Ex 3F, P61

(1)

S	U	V	A	T
100	2	1.5	?	

use $v^2 = u^2 + 2as$, $\therefore (1.5)^2 = 4 + 2(100)a$

$\therefore a = -\frac{7}{800}$

Then $F = ma \Rightarrow F = 10^7 \times \frac{-7}{800} = -87500\,N$

So magnitude of Resistance is 87500 N

(2) In non-vector form we have $s = ut + \frac{1}{2}at^2$.
In vector form it is $\underline{r} = \underline{u}t + \frac{1}{2}\underline{a}t^2$, all from the origin (0, 0).
But we also have a starting point $\underline{r}_0 = (2\underline{i} + 5\underline{j})$ m

So $\underline{r} = \underline{r}_0 + \underline{u}t + \frac{1}{2}\underline{a}t^2$.

we know $\underline{u} = 0\underline{i} + 0\underline{j} = \underline{0}$. we need $\underline{a}$.

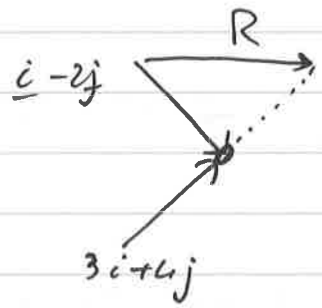
Here $\underline{F} = m\underline{a}$, $\therefore 2\underline{i} + 4\underline{j} = 2\underline{a} \Rightarrow \underline{a} = (\underline{i} + 2\underline{j})\,m/s^2$

So $\underline{r} = 2\underline{i} + 5\underline{j} + \underline{0}t + \frac{1}{2}(\underline{i} + 2\underline{j})t^2$

at $t=3$: $\underline{r} = 2\underline{i} + 5\underline{j} + \frac{1}{2}(\underline{i} + 2\underline{j}).9$

So $\underline{r} = (6.5\underline{i} + 14\underline{j})$ m

(3) <u>Diagram</u>



(a) Resultant $\underline{R} = \underline{i} - 2\underline{j} + 3\underline{i} + 4\underline{j} = (4\underline{i} + 2\underline{j})$ N

Net $F = ma \Rightarrow 4\underline{i} + 2\underline{j} = 2\underline{a}$

$\Rightarrow \underline{a} = (2\underline{i} + \underline{j})$ m/s^2

(b) This is SUVAT in vector form, with $\underline{r}_0 = 2\underline{i} - \underline{j}$,
$\underline{u} = 4\underline{i} + 3\underline{j}$, $\underline{a} = 2\underline{i} + \underline{j}$

In non-vector form we would use $s = ut + \frac{1}{2}at^2$. Here we use

$$\underline{r} = \underline{r}_0 + \underline{u}t + \tfrac{1}{2}\underline{a}t^2$$

$$\therefore \underline{r} = 2\underline{i} - \underline{j} + (4\underline{i} + 3\underline{j})t + \tfrac{1}{2}(2\underline{i} + \underline{j})t^2$$

Collect all $\underline{i}$ & $\underline{j}$ terms:

$$\underline{r} = (t^2 + 4t + 2)\underline{i} + (\tfrac{1}{2}t^2 + 3t - 1)\underline{j} \text{ m}$$

Now, direction of acceleration $\underline{a}$ is $\theta = \tan^{-1}\frac{1}{2} \Rightarrow \theta = 26.565°$
" " position vector $\underline{r}$ is

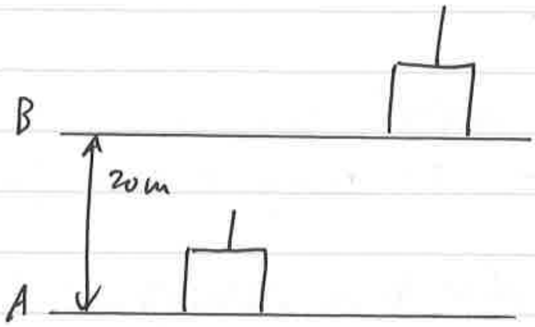
$$\theta = \tan^{-1}\frac{\frac{1}{2}t^2 + 3t - 1}{t^2 + 4t + 2}$$

This has to equal direction of acceleration $\underline{a}$.

