STAEDTLER® No. 937 811E Engineer's Computation Pad

•46 The length of a bicycle pedal arm is 0.152 m, and a downward force of 111 N is applied to the pedal by the rider. What is the magnitude of the torque about the pedal arm's pivot when the arm is at angle (a) 30°, (b) 90°, and (c) 180° with the vertical?

TORQUE $= \vec{\tau} = \vec{r} \times \vec{F}$

$\tau = rF\sin\measuredangle(\vec{r}, \vec{F})$

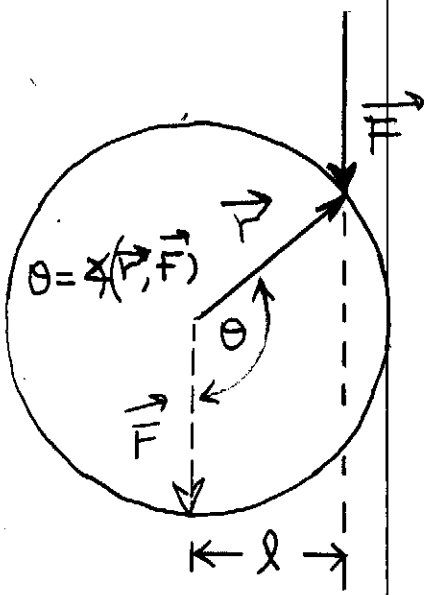
$\tau = F(r\sin\measuredangle(\vec{r}, \vec{F})) = F(l = \text{moment arm})$

l = moment arm = $\perp$ distance from axis of Rotation (the point of origin of calculating torques) to the "LINE OF ACTION" OF THE FORCE.

= MINIMUM DISTANCE FROM AXIS OF ROTATION (ORIGIN OF TORQUE'S $\vec{r}$ VECTOR) TO "LINE OF ACTION OF THE FORCE"

$= r\sin\measuredangle(\vec{r}, \vec{F}) = r\sin\theta = r\sin(180-\theta) = -r\sin(360-\theta)$

THE DIRECTION OF $\vec{\tau} = \vec{r} \times \vec{F}$ IS OBTAINED VIA THE RIGHT-HAND SCREW RULE. RESULTING HERE IN THE DIRECTION ALONG THE AXIS OF ROTATION IN THE DIRECTION OF BOTH THE INDUCED ANGULAR ACCELERATION $\vec{\alpha}$ & ANGULAR VELOCITY $\vec{\omega}$



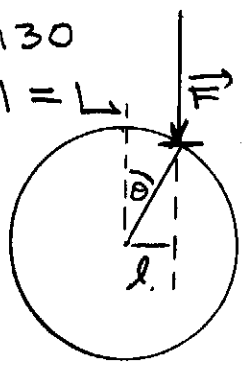
a) 30° wrt vertical $\Rightarrow l = L\sin 30$

Where PEDAL LENGTH $= |\vec{r}| = L$

$l = L/2$

$\tau_{30°} = F\frac{L}{2} = 111\frac{0.152}{2}$

$= 8.44$ Nm

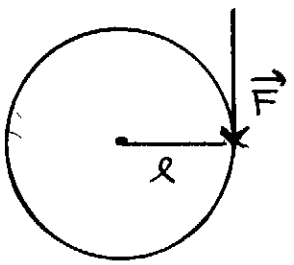


b) 90° wrt vertical

$l = L\sin 90 = L$

$\tau_{90°} = \tau_{max} = FL$

$= 111(0.152) = 16.9$ Nm



c) 180° wrt vertical

$l = L\sin 0 = 0$

$\tau_{180°} = 0$ Nm

NO TURNING ACTION!

