MyStudyBro - Revision Exercise Tool

This Revision Handout includes the Questions and Answers of a total of 5 exercises!

Chapters:

Statics - M1 (Pearson Edexcel)

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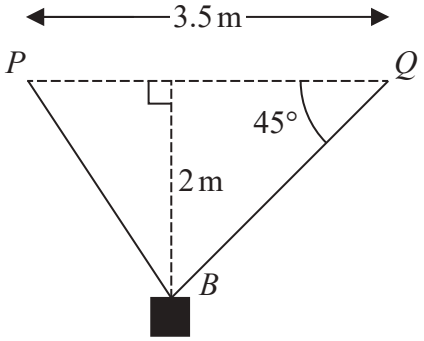

Figure 3

A small metal box of mass 6 kg is attached at B to two ropes BP and BQ. The fixed points P and Q are on a horizontal ceiling and $PQ = 3.5$ m. The box hangs in equilibrium at a vertical distance of 2 m below the line PQ, with the ropes in a vertical plane and with angle $BQP = 45°$, as shown in Figure 3. The box is modelled as a particle and the ropes are modelled as light inextensible strings. Find

(i) the tension in BP,

(ii) the tension in BQ.

(10)

Question Number	Scheme	Marks
5.	$PM = 3.5 - 2\tan 45^o = 1.5$ OR $PB = \sqrt{3.5^2 + (\frac{2}{\sin 45})^2 - 2\times 3.5\times(\frac{2}{\sin 45})\cos 45^o} = 2.5$	M1
	$\tan\alpha = \frac{1.5}{2}; \cos\alpha = \frac{4}{5}; \sin\alpha = \frac{3}{5}$	A1
	OR $\alpha = 37^o$ *or* $(90^o - \alpha) = 53^o$ (at least 2SF)	
	$T_P\cos\alpha + T_Q\cos 45^o = 6g$	M1 A2 -1 ee
	$T_P\sin\alpha = T_Q\cos 45^o$	M1 A1
	$T_P = \frac{30g}{7} = 42$ N; $T_Q = 36$ or 35.6 N	**DM1** A1; A1
		10
	Notes	
	First M1 for finding the length of *PM* or *PB*	
	First A1 for a correct trig ratio for α or $(90^o - \alpha)$ or a correct value for α or $(90^o - \alpha)$ Do not penalise accuracy here if their final answers for the tensions are correct.	
	N.B. If they assume the tensions are the same , no further marks available If they think α = 30 or 60 or....., they could get all 5 resolving marks as a value of α is not required **but if α = 45, only M marks available.** However, if α and 45 are interchanged in the resolving equations - no marks available for resolving	
	Second M1 for resolving vertically with usual rules	
	Second/Third A1's for a correct equation, (α does not need to be substituted) -1 each error	
	Third M1 for resolving horizontally with usual rules	
	Fourth A1 for a correct equation (α does not need to be substituted but if it is , follow through on their value)	
	Fourth DM1, dependent on all **THREE** previous M marks, for solving for either tension	
	Fifth A1 for T_P Allow 42.0 Units not needed	
	Sixth A1 for T_Q Units not needed	
	Alternative, using Triangle of Forces/Lami's Theorem, for middle 5 marks.	
	$\frac{T_P}{\sin 45^o} = \frac{6g}{\sin(45^o + \alpha)}$ OR $\frac{T_Q}{\sin(180^o - \alpha)} = \frac{6g}{\sin(45^o + \alpha)}$	M1 A2 -1 ee
	$\frac{T_Q}{\sin(180^o - \alpha)} = \frac{6g}{\sin(45^o + \alpha)}$ OR $\frac{T_P}{\sin 45^o} = \frac{6g}{\sin(45^o + \alpha)}$ OR $\frac{T_P}{\sin 45^o} = \frac{T_Q}{\sin(180^o - \alpha)}$	M1 A1
	N.B. Treat omission of *g* as one error	

