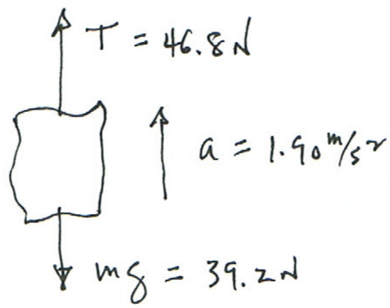
PHY 1401

Chapter 4
Homework Solutions

Michael F. McGraw
June 2010

CHAP 4 #21



$\Sigma F = ma$

$= T - mg = ma$

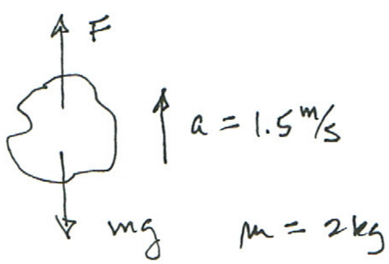
$T = ma + mg = m(a+g)$

$m = \frac{T}{a+g}$

$m = \frac{46.8}{1.90 + 9.8}$

$\boxed{m = 4.0 \text{ kg.}}$

#26.



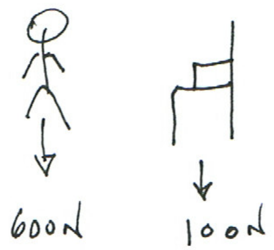
$\Sigma F = F - mg = ma$

$F = m(a+g)$

$= 2(1.5 + 9.8)$

$\boxed{F = 22.6\text{N}}$

#33.

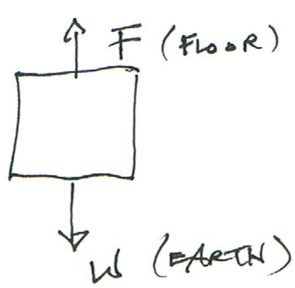


(a.)

ARM RESTS	2 X 25N = 50N ↑
SEAT	500N ↑
FLOOR	100 ↑
	600N ↑

(b.) WITH THE WOMAN IN THE CHAIR THE FLOOR EXERTS A FORCE = 700N

(c.)



CHAPTER 4

#39

QUES: (a) WHAT IS YOUR WEIGHT IN NEWTONS?

(b.) HOW MANY NEWTONS IN 250g?

(c.) WHAT "WEIGHS" 1 NEWTON?

(a.) $W(\text{NEWTONS}) = W(\text{LBS}) \times \frac{\text{kg}}{2.2046\ \text{LBS}} \times 9.8 = W(\text{LBS}) \cdot 4.445$

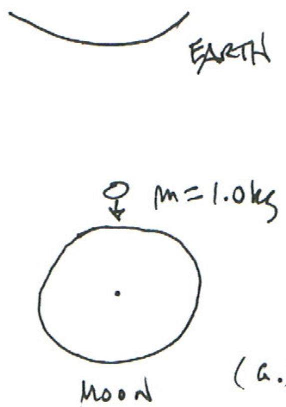
(b.) $250\text{g} = 0.250\ \text{kg}$

$W = mg = 0.250\,(9.8) = 2.45\ \text{N}$

(c.) $\frac{250\text{g}}{2.45\text{N}} = 102\ \frac{\text{g}}{\text{N}}$.

AN OBJECT WEIGHING 1 N HAS A MASS OF 102g.

CHAP 4 – # 42



(a.) WHICH WAY DOES IT FALL?

(b.) F_{MOON} ON ROCK ON SURFACE OF MOON?

(c.) F_{EARTH} ON ROCK ON SURFACE OF MOON?

(d.) NET GRAVITATIONAL FORCE ON ROCK?

(a.) IT FALL TO THE MOON'S SURFACE.

$R_E = 6.371 \times 10^6$ m $M_E = 5.974 \times 10^{24}$ kg

$R_M = 1.737 \times 10^6$ m $M_m = 7.349 \times 10^{22}$ kg

$R_{E-M} = 3.845 \times 10^8$ m. $G = 6.674 \times 10^{-11}\ m^3/kg \cdot s^2$

(b.) $$F_{MOON} = \frac{G M_m m}{R_M^2} = \frac{6.674 \times 10^{-11} \cdot 7.349 \times 10^{22} \cdot 1.0}{(1.737 \times 10^6)^2}$$

$$F_{MOON} = \frac{(6.674)(7.349)}{(1.737)^2} \times 10^{-1}$$

$$F_{MOON} = 16.26 \times 10^{-1}$$

$$\boxed{F_{MOON} = 1.626\ N}$$

(c.) $$F_{EARTH} = \frac{G M_E m}{R^2}; \quad R = R_{E-M} - R_M = 3.845 \times 10^8 - 0.01737 \times 10^8$$

$$R = 3.828 \times 10^8\ m$$

$$F_{EARTH} = \frac{6.674 \times 10^{-11} \cdot 5.974 \times 10^{24}}{(3.828 \times 10^8)^2} = \frac{(6.674)(5.974)}{(3.828)^2} \times 10^{-3}$$

