9MA0/03 Mock Paper: Part B Mechanics Mark scheme

Question	Scheme	Marks	AOs
1	$\mathbf{r} = (-4.5\mathbf{i} + 3\mathbf{j})$	B1	1.1b
	Use of $\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$	M1	3.1b
	$(-4.5\mathbf{i} + 3\mathbf{j}) = 3\mathbf{u} + 0.5(\mathbf{i} - 2\mathbf{j})\ 3^2$	A1**ft**	1.1b
	$\mathbf{u} = (-3\mathbf{i} + 4\mathbf{j})$	A1	1.1b
		(4)	
			(4 marks)

Notes:

B1: Correct displacement vector

M1: Use of correct strategy and/or formula to give equation in **u** only (could be obtained by two integrations)

A1ft: Correct equation in **u** only, following their displacement vector

A1: Correct answer

Question	Scheme	Marks	AOs
2	Differentiate wrt t	M1	1.1a
	$\mathbf{a} = (2t - 3)\,\mathbf{i} - 12\,\mathbf{j}$	A1	1.1b
	$(2t - 3)^2 + (-12)^2$	M1	1.1b
	$(2t - 3)^2 + (-12)^2 = (6.5 / 0.5)^2$ oe	M1	2.1
	$4t^2 - 12t - 16 = 0$	A1	1.1b
	$(t - 4)(t + 1) = 0$	M1	1.1b
	$t = 4$	A1	1.1b
		(7)	
			(7 marks)

Notes:

M1: At least one power going down
A1: A correct expression
M1: Sum of squares of components (with or without square root) of **a** or **F**
M1: Equating magnitude to 6.5/0.5 or 6.5 as appropriate and squaring both sides
A1: Correct quadratic = 0 in any form
M1: Attempt to solve a 3 term quadratic
A1: 4

Question	Scheme	Marks	AOs
3(a)	Resolve perp to the plane	M1	3.1b
	$R + 25\sin30^o = 3g\cos20^o$	A1	1.1b
	Equation of motion up the plane	M1	3.1b
	$25\cos30^o - 3g\sin20^o - F = 3a$	A1	1.1b
	$F = 0.3R$	B1	1.2
	Correct strategy: sub for F and solve for a	M1	3.1b
	$a = 2.4$ or 2.35 (m s^{-2})	A1	2.2a
		(7)	
(b)	e.g. Include air resistance	B1	3.5c
		(1)	
(c)	$R = 3g\cos20^o$ so $F\max = 0.9\ g\cos20^o$	B1	3.1b
	Consider $3g\sin20^o - 0.9g\cos20^o$	M1	2.1
	Since > 0 , box moves down plane. *	A1*	2.2a
		(3)	
			(11 marks)

Notes:

(a)
M1: Using an appropriate strategy to set up first of two equations, with usual rules applying
A1: g does not need to be substituted
M1: Using an appropriate strategy to set up second of two equations, with usual rules applying
A1: Neither g nor F need to be substituted (-1 each error)
B1: $F = 0.3R$ seen
M1: Correct overall strategy to solve problem by substituting for F and solving for a
A1: Only possible answers, since g = 9.8 used.

(b)
B1: e.g. include air resistance, allow for the weight of the rope

(c)
B1: Correct overall strategy (First equation could be implied)
M1: Must be difference or a comparison of the two values
A1*: Given answer

Question	Scheme	Marks	AOs
4(a)	Moments about A (or any other complete method)	M1	3.3
	$T\cos30^o$ x $(1\sin30^o) = 20g$ x 1.5	A1	1.1.b
	$T\cos30^o$ x $(1\sin30^o) = 20g$ x 1.5	A1	1.1.b
	$T =$ 679 or 680 (N)	A1	1.1.b
		(4)	
(b)	Resolve horizontally	M1	3.1b
	$X = T\cos60^o$	A1	1.1b
	Resolve vertically	M1	3.1b
	$Y = T\cos30^o - 20g$	A1	1.1b
	Use of $\tan\theta = \frac{Y}{X}$ and sub for T	M1	3.4
	49^o (or better), below horizontal, away from wall	A1	2.2a
		(6)	
(c)	Tension would increase as you move from D to C	B1	3.5a
	Since each point of the rope has to support the length of rope below it	B1	2.4
		(2)	
(d)	Take moments about G, $1.5Y = 0$	M1	3.3
	$Y = 0$ hence force acts horizontally.*	A1*	2.2a
		(2)	
			(14 marks)

Notes:

(a)
M1: Correct overall strategy e.g. M(A), with usual rules, to give equation in T only
A1: (A1A0 one error) Condone 1 error
A1: (A0A0 two or more errors)
A1: Either 679 or 680 (since $g = 9.8$ used)

(b)
M1: Using an appropriate strategy to set up first of two equations, with usual rules applying
e.g. Resolve horiz. or M(C)
A1: Correct equation in X only
M1: Using an appropriate strategy to set up second of two equations, with usual rules applying
e.g. Resolve vert. or M(D)
A1: Correct equation in Y only

M1: Using the model and their X and Y **A1:** 49 or better (since g cancels) Need all three bits of answer to score this mark or any other appropriate angle e.g 41^{o} to wall, downwards and away from wall
(c) **B1:** Appropriate equivalent comment **B1:** Appropriate equivalent reason
(d) **M1:** Using the model and any other complete method e.g. the three force condition for equilibrium **A1*:** Correct conclusion GIVEN ANSWER

Question	Scheme	Marks	AOs
5(a)	Using the model and horizontal motion: $s = ut$	M1	3.3
	$12 = T \times 45\cos 10^o$	A1	1.1b
	$T = 0.2707..$	A1	1.1b
	Using the model and vertical motion: $s = ut + \frac{1}{2}at^2$	M1	3.4
	$s = 45T\sin 10^o + 4.9T^2$	A1	1.1b
	Correct strategy: sub for T and find s	M1	3.1b
	$d = 3.5 - 2.4752 - 1$	M1	3.1b
	$= 2.5$ (cm) (2 SF)	A1	2.2a
		(8)	
(b)	Using the model and vertical motion: $v = u + at$	M1	3.3
	$v = 45\sin 10^o + 9.8T$	A1	1.1b
	Speed $= ((45\cos 10^o)^2 + v^2)^{0.5}$	M1	3.1b
	46 (m s^{-1}) (2 SF)	A1	1.1b
		(4)	
(c)	Model does not take account of air resistance.	B1	3.5b
	Model does not take account of the size of the tennis ball	B1	3.5b
		(2)	
			(14 marks)

Notes:

(a)
M1: Using the model and correct strategy
A1: Correct equation in T only
A1: 0.271 or better
M1: Using the model and correct strategy
A1: Correct equation
M1: Sub for T and solve for s
M1: Correct method to find d using their s
A1: 2.5 is the only correct answer

(b)
M1: Using the model and correct strategy
A1: Correct equation
M1: Must have found a v and usual rules apply. Square root is needed.

A1: 46 (2 SF) is only correct answer
(c)
B1: Other appropriate answer e.g. spin of the ball, wind effect
B1: Other appropriate answer e.g. spin of the ball, wind effect