Moments - Answers

June 2017 Mathematics Advanced Paper 1: Mechanics 1

1.

Question Number	Scheme	Marks
3(a)		
	$(-)\ R+5R=75g+30g+75g$	
	$M(A)\quad 75gx+75g2x+30g\times3=5R\times4$	M1 A2
	$x=\frac{34}{15}=2.3$ or better	M1 A2
		A1
	(N.B. Or another Moments Equation)	(M1 A2)
		(7)
(b)	uniform – mass is or acts at midpoint of plank; centre of mass is at middle of plank; weight acts at the middle of the plank, centre of gravity is at midpoint	B1 B1
		(2)
	rod - plank does not bend, remains straight, is inflexible, is rigid	
		9

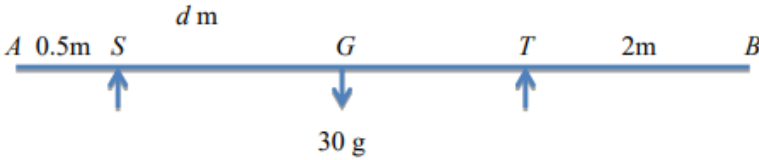|	Notes	
(a)	First M1 for either a vertical resolution (with correct of terms) or a moments equation (all terms dim correct and correct no. of terms) First A1 and Second A1 for a correct equation in R (or S where $S = 5R$) only or R and x only or S and x only. (-1 each error , A1A0 or A0A0) Second M1 for 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 $S = 5R$) only or R and x only or S and x only. (-1 each error, A1A0 or A0A0) Fifth A1 for $x = {}^{34}/_{15}$ oe or 2.3 (or better) **(i)** In a moments equation, if R and $5R$ (or S and $0.2S$) 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, or $S = 5R$ is never used, treat as 1 error. **(iv)** Full marks possible if all g's omitted. **(v)** For inconsistent omission of g, penalise each omission. $M(B), R \leftrightarrow 6 + 5R \leftrightarrow 2 = 75g(6-x) + 75g(6-2x) + 30g \leftrightarrow 3$ $M(C), 75g(4-x) + 75g(4-2x) + 30g \leftrightarrow 1 = R \leftrightarrow 4$ $M(G), 75g(3-x) + 5R \leftrightarrow 1 = R \leftrightarrow 3 + 75g(2x-3)$ $M(P), Rx + 30g(3-x) + 75gx = 5R(4-x)$ $M(Q), 75gx + 30g(2x-3) + 5R(4-2x) = R \leftrightarrow 2x$	
(b)	First B1 for first correct answer seen. Second B1 for the other answer, but only award this second mark if no extras given.	

2.

Question Number	Scheme	Marks
4	$$F = \mu R$$ $(\nwarrow), \quad R = 10\sin\alpha + 5g\cos\alpha \quad (45.2)$ $(\nearrow), \quad F = 5g\sin\alpha - 10\cos\alpha \quad (21.4)$ $$\mu = \frac{g\sin\alpha - 2\cos\alpha}{2\sin\alpha + g\cos\alpha} = 0.47 \text{ or } 0.473$$	B1 M1 A2 M1 A2 M1 A1 **9**
	Notes	
	B1 for $F = \mu R$ seen or implied First M1 for resolving perpendicular to the plane with usual rules First and second A1's for a correct equation. A1A0 if one error. Second M1 for resolving parallel to the plane with usual rules Third and fourth A1's for a correct equation. A1A0 if one error. If m is used instead of 5, penalise once in each equation. Third M1 <u>independent</u> for eliminating R to produce an equation in μ only. Does not need to be $\mu = ...$ Fifth A1 for 0.47 or 0.473.	

3.

Question Number	Scheme	Marks
5.	$$\mu R$$ $$R = 2g\cos 20° + 40\cos 60°$$ $$F = 40\cos 30° - 2g\cos 70°$$ $$\mu = \frac{40\cos 30° - 2g\cos 70°}{2g\cos 20° + 40\cos 60°}$$ $$= 0.73 \text{ or } 0.727$$	B1 M1 A2 M1 A2 M1 M1 A1
		10

	Notes	
5.	B1 for μR seen or implied.	
	First M1 for resolving perpendicular to the plane with usual rules (must be using 2(g) with 20^0 or 70^0 and 40 with 30^0 or 60^0)	
	First and second A1's for a correct equation. A1A0 if one error	
	Second M1 for resolving parallel to the plane with usual rules (must be using 2(g) with 20^0 or 70^0 and 40 with 30^0 or 60^0)	
	Third and fourth A1's for a correct equation. A1A0 if one error	
	Third M1 <u>independent</u> for eliminating R to produce an equation in μ only. Does not need to be $\mu = \dots$	
	Fourth M1 <u>independent</u> for solving for μ	
	Fifth A1 for 0.727 or 0.73	
	N.B. They may choose to resolve in 2 other directions e.g. horizontally and vertically.	
	N.B. If F is replaced by $-F$ in the second equ^n, treat this as an error unless they subsequently explain that they have their F acting in the wrong direction, in which case they could score full marks for the question.	

