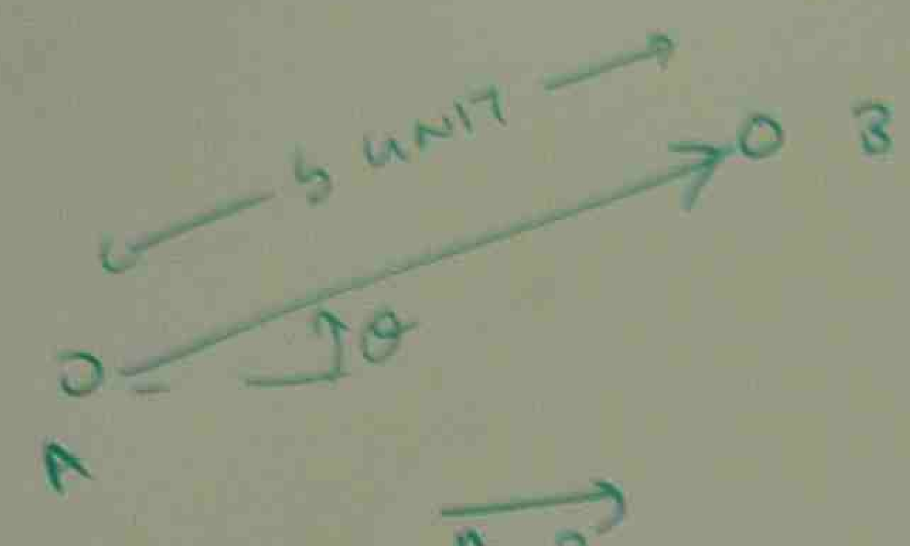
VECTORS

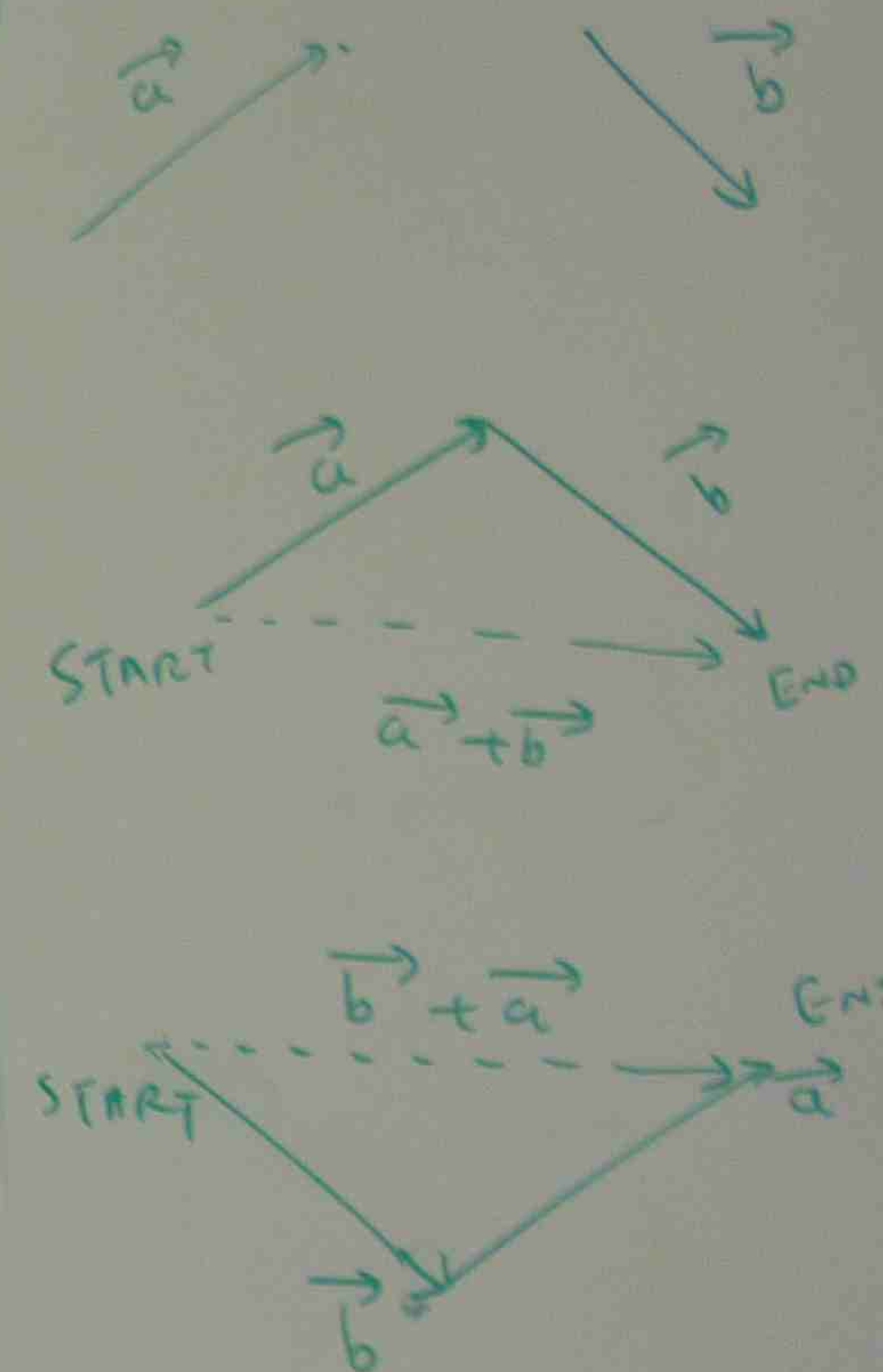
VECTOR HAS MAGNITUDE AND DIRECTION



$\overrightarrow{AB}$

DISPLACEMENT VECTOR

ADDING THE VECTORS

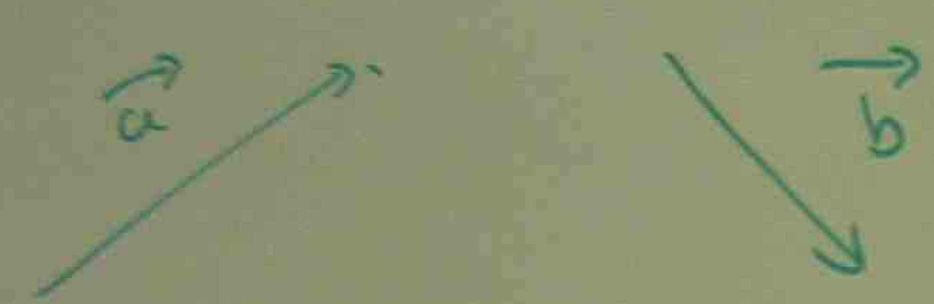


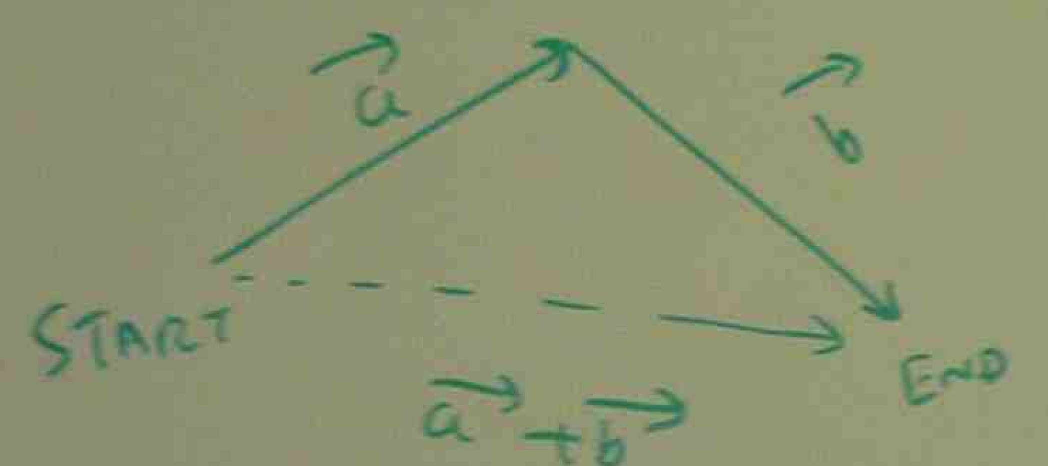
$$\vec{a} + \vec{b} = \vec{b} + \vec{a}$$

