Tues: Warm Up 6 (D2L)

Thurs: Discussion / quiz Ex 105, 107, 109, 112
113, 122, 124, 127

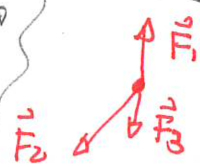
Newtonian mechanics

Newton's Second Law uses the following scheme

object, mass m

specify forces

→ Free body diagram



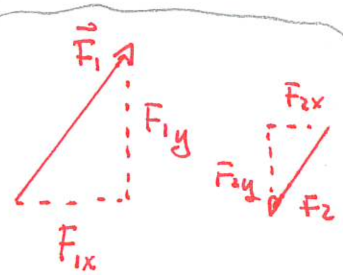
→ Relates to acceleration

$$\vec{F}_{net} = \sum \vec{F}_i = m\vec{a}$$

$$\Rightarrow F_{netx} = F_{1x} + F_{2x} + \ldots = ma_x$$

$$F_{nety} = F_{1y} + F_{2y} + \ldots = ma_y$$

What this requires practically is to work with vectors



Get components of each vector

→ Add components and set equal to $m\vec{a}$

x comp $F_{1x} + F_{2x} + \ldots = ma_x$

y comp $F_{1y} + F_{2y} + \ldots = ma_y$

Include as much information about acceleration as possible

THEN algebra produces remaining unknown info.

Quiz 1 60% - 80%

40% - 50%

Equilibrium

A special case of dynamics is equilibrium. An object is in equilibrium $\Leftrightarrow$ object is at rest or moves with constant velocity

$\Leftrightarrow$ acceleration is zero.

Examples include

1) buildings and rigid structures
2) limbs in traction.

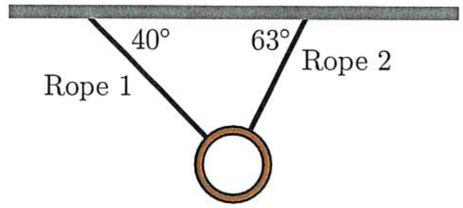
In this case

$$\vec{F}_{net} = m\vec{a} = 0 \Rightarrow \vec{F}_{net} = 0 \Rightarrow \sum F_{ix} = 0 \text{ AND } \sum F_{iy} = 0$$

Quiz 2 40% - 50%

30% —

129 Suspended ring in equilibrium, 2



A 2.50 kg ring is suspended from the ceiling and by two ropes as illustrated. The aim of this exercise is to use Newton's 2$^{\text{nd}}$ Law to determine the tension in each rope. *(131Sp2023)*

a) Draw a free body diagram for the ring. Label the tension forces $\vec{\mathbf{T}}_1$ and $\vec{\mathbf{T}}_2$.

b) Write Newton's 2$^{\text{nd}}$ Law in its component form, i.e. write

$$F_{\text{net }x} = \Sigma F_{ix} = ma_x \qquad (5)$$
$$F_{\text{net }y} = \Sigma F_{iy} = ma_y \qquad (6)$$

Insert as much information as possible about the acceleration. You will return to these equations shortly; they will generate the algebra that eventually gives you the tensions.

c) These equations require all components of all forces, including the two unknown tension forces. In order to manage these, you should express the components of each tension force in terms of its magnitude. When doing this denote the magnitude of the tension in rope 1 by T_1 and for rope 2, by T_2.

d) List as much information as possible about each component for each force; each could be a number or an algebraic expression. Use one of the two formats below.

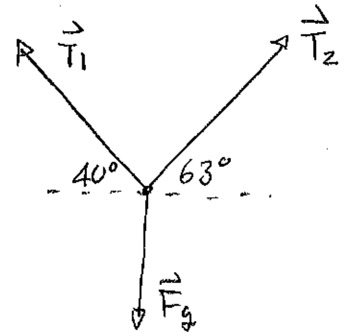
$$F_{gx} = \cdots$$
$$F_{gy} = \cdots$$
$$T_{1x} = \cdots$$
$$T_{1y} = \cdots$$
$$\vdots$$

Force	x comp	y comp
$\vec{\mathbf{F}}_g$		
$\vec{\mathbf{T}}_1$		
$\vdots$		

e) Use Eq. (5) to obtain an equation relating various quantities that appear in this problem. Do the same with Eq. (6). You should get two expressions that contain the two unknowns T_1 and T_2. Solve them for the unknowns.

Answer:

a)
c)



b) $\sum F_x = m a_x^{0} \Rightarrow \sum F_x = 0$

$\sum F_y = m a_y \Rightarrow \sum F_y = 0.$

d) $F_g = mg = 2.50\,kg \times 9.80\,m/s^2$

$= 24.5\,N$

$T_{1x} = -T_1 \cos 40°$

$T_{1y} = T_1 \sin 40°$

$T_{2x} = T_2 \cos 63°$

$T_{2y} = T_2 \sin 63°$

	x	y
$\vec{F}_g$	0	$-24.5\,N$
$\vec{T}_1$	$-T_1 \cos 40°$	$T_1 \sin 40°$
$\vec{T}_2$	$T_2 \cos 63°$	$T_2 \sin 63°$

e) $\sum F_x = 0 \Rightarrow -T_1 \cos 40° + T_2 \cos 63° = 0$

$\Rightarrow T_2 \cos 63° = T_1 \cos 40°$

$\Rightarrow T_2 = \frac{\cos 40°}{\cos 63°} T_1 = \frac{0.766}{0.454} T_1 = 1.69\,T_1$

$\Rightarrow T_2 = 1.69\,T_1$

$\sum F_y = 0 \Rightarrow -24.5\,N + T_1 \sin 40° + T_2 \sin 63° = 0$

$\Rightarrow T_1 \sin 40° + 1.69\,T_1 \sin 63° = 24.5\,N$

$\Rightarrow T_1 (\sin 40° + 1.69 \sin 63°) = 24.5\,N$

$\Rightarrow T_1\, 2.15 = 24.5\,N \Rightarrow T_1 = 11.4\,N$

Then $T_2 = 1.69\,T_1 \Rightarrow T_2 = 1.69 \times 11.4\,N \Rightarrow T_2 = 19.3\,N$