4.

Question Number	Scheme	Marks
6.	d m A 0.5m S G T 2m B 30 g $M(S)$: $Mg \leftrightarrow 0.5 = 30g(d-0.5)$ $M(T)$: $Mg \leftrightarrow 2 = 30g(4-d)$ dividing: $4 = \dfrac{(4-d)}{(d-0.5)}$ => (i) $d = 1.2$ => (ii) $M = 42$	M1 A1 M1 A1 DM1 A1 A1

6.	**Notes**	
	N.B. They may use a different variable, other than d, in their moments equations e.g. say they use $x = SG$ consistently, they can score all the marks for their two equations and if they eliminate x correctly, DM1 A1 (for M), and, if they found x correctly, then added 0.5 to obtain d, the other A1 also.	
	First M1 for moments about S (need correct no. of terms, so if they don't realise that the reaction at T is zero it's M0) *to give an equation in d and M only*.	
	First A1 for a correct first equation *in d and M only*. (A1 for both g's or no g's but A0 if one g is missing)	
	N.B. They may use 2 equations and eliminate to obtain their equation *in d and M only* e.g. $M(A)$ $0.5R_S = 30gd$ and (^) $R_S = 30g + Mg$ and then eliminate R_S. The M mark is only earned once they have produced an equation *in d and M only,* with all the usual rules about correct no. of terms etc applying to all the equations they use to obtain it.	
	Second M1 for moments about T (need correct no. of terms, so if they don't realise that the reaction at S is zero it's M0) *to give an equation in d and M only*	
	Second A1 for a correct second equation *in d and M only*. (A1 for both g's or no g's but A0 if one g is missing)	
	N.B. They may use 2 equations and eliminate to obtain their equation *in d and M only* e.g. $M(B)$ $2R_T = 30g(6 - d)$ and (^) $R_T = 30g + Mg$ and then eliminate R_T. The M mark is only earned once they have produced an equation *in d and M only,* with all the usual rules about correct no. of terms etc applying to all the equations they use to obtain it.	

	Third M1, <u>dependent on 1st and 2nd M marks</u>, for eliminating either M or d to produce an equation in either d only or M only.	
	Third A1 for $(d =)$ 1.2 oe (**N.B.** Neither this A mark nor the next one can be awarded <u>if there are any errors in the equations</u>.) **Beware:** If one g is missing consistently from each of their equations, they can obtain $d = 1.2$ but award A0	
	Fourth A1 for $(M =)$ 42	
	Scenario 1: Below are the possible equations, (if they don't use *M(S)*), any two of which can be used, by eliminating R_S , to obtain an equation *in d and M only* , for the first M1. N.B. If R_T appears in any of these and doesn't subsequently become zero then it's M0.	
	M(A) $0.5R_S = 30gd$	
	M(B) $5.5R_S = 30g(6 - d) + 6Mg$	
	M(T) $3.5R_S = 30g(4 - d) + 4Mg$	
	(^) $R_S = 30g + Mg$	
	Scenario 2: Below are the possible equations, (if they don't use *M(T)*), any two of which can be used, by eliminating R_T, to obtain an equation *in d and M only* , for the second M1. N.B. If R_S appears in any of these and doesn't subsequently become zero then it's M0.	
	M(A) $4R_T = 30gd + 6Mg$	
	M(B) $2R_T = 30g(6 - d)$	
	M(S) $3.5R_T = 30g(d - 0.5) + 5.5Mg$	
	(^) $R_T = 30g + Mg$	

5.

Question Number	Scheme	Marks
3	$T_P \cos 55 = T_Q \cos 35$	M1 A1
	$T_P \sin 55 + T_Q \sin 35 = 2g$	M1 A1
	Eliminating T_P or T_Q	M1
	$T_P = 16$N or 16.1N; $T_Q = 11$N or 11.2N	A1 A1
		7
ALT 1	$\left(\text{Along } RP \right) T_P = 2g \cos 35° = 16$N or 16.1N	M1 M1 A1 A1
	$\left(\text{Along } RQ \right) T_Q = 2g \cos 55° = 11$N or 11.2N	M1 A1 A1
	Notes	
	First M1 for resolving horizontally with correct no. of terms and both T_P and T_Q terms resolved. (M0 if they assume $T_P = T_Q$) First A1 for a correct equation. Second M1 for resolving vertically with correct no. of terms and both T_P and T_Q terms resolved. (M0 if they assume $T_P = T_Q$) Second A1 for a correct equation. Third M1 (independent) for eliminating either T_P or T_Q <u>Third</u> A1 for $T_P = 16$ (N) or 16.1 (N) <u>Fourth</u> A1 for $T_Q = 11$ (N) or 11.2 (N) N.B. If both are given to more than 3SF, deduct the third A1.	