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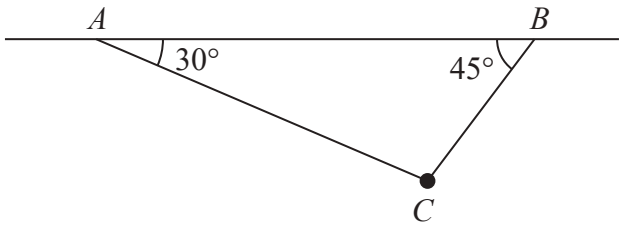


Figure 1

A particle of weight W is attached at C to two light inextensible strings AC and BC. The other ends of the strings are attached to fixed points A and B on a horizontal ceiling. The particle hangs in equilibrium with the strings in a vertical plane and with AC and BC inclined to the horizontal at 30° and 45° respectively, as shown in Figure 1.

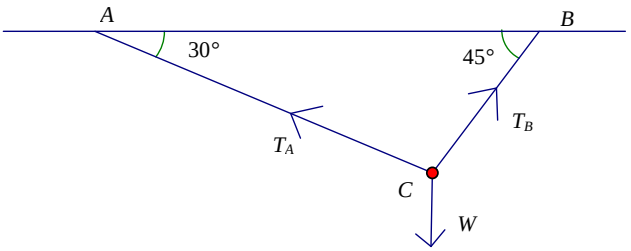
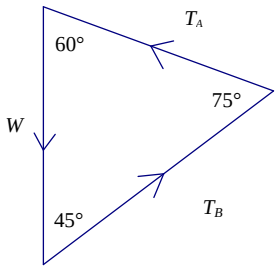
Find, in terms of W,

(i) the tension in AC,

(ii) the tension in BC.

(7)

January 2018
Mechanics 1 – WME01
Mark Scheme

Question Number	Scheme	Marks
1		
	N.B. If they assume that the tensions are the same, can score max:M0A0M1A0DM0A0A0. **If they use the same angles, can score max: M1A0M1A0DM0A0A0**	
	Resolve parallel to AB: $T_A\cos 30 = T_B\cos 45$	M1A1
	Resolve perpendicular to AB: $W = T_A\sin 30 + T_B\sin 45$	M1A1
	Solve for T_A or T_B	**DM**1
	$T_A = \dfrac{2}{1+\sqrt{3}}W\left(=0.73W\right)$ (or better)	A1
	$T_B = \dfrac{\sqrt{6}}{1+\sqrt{3}}W\left(=0.90W\right)$ (or better)	A1
		(7)
	Alternative (triangle of forces):	
		
	Sine rule for T_A: $\dfrac{T_A}{\sin 45} = \dfrac{W}{\sin 75}$ M1A1	
	Sine rule for T_B: $\dfrac{T_B}{\sin 60} = \dfrac{W}{\sin 75}$ M1A1	
	Solve for T_A or T_B: $T_A = 0.73W$ (or better) **DM**1A1	
	$T_B = 0.90W$ (or better) A1	
	(7)	
		[7]

Question Number	Scheme	Marks
	Notes for question 1	
1	First M1 for resolving horizontally with usual rules	
	First A1 for a correct equation	
	Second M1 for resolving vertically with usual rules	
	Second A1 for a correct equation	
	Third **DM**1, dependent on both previous M marks, for solving for either T_A or T_B	
	Third A1 for $T_A = 0.73W$ or better or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal. Allow 'invisible brackets'	
	Fourth A1 for $T_B = 0.90W$ or better ($0.9W$ is A0) or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal.	
	Alternative using sine rule or Lami's Theorem	
	First M1A1 for $\frac{T_A}{\sin 45} = \frac{W}{\sin 75}$ oe (e.g. allow sin 105 or reciprocals)	
	Second M1 for $\frac{T_B}{\sin 60} = \frac{W}{\sin 75}$ (allow sin 30 and/or sin 105)	
	Second A1 for $\frac{T_B}{\sin 60} = \frac{W}{\sin 75}$	
	Third **DM**1, dependent on either previous M mark, for solving for either T_A or T_B	
	Third A1 for $T_A = 0.73W$ or better or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal.	
	Fourth A1 for $T_B = 0.90W$ or better or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal.	

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7.

