OCR
Oxford Cambridge and RSA

GCE

Mathematics

Unit **4728**: Mechanics 1

Mark Scheme for June 2014

Advanced Subsidiary GCE

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Annotations and abbreviations

Annotation in scoris	**Meaning**
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓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
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*, D*M1	Method 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
CorS	Cos or Sin
SorC	Sin or Cos

Subject-specific Marking Instructions for GCE Mathematics (OCR) Mechanics strand

a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts as close as possible to the work for which they are awarded. 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 total mark you have awarded, by placing a green tick as close as possible to each element of the solution which gains a mark. This helps create a clerical check that the mark entered via the keyboard is the correct total.

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, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) 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, eg 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

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg 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, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

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 and we do not penalise over-specification.

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 final answer that agrees with the correct value to 2 s.f.(if the answer has no exact decimal value), or 3sf (if the answer has an exact decimal value with more than 3 significant figures). Improper fractions are not acceptable for final answers. ft should be used so method marks (M1, DM1) are not affected, and for accuracy marks as specified in the mark scheme (A1ft). A1ft marks follow through specific errors in a candidate's earlier work, e.g. cv(*T*) where a candidate has wrong calculated a value of *T.*

There is no penalty for using a wrong value for *g*.

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 or B 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 graphical 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	Guidance	
1	(i)		$v^2 = 3.5^2 + 2g \times 5$ $v = 10.5$ ms^{-1}	M1 A1 [2]	Uses $v^2 = 3.5^2$ +/– $2g5$	Accept -3.5^2 for $(-3.5)^2$ etc
	(ii)		$5 = 0.87u - g \times 0.87^2/2$ $u = 10.0$ m s^{-1}	M1 A1 A1 [3]	+/-5 = $0.87u$ +/– g 0.87^2 /2	May come from $s = vt - gt^2/2$
	(iii)		Change = $0.2 \times 10.5 + 0.2 \times 10$ Change = 4.1(0) kg m s^{-1}	M1 A1 [2]	Or +/- 0.2(Ans(i) +/– Ans(ii)) It is OK get -4.1 from correct work	
2	(i)		$2.5\sin\theta = 2.4$ $\theta = 73.7$ $2.5\cos\theta = F$ $F = 0.7$ *OR* $2.4^2 + F^2 = 2.5^2$ *or* $F^2 = 2.5^2 - 2.4^2$ $F = 0.7$	M1 A1 M1 A1 [4] M1 A1	2.5CorSθ = 2.4 Accept 74 F = 2.5 SorCθ, opposite to that above Exact, but allow 0.702 (3 sf) $\theta = 73.7$	$2.5\cos\theta = 2.4$ M1 hence $\theta = 16.3$ A0 $2.5\sin\theta = F$ M1 hence F =0.7(00) A1 SC F can then be used to find θ
	(ii)		$2.4 = 0.2a$ $a = 12$ ms^{-2} Bearing (0)90° *OR* "To right"," opposite old 2.4 N force" etc	M1 A1 B1 [3]	N2L, Any horizontal force other than F, 0.7, 2.5 (Do not treat removing/using 2.5 as a MR) 12.0 from 2.5sin73.7 /0.2 Angle value other than exactly 90° or 0° B0 Allow B1 for force dirn, if accn not found	Including g, automatically M0 Horizontal is B0 (ambiguous)

Question			Answer	Marks	Guidance	
3	(i)		3 ms^{-1}	B1 [1]		MR $(0.6t^3 + 3)$, award B1 here
	(ii)		$x = \int (0.6t^2 + 3)\,dt$ $x = 0.6t^3/3 + 3t$ (+ c) Substitutes 1.5 in expression for x $x(1.5) = 5.175$ m	M1* A1 D*M1 A1 [4]	Integrates v Accept with/without + c Needs integration and 2 terms in t Only without +c. Accept 5.17, 5.18	MR $(0.6t^3 + 3)$ $0.6t^4/4 + 3t$ is A0 MR 5.26 only gets A1ft
	(iii)		$a = d(0.6t^2 + 3)/dt$ $6 = 2 \times 0.6t$ $v(5) = 18$ ms^{-1}	M1* D*M1 A1 [3]	Differentiates v Plus attempt to solve $a(t) = 6$	MR $(0.6t^3 + 3)$ gives t=1.82(57..) v(1.8257..) = 6.65 (3 sf)
4	(i)		Calculation for both "before" Momentum (magnitudes) Compares both terms without arithmetic error Shows direction of after total momentum conflicts with the before velocity/momentum of Q	M1 A1* D*A1 [3]	Must not include g Vector nature of momentum by word or sign (+/-)	Explicit reference to after momentum or conservation of momentum essential.
	(ii)		TMB = +/-(0.2 × 4 + 0.3 × (–2)) $0.8 – 0.6 = 0.2v + 0.3v$ $v = 0.4$ m s^{-1} $0.8 – 0.6 = -0.2v + 0.3v$ $v = 2$ m s^{-1}	B1 M1 A1 M1 A1 [5]	Accept inclusion of g Allow if g included in all terms Not awarded if g included Allow if g included in all terms Not awarded if g included	LHS must be difference for both M1 marks SC $0.8 – 0.6 = 0.2v - 0.3v$ M1 Speed = 2 **and** the direction of motion of Q is reversed A1