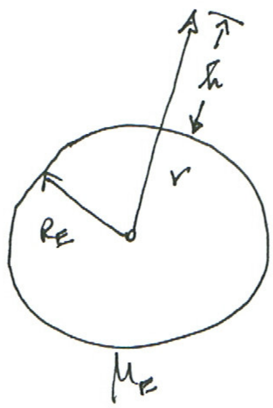
$$\boxed{F_{EARTH} = 2.70 \times 10^{-3}\ N}$$

d.) NET GRAV FORCE $= F_{MOON} - F_{EARTH} = 1.626 - 2.70 \times 10^{-3}$ N

NET FORCE $= 1.626 - 0.003$

$$\boxed{\text{NET FORCE} = 1.623\ N}$$

CHAP 4 #48



QUES: FIND h.

$m = 5.00\,kg$

$g(h) = 9.792\,\frac{N}{kg} = \frac{GM_E}{(R_E+h)^2}$

$g(R_E) = 9.803\,\frac{N}{kg} = \frac{GM_E}{R_E^2}$

$$\frac{g(R_E)}{g(h)} = \frac{\frac{GM_E}{R_E^2}}{\frac{GM_E}{(R_E+h)^2}} = \left(\frac{R_E+h}{R_E}\right)^2 = \left(1+\frac{h}{R_E}\right)^2$$

$$\frac{9.803}{9.792} = \left(1+\frac{h}{R_E}\right)^2$$

$$1+\frac{h}{R_E} = \sqrt{\frac{9.803}{9.792}} = 1.000562$$

$$\frac{h}{R_E} = 5.62\times10^{-4}$$

$$h = 5.62\times10^{-4}(6.371\times10^6)$$

$$\boxed{h = 3580\,m}$$

CHAPTER 4

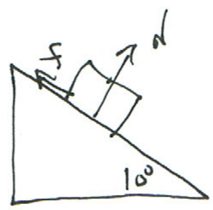
#54. A CASE IS ON AN INCLINE PLANE OF ANGLE $\theta = 10°$. GIVE THE DIRECTION OF THE NORMAL FORCE AND FRICTION FORCE WHEN:

(a) CASE IS AT REST.

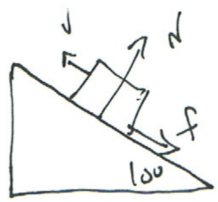
(b.) PUSHED UP THE RAMP.

(c.) PUSHED DOWN THE RAMP.

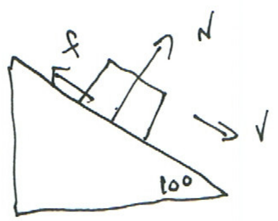
(a.)



(b.)

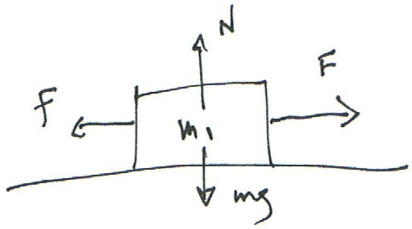


(c.)



CHAPTER 4

PROBLEM 63



$m_1 = 3.0$ kg

$F = 12.0$ N

$m_2 = 7.0$ kg

QUES: (a) $\mu_s = ?$

(b.) $m_1 \rightarrow m_1 + m_2$

F applied

F_{min} needed to make both blocks move?