Figure 2

A washing line $ABCD$ is fixed at the points A and D. There are two heavy items of clothing hanging on the washing line, one fixed at B and the other fixed at C. The washing line is modelled as a light inextensible string, the item at B is modelled as a particle of mass 3 kg and the item at C is modelled as a particle of mass M kg. The section AB makes an angle α with the horizontal, where $\tan\alpha = \frac{3}{4}$, the section BC is horizontal and the section CD makes an angle β with the horizontal, where $\tan\beta = \frac{12}{5}$, as shown in Figure 2. The system is in equilibrium.

(a) Find the tension in AB.

(4)

(b) Find the tension in BC.

(3)

(c) Find the value of M.

(5)

Question Number	Scheme	Marks	Notes
7a	$\sin\alpha = \frac{3}{5}$ or $\cos\alpha = \frac{4}{5}$	B1	Correct trig ratios for α seen or implied Watch out - it could be up beside the diagram
	At B, $(\uparrow)$	M1	Complete method to form equation in T_{AB}
	$\Rightarrow \quad T_{AB}\sin\alpha = 3g$	A1	Correct unsimplified equation
	$T_{AB} = 5g = 49$ N	A1	
		(4)	
7b	At B, $(\rightarrow)$	M1	Complete method to form equation in T_{BC}
	$\Rightarrow \quad T_{AB}\cos\alpha = T_{BC}$	A1	Correct unsimplified equation. Allow with their T_{AB}
	$T_{BC} = 4g = 39$ or 39.2 N	A1	
		(3)	
7c	Resolve at C:	M1	Resolve to form equation in T_{CD} There is a lot of confusion over the labelling of the tensions. Allow if a value is used correctly, whatever it is called.
	At C, $(\rightarrow)$ $T_{CD}\cos\beta = T_{BC}$	A1	One correct equation in T_{CD} Could be whole system equations e.g. $T_{AB}\cos\alpha = T_{CD}\cos\beta$ $T_{AB}\sin\alpha + T_{CD}\sin\beta = (3+M)g$
	At C, $(\uparrow)$ $T_{CD}\sin\beta = Mg$	A1	Two correct equations in T_{CD} (=101.92)
	$\tan\beta = \dfrac{Mg}{T_{BC}}$	DM1	Dependent on previous M1. Use $\tan\beta$ and solve for M
	$Mg = 4g \times \frac{12}{5} \Rightarrow M = 9.6$	A1	
		(5)	
		[12]	

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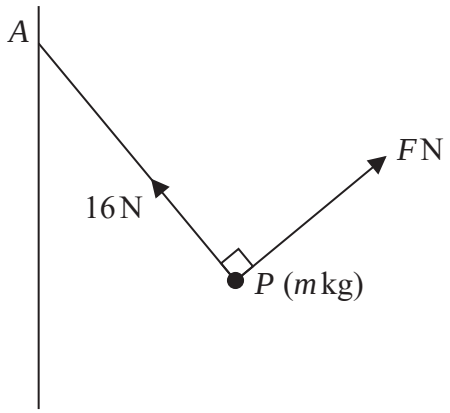

Figure 2

A particle P of mass m kg is attached to one end of a light inextensible string of length 2.5 m. The other end of the string is attached to a fixed point A on a vertical wall. The tension in the string is 16 N. The particle is held in equilibrium by a force of magnitude F newtons, acting in the vertical plane which is perpendicular to the wall and contains the string. This force acts in a direction perpendicular to the string, as shown in Figure 2.

Given that the horizontal distance of P from the wall is 1.5 m, find

(i) the value of F,

(ii) the value of m.

