Mock Exam 1

MATHEMATICS **9709**

Paper 4 Mechanics **1 hour 15 minutes**

MARK SCHEME

Maximum Mark: 55

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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1

[s = (0 + 0.5)/2 x 7]	M1		For using (u + v)/2 = s/t
s = 1.75m	A1		May be implied
PE gain = 160g x 1.75	B1ft		
KE gain = ½ 160 x 0.5^2	B1		
[WD = 2800 + 20]	M1		For using WD = PE gain + KE gain
Work done is 2820J	A1	[6]	

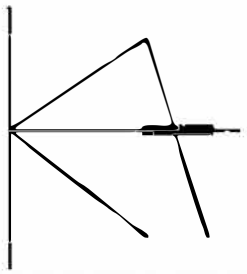
SR (max 4/6) for candidates who use a non-energy method		
[s = (0 + 0.5)/2 x 7]	M1	For using (u + v)/2 = s/t
s = 1.75m	A1	
[a = 1/14, T = 160g + 160/14, WD = 1611.4... x 1.75]	M1	For finding the acceleration and using Newton's second law (3 terms) to find the tension in the rope, then multiplying by the distance
Work done is 2820J	A1	

2

Question	Answer	Marks	Guidance
a	[$T - 200 = 700 \times -12$] Car: $-T - 600 - F = 1600 \times -12$ System: $-600 - 200 - F = 2300 \times -12$	**M1**	Apply Newton's 2nd law to the trailer or apply Newton's 2nd law to the car and to the system and eliminate the braking force, F.
	Magnitude of T = 8200 N	**A1**	
		2	
b	Car [$T - F - 600 = 1600 \times -12$] or System [$-600 - 200 - F = 2300 \times -12$]	**M1**	Apply Newton's second law either to the car or to the system with braking force = F and use of *their* T from **6(a)**
	Braking force F = 26800 N	**A1**	
		2	
c	[$v^2 = 22^2 + 2 \times -12 \times 17.5$]	**M1**	A complete method using constant acceleration equations which would lead to an equation for finding v, using $u = 22$, $s = 17.5$ and $a = -12$
	$v = 8\ \text{ms}^{-1}$	**A1**	AG
		2	
d	[$2300 \times 8 + m \times 0 = 2300 \times 2 + m \times 5$]	**M1**	For applying the conservation of momentum equation to the system of car, trailer and van, where m = mass of the van
		A1	Correct equation
	m = 2760 kg	**A1**	
		3	

3	**(i)** (dv/dt) = -0.02t + 0.5 **or** v = -0.01[(t – T)^2 – 100V] where T = 25 and V = 5.25 (or equivalent)	B1		
		M1		For solving dv/dt = 0 or for selecting t = T or v_{max} = V May be implied when v_{max} = V is selected and T is 25 in the 'B1' expression for v
	t = 25	A1		
	Maximum velocity is 5.25ms^{-1}	A1	[4]	
	(ii)	M1		For integrating v(t)
	$s_2 = -0.01t^3/3 + 0.5t^2/2 - t$	A1		
		M1		For using limits 10 and 30
	$s_2 = (-90 + 225 – 30) – (-10/3 + 25 – 10)$ (= 93.3m)	A1		
		M1		For evaluating v(10) and v(30)
	v(10) = 3 and v(30) = 5	A1		
		M1		For evaluating s_1 and s_3
	s_1 = ½ 3x10 and s_3 = ½ 5x50	A1ft		ft incorrect values of v(10) and/or v(30)
	Distance is 233m	A1ft	[9]	ft 140 + s_2 (depends on the 1stM1)
				SR for candidates who treat the first line segment as part of the curve in part **(ii)** (max. mark 6/9)
				Integration M1 A1 as scheme
				$s_1 + s_2$ = 105 A1
				v(30) = 5 B1
				s_3 = ½ 5x50 B1ft
				Distance is 230m A1ft (ft 125 + s1 + s_2)

4	(i)	$T_{BM} = T_{AM}$ or $T_{BM}\cos 30^o = T_{AM}\cos 30^o$	B1	
		For resolving forces at M horizontally $(2T\sin 30^0 = 5)$ or for using the sine rule in the triangle of forces $(T \div \sin 60^o = 5 \div \sin 60^o)$ or for using Lami's theorem $(T \div \sin 120^o = 5 \div \sin 120^o)$	M1	
		Tension is 5 N A.G.	A1	3
	(ii)	For resolving forces on B horizontally $(N = T\sin 30^0)$ or from symmetry $(N = 5/2)$ or for using Lami's theorem $(N \div \sin 150^o = 5 \div \sin 90^o)$	M1	
		For resolving forces on B vertically (3 terms needed) or for using Lami's theorem	M1	
		$0.2 \times 10 + F = T\cos 30^0$ or $(0.2g + F) \div \sin 120^o = T \div \sin 90^o$	A1	
		For using $F = \mu R$ $(2.33 = 2.5\mu)$	M1	
		Coefficient is 0.932	A1	5
	(iii)	$(0.2 + m)g - 2.33 = 5\cos 30^0$ or $mg = 2(2.33)$	B1 √	
		$m = 0.466$	B1	2

5		(i)	For applying Newton's 2nd law to A or B or for using $(m_1 + m_2)a = (m_2 - m_1)g$	M1	
			$0.15a = T - 0.15g$	A1	
			$0.25a = 0.25g - T$	A1	
			Alternative for the above 2 A marks: $(0.15 + 0.25)a = (0.25 - 0.15)g$ A2		
			Acceleration is $2.5 ms^{-2}$ (ft only for 0.25 following the absence of g) (2.45 from g = 9.8 or g = 9.81)	A1ft	4
		(ii)	$v = 5$ ft for 2 x ans(i) (4.9 from g = 9.8 and 4.90(5) from g = 9.81)	B1 ft	
			For using $v = u + at$ to find time up or time down or total time up and down; acceleration *must* be $\pm g$	M1	
			$t = 2 \times \frac{5}{10}$ or $-5 = 5 - 10t$	A1ft	
			Slack for 1s	A1	4
		(iii)	 For 2 line segments representing motion with the string taut	B1	
			For the line segment representing motion of A with the string slack	B1	
			For the line segment $v = 0$ representing B stationary with the string slack	B1	3

6 **(i)**	PE gain = $mg(2.5\sin 60^\circ)$	B1	
	For using KE = ½ mv^2	M1	
	For using the principle of conservation of energy ($\frac{1}{2}m8^2 - \frac{1}{2}mv^2 = mg(2.5\sin 60^\circ)$)	M1	
	Alternative for the above 3 marks: For using Newton's Second Law or stating $a = -g\sin 60^0$ a = -8.66 (may be implied) For using $v^2 = u^2 + 2as$ $(v^2 = 64 - 2\times 8.66\times 2.5)$	 M1* A1 M1dep*	
	Speed is 4.55 ms^{-1} Accept 4.64 from 9.8 or 9.81	A1	4
(ii)	For using ½ mu^2 (>) mgh_{max} (½ 8^2 > 10 h_{max})	M1	
	For obtaining 3.2m A.G.	A1	2
(iii)	Energy is conserved or absence of friction or curve BC is smooth (or equivalent) and B and C are at the same height or the PE is the same at A and B (or equivalent)	B1	1