adamjee maths

A-LEVEL MATHS / EDEXCEL / FREE RESOURCES

Connected particles

Mark scheme

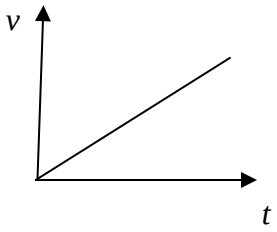
2 questions

Exam questions and marking instructions remain credited to their board.

Contents

1 October 2021 - Paper 3 Mechanics - Q2

2 June 2018 - Paper 3 - Q9

2(a)	Equation of motion for A	M1	3.3
	$3mg\sin\alpha - F - T = 3ma$	A1	1.1b
		(2)	
2(b)	Resolve perpendicular to the plane	M1	3.4
	$R = 3mg\cos\alpha$	A1	1.1b
	$F = \frac{1}{6}R$	B1	1.2
	Equation of motion for B **OR** for whole system	M1	3.3
	$T - mg = ma$ **OR** $3mg\sin\alpha - F - mg = 3ma + ma$	A1	1.1b
	Complete method to solve for a	DM1	3.1b
	$a = \frac{1}{10}g$ *	A1*	2.2a
		(7)	
2(c)		B1	1.1b
	e.g. acceleration (of B) is constant; dependent on first B1	DB1	2.4
		(2)	
2(d)	e.g. the tensions in the two equations of motion would be different. Tension on A would be different to tension on B	B1	3.5a
		(1)	
			(12 marks)

Notes: **N.B.** If m's are consistently missing treat as a MR, so max
(a) M1A0 (b) M1A0B0M1A1M1A1 (c) B1B1 (d) B1

For (a) and (b), allow verification, but must see full equations of motion.

2a	M1	Equation in T and a with correct no. of terms, condone sign errors and sin/cos confusion (If one of the 3's is missing, allow M1) N.B. Treat sin(3/5) etc as an A error but allow recovery
	A1	Correct equation (allow $(-a)$ instead of a in <u>both</u> equations)

2b	M1	Correct no. of terms, condone sign errors and sin/cos confusion Allow if appears in (a)
	A1	Correct equation
	B1	Seen anywhere in (a) or (b), including on a diagram
	M1	Equation (for B) in T and a with correct no. of terms, condone sign errors and sin/cos confusion **OR Whole system equation** with correct no. of terms, condone sign errors and sin/cos confusion
	A1	Correct equation
	DM1	Complete method (trig may not be substituted), dependent on M1 in (a) and second M1 in (b) if they use two equations, or second M1 in (b) if they use one equation.
	A1*	Correct answer correctly obtained.
2c	B1	Straight line starting at the origin (could be reflected in the t-axis). B0 if continuous vertical line at the end.
	DB1	Dependent on first B1, for any equivalent statement
2d	B1	B0 if incorrect extras

Question	Scheme	Marks	AOs
	Part (a) is a 'Show that..' so equations need to be given in full to earn A marks		

9(a)	Moments about A (or any other complete method)	M1	3.3
	$T2a\sin a = Mga + 3Mgx$	A1	1.1b
	$T = \dfrac{Mg(a+3x)}{2a\times\frac{3}{5}} = \dfrac{5Mg(3x+a)}{6a}$ * GIVEN ANSWER	A1*	2.1
		(3)	
(b)	$\dfrac{5Mg(3x+a)}{6a}\cos a = 2Mg$ **OR** $2Mg.2a\tan\alpha = Mga + 3Mgx$	M1	3.1b
	$x = \dfrac{2a}{3}$	A1	2.2a
		(2)	
(c)	Resolve vertically **OR** Moments about B	M1	3.1b
	$Y = 3Mg + Mg - \dfrac{5Mg(3.\frac{2a}{3}+a)}{6a}\sin a$ $2aY = Mga + 3Mg(2a - \frac{2a}{3})$ **Or**: $Y = 3Mg + Mg - \left(\dfrac{2Mg}{\cos\alpha}\right)\sin\alpha$	A1**ft**	1.1b
	$Y = \dfrac{5Mg}{2}$ **N.B.** May use $R\sin\beta$ for Y and/or $R\cos\beta$ for X throughout	A1	1.1b
	$\tan\beta = \dfrac{Y}{X}$ or $\dfrac{R\sin\beta}{R\cos\beta} = \dfrac{\frac{5Mg}{2}}{2Mg}$	M1	3.4
	$= \dfrac{5}{4}$	A1	2.2a
		(5)	
(d)	$\dfrac{5Mg(3x+a)}{6a} \le 5Mg$ and solve for x	M1	2.4
	$x \le \dfrac{5a}{3}$	A1	2.4
	For rope not to break, block can't be more than $\dfrac{5a}{3}$ from A oe Or just: $x \le \dfrac{5a}{3}$, if no incorrect statement seen. **N.B. If the correct inequality is not found,** their comment must mention 'distance from A'.	B1 **A1**	2.4
		(3)	
			(13 marks)

Notes:

(a)

M1: Using M(A), with usual rules, or any other complete method to obtain an equation in a, M, x and T only.

A1: Correct equation

A1*: Correct PRINTED ANSWER, correctly obtained, need to see $\sin\alpha = \frac{3}{5}$ used.

(b)

M1: Using an appropriate strategy to find x. e.g. Resolve horizontally with usual rules applying OR Moments about C. Must use the given expression for T.

A1: Accept $0.67a$ or better

(c)

M1: Using a complete method to find Y (or $R\sin\beta$) e.g. resolve vertically or Moments about B, with usual rules

A1 ft: Correct equation with their x substituted in T expression or using $T = \frac{2Mg}{\cos\alpha}$

A1: Y (or $R\sin\beta$) $= \frac{5Mg}{2}$ or $2.5Mg$ or $2.50Mg$

M1: For finding an equation **in tan β only** using $\tan\beta = \frac{Y}{X}$ or $\tan\beta = \frac{X}{Y}$

This is independent but must have found a Y.

A1: Accept $\frac{-5}{4}$ if it follows from their working.

(d)

M1: Allow $T = 5Mg$ or $T < 5Mg$ and solves for x, showing all necessary steps (M0 for $T > 5Mg$)

A1: Allow $x = \frac{5a}{3}$ or $x < \frac{5a}{3}$. Accept $1.7a$ or better.

B1: Treat as A1. For any appropriate equivalent fully correct comment or statement. E.g. maximum value of x is $\frac{5a}{3}$

Question	Scheme	Marks	AOs