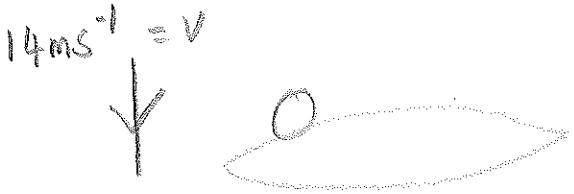
1. M1 June 2016

$v = u + at$

$v^2 = u^2 + 2as$

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

(1)

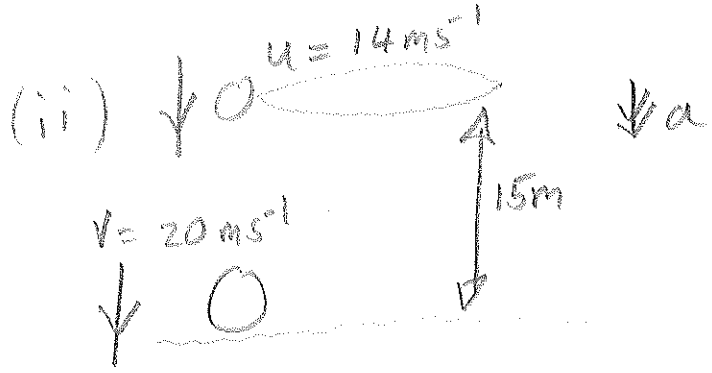


(i) $v^2 = u^2 + 2as$

$14^2 = 0^2 + 2 \times 9.8 \times s$

$s = 10m$

(ii)

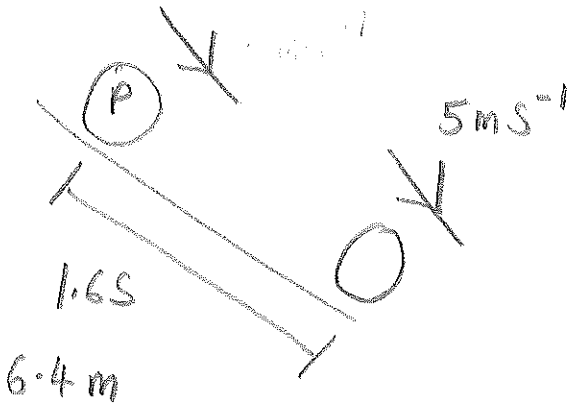


$v^2 = u^2 + 2as$

$20^2 = 14^2 + 2 \times a \times 15$

$a = 6.8ms^{-2}$

(2)



(i) $s = ut + \frac{1}{2}at^2$

$6.4 = u \times 1.6 + \frac{1}{2} a \times 1.6^2$

$6.4 = 1.6u + 1.28a$ (1)

$v = u + at$

$5 = u + a \times 1.6$

$\Rightarrow u = 5 - 1.6a$ (2)

Sub (2) into (1)

$6.4 = 1.6(5 - 1.6a) + 1.28a$

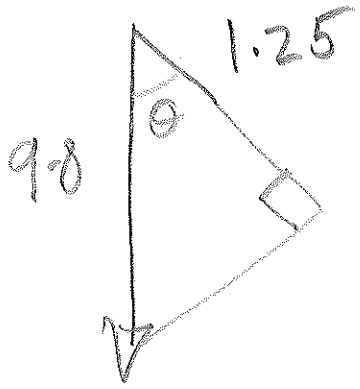
$6.4 = 8 - 2.56a + 1.28a$

$1.28a = 1.6$

$a = 1.25ms^{-2}$

M1 June 2016

(2) (ii)



$\cos\theta = \frac{1.25}{9.8} \Rightarrow \theta = 82.67190203$

2.