(a.) JUST STARTING TO MOVE

$\rightarrow a = 0;\ \mu = \mu_s$

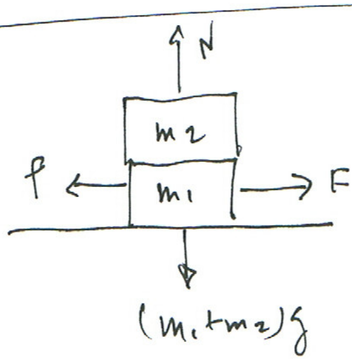
$\Sigma F_x = F - f = 0 \qquad f = \mu_s N = \mu_s mg$

$\Sigma F_y = N - mg = 0 \rightarrow N = mg$

$\rightarrow \Sigma F_x = 0 \Rightarrow F = f = \mu_s mg$

$$\therefore \mu_s = \frac{F}{mg} = \frac{12}{3(9.8)} = \boxed{0.41}$$

(b.)



JUST STARTING TO MOVE $\rightarrow a = 0$

AND $\mu = \mu_s$

$\Sigma F_x = F - f = 0$

$\Sigma F_y = N - (m_1 + m_2)g = 0$

$N = (m_1 + m_2)g$

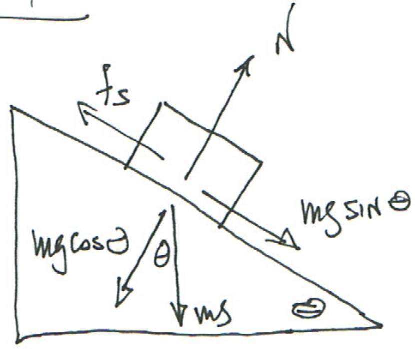
$\rightarrow F = f = \mu_s N = \mu_s (m_1 + m_2) g$

$F = 0.41(3+7)(9.8)$

$$\boxed{F = 40.2\text{ N}}$$

CHAPTER 4

#67



GIVEN:

θ IS VARIABLE ; $\mu_s = 0.30$

QUES: FIND THE VALUE OF θ FOR WHICH THE BLOCK JUST STARTS TO SLIDE.

WHEN THE BLOCK STARTS TO SLIDE $f_s = f_s^{max} = \mu_s N$

$$\Sigma F_x = mg\sin\theta - f_s = 0 \quad (1)$$

$$\Sigma F_y = N - mg\cos\theta = 0 \quad (2)$$

$$N = mg\cos\theta$$

FROM EQN (1)

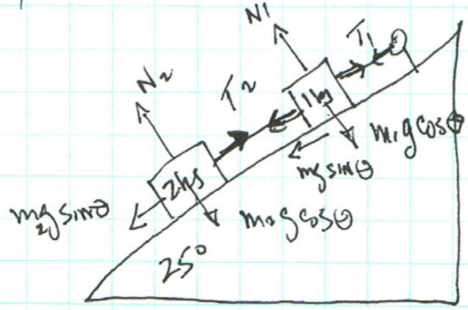
$$mg\sin\theta = f_s^{max} = \mu_s N = \mu_s mg\cos\theta$$

$$\mu_s = \frac{mg\sin\theta}{mg\cos\theta} = \tan\theta$$

$$\theta = \tan^{-1}(\mu_s) = \tan^{-1}(0.30)$$

$$\boxed{\theta = 16.7^\circ}$$

(73)



NO FRICTION

$m_1 = 1.0\,kg$

$m_2 = 2.0\,kg$

$a = 0$

QUES: $T_1 = ?$ $T_2 = ?$

2kg mass

$\Sigma F_x = T_2 - m_2 g \sin\theta = 0$

$\Sigma F_y = N_2 - m_2 g \cos\theta = 0$

$T_2 = m_2 g \sin\theta$
$= 2(9.8)\sin 25$

$\boxed{T_2 = 8.28\,N}$

1kg mass

$\Sigma F_x = T_1 - T_2 - m_1 g \sin\theta = 0$

$\Sigma F_y = N_1 - m_1 g \cos\theta = 0$

$T_1 = T_2 + m_1 g \sin\theta$

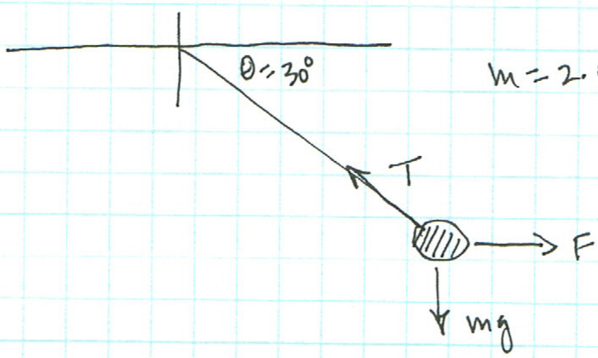
$T_1 = m_2 g \sin\theta + m_1 g \sin\theta$

