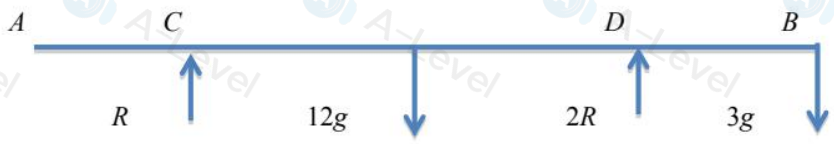
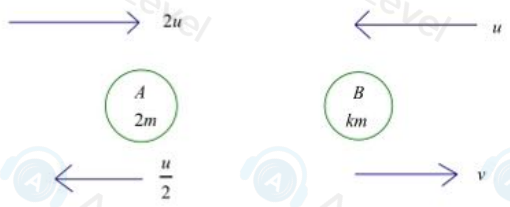
Q	Scheme	Marks	Notes
2a	Resolve vertically or take moments	M1	**First** equation in R_C and/or R_D. Dimensionally correct, correct no. of terms. Condone sign errors. **N.B.** $3Rc + 2R_D = 75g$ or $5Rc = 75g$ are both M0A0 unless they recover.
			N.B. They may use: $R_C = 2R$ and $R_D = 3R$ so $5R = 75g$ is M1A1
	$\updownarrow R_C + R_D = 50g + 25g\,(= 75g)$	A1	Correct unsimplified equation but A0 if they assume $R_C = R_D$. **N.B.** This mark can be awarded even if they clearly have $R_C = 3X$ and $R_D = 2X$ oe
	Form a moments equation or resolve vertically	M1	**Second** equation in R_C and/or R_D. Dimensionally correct, correct no. of terms. Condone sign errors
	M(D): $50gx + 25g \times 1.2 = 3.3R_C$ M(A): $0.9R_C + 4.2R_D = 3 \times 25g + (4.2 - x)50g$ M(B): $5.1R_C + 1.8R_D = 3 \times 25g + (1.8 + x)50g$ M(C): $3.3R_D = 2.1 \times 25g + (3.3 - x)50g$ M(E): $2.1R_C = (x - 1.2)50g + 1.2R_D$ M(G): $R_D x = 25g(x - 1.2) + R_C(3.3 - x)$	A1	Correct unsimplified equation in R_D or R_C seen but give A0 if the equation is incorrect e.g if they put $3R$ (in place of R_C) straight into the equation. A0 if they assume $R_C = R_D$.
	$(2R_D = 3R_C \Rightarrow R_C = 30g)$ $50x + 30 = 99$	M1	Complete method, using either $2R_D = 3R_C$ or $2R_C = 3R_D$ to find an equation in x only
	$x = \frac{69}{50} = 1.38$ * **N.B.** Two **correct** equations and use of $2R_C = 3R_D$ leads to $x = 2.37$ and could score max : M1A1M1A1M1A0*	A1*	Obtain given answer from correct working, with no incorrect equations seen.
		[6]	
2b	Complete method to form an equation in M only.	M1	e.g. moments about D or vertical resolution and

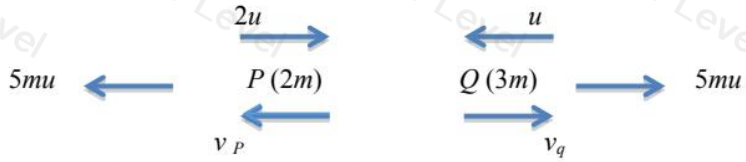
			moments about another point or two moments equations. Dimensionally correct equation. Condone sign errors
	M(D) $25g\times1.2+50g\times1.38=1.8Mg$ **OR any two of :** $(50+25+M)g=R_D$ M(A) $4.2R_D=3\times25g+(4.2-1.38)50g+6Mg$ M(B) $1.8R_D=3\times25g+(1.8+1.38)50g$ M(C) $3.3R_D=2.1\times25g+(3.3-1.38)50g+5.1Mg$ M(E) $3Mg=(1.38-1.2)50g+1.2R_D$ M(G) $R_D\times1.38=25g(1.38-1.2)+Mg(1.38+1.8)$ **AND** R_D eliminated	A1	Correct unsimplified equation in M
	(M) = 55	A1	Correct only
		[3]	
		(9)	