Question			Answer	Marks	Guidance	
5	(i)		$5/(T-3) = -4$ *OR* $5/(3-T) = 4$ $T = 1.75$	M1 A1 [2]	Accept verification, $4 \times (3 - 1.75)$ M1 $= 5$ A1 *OR* 5/(3-1.75) M1 = 4 A1	
	(ii)	(a)	-4 ms^{-1}	B1 [1]		
		(b)	4 ms^{-1}	B1 [1]		
		(c)	4 ms^{-1}	B1 [1]		
	(iii)		$2 \times (-)4$, 2×4, $(1 \times)4$ $d = (-)5 + (-)8 + 8 + 4$ $d = 25$ m	M1* D*M1 A1 [3]	Calculates any one unknown distance Adds 5 and "3 other" distances or -5 and "3 other" displacements Correctly comes from 4x(1.25+4+1) 3/3	Allow if only one calc. correct Note t=5 to t=9, t=5 to t=10 etc, may be one term
	(iv)		$v = \mathrm{d}(20t - t^2 - 96)/\mathrm{d}t$ $v = 20 - 2t$ $20 - 2t = -4$ $t = 12$ (ignore any solutions less than 10)	M1* A1 D*M1 A1 [4]	Differentiates x, accept $20 - t$ as "differentiation" $20 - 2t + c = -4$ is DM0 Only from $20-2t = -4$. This answer can arise fortuitously from solving $20t - t^2 - 96=0$.	SC Verifying that t=12 gives v= -4 can gain final M1A1 (A special case of trial and refinement)

Question			Answer	Marks	Guidance	
6	(i)		$3 = 8\mu$ $\mu = 0.375$	M1 A1 [2]	Uses $F = \mu R$, Allow R is 8 or 8g, Fr =3 only 3/8 (fraction), not 3÷8 (division)	
	(ii)		$C^2 = 3^2 + 8^2$ $C = 8.54$ N tanθ =3/8 or tanθ =8/3 $\theta = 20.6°$ with vertical or 69.4° with horizontal	M1 A1 M1 A1 [4]	Uses Pythagoras with 3 and 8 or 8g Accept 8.5 or √73 Uses tan with 3 and 8 or 8g Accept 21 or 69, direction clear by words or diagram.	 Or CorS with answer for C isw work after correct angle magnitude found
	(iii)	(a)	T(cos0) – 3 = +/-3 $T = 6$	M1 A1 [2]	T(cos0) – 3 = 0 is M0 Answer alone is sufficient for M1A1	Tcos0 –3= -3 assumes Fr direction has not changed
	(iii)	(b)	R = +/-(8 – T × SorC30) $R = 8 - T$sin30 Fr = +/– (T × CorS30 – 3) $Fr = T$cos30 – 3 0.375 = (Tcos30 – 3) / (8 – Tsin30) $T = 5.70$ *OR* Alternative for last 4 marks Fr = 0.375(8 – Tsin30) Fr = +/– (T × CorS30 - 3) $Fr = T$cos30 – 3 0.375(8 – Tsin30) = Tcos30 – 3 $T = 5.70$	M1 A1 M1 A1 M1 A1 [6] - M1 A1 M1 A1	Accept 8g with cmpt T oe Accept 3 with cmpt T, not T×CorS30+/–3= 0 oe Accept use of μ from (i). For forming an equation in T alone. Accept use of μ from (i). oe For forming an equation in T alone.	(This is required also in the SC case) SC Does not allow for change in direction of Friction $Fr = 3 - T$cos30 A1 0.375 = (3-Tcos30) / (8 – Tsin30) M1 $T = 0$ A0 SC (Alternative) Fr = 0.375(8 – Tsin30) Fr = +/– (T × CorS30 - 3) M1 $Fr = 3 - T$cos30 A1 0.375(8–Tsin30) = (3-Tcos30) M1 $T = 0$ A0

Question			Answer	Marks	Guidance	
7	(i)		$s = 0.6 \times 2 + 0.9 \times 2^2 /2$ $s = 3$ $AB = 6$ m	M1 A1 A1 [3]	Uses $s = ut + at^2/2$, $u \neq 0$, $a \neq g$ or gCorS30	
	(ii)		$V_M = 0.6 + 0.9 \times 2$ *OR* $V_M{}^2 = 0.6^2 + 2\text{x}0.9\times3$ $a = g\sin30$ $V_B{}^2 = 2.4^2 + 2(9.8\sin30) \times 3$ $V_B = 5.93$ ms^{-1}	 B1 B1 M1 A1 [4]	2.4 5.76 4.9 Uses $v^2 = u^2 + 2as$, $u \neq 0$ or 0.6, $a \neq g$ or 0.9, $s \neq AB$(i) Accept 5.9	Award if found in (i) and used in (ii) If AB(i) = 3, allow its use for final M1A1
	(iii)		$0.3 \times 0.9 = 0.3g\sin30 - T$ $T = 1.2$ N	M1 A1 A1 [3]	N2L, $0.3 \times 0.9 = +/-(0.3g\text{CorS}30 - T)$	$a = 0.9$ essential, $m = 0.3$ but if 0.4 used in (iii) AND 0.3 used in (iv), treat as a single mis-read
	(iv)		$0.4 \times 0.9 = 0.4g\sin30 + 1.2 - Fr$ $Fr = 2.8$ $R = 0.4g\cos 30$ $\mu = 2.8/3.39$ $\mu = 0.825$	M1* A1ft A1 B1 D*M1 A1 [6]	N2L, 3 forces inc +/-(0. 4gCorS30 + T) ft cv(T) in (iii) May be shown by mu calculation May be implied, 3.39(48...) $2.8 = 3.39(48)\,\mu$, both forces positive Accept 0.82, not 0.83 or 0.826	$a = 0.9$ or value used in (iii), m=0.4 but if 0.4 used in (iii) AND 0.3 used in (iv), treat as a single mis-read Awarded only if M1 forN2L equation

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