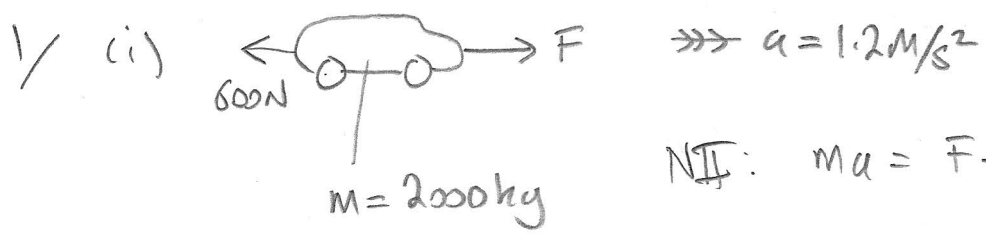


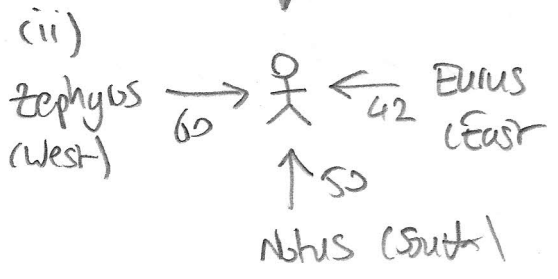
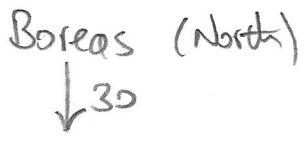
FORCES & ACCELERATION



Net: $ma = F - 600$

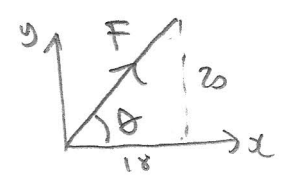
$\therefore F = 2000 \times 1.2 + 600 \quad (N)$

$F = 3000N$



vector sum of force is: (in N)

$\begin{pmatrix} 60 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ -30 \end{pmatrix} + \begin{pmatrix} -42 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ 50 \end{pmatrix} = \begin{pmatrix} 18 \\ 20 \end{pmatrix}$



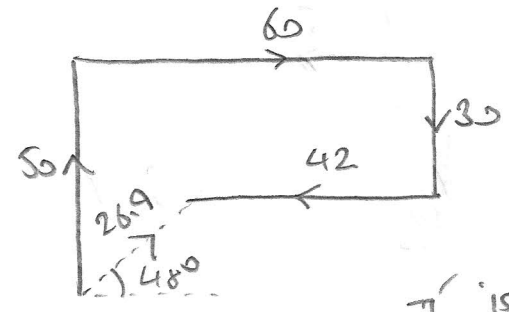
Net force ("resultant force") is of magnitude:

$F = \sqrt{18^2 + 20^2} = 26.9N$

at angle $\theta = \tan^{-1}\left(\frac{20}{18}\right) = 48^\circ$

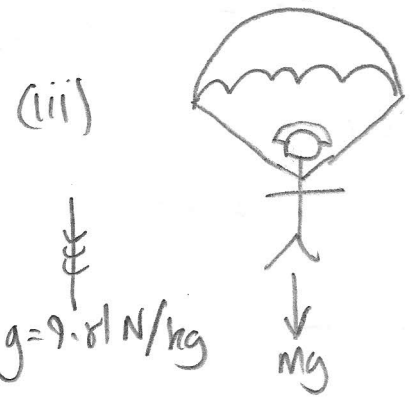
So bearing (ie clockwise from N) is 042°

Note vector addition is:



--- is the resultant force.