So $\frac{1}{2} = \dfrac{\frac{1}{2}t^2+3t-1}{t^2+4t+2} \Rightarrow \frac{1}{2}t^2+2t+1 = \frac{1}{2}t^2+3t-1$

$\therefore \quad 2t+1 = 3t-1 \Rightarrow t = 2$ sec.

(4)

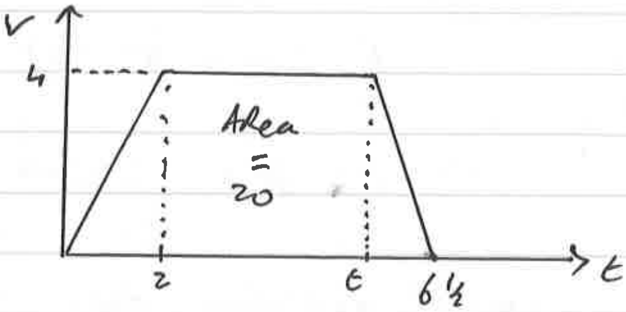


S	U	V	A	T	(2)
20	0			$6\frac{1}{2}$	

S	U	V	A	T	(1)
	0		2	2	

By (1) : $v = u + at \Rightarrow v = 0 + (2)(2) = 4$

So



To find the decelleration from t to $6\frac{1}{2}$ sec, find t.
Since total Area = 20 we have

$$20 = \tfrac{1}{2}(2)(4) + (t-2)(4) + \tfrac{1}{2}(6.5-t)(4)$$

So $\quad 20 = 4 + 4t - 8 + 13 - 2t$

$\therefore \quad 11 = 2t \Rightarrow t = 5.5$

So decelleration is the slope over $t \to 6\frac{1}{2}$: $\dfrac{4}{6.5-5.5} = 4\ m/s^2$

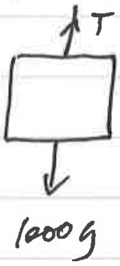
Net $F = ma$

$\therefore \quad T - 500g = 500(2)$

$\Rightarrow \quad T = 5900\,N$

5

a

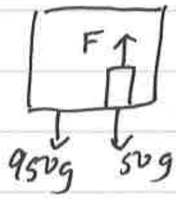
i) 

Net $F = ma$

$\therefore \quad T - 1000g = 1000(0),$

due to uniform speed (i.e. $a = 0$)

So $\quad T = 1000g = 9800\,N \uparrow$

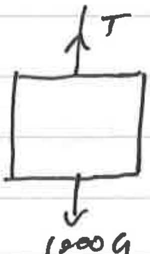
ii) 

Net $F = ma$

$\therefore \quad F - 50g = 50(0)$

$\Rightarrow \quad F = 50g = 490\,N \uparrow$

b

i) $a = 2 \downarrow$ 

$\uparrow$ upward direction, downward / -ve acceleration

$\therefore$ Net $F = ma$

$\Rightarrow \quad T - 1000g = 1000(-2)$

$\Rightarrow \quad T = 7800\,N \uparrow$

ii) Similarly $\quad F - 50g = 50(-2) \Rightarrow F = 390\,N. \uparrow$

(6) Net $F = ma$

$\therefore\ 3g - T = 3a$ (1)

& $T - 2g = 2a$ (2)

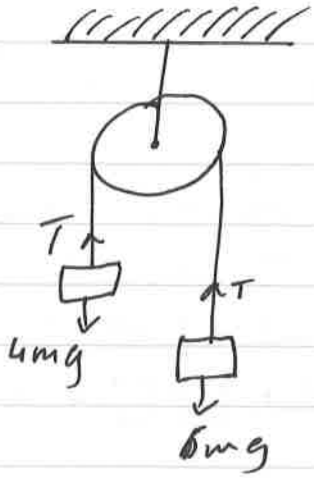
So 2(1) − 3(2) gives

$$\begin{array}{r} 6g - 2T = 6a \\ -\quad 3T - 6g = 6a \\ \hline 12g - 5T = 0 \end{array}$$

$\Rightarrow T = \frac{12}{5} g$ N

Assume: light inextensible String & massless pulley.