Question Number	Scheme	Marks
3.	 $(\uparrow)\quad R+2R=12g+3g$ $M(A),\quad 2Rx+3R=12g.4+3g.8$ $x=5.7$	M1 A2 M1 A2 A1 **7**
	Notes	
	First M1 for either a vertical resolution (with correct of terms) or a moments equation (all terms dim correct and correct no. of terms) First A1 and Second A1 for a correct equation in R (or S where $S = 2R$) only or R and x only or S and x only. (-1 each error , A1A0 or A0A0) Second M1 for either a vertical resolution (with correct of terms) or a moments equation (all terms dim correct and correct no. of terms) Third A1 and Fourth A1 for a correct equation in R (or S where $S = 2R$) only or R and x only or S and x only. (-1 each error, A1A0 or A0A0) Fifth A1 for $x = 5.7$ oe **N.B. On ePen, first 3 marks are for a vertical resolution, if it appears, second 3 marks are for a moments equation.** **If no vertical resolution, award marks as they appear for the (two) moments equation(s).** **(i)** In a moments equation, if R and $2R$ (or S and $0.5S$) are interchanged, treat as 1 error. **(ii)** Ignore diagram if it helps the candidate. **(iii)** If an equation is correct but contains both R and S, treat as 1 error. **(iv)** Full marks possible if all g's omitted. **(v)** For inconsistent omission of g, penalise each omission. $M(B),\ R\times 5+S(8-x)=12g\times 4$ $M(C),\ S(x-3)=12g\times 1+3g\times 5$ $M(D),\ R(x-3)+3g(8-x)=12g(x-4)$ **N.B. If they use a different variable, other than *x, for a length, with it clearly marked on the diagram,* they can score all the marks for any moments equation.**	

Question Number	Scheme	Marks
3a		
	Impulse on $A \quad = 2m\left(\frac{u}{2}-(-2u)\right)$	M1A1
	Magnitude of impulse $= 5mu$	A1
		(3)
3b	CLM: $2m\times 2u - km\times u = 2m\times\left(-\frac{u}{2}\right)+kmv$	M1A1
	Use of $v>0$: $kmv = 5mu - kmu > 0$	**DM**1
	$\Rightarrow k<5$ **Given Answer**	A1
		(4)
3b alt	**Alternative**: Impulse on B: $5mu = km\left(v-(-u)\right)$ M1A1	
	$v=\frac{5u}{k}-u$ **OR** $k=\frac{5u}{u+v}$	
	Use of $v>0$: $\frac{5u}{k}-u>0\Rightarrow k<5$ **OR** if $v>0$, then $k<5$ **Given Answer** **DM**1A1	
	(4)	
		[7]
	Notes for question 3	
3a	M1 for using impulse = change in momentum for A (M0 if *clearly* adding momenta or if g is included or if not using $2m$ in *both* terms) but condone sign errors.	
	First A1 for $2m\left(\frac{u}{2}-(-2u)\right)$ or $-2m\left(\frac{u}{2}-(-2u)\right)$	
	Second A1 for $5mu$ (must be positive since magnitude) terms collected	
3a alt	**Alternative**: Use CLM to find $v=\frac{5u}{k}-u$ then use Impulse on B: = km ((5u/k - u) + u) M1A1 for the <u>complete</u> method = $5mu$ A1	
3b	First M1 for CLM with correct no. of terms, all dimensionally correct. Condone consistent g's or cancelled m's and sign errors.	
	First A1 for a correct equation (allow $-v$ in place of v)	
	Second **DM**1 for use of $v>0$ or $v<0$ as appropriate	
	Second A1 for given answer correctly obtained.	

Question Number	Scheme	Marks
3balt	First M1 for using their impulse on A = change in momentum for B (M0 if *clearly* adding momenta or if g is included or if not using km in *both* terms) but condone sign errors.	
	First A1 for a correct equation (allow $-v$ in place of v)	
	Second **DM**1 for use of $v > 0$ or $v < 0$, as appropriate, but must be from a correct v or k, to deduce given answer.	
	Second A1 for given answer correctly obtained.	

