KEY

P11

Force of Tension

Practice

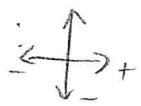
1. Will an 8.5-kg object accelerate if it is pulled by two ropes: Rope 1 pulls 55N [R35° U] and Rope 2 pulls 97 N[U] ? <u>If it accelerates, find this acceleration. Justify your answer.</u>

G: $m = 8.5\,kg$

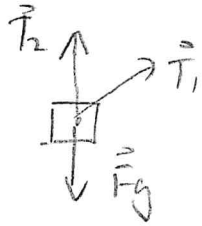
$\vec{T}_1 = 55N[R35°U]$

$\vec{T}_2 = 97N[U]$

R: $\vec{a} = ?\ m/s^2$

A: 

· Assume: object is suspended ⇒ there is no surface of contact ⇒ $\vec{F}_N$ does not exist.



· $\vec{F}_{net} = \vec{F}_g + \vec{T}_1 + \vec{T}_2$

· $\vec{a} = \dfrac{\vec{F}_{net}}{m}$

S: $\vec{F}_g = [0, -mg]$

$= [0, -83.3]N$

$\vec{T}_1 = [55\cos 35°, 55\sin 35°]$

$= [45.0534, 31.5467]N$

$\vec{T}_2 = [0, 97]N$

$\vec{F}_{net} = [0, -83.3] + [45.0534, 31.5467] + [0, 97]$

$= [45.0534, 45.2467]N$

$\vec{a} = \dfrac{[45.0534, 45.2467]}{8.5}$

$\vec{a} = [5.3004, 5.3231]\ m/s^2$

$\|\vec{a}\| = \sqrt{5.3004^2 + 5.3231^2}$

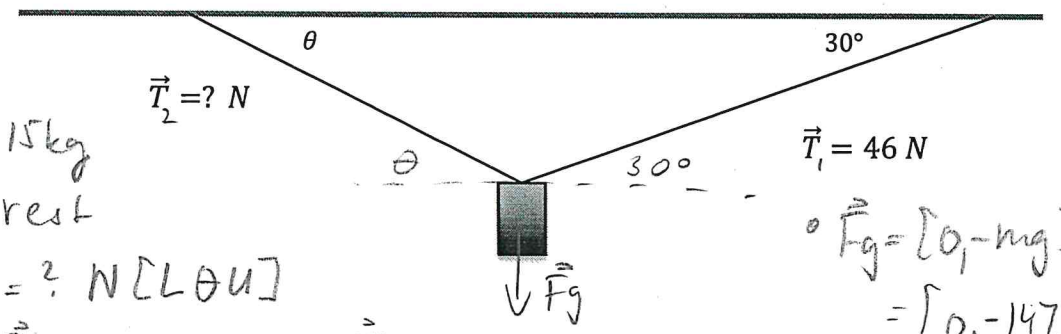
$= 7.5\ m/s^2$

$\theta = \tan^{-1}\left(\dfrac{5.3231}{5.3004}\right)$

$\theta = 45°$

∴ The object accelerate at $7.5\ m/s^2$ [R45°U].

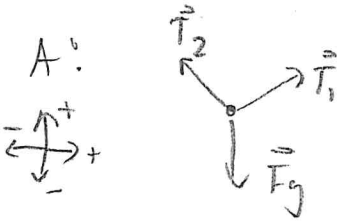
2. Provided that the object is suspended by two cables according to the diagram below, what force of tension will keep a 15-kg object at rest?



G: m = 15 kg
• at rest

R: $\vec{T}_2$ = ? N [L θ U]

A:



• $\vec{F}_{net} = [0, 0]$ N

• $\vec{F}_{net} = \vec{F}_g + \vec{T}_1 + \vec{T}_2$

• $\vec{F}_g = [0, -mg]$
$= [0, -147]$ N

• $\vec{T}_1 = [46\cos 30°, 46\sin 30°]$
$= [39.8372, 23]$ N

• $\vec{T}_2 = [-x\cos\theta, x\sin\theta]$

S: $[0, 0] = [0, -147] + [39.8372, 23] + [-x\cos\theta, x\sin\theta]$

horizontal

$0 = 39.8372 - x\cos\theta$

$\frac{-39.8372}{-\cos\theta} = \frac{-x\cos\theta}{-\cos\theta}$

$x = \frac{39.8372}{\cos\theta}$

$x = \frac{39.8372}{\cos 72.1895}$

$x = 130$ N

vertical

$0 = -147 + 23 + x\sin\theta$

$0 = -124 + x\sin\theta$

$124 = x\sin\theta$

$124 = \frac{39.8372}{\cos\theta} \cdot \sin\theta$

$124 = 39.8372 \frac{\sin\theta}{\cos\theta}$

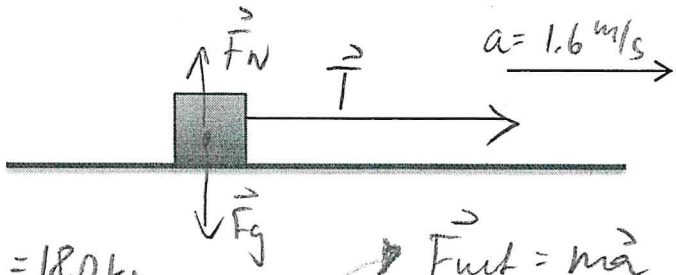
$\frac{124}{39.8372} = \tan\theta$

$\theta = \tan^{-1}\left(\frac{124}{39.8372}\right)$

$\theta = 72°$

S: The force of tension of 1.3×10^2 N [L 72° U] will sustain the object at rest.

3. A) Find the magnitude of the force of tension in the rope given that the 18.0-kg object accelerates at 1.6m/s² [R]. Assume that the surfaces of contact are frictionless.



G: $m = 18.0\ kg$
no friction
$a = 1.6\ m/s^2\ [R]$

R: $\vec{T} = ?\ N\ [R]$

A: $\vec{F}_{net} = \underbrace{\vec{F}_g + \vec{F}_N}_{0} + \vec{T}$

$\vec{F}_{net} = \vec{T}$

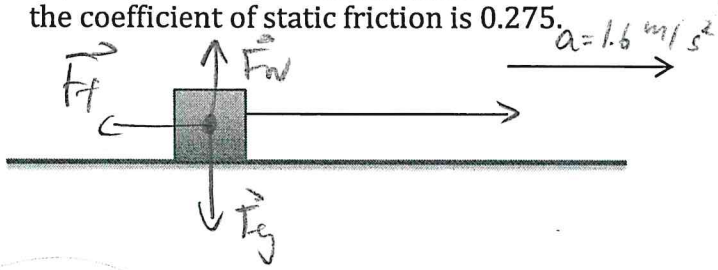
$\vec{F}_{net} = m\vec{a}$

$\vec{T} = m\vec{a}$

S: $= (18)(1.6)$
$= 28.8\ N$

S: The tension in the rope is 29N [R]

3. B) Find the magnitude of the force of tension in the rope given that the 18.0-kg object accelerates at 1.6m/s² [R]. The coefficient of kinetic friction is 0.21 and the coefficient of static friction is 0.275.



S: the force of tension is 66N [R]

$\mu_k = 0.21$ accelerates ⇒ moves
$\mu_s = 0.275$

$\vec{F}_{net} = \vec{F}_g + \vec{F}_N + \vec{T} + \vec{F}_f$

$ma = 0 + T - \vec{F}_f$

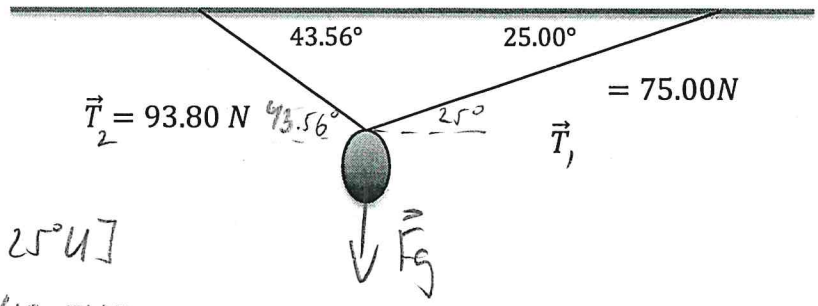
$T = ma + F_f$

$T = ma + \mu \cdot F_N$

S: $T = (18.0)(1.6) + (0.21)(18.0)(9.8)$

$\vec{T} = 65.844\ N\ [R]$

4. Find the mass of a stationary object suspended by two ropes according to the diagram below:



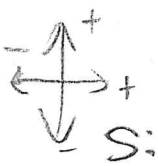
G: $\vec{T}_1 = 75.00N[R25°U]$

$\vec{T}_2 = 93.80N[L43.56°]$

at rest

R: $m = ?\ kg$

A:



$\vec{F}_{net} = [0,0]N$

S: $\vec{F}_g = [0, -mg]$

$\vec{F}_g = [0, -9.8m]N$

$\vec{T}_1 = [75\cos 25°, 75\sin 25°]$

$= [67.9731, 31.6964]N$

$\vec{T}_2 = [-93.8\cos 43.56°, 93.8\sin 43.56°]$

$= [-67.9725, 64.6389]N$

$[0,0] = [0, -9.8m] + [67.9731, 31.6964] + [-67.9725, 64.6389]$

$0 = 67.9731 - 67.9725$

$0 = 0$ ✓

$0 = -9.8m + 31.6964 + 64.6389$

$\frac{9.8m}{9.8} = \frac{96.3353}{9.8}$

$m = 9.8kg$

S: The object's mass is 9.8kg.