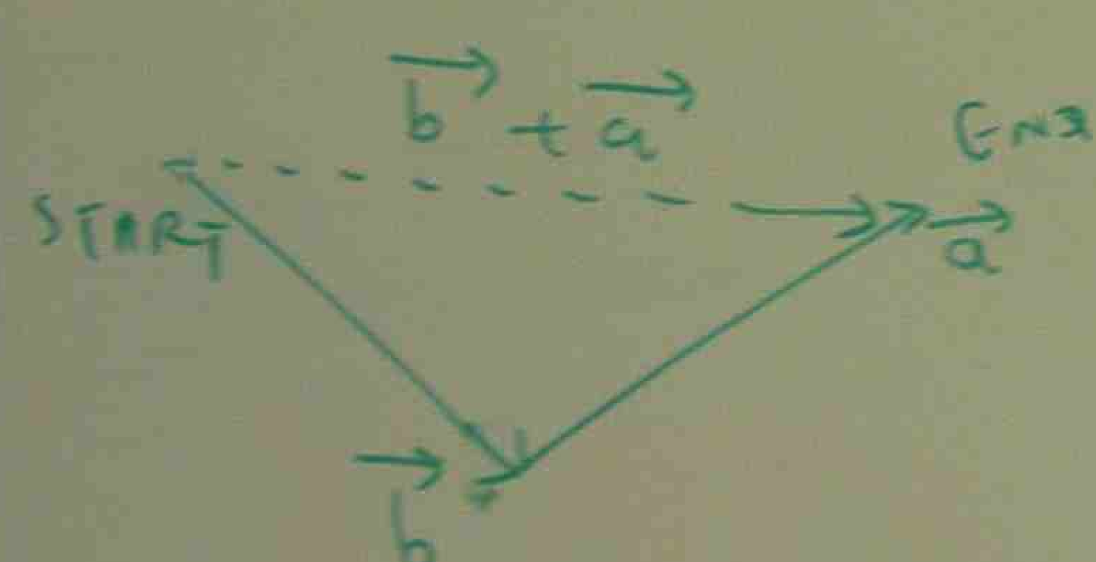
AND DIRECTION

POINT)

ADDING THE VECTORS







$$\vec{a}+\vec{b}=\vec{b}+\vec{a}$$

REVERSAL OF VECTOR

VECTOR LAWS

$\vec{a}+\vec{b}=\vec{b}+\vec{a}$ (COMMUTATIVE LAW)

$(\vec{a}+\vec{b})+\vec{c}=\vec{a}+(\vec{b}+\vec{c})$ (ASSOCIATIVE LAW)

$\vec{b}+(-\vec{b})=0$ (VECTOR SUBSTRACTION)

ph

AL of VECTOR

$-\vec{b}$

LAWS

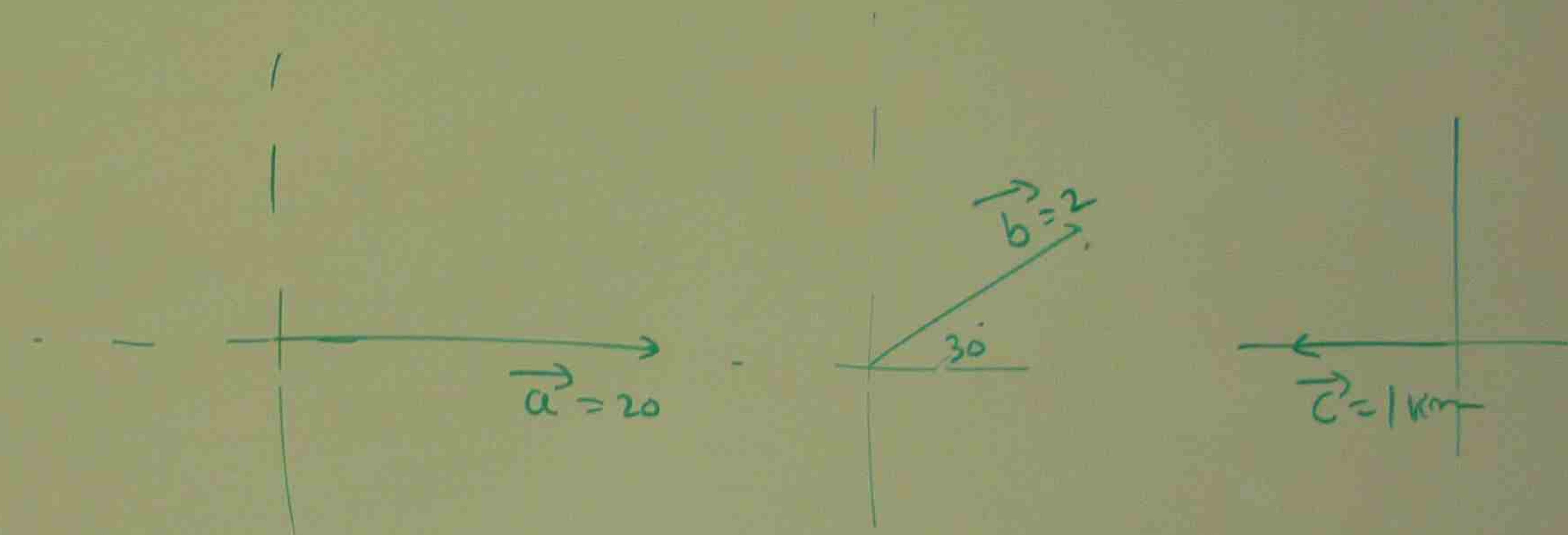
$\ldots + \vec{a}$ (COMMUTATIVE LAW)

