Teacher Support Materials

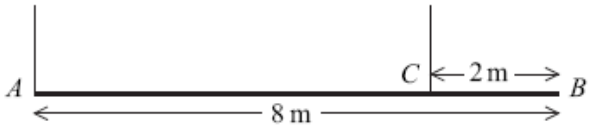
Maths GCE

Paper Reference MM2A (Questions 1,2,4)

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334). Registered address: AQA, Devas Street, Manchester M15 6EX.
Dr Michael Cresswell, Director General.

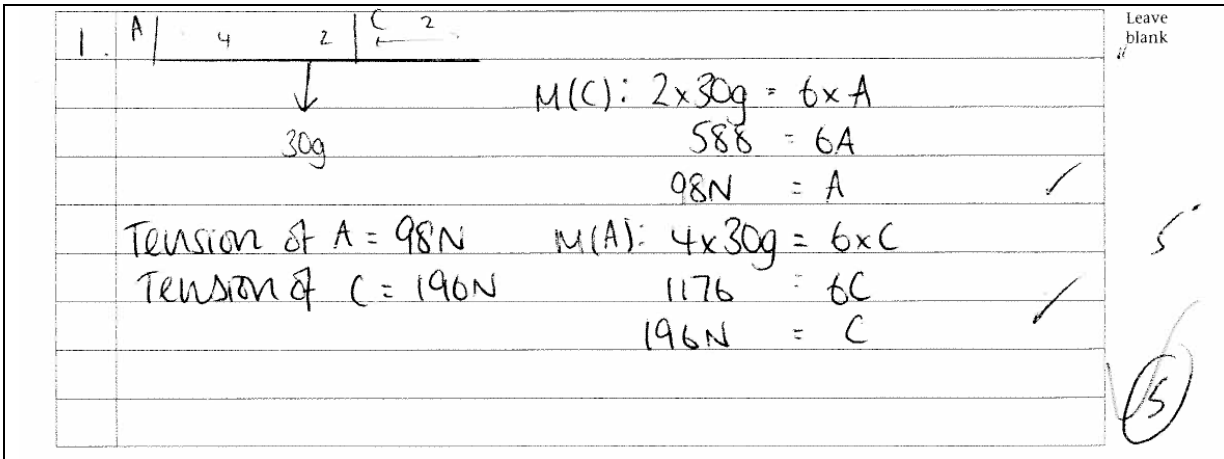
Question 1

1 A uniform plank, AB, is 8 m long and has mass 30 kg. It is supported in equilibrium in a horizontal position by two vertical inextensible ropes. One of the ropes is attached to the plank at A and the other rope to the point C, where $BC = 2$ m, as shown in the diagram.



Find the tension in each rope. *(5 marks)*

Student Response



Commentary

This script shows a reasonable clear diagram followed by information regarding the method, such as moments about *C*. This enabled the candidate to find quickly and concisely the tension in each of the two ropes.

Mark scheme

Q	Solution	Marks	Total	Comments
1	Moments about A:			OE
	$6S = 4 \times 30g$	M1A1		
	$S = 20g$ N or 196 N	A1		
	Resolving vertically: $R + S = 30g$	M1		
	$R = 10g$ N or 98 N	A1	5	SC3 20 N; 10 N
	Total		**5**	