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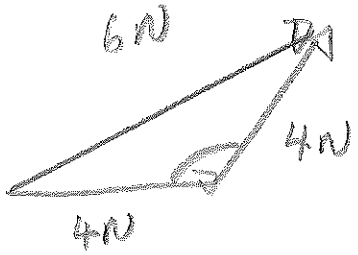
(3)



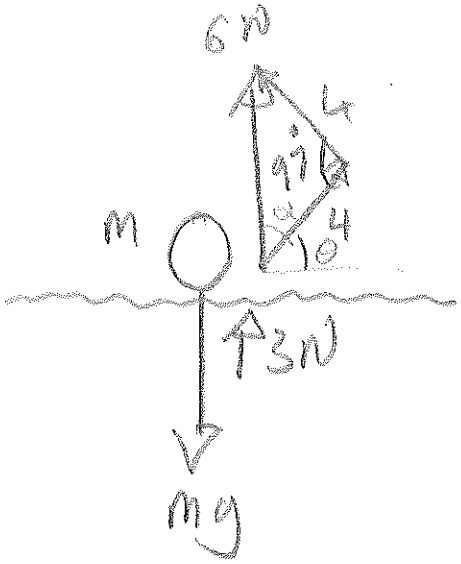
$c^2 = a^2 + b^2 - 2ab\cos C$

$36 = 16 + 16 - 32\cos C$

$C = 97.18075578°$

Surface 'smooth' so friction is assumed to be zero.

If remains at rest, resultant must be 0



Resolve vertically

$mg = 3 + 6$

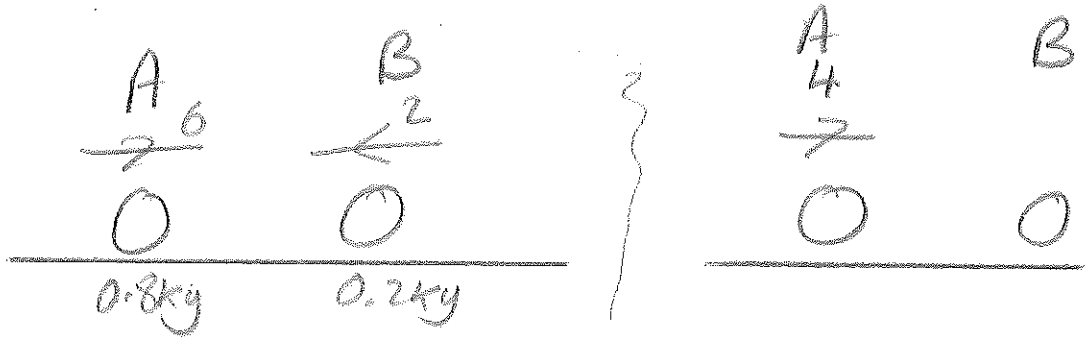
$m = \frac{9}{g} = \frac{45}{49}$ kg

$\frac{\sin 97}{6} = \frac{\sin \alpha}{4} \Rightarrow \alpha = 41.42945763$

$90 - 41.42945763 = 48.57054237$

3. M1 June 2016

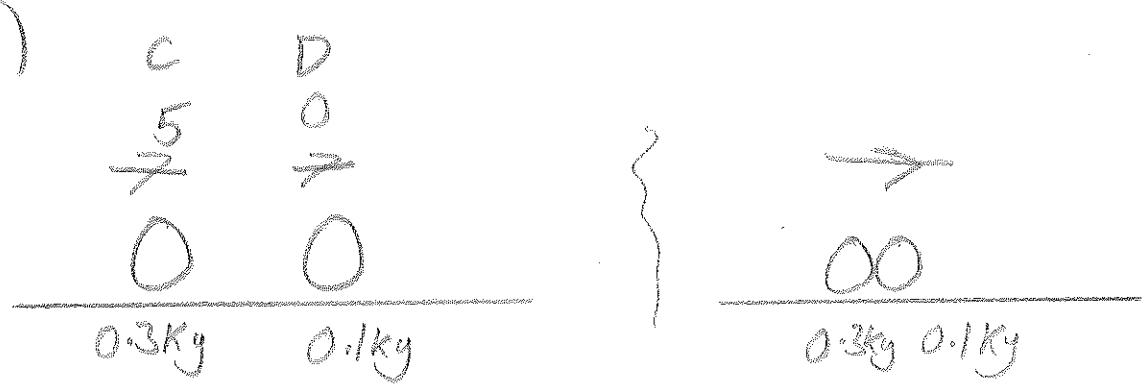
(4) (i)



