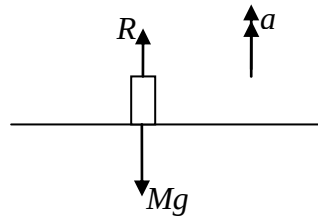


M1

Q	Solution	Mark	Notes
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1.



N2L applied to man

M1 R and Mg opposing.
dim correct

$$R - Mg = Ma$$

A1

$$680 = M(9.8 + 0.2)$$

$$M = \underline{68}$$

A1 cao

N2L applied to Lift and Man

M1 T and weight opposing.
dim correct.

$$T - 1868g = 1868a$$

A1 ft M

$$T = \underline{18680 \text{ (N)}}$$

A1 ft M

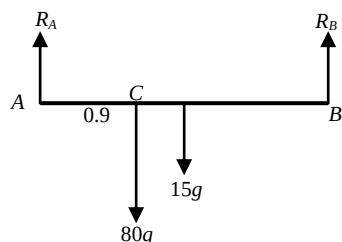
Q	Solution	Mark	Notes
2.	Apply N2L to B	M1	dim correct, all forces.
	$5g - T = 0$	A1	allow $5a$ RHS $5g$ and T opposing.
	Resolve perpendicular to plane for A	M1	allow sin
	$R = 4g \cos \alpha$	A1	
	Apply N2L to A	M1	Friction opposes motion.
	$T - 4g \sin \alpha - F = 0$	A1	Allow $4a$ RHS and/or cos
	At limiting equilibrium $F = \mu R$	M1	used
	$\mu = \frac{F}{R} = \frac{45g}{48g} = \frac{15}{16}$	A1	convincing
	$T = 5g = 49$		
	$F = T - 4g \sin \alpha = \frac{45g}{13} = \frac{441}{13} = 33.9231$		
	$R = 4g \times \frac{12}{13} = \frac{48g}{13} = \frac{2352}{65} = 36.1846$		

Q	Solution	Mark	Notes
3(a)	Conservation of momentum	M1	attempted, equation, dim correct.
	$3 \times 8 + 5 \times 2 = 3v_A + 5v_B$	A1	
	$3v_A + 5v_B = 34$		
	Restitution	M1	
	$v_B - v_A = -\frac{1}{3}(2 - 8)$	A1	
	$v_B - v_A = 2$		
	$3v_A + 5v_B = 34$		
	$-3v_A + 3v_B = 6$		
	Adding	m1	dep on both M's
	$8v_B = 40$		
	$v_B = \underline{5 \text{ (ms}^{-1}\text{)}}$	A1	cao
	$v_A = \underline{3 \text{ (ms}^{-1}\text{)}}$	A1	cao
3(b)	Impulse = change of momentum	M1	used
	$I = 5 \times 5 - 5 \times 2 = \underline{15 \text{ (Ns)}}$	A1	ft v_A or v_B

Q	Solution	Mark	Notes
4	Moments about x-axis $= 5 \times (-1) + 2 \times (3) + 3 \times 5 + 6 \times 0$ $16y = 16$ $y = 1$	B1 M1 A1	si cao
	Moments about y-axis $= 5 \times 4 + 2 \times 2 + 3 \times (-2) + 6 \times (-3)$ $16x = 0$ $x = 0$	B1 M1 A1	si cao

Q	Solution	Mark	Notes
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5(a)



Moments about A

$$2.8R_B = 80g \times 0.9 + 15g \times 1.4$$

$$R_B = \underline{325.5 \text{ (N)}}$$

Vertical forces in equilibrium

$$R_A + R_B = 80g + 15g$$

$$R_A = \underline{605.5 \text{ (N)}}$$

M1 3 terms, dim correct
Equation required
A1 correct equation
B1 any correct moment

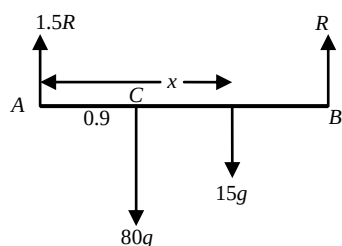
A1 cao

M1 all forces, no extra

A1

A1 cao

5(b)