Question 2

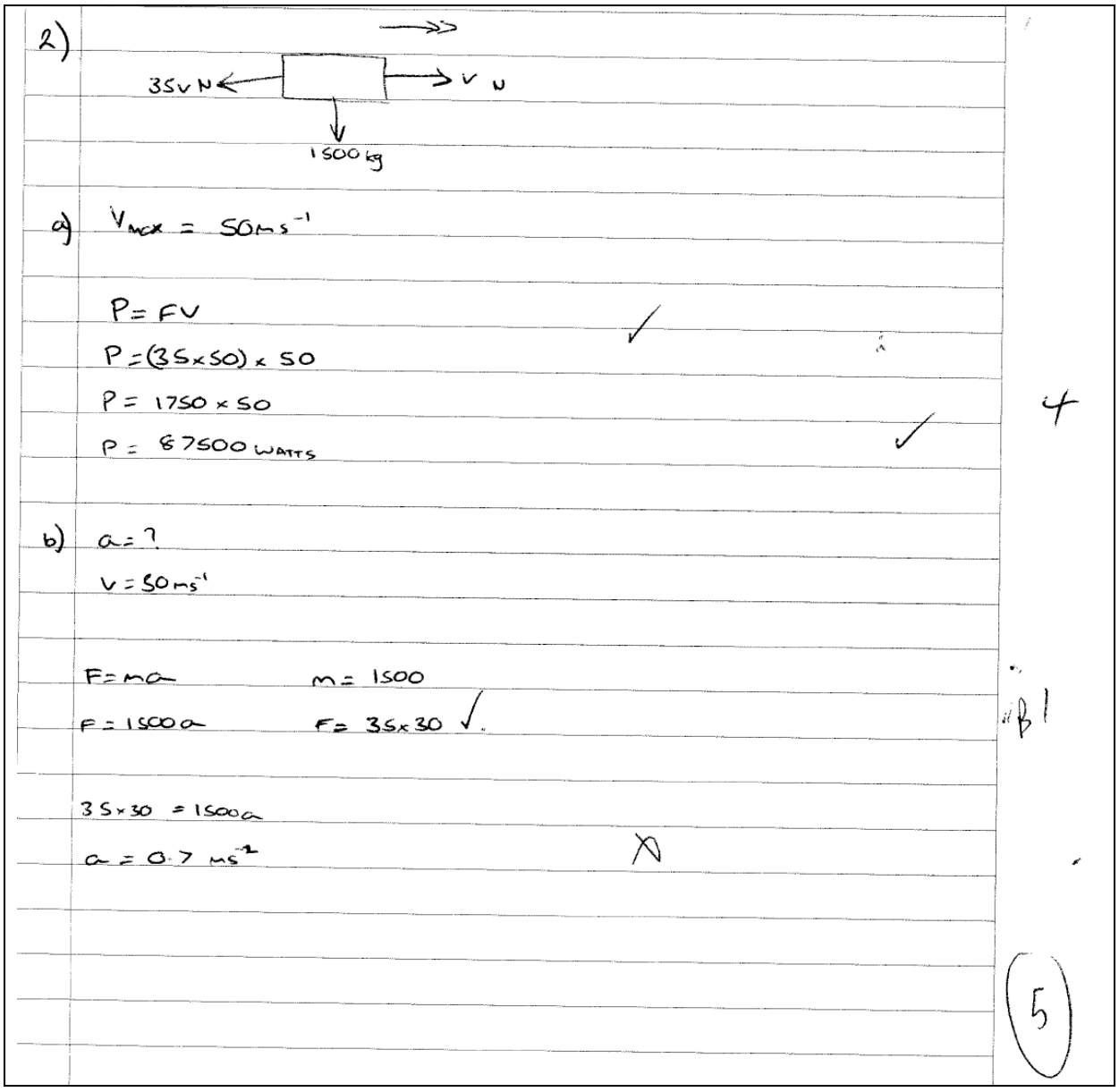
2 A car of mass 1500 kg is travelling along a straight horizontal road. When the car is travelling at a speed of v m s^{-1}, it experiences a resistance force of magnitude $35v$ newtons.

(a) On this road, the car has a maximum speed of 50 m s^{-1}.

Show that the maximum power of the car is 87 500 watts. *(4 marks)*

(b) Find the maximum possible acceleration of the car when its speed on the road is 30 m s^{-1}. *(5 marks)*

Student response



Commentary

Part (a) was completed correctly by most candidates and this script shows a typical answer.

In part (b) candidates realised that they had to find the new resistance force and this script shows that the candidate found 35 × 30 (= 1050), which is the resistance. Unfortunately, this example also shows the common error of ignoring the engine force. Candidates needed to find the new force exerted by the engine to find the resulting acceleration force before using $F = ma$. As the resistance force shown in this script is – 1050N, the candidate should have been concerned that, instead of accelerating, this response showed that the car was decelerating.