$m_A u_A + m_B u_B = m_A v_A + m_B v_B$

$0.8 \times 6 + 0.2 \times (-2) = 0.8 \times 4 + 0.2 v_B \Rightarrow v_B = \underline{\underline{6\ ms^{-1}}}$

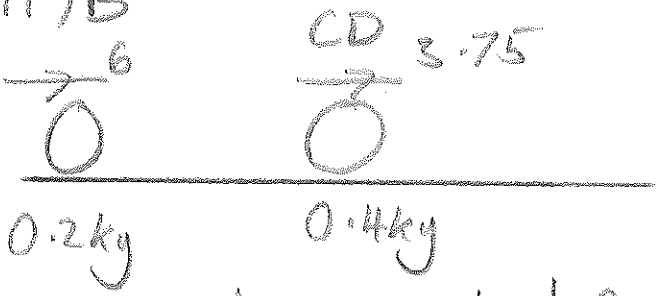
(ii)



$m_C u_C + m_D u_D = (m_C + m_D) V$

$0.3 \times 5 + 0 = 0.4V \Rightarrow V = 3.75\ ms^{-1}$

(iii)



greatest speed of combined, if B stops

$m_B u_B + m_{CD} u_{CD} = 0 + m_{CD} v_{CD}$

$0.2 \times 6 + 0.4 \times 3.75 = 0.4 \times v_{CD}$

$v_{CD} = 6.75\ ms^{-1}$

Mark scheme, B must be $4\ ms^{-1}$ or A will collide with it so

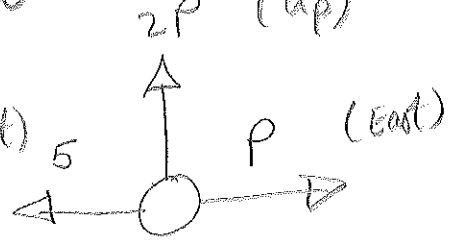
$0.2 \times 6 + (0.3 + 0.1) \times 3.75$

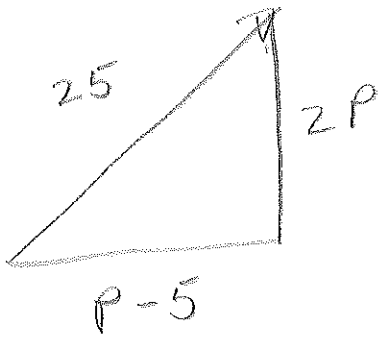
$= 0.2 \times 4 + 0.4V$

$\Rightarrow V = 4.75\ ms^{-1}$

4. M1 June 2016

(5)





$25^2 = (2P)^2 + (P-5)^2$

$625 = 4P^2 + P^2 - 10P + 25$

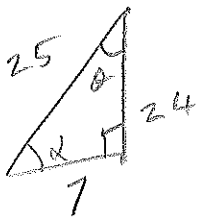
$0 = 5P^2 - 10P - 600$

$0 = P^2 - 2P - 120$

$0 = (P-12)(P+10)$

$P = 12$ or $P = -10$

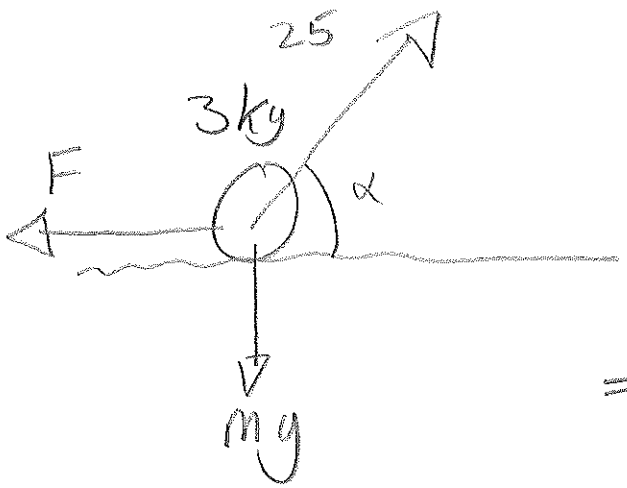
Taking P as positive.