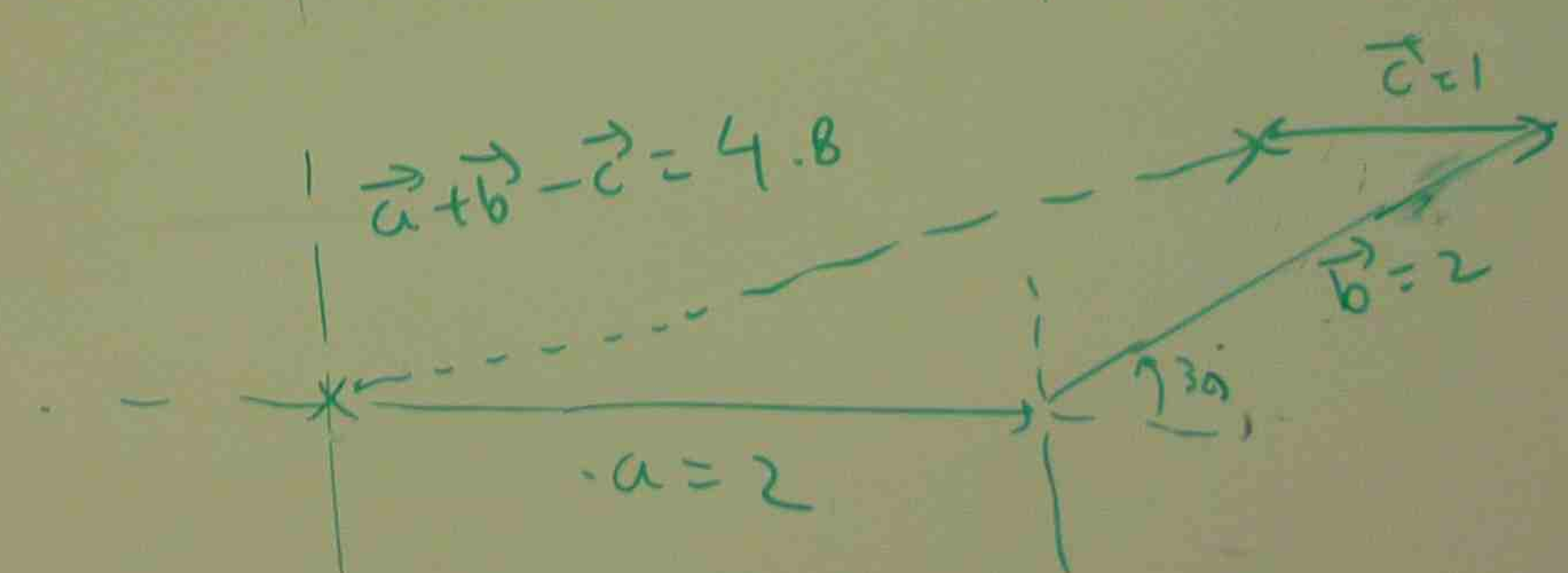
$\ldots \vec{c} = \vec{a} + (\vec{b} + \vec{c})$ (ASSOCIATIVE LAW)

$\ldots - \vec{b}) = 0$ (VECTOR SUBSTRACTION)

pb THE MAGNITUDE of $\vec{a}$ IS 2 km DUE EAST. $\vec{b}$, 2 km 30° NORTH of EAST, $\vec{c}$ 1km DUE WEST

WHAT IS THE GREATEST DISTANCE AT THE END of THIRD DISPLACEMENT.





pb

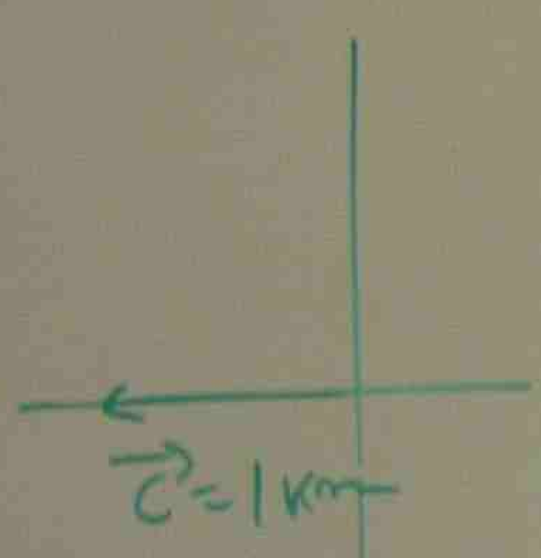
$\vec{a}$

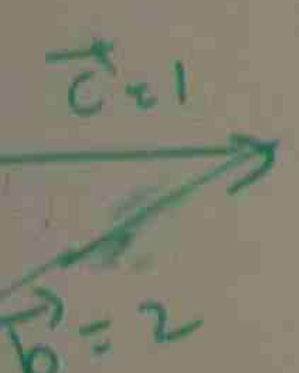
$\vec{a}$

... DUE EAST.

$\vec{c}$ 1 km DUE WEST

THE END OF





pb THE MAGNITUDE OF DISPLACEMENTS $\vec{a}$ AND $\vec{b}$ ARE 3 m AND 4 m RESPECTIVELY. CONSIDERING VARIOUS ORIENTATIONS OF $\vec{a}$ AND $\vec{b}$ (a) WHAT IS THE MAXIMUM POSSIBLE MAGNITUDE FOR $\vec{c}$ AND (b) THE MINIMUM POSSIBLE MAGNITUDE?

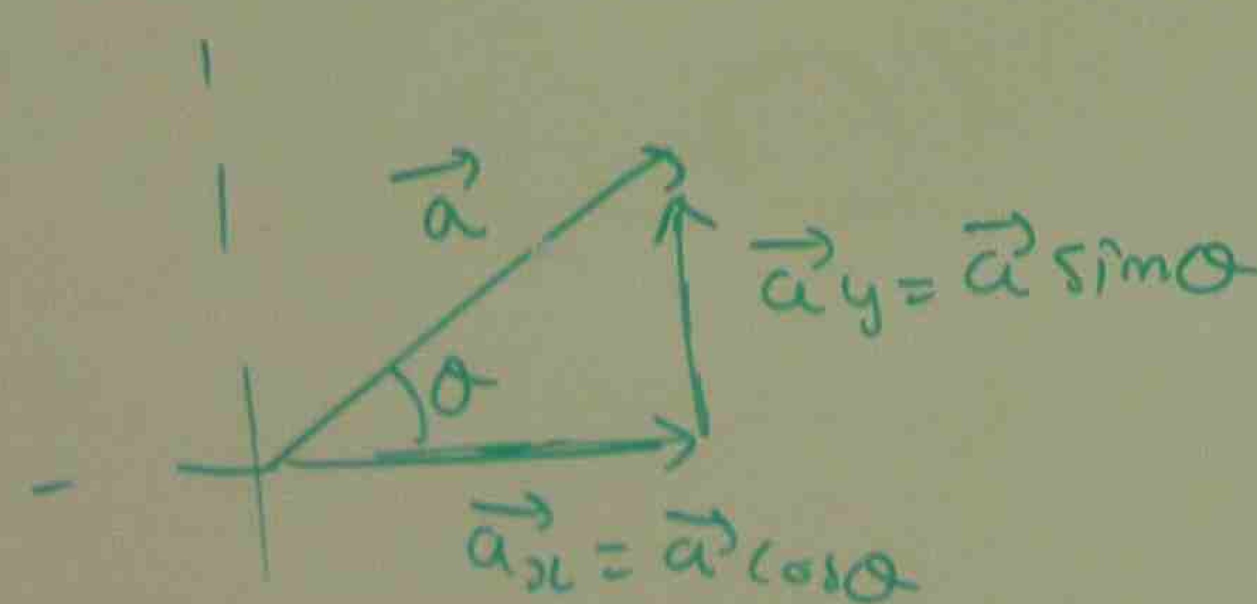
$\vec{a}$ AND $\vec{b}$ IN THE SAME DIRECTION = MAXIMUM: $\vec{a} + \vec{b} = 3 + 4 = 7$

$\vec{a}$ AND $\vec{b}$ IN DIRECTLY OPPOSITE = MINIMUM: $\vec{a} - \vec{b} = 3 - 4 = \overrightarrow{-1}$

(OR)

$\vec{b} - \vec{a} = 4 - 3 = \overleftarrow{1}$

COMPONENTS OF VECTOR (RESOLVING THE VECTOR)



$$\tan\theta = \frac{|\vec{a}_y|}{|\vec{a}_x|}$$

$$\theta = \tan^{-1} \frac{|\vec{a}_y|}{|\vec{a}_x|}$$

pb A 5 m ...
ON AN ...
SIGHTED ...
MAKING ...
NORTH.
THE AIR ...
SIGHTED ...