Resolve vertically

$$1.5R + R = 95g$$

$$R = 38g$$

Moments about A

$$2.8 \times R = 80g \times 0.9 + 15g \times x$$

$$x = \frac{172}{75} = \underline{2.3 \text{ (m)}}$$

M1

A1

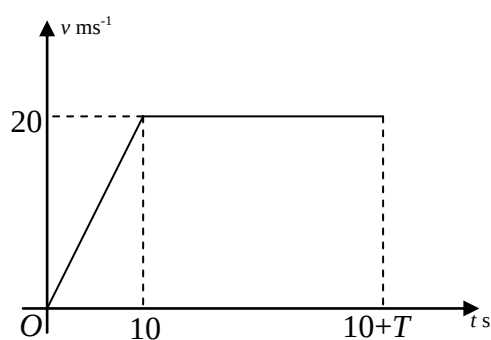
M1 3 terms, dim correct

A1 oe

A1 cao

Q	Solution	Mark	Notes
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6(a)



B1	labels, units and shape
B1	(0, 0) to (10, 20)
B1	(10, 20) to (10+T, 20)

6(b) $v = u + at$, $v=20$, $u=0$, $t=10$
 $20 = 0 + 10a$
 $a = \underline{2 \text{ (ms}^{-2}\text{)}}$

M1
A1

6(c) Total distance = area under graph
 $D = 0.5 \times 10 \times 20 + 20T$
 $D = 100 + 20T \text{ (m)}$

M1	attempted
B1	one correct area
A1	cao

6(d) $s = ut + 0.5at^2$, $u=0$, $t=5+T$, $a=2$
 $s = 0.5 \times 2 \times (5+T)^2$
 $D = 25 + 10T + T^2$

M1
A1

$25 + 10T + T^2 = 100 + 20T$
 $T^2 - 10T - 75 = 0$
 $(T + 5)(T - 15) = 0$
 $T = 15$
 $D = \underline{400 \text{ (m)}}$

M1	Ft exp for D in (d) and (c)
A1	cao
A1	cao

Q	Solution	Mark	Notes
7	Resolve in 80 N direction $80 = P\cos 60^\circ + Q\cos 45^\circ$	M1 A1	Equation required
	Resolve in 25 N direction $25 = P\sin 60^\circ - Q\sin 45^\circ$	M1 A1	Equation required
	$160 = P + Q\sqrt{2}$ $50 = P\sqrt{3} - Q\sqrt{2}$		
Adding	$(1 + \sqrt{3})P = 210$ $P = \underline{76.9}$ $Q = \underline{58.8}$	m1 A1 A1	dep on both M's cao cao penalise once if not 1 d.p.

Q	Solution	Mark	Notes
8(a)	Use of $v^2=u^2+2as$ with $u=(\pm)2.1, a=(\pm)9.8,$ $s=(\pm)4.$ $v^2 = 2.1^2 + 2 \times 9.8 \times 4$ $v = 9.1$ speed of rebound $= 9.1 \times \frac{4}{7}$ $= \underline{5.2 \text{ (ms}^{-1}\text{)}}$	M1 A1 A1 m1 A1	allow - convincing
8(b)	We require smallest n st $\left(\frac{4}{7}\right)^n \times 9.1 < 1$ 4 bounces	M1 A1	oe, si trial & error

Q	Solution				Mark	Notes
9	<i>BCD</i>	45	19	(5)	B1	for 19
	<i>ABDE</i>	160	8	(5)		
	Circle	9π	7	(5)	B1	both 8 and 7 required
	Lamina	$205-9\pi$	x	(y)	B1	expressions for areas, oe
	Moments about <i>AE</i>				M1	
	$(205-9\pi)x + 9\pi \times 7 = 160 \times 8 + 45 \times 19$				A1	signs correct. Ft table if at least one B1 for c of m gained.
	$x = \underline{10.96}$				A1	cao
	$y = \underline{5}$				B1	