Example 2.2

Resolve the $100 \text{ N}$ force along the x- and y-axes. *Follow the steps as in Example 2.1*

\[ F = 100 \text{ N} \]

TUTORIAL

2.1 Resolve the given forces into the specified directions. (*Follow the steps as in Example 2.1*)

\[ F_n = 433 \text{ N} \quad F_t = 250 \text{ N} \]

2.2 Resolve the $300 \text{ N}$ pulling force (tension) into rectangular components in

(a) the x and y directions.

(b) the vertical and horizontal directions

Answers:

\[
\begin{align*}
2.1 \text{ (a)} & \quad F_x = 64.71 \text{ N} \\
& \quad F_y = 241.5 \text{ N} \\
2.1 \text{ (b)} & \quad F_x = 281.9 \text{ N} \\
& \quad F_y = 102.6 \text{ N} \\
2.2 \text{ (a)} & \quad F_v = 172.1 \text{ N} \uparrow \\
& \quad F_h = 245.7 \text{ N} \rightarrow
\end{align*}
\]
2.5 Addition of Moments

If more than one force or its components act on a body, the resultant moment (\(\Sigma M\)), is the algebraic sum of all the moments acting about the same point. If clockwise moment is taken as positive then anticlockwise will be negative, or vice versa.

Example 2.8

Determine the resultant moment \(\Sigma M\) about various points, neglecting the weight of the structure. (Resolve the force where necessary).

![Diagram](https://example.com/diagram.png)

\[M_A \text{ (for 100N force)} = \_\_\_\_\_
\]
\[M_A \text{ (for 25N force)} = \_\_\_\_
\]
\[\Sigma M_A = \_\_\_\_
\]

\[M_D \text{ (for 100N force)} = \_\_\_\_
\]
\[M_D \text{ (for 25N force)} = \_\_\_\_
\]
\[\Sigma M_D = \_\_\_\_
\]

\[\Sigma M_A = \_\_\_\_
\]
\[\Sigma M_C = \_\_\_\_
\]
\[\Sigma M_E = \_\_\_\_
\]
\[\Sigma M_F = \_\_\_\_
\]
2.7 Calculate the moment of the given force about point A in the following cases. 
Indicate the resolved components. (Ans: 58.99 Nm \(\bigcirc\), 953.5 Nm \(\bigcirc\))

2.6 Couples

Couples are commonly encountered in engineering. A couple consists of two equal and opposite forces having separate lines of action. We often represent a couple with a curved arrow, i.e. \(\bigcirc\) or \(\bigcirc\).

A couple has the following characteristics:
1. The resultant force of a couple is zero.
2. The moment of a couple is the product of one of the forces and the perpendicular distance between their lines of action.
3. The moment of a couple is the same for all points in the plane of the couple.

Example 2.11

Calculate the moment of the couple applied to the steering wheel shown. Diameter of the steering wheel is 45 cm.
Table Showing Reactions for Various Support Types

<table>
<thead>
<tr>
<th>Type of Support</th>
<th>Direction of reaction</th>
<th>No. of unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rollers</td>
<td></td>
<td>1 unknown reaction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direction is normal to the supporting surface.</td>
</tr>
<tr>
<td>2. Smooth surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Cables/chain</td>
<td>1 unknown tension F pulling away from the body.</td>
<td></td>
</tr>
<tr>
<td>4. Rigid links or bars</td>
<td>1 unknown reaction.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Direction along the link, either in compression or tension.</td>
<td></td>
</tr>
</tbody>
</table>
2.21 A 4 kN crate with its mass centre at G rests against a smooth wall as shown. Determine with the aid of a free body diagram,

a) the reaction at point A of the crate.
b) magnitude and direction of the ground reaction at B.

( 0.8782 kN ; 4.095 kN ; 77.62° )

2.22 The flip-up table-top ABC weighs 20 N and its CG is at the middle of AC. It is supported by a hinge at A and a pin-ended bar at B which is anchored at the wall.

Calculate the reactions at A and B of the table-top.

( 219 N, 36.4° , 274.1 N, 50° )
*2.29  A mass of 10 kg is supported by two cables DB and DE as shown in the figure. The beam ABC has a mass of 3 kg and is held in equilibrium by a pin at A and a frictionless roller at C.

a) Sketch a free body diagram of the point D and show that the tensions in the cables DB and DE are 67.1 N and 52.2 N respectively.

b) Sketch a free body diagram of the uniform beam ABC and determine:
   i) the reaction at C;
   ii) the reaction at A.

   (i) \( R_C = 204.8 \text{ N, } 45^\circ \) 
   (ii) \( 187.4 \text{ N, } 17.8^\circ \)