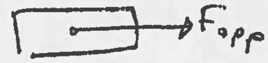
2.1 - Newtons Laws



① $V_0 = 0$

$V_f = 500.0\,m/s$

$d = 0.70\,m$

$kg = 6.0\,g = 0.0060\,kg$

$V^2 = V_0^2 + 2ad$

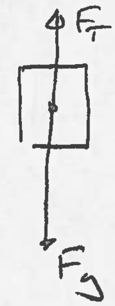
$\frac{V^2 - V_0^2}{2d} = a = \frac{V^2}{2d} = \frac{(500)^2}{(2 \cdot 0.70)} = 178571\,m/s^2$

$F = ma = 0.0060\,kg \cdot 178571\,m/s^2$ [2.1N]

$= \boxed{1.1 \times 10^3\,N}$

2) $kg = 0.10\,g = 0.00010\,kg$

$F = 5.6 \times 10^{-4}\,N$



$F_{net} = F_g - F_T = 0.00010\,kg \cdot 9.8\,m/s^2 - 5.6 \times 10^{-4}\,N =$

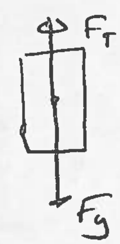
$= 0.00042\,N$

$a = \frac{F}{m} = \frac{0.00042\,N}{0.00010\,kg} = \boxed{4.2\,m/s^2 \text{ down}}$ (gravity > Tension)

3)
a) $F_T = 650\,N$

$m = 75\,kg$

$a = 9.8\,m/s^2$



$F_{net} = F_g - F_T$

$= 75\,kg \cdot 9.8\,m/s^2 - 650\,N$

$= 85\,N$

$a = \frac{F_{net}}{m} = \frac{85\,N}{75\,kg} = \boxed{1.1\,m/s^2}$

b) $V_0 = 0$

$a = 1.1\,m/s^2$

$d = 24$

$V = ?$

$V^2 = \cancel{V_0^2} + 2ad$

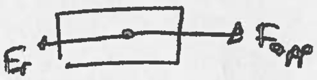
$V = \sqrt{2ad}$

$V = \sqrt{2(1.1)(24)} = \boxed{7.3\,m/s}$

4) $F_F = 75N$

$a = 1.5m/s^2$

$m = 25kg$



$F_{net} = ma = 1.5m/s^2 \cdot 25kg$

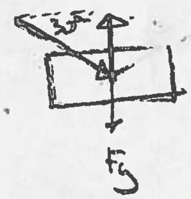
$= 37.5N$

$F_{net} = F_{app} - F_F$

$F_{app} = F_{net} + F_F = 37.5N + 75N$

$= 110N$

5)