W - -

$\vec{a}_x$ ...

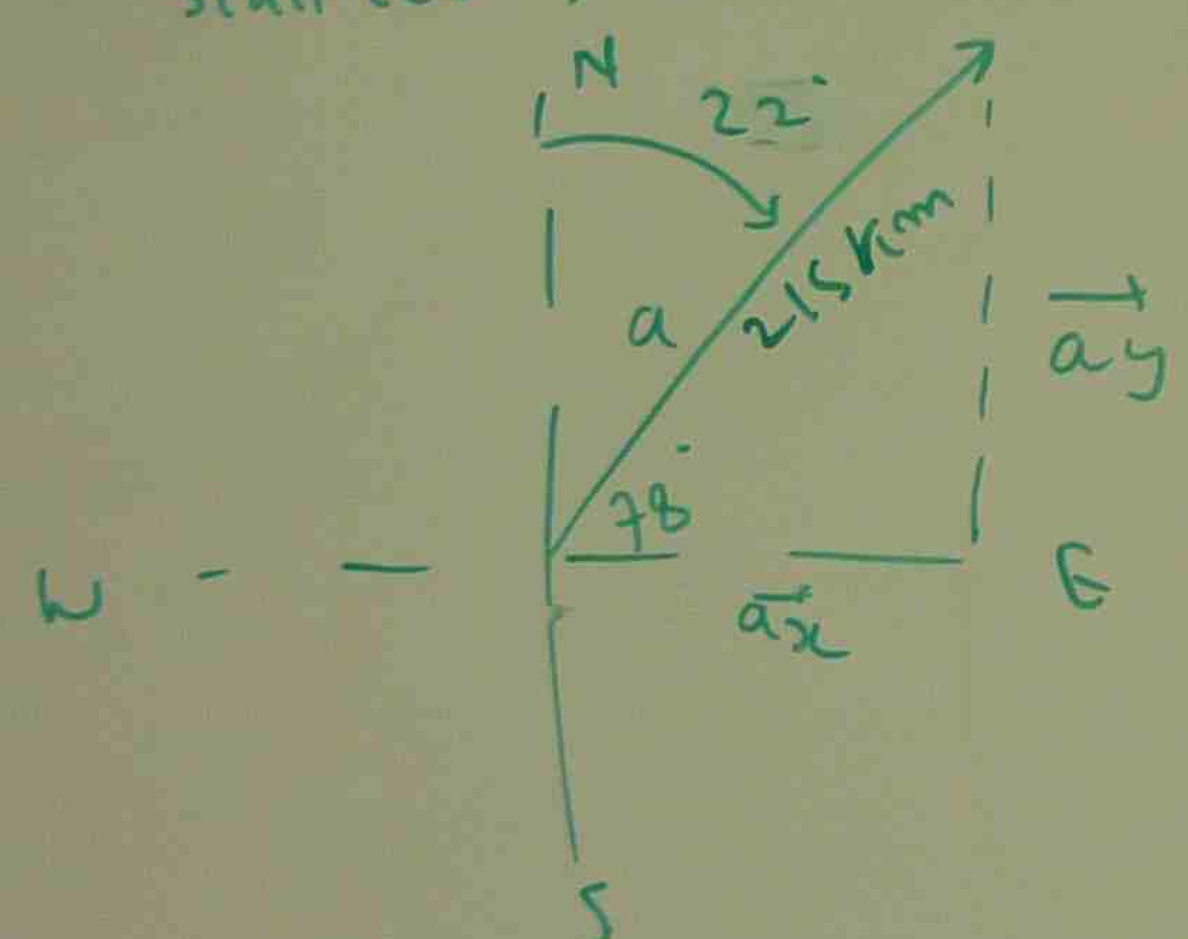
$\vec{a}_y$ ...

+4 = 7

-4 = -1

-3 = 1

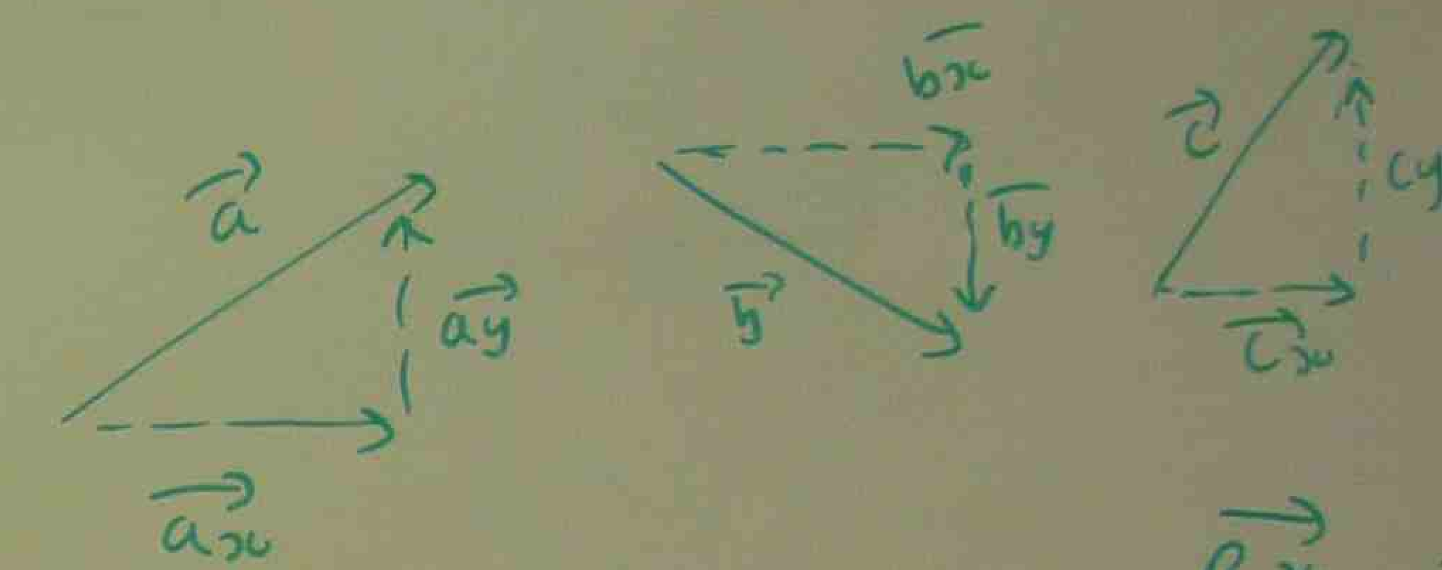
pb A SMALL AIRPLANE LEAVES AN AIRPORT ON AN OVERCAST DAY AND IS LATER SIGHTED 215 km AWAY IN A DIRECTION MAKING AN ANGLE OF 22° EAST OF DUE NORTH. HOW FAR EAST AND NORTH IS THE AIRPLANE FROM THE AIRPORT WHEN SIGHTED ?



