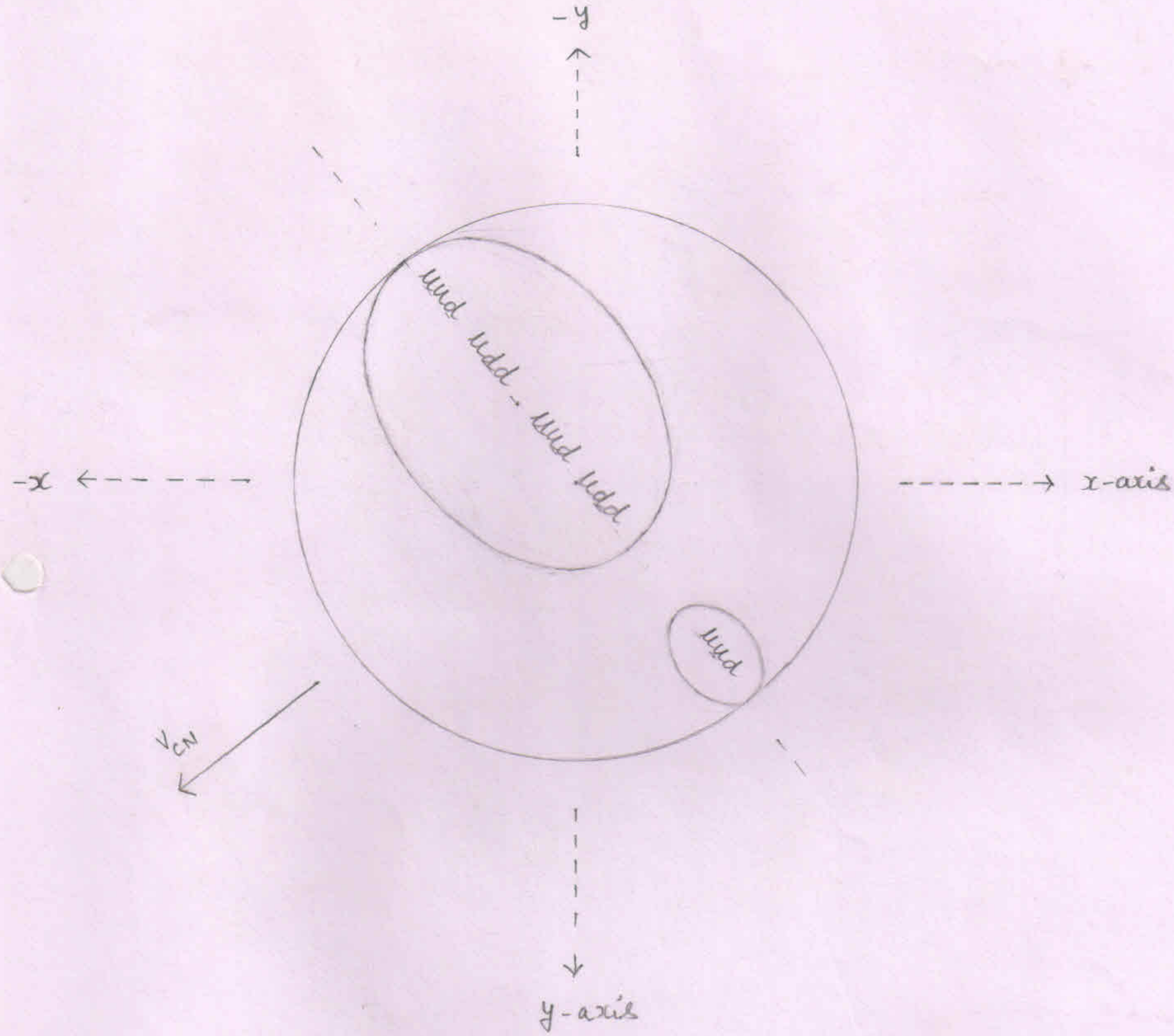
Formation of lobes within into the homogenous compound nucleus or the transformation of the homogenous compound nucleus into the heterogenous compound nucleus :-

The central group of quarks with its surrounding gluons to become a stable and the just lower nucleus (the helion-4) than the homogenous nucleus (the lithion-5) includes the other three (nearby located) groups of quarks with their surrounding gluons and rearrange to form the 'A' lobe of the heterogenous compound nucleus.

While the remaining group of quarks to become a stable nucleus (the proton) includes its surrounding gluons or mass [out of the available mass (or gluons) that is not included in the formation of the lobe 'A'] and rearrange to form the 'B' lobe of the heterogenous compound nucleus.

Thus, due to formation of two dissimilar lobes within into the homogenous compound nucleus, the homogenous compound nucleus transforms into the heterogenous compound nucleus.