$m = 15kg$

$F_{app} = 90N$

$a_g = 9.8m/s^2$

Constant speed = 0 acceleration

$F_F = F_{app_x}$

$F_F = 90N \cdot \cos(30)$

$= 78N$

b) $F_g = m \cdot a = 15kg \cdot 9.8m/s^2$

$= 147N$

Force of gravity + vertical component of applied force

$F_N = 147N + 90N \cdot \sin(30)$

$= \boxed{192N} = \boxed{1.9 \times 10^2 N}$

c) $\mu = \frac{F_F}{F_N} = \frac{78N}{192N} = 0.41$

d) $a = 0.80m/s^2$

$m = 15kg$

$F_{net} = ma = 0.80m/s^2 \cdot 15kg = 12N$

$F_{net} + F_F = F_{app_x}$

$F_A \cdot \cos 30° = 15(0.8) + 0.41F_N$

$F_A \cdot \cos 30° = 12 + 0.41(F_g + F_{app_y})$

$F_A \cdot \cos 30° = 12 + 60.27 + 0.41 \cdot F_A \cdot \sin(30°)$

$F_A \cos(30°) - 0.41 F_A \sin(30°) = 72.27$

$0.661 F_A = 72.27N$

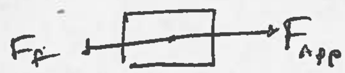
$F_A = \boxed{110N}$

6) $a = 4.50 m/s^2$

$m = 83kg$

$F_f = ?$

$F_{net} = F_f$



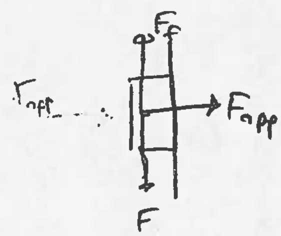
$ma = F_f$

$4.50m/s^2 \cdot 83kg = F_f = 373.5N = \boxed{370N}$

7) $a = 9.8m/s$

$m = 3.75kg$

$F_f = F_g$



$F_f = 9.8m/s^2 \cdot 3.75kg$

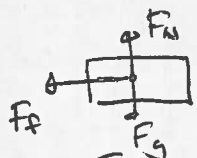
$\boxed{= 37N}$

8) $m = 1.20 \times 10^3 kg$

$V_0 = 22.5 m/s$

$V = 0m/s$

$d = 112m$



$a = \frac{V_0^2}{2d} = \frac{(22.5)^2}{2(112)} = 2.26 m/s^2$ backwards

$F_{net} = m \cdot a = 1.20 \times 10^3 kg \cdot 2.26 m/s^2$

$= \boxed{2.71 \times 10^3 N \text{ backwards}}$

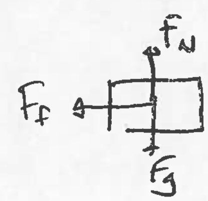
9) $d = 25m$

$a = ?$

$V_0 = 11m/s$

$V = 0m/s$

$a = \frac{V_0^2}{2d} = \frac{(11)^2}{2(25)} = 2.42 m/s$ backwards



$F_N = F_g$

$F_f = \mu F_n = \mu F_g$

$\cancel{m}a = \mu \cancel{m}g$

$\frac{a}{g} = \mu = \left(\frac{2.42}{9.80}\right) = \boxed{0.25}$

(10) (a) $m_1 = 6.8\,kg$

$m_2 = 5.2\,kg$

$m_T = 12.0\,kg$

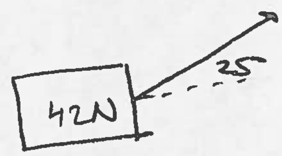
$F = 85N$

$a = \frac{F}{m} = \frac{85N}{12.0kg} = 7.1\,m/s^2$

(b) The 85N is splitt between the two blocks.
The split depends on their mass.

$M_1 \text{ on } M_2 = F_T \cdot \frac{m_2}{m_T} = 85N \cdot \frac{5.2kg}{12.0kg} = 37N$

(11)



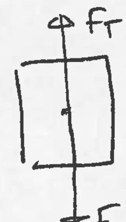
$F_g = 42N$

$F_{app} = 28N$

$F_N = F_g - F_{app_y} = 42N - 28N \cdot \sin(25)$

$= 30.\,N$

(12)



$F_g = 1.20 \times 10^3\,kg \cdot 9.80\,m/s^2$
$= 1.176 \times 10^4\,N$

(a) $F_T = F_g - 1.20 \times 10^3\,kg \cdot 1.05\,m/s^2$
$= \boxed{1.05 \times 10^4\,N}$

(b) $F_T = F_g + 1.20 \times 10^3\,kg \cdot 1.05\,m/s^2$
$= \boxed{1.30 \times 10^4\,N}$

(c) No acceleration = 0 Force

$F_T = F_g = \boxed{1.18 \times 10^4\,N}$

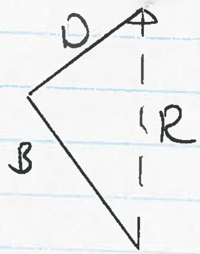
(13)

$F_{app} = m \cdot g = 1.5\,kg \cdot 9.8\,m/s^2$
$= 14.7\,N$

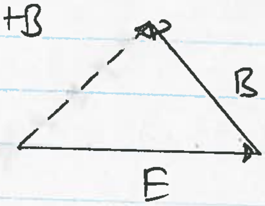
a of system; $a = \frac{F_{app}}{m_T} = \frac{14.7N}{2.5kg} = 5.9\,m/s^2$