ALT 1	**Alternative 1 (resolving along each string)** First M2 for resolving along one of the strings (e.g. $T_P = 2g\cos35°$) First A1 for a correct equation ($T_P = 2g\sin35°$ scores M2A0A0) Third A1 for $T_P = 16$ (N) or 16.1 (N) Third M1 for resolving along the other string (e.g. $T_Q = 2g\cos55°$) Second A1 for a correct equation ($T_Q = 2g\sin55°$ scores M1A0A0) Fourth A1 for $T_Q = 11$ (N) or 11.2 (N)	

ALT 2	**Alternative 2 (using a Triangle of Forces)**
	Both of the equations in Alternative 1 could come from using *sohcahtoa* or The Sine Rule on a triangle of forces, so mark in the same way.
	Note that, in either case, once they have found either T_P or T_Q, they could then use $T_P = T_Q \tan55°$ or $T_Q = T_P \tan55°$ to find the other one. (Note that both of these are equivalent to the horizontal resolution) or Pythagoras.
	e.g. $T_P = 2g\cos35°$ M2 First A1
	      $= 16$ (N) or 16.1 (N) Third A1
	    $T_Q = T_P \tan 35°$ or $\sqrt{\{(2g)^2 - (T_P)^2\}}$ M1 Second A1
	      $= 11$ (N) or 11.2 (N) Fourth A1	

	N.B. If they are clearly using The Sine Rule but have say 35°, 55° and 80° in their triangle, all 3 M marks would be available and at most 1 A mark e.g. $T_P = \dfrac{2g\sin55}{\sin80}$ M2 A0A0 $T_Q = \dfrac{T_P\sin35}{\sin55}$ M1 SecondA1 A0	

6.

Question Number	Scheme	Marks
5(a)	$T_A + T_C = 85g$ OR $M(A)$, $25g \times 2.5 + 60g \times 5 = 4.5 \times T_C$ OR $M(C)$, $T_A \times 4.5 + 60g \times 0.5 = 25g \times 2$ OR $M(B)$, $T_A \times 5 + T_C \times 0.5 = 25g \times 2.5$ OR $M(G)$, $T_A \times 2.5 + 60g \times 2.5 = 2 \times T_C$ $T_A = \dfrac{40g}{9} = 44$N or 43.6N; $T_C = \dfrac{725g}{9} = 790$N or 789 N	M1 A1 M1 A1 A1; A1 (6)
(b)	$M(C)$, $25g \times 2 = Mg \times 0.5$	M1 A1
(i)	$M = 100$	A1
(ii)	$T_c = 25g + 100g$ $T_c = 125g$ (1200 or 1230)N	M1 A1 B1 (6) 12
	Notes	
5(a)	First M1 for a moments or vertical resolution equation, with correct no. of terms and dimensionally correct. First A1 for a correct equation. Second M1 for a moments equation, with correct no. of terms and dimensionally correct. Second A1 for a correct equation. Third A1 for 44 (N) or 43.6 (N) or 40g/9 Fourth A1 for 790 (N) or 789 (N) or 725g/9 Deduct 1 mark for inexact multiples of g **N.B.** If they assume that both tensions are the same, can only score max M1 in (a) for *M(A)* or *M(C)*. <u>If a vertical resolution is used, please give marks for this equation FIRST. If not, enter marks for each moments equation in the order in which they appear.</u>	
5(b)	<u>**SCHEME CHANGE**</u> B1 BECOMES THE FOURTH A1 First M1 for a moments equation <u>with $T_A = 0$</u> First A1 for a correct equation Second A1 for $M = 100$ Second M1 for a(nother) moments or vertical resolution equation <u>with $T_A = 0$</u> Third A1 for a correct equation Fourth A1 (B1) for $T_C = 125g$ or 1230 (N) or 1200 (N) *N.B. Some candidates may need to solve 2 simult. equations in M and T_C and so will earn the 'equation' marks before they earn Second and Fourth A (B) marks.* <u>If a vertical resolution is used, please give marks for this equation SECOND. If not, enter marks for each moments equation in the order</u>	

The possible equations are:
$T_C = 25g + Mg$
M(C), $25g \times 2 = Mg \times 0.5$
M(A), $25g \times 2.5 + 5Mg = 4.5 T_C$
M(B), $25g \times 2.5 = T_C \times 0.5$
M(G), $T_C \times 2 = Mg \times 2.5$

Any two of these can each earn M1A1 (M0 if incorrect no. of terms)
Then Second A1 for $M = 100$
And Fourth A1 (B1) for $T_C = 125g$ or 1230 or 1200

N.B. No marks in (b) if they use any answers from (a) or $M = 60$

7.

