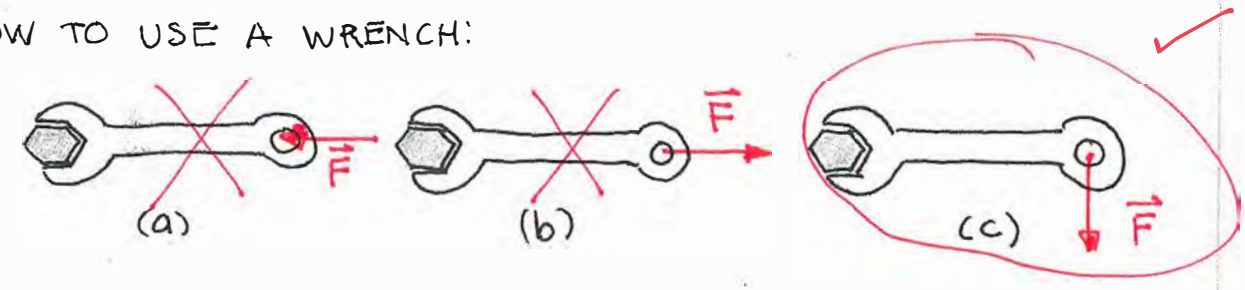
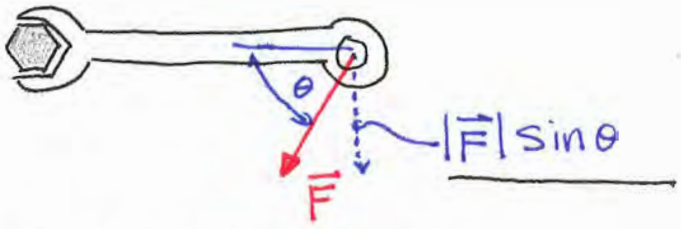
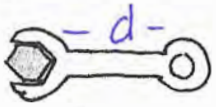
HOW TO USE A WRENCH:

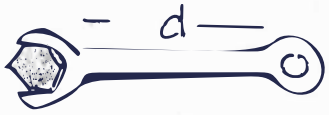


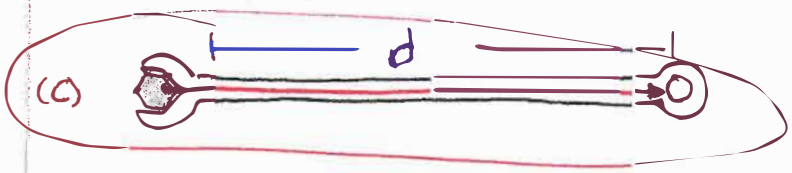
ONLY THE PART of THE FORCE THAT IS PERPENDICULAR TO THE WRENCH IS USEFUL.



NOW, PICK YOUR FAVORITE WRENCH:

(a) 

(b) 

(c) 

AND SO THE USEFUL QUANTITY IS

$d|\vec{F}|\sin\theta$

WHICH WAY TIGHTENS BOLT? WHICH WAY LOOSENS IT?

MAGNITUDE & DIRECTION ARE IMPORTANT.

SOUNDS LIKE A VECTOR.

Formal Definition of a Moment

$\vec{M}_o \equiv \vec{r} \times \vec{F}$

$\vec{r}$: position vector from O to F

About point O

Fingers: $\vec{r}$ into $\vec{F}$

Thumb: $\vec{M}_o$ dir.

- $|\vec{M}_o| = |\vec{r}||\vec{F}| \sin\theta$
- Direction is $\perp$ to $\vec{r}$ & $\vec{F}$ using right hand rule.

OR USE

$$\vec{M}_o = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

Most useful in 3-D.

Properties: Not commutative

- $\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$
- $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$
- If $\vec{B} = \vec{B}_1 + \vec{B}_2$

$\vec{A} \times \vec{B} = \vec{A} \times (\vec{B}_1 + \vec{B}_2) = \vec{A} \times \vec{B}_1 + \vec{A} \times \vec{B}_2$

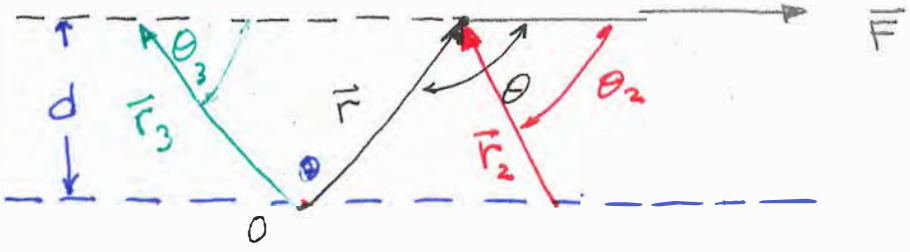
Lets us find $\vec{M}_o$ by breaking $\vec{F}$ into components.

$\hat{i} \times \hat{i} = 0 \quad \hat{i} \times \hat{j} = \hat{k} \quad \hat{i} \times \hat{k} = -\hat{j}$

$\hat{j} \times \hat{i} = -\hat{k} \quad \hat{j} \times \hat{j} = 0 \quad \hat{j} \times \hat{k} = \hat{i}$

$\hat{k} \times \hat{i} = \hat{j} \quad \hat{k} \times \hat{j} = -\hat{i} \quad \hat{k} \times \hat{k} = 0$

CONSIDER THE MOMENT ABOUT O DUE TO FORCE $\vec{F}$.



WHAT IS $|\vec{M}_o| = ?$ $|\vec{r}||\vec{F}|\sin\theta$

NOW FIND $|\vec{r}_2 \times \vec{F}|$. $= |\vec{r}_2||\vec{F}|\sin\theta_2 = |\vec{r}_3||\vec{F}|\sin\theta_3$

$|\vec{r}|\cdot\sin\theta = |\vec{r}_2|\sin\theta_2 =$ d .

COOL THING NUMBER 1: CAN FIND $\vec{M}_o$ BY USING ANY $\vec{r}$ FROM O TO ANY PLACE ALONG LINE of ACTION of $\vec{F}$.

COOL THING NUMBER 2: INFORMAL DEFINITION of A MOMENT.

A MOMENT ABOUT A POINT IS A "FORCE TIMES A PERPENDICULAR DISTANCE."