2.2. Forces in 2 dymension

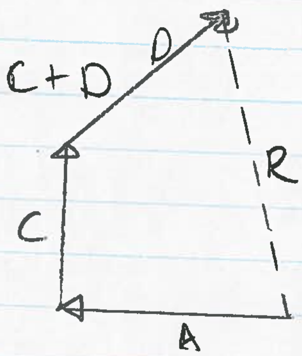
① i) B+D



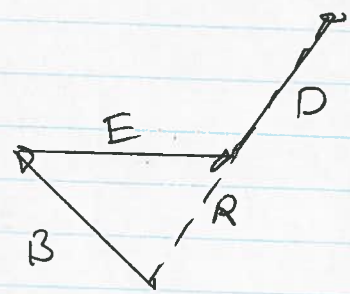
ii) E+B



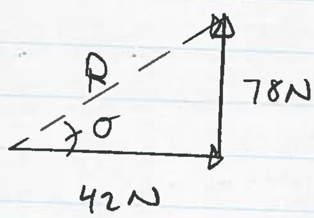
iii) A+C+D



iv. B+E+D



② ⓐ



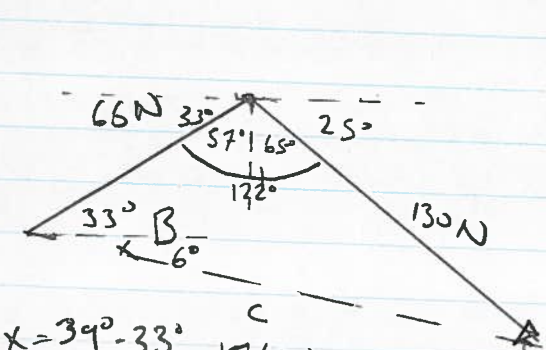
$R = \sqrt{(78)^2 + (42)^2}$
$= 89N$

$\theta = \tan^{-1}\left(\frac{78}{42}\right) = 62°$ N of E OR 28° E of N

89N 28° E of N

ⓑ $a = \frac{F}{m} = \frac{89N}{2.4kg} = 37m/s^2$ 28° E of N

③



$c^2 = a^2 + b^2 + 2ab\cos(C)$
$c = \sqrt{(66)^2 + (130)^2 + 2(66)(130)\cos(122)}$
$c = 174N$

$\frac{\sin B}{b} = \frac{\sin C}{c}$

$B = \sin^{-1}\left(\frac{b}{c} \cdot \sin(C)\right)$
$= 39°$

$x = 39° - 33°$
$= 6°$

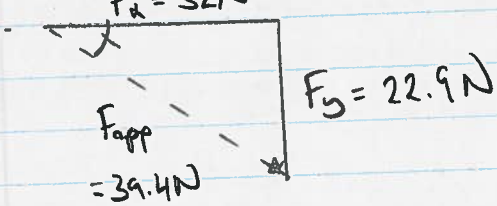
174N

(174N 6°)

(4) Split into x and y components

$$\Sigma F_x = 25N + 30N \cdot \cos(45°) - 20N\cos(45°)$$
$$= 32N$$
$$\Sigma F_y = 30N \cdot \sin(45°) + 20N - 20N\sin(45) - 50N$$
$$= -22.9N$$

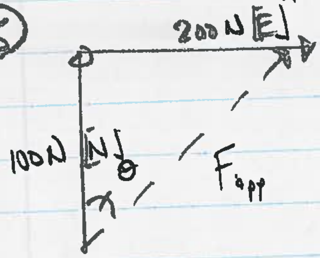
$$F_{app} = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = \sqrt{32N + -22.9N} = 39.4N$$



$$\theta = \tan^{-1}\left(\frac{22.9}{32}\right) = 35.6°$$

39.4N 35.6° E of N

(5)

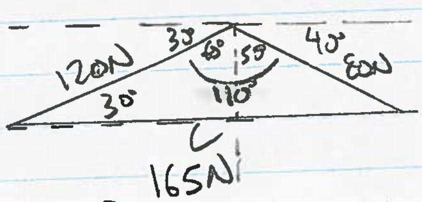


$$F_{app} = \sqrt{(100)^2 + (200)^2}$$
$$= 224N$$

$$\theta = \tan^{-1}\left(\frac{200}{100}\right) = 63° \text{ E of N}$$

224N 63° E of N

(6) (a)



$$c^2 = a^2 + b^2 - 2ab\cos(C)$$
$$c = \sqrt{a^2 + b^2 - 2ab\cos(C)}$$

$$c = \sqrt{(120)^2 + (80)^2 - 2(120)(80)\cdot\cos(110)}$$
$$= 165N$$

$\theta = 30 - 27°$
$= 3°$ N of E

165N 3° N of E

$$\frac{\sin A}{a} = \frac{\sin C}{c}$$

$$A = \sin^{-1}\left(\frac{a}{c} \cdot \sin C\right) = \sin^{-1}\left(\frac{80}{165} \cdot \sin(110)\right)$$
$$= 27°$$

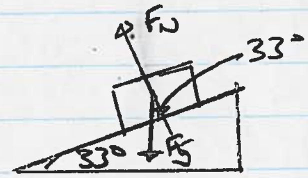
2.3 - Inclines

① $F_N = F_g \cdot \cos(33)$

$= m \cdot g \cdot \cos(33)$

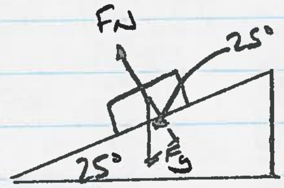
$= 7.6 \cdot 9.8 \cdot \cos(33) = 62.46\,N$