Question Number	Scheme	Marks
8(a)	$$R = 4g\cos\alpha$$	M1 A1
	$$T - 0.5g = 0.5a$$	M1 A1
	$$4g\sin\alpha - T - F = 4a$$	M1 A1
	(OR: $4g\sin\alpha - F - 0.5g = 4.5a$)	
	$F = \dfrac{1}{2}R;$ $\sin\alpha = \dfrac{4}{5}$ or $\cos\alpha = \dfrac{3}{5}$	B1; B1
	Eliminating a or finding a	M1
	Solving for T (must have had an a)	M1
	$T = \dfrac{2g}{3}$N or 6.5N or 6.53N	A1
		(11)
(b)	Magnitude $= 2T\cos\left(\dfrac{90 - \alpha}{2}\right)$	M1 A1
	$= 2 \times \dfrac{2g}{3} \times \dfrac{3}{\sqrt{10}}$ (0.94868..)	**A1 ft on T**
	$= 12N$ or 12.4N $\left(\dfrac{4g}{\sqrt{10}}\right)$	A1 (4)
		15

	Notes	
8(a)	First M1 for resolving perp to plane, with usual criteria First A1 for a correct equation Second M1 for resolving vertically, with usual criteria Second A1 for a correct equation, in terms of a and T Third M1 for resolving parallel to the slope, with usual criteria. Third A1 for a correct equation , in terms of a, F and T <u>N.B. Their a could be UP the slope in which case all 4 marks for the 2</u> <u>equations are available with $-a$ replacing a, provided they are</u> <u>consistent. If they are inconsistent, then assume the vertical resolution</u> <u>is the correct one and mark accordingly.</u> Either of the above two equations can be replaced by the 'whole system' equation **N.B. If they use a = 0, in any of the above 3 equations, and they use the equation to find T, they lose both marks for that equation, and they lose the two M marks for eliminating and solving.** First B1 for $F = \frac{1}{2}R$ seen or implied; Second B1 for $\sin\alpha = 0.8$ or $\cos\alpha = 0.6$ seen or implied. Allow close approximations if $\alpha = 53.1°...$ used. Fourth M1 independent for eliminating a or finding a. Fifth M1 for solving for T but must have had an a. Fourth A1 for 2g/3, 6.5 or 6.53.	
(b)	First M1 for a complete method for finding the magnitude of the resultant (**N.B.** M0 if same tensions used) $2T\cos\left(\dfrac{90° - \alpha}{2}\right)$. Allow sin/cos confusion and allow $2T\cos\left(\dfrac{\alpha}{2}\right)$ **OR** $\sqrt{(T + T\sin\alpha)^2 + (T\cos\alpha)^2}$. Allow sin/cos confusion and allow omission of √ sign, but only if $R^2 = $ .... is included **OR** $\sqrt{T^2 + T^2 - 2T^2\cos(90° + \alpha)}$. Allow $(90° - \alpha)$ but must be cos and and allow omission of √ sign, but only if $R^2 = $.......is included **OR** $\dfrac{T\sin(90 + \alpha)}{\sin\left(\dfrac{90° - \alpha}{2}\right)}$. (**Sine Rule**) Allow sign errors in angles but must be sin First A1 for correct expression in terms of T and α Second A1, **ft** on their T, for a 'correct' **single numerical** answer Third A1 cao for 12 (N) or 12.4 (N)	

8.

Question Number	Scheme	Marks
4a	Resolving vertically: $T + 2T(=3T) = W$	M1A1
	Moments about A: $2W = 2T \times d$	M1A1
	Substitute and solve: $2W = 2\dfrac{W}{3}d$	DM1
	$d = 3$	A1
		(6)
b	Resolving vertically: $T + 4T = W + kW$ $\quad (5T = W(1+k))$	M1A1 ft
	Moments about A: $2W + 4kW = 3 \times 4T$	M1A1 ft
	Substitute and solve: $2W + 4kW = \dfrac{12}{5}W(1+k)$	DM1
	$\qquad 2 + 4k = \dfrac{12}{5} + \dfrac{12}{5}k$	
	$\qquad \dfrac{8}{5}k = \dfrac{2}{5},\qquad\qquad k = \dfrac{1}{4}$	A1
		(6)
		[12]

Notes for Question 4

N.B. In moments equations, for the M mark, all terms must be force x distance but take care in the cases when the distance is 1.

Question 4(a)

N.B. If Wg is used, mark as a misread. *If T and 2T are reversed, mark as per scheme NOT as a misread.*

First M1 for an equation in W and T and possibly d (either resolve vertically or moments about any point other than the mid-pt), with usual rules.

First A1 for a correct equation.

Second M1 for an equation in W and T and possibly d (either resolve vertically or moments about any point other than the mid-pt), with usual rules.

Second A1 for a correct equation.

