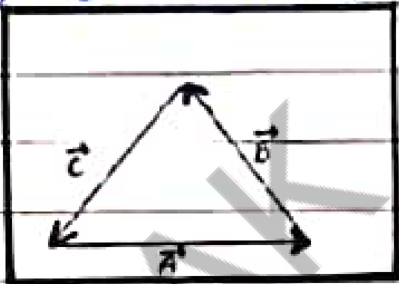
Q. No. 2 (i) **Reason:-** Yes, it is possible to add three vectors of equal magnitude but different directions to get a null vector if they are added to form a closed triangle.

Explanation:- → Consider three vectors $\vec{A}, \vec{B}$ & $\vec{C}$ as shown in figure.



→ It is clear that sum of the vectors is zero because the head of the last vector coincides with the tail of first vector.

→ There is no space to draw the resultant vector, so resultant will be a null vector.

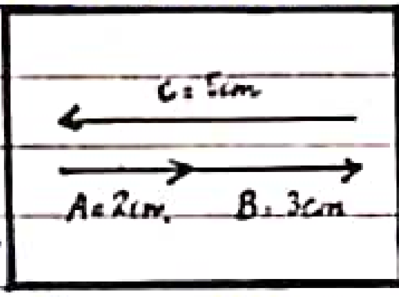
Mathematically

$$\boxed{\begin{array}{c}\vec{A}+\vec{B}+\vec{C}=0\\ \vec{R}=0\end{array}}$$

Conclusion:- The resultant will be a null vector.

Q. No. 2 (ii) **Reason:-** Yes, it is possible.

Explanation:- → Consider three vectors $\vec{A}, \vec{B}$ & $\vec{C}$ as shown in figure.



→ Vectors $\vec{A}$ & $\vec{B}$ are directed toward +ve x-axis and sum of their magnitude is 5. Vector $\vec{C}$ is directed towards -ve x-axis and its magnitude is also 5. Vector sum of these three vectors is zero.

→ It is clear that sum of the vectors is zero because the head of the last vector $\vec{C}$ coincides with the tail of first vector $\vec{A}$.

Mathematically

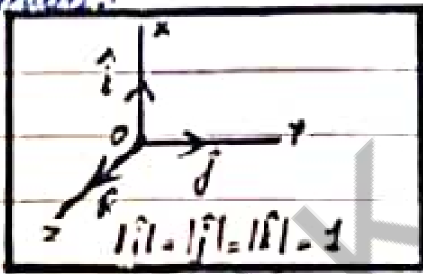
$$\boxed{\begin{array}{c}\vec{A}+\vec{B}+\vec{C}=0\\ 2+3+(-5)=0\end{array}}$$

Conclusion:- The resultant will be a null vector.

Q. No. 2 (iii) **Reason:-** Unit vectors have magnitude one and are unitless vectors. So, no units are associated with unit vectors $\hat{i}, \hat{j}, \hat{k}$, they are used only to represents the direction.

Explanation:- Unit vector is given by formula:

$$\boxed{\hat{A} = \frac{\vec{A}}{|\vec{A}|}}$$

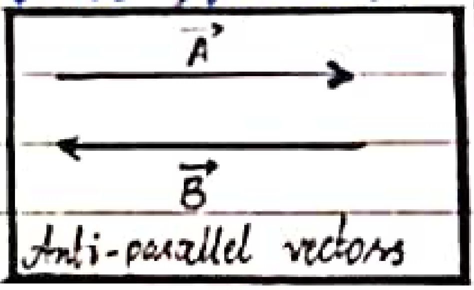


→ We see that unit vector is obtained by dividing a vector with its magnitude. As both vector and its magnitude have same units, so their gives no unit of unit vector.

Conclusion:- Because of the above reasons, $\hat{i}, \hat{j}, \hat{k}$ have no units and represents the direction of components of a vector along x-axis, y-axis and z-axis respectively.

Q. No. 2 (iv) **Reason:-** Yes, scalar product of two vectors can be negative.

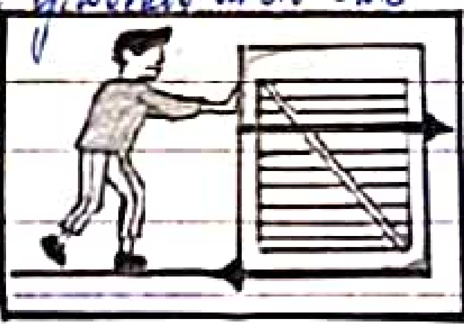
Proof:- If two vectors are anti-parallel ($\theta = 180°$) then their scalar product is negative.



