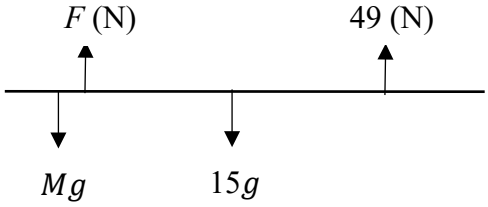
Mark Scheme

Moments

Pearson Edexcel GCE
In Mathematics (9MA0)
Paper 32 Mechanics

Question	Scheme	Marks
1	$(5\times 7)+(3\times 2)-(18\times 4\sin 30^{\circ})$	M1A1A1
	5	A1
	Nm	B1
		(5 marks)

Notes		
	M1	Correct number of terms, dimensionally correct, condone sin/cos confusion.
	A1	Correct unsimplified expression, with at most one error. Allow the negative expression
	A1	Correct unsimplified expression, with no errors. Allow the negative expression
	A1	Must be positive
	B1	Correct units seen

Question	Scheme	Marks
2a		B1 B1
		(2)
2b	Take moments about S_1	M1
	$0.5\times Mg+4\times 49=2\times 15g$	A1 A1
	$M=20$	A1
		(4)
2c	$F+49=20g+15g$	M1
	$(F=)294$ (N)	A1
		(2)
2d	The centre of mass is at the midpoint of the beam Or The beam has no thickness Or The beam is rigid.	B1
		(1)
2e	Her mass is concentrated at a point	B1
		(1)
		(10 marks)

Notes		
2a	B1	All four forces correctly placed
	B1	All four forces correctly placed and labelled
2b	M1	Correct number of terms, dimensionally correct, condone sign errors.
	A1	Correct equation, with at most one error
	A1	Correct equation
	A1	Correct value for M
2c	M1	Resolve vertically
	A1	Correct answer
2d	B1	Any equivalent statement
2e	B1	Any equivalent statement

Question	Scheme	Marks
3a	The weight acts at the centre of the beam.	B1
		(1)
3b	Take moments about M	M1
	$2.5 \times 28g = x \times 32g$	A1 A1
	Other possible equations (which score as above): Moments about A $NR_M = 28g + 25g + 32g = 85g \rightarrow\ 2.5 \times 85g = 2.5 \times 25g + x \times 32g$ $x = 4.6875$ Moments about B $NR_M = 28g + 25g + 32g = 85g$ $\rightarrow\ 2.5 \times 85g = 5 \times 28g + 2.5 \times 25g + x \times 32g$ $x = 0.3125$	
	0.3125 m	A1
		(4)
3c	Take moments about M	M1
	$2.5 \times 28g + 98 = d \times 25g + 2.1875 \times 32g$	A1 A1
	($d = 0.4$) so distance from A is 2.9 (m)	A1
		(4)
		(9 marks)

Notes		
3a	B1	The centre of mass is at M oe
3b	M1	Correct number of terms, dimensionally correct, condone sign errors
	A1	Correct equation with at most one error
	A1	Correct equation
	A1	Correct distance from B, units not required.
3c	M1	Correct number of terms, dimensionally correct, condone sign errors
	A1	Correct equation with at most one error.
	A1	Correct equation
	A1	Correct distance from A, units not required.

Note: It is possible to acknowledge the moments of the two children about the midpoint cancel each other out, leading to $98 = d \times 25g$. This achieves M1A1A1