Third M1, dependent on first and second M marks, for solving for d

Third A1 for $d = 3$ cso

N.B. If a single equation is used (see below) by taking moments about the mid-point of the rod, $2T = 2T(d-2)$, this scores M2A2 (-1 each error)

Third M1, dependent on first and second M marks, for solving for d

Third A1 for $d = 3$ cso

N.B. If Wg and kWg are used, mark as a misread.
If they use any results from (a), can score max M1A1 in (b) for one equation.
If T and 4T are reversed, mark as per scheme NOT as a misread.
First M1 for an equation in W and a tension T_1 and possibly their d or their d and k (either resolve vertically or moments about any point), with usual rules.
First A1 **ft** on their d, for a correct equation.
Second M1 for an equation in W and **the same tension** T_1 and possibly their d or their d and k (either resolve vertically or moments about any point), with usual rules.
Second A1 **ft** on their d, for a correct equation.
Third M1, dependent on first and second M marks, for solving to give a numerical value of k
Third A1 for $k = 1/4$ *oe* cso
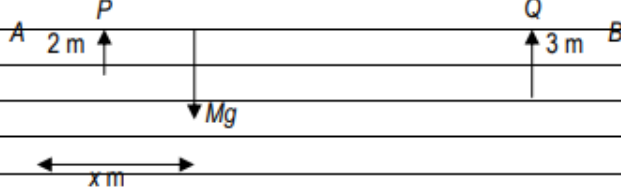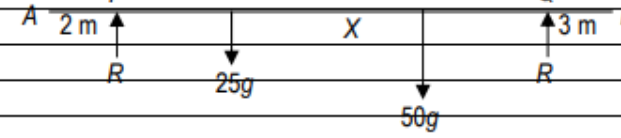
May 2013 Mathematics Advanced Paper 1: Mechanics 1

9.

Question Number	Scheme	Marks
3.	$T\cos\alpha - F = 2g\cos 60^{\circ}$	M1 A1
	$T\sin\alpha + R = 2g\cos 30^{\circ}$	M1 A1
	$F = \frac{1}{3}R$	B1
	eliminating F and R	DM1
	$T = g(1 + \frac{1}{\sqrt{3}})$, 1.6g (or better), 15.5, 15 (N)	DM1 A1
		(8)
		[8]
	Notes for Question 3	
Q3	First M1 for resolving parallel to the plane with correct no. of terms and both T and $2g$ terms resolved. First A1 for a correct equation. (use of α instead of 30° or 60° or vice versa is an A error not M error; similarly if they use sin(3/5) or cos(4/5) when resolving, this can score M1A0) Second M1 for resolving perpendicular to the plane with correct no. of terms and both T and $2g$ terms resolved. Second A1 for a correct equation (use of α instead of 30° or 60° or vice versa is an A error not M error; similarly if they use sin(3/5) or cos(4/5) when resolving, this can score M1A0) B1 for $F = 1/3\, R$ seen or implied. Third M1, dependent on first two M marks and appropriate angles used when resolving in *both* equations, for eliminating F and R. Fourth M1 dependent on third M1, for solving for T Third A1 for 15(N) or 15.5 (N). N.B. The first two M marks can be for two resolutions in any directions. Use of tan α = 4/3 leads to an answer of 17.83…and can score max 7/8.	

10.

Question Number	Scheme	Marks
6.		
(a)		
	M(P), $\quad 50g \times 2 = Mg \times (x-2)$	M1 A1
	M(Q), $\quad 50g \times 3 = Mg \times (12-x)$	M1 A1
(i)	$M = 25$ (kg)	DM1 A1
(ii)	$x = 6$ (m)	DM1 A1
		(8)
(b)		
	$(\uparrow)R + R = 25g + 50g$	M1 A1 ft
	M(A), $\; 2R + 12R = 25g \times 6 + 50g \times AX$	M1 A1 ft
	$AX = 7.5$ (m)	DM1 A1
		(6)
		[14]

	Notes for Question 6	
Q6(a)	First M1 for moments about P equation with usual rules (or moments about a different point AND vertical resolution and R then eliminated) (M0 if non-zero reaction at Q) Second M1 for moments about Q equation with usual rules (or moments about a different point AND vertical resolution) (M0 if non-zero reaction at P) Second A1 for a correct equation in M and same unknown. Third M1, dependent on first and second M marks, for solving for M Third A1 for 25 (kg) Fourth M1, dependent on first and second M marks, for solving for x Fourth A1 for 6 (m) <u>N.B. No marks available if rod is assumed to be uniform but can score max 5/6 in part (b), provided they have found values for M and x to f.t. on.</u> If they have just invented values for M and x in part (a), they can score the M marks in part (b) but <u>not</u> the A marks.	
Q6(b)	First M1 for vertical resolution or a moments equation, with usual rules. First A1 **ft** on their M and x from part (a), for a correct equation. (must have *equal reactions* in vertical resolution to earn this mark) Second M1 for a moments equation with usual rules. Second A1 **ft** on their M and x from part (a), for a correct equation in R and same unknown length. Third M1, dependent on first and second M marks, for solving for AX *(not their unknown length)* with $AX \leq 15$ Third A1 for $AX = 7.5$ (m) N.B. If a single equation is used (see below), equating the sum of the moments of the child and the weight about P to the sum of the moments of the child and the weight about Q, this can score M2 A2 **ft** on their M and x from part (a), provided the equation is in one unknown. Any method error, loses both M marks. e.g. $25g.4 + 50g(x - 2) = 25g.6 + 50g(12 - x)$ oe.	

11.