$\uparrow \frac{1}{2} C_D \rho \pi r^2 v^2$



$v = 400m/s$ in eq drag = weight

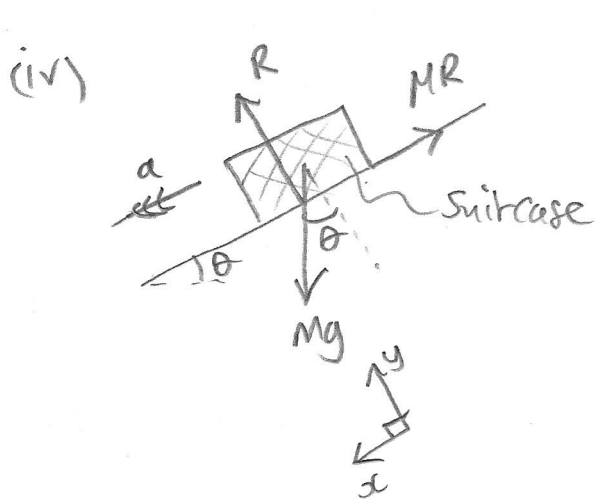
$\therefore Mg = \frac{1}{2} C_D \rho \pi r^2 v^2$

$\therefore \sqrt{\frac{2Mg}{C_D \rho \pi v^2}} = r$

$g = 9.81 N/kg$

$$\therefore r = \sqrt{\frac{2 \times 65 \times 9.81}{0.8 \times 1.23 \times \pi \times 4.00^2}} = \boxed{5.1 \text{ m}}$$

(i.e. the parachute radius)