$\vec{a_x} = 215 \cos 78 = 44.7 \text{ km}$

$\vec{a_y} = 215 \sin 78 = 209 \text{ km}$

ADDING VECTOR BY COMPONENTS



R = RESULTANT VECTOR $\to$ $\vec{R_x}$ $\rightarrow$, $\vec{R_y}$ $\uparrow$

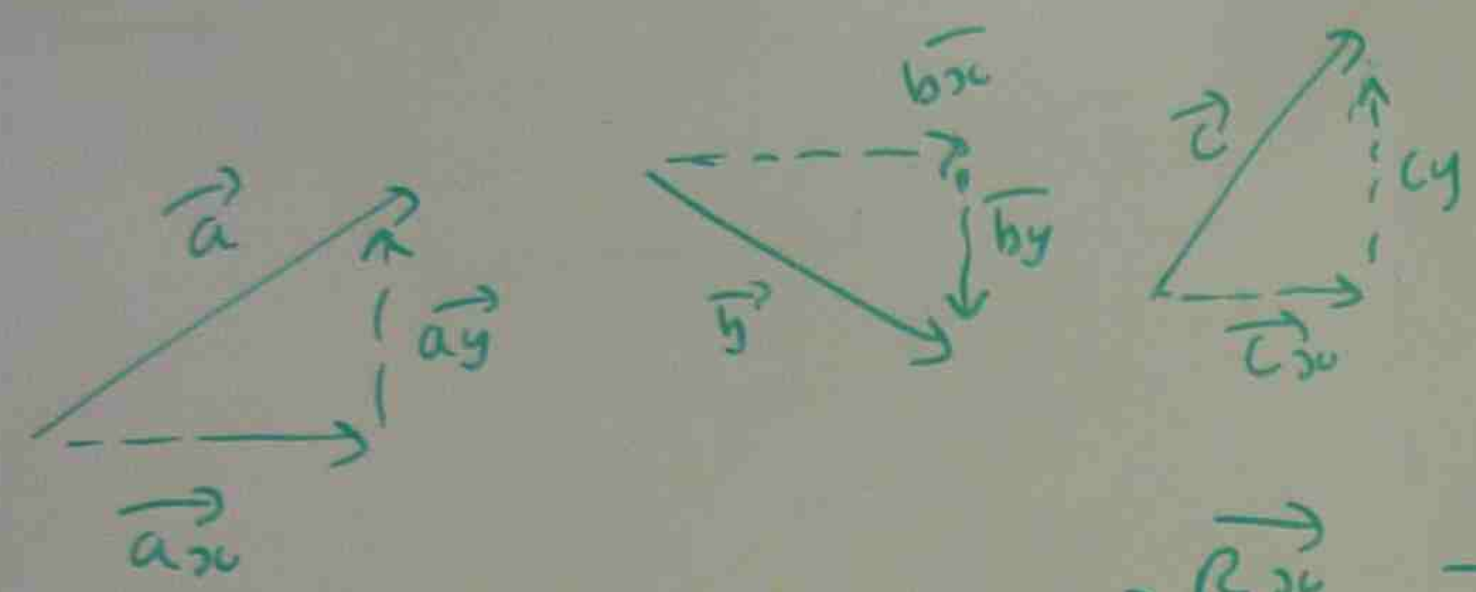
$\vec{R_x} = \vec{a_x} + \vec{b_x} + \vec{c_x}$

$\vec{R_y} = (+\vec{a_y}) + (-\vec{b_y}) + (+\vec{c_y})$

$R = \sqrt{(\vec{R_x})^2 + (\vec{R_y})^2} \quad \angle \tan^{-1} \frac{\vec{R_y}}{\vec{R_x}}$

pb

ADDING VECTOR BY COMPONENTS



R = RESULTANT VECTOR

$\vec{R_x}$ $\rightarrow$

$\vec{R_y}$ $\uparrow$

$$\vec{R_x} = \vec{a_x} + \vec{b_x} + \vec{c_x}$$

$\uparrow +$

$$\vec{R_y} = (+\vec{a_y}) + (-\vec{b_y}) + (+\vec{c_y})$$

$$R = \sqrt{(\vec{R_x})^2 + (\vec{R_y})^2} \;\angle \tan^{-1}\frac{\vec{R_y}}{\vec{R_x}}$$

$$\vec{a} = a_1\hat{i} + a_2 j + a_3 k$$

$$\vec{b} = b_1 i + b_2 j + b_3 k$$

$$\vec{c} = c_1 i + c_2 j + c_3 k$$

pb

$\vec{a} = 4.2\, i - 1.5\, j$

$\vec{b} = -1.6\, i + 2.9\, j$

$\vec{c} = -3.7\, j$ FIND THE RESULTANT VECTOR.