$T_1 = (m_1 + m_2) g \sin\theta$

$T_1 = 3(9.8)\sin 25 = \boxed{12.4\,N}$

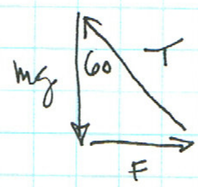
---

(78)



$m = 2.0\,kg$

QUES: $F = ?$ $T = ?$



$\tan 60° = \dfrac{F}{mg}$

$F = mg \tan 60° = 2(9.8)(1.73)$
$\boxed{= 33.9\,N}$

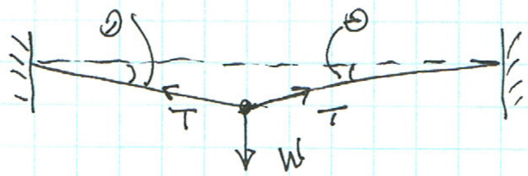
$\cos 60° = \dfrac{mg}{T}$

$T = \dfrac{mg}{\cos 60°} = \dfrac{2(9.8)}{1/2} = 4(9.8)$

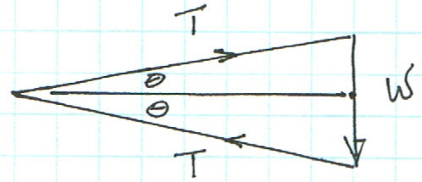
$\boxed{T = 39.2\,N}$

CHAP 4

80



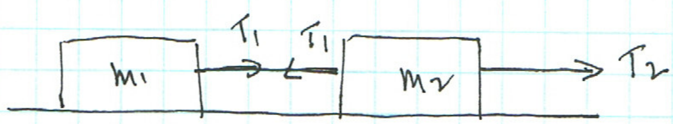
QUES: T = ?



$$\sin\theta = \frac{W/2}{T}$$

$$T = \frac{W}{2\sin\theta}$$

83.



NO FRICTION
MASSLESS CORD

QUES: $\frac{T_1}{T_2} = ?$

BOTH HAVE SAME ACCELERATION

BOTH MASSES.

$$\Sigma F = T_2 = (m_1 + m_2)\,a \qquad a = \frac{T_2}{m_1 + m_2}$$

BODY m_1

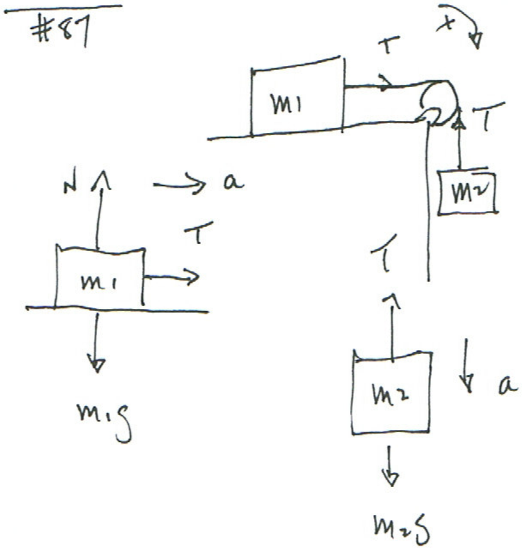
$$\Sigma F_x = T_1 = m_1 a \qquad a = \frac{T_1}{m_1}$$

$$\therefore \quad \frac{T_1}{m_1} = \frac{T_2}{m_1 + m_2}$$

$$\frac{T_1}{T_2} = \frac{m_1}{m_1 + m_2}$$

CHAP 4

#87



$m_1 = 3\,kg$

$m_2 = 2\,kg$

Q: a.) $a = ?$

b.) v_1 at $t = 1.2\,s$

c.) Movement of # during $\Delta t = 1.2\,s$

d.) Displacement after $\Delta t = 0.40\,s$

BODY 1

$\Sigma F_x = T = m_1 a \quad (1)$

$\Sigma F_y = N - m_1 g = 0 \quad (2)$

BODY 2

$\Sigma F_x = 0 \quad (3)$

$\Sigma F_y = m_2 g - T = m_2 a \quad (4)$

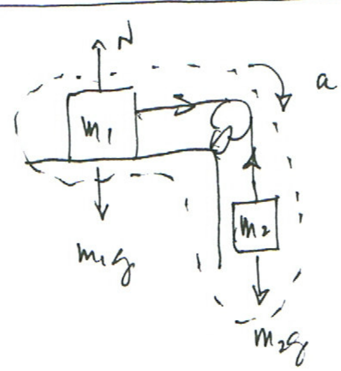
SUB (1) INTO (4)

