1(a) (i) Use of $v^2 = u^2 + 2as$ with $u = 0$, $a = (\pm)9.8$, $s = (\pm)160$ M1

$v^2 = 0 + 2 \times 9.8 \times 160$ A1

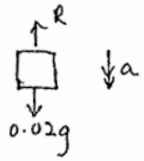
$v = \underline{56\ ms^{-1}}$ A1

(ii) Use of $s = ut + \frac{1}{2}at^2$ with $s = (\pm)160$, $u = 0$, $a = (\pm)9.8$ M1

$(-)160 = \frac{1}{2} \times (-)9.8\, t^2$ ft v A1√

$t = \underline{\frac{40}{7}\ s} = 5\frac{5}{7}$ = 5.71 cao A1

(b)



use of 0.2 for mass mark as M0 A1

(i) Use of N2L dim. correct M1

$0.02g - 0.096 = 0.02a$ A1

$a = \underline{5\ ms^{-2}}$ A1

(ii) Use of $s = ut + \frac{1}{2}at^2$ with $u = 0$, $a = (\pm)5$, $t = 4$ M1

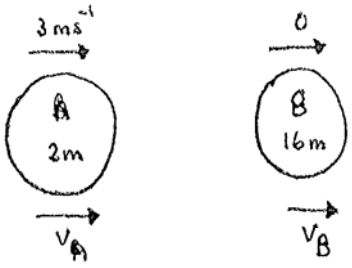
$s = \frac{1}{2} \times 5 \times 4^2$ ft a A1√

$= 40$

∴ Height above ground $= 160 - 40$

$= \underline{120\ m}$ A1√

2(a)



Conservation of momentum — allow mixed units M1

$2\times3(m) + 16\times0(m) = 2V_A(m) + 16V_B(m)$ A1

$V_A + 8V_B = 3$

Restitution — allow mixed units M1

$V_B - V_A = -\frac{1}{2}(0-3)$ A1

$-V_A + V_B = \frac{3}{2}$

Adding

$9V_B = \frac{9}{2}$ dep on both Ms m1

$V_B = \frac{1}{2}$ ms^{-1} ft 1slip A1

$V_A = V_B - \frac{3}{2}$

$= -1$ ms^{-1} ft 1slip A1

Allow V_A going to left.
Consistent equations

(b) Impulse $I = 2\cdot m(-1-3)$ M1

$= -8m$ Ns allow no − A1√ B1

In the direction opposite to the original motion of A A1

3 (a) $T = \frac{600}{20}$

$= \underline{30}$ B1

(b) Using $s = ut + \frac{1}{2}at^2$ with $u = 15$, $s = 600$, $t = 30$ M1

$600 = 15 \times 30 + \frac{1}{2}a \times 30^2$ A1

$a = \underline{\frac{1}{3}\ ms^{-2}}$ accept 0·3, 0·33 etc A1

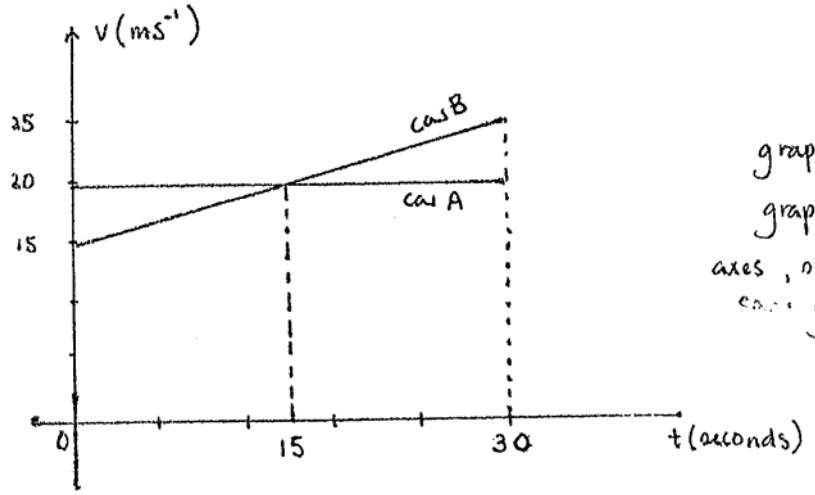
(c) Using $s = \frac{1}{2}(u+v)t$ with $s = 600$, $u = 15$, $t = 30$ M1

$600 = \frac{1}{2}(15+v) \times 30$ A1√

$v = \underline{25\ ms^{-1}}$ cao A1

PA if 0·3 or 0·33 used

(d)



graph A B1 allow any graph

graph B B1√ allow any graph

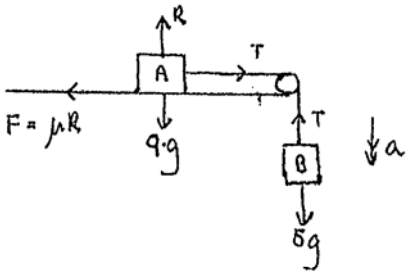
axes, scales etc B1

can't graph

required time when A and B have the same speed is 15 s A

ft d's v B1√

4 (a)



