OCR
Oxford Cambridge and RSA

AS Level Further Mathematics A

Y533/01 Mechanics

Practice Paper Set 1

MARK SCHEME

Duration: 1 hour 15 minutes

MAXIMUM MARK   60

This document consists of 9 pages

Text Instructions

1. Annotations and abbreviations

Annotation in scoris	Meaning
✓and ✘	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	Meaning
E1	Mark for explaining a result or establishing a given result
dep*	Mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This question includes the instruction: In this question you must show detailed reasoning.

2. Subject-specific Marking Instructions for AS Level Further Mathematics A

a   Annotations should be used whenever appropriate during your marking. The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded. For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b   An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever you should contact your Team Leader.

c   The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
Mark for explaining a result or establishing a given result. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d   When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e   The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case, please escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f   Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.) We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so. When a value is given in the paper only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case. When a value is not given in the paper accept any answer that agrees with the correct value to 2 s.f. Follow through should be used so that only one mark is lost for each distinct accuracy error, except for errors due to premature approximation which should be penalised only once in the examination. There is no penalty for using a wrong value for g. E marks will be lost except when results agree to the accuracy required in the question.

g   Rules for replaced work: if a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests; if there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others. NB Follow these maths-specific instructions rather than those in the assessor handbook.

h   For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question. Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working. 'Fresh starts' will not affect an earlier decision about a misread. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i   If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j   If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Marks	AOs	Guidance	
1	(i)		$65 \times 9.8 \times 78$ awrt 49 700 (J)	M1 A1 [2]	1.1 1.1	Allow M mark with g omitted Or 49.7 kJ but not just 49.7	
1	(ii)		$\dfrac{49\,700}{90 \times 60}$ 9.20 (W)	M1 A1 [2]	1.1a 1.1	Dividing their value from (i) by a time	
2			$[G] = \dfrac{[F][r]^2}{[m_1][m_2]}$ or $[G] = \dfrac{[F][r]^2}{[m]^2}$ $[r] = \text{L}$ and $[m] = \text{M}$ $[F] = \text{M}[a] = \text{MLT}^{-2}$ So $[G] = \text{M}^{-1}\text{L}^3\text{T}^{-2}$	M1 B1 B1 A1 [4]	1.1 1.1 1.1 1.1	Use of rearranged formula to find $[G]$ soi soi Correct answer $\text{M}^{-1}\text{L}^3\text{T}^{-2}$	
3	(i)		$u = \dfrac{9.3}{1.5}$ Initial KE $= \frac{1}{2} \times 1.5 \times 6.2^2$ $(= 28.83)$ PE gain $= 1.5g \times 2.4\left(1 - \cos\frac{1}{6}\pi\right)$ $= 4.72\ldots$ $\frac{1}{2} \times 1.5 \times 6.2^2 = \frac{1}{2} \times 1.5 v^2 + 4.72...$ $v = 5.67$	M1 B1 M1 A1 M1 A1 [6]	3.3 3.4 3.4 1.1 1.1 1.1	Use of impulse = change of momentum Need not be evaluated Attempt at $1.5g \times$ height May be implied by correct answer www Use of conservation of energy (3 terms)	allow trig errors
3	(ii)		Required gain in PE is $1.5g \times 2.4 = 35.28$ $35.28 > 28.83$, so not enough energy to reach the level **Alternative solution** $\frac{1}{2} \times 1.5 \times 6.2^2 = 1.5g \times 2.4(1 - \cos\theta)$ $\cos\theta = 0.1828... < 1$ so comes to rest below horizontal	M1 E1 M1 E1 [2]	3.1a 3.5a		 $\theta \approx 1.39$ (79.5°)

Question			Answer	Marks	AOs	Guidance	
4	**(i)**		KE gain of carriage is $\frac{1}{2} \times 6000 \times 5.6^2$ $(= 94\,080)$	**B1**	**1.1a**	Need not be evaluated at this stage	
			Work done by tension = KE gain of carriage	**M1**	**2.2a**	May just be stated, or can be implied by answer for work done	
			$94\,100$ (J)	**A1**	**1.1**		
			Alternative solution				
			$5.6^2 = 2 \times a \times 250 \Rightarrow a = 0.0627$	**B1**		Correct acceleration from *suvat*	
			$T\cos\theta = 6000a$ and Work done $= T\cos\theta \times 250$	**M1**		Both steps soi	
			$94\,100$ (J)	**A1**			
				[3]			
4	**(ii)**		$T\cos\theta \times 250 = 94\,080$	**M1**	**3.4**	M0 if $\cos\theta$ taken as 1	Marks may be implied by earlier work if alternative solution used in **(i)**
			$\cos\theta = \frac{12}{13}$	**B1**	**1.1**	oe, eg $0.923\ldots$; may occur in **(i)**	
			Tension is 408 (N)	**A1**	**1.1**		
				[3]			
4	**(iii)**		$F = \dfrac{68000}{8.4}$ $(= 8095.23\ldots)$	**B1**	**3.1a**	Need not be evaluated	
			$a = \dfrac{8095}{16000}$	**M1**	**1.1**	Use of Newton II to find a	
			$= 0.506$	**A1**	**1.1**	Accept 0.51	
				[3]			