$\cos\theta = \left(\frac{24}{25}\right) \Rightarrow \theta = 16.26020471^\circ$

$\alpha = 90 - \theta = 73.73979529$

$\mu = 0.15$



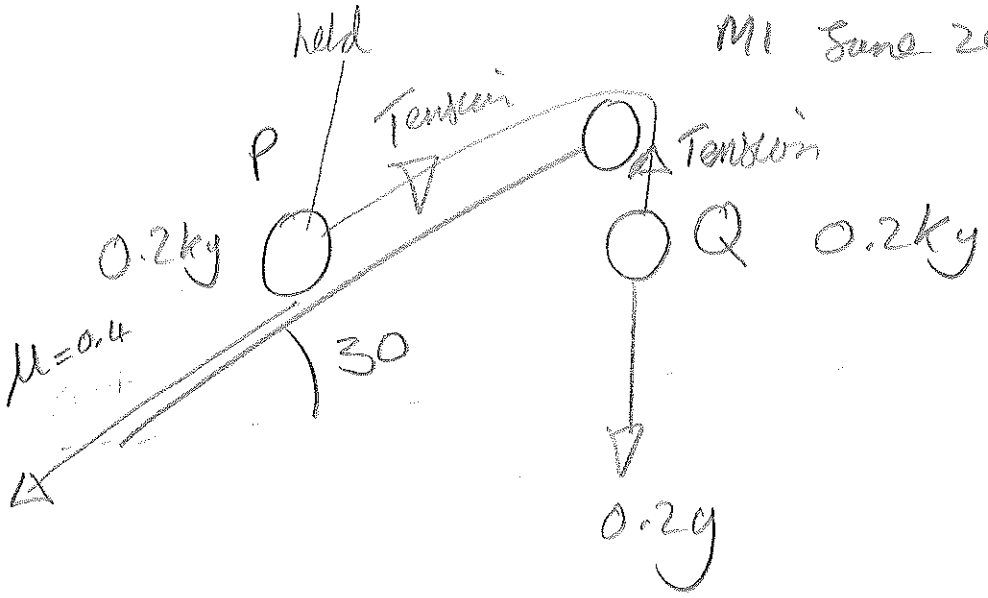
Resolve vertically

$25\sin\alpha + \text{Normal} = 3g$

$\Rightarrow \text{Normal} = 5.4\text{N}$

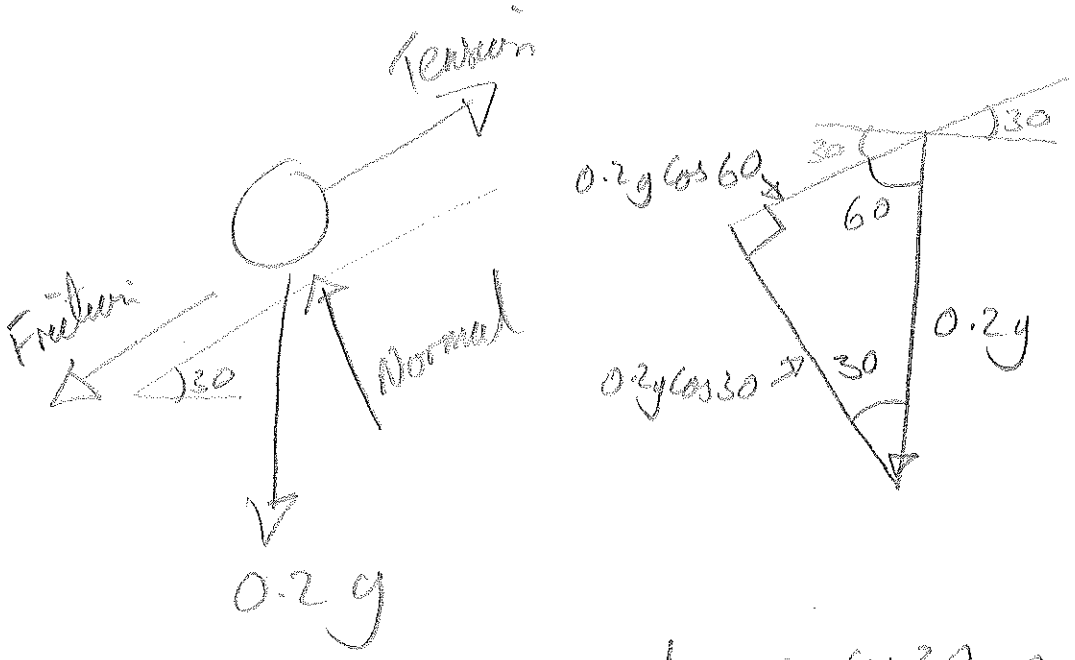
$25\cos\alpha - 5.4 \times 0.15 = 3a \Rightarrow a = 2.06\ ms^{-2}$