Question	Scheme	Marks
4a	Take moments about D, to give an equation in T_C only	M1
	$4 \times 18g = 6 \times T_C \sin\theta$	A1 A1
	Other possible equations are shown below. T_D would need to be eliminated from any two of them to give an equation in T_C only to earn M1A1A1. Resolve vertically $T_C \sin\theta + T_D \sin\alpha = 18g$ Moments about A $2 \times T_C \sin\theta + 8 \times T_D \sin\alpha = 4 \times 18g$ Moments about E $2 \times T_C \sin\theta = 4 \times T_D \sin\alpha$ Moments about B $8 \times T_C \sin\theta + 2 \times T_D \sin\alpha = 6 \times 18g$	
	$T_C = 20g$ = 196 (N)	A1*
		(4)
4b	Resolve vertically	M1
	$20g \sin\theta + T_D \sin\alpha = 18g$	A1
	Other possible equations which can score M1A1: Moments about A $2 \times 20g \sin\theta + 8 \times T_D \sin\alpha = 4 \times 18g$ Moments about C $2 \times 18g = 6 \times T_D \sin\alpha$ Moments about E $2 \times 20g \sin\theta = 4 \times T_D \sin\alpha$ Moments about B $8 \times 20g \sin\theta + 2 \times T_D \sin\alpha = 6 \times 18g$	
	Resolve horizontally	M1
	$T_C \cos\theta = T_D \cos\alpha$	A1
	$T_D \sin\alpha = 6g$ and $T_D cos\,\alpha = 16g \rightarrow T_D \tan\alpha = \frac{6g}{16g}$	dM1
	$\tan\alpha = \frac{3}{8}$	A1
		(6)
4c	$T_C = 0$	B1
	Take moments about D	M1
	$4 \times 18g = 2 \times Mg$	A1
	$M = 36$	A1
		(4)
		(14 marks)

Notes		
4a	M1	Complete method to obtain an equation in T_C only
	A1	Correct equation with at most one error
	A1	Correct equation
	A1*	Given answer correctly obtained.
4b	M1	Correct number of terms, dimensionally correct, condone sin/cos confusion and sign errors.
	A1	Correct equation
	M1	Correct number of terms, dimensionally correct, condone sin/cos confusion and sign errors.
	A1	Correct equation
	dM1	Dependent on previous two M marks for using the trigonometric identity to reach an expression for $\tan\alpha$
	A1	Correct simplified value
4c	B1	States or implies that $T_C = 0$
	M1	Correct number of terms, dimensionally correct, condone sign errors.
	A1	Correct equation
	A1	Correct value of M

Question	Scheme	Marks
5a	Take moments about A	M1
	$3a \times 21g \cos 45 = 4.5a \times N_B$	A1
	$(N_B =) 7\sqrt{2}\text{g}$	A1
		(3)
5b	Resolve vertically:	M1
	$R_A = 21g - N_B \cos 45 \qquad (R_A = 14g)$	A1
	Resolve horizontally:	M1
	$F_A = N_B \sin 45 \qquad (F_B = 7g)$	A1
	Other possible equations (any of which can score M1A1): Parallel to the plank $R_A \sin 45 \ + F_A \cos 45 = 21g \sin 45$ Perpendicular to the plank $R_A \cos 45 + N_B = \ F_A \sin 45 \ + 21g \cos 45$ Moments about B $4.5a \times R_A \cos 45 = 4.5a \times F_A \sin 45 \ + 1.5a \times 21g \cos 45$ Moments about Midpoint $3a \times R_A \cos 45 = 3a \times F_A \sin 45 \ + 1.5a \times N_B$ Moments about end of ladder $6a \times R_A \cos 45 + 1.5a\ N_B = 6a \times F_A \sin 45 \ + 3a \times 21g \cos 45$	
	$F = \mu R$ and two of their equations used to solve for μ	dM1
	$\mu = 0.5$	A1
		(6)
5c	Model the branch as rough/include friction between the branch and the ladder. Model the ladder as non-uniform Do not model the ladder as a rod as it has thickness.	B1 B1 B1
		(3)
		(12 marks)

Notes		
5a	M1	Correct number of terms, dimensionally correct, condone sin/cos confusion and sign errors. Condone consistent omission of a
	A1	Correct equation, $\cos 45$ may or may not be replaced by $\frac{\sqrt{2}}{2}$ Omission of a is A0A0
	A1	$7\sqrt{2}g$ or 97 or 97.0
5b	M1	Correct number of terms, dimensionally correct, condone sin/cos confusion and sign errors.
	A1	Correct first equation, N_B does not need to be substituted
	M1	Correct number of terms, dimensionally correct, condone sin/cos confusion and sign errors.
	A1	Correct second equation, N_B does not need to be substituted
	dM1	Dependant on previous two M marks, must reach a value for μ
	A1	0.5 oe
5c	B3	Any 3 correct refinements, ignore extras unless incorrect then subtract a mark for each