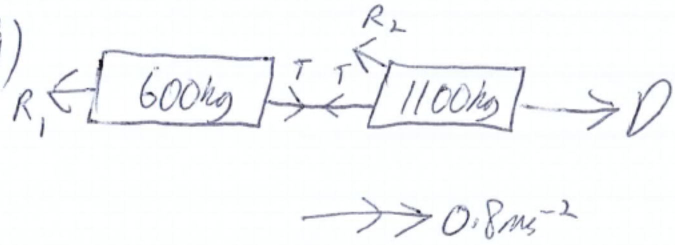
M1 Exam Jan. '07 OC

① (i)



Horizontal forces on trailer:- $T - R_1 = 700 - R_1$

$F=ma$ then gives $700 - R_1 = 600 \times 0.8$

so $\underline{R_1 = 220N}$

(ii) Horizontal forces on car:- $D - R_2 - T = 1400 - R_2$

Again, $F=ma$ gives $1400 - R_2 = 1100 \times 0.8$

so $\underline{R_2 = 520N}$

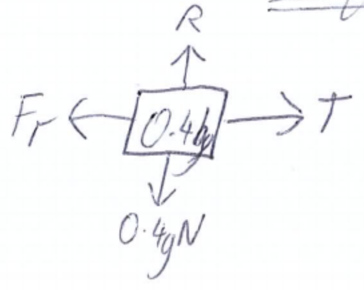
② (i) $15\sin\alpha + 11\sin\beta - 13 = 15 \times 0.28 + 11 \times 0.8 - 13$
$= 0$

(Resolving in Y-direction)

(ii) Resolving in (positive) X-direction:- $15\cos\alpha - 11\cos\beta = 7.79N$

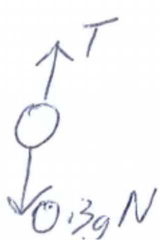
(iii) In direction of positive x-axis

③ (i)



· As system is in limit, $F_r = \mu R$, & $F_r = T$

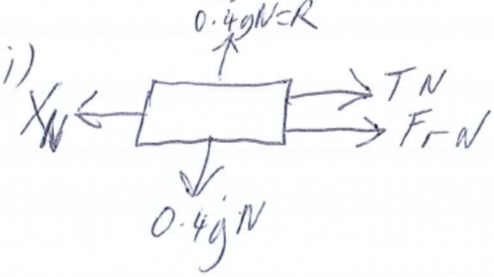
· $R = 0.4g$, so $T = 0.4g.\mu$ (A)



· Again, equilibrium gives $T = 0.3g$. (B)

(A) & (B) give $0.4g\,\mu = 0.3g$, so $\boxed{\mu = \frac{3}{4}}$

(ii)



Now $X = T + F_r$

ie $X = T + \mu R$

ie. $X = T + 0.75 \times 0.4g$

But $T = 0.3g$, so $X = 0.3g + 0.3g = \underline{0.6g}$

$= \underline{5.88}$.

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(4) (i) Momentum before collision:- $4 \times 0.8 - 2 \times 0.6 = 2\,Ns$

Momentum after $= 2 \times 0.6 + v \times 0.8 = 1.2 + 0.8v$

Conservation of momentum:- $1.2 + 0.8v = 2$

so $0.8v = 0.8$

$\underline{v = 1\,ms^{-1}}$

(ii) (a) $2 \times 0.6 - 0.5 \times 0.7 = 0.85\,Ns$

If direction of N's motion is not reversed, then M's must be. Then both spheres are moving in the negative direction, & so total momentum would be negative. But conservation says that it is not.

(b) Momentum after collision $= 0.7v$, so conservation gives:-

$0.85 = 0.7v$,

so $\underline{v = 1.21\,ms^{-1}}$ (to 3s.f.)

(5) (i) $a = \frac{dv}{dt}$, so $v = \int a\,dt = 0.9t^2 + C$

As particle starts at rest ($v=0$ when $t=0$), $C=0$, so $\underline{v = 0.9t^2}$.

(ii) $v = \frac{ds}{dt}$, so $s = \int v\,dt = 0.3t^3 + C'$,

Again, $s=0$ when $t=0$, so $C'=0$.
So $s = 0.3t^3$ & when $t=4$:-
$s = 0.3 \times 4^3 = \underline{19.2\text{m}}$

(iii) Particle then travels for 3 seconds with acceleration 7.2ms^{-2}. It's initial speed is given by $0.9 \times 4^2 = 14.4\text{ms}^{-1}$
Now

$s = ut + \frac{1}{2}at^2$ gives $s = 14.4 \times 3 + \frac{1}{2} \times 7.2 \times 3^2$
$= 75.6\text{m}$

So total <u>displacement</u> is $19.2 + 75.6 = \underline{94.8\text{m}}$.

