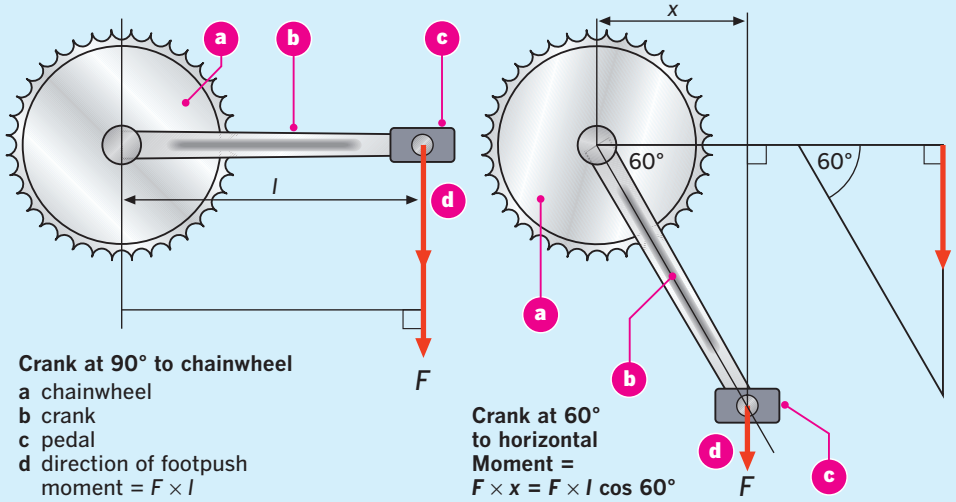
# Turning effect of a force

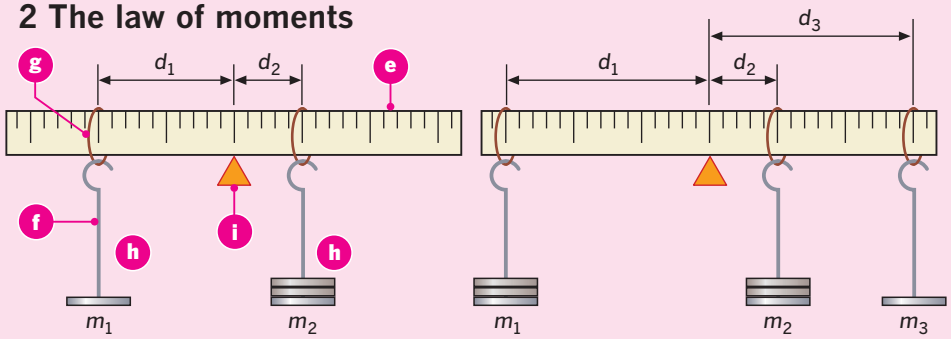
## 1 The moment of a force




**Crank at 90° to chainwheel**
**a** chainwheel
**b** crank
**c** pedal
**d** direction of footpush
moment = $F \times l$

**Crank at 60° to horizontal**
**Moment =**
$F \times x = F \times l \cos 60°$

## 2 The law of moments

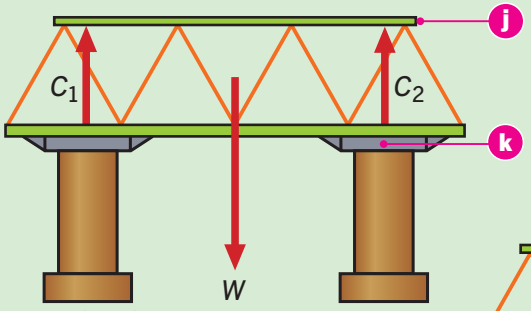



$m_1d_1 = m_2d_2$

$m_1d_1 = m_2d_2 + m_3d_3$

**e** meter rule
**f** slotted mass hangers
**g** wire loops
**h** slotted masses
**i** pivot

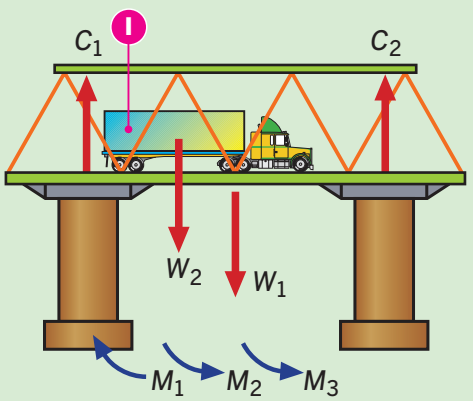
## 3 Parallel forces in equilibrium




$W = C_1 + C_2$

pillar 1 pillar 2

**j** bridge
$W$ = weight of bridge
$C_1$ = reaction of pillar 1
$C_2$ = reaction at pillar 2
**k** pivot




**l** truck
$W_2$ = weight of truck
$M_1$ = clockwise moment of C1 about pivot
$M_2$ = anticlockwise moment of truck
$M_3$ = anticlockwise moment of weight of bridge

$C_1 + C_2 = W_1 + W_2$
$M_1 = M_2 + M_3$

**Key words**

*equilibrium*
*lever*
*moment*
*torque*

## 1 The moment of a force

- The turning effect of a force around a point is called the *moment* or *torque*. The moment of a force is the product of the force and its *perpendicular* distance from the turning point.
- When the crank is *horizontal* the moment = F x l.
- When the crank is 60° to the horizontal the perpendicular distance from the force to the turning point = x = l cos 60°. The moment in this position is therefore = F x l cos 60°.

## 2 The law of moments

- The law of moments (law of the *lever*) states that when a body is in *equilibrium* the sum of the clockwise moments about any point is equal to the sum of the anticlockwise moments about the same point.
- When the meter rule is horizontal $m_1d_1 = m_2d_2$. Therefore, if $d_1$ is twice the distance $d_2$, $m_1$ must be half the weight of $m_2$. A lighter person can counterbalance a heavier person on a seesaw by moving nearer to the pivot.
- Provided that a meter rule is uniform in shape and composition its mass can be thought of as being concentrated at its geometric center. When a meter rule is pivoted at its center, its weight acts at the pivot and produces no moments otherwise the weight of the rule must be taken into account in calculations on moments.

## 3 Parallel forces in equilibrium

- As the truck moves across the bridge from pillar 1 towards pillar 2, the anticlockwise moments about the top of pillar 2 decrease and therefore the magnitude of $C_1$ decreases.
- Conversely, the clockwise moments acting about the top of pillar 1 increase and therefore the magnitude of $C_2$ increases.