2.(a)	$M(D),\quad 8R = (80g \times 6) + (200g \times 4)$	M1 A1
	$R = 160g,\ 1600,\ 1570$	A1 (3)
(b)	$(\uparrow),\quad 2S = 80g + 200g$	M1
	$S = 140g,\ 1400,\ 1370$	A1 (2)
(c)	$M(B),\quad Sx + (S \times 10) = (80g \times 8) + (200g \times 6)$	M1 A2
	$140x + 1400 = 640 + 1200$	
	$140x = 440$	
	$x = \frac{22}{7}$	A1 (4)
		9
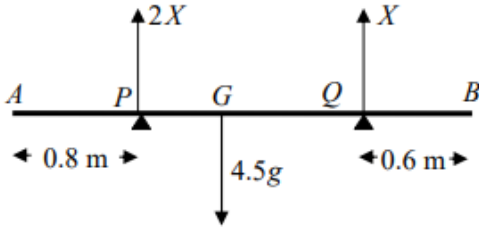
12.

3.	$(\uparrow),\quad T\cos 30 + F\cos 60 = 2g$	M1 A1
	$(\rightarrow),\quad T\cos 60 - F\cos 30 = 0$	M1 A1
	$F = g = 9.8$	M1 A1
	$T = \sqrt{3}g = 17 \text{ or } 17.0$	M1 A1 8
OR:	$(\nearrow),\quad F = 2g\cos 60$	M1 A1
	$(\nwarrow),\quad T = 2g\cos 30$	M1 A1
	$F = g = 9.8$	M1 A1
	$T = \sqrt{3}g = 17 \text{ or } 17.0$	M1 A1 8

13.

4.	$12.6^2 = 2a.50 \qquad (\Rightarrow a = 1.5876)$	M1 A1
	$800g\sin 15 - F = 800a$	M1 A1
	$R = 800g\cos 15$	M1 A1
	$F = \mu R$	B1
	$800g\sin 15 - \mu 800g\cos 15 = 800 \times 1.5876$	M1
	$\mu = 0.1,\ 0.10,\ 0.100$	A1
		9

14.

Question Number	Scheme	Marks
2.		
(a)	$\uparrow$ $\qquad 2X + X = 4.5g$	M1 A1
	Leading to $X = \dfrac{3g}{2}$ or 14.7 or 15 (N)	A1 (3)
(b) M(A)	$4.5g \times AG = (2X) \times 0.8 + X \times 2.4$	M1 A2 ft (1,0)
	$AG = \dfrac{4}{3}$ (m), 1.3, 1.33,...	A1 (4)
		[7]

Question 2(a)
First M1 for a complete method for finding R_Q, either by resolving vertically, or taking moments twice, with usual criteria (allow M1 even if $R_P = 2R_Q$ not substituted)
First A1 for a correct equation in either R_Q or R_P ONLY.
Second A1 for 1.5g or 14.7 or 15 (A0 for a negative answer)
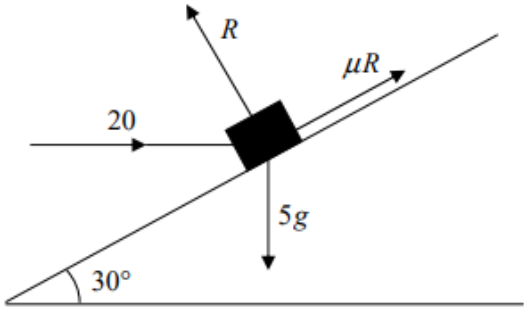
Question 2(b)
First M1 for taking moments about any point, with usual criteria.
A2 ft for a correct equation (A1A0 one error, A0A0 for two or more errors, ignoring consistent omission of g's) in terms of X and their x (which may not be AG at this stage)
Third A1 for $AG = 4/3$, 1.3, 1.33,..... (any number of decimal places, since g cancels) need '$AG =$' or x marked on diagram

N.B. if $R_Q = 2R_P$ throughout, mark as a misread as follows:
(a) M1A1A0 (resolution method) (b) M1A0A1A1, assuming all work follows through correctly..

15.

Question Number	Scheme	Marks
3.		
	(a) ⊥ plane $\qquad R = 20\cos 60° + 5g\cos 30°$	M1 A2(1,0)
	$\qquad = 52.4 \ (\text{N})$ or 52	A1 (4)
	(b) $\qquad\qquad\qquad\qquad F_r = \mu R$	B1
	P plane $\qquad F + 20\cos 30° = 5g\cos 60°$	M1 A2(1, 0)
	$\qquad$ Leading to $\mu = 0.137$ or 0.14	A1 (5) [9]

Question 3(a)
First M1 for resolving perpendicular to plane with usual criteria
First A2 for a correct equation (A1A0 one error, A0A0 for two or more errors)
Second A1 for either 52 or 52.4
N.B. In part (a), the M1 is for a <u>complete method</u>, so they must have sufficient equations to be able to solve for R. The A2 marks are then for *all* the equations.

