M1 – Resolving Forces

(1) $\Sigma F_x = 0 \quad 60 - S\cos 30 = 0 \quad -(1)$

$\Sigma F_y = 0 \quad R + S\sin 30 - 80 = 0 \quad -(2)$

From (1) $60 = S\cos 30$

$S = \frac{60}{\cos 30} = 40\sqrt{3} \quad (69.3\ N)$

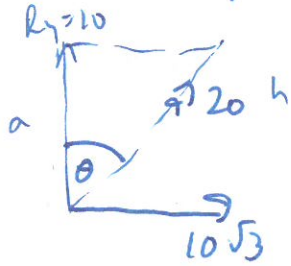
From (2) $R = 80 - 40\sqrt{3}\sin 30$

$= 45.4\ N$

(2). $R_x = \Sigma F_x = 12\sqrt{3} - 4\sqrt{3}\cos 60 = 10\sqrt{3}$

$R_y = \Sigma F_y = 16 - 4\sqrt{3}\sin 60 = 10$

Now $R = \sqrt{10^2 + (10\sqrt{3})^2} = \sqrt{400} = 20\ N$ as required.



$\cos\theta = \frac{10}{20}$

$\theta = \cos^{-1}\left(\frac{1}{2}\right) = 60°.$

(3) in equilib $\therefore \Sigma F_x = 0 \quad T_2\cos 60 - T_1\cos 45 = 0 \quad -(1)$

$\Sigma F_y = 0 \quad T_2\sin 60 + T_1\sin 45 - 6g = 0 \quad -(2)$

From (1) $T_1\cos 45 = T_2\cos 60$

$T_1 = \frac{T_2\cos 60}{\cos 45}$

$T_1 = \frac{\sqrt{2}}{2}T_2 \quad -(3)$

in (2) $T_2\sin 60 + \left(\frac{\sqrt{2}}{2}T_2\right)\sin 45 = 6g$

$T_2\left(\sin 60 + \frac{\sqrt{2}}{2}\sin 45\right) = 6g \qquad T_2 = 43.0\ N$

in (3) $T_1 = 30.4\ N.$

(4) $\Sigma F_x = 0 \quad F - R\cos 45 - S\cos 30 = 0$ — (1)

$\Sigma F_y = 0 \quad R\sin 45 - S\sin 30 = 0$ — (2)

$R\sin 45 = S\sin 30$

$S = \dfrac{R\sin 45}{\sin 30}$

$S = R\sqrt{2}$ — (3)

in (1) $R\cos 45 + R\sqrt{2}\cos 30 = 8$

$R[\cos 45 + \sqrt{2}\cos 30] = 8$

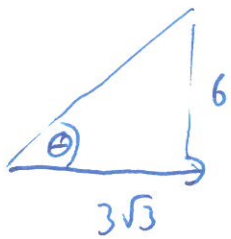
$R = \dfrac{8}{[\cos 45 + \sqrt{2}\cos 30]} = 4.1\,N$

in (3) $S = 4.1 \times \sqrt{2} = 5.9\,N$

(5) $R_x = \Sigma F_x = 15\cos 30 - 9\cos 30 = 3\sqrt{3}\,N$

$R_y = \Sigma F_y = 18 - 15\sin 30 - 9\sin 30 = 6$

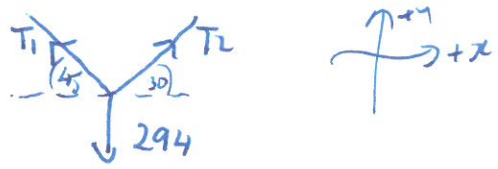
$R = \sqrt{(3\sqrt{3})^2 + 6^2} = \sqrt{63}$



$\tan\theta = \dfrac{6}{3\sqrt{3}}$

$\theta = 49.1°$ above horizontal.

(6). (a) Tension in OP $= 30g = 294\ N$

(b) 

(c) $\Sigma F_x = 0 \quad T_2 \cos 30 - T_1 \cos 45 = 0$ — (1)

$\Sigma F_y = 0 \quad T_2 \sin 30 + T_1 \sin 45 - 294 = 0$ — (2)

From (1) $T_2 = \dfrac{T_1 \cos 45}{\cos 30} = \dfrac{T_1\sqrt{6}}{3}$ — (3)

in (2) $\left(\dfrac{T_1\sqrt{6}}{3}\right)\sin 30 + T_1 \sin 45 = 294$

$T_1\left[\dfrac{\sqrt{6}}{6} + \dfrac{\sqrt{2}}{2}\right] = 294$

$T_1 = 263.6\ N.$

in (3) $T_2 = 215.2\ N.$

(7) $\Sigma F_x = 0 \quad 40 - T\cos\theta - 50\cos 60 + 60\cos 80 = 0$ — (1)

$\Sigma F_y = 0 \quad T\sin\theta - 50\sin 60 - 60\sin 80 = 0$ — (2)

From (1) $T\cos\theta = 40 - 50\cos 60 + 60\cos 80$ — (3)

From (2) $T\sin\theta = 50\sin 60 + 60\sin 80$ — (4)

(4) ÷ (3) $\dfrac{T\sin\theta}{T\cos\theta} = \dfrac{50\sin 60 + 60\sin 80}{40 - 50\cos 60 + 60\cos 80}$

$\tan\theta = 4.02$

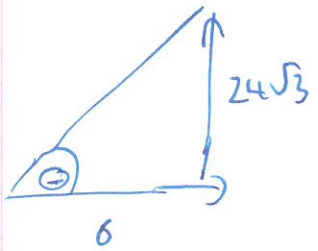
$\theta = \tan^{-1}(4.02) = 76.1°$

in (4) $T = \dfrac{50\sin 60 + 60\sin 80}{\sin(76.1)} = 105.5\ N.$

(8) $R_x = \Sigma F_x = 3 + 16\cos 60 - 10\cos 60 = 6$

$R_y = \Sigma F_y = 16\sin 60 + 11\sqrt{3} + 10\sin 60 = 24\sqrt{3}$

$R = \sqrt{6^2 + (24\sqrt{3})^2} = \sqrt{1764} = 42N.$



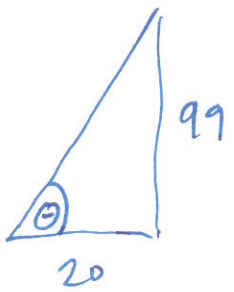
$\tan\theta = \frac{24\sqrt{3}}{6}$

$\theta = 81.8$ above horizontal

(9) $R_x = \Sigma F_x = 56 - 60\sin\alpha = 56 - 60\times\frac{3}{5} = 20$

$R_y = \Sigma F_y = 78 + 60\cos\alpha - 27 = 78 + 60\times\frac{4}{5} - 27 = 99$

$R = \sqrt{20^2 + 99^2} = 101\ N.$



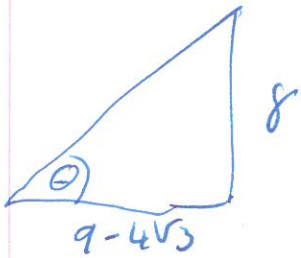
$\tan\theta = \frac{99}{20}$

$\theta = 78.6°.$

(10) $R_x = \Sigma F_x = 9 - 8\cos 30 = (9 - 4\sqrt{3})$

$R_y = \Sigma F_y = 12 - 8\sin 30 = 8.$

$R = \sqrt{(9-4\sqrt{3})^2 + 8^2} = 8.3N$



$\tan\theta = \frac{8}{9-4\sqrt{3}}$

$\theta = 75.5°$