Moments and Couples
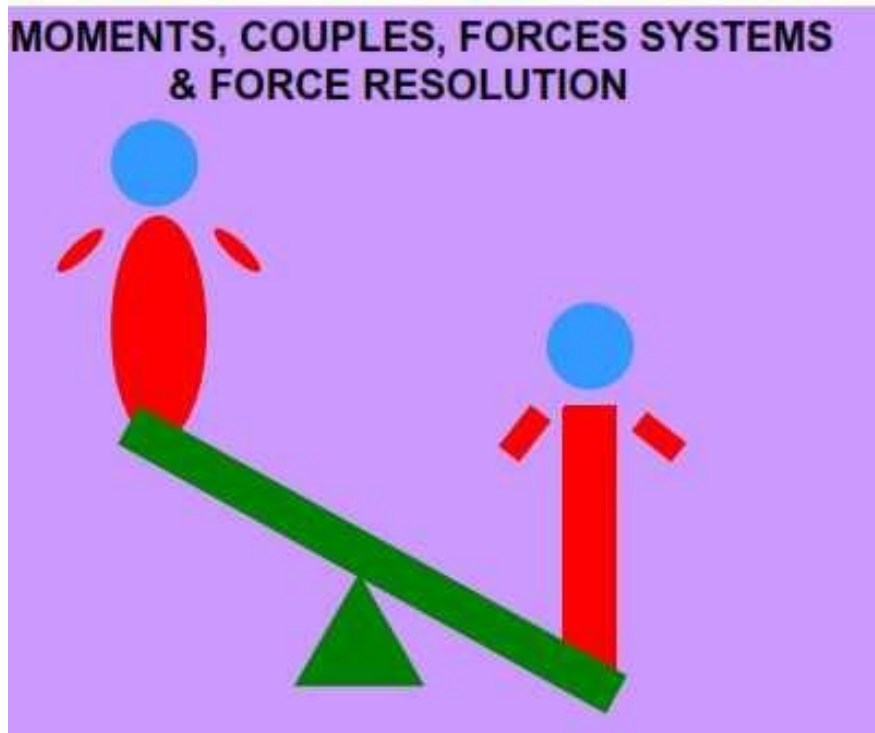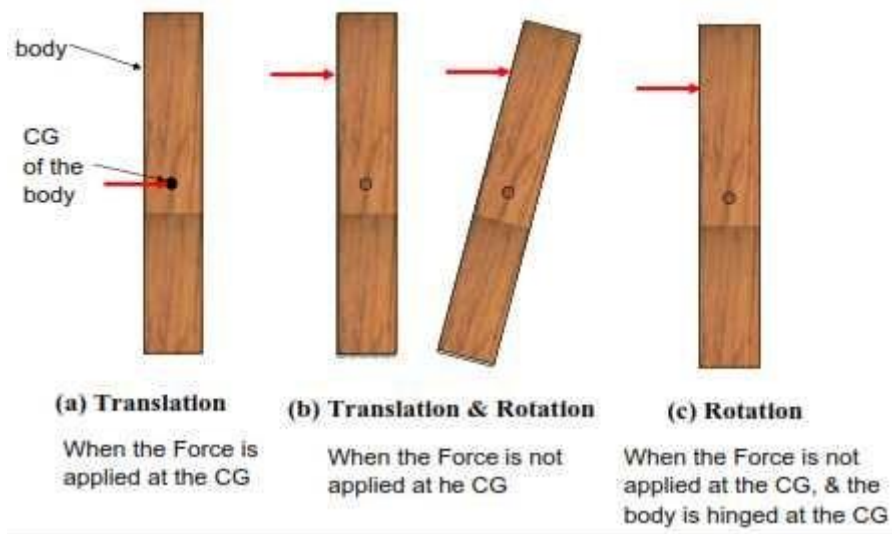
If a Force **P** is applied at the midpoint of the free, rigid, uniform object, it will slide the object such that every point moves an equal distance. The object is said to translate.

If the same force is applied at some other point as in second figure, then the object will both translate and rotate.

If the point on the object is fixed against translation, (third figure) then the applied force causes the object to rotate only.