Question 3(b)
B1 for use of $F = \mu R$ (could just be on diagram)
First M1 (allow if F is used rather than μR) for resolving parallel to the plane with usual criteria
First A2 for a correct equation (A1A0 one error, A0A0 for two or more errors)
Second A1 for either 0.14 or 0.137
N.B. If they resolve vertically AND horizontally, there are max 6 marks available (M1A2, M1A2) for the TWO equations, but if they only have one equation, there are no marks available for that equation.
The marks for the horizontal resolution should be entered first on ePen.
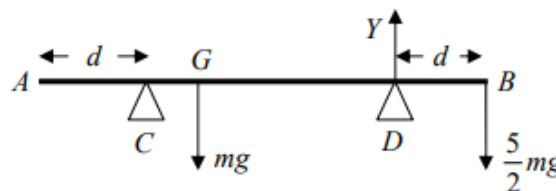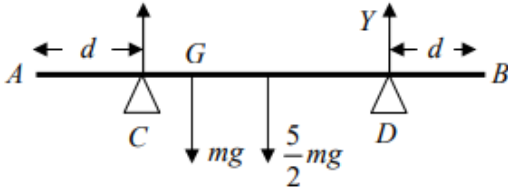
16.

Question Number	Scheme	Marks
4 (a)		
	$\text{M}(D) \qquad mg \times GD = \dfrac{5}{2} mg \times d$	M1 A1
	$\qquad\qquad GD = \dfrac{5}{2} d$ ✱	DM1 A1
		(4)
(b)		
	$\text{M}(C) \qquad mg \times \dfrac{d}{2} + \dfrac{5}{2} mg \times \dfrac{3}{2} d = Y \times 3d$	M1 A2(1, 0)
	Leading to $\qquad\qquad Y = \dfrac{17}{12} mg$	DM1 A1
		(5)
		9
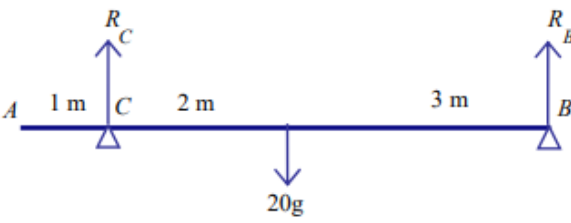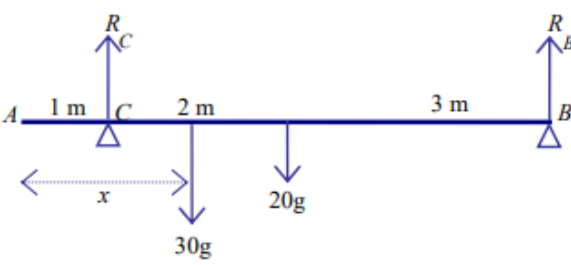
17.

Question Number	Scheme	Marks
3.	$4\cos\alpha + F = W\sin\alpha$ $R = 4\sin\alpha + W\cos\alpha$ $F = 0.5R$ $\cos\alpha = 0.8$ or $\sin\alpha = 0.6$ $R = 20N$ ** GIVEN ANSWER $W = 22N$	M1 A1 M1 A1 B1 B1 M1 A1 A1 (9)
OR	$R\sin\alpha = 4 + F\cos\alpha$ $R\cos\alpha + F\sin\alpha = W$ $F = 0.5R$ $\cos\alpha = 0.8$ or $\sin\alpha = 0.6$ $R = 20N$ ** GIVEN ANSWER $W = 22N$	M1 A1 M1 A1 B1 B1 M1 A1 A1 (9) **9**

18.
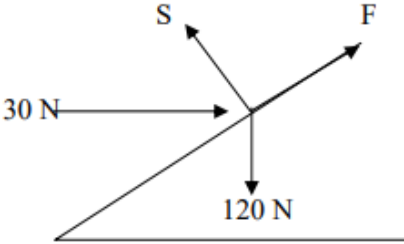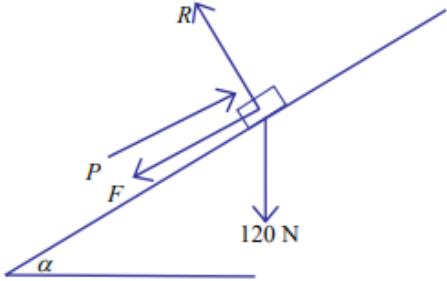
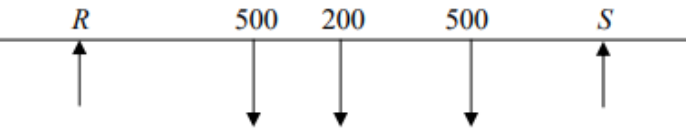| Question Number		Scheme	Marks
5.	**(a)**	2 m 2 m 2 m Q 2 m P ————————————— R X $40g$ $20g$ X Mg	
	(i)	**EITHER** $M(R), 8X + 2X = 40g \times 6 + 20g \times 4$	M1 A2
		solving for X, $X = 32g = 314$ or 310 N	M1 A1
	(ii)	($\uparrow$) $X + X = 40g + 20g + Mg$ (or another moments equation)	M1 A2
		solving for M, $M = 4$	M1 A1
	(i)	**OR** $M(P), 6X = 40g \times 2 + 20g \times 4 + Mg \times 8$	M1 A2
		solving for X, $X = 32g = 314$ or 310 N	M1 A1
		($\uparrow$) $X + X = 40g + 20g + Mg$ (or another moments equation)	M1 A2
	(ii)	solving for M, $M = 4$	M1 A1 (10)
	(b)	Masses concentrated at a point or weights act at a point	B1 (1) **11**

19.

