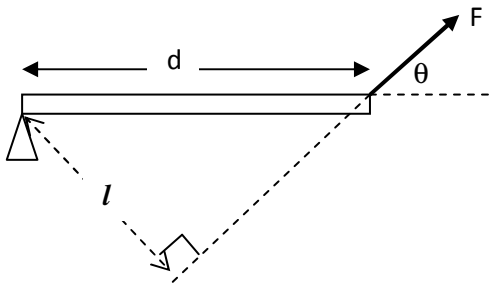
Torque Worksheet #2 ***Answer Key*** (Lever Arm Distance) A.Byres

1) State the 2nd Condition for equilibrium _ **ΣT = 0 or sum of Torques = 0**_
2) When using the 2nd Condition, the force is typically _**perpendicular**__ to the _**displacement**_
3) If the Force is not ⊥ to the direction then you will need to use either the _**force ⊥ (F.sinθ x d)**_ or you will need to use the _**lever arm distance (moment arm)** _ .
4) The Lever arm distance or Moment arm, as it is also known, are found perpendicular to _**the line of force**__ and it ***must*** pass through the _**Pivot point or fulcrum**___ .
5)



In order to find the net torque on the beam shown on the left we must either use lever arm distance or force perpendicular to the beam. $(l = d\ sin\ \theta)$

If the beam has a 5.0 kg mass, θ = 60° and d, the length of the beam is 1.8m find the ***F*** needed to produce equilibrium, both ways!

$$\sum T = 0$$
$$\therefore \sum T_{cw} = \sum T_{ccw}$$
$$(5 \bullet 9.80 \bullet 0.9m) = Fd \sin\theta$$
$$(44.1Nm) = F(1.8)\sin 60^\circ$$
$$F = 28\text{N}$$

Same answer both ways!!

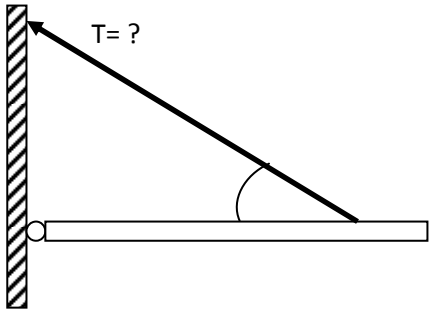
a) Use the diagram above and find out what the lever arm distance would be if the d = 1.8 m and the angle (θ) was a)70°, b) 50° and c) 30°
Ans: a) $l = 1.69$m b) $l = 1.38$m c) $l = 0.90$ m

b) What do you notice about *l*?
The lever arm distance is getting smaller as the angle gets closer to zero degrees

c) What does this mean for the magnitude of F if equilibrium is to be maintained?
It means that F must get proportionately larger as the angle tend towards 0

6) A uniform beam of 5.00 kg, and 2.50m length is suspended as shown. What will be the tension in the supporting rope connected 0.500m from the non-hinged end at a 40.0° angle.

$$\sum T_{cw} = \sum T_{ccw}$$
$$5 \bullet 9.80 \bullet 2.50/2 = T \bullet d \sin\theta$$
$$61.25 = T \bullet 2.0 \sin 40°$$
$$T = 47.6\text{N}$$



7) Repeat the question from above, but now a 7.5 kg mass is suspended from the right hand end, what will the new tension be?

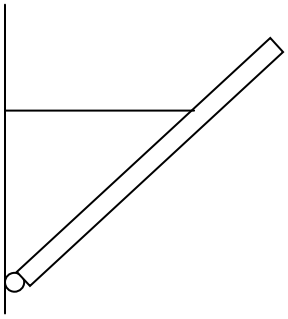
$$\sum T_{cw} = \sum T_{ccw}$$

$$(5 \bullet 9.80 \bullet 2.50/2) + (7.5 \bullet 9.80 \bullet 2.50) = T \bullet d \sin\theta$$

$$61.25 + 183.75 = T \bullet 2.0 \sin 40°$$

$$T = 191\text{N}$$

8) Solve for the tension in the cable if the beam has a mass of 21 kg, has a length of 3.0m long and is at an angle of 30° to the vertical. The cable is 1/3 from the top of the beam.



$$\sum T_{cw} = \sum T_{ccw}$$

$$21 \bullet 9.80 \bullet 1.5 \sin 30 = T \bullet 2.0 \cos 30$$

$$154.35\ \text{Nm} = T 1.732\text{m}$$

$$T = 89.11\text{N}$$