$$\vec{a} + \vec{b} + \vec{c} = 4.2i - 1.5j + (-1.6i + 2.9j) + (-3.7j)$$

$$R = (4.2i - 1.6i) - 1.5j + 2.9j - 3.7j$$

$$= 2.6\, i - 5.2j + 2.9j$$

$$= 2.6\, i - 2.3\, j$$

$$R = \sqrt{2.6^2 + 2.3^2} \;\angle -\tan^{-1}\frac{2.3}{2.6} = 3.5 \angle -41$$

MULTIPLYING VECTOR

SCALOR PRODUCT $\longrightarrow$ MAGNITUDE

$$\vec{a} = a_1 i + a_2 j + a_3 k$$

$$\vec{b} = b_1 i + b_2 j + b_3 k$$

$$\vec{a} \cdot \vec{b} = a \cdot b_1 + a_2 \cdot b_2 + a_3 \cdot b_3$$

Pn

$$\vec{a} = 3i + 4j + 5k$$

$$\vec{b} = 2i + 1j + 3k$$

$$\vec{a} \cdot \vec{b} = 3 \cdot 2 + 4 \cdot 1 + 5 \cdot 3$$

$$= 6 + 4 + 15$$

$$= 25$$

CROSS PRODUCT $\longrightarrow$ MA

$$\vec{F} = \vec{\phi} \times$$

FORCE FLUX

MULTIPLYING VECTOR

SCALOR PRODUCT $\longrightarrow$ MAGNITUDE

$\vec{a} = a_1 i + a_2 j + a_3 k$

$\vec{b} = b_1 i + b_2 j + b_3 k$

$\vec{a} \cdot \vec{b} = a \cdot b_1 + a_2 \cdot b_2 + a_3 \cdot b_3$

eg

$\vec{a} = 3i + 4j + 5k$

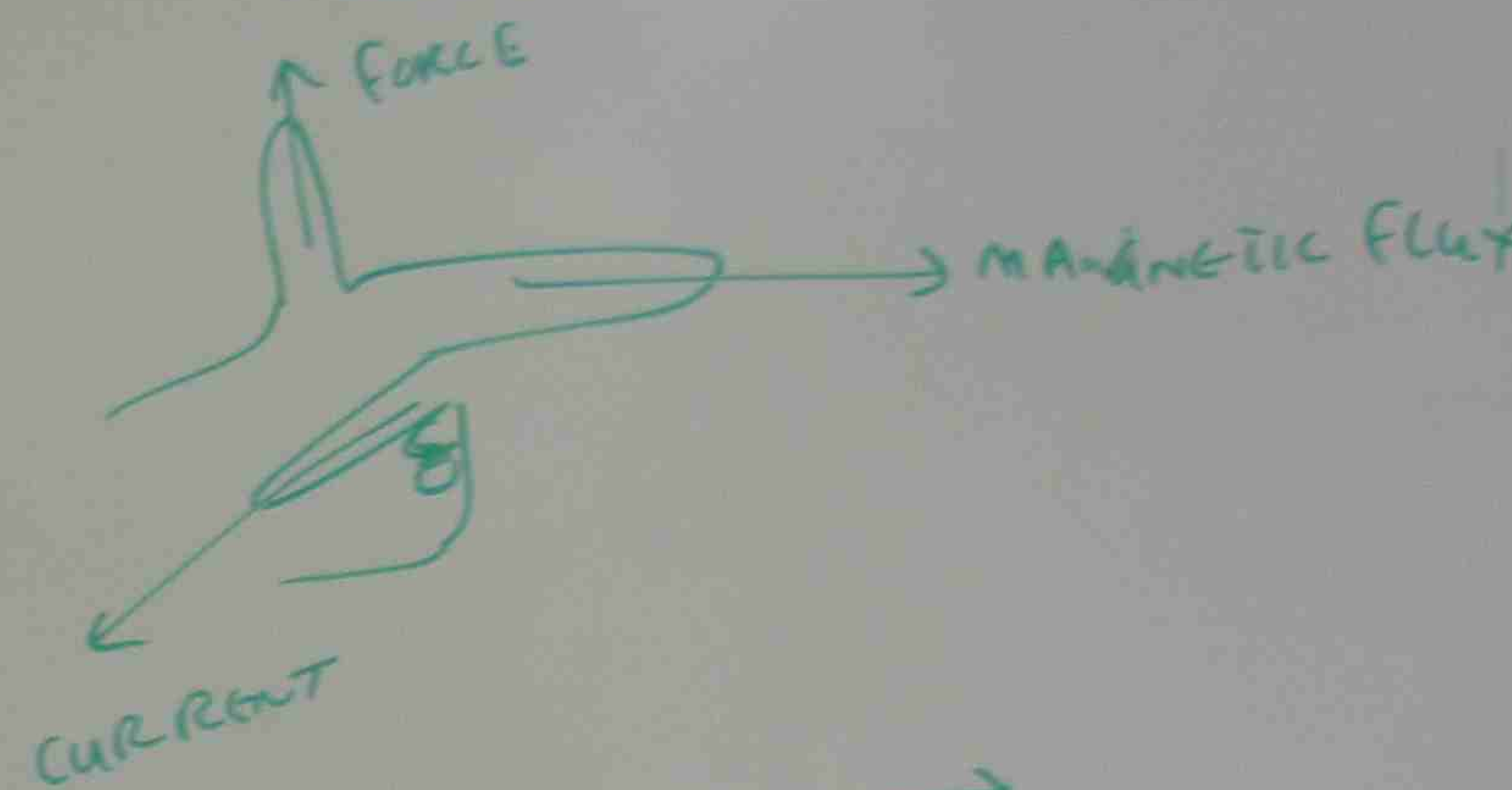
$\vec{b} = 2i + 1j + 3k$

$\vec{a} \cdot \vec{b} = 3 \cdot 2 + 4 \cdot 1 + 5 \cdot 3$

$= 6 + 4 + 15$

$= 25$

CROSS PRODUCT $\longrightarrow$ MAGNITUDE + DIRECTION



$\vec{F} = \vec{\phi} \times \vec{I}$

FORCE FLUX CURRENT

USE DETERM...

PRODUCT

$\vec{a} = a_1 i + \ldots$

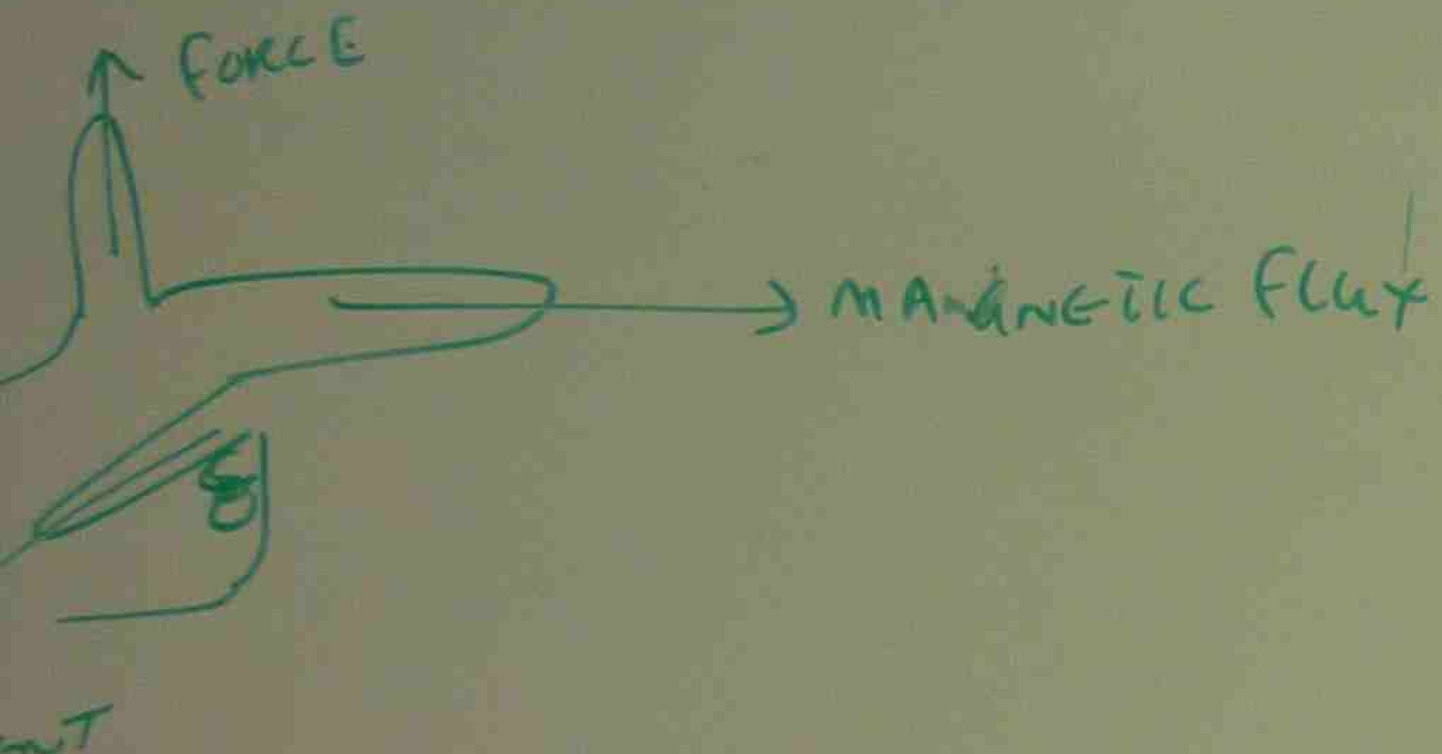
$\vec{b} = b_1 i + \ldots$

$\vec{a} \times \vec{b} = \ldots$

$i \begin{vmatrix} a_2 \ldots \\ b_2 \ldots \end{vmatrix}$

$i \left[a_2 b_3 - \ldots \right.$

PRODUCT → MAGNITUDE + DIRECTION



$= \vec{\Phi} \times \vec{I}$

FLUX CURRENT

USE DETERMINANT TO CALCULATE CROSS PRODUCT

$\vec{a} = a_1 i + a_2 j + a_3 k$

$\vec{b} = b_1 i + b_2 j + b_3 k$

$$\vec{a} \times \vec{b} = \begin{vmatrix} i & j & k \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