$m_2 g - T = m_2 g - m_1 a = m_2 a$

$m_2 g = (m_1 + m_2)\, a$

$$\boxed{\left(\frac{m_2}{m_1 + m_2}\right) g = a}$$

SYSTEM = BODY 1 + BODY 2



INTERNAL FORCES CANCEL

$\Sigma F_x = T - T + m_2 g = (\text{SYS MASS})\, a$

$m_2 g = (m_1 + m_2)\, a$

$$\boxed{\left(\frac{m_2}{m_1 + m_2}\right) g = a}$$

$a = \frac{2}{2+3} \cdot 9.8 = \frac{2}{5}(9.8) = 3.92\,m/s^2$

$\vec{a}_1 = 3.92\,m/s^2$ TO THE RIGHT

$\vec{a}_2 = 3.92\,m/s^2$ DOWN

CHAP 4 #87 CONTINUED

b.) v_1 at $t = 1.2s$

$$v_1 = v_{1i} + at$$

$$v_1 = 0 + 3.92(1.2)$$

$$= 4.70 \text{ m/s}$$

c.) Movement during $\Delta t = 1.2s$.

$$\Delta x = v_{0i}\Delta t + \frac{1}{2}a\Delta t^2$$

$$\Delta x = 0 + \frac{1}{2}(3.92)(1.2)^2$$

$$\Delta x = 2.82m$$

d. DISPLACEMENT AFTER $\Delta t = 0.40$

$$\Delta x = \frac{1}{2}a\Delta t^2$$

$$\Delta x = \frac{1}{2}(3.92)(0.4)^2$$

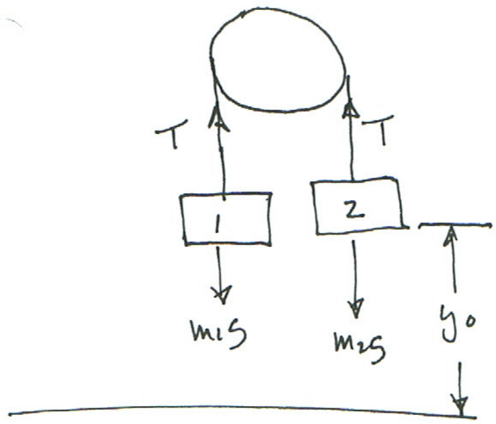
$$\Delta x = 0.31m.$$

$\vec{D}_1 = 0.31m$ to the right

$\vec{D}_2 = 0.31m$ down

CHAPTER 4

#91



$m_1 = 3.6$ kg
$m_2 = 9.2$ kg
$y_0 = 140$ cm

QUES: HOW LONG DOES MASS m_2 TAKE TO REACH THE FLOOR?

FIRST FIND THE ACCELERATION OF THE SYSTEM

$$\Sigma F = m_2 g - m_1 g = (m_1 + m_2) a$$

$$a = \left(\frac{m_2 - m_1}{m_1 + m_2}\right) g$$

NOW COMPUTE THE DISTANCE

$$y = y_0 + v_{0y} t - \frac{1}{2} a t^2$$

$$0 = 1.40 + 0 - \frac{1}{2}\left(\frac{m_2 - m_1}{m_1 + m_2}\right) g t^2$$

$$1.40 = \frac{1}{2}\left(\frac{9.2 - 3.6}{9.2 + 3.6}\right)(9.8) t^2$$

$$1.40 = 4.9\left(\frac{5.6}{12.8}\right) t^2$$

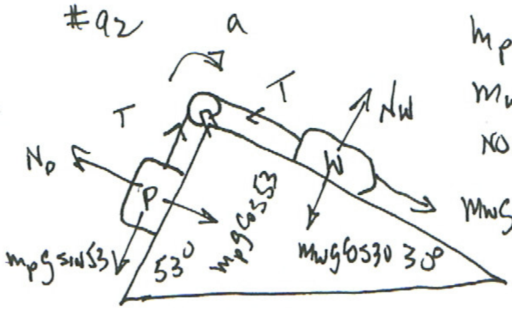
$$t^2 = \frac{1.40}{4.9}\left(\frac{12.8}{5.6}\right)$$

$$t^2 = 0.653$$

$$\boxed{t = 0.808 s}$$

CHAPTER 4

#92



$m_P = 7.00$ kg

$m_W = 10.00$ kg

NO FRICTION

QUES:

(a.) $a = ?$

(b.) RELEASED FROM REST - HOW FAR WILL THE PUMPKIN TRAVEL IS 0.30s ?