Moment of a Force

F

d
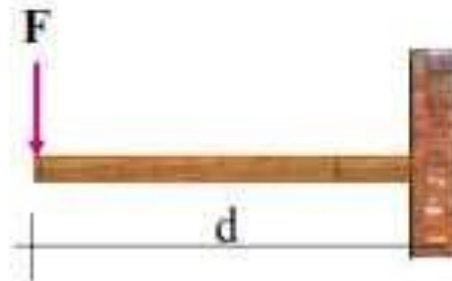
The tendency of a force to produce rotation of a body about some reference axis or point is called the MOMENT OF A FORCE
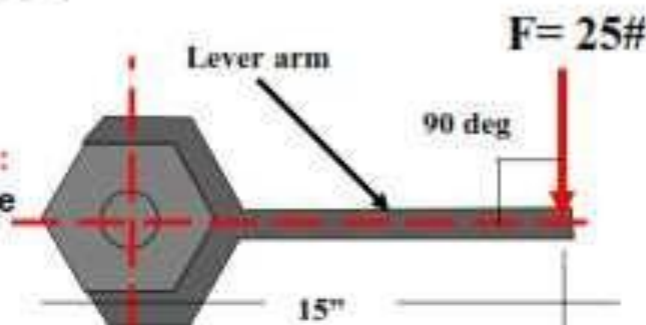
$$M=F\times d$$

Common Examples in the Application of the Concept of Moment

Example One: Closing the Door

Moment = Force x Perpendicular Distance = Fxd

Example Two: Tightening the NUT

Lever arm

F= 25#

90 deg

15"

$$M = -F \times d$$
$$= -25 \times 15$$
$$= -375 \text{ #-in}$$

Sign Convention for Moments

−

Clockwise negative

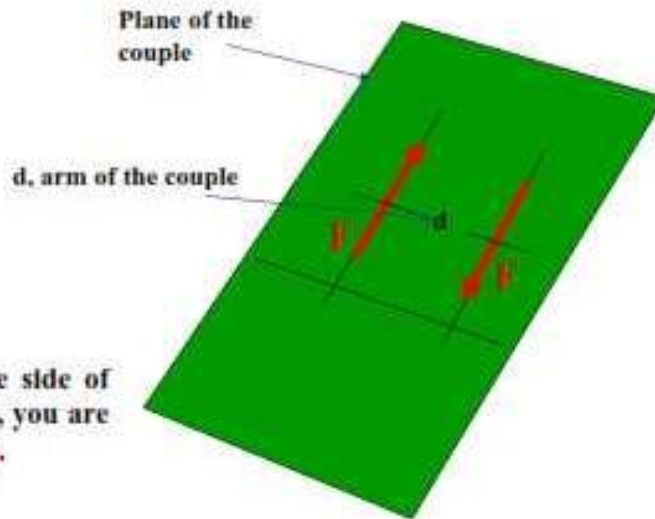+
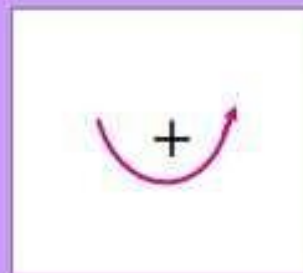
Anti-clockwise positive