Mathematically:-

$$\boxed{\begin{aligned} \vec{A} \cdot \vec{B} &= AB\cos 180° \\ &= AB(-1) = -AB \end{aligned}}$$

Example:- → If a body is pushed on the ground, then the force of friction ($\vec{f}$) acts opposite to displacement ($\vec{d}$) covered by the body, then work done by friction is:-



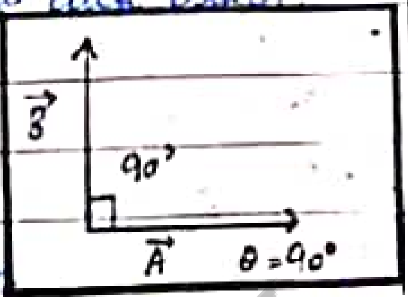
$$W = \vec{f} \cdot \vec{d}$$

$$= fd \cos\theta$$

Conclusion:- Since $\vec{f}$ and $\vec{d}$ are opposite ($\theta = 180°$) So,

$$W = fd\cos 180° \Rightarrow W = fd(-1) \Rightarrow W = -fd$$

Q. No. 2 (v) **Scalar Product case:** The scalar product of two vectors can be zero if both vectors are perpendicular to each other.

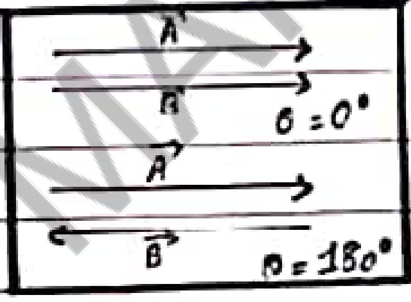


Perpendicular Vectors:- $\vec{A}\cdot\vec{B} = AB\cos 90°$

$$\vec{A}\cdot\vec{B} = AB(0)$$

$$\vec{A}\cdot\vec{B} = 0$$

Vector product case:- The magnitude of vector product is zero if both vectors are parallel or anti-parallel.



Parallel vectors:- $\vec{A}\times\vec{B} = AB\sin 0°\hat{n}$

$$A\times B = AB(0)\hat{n} = 0 \quad \hat{n} = \vec{0}$$

So, in this way magnitude of $\vec{A}\times\vec{B}$ is equal to zero.

Anti-Parallel vectors:- $\vec{A}\times\vec{B} = AB\sin 180°\hat{n}$

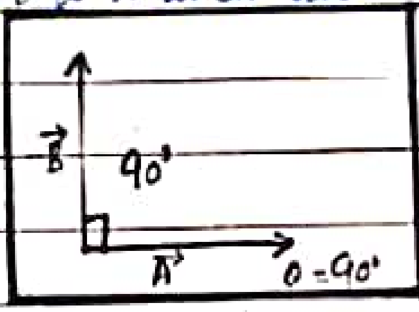
$$A\times B = AB(0)\hat{n} = 0 \quad \hat{n} = \vec{0}$$

So, in this way magnitude of $\vec{A}\times\vec{B}$ is equal to zero.

Q. No. 2 (vi) Vector $\vec{B}$ is a null vector.

Reason:-

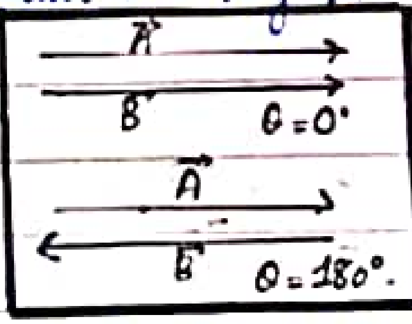
Case 1:- If $\vec{B}$ is non-zero then it perpendicular to $\vec{A}$ then their scalar product will be zero. $\vec{A}\cdot\vec{B} = AB\cos 90°$



$$\vec{A}\cdot\vec{B} = A(0)$$

$$\vec{A}\cdot\vec{B} = 0$$

Case 2:- If $\vec{B}$ is non-zero it is parallel or antiparallel to $\vec{A}$ then magnitude of vector product will be zero.