(c.) WHAT IS THE SPEED OF THE WATERMELON AFTER 0.20s ?

PUMPKIN

(a.) $\Sigma F = T - m_P g \sin 53 = m_P a$

WATERMELON

$\Sigma F = m_W g \sin 30 - T = m_W a$

ADD THE TWO EQNS TOGETHER

$$(T - m_P g \sin 53) + (m_W g \sin 30 - T) = (m_P + m_W) a$$

$$a = \left(\frac{m_W \sin \quad - m_P \sin 53}{m_W + m_P}\right) g$$

$$a = \frac{10 \sin 30 - 7 \sin 53}{17}(9.8) = -\frac{0.590}{17}(9.8)$$

$$\boxed{a = -0.340 \, m/s^2}$$

WATERMELON MOVES UP THE INCLINE

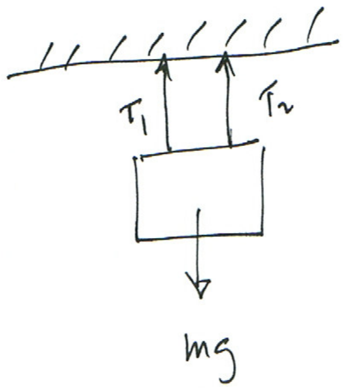
(b.) $x = \frac{1}{2} a t^2 = \frac{1}{2}(0.340)(0.30)^2 = \boxed{1.53 \text{ cm.}}$

(c.) $v = v_0 + at = 0 + (0.340)(0.20) = \boxed{6.8 \text{ cm/s}}$

CHAPTER 4

#130

WORKING IT BACKWARDS



BY SYMMETRY $T_1 = T_2 = T$

$mg = 15\,N$

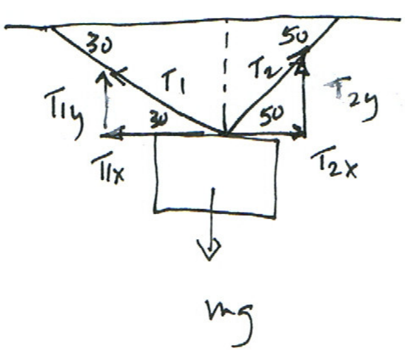
$T_{max} = 12\,N$

$$\Sigma F_y = T_1 + T_2 - mg = 0$$

$$T_1 + T_2 = 2T = mg$$

$$T = \frac{mg}{2} = \frac{15}{2} = 7.5\,N \le T_{max} = 12\,N$$

THIS ARRANGEMENT WORKS



AS BEFORE

$$\Sigma F_y = T_{1y} + T_{2y} - mg = 0$$

$$T_{1y} + T_{2y} = mg \quad (1)$$

$$\Sigma F_x = T_{2x} - T_{1x} = 0$$

$$T_{2x} = T_{1x} \quad (2)$$

DUE TO THE SMALLER ANG $\quad T_1 > T_2$

WHAT IS T_1? $\quad T_1 = \sqrt{T_{1x}^2 + T_{1y}^2} \quad (3)$

FROM (1) $\quad T_{1y} = T_1 \sin 30 \qquad T_{2y} = T_2 \sin 50$

$\qquad T_{1x} = T_1 \cos 30 \qquad T_{2x} = T_2 \cos 50$

$$T_1 \sin 30 + T_2 \sin 50 = mg \quad (4)$$

$$T_1 \cos 30 = T_2 \cos 50 \quad (5)$$

$$T_1 = T_2 \frac{\cos 50}{\cos 30} = 13.2 \frac{0.643}{0.866} = \boxed{9.80\,N}$$

$$T_2 \frac{\cos 50}{\cos 30} \cdot \sin 30 + T_2 \sin 50 = mg$$

$$T_2 \left[\sin 50 + \cos 50 \cdot \frac{\sin 30}{\cos 30} \right] = mg$$

$$T_2 = \frac{mg}{\sin 50 + \cos 50 \tan 30}$$

$$= \frac{15}{0.766 + \frac{0.643}{\sqrt{3}}}$$

$$= \frac{15}{1.14}$$

$$\boxed{T_2 = 13.2\,N}$$