

GCE

Mathematics

Unit **4728**: Mechanics 1

Advanced Subsidiary GCE

Mark Scheme for June 2015

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

© OCR 2015

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
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	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

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 for responses that are not awarded 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 and must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained. 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 solution. 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 are awarded to 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. Accuracy 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 method 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 answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this does not apply in the 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 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 indicated results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. (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 be given 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if it 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 otherwise stated. In 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 in all cases.

When a value is not given in the paper

Accept any answer that agrees with the correct value to 3 s.f. +/- 1 on the third significant figure.

ft should be used so that only one mark is lost for each distinct accuracy error, except for errors due to ... the app 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 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 ex 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 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 generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the q

Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, 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 co 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 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	Guida...
1	(i)	$v^2 = 14^2 + 2g \times 30$ $v = 28 \text{ m s}^{-1}$	M1 A1 [2]	$v^2 = u^2 + 2gs$
1	(ii)	$s = 14 \times 0.4 + g \times 0.4^2 / 2$ $s = 6.384 \text{ m}$	M1 A1 [2]	Accept 6.38
1	(iii)	$15 = 28t - gt^2 / 2$ $4.9t^2 - 28t + 15 = 0$ $t = (5.12) 0.598 \text{ s}$ <i>OR</i> $28^2 = u^2 + 2g \times 15$ $28 = \sqrt{(490) + gt}$ $t = 0.598 \text{ s}$ <i>OR</i> $15 = 14t + gt^2 / 2$ $30 = (14 + 28)t/2$ $t = 0.598 \text{ s}$	M1* D*M1 A1 [3] M1* D*M1 A1 M1* D*M1 A1	$v^2 = 14^2 + 2g \times 15$ Attempts to solve 3 term QE Finding total time.
2	(i)	Before momentum = $+/- (0.4u - 0.3 \times 8)$ $0.4u - 0.3 \times 8 = -0.4u + 0.3 \times 8$ $u = 6$	B1 M1 A1ft A1 [4]	Uses momentum cons. 4 non-zero terms ft candidates "before" expression
2	(ii)	After momentum = $+/- 9m$ $0.3 \times 8 - 3m = 9m$ $m = 0.2$	B1 M1 A1ft A1 [4]	Uses momentum conservation 3 non-zero terms ft candidates "after" expression

Question		Answer	Marks	Guidance
3	(i)	A cycles $(= 20 \times 1) = 20$ km B walks $= 20/4$ h Time $= 5$ hours	B1 M1 A1 [3]	
3	(ii)	$20 \times 1 + 5(T - 1)$ $= 4 \times 5 + 15(T - 5)$ $T = 7$ <i>OR</i> $5(T - 1)$ $= 15(T - 5)$ $T = 7$	B1 M1 A1 [3] B1 M1 A1	Total A or B distance correct Equates total distances for A and B Accept cv(5) Using t instead $t = 2$ gets B1 Needs consistency
3	(iii)	Total distance (A) $= 20 \times 1 + 5(7 - 1)$ $J = 50$ km	M1 A1 [2]	Or (B) $4 \times 5 + 15 \times (7 - 5)$ cv(7) and, for
4	(i)	$x = \pm(10 - 6\cos 70)$, $y = 6\sin 70$ <i>OR</i> $\pm(10\cos 70 - 6)$, $10\sin 70$ <i>OR</i> correct resolving in 2 perpendicular directions $R^2 = \{\pm(10 - 6\cos 70)\}^2 + (6\sin 70)^2 =$ $\{\pm(10\cos 70 - 6)\}^2 + (10\sin 70)^2$ $R = 9.74$ N $\tan \alpha = (6\cos 20)/(10 - 6\sin 20)$ $\alpha = 35.4^\circ$	B1, B1 M1 A1 M1 A1 [6]	B1 B1 $10\cos 55 + 6\cos 55 (= 9.177)$ $\pm(10\sin 55 - 6\sin 55) (= \pm 3.2766)$ $R^2 = (10\cos 55 + 6\cos 55)^2 +$ $(10\sin 55 - 6\sin 55)^2$ $R = 9.74$ N www Uses cosine rule $R^2 = 6^2 + 10^2$ Uses angle of $R = 9.74$ N $\sin \alpha / 6 = \sin 70 / 10$ $\alpha = 35.4^\circ$