$$i \begin{vmatrix} a_2 & a_3 \\ b_2 & b_3 \end{vmatrix} - j \begin{vmatrix} a_1 & a_3 \\ b_1 & b_3 \end{vmatrix} + k \begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}$$

$$i\,[a_2 b_3 - b_2 a_3] - j\,[a_1 b_3 - b_1 a_3] + k\,[a_1 b_2 - b_1 a_2]$$

$\cdot\ \vec{b} \times \vec{a} =$

$= i \begin{vmatrix} b_2 & \\ a_2 & \end{vmatrix}$

$= i\,[b_2 a_3 -$

pb $\vec{a} = 2$

$\vec{b} = 3$

FIND

...INANT TO CALCULATE CROSS

$\dots a_2 j + a_3 k$

$\dots b_2 j + b_3 k$

$$\begin{vmatrix} i & j & k \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

$$\dots \; - j \begin{vmatrix} a_1 & a_3 \\ b_1 & b_3 \end{vmatrix} + k \begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}$$

$$\dots a_3] - j\,[a_1 b_3 - b_1 a_3] + k\,[a_1 b_2 - b_1 a_2]$$

$$\vec{b} \times \vec{a} = \begin{vmatrix} i & j & k \\ b_1 & b_2 & b_3 \\ a_1 & a_2 & a_3 \end{vmatrix}$$

$$= i \begin{vmatrix} b_2 & b_3 \\ a_2 & a_3 \end{vmatrix} - j \begin{vmatrix} b_1 & b_3 \\ a_1 & a_3 \end{vmatrix} + k \begin{vmatrix} b_1 & b_2 \\ a_1 & a_2 \end{vmatrix}$$

$$= i\,[b_2 a_3 - a_2 b_3] - j\,[b_1 a_3 - a_1 b_3] + k\,[b_1 a_2 - a_1 b_2]$$

pb

$\vec{a} = 2i + 3j + 4k$

$\vec{b} = 3i + 2j + 2k$

FIND $\vec{a} \times \vec{b}$ AND $\vec{b} \times \vec{a}$

pb THE MA...

4 m ...

$\vec{a}$ AN...

FOR $\vec{c}$ ...

$\vec{a}$ AND $\vec{b}$ ...

$\vec{a}$ AND $\vec{b}$ ...

comp...

TERMINANT TO CALCULATE CROSS

T

$i + a_2 j + a_3 k$

$+ b_2 j + b_3 k$

$$= \begin{vmatrix} i & j & k \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

$$\begin{vmatrix} & a_3 \\ & b_3 \end{vmatrix} - j \begin{vmatrix} a_1 & a_3 \\ b_1 & b_3 \end{vmatrix} + k \begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}$$

$$- b_2 a_3] - j\,[a_1 b_3 - b_1 a_3] + k\,[a_1 b_2 - b_1 a_2]$$

$$\vec{b} \times \vec{a} = \begin{vmatrix} i & j & k \\ b_1 & b_2 & b_3 \\ a_1 & a_2 & a_3 \end{vmatrix}$$

$$= i \begin{vmatrix} b_2 & b_3 \\ a_2 & a_3 \end{vmatrix} - j \begin{vmatrix} b_1 & b_3 \\ a_1 & a_3 \end{vmatrix} + k \begin{vmatrix} b_1 & b_2 \\ a_1 & a_2 \end{vmatrix}$$

$$= i\,[b_2 a_3 - a_2 b_3] - j\,[b_1 a_3 - a_1 b_3] + k\,[b_1 a_2 - a_1 b_2]$$

<u>pb</u> $\vec{a} = 2i + 3j + 4k$

$\vec{b} = 3i + 2j + 2k$

FIND $\vec{a} \times \vec{b}$ AND $\vec{b} \times \vec{a}$

$\vec{a} \times \vec{b} =$

$= i \,|$

$= i\,[3$

$= -2$

$= -2$

$\vec{b} \times \vec{a} =$

$i \,|\, 2$

3

$i\,[2\times$

$\begin{vmatrix} b_1 & b_2 \\ a_1 & a_2 \end{vmatrix}$

$] + k[b_1 a_2 - a_1 b_2]$

$\times \vec{a}$

$$\vec{a} \times \vec{b} = \begin{vmatrix} i & j & k \\ 2 & 3 & 4 \\ 3 & 2 & 2 \end{vmatrix}$$

$$= i\begin{vmatrix} 3 & 4 \\ 2 & 2 \end{vmatrix} - j\begin{vmatrix} 2 & 4 \\ 3 & 2 \end{vmatrix} + k\begin{vmatrix} 2 & 3 \\ 3 & 2 \end{vmatrix}$$

$$= i[3\times 2 - 2\times 4] - j[2\times 2 - 3\times 4] + k[2\times 2 - 3\times 3]$$

$$= -2i - j(-8) + k[4-9]$$

$$= -2i + 8j - 5k$$

$$\vec{b} \times \vec{a} = \begin{vmatrix} i & j & k \\ 3 & 2 & 2 \\ 2 & 3 & 4 \end{vmatrix}$$

$$i\begin{vmatrix} 2 & 2 \\ 3 & 4 \end{vmatrix} - j\begin{vmatrix} 3 & 2 \\ 2 & 4 \end{vmatrix} + k\begin{vmatrix} 3 & 2 \\ 2 & 3 \end{vmatrix}$$

$$i[2\times 4 - 3\times 2] - j[3\times 4 - 2\times 2] + k[3\times 3 - 2\times 2]$$