Question			Answer	Marks	AOs	Guidance	
5	**(i)**		Initially, total momentum is in direction of motion of B so final total momentum is also in this direction; hence both cannot be moving in the opposite direction, which would be the case if A's direction of motion was not reversed	**M1** **E1** **[2]**	**3.5a** **3.5a**	For considering total momentum and realising relevance of 2.1×3 being greater than 1.3×2, oe Full explanation required	Positive/negative directions should be defined by candidates or may be inferred from a momentum equation or other evidence
5	**(ii)**		$v_A = -4$ $1.4 \times 2 + 2.1 \times (-3) = 1.4 \times (-4) + 2.1 v_B$ $v_B = 1$ in opposite direction to B's original motion	**B1** **M1** **A1** **A1** **[4]**	**3.3** **3.4** **1.1** **2.4**	oe, eg use of opposite signs for velocities of A before and after impact Use of conservation of momentum with 4 terms; allow 1 sign error for M mark Completely correct equation Clear indication of direction required	
5	**(iii)**		$v_B - v_A = -e(2 - (-3))$ $e = 1$	**M1** **A1** **[2]**	**3.4** **1.1**	With their numerical v_A and v_B	
5	**(iv)**		No KE is lost in the collision (as it is perfectly elastic)	**E1ft** **[1]**	**1.2**	FT conclusion so long as their $e \in [0, 1]$	
5	**(v)**		$\pm(2.1 \times 1 - 2.1 \times (-3))$ or $\pm(1.4 \times (-4) - 1.4 \times 2)$ (Impulse is) 8.4 (N s) So it will be damaged	**M1** **A1** **E1ft** **[3]**	**3.4** **1.1** **3.5a**	Change of momentum for either particle	
5	**(vi)**		They have the same 'damage threshold' **and** equal and opposite impulses act on the particles in the collision	**E1** **[1]**	**2.4**	Allow quote of 'Newton's Third Law' for second aspect	

Question			Answer	Marks	AOs	Guidance	
6	(i)		$r = \dfrac{0.5}{0.625} = 0.8$	**B1** **[1]**	**1.1**	AG; use of $v = r\omega$ must be indicated	
6	(ii)		$\tan\theta = \dfrac{0.8}{1.8}$ oe	**B1**	**1.1**	soi, eg by correct value of an angle or its sine or cosine	At any stage
			Resolving vertically and horizontally:	**M1**	**3.1a**	For attempt at either resolution (3 forces required for vertical equation; Newton II for horizontal equation)	Equations must include attempt to resolve T
			$T\cos\theta + R = mg$	**A1**	**1.1**		Candidates may work with angle to the horizontal instead
			$T\sin\theta = \dfrac{mv^2}{r}$ or $T\sin\theta = m\omega^2 r$	**A1**	**1.1**		
			Solve pair of equations to find R $R = 1.82$	**M1** **A1** **[6]**	**1.1a** **1.1**		
6	(iii)		$T\cos\theta = mg$ and $T\sin\theta = \dfrac{mv^2}{r}$	**B1**	**2.2a**	Two equations, with condition $R = 0$ soi	
			$\tan\theta = \dfrac{v^2}{rg}$	**A1**	**1.1**	oe	
			$v = 1.87$	**A1** **[3]**	**1.1**		

Question			Answer	Marks	AOs	Guidance	
7			$mu + 2m \times (-2u) = mv_A + 2mv_B$ (oe)	**M1**	**2.1**	Conservation of momentum attempted	Positive direction may be chosen as the original direction of motion of B, thus reversing all signs
				A1	**1.1**	Completely correct equation (any form)	
			$v_B - v_A = e(u - (-2u))$	**M1**	**2.1**	oe; restitution equation attempted	
				A1	**1.1**	Completely correct equation (any form)	
			$v_A = -u(1 + 2e)$	**M1**	**3.1a**	Solving for v_A and v_B	
			$v_B = u(1 - e)$	**A1**	**1.1**	For both correct	
			KE of A is $\frac{1}{2}mu^2(1 + 2e)^2$	**B1ft**	**1.1**		
			KE of B is $\frac{1}{2} \times 2mu^2(1 - e)^2$	**B1ft**	**1.1**		
			$\frac{1}{2}mu^2(1 + 2e)^2 = 8 \times \frac{1}{2} \times 2mu^2(1 - e)^2$	**M1**	**3.1a**	Equation for e using ratio of $KE_A : KE_B$	
			$4e^2 - 12e + 5 = 0$ or $1 + 2e = \pm 4(1 - e)$	**M1**	**1.1**	Forming and solving 3-term quadratic	oe
			$e = \frac{5}{2} > 1$ rejected	**A1**	**3.2a**	Must see explicit rejection for this mark	
			$e = \frac{1}{2}$	**A1**	**2.2a**		
			Alternative solution				
			$mu + 2m \times (-2u) = mv_A + 2mv_B$	**M1A1**		As in solution above	
			$v_A + 2v_B = -3u$	**A1**		soi	
			$\frac{1}{2}mv_A^2 = 8 \times \frac{1}{2} \times 2mv_B^2$	**M1**		Use of given KE ratio	
				A1		Correct equation (unsimplified)	
			$v_A = \pm 4v_B$	**A1**		Must have $\pm$ at this stage	
			$v_A = 4v_B \Rightarrow v_B = -\frac{1}{2}u$ and $v_A = -2u$	**M1**		Using either of the two possible cases	
			so $-\frac{1}{2}u - (-2u) = e(u - (-2u))$	**M1**		oe; restitution equation attempted	
			$e = \frac{1}{2}$	**A1**			
			$v_A = -4v_B \Rightarrow v_B = \frac{3}{2}u$ and $v_A = -6u$	**M1**			Or argument that $v_B > v_A$ is not physically possible
			so $\frac{3}{2}u - (-6u) = e(u - (-2u))$	**M1**		oe	
			$e = \frac{5}{2} > 1$ rejected	**A1**			
				[12]			