$= 62\,N$



② Same as above! $F_F = \mu F_N = 0.20\,(\;\;N) = 12.49\,N = 12\,N$

③

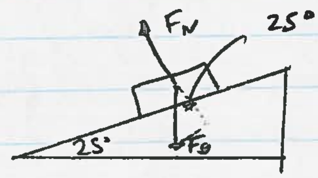


$F_N = F_g \cdot \cos(25)$

$= 16.2 \cdot 9.80 \cdot \cos(25)$

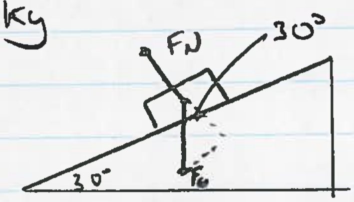
$= 144\,N$

④ $F_g = 445\,N$



parallel component $= F_{gx} = F_g \cdot \sin(25) = 445\,N \cdot \sin(25) = 188\,N$

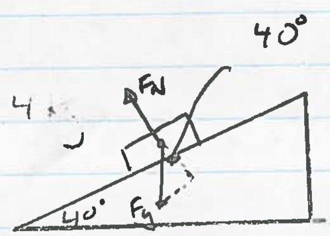
⑤ $m = \frac{F}{g} = 325\,N / 9.8 = 33.2\,kg$



$F_{gx} : 325\,N \cdot \sin(30°) = 162.5\,N$

$a = \frac{F}{m} = \frac{162.5}{33.2} = 4.90\,m/s^2$

⑥ $F_{opp} = F_F + F_{net}$



$F_F = F_{opp} - F_{net}$

$F_F = F_g \cdot \sin(40°) - m \cdot a$

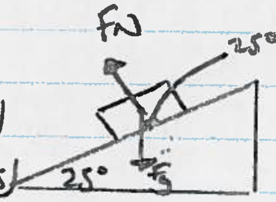
$= 435 \cdot \sin(40°) - \frac{435}{9.8}(0.25) = 269\,N$

(7) $F_{app} = F_{net} - F_F$

$= F_g \cdot \sin(25) + \mu \cdot F_g \cdot \cos(25)$

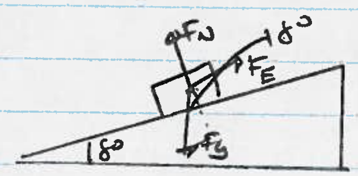
$F_{app} = 125 \cdot \sin(25) + 0.18 \cdot 125 \cdot \cos(25)$

$= 72.3\,N$



(8) $d = 10.0\ m$

$t = ?$

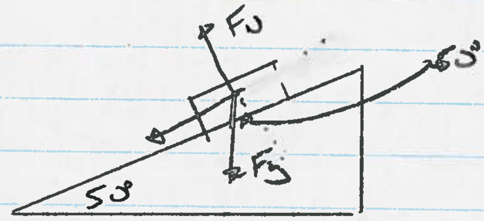


$F_{app} = F_{Net} + F_F = m \cdot g \cdot \sin(18^\circ) - m \cdot g \cdot \cos(18^\circ) \cdot 0.10 = m \cdot a$

$2.10\ m/s = a$

$t = \sqrt{\frac{2d}{a}} = 3.1\,s$

(9) Find a



$= \mu F_N = \mu \cdot F_g \cdot \cos(50)$

$F_{net} = F_{app} + F_F = m \cdot g \sin(50^\circ) + 0.20 \cdot m g \cdot \cos 50^\circ = m a$

$a = 8.77\,m/s^2$

$V^2 = V_0^2 + 2ad$

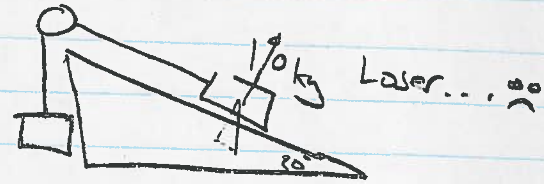
$\frac{-V_0^2}{2a} = d = -\frac{(41.7)^2}{2 \cdot (-8.77)} = 99\ m$

$150\,\frac{km}{hr} \times \left(\frac{1000\,m}{3600\,s}\right) = 41.7\,m/s$

$100\ m - 99\ m = 1.0\ m$

Worksheet 2.4 Two objects on an Incline

1)

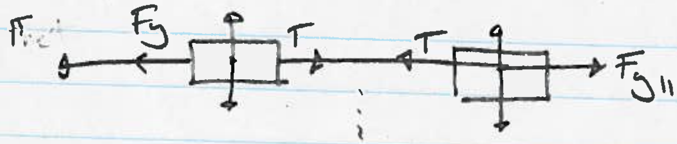


(a) $F_{Net} = m_1 g - m_2 g \sin(30°)$ winner!

