AS Further Mathematics 8FM0

Specimen Paper - Further Mechanics 2 Mark Scheme

Question	Scheme	Marks	AOs
1(a)	From AB : 0 $2a$ $4a$ $3.5a$	B1	1.2
	From BC : a 0 $0.5a$ a	B1	1.2
	Mass ratios: 2 4 1 1 8	B1	1.2
	$2\times 0 + 4\times 2a + 1\times 4a + 1\times 3.5a = 8\overline{x}$	M1	2.1
	(i) $\overline{x} = \frac{31a}{16}$	A1	1.1b
	$2\times a + 4\times 0 + 1\times 0.5a + 1\times a = 8\overline{y}$	M1	2.1
	(ii) $\overline{y} = \frac{7a}{16}$	A1	1.1b
		(7)	
(b)	Uniform $\Rightarrow$ cm at mid-pt so used in 'distances' OR uniform $\Rightarrow$ mass proportional to length so used in mass ratios	B1	2.4
		(1)	
(c)	Recognition that G will be vertically below A and use of $\tan\theta = \frac{\overline{x}}{2a-\overline{y}}$, either way up	M1	2.1
	$\tan\theta = \frac{31}{25}$ (may not be simplified)	A1**ft**	1.1b
(d)	$\theta = 51^\circ$ or 0.89 rad or better	A1	1.1b
		(3)	
	Moments about mid-point of BC	M1	2.1
	$Mg(2a - \frac{31a}{16}) = kMg(a + 0.5a)$ ft on their $\overline{x}$	A1**ft**	1.1b
		A1**ft**	1.1b
	$k = \frac{1}{24}$	A1	1.1b
		(4)	
			(15 marks)

Question 1 notes:
(a) **B1:**Correct distances from AB seen or implied **B1:**Correct distances from BC seen or implied **B1:**Correct mass ratios seen or implied **(i)** **M1:** Correct no. of dimensionally correct terms **A1:** At least 2 SF if decimal multiple **(ii)** **M1:** Correct no. of dimensionally correct terms **A1:** At least 2 SF if decimal multiple
(b) **B1:** Either use
(c) **M1:** Accept either way up **A1 ft:** Follow through on their answers from (a) **A1:** cao
(d) **M1:** All relevant dimensionally correct terms included, with no extras **A1 ft:** Follow through on their answers from (a), allow one slip **A1 ft:** Follow through on their answers from (a), all correct **A1:** Correct answer for k : $\frac{1}{24}$, 0.042 or better

Question	Scheme	Marks	AOs
2(a)	Resolving vertically	M1	3.4
	$R\cos\alpha = mg$	A1	1.1b
	Equation of motion	M1	3.4
	$R\sin\alpha = \frac{mv^2}{40}$	A1	1.1b
	Eliminate R and solve for v	M1	1.1.
	$v = 17$ or 17.1 (m s^{-1})	A1	1.1b
		(6)	
(b)	Resolving vertically	M1	3.4
	$R\cos\alpha = mg + F\sin\alpha$	A1	1.1b
		A1	1.1b
	Equation of motion	M1	3.4
	$R\sin\alpha + F\cos\alpha = \frac{m39^2}{40}$	A1	1.1b
		A1	1.1b
	Recognition that max speed implies use of $F = \mu R$	B1	3.1b
	Eliminate R to form equation in μ only	M1	2.1
	Solve for μ	M1	1.1b
	$\mu = 0.80$ or 0.801	A1	1.1b
		(10)	
			(16 marks)

Question 2 notes
(a) **M1:** Correct number of terms with R resolved **A1:** A correct equation **M1:** Correct number of terms with R resolved **A1:** A correct equation **M1:** Must have two equations **A1:** Answer depends on $g = 9.8$ so only two possible answers
(b) **M1:** Correct number of terms with R and F resolved **A1:** A correct equation,condone 1 error **A1:** A correct equation **M1:** Correct number of terms with R and F resolved **A1: :** A correct equation,condone 1 error **A1:** A correct equation **B1:** Must be used in an equation **M1:** Must have two equations **M1:** Must have two equations **A1:** Answer depends on $g = 9.8$ so only two possible answers

Question	Scheme	Marks	AOs
3(a)	Use $\frac{\mathrm{d}v}{\mathrm{d}t}$ and separate the variables	M1	3.4
	$\frac{\mathrm{d}v}{\mathrm{d}t}=\frac{50}{v}-\frac{v}{8}\Rightarrow\int\mathrm{d}t=\int\frac{8v\,\mathrm{d}v}{400-v^2}$	A1	1.1b
	Integrate both sides	M1	1.1b
	$t=-4\ln(400-v^2)+C$	A1	1.1b
	Use initial conditions of the model to give $t=-4\ln(400-v^2)+4\ln 375$	M1	3.4
	Rearrange to make v^2 the subject	M1	1.1b
	$v^2=400-375\mathrm{e}^{-\frac{1}{4}t}$	A1	1.1b
		(7)	
(b)	$(375)\mathrm{e}^{-\frac{1}{4}t}\to 0$ as t increases, so $v^2\to 400$	M1	2.4
	Hence $v\to 20$	A1	2.1
		(2)	
			(9 marks)

Notes:

(a)
M1: Uses model to set up DE
A1: A correct separated expression in v and t only
M1: Clear attempt (must be a ln) to integrate both sides
A1: Correct indefinite integrals
M1: Using $t = 0$, $v = 5$ to find a particular solution of the DE
A1: Correct expression for v^2

(b)
M1: Clear explanation
A1: Correct deduction