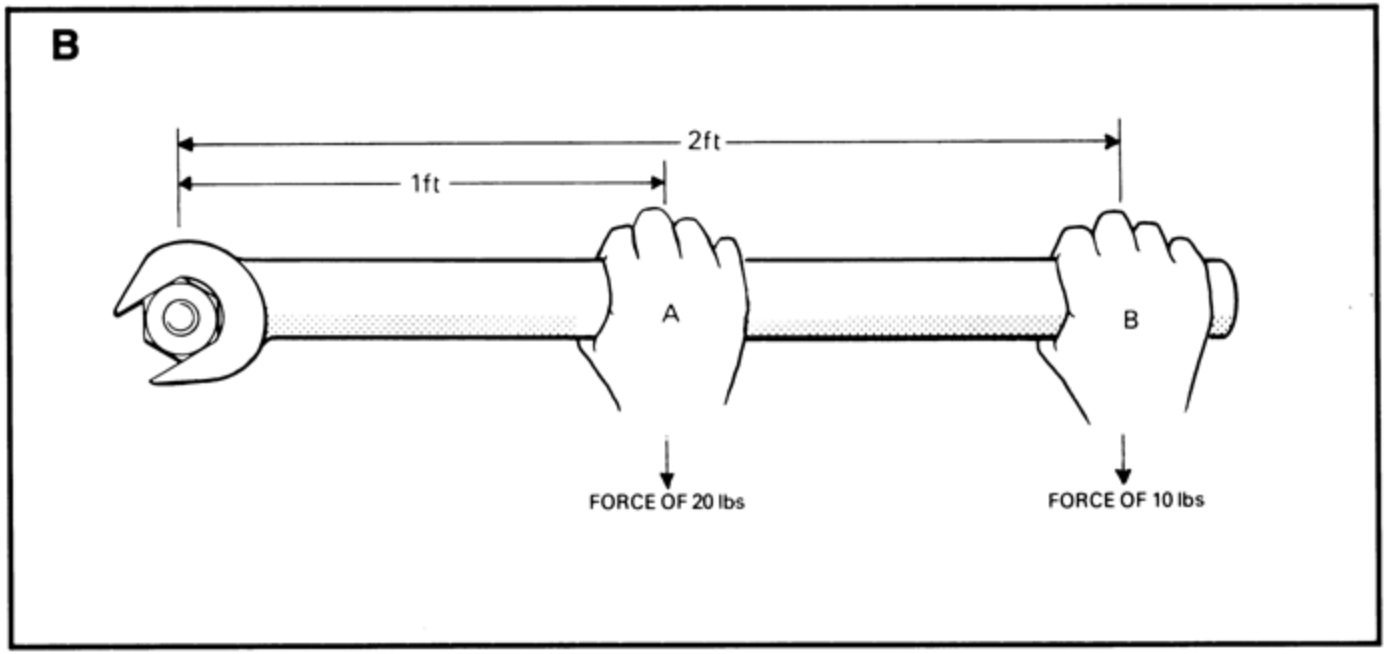
Torque

What is Torque?

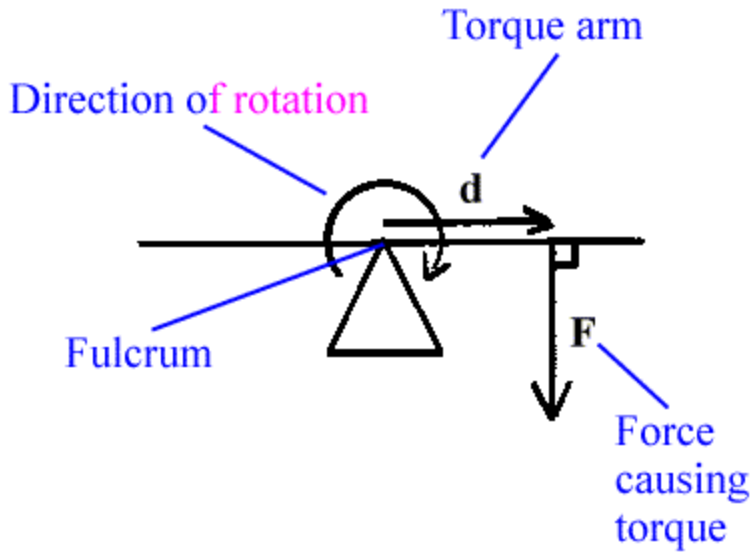
- A **torque** is the turning force exerted on a rigid object causing it to turn about its fulcrum.



Effort of Force/Distance on Torque

- The further the effort force from the fulcrum, the greater the rotational effect.

- The greater the force on the lever, the greater the effect on rotation.



Torque Formula

$$\tau = F\ d$$

- Where:
  - τ = torque (N•m)
  - F = force (N)
  - d = distance (m) [The distance is always measured from the force considered to the fulcrum (or pivot).]