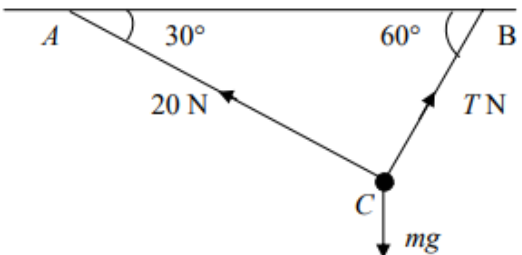| Question Number	Scheme	Marks
3. (a)	Taking moments about B: $5 \times R_C = 20g \times 3$ $R_C = 12g$ or $60g/5$ or 118 or 120 Resolving vertically: $R_C + R_B = 20g$ $R_B = 8g$ or 78.4 or 78	M1A1 A1 M1 A1 (5)
(b)	Resolving vertically: $50g = R + R$ Taking moments about B: $$5 \times 25g = 3 \times 20g + (6-x) \times 30g$$ $$30x = 115$$ $$x = 3.8 \text{ or better or } 23/6 \text{ oe}$$	B1 M1 A1 A1 A1 (5) [10]

20.

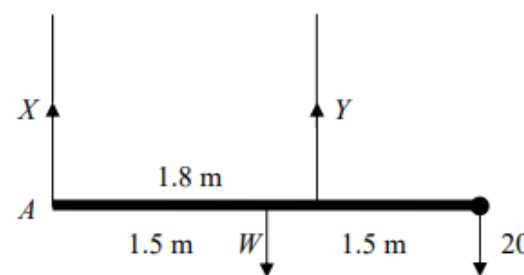| Question Number	Scheme	Marks
6. (a)	 Resolving perpendicular to the plane: $S = 120\cos\alpha + 30\sin\alpha$ $\quad = 114$ *	M1 A1 A1 A1 (4)
(b)	 Resolving perpendicular to the plane: $\quad R = 120\cos\alpha$ $\quad\quad = 96$ $F_{max} = \frac{1}{2}R$ Resolving parallel to the plane: In equilibrium: $P_{max} = F_{max} + 120\sin\alpha$ $\quad\quad\quad\quad = 48 + 72 = 120$	M1 A1 A1 M1 M1 A(2,1,0) A1 (8)
(c)	$30 + F = 120\sin\alpha$ **OR** $30 - F = 120\sin\alpha$ So $F = 42$N acting up the plane.	M1 A1 A1 (3) **[15]**

May 2010 Mathematics Advanced Paper 1: Mechanics 1

21.

Question Number	Scheme	Marks
Q4		
	$M(B)$,	
	$500x + 500.2x + 200x3 = Rx5 + Sx1$ (or any valid moments equation)	M1 A1 A1
	$(\downarrow) R + S = 500 + 500 + 200 = 1200$ (or a moments equation)	M1 A1
	solving for x; $x = 1.2$ m	M1 A1 cso
		[7]

Jan 2010 Mathematics Advanced Paper 1: Mechanics 1

22.

Question Number	Scheme	Marks
Q3.		
(a)	$R(\rightarrow)$ $20\cos 30° = T\cos 60°$	M1 A2 (1,0)
	$T = 20\sqrt{3}$, 34.6, 34.64,...	A1 (4)
(b)	$R(\uparrow)$ $mg = 20\sin 30° + T\sin 60°$	M1 A2 (1,0)
	$m = \dfrac{40}{g}(\approx 4.1), 4.08$	A1 (4)
		[8]

23.

Q4.	(a)		

(a)

$$M(A) \qquad W \times 1.5 + 20 \times 3 = Y \times 1.8$$ — M1 A2 (1, 0)

$$Y = \frac{5}{6}W + \frac{100}{3} \quad \ast$$ cso   A1   (4)

(b)   ↑ $X + Y = W + 20$ or equivalent   M1 A1

$$X = \frac{1}{6}W - \frac{40}{3}$$ A1   (3)

(c) $$\frac{5}{6}W + \frac{100}{3} = 8\left(\frac{1}{6}W - \frac{40}{3}\right)$$ M1 A1 ft

$$W = 280$$ A1   (3)

                                                                          [10]

Alternative to (b)

$M(C) \quad X \times 1.8 + 20 \times 1.2 = W \times 0.3$ M1 A1

$$X = \frac{1}{6}W - \frac{40}{3}$$ A1