[3] Formation of lobes



⇒ Within into the homogenous compound nucleus, the greater nucleus is the helium-4 nucleus and the smaller nucleus is the proton while the remaining space represents the remaining gluons.

⇒ Within into the homogenous compound nucleus, the greater nucleus is the lobe 'A' while the smaller nucleus is the lobe 'B'

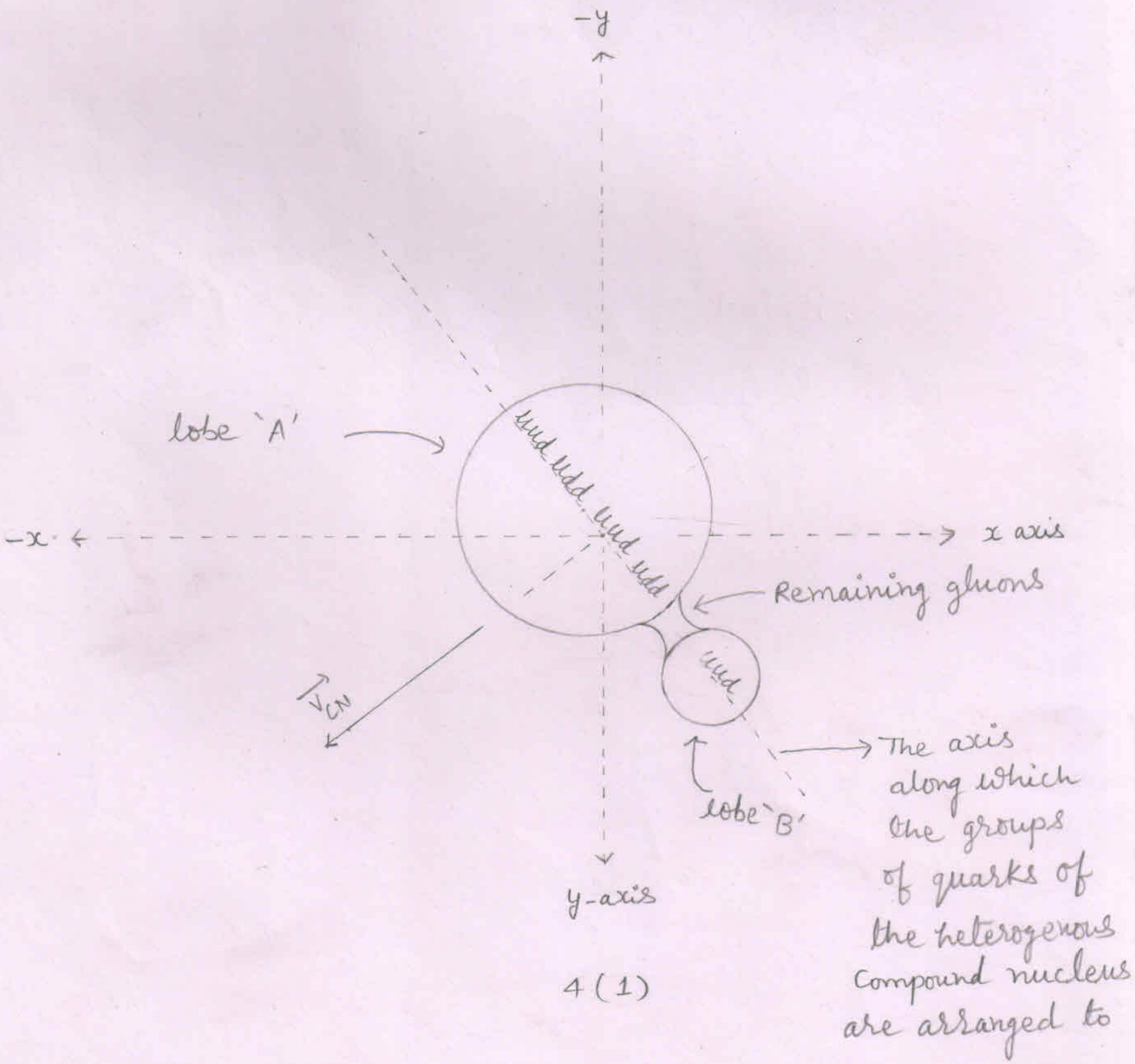
4. Final stage of the heterogenous compound nucleus:-

The process of formation of lobes creates voids between the lobes. So, the remaining gluons [or the mass that is not involved in the formation of any lobe] rearrange to fill the void(s) between the lobes and thus the remaining gluons form a node between the two dissimilar lobes of the heterogenous compound nucleus.

Thus, the reduced mass (or the remaining gluons) keeps both the dissimilar lobes - of the heterogenous compound nucleus - joined them together.