Mark Scheme

2(a)	Using Power = Force × Velocity: Power = 35 × 50 × 50 = 87500 watts	M1 M1B1 A1	 4	 B1 for force 35 × 50 AG
(b)	When speed is 30 m s^{-1}, resistance force is 35 × 30 = 1050 N	 B1	 	 B1 for 35 × 30
	Force exerted by the engine is $\frac{87500}{30}$	M1		
	= 2916.7	A1		Accept 2920, 2917 etc
	Using $F = ma$: $2916.7 - 1050 = 1500a$	M1		At least 1 LHS term correct (2 terms on LHS)
	$a = 1.24$ m s^{-2}	A1	5	
	Total		**9**	

Question 4

4 An elastic string of natural length 1.5 metres has one end attached to a fixed point O. A particle of mass 4 kg is attached to the other end of the string. The particle is released from rest at O.

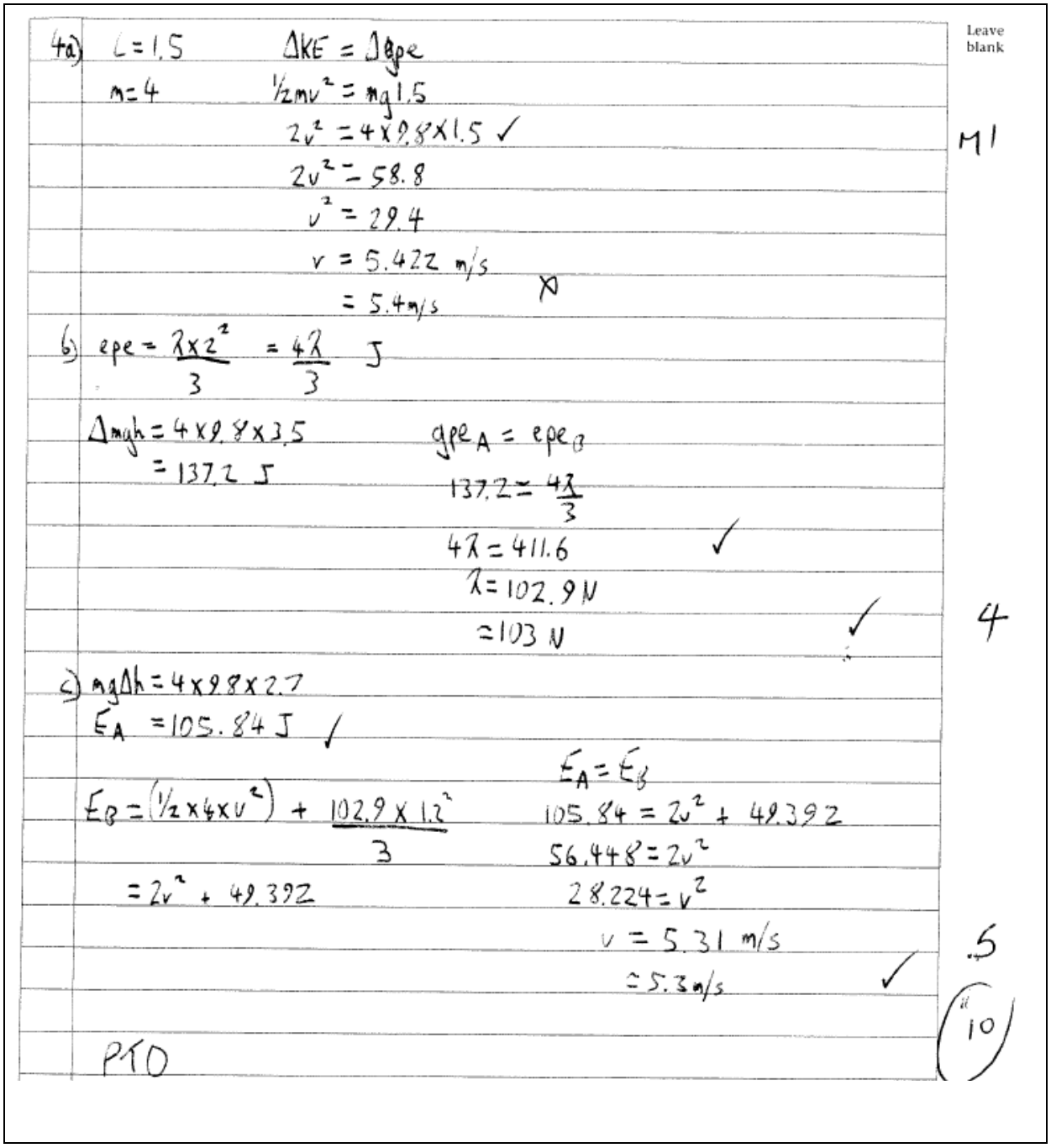
(a) Find the kinetic energy of the particle when the string becomes taut. *(2 marks)*