(7)



Net $F = ma$

$\therefore\ 6mg - T = 6ma$ (1)

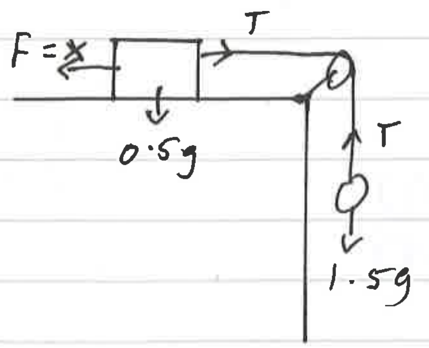
$T - 4mg = 4ma$ (2)

So 4(1) − 6(2) gives

$$\begin{array}{r} 24mg - 4T = 24ma \\ -\quad 6T - 24mg = 24ma \\ \hline -10T + 48mg = 0 \end{array}$$

$\therefore T = \frac{24}{5} mg$ N

(8)



$g = 10\,m/s^2$ here

Equilibrium $\Rightarrow a = 0$

So for 1.5kg : $1.5g - T = 0$ (1)
0.5kg : $T - X = 0$ (2)

So adding : $1.5g - X = 0 \Rightarrow X = 15N.$

X is now 12 Newtons $\Rightarrow$ acceleration, and given : $u = 0$,
$t = 2$, $s = ?$, $a = ?$, so find a then s

$\therefore$ by (1) & (2) : $15 - T = 1.5a$
$T - 12 = 0.5a$

adding : $3 = 2a \Rightarrow a = 1.5\,m/s^2$

So now: S U V A T , hence $S = ut + \frac{1}{2}at^2$
? 0 $\frac{3}{2}$ 2 $\Rightarrow S = 0 + \frac{1}{2}\left(\frac{3}{2}\right).4 = 3m.$

(9) Block A : $6g - P = 6a$ (1)
B : $P - Q = 5a$ (2)
C : $Q - 3g = 3a$ (3)

So (1) + (2) + (3) is $6g - 3g = 14a \Rightarrow a = 2.1\,m/s^2$ ($g = 9.8$)

& (2) + (3) is $P - 3g = 8a \Rightarrow P = 8(2.1) + 3g = 46.2N$
& (1) + (2) is $6g - Q = 11a \Rightarrow Q = 6g - 11(2.1) = 35.7N.$

Now,

S	U	V	A	T
0·6	0		2.1	?

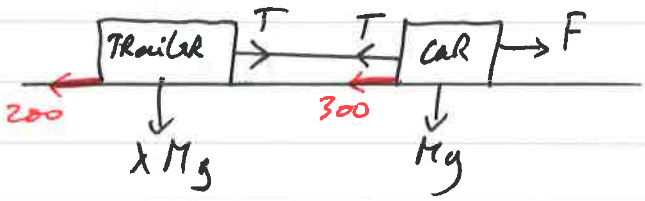
So $s = ut + \frac{1}{2}at^2 \Rightarrow 0.6 = 0 + \frac{1}{2}(2.1)t^2$

$\Rightarrow t = 0.756$ sec (ignore −ve answer)

(10) Total Net Force = ma

And given $F = 2000\,N$

$\Rightarrow a = 0.3\ m/s^2$



So $2000 - 300 - 200 = (0.3)M(\lambda + 1)$

$\Rightarrow M(\lambda + 1) = 5000$ ✓

Now $T - 200 = \lambda M(0.3)$ (1)

& $F - 300 - T = M(0.3)$ (2)

When $T = 500$ (2) is $1200 = M(0.3) \Rightarrow M = 4000$

And by (1) : $500 - 200 = \lambda(4000)(0.3) \Rightarrow \lambda = \frac{1}{4}$.