VISUAL PHYSICS ONLINE

DYNAMICS

EQUILIBRIUM

YouTube: 1994 Fairchild Air Force Base B-52 Plane Crash

WARNING!!! This video contains actual crash footage. Viewer discretion is advised.

Conditions for Equilibrium

An object is in equilibrium if:

- The resultant force acting on the object is zero.

  $$\text{resultant (net) force} \quad \sum \vec{F} = 0$$

- The sum of the torques (moments) acting on an object must be zero.

  $$\text{resultant (net) torque} \quad \sum \vec{\tau} = 0$$

Example

A flower pot which has a mass of 5.55 kg is suspended by two ropes – one attached horizontally to a wall and the other rope sloping upward at an angle of 40^{o} to the roof. Calculate the tension in both ropes.

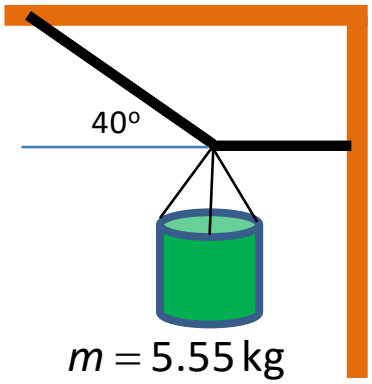
Solution

How to approach the problem:

Identify Setup Execute Evaluate

- Visualize the situation – write down all the given and unknown information.
- Draw a free-body diagram – forces.
- Draw a free-body diagram – x and y components for the forces.
- Forces can be added using the head-to-tail method but it is best to solve the problem using x and y components.
- Object at rest: apply Newton's 1^{st} law to the x and y components.
- Solve for the unknown quantities.

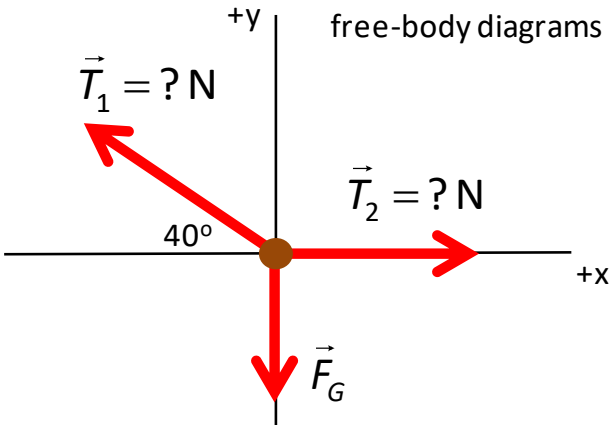
physical picture



$m = 5.55\,\text{kg}$

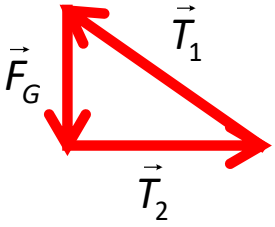
$g = 9.81\,\text{m.s}^{-2}$

free-body diagrams

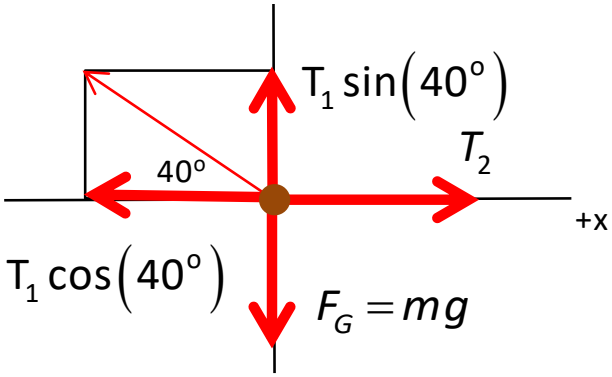


Object is stationary:
Newton's 1st law

$$\sum \vec{F} = \vec{T}_1 + \vec{T}_2 + \vec{F}_G = 0$$



free-body diagrams



$$\sum F_x = 0 \qquad \sum F_y = 0$$

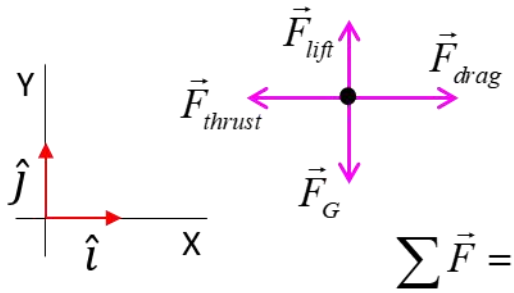
Applying Newton's 1st law to the x and y components for the forces:

$$\sum F_x = T_2 - T_1 \cos 40^\circ = 0 \quad T_2 = T_1 \cos 40^\circ$$

$$\sum F_y = T_1 \sin 40^\circ - mg = 0 \quad T_1 = \frac{mg}{\sin 40^\circ} = \frac{(5.55)(9.81)}{\sin 40^\circ} = 84.7\ \text{N}$$

$$T_2 = T_1 \cos 40^\circ = (84.7)\cos 40^\circ = 64.9\ \text{N}$$

How can an aircraft fly at a constant velocity?



$$\sum \vec{F} = \vec{F}_G + \vec{F}_{lift} + \vec{F}_{thrust} + \vec{F}_{drag} = 0$$

$$\Rightarrow \quad \vec{a} = 0 \quad \Rightarrow \quad \vec{v} = 0$$

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If you have any feedback, comments, suggestions or corrections please email:

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