Parallel Vectors:- $\vec{A}\times\vec{B} = AB\sin 0°\hat{n}$

$$\vec{A}\times\vec{B} = AB(0)\hat{n} \qquad 0\hat{n} = \vec{0}$$

Antiparallel Vectors:- $\vec{A}\times\vec{B} = AB\sin 180°\hat{n}$

$$\vec{A}\vec{B} = AB(0)\hat{n} \quad 0\hat{n} = \vec{0}$$

Conclusion:- From above situation we can conclude that these vectors can never be perpendicular, parallel (antiparallel) simultaneously.

Q. No. 2 (vii) **Reason:-** Yes, A particle experiencing only one force can't be in equilibrium.

Explanation:- → According to first condition of equilibrium a body will be in equilibrium if net force acting on it zero

$$\Sigma F = 0$$

→ But under action of single force, net force cannot be zero.

→ Also, body will have acceleration. Therefore body cannot be in equilibrium under the action of a single force.

Conclusion:- From above explanation we can conclude that the body under the action of a single force cannot be in equilibrium.

Q. No. 2 (viii) Consider the door that has the handle on the right and the hinges on the left as shown. When we pull or push the door, it rotates due to applied torque.

When door is pulled toward us:- When we pull the handle of the door towards us to close it, the door will rotate clockwise (Moment of force will be inward by Right hand rule).

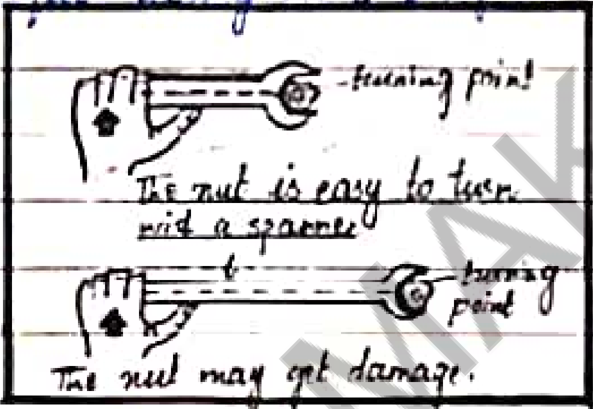
When door is pushed away from us:-
When we push the door away from us to open it, the door will rotate anti-clockwise (Moment of force will be outward by Right hand rule).

Does your answer depend on whether the door open towards or away from you?:- Yes, the direction of torque will be reversed if door opens or closes opposite to the situation.

Q. No. 2 (ix) **Reason:** We should not use large wrench to tighten a small bolt because it may damage the nut due to application of large torque.

Explanation: We know that torque acting on a body is:-

$$\boxed{\tau = rF}$$

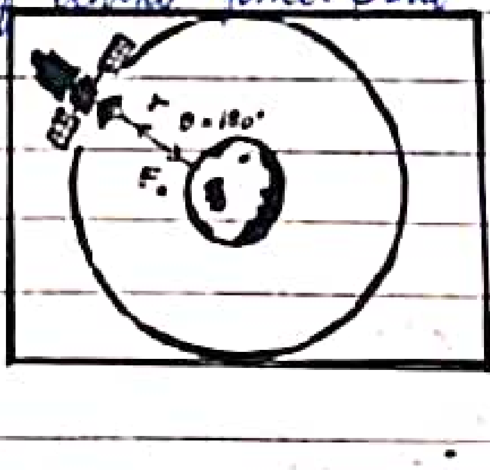


$\Rightarrow$ Torque = (Moment arm)(magnitude of force)

Conclusion: It is obvious from above equation that large wrench will provide greater moment arm and hence can apply greater torque on nut even with the small force. This greater force acting on the small nut may damage it.

Q. No. 2 (x) **Reason:** No, central force e.g. Centripetal force can't apply torque on the body.

Example: Centripetal force is example of central force. Since gravitational force between earth and satellite acts as centripetal force. Moment arm (Displacement between earth and satellite) i.e radius of orbit makes angle of 180°.



Mathematically:

$$\tau = rF\sin\theta$$
since $\theta = 180°$
So, $\tau = rF\sin 180°$
$$\tau = rF(0)$$
$$\tau = 0$$

Conclusion: So, we conclude that central forces can't apply torque