5. (6) M1 June 2016



(i) Tension in the string = $0.2g\,N = 1.96\,N$

After P is released



Resolve 90° to slope $Normal - 0.2g\cos 30 = 0$

$Normal = 0.2g\cos 30$

$Friction = \mu R = 0.4 \times 0.2g\cos 30 = 0.6789639166$

For P $0.2g\cos 60 + Tension - Friction = ma$ mass of ball 0.2kg

For Q $Weight - Tension = ma$

So $-0.2g\cos 60 + Weight - Friction = 2ma$

$-0.2g\cos 60 + 0.2g - 0.6789639166 = 2 \times 0.2 \times a$

$\Rightarrow a = 0.7525902055\ ms^{-2}$

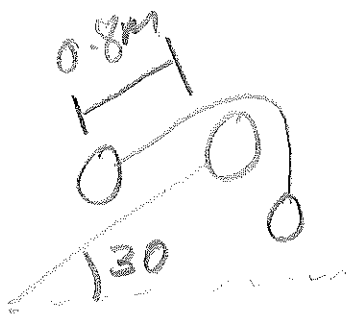
(6)

So weight - Tension = ma

$0.2g - \text{Tension} = 0.2 \times 0.75\ 25902085$

$\Rightarrow$ Tension = 1.809481958N

6. M1 June 2016

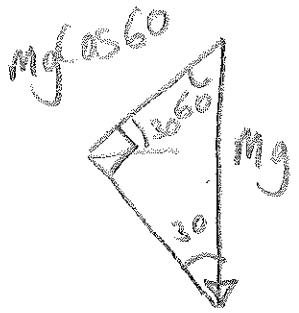


$V = u + at$

$V^2 = u^2 + 2as$

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

(ii) Before Q striked the floor $V = 0$, $u = ?$, $s = 0.8$



Also friction downwards

Force down

$mg\cos 60 + m \times 0.4g\cos 30$

$F = ma$

$F = ma \Rightarrow a = 8.294819583$

$0 = u^2 + 2(-8.294819583 \times 0.8) = 3.643036005$

(iii) Friction $= 0.678963$ Normal $= 0.2g\cos 30$

$= 1.697409791$

$0.678963^2 + 1.697409791^2 = 1.828659544\,N$

7. M1 June 2016

(7)(i) acceleration of A $0.18t$

B variable acceleration 5 seconds then $9\,ms^{-1}$

so time when A velocity $9\,ms^{-1}$ $\int_0^T 0.18t\,dt$

$= \left[\frac{0.18t^2}{2}\right]_0^T = 0.09T^2 = 9 \Rightarrow \underline{\underline{T = 10}}$

(ii) When $t=0$ $s = ut + 0.08t^3$

$\frac{ds}{dt} = u + 3 \times 0.08t^2$

when $t=5$ $\frac{ds}{dt} = 9$ $9 = u + 3 \times 0.08 \times 5^2$

$\Rightarrow u = 3\,ms^{-1}$

so if $t=5$ $s = 3 \times 5 + 0.08 \times 5^3 = 25m$

(iii) Distance B travels $25m + 10 \times 9 + 1 \times \frac{(9 + V_B)}{2}$

Distance A travels velocity $= 0.09t^2$

$\int_0^T 0.09t^2\,dt = \left[0.03t^3 + c\right]_0^T$

when $t=0$ displacement is 0 so $c=0$

$\therefore$ when $t=16$ distance travelled is $0.03 \times 16^3 = 122.88m$

so $122.88 = 25 + 90 + \left(\frac{9 + V_B}{2}\right) \Rightarrow V_B = 6.76\,ms^{-1}$