(7)

Question Number	Scheme	Marks
4.	$\sin\theta = \frac{3}{5}$ or $\cos\theta = \frac{4}{5}$ or $\tan\theta = \frac{3}{4}$ oe (may use the angle the string makes with the horizontal, the complementary angle) seen or implied by use of a trig function of e.g. 37° or 53° anywhere. **N.B.** If they assume angles are 45° can score max B0M1A0A1M0A0A0	B1
	Any *two* of the following equations: R$(\rightarrow)$: $F\cos\theta = 16\sin\theta$ oe e.g. $F = 16\tan\theta$ (from triangle of forces) R($\nearrow$): $F = mg\sin\theta$ R$(\uparrow)$: $mg = 16\cos\theta + F\sin\theta$ R($\nwarrow$): $16 = mg\cos\theta$ $(mg)^2 = F^2 + 16^2$ (Pythagoras from triangle of forces) **N.B**. In all of these equations, θ is what they *think* the angle that the string makes with the vertical is.	M1A1 (1^{st} equation) M1A1 (2^{nd} equation)
(i)	$F = 12$ (A0 if 12 obtained from rounding an inaccurate answer and A0 for 12.0) **N.B. If $F = 12$ is given as answer, without any evidence of rounding, give BOD and award A1.**	A1
(ii)	$m = 2.04$ or 2.0 (A0 for 2)	A1 **[7]**
	Notes for qu 4	
	B1 for any correct trig ratio seen	
	First M1 for 1^{st} equation seen with usual rules	
	First A1 for a correct equation	
	Second A1 is now M1 for 2^{nd} equation seen with usual rules	
	Second M1 is now A1 for a correct equation	
	Third A1 for 12	
	Fourth A1 for 2.04 or 2.0 (A0 for 2)	

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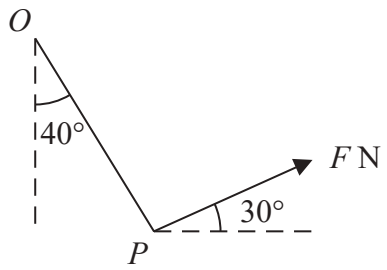


Figure 1

A particle P of weight 5 N is attached to one end of a light string. The other end of the string is attached to a fixed point O. A force of magnitude F newtons is applied to P. The line of action of the force is inclined to the horizontal at 30° and lies in the same vertical plane as the string. The particle P is in equilibrium with the string making an angle of 40° with the downward vertical, as shown in Figure 1.

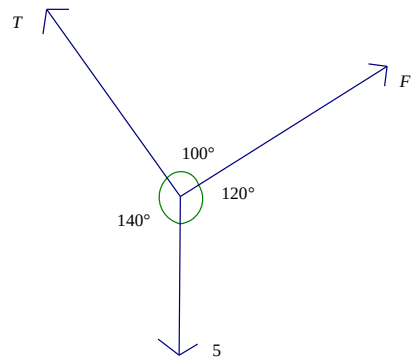
Find

(i) the tension in the string,

(ii) the value of F.

(7)

June 2017 Standardisation
WME01 Mechanics M1
Mark Scheme

Question	Scheme	Marks	Notes
1.	Vertically: $T\cos 40 + F\cos 60 = 5$	M1	First equation seen for resolution of forces. No missing/additional terms Condone sin/cos confusion and sign error(s) 5*g* in place of 5 is an accuracy error *T* must link with 40 or 50 and *F* with 60 or 30
		A1	Correct equation
	Horizontally: $T\cos 50 = F\cos 30$	M1	Second equation seen for resolution of forces No missing/additional terms Condone sin/cos confusion and sign error(s) 5*g* in place of 5 is an accuracy error *T* must link with 40 or 50 and *F* with 60 or 30
		A1	Correct equation
	Perpendicular to line of *F*: $T\cos 10 = 5\cos 30$		
	Perpendicular to line of *T*: $F\cos 10 = 5\cos 50$		
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N = 4.4 N (or better)	A1	One correct
	$F = 3.263....$ = 3.3 N(or better)	A1	Both correct
		[7]	
1 alt			Solution using Lami's theorem Or a triangle of forces
	$\frac{5}{\sin 100} = \frac{F}{\sin 140} = \frac{T}{\sin 120}$	M1	One pair including $\frac{5}{\sin 100}$ or $\frac{5}{\sin 80}$ Incorrect pairing of forces and angles is M0
		A1	Two fractions correct
		M1	Second pair of fractions
		A1	All correct
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N = 4.4 N (or better)	A1	One correct
	$F = 3.263....$ = 3.3 N(or better)	A1	Both correct