$F_{Net} = (9.8)(2.0) - (1.0)(9.8) \cdot \sin(30°)$
$= 14.7N$

$a = \frac{F_{net}}{m_{total}} = \frac{14.7N}{3.0\,kg} = 4.9\,m/s^2$

(b)



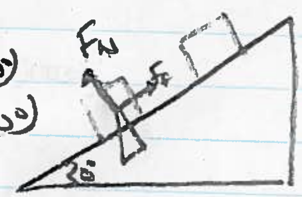
$F_{Net} = F_g - T$
$T = F_g - F_{net}$
$T = (2.0)(9.8) - (2)(4.9)$
$= 9.8N$

$F_{Net} = T - F_{g\parallel}$
$T = F_{net} + F_{g\parallel}$
$T = (1.0)(4.9) + (1.0)(9.8) \cdot \sin(30°)$
$= 9.8N$

(2) $F_{net} = m_1 g - m_2 g \sin(30°) - \mu m_2 \cdot g \cdot \cos(30°)$
$F_{net} = (9.8)(2.0) - (1.0)(9.8)\sin(30°) - 0.135\,(1.0)(9.8) \cdot \cos(30°)$
$= 13.55N$

$a = \frac{F_{net}}{m_{total}} = \frac{13.55N}{(3.0)} = 4.5\,m/s^2$

(3) a. m_1: $F_{net} = F_{g\parallel} - F_f$
$a = g \cdot \sin(30) - \mu \cdot g \cdot \cos(30°)$
$a = 9.8 \cdot \sin(30) - 0.10 \cdot 9.8 \cdot \cos(30°)$
$= 4.05\,m/s = 4.1\,m/s$

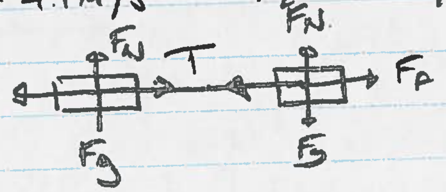


m_2: $F_{net} = F_{g\parallel} - F_f$
$a = g \cdot \sin(30) - \mu \cdot g \cdot \cos(30)$
$= 9.8 \cdot \sin(30) - 0.20 \cdot 9.8 \cdot \cos(30)$
$= 3.2\,m/s$

(b) because m_2 has a smaller acceleration than m_1 the string will be immediately loosened.
Both masses will continue at the same acceleration.

$a_1 = 4.1\,m/s^2$ $\quad a_2 = 3.2\,m/s^2$

(c)

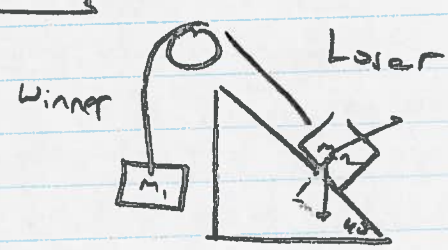


acceleration will be = !

$$F_{total} = a_1 \cdot m_1 + a_2 \cdot m_2 = (4.05)(1.0) + (3.2)(2.0) = 10.45$$

$$a = \frac{F_{total}}{M_{total}} = 3.48 = \boxed{3.5\,m/s}$$

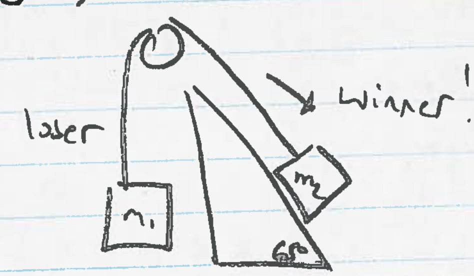
(4)



$$F_{net} = m_1 g - m_2 \cdot g \cdot \sin(40^\circ) = 0.7703\,N$$

$$a = \frac{F_{net}}{m_{total}} = \left(\frac{0.7703}{0.90}\right) = 0.86\,m/s^2$$

(5)



$$F_{net} = m_2 g \sin(65^\circ) - m_1 \cdot g = 186.5\,N - 176.4 = 10.1\,N$$

$$a = \frac{F_{net}}{m_{tot}} = \frac{10.1\,N}{39\,kg} = \boxed{0.26\,m/s^2}$$