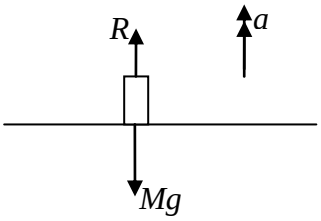
M1

Q	Solution	Mark	Notes
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*

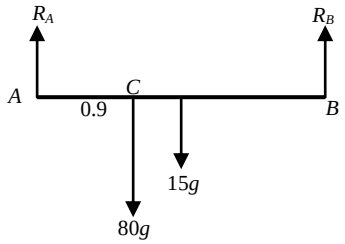
Q	Solution	Mark	Notes
2.	Apply N2L to B	M1	dim correct, all forces. allow $5a$ RHS
	$5g - T = 0$	A1	$5g$ and T opposing.
	Resolve perpendicular to plane for A	M1	allow sin
	$R = 4g\cos\alpha$	A1	
	Apply N2L to A	M1	Friction opposes motion. Allow $4a$ RHS and/or cos
	$T - 4g\sin\alpha - F = 0$	A1	
	At 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.
	$3\times8 + 5\times2 = 3v_A + 5\,v_B$	A1	
	$3v_A + 5\,v_B = 34$		
	Restitution	M1	
	$v_B - v_A = -\frac{1}{3}(2-8)$	A1	
	$v_B - v_A = 2$		
	$3v_A + 5\,v_B = 34$		
	$-3v_A + 3v_B = 6$		
Adding		m1	dep on both M's
	$8v_B = 40$		
	$v_B = \underline{5\ (\text{ms}^{-1})}$	A1	cao
	$v_A = \underline{3(\text{ms}^{-1})}$	A1	cao
3(b)	Impulse = change of momentum	M1	used
	$I = 5\times5 - 5\times2 = \underline{15\ (\text{Ns})}$	A1	ft v_A or v_B

Q	Solution	Mark	Notes
4	Moments about x-axis		
	$=5\times(-1) + 2\times(3) + 3\times5 + 6\times0$	B1	
	$16y = 16$	M1	si
	$y = 1$	A1	cao
	Moments about y-axis		
	$=5\times4 + 2\times2 + 3\times(-2) + 6\times(-3)$	B1	
	$16x = 0$	M1	si
	$x = 0$	A1	cao

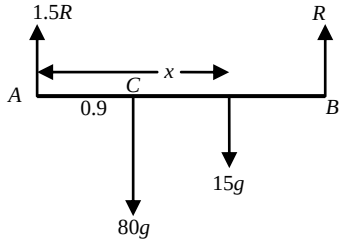
Q	Solution	Mark	Notes

5(a)

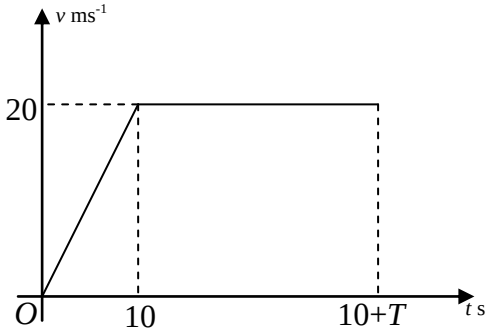


Moments about A	M1	3 terms, dim correct Equation required
$2.8R_B = 80g\times0.9 + 15g\times1.4$	A1 B1	correct equation any correct moment
$R_B =$ 325.5 (N)	A1	cao
Vertical forces in equilibrium	M1	all forces, no extra
$R_A + R_B = 80g + 15g$	A1	
$R_A =$ 605.5 (N)	A1	cao

5(b)



Resolve vertically	M1	
$1.5R + R = 95g$	A1	
$R = 38g$		
Moments about A	M1	3 terms, dim correct
$2.8\times R = 80g\times0.9 + 15g\times x$	A1	oe
$x = \frac{172}{75} =$ 2.3 (m)	A1	cao

Q	Solution	Mark	Notes
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	M1	
	$20 = 0 + 10a$		
	$a = \underline{2\ (\text{ms}^{-2})}$	A1	
6(c)	Total distance = area under graph	M1	attempted
	$D = 0.5 \times 10 \times 20 + 20T$	B1	one correct area
	$D = 100 + 20T$ (m)	A1	cao
6(d)	$s = ut + 0.5at^2$, u=0, t=5+T, a=2	M1	
	$s = 0.5 \times 2 \times (5+T)^2$	A1	
	$D = 25 + 10T + T^2$		
	$25 + 10T + T^2 = 100 + 20T$	M1	Ft exp for D in (d) and (c)
	$T^2 - 10T - 75 = 0$		
	$(T + 5)(T - 15) = 0$		
	$T = 15$	A1	cao
	$D = \underline{400\ (\text{m})}$	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		m1	dep on both M's
	$(1 + \sqrt{3})P = 210$		
	$P = \underline{76.9}$	A1	cao
	$Q = \underline{58.8}$	A1	cao penalise once if not 1 d.p.

Q	Solution	Mark	Notes
8(a)	Use of $v^2=u^2+2as$ with $u=(\pm)2.1, a=(\pm)9.8,$ $s=(\pm)4$.	M1	
	$v^2 = 2.1^2+2\times9.8\times4$	A1	
	$v = 9.1$	A1	allow -
	speed of rebound $= 9.1 \times \frac{4}{7}$	m1	
	$= \underline{5.2\ (\text{ms}^{-1})}$	A1	convincing
8(b)	We require smallest n st $\left(\frac{4}{7}\right)^n \times 9.1 < 1$	M1	oe, si trial & error
	4 bounces	A1	

Q	Solution				Mark	Notes
9	*BCD*	45	19	(5)	B1	for 19
	ABDE	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 *AE*				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	