$$g = 9.81 \text{ N/kg}$$

$$\text{NII} \quad // x: ma = mgsin\theta - MR$$

$$// y: 0 = R - Mg\cos\theta$$

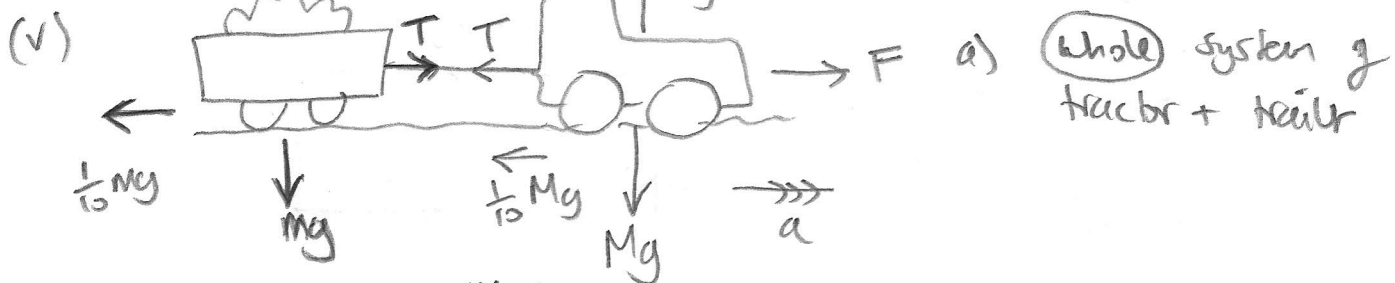
$$\therefore R = Mg\cos\theta$$

$$\therefore ma = mgsin\theta - \mu Mg\cos\theta$$

$$\therefore \mu Mg\cos\theta = mgsin\theta - ma$$

$$\therefore \boxed{\mu = \tan\theta - \frac{a}{g\cos\theta}}$$

$$\therefore \mu = \tan 45^\circ - \frac{6.0}{9.81 + 6.545} = \boxed{0.14}$$



→ Brakes on trailer

→ Brakes on tractor

$$\text{NII} \quad // x: (M+m)a = F - \frac{1}{10}(m+M)g$$

$$\therefore F = (M+m)\left(a + \frac{g}{10}\right)$$

$$F = (11,000 + 21,000)\left(3.14 + \frac{9.81}{10}\right)$$

$$= \boxed{131,900 \text{ N}}$$

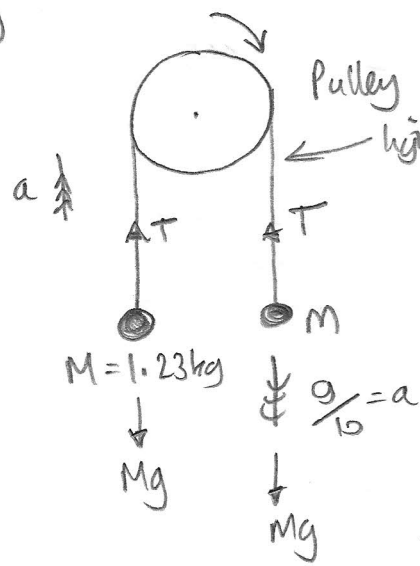
b) NII for trailer:

$$ma = T - \frac{1}{10}mg \quad \therefore T = m\left(a + \frac{g}{10}\right) = 21000\left(3.14 + \frac{9.81}{10}\right)$$

$$= \boxed{86,500 \text{ N}}$$

②

(vi)



NII for mass M: $Ma = Mg - T$ (1)
 " " " M: $Ma = T - Mg$ (2)

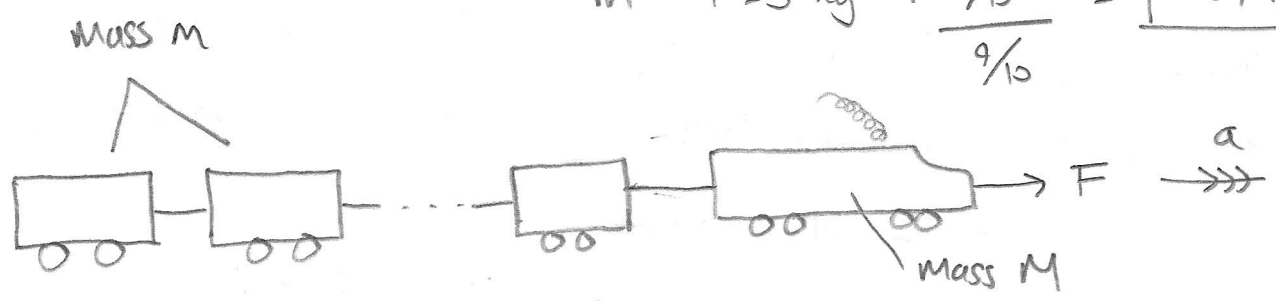
$\therefore T = M(a + g)$
 $\therefore m(g - a) = T = M(a + g)$

$$m = \frac{M(a + g)}{g - a}$$

So $m = 1.23 \text{ kg} \times \frac{1 + \frac{1}{10}}{1 - \frac{1}{10}}$

$m = 1.23 \text{ kg} \times \frac{11/10}{9/10} = \boxed{1.51 \text{ kg}}$

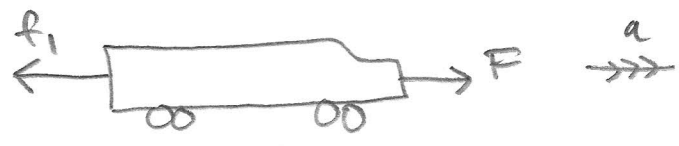
(vii)



Whole system of locomotive + N carriages

NII: $F = (Nm + M)a$

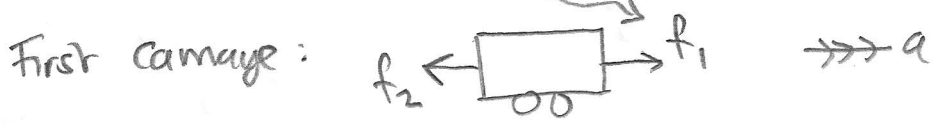
Forces on locomotive:



NII: $F - f_1 = Ma \quad \therefore f_1 = F - Ma$

$\therefore \boxed{f_1 = Nma}$

(Note NII explains why this) force is f_1



NII: $f_1 - f_2 = ma \quad \therefore f_2 = f_1 - ma$

$\boxed{f_2 = (N-1)ma}$

3