(6) (i) Let greatest speed be V.
As lines are straight, acceleration is constant, & then deceleration is constant.

Using $s = \frac{1}{2}(u+v)t$ on <u>acceleration</u> we get

$s = \frac{1}{2}(0+V)t$. (A)

On <u>deceleration</u> we get:-

$(8-s) = \frac{1}{2}(V+0)(25-t)$ (B)

Adding (A) & (B) we get:- $8 = \frac{1}{2}vt + \frac{1}{2}v$ [illegible]

$= 12.5v$

So $\underline{v = 0.64 ms^{-1}}$

(ii) $V = 0.02 \times 40 = \underline{0.8}$.

(iii) $135 - 25 - 40 - 40 = 30s$ between reaching Vms^{-1} & coming to rest 40m above ground.

The area under the graph is the displacement.
The first triangle has area $\frac{1}{2} \times 25 \times 0.64 = 8m$
The second triangle has area $\frac{1}{2} \times 40 \times V = 20 \times 0.8 = 16m$

Final trapezium has area $\frac{1}{2}(30+T)V = 12 + 0.4T$

So $8 + 16 + (12 + 0.4T) = 40$

ie $0.4T = 4$
so $\underline{T = 10s}$

(iv) The hoist goes from $0.8ms^{-1}$ to $0ms^{-1}$ in $30 - 10 = 20s$

$a = \frac{v-u}{t} = \frac{0.8}{20} = \underline{0.04ms^{-2}}$

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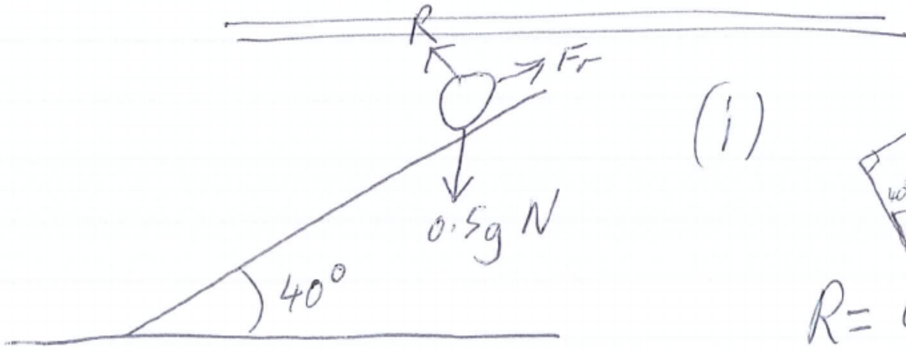
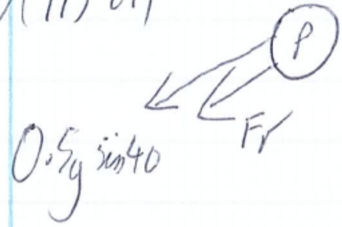


(i)

$R = 0.5g\cos 40$
$= 3.754$

So $Fr = \mu R = 0.6 \times 3.754 = \underline{2.25N}$ (to 3s.f.)

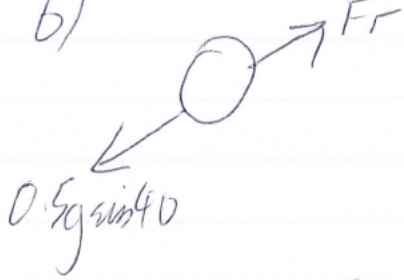
⑦ (ii) a)



$F = 0.5g\sin 40 + Fr =$
$= 3.14966 + 2.25 = 5.4\,N$

So $F=ma$ gives $a = 5.4/0.5 = \underline{10.8\,ms^{-2}}$

b)



$F = 0.5g\sin 40 - Fr$
$= 0.8947$

So $F=ma$ gives $a = \frac{0.8947}{0.5} = \underline{1.79\,ms^{-2}}$

(iii) a) When $t=0$ we have, $u = 4\,ms^{-1}$ & we want to find t when $v=0$:-

$v = u + at$ gives :-

$t = \frac{(0-4)}{10.8} = \underline{0.370\,s}$ (to 3sf)

b) Using $v^2 = u^2 + 2as$ we see $s = \frac{0-4^2}{2\times 10.8}$
$= 0.74\,m$

So P starts 0.74m from A with $u=0$, and $a = 1.79\,ms^{-2}$

Using $s = ut + \frac{1}{2}at^2$ we see

$t^2 = 0.74 \div \left(\frac{1}{2}\times 1.79\right) = 0.83$

So $t = 0.908\,s$

So total time is $0.908 + 0.370 = \underline{1.28\,s}$

(to 3.s.f.)