Example 1

- If you push on a door at a distance of 0.60 m from the hinges, with a force of 150 N, what is the magnitude of the torque produced?

Given

$F = 150\ N$

$d = 0.60\ m$

Unknown

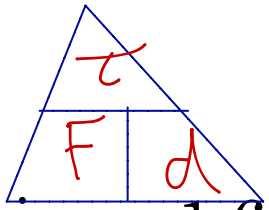
τ = torque

Select $\tau = F \times d$

$= 150\ N \times 0.6\ m$

$\tau = 90\ N \cdot m$

Example 2



- While shovelling snow using a 1.6 m long shovel, you place your hand at the mid point to create the fulcrum and produce a torque of 250 N•m. What is the magnitude of the force that you apply?

Given

$d = 1.6\ m$

$\tau = 250\ N \cdot m$

Unknown

F = force

Steps

$F = \frac{\tau}{d}$

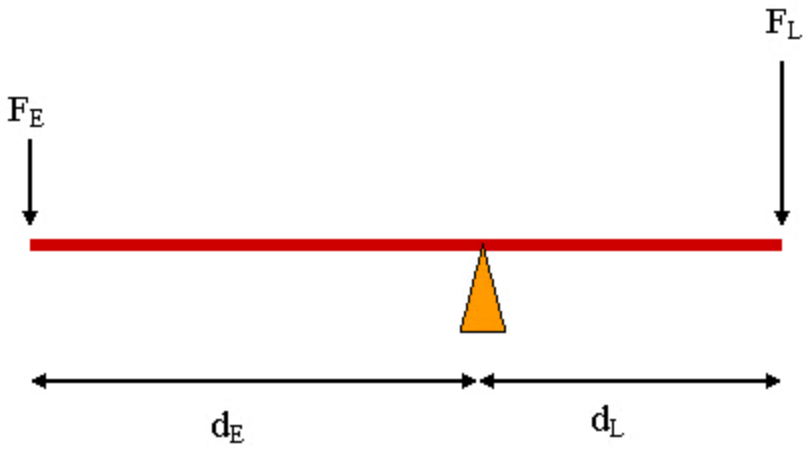
$F = \frac{250\ N \cdot m}{1.6\ m}$

$F = 156\ N$

Law of the Lever

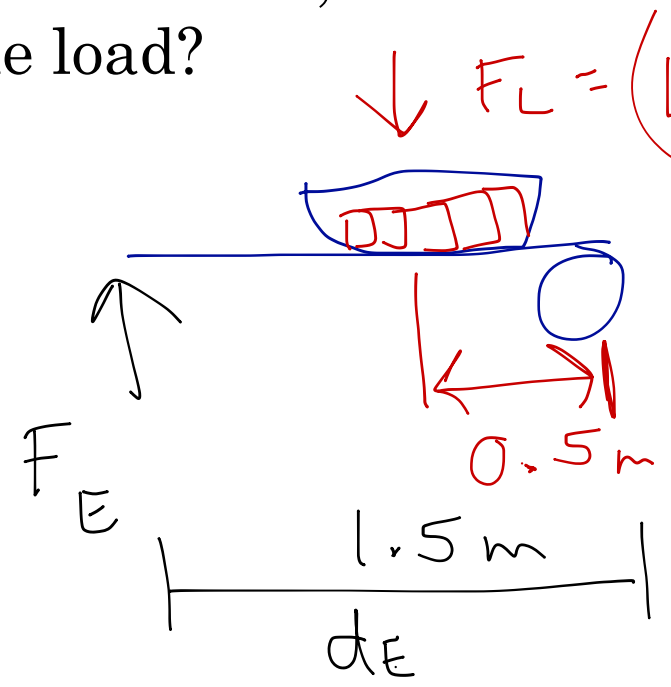
- When a lever is in equilibrium, the effort torque is equal to the load torque.
- (When a lever is in equilibrium, it is at rest, e.g., it is not rotating. For a lever to be at rest, the effort torque must be equal to the load torque.)

$$(F_E)(d_E) = (F_L)(d_L)$$



Example

- A wheelbarrow is loaded with 140 kg of bricks. The distance between the load and fulcrum is 0.50 m. If the distance between the effort and the fulcrum is 1.5 m, what is the effort required to lift the load?



$F_L = (140\,kg)(9.8\,m/s^2)$

$F_L = 1372\,N$

$d_L = 0.5\,m$

$d_E = 1.5\,m$

$F_E = ?$

$$F_L d_L = F_E d_E$$

$$\frac{F_L d_L}{d_E} = F_E$$

$$\frac{(137\text{ N})(0.5\text{ m})}{1.5\text{ m}} = F_E$$

$$457\text{ N} = F_E$$

HW

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