(b) The particle first comes to rest when it is 3.5 metres below O.

Show that the modulus of elasticity of the string is 103 N, correct to three significant figures. *(4 marks)*

(c) Find the speed of the particle when it is 2.7 metres below O. *(5 marks)*

Student Response



4a) $L = 1.5$, $m = 4$

$\Delta KE = \Delta gpe$

$\frac{1}{2}mv^2 = mg1.5$

$2v^2 = 4 \times 9.8 \times 1.5$ ✓

$2v^2 = 58.8$

$v^2 = 29.4$

$v = 5.422$ m/s

$= 5.4$ m/s ✗

M1

b) $epe = \frac{\lambda \times 2^2}{3} = \frac{4\lambda}{3}$ J

$\Delta mgh = 4 \times 9.8 \times 3.5$

$= 137.2$ J

$gpe_A = epe_B$

$137.2 = \frac{4\lambda}{3}$

$4\lambda = 411.6$ ✓

$\lambda = 102.9$ N

≈ 103 N ✓

4

c) $mg\Delta h = 4 \times 9.8 \times 2.7$

$E_A = 105.84$ J ✓

$E_B = (\frac{1}{2} \times 4 \times v^2) + \frac{102.9 \times 1.2^2}{3}$

$= 2v^2 + 49.392$

$E_A = E_B$

$105.84 = 2v^2 + 49.392$

$56.448 = 2v^2$

$28.224 = v^2$

$v = 5.31$ m/s

≈ 5.3 m/s ✓

5

10

PTO

Leave blank

Commentary

In part (a) the expected response was that the kinetic energy of the particle when the string became taut equalled the change in potential energy.

This script shows the candidate using conservation of energy to find the velocity when the string became taut. Often this was used as the basis for finding the kinetic energy of the particle, but not in this script. Candidates would be well advised to ensure that they do check that they have answered the question.

Part (b) is answered well, but in part (c), the candidate gives an answer to correct to two significant figures. The rubric asks for a three significant figure answer. However, the candidate was not penalised on this occasion as the three significant figure answer is clearly given before the two significant answer.

Mark Scheme

Q	Solution	Marks	Total	Comments
4(a)	KE is loss in PE			
	$= 4 \times g \times 1.5$	M1		M1 for $mgh = 58.8$ and then find v without finding KE
	$= 6g$ J or 58.8 J	A1	2	
(b)	When 3.5 m below O, extension is 2 m			
	EPE is $\frac{\lambda x^2}{2l} = \frac{\lambda(2)^2}{2\times1.5} = \frac{4}{3}\lambda$	M1		
	Change in potential energy of the particle is			
	$4 \times g \times 3.5$	M1		
	$= 14g$ or 137.2	A1		
	$\frac{4}{3}\lambda = 14g$			
	$\lambda = 102.9$ N or 103 N	A1	4	AG
(c)	When particle is 2.7 m below O,			
	EPE is $\frac{\lambda x^2}{2l} = \frac{\lambda(1.2)^2}{2\times1.5} = 49.392$	M1A1		Accept 49.44 [from 103]
	Change in potential energy of the particle [from initial position] is			
	$4 \times g \times 2.7 = 10.8g$ or 105.84	B1		
	Conservation of energy:			
	$105.84 = \frac{1}{2} \times m \times v^2 + 49.392$	M1		M1 for 3 terms and $4 \times g \times h$
	$2v^2 = 56.448$			
	Speed is 5.3126 m s^{-1} $= 5.31$ m s^{-1}	A1	5	CAO
	Total		**11**	