N2L to B	$T = 5g = 49$	B1
N2L to A	$T = F = 49$	B1
Resolve ↑ for A	$R = 9g = 88.2$	B1
System in equilibrium	$F \leq \mu R$	for $F = \mu R$ used M1
	$\mu \geqslant \frac{5g}{9g} = \frac{5}{9}$	(or $\leqslant$) A1

(b)

$R = 9g = 88.2$

$F = \mu R$

$= 0.5 \times 9 \times 9.8$

$= 4.5g = 44.1$ B1

N2L to B	$5g - T = 5a$	M1 A1
N2L to A	$T - F = 9a$	M1 A1
	$T - 4.5g = 9a$	

Adding $5g - 4.5g = 14a$ dep on both Ms. M1

$a = \frac{0.5 \times 9.8}{14}$

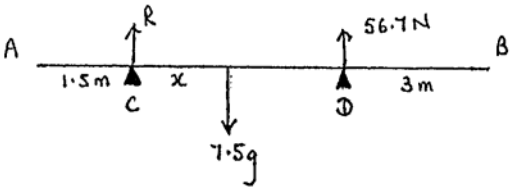
$= \underline{0.35\ ms^{-2}}$ A1

$T = 9 \times 0.35 + 4.5 \times 9.8$

$= \underline{47.25\ N}$ cao A1

dep. only on one M

5.



(a) Moment about C

$7.5g\,x = 56.7 \times (5 - 1.5)$ — dim. correct M1

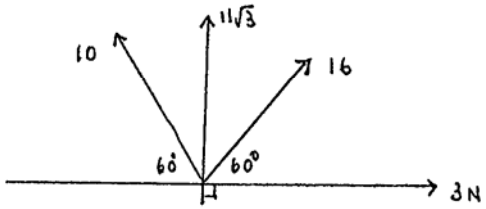
$x = \underline{2.7\text{ m}}$. A1 B1

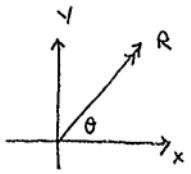
cao A1

(b) Resolve ↑ $R + 56.7 = 7.5g$ M1

$R = \underline{16.8\text{ N}}$ A1

6.





Resolve → $X = 3 + 16\cos 60° - 10\cos 60°$ Resolving M1 A1 all terms (not =) A1

$= \underline{6\text{ N}}$

Resolve ↑ $Y = 11\sqrt{3} + 10\sin 60° + 16\sin 60°$ Resolving M1 A1 all terms (not =) A1

$= \underline{24\sqrt{3}\text{ N}} = 41.5692$

$R = \sqrt{6^2 + (24\sqrt{3})^2}$ M1

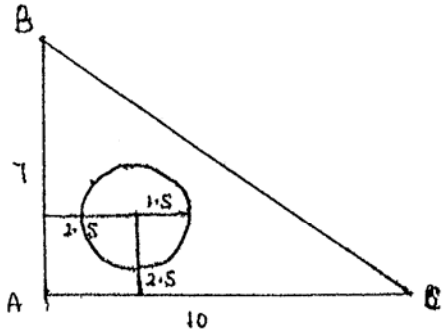
$= \underline{42\text{ N}}$ ft X, Y A1√

penalise PA.

$\tan\theta = \frac{24\sqrt{3}}{6}$ M1

$\theta = \underline{81.8°}$ ft X, Y. A1√

7.



			from AB	from AC	
(a)	ΔABC	35	$\frac{10}{3}$	$\frac{7}{3}$	B1 B1 B1 (Areas)
	Circle	$\pi\left(\frac{3}{2}\right)^2 = 7{\cdot}069$	$\frac{5}{2}$	$\frac{5}{2}$	B1
	Lamina	$35 - \frac{9}{4}\pi = 27{\cdot}92$	x	y	

(i) $35 \times \frac{10}{3} = \frac{9}{4}\pi \times \frac{5}{2} + \left(35 - \frac{9}{4}\pi\right)x$ M1 A1√

$x = \underline{3{\cdot}54}$ cao A1

(ii) $35 \times \frac{7}{3} = \frac{9}{4}\pi \times \frac{5}{2} + \left(35 - \frac{9}{4}\pi\right)y$ M1 A1√

$y = \underline{2{\cdot}29}$ cao. A1

(b) Required angle $\theta = \tan^{-1}\left(\frac{2{\cdot}29}{3{\cdot}54}\right)$ M1

$= \underline{32{\cdot}9^\circ}$ ft x, y. A1√