Question Number	Scheme	Marks	Notes
4 (a)	(i) $M(D)\ 3R_C + 1\times 3g = 2\times 4g + 5\times 2g$	M1	e.g.Take moments about D – requires all 4 terms of the correct form, but condone sign errors. 1x need not be seen
		A1	Correct unsimplified equation
	$R_C = 5g$ or 49 N	A1	
	(ii) $R(\uparrow)\ R_C + R_D = 4g + 2g + 3g$	M1	e.g.Resolve vertically to form an equation in R_C and R_D, requires all 5 terms
		A1	Correct unsimplified equation
	$R_D = 4g$ or 39 or 39.2N	A1 (6)	
Alt	$M(A)\ 3\times 4g + 6\times 3g = 2R_C + 5R_D\ (=30g)$	M1A1	Two equations – M1A1 for each
	$M(B)\ 3\times 4g + 6\times 2g = R_D + 4R_C\ (=24g)$	M1A1	
	$M(C)\ 3R_D + 2\times 2g = 1\times 4g + 4\times 3g$		
	$M(\text{centre})\ 3g\times 3 + R_C = 2R_D + 2g\times 3$		
	$R_C = 5g$ or 49 N, $R_D = 4g$ or 39 or 39.2N	A1,A1	Solve simultaneously for R_C and R_D
(b)	$M(D)\ 3R_C + xg = 8g + 10g \quad (3R_C = (18-x)g)$	M1	First equation in x and R (or R_C and R_D) – correct terms required but condone sign slips.
	$R(\uparrow)\ R_C + R_D = 4g + 2g + xg$	M1	A second equation, correct terms required but condone sign slips.
	Alternatives: $M(B)\ 4R_C + R_D = 12g + 12g$		
	$M(A): 2R_C + 5R_D = 6xg + 3\times 4g$		
	$M(C): 2\times 2g + 3R_D = 4xg + 1\times 4g$		
	$2(18-x)g = 3(6+x)g$	DM1	Use $R_C = R_D$ and solve for x. (as far as $x =$…..) Dependent on the two previous M marks.
	$x = 3.6$	A1 (4) **[10]**	

Question Number	Scheme	Marks
1.(a)	 $5mu = 2m(v_P - -2u)$ $v_P = \frac{1}{2}u$	M1 A1 A1 (3)
(b)	Reversed	B1 (1)
(c)	$5mu = 3m(v_Q - -u)$ $v_Q = \frac{2}{3}u$ **OR** $2m2u - 3mu = -2m\frac{1}{2}u + 3m\ v_Q$ $v_Q = \frac{2}{3}u$	M1 A1 A1 (3) **OR** M1 A1 A1 (3) **7**
	Notes	
1.(a)	First M1 for a complete method to find v_P (M0 for CLM only, with 2 unknowns) for use of $5mu$ = change in momentum of P (must have $2m$ in both terms) (M0 if *clearly* adding momenta) but condone sign errors. First A1 for a correct equation in v_P only. Second A1 for ½ u (A0 if –ve)	
1.(b)	B1 for reversed – only allow if ½ u or - ½ u has been correctly obtained in (a). Allow: '(Yes) it has' but NOT just 'Yes' nor 'has been changed' nor just "opposite"	
1.(c)	First M1 for a complete method to find v_Q (M0 for CLM only, with 2 unknowns) for use of $5mu$ = change in momentum of Q (must have $3m$ in both terms) (M0 if *clearly* adding momenta) but condone sign errors. First A1 for a correct equation in v_Q only. Second A1 for $\frac{2}{3}u$ or $0.67u$ or better (A0 if –ve) **OR** First M1 for a complete method to find v_Q for use of CLM with correct no. of terms and their v_P (M0 for CLM only, with 2 unknowns) but condone sign errors. First A1 for a correct equation in v_Q only. Second A1 for $\frac{2}{3}u$ or $0.67u$ or better (A0 if –ve) **N.B.** They may find v_Q first i.e. do (c) first, then use CLM in (a).	