Concept of a Couple
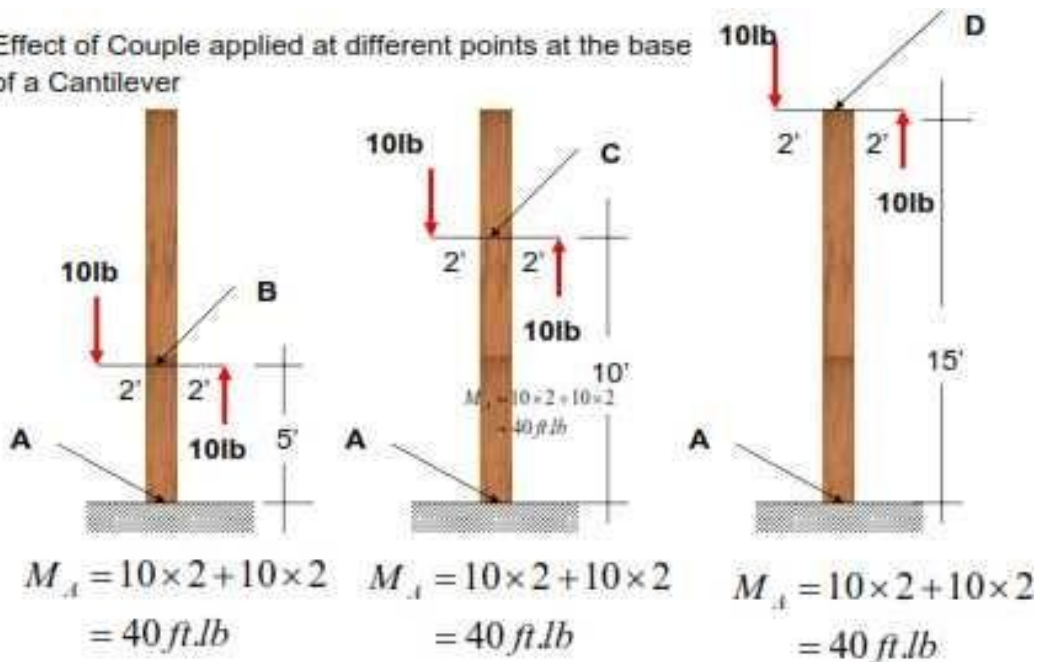
Plane of the couple

d, arm of the couple

When you grasp the opposite side of the steering wheel and turn it, you are applying a **couple to the wheel.**

A **couple** is defined as two forces (coplanar) having the **same magnitude, parallel lines of action, but opposite sense.** Couples have pure **rotational effects** on the body with no capacity to translate the body in the vertical or horizontal direction. (Because the sum of their horizontal and vertical components are zero)

Effect of Couple applied at different points at the base of a Cantilever
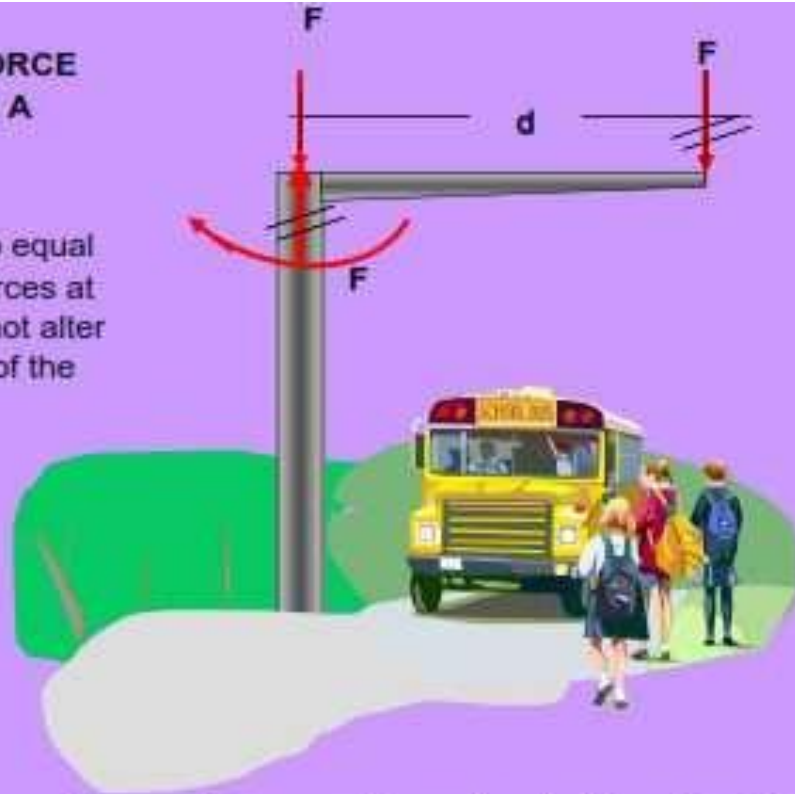
$$M_A = 10 \times 2 + 10 \times 2$$
$$= 40\,ft.lb$$

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$$= 40\,ft.lb$$

Thus it is clear that the effect of a couple at the base of the Cantilever is independent of it's (couple's) point of application.

REPLACING A FORCE WITH A FORCE & A COUPLE

1. Introduce two equal and opposite forces at B (which does not alter the equilibrium of the structure)

2. Replace the above two Forces with a Couple= F.d

Hence a Force can be replaced with an Equivalent Fore and a Couple at another point.