$$2i - 8j + 5k$$

$$\vec{a} \times \vec{b} = -[\vec{b} \times \vec{a}]$$

Pb A SMALL

ON AN OVER

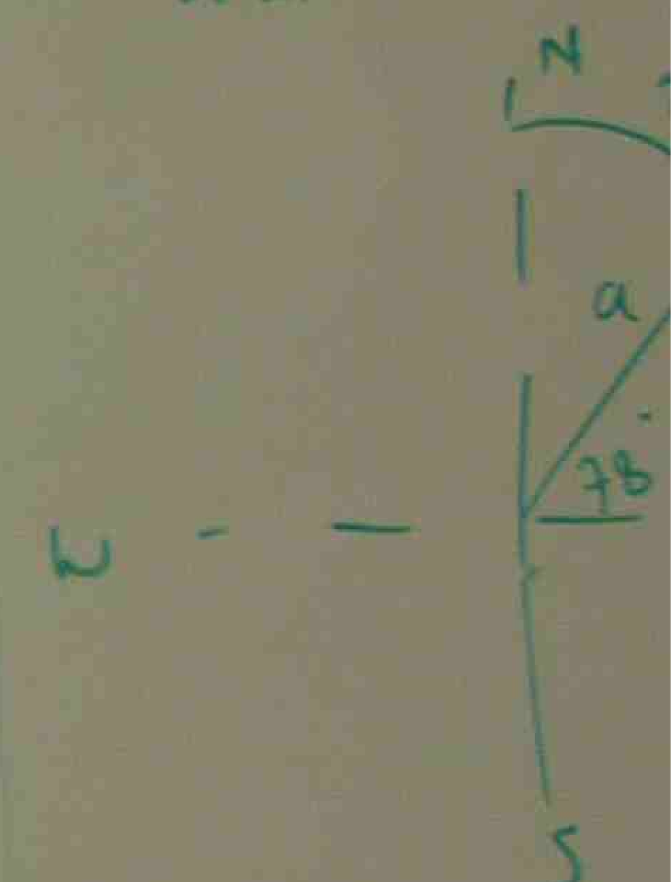
SIGHTED 2

MAKING AN

NORTH. HOW

THE AIR PLAN

SIGHTED ?



$\vec{a}_x = 21$

$\vec{a}_y = 21$

SK

$\vec{b} \times \vec{a}$]

FORCE AND MOTION

$$\bar{F} = m \times a$$

F = FORCE (N)

m = MASS (kg)

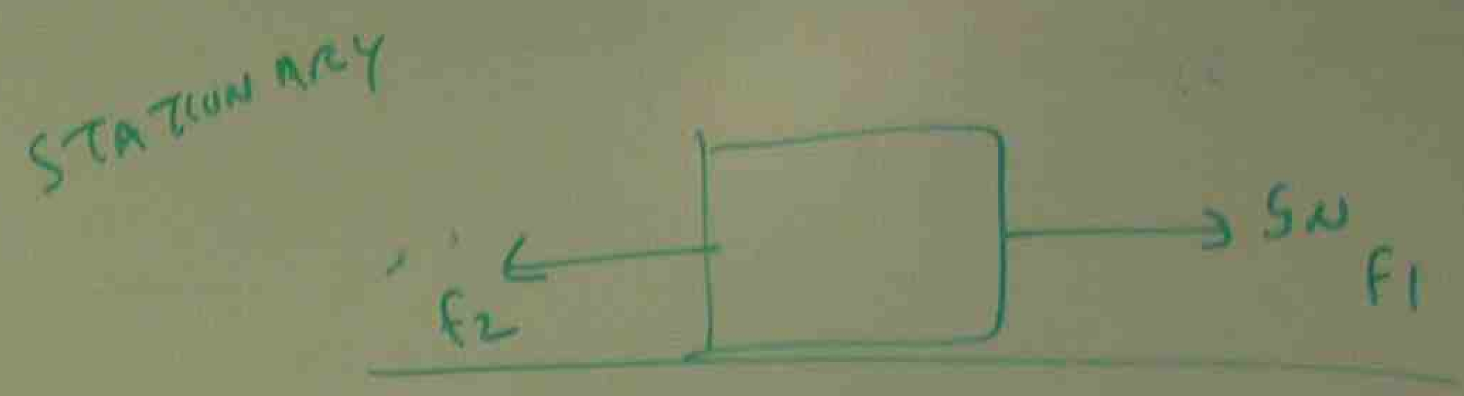
a = ACCELERATION (m/s^2)

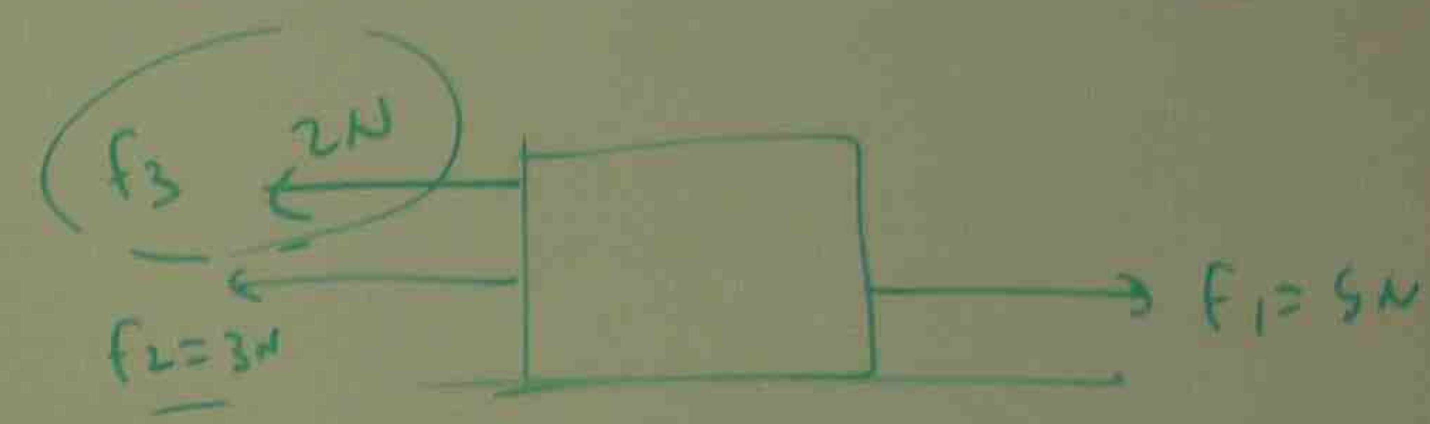
pb THE FIGURE SHOWS TWO HORIZONTAL FORCES ACTING ON THE BLOCK.

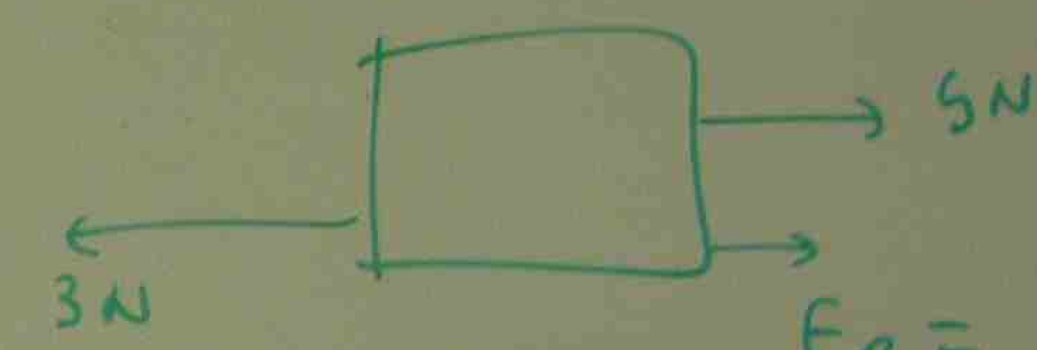
WHAT IS THE THIRD FORCE

WHEN THE BLOCK IS STATIONARY

THE BLOCK IS MOVING TO THE RIGHT AT CONSTANT SPEED OF 5 m/s.







$F_R = 5-3 = 2$ N