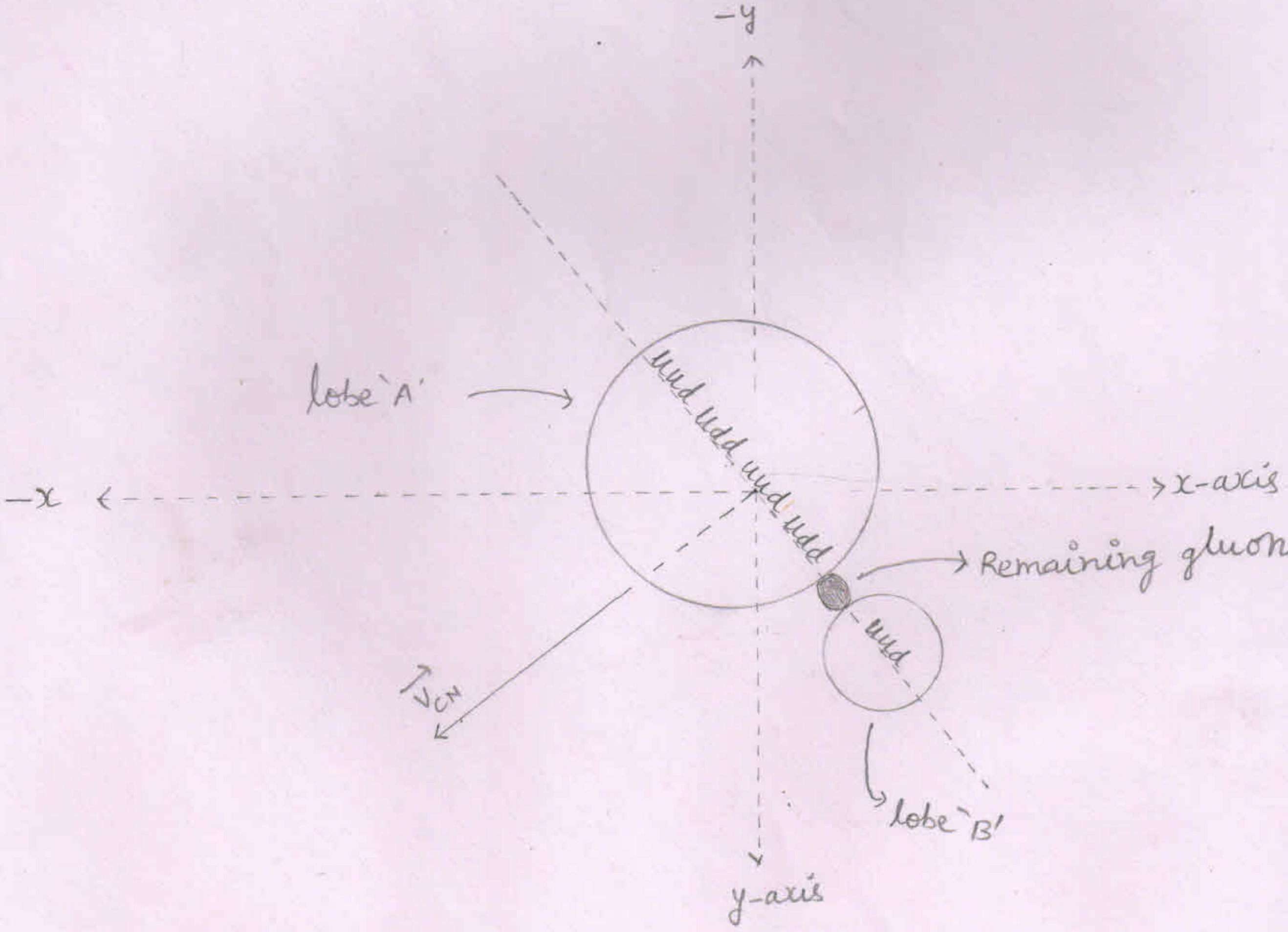
So, finally, the heterogenous compound nucleus becomes like an abnormal digit eight or becomes like a dumb-bell.

Final stage of the heterogenous compound nucleus



4 (1)

Final stage of the heterogenous compound nucleus



The splitting of the heterogenous compound nucleus :-

⇒ The heterogenous compound nucleus, due to its instability, splits according to the lines parallel to the direction of the velocity of the compound nucleus ($\vec{V}_{CN}$) into three particles – the helium-4 nucleus, the proton and the reduced mass (Δm).

Out of them, the two particles (the helion-4 and the proton) are stable while the third one (reduced mass) is unstable.