Question		Answer	Marks	Guida.
4	(ii)	Force = $(20 - 9.74) = 10.3 \text{ N}$	B1ft [1]	Difference of weight and Resultant ft 20 - cv(9.74)
4	(iii)	$\tan\theta = +/- (10 - 6\cos70) / 6\sin70$ OR $\tan\phi = +/- (6\sin70) / (10 - 6\cos70)$ Angle = 54.6°	M1 A1 [2]	Uses resultant is vertical Angle = $90 -$ Angle = 54.6
5	(i)	$Fr = 0.2 \times 0.4g$ $1.2 - 0.2 \times 0.4g = 0.4a$ $a = 1.04 \text{ m s}^{-2}$	B1 M1 A1 [3]	N2L, 2 forces
5	(ii)	$R = 0.4g - 1.2\sin20$ $1.2\cos20 - 0.2(0.4g - 1.2\sin20) = 0.4a$ $a = 1.06 \text{ m s}^{-2}$	B1 M1 A1 [3]	N2L, 2 forces, cmpt of 1.2 and Fr not $Fr(i)$ SC $R = 0.4g$ $1.2\cos20 - 0.2$ $a = 0.654 \text{ m s}^{-2}$ Give B1M1
5	(iii)	$1.2\cos70 - 0.2(0.4g - 1.2\sin70)$ (Total is negative,) friction not overcome by (tractive) force $a = 0 \text{ m s}^{-2}$	M1 A1 A1 [3]	Difference of two relevant forces, neither used earlier (or find and compare) SC $1.2\cos70$ Mark as correct Only finding scores maximum
5	(iv)	$1.2 < 0.4g$ (oe, soi) P cannot rise from table or $a = 0 \text{ m s}^{-2}$	M1 A1 [2]	Comparison of weight and 1.2 without involving R Only finding a negative acceleration scores M0 SC Sum of w P can't go th B1 only

Question		Answer	Marks	Guidance
6	(i)	$v = \int 4 + 12t \, dt$ $v = 4t + 12t^2/2 (+ c)$ $(t = 0, v = 2) \, c = 2$ and $v(3) = 4 \times 3 + 12 \times 3^2/2 (+ 2)$ $v = 68 \, \text{m s}^{-1}$	M1* A1 D*M1 A1 [4]	Integrates acceleration Award without (+ c) Evaluates constant
6	(ii)	$\int 4t + 6t^2 (+2) dt$ $x = 4t^2/2 + 6t^3/3 + 2t (+ d)$ $x(3) = 4 \times 3^2/2 + 6 \times 3^3/3 (+ 3 \times 2)$ $x = 78 \, \text{m}$	M1* A1ft D*M1 A1 [4]	Integrates velocity accept omission of d for all subsequent marks ft on incorrect
6	(iii)	$k = 132$	B1ft [1]	ft cv(78) + 54
6	(iv)	$v = d(k - 2t^3) / dt$ $v = -2 \times 3t^2$ $v(3) = -6 \times 3^2 (= -54)$ $68m - 54m = 2mv$ $v = 7 \, \text{m s}^{-1}$	M1* A1 D*M1 M1 A1 [5]	Differentiates displacement Award even if k wrong earlier Substitutes $t = 3$ Conservation of momentum, must have $2m$, cv(68) No marks if g apparently ca

Question			Answer	Marks	Guidance
7	(i)		$T - 0.3g\sin 30 = 0.3a$ OR $0.4g\sin 30 - T = 0.4a$ $0.4g\sin 30 - 0.3g\sin 30 = 0.7a$ $a = 0.7 \text{ m s}^{-2}$ $T = 0.3g\sin 30 + 0.3 \times 0.7$ $T = 1.68 \text{ N}$	B1 M1 A1 M1 A1 [5]	Either correct N2L for one particle May be awarded later in (i) Allow combined approach as "method", must be components of weight, allow $mg(\cos/\sin)30$ Allow $0.3g(\cos/\sin)30$. Accept cv(0.7)
			AG		Put... for a su... correctly e... Consult TL... particles. May use the
7	(ii)		$V = 1.8 \times 0.7$ $V = 1.26 \text{ m s}^{-1}$	M1 A1 [2]	Accept cv(0.7)
7	(iii)		$\text{Dec} = 1.26 / 1.4$ $\text{Dec} = 0.9 \text{ m s}^{-2}$	M1 A1 [2]	Accept $1.8 \times 0.7 / 1.4$ Or $a = +/-0.9$ cv(1.26)
7	(iv)	(a)	$T - 0.3g\sin 30 = -0.3 \times 0.9$ $T = 1.2$	M1 A1ft A1 [3]	N2L, 2 forces including cmpt of weight cv(0.9) but signs must be consistent with the direction of motion Allow $mg(\cos/\sin)30$
7	(iv)	(b)	$-0.4 \times 0.9 = 0.4g\sin 30 - T - F_r$ $-0.4 \times 0.9 = 0.4g\sin 30 - 1.2 - F_r$ $F_r = 1.12 \text{ N}$	M1 A1ft A1 [3]	N2L, 3 forces including cmpt of weight cv(0.9) and cv(1.2) but signs must be consistent with the direction of motion Allow $mg(\cos/\sin)30$

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2015