⇒ According to the law of inertia, each particle that has separated from the compound nucleus, has an inhereted velocity ($\vec{V}_{o_{inh}}$) equal to the velocity of the compound nucleus ($\vec{V}_{CN}$).

⇒ So, for conservation of momentum

$$M\vec{V}_{CN} = (m_{he-4} + \Delta m + m_p)\,\vec{V}_{CN}$$

where,

M = Mass of the compound nucleus that is equal to the mass of the lithion-5.

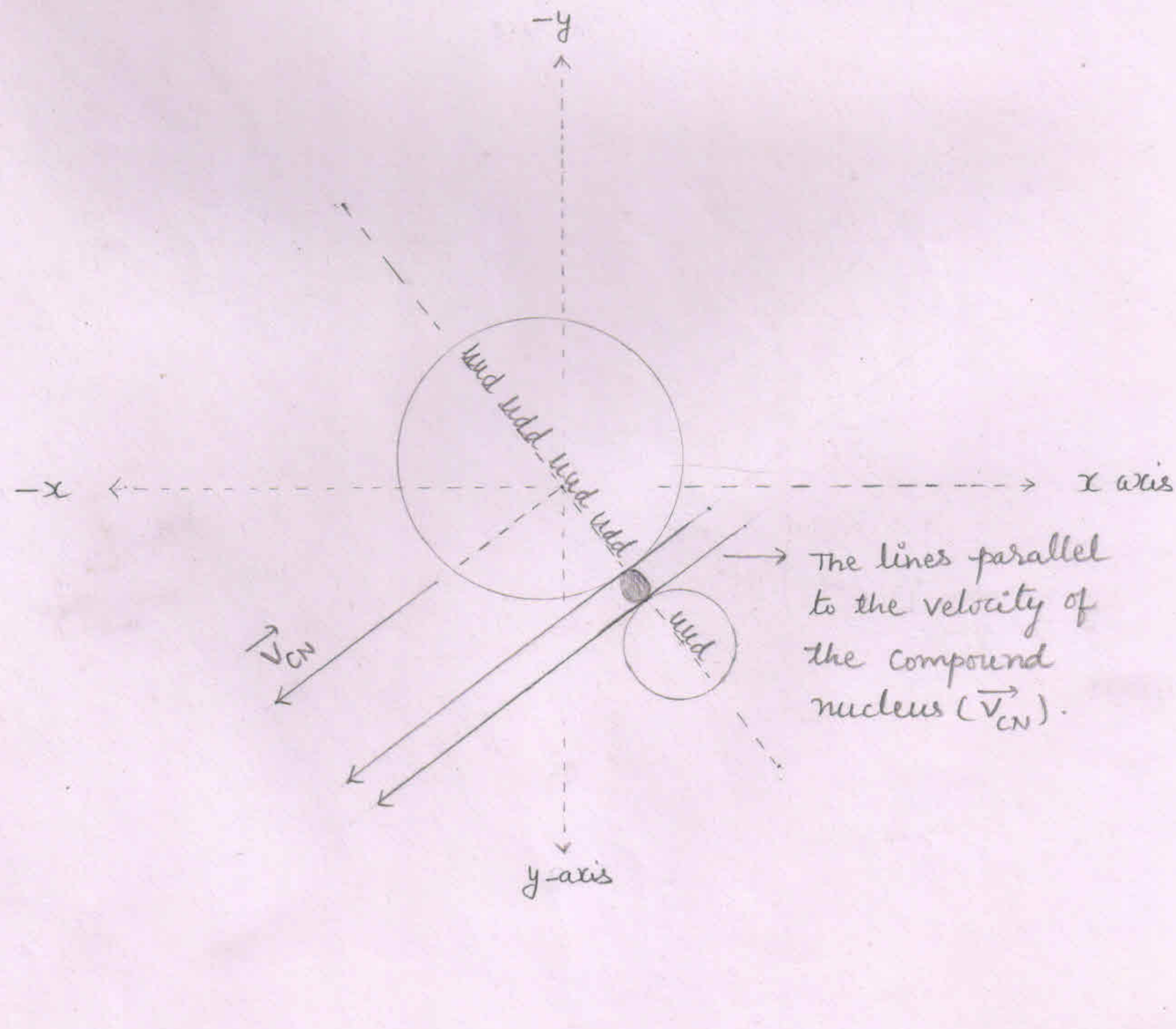
$\vec{V}_{CN}$ = velocity of the compound nucleus.

m_{he-4} = mass of the helium-4 nucleus

Δm = reduced mass

m_p = mass of the proton

The splitting of the heterogenous compound nucleus



The splitting of the heterogenous compound nucleus :-

The heterogenous compound nucleus splits into three particles - the helium-4 nucleus, the reduced mass (Δm) and the proton