OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced Subsidiary GCE

Unit **4728:** Mechanics 1

Mark Scheme for January 2011

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, 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 2011

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone:	0870 770 6622
Facsimile:	01223 552610
E-mail:	publications@ocr.org.uk

1 i	ΔMom P = 0.5(2.4 + 0.2)	M1	+/- 0.5(2.4 ± 0.2)	MR P/Q +/-0.8(1.5+/-0.2) M1A0
	ΔMom P = +/-1.3 kgms^{-1}	A1 [2]		

ii	Momentum before = 0.5x2.4 – 0.8x1.5	B1	+/-(0.5x2.4 – 0.8x1.5)	Cont MR 0.5x2.4-0.8x1.5
		M1	Uses mom before = mom after	Uses mom before = mom after
	0.5x2.4+/ – 0.8x1.5 = +/-(-0.5x0.2 +/- 0.8v)	A1ft	Cv(Expression for before momentum)	0.5x2.4+/-0.8x1.5 = +/-(0.8x0.2+/-0.5v)
	Speed = 0.125 ms^{-1}	A1	1/8, +ve (not 0.13)	0.32 B1 M1A1A1 ft
	OR	[4]		
	ΔMom Q =+/- (+/-0.8v – 0.8x1.5)	B1		
		M1	Uses ΔMom P = ΔMom Q	
	1.3 = +/-(0.8v – 0.8x1.5)	A1ft	Cv(ans(i)) = +/-(+/-0.8v – 0.8x1.5)	
	Speed = 0.125 ms^{-1}	A1	1/8, +ve (not 0.13)	

2 i	10CorSα = 8	M1	Component of 10 = 8	CorS is Cos or Sin (passim)
	10cosα = 8	A1		
	α = 36.9°	A1	Accept 37 36.8 and 37 from 36.7	Do not accept 36.7
	OR	[3]		
	10CorSα = F	M1	Using value of F(ii)	
	10sinα = 6	A1ft	Using F(=6) from (ii)	
	α = 36.9°	A1		
	OR			
	tanθ = F/8	M1	OR tanθ = 8/F, using value of F from (ii)	
	tanα = 6/8	A1ft		
	α = 36.9°	A1		

ii		M1	F = 10CorSα	
	F = 10sin36.9	A1ft	Allow 10Cos53.1	
	F = 6 N	A1	Accept 6.01 (or from 10Cos53.1) or 6.0	anything rounding to 6.0 from correct working.
	OR	[3]		
		M1	Pythagoras, 3 squared terms	Accept F^2 = 8^2+ 10^2
	F^2 +8^2 = 10^2	A1		
	F = 6 N	A1		

3 i	$v^2 = (+/-5)^2 + 2 \times 9.8 \times 2.5$ Speed (or v) = 8.6(0) ms^{-1} OR $0 = 5^2 – 2 \times 9.8 \times s$ with $v^2 = (0) + 2 \times 9.8(s+2.5)$ $v^2 = 2 \times 9.8 \times (2.5+1.28)$ Speed = 8.6(0) ms^{-1}	M1 A1 A1 [3] M1 A1 A1	Uses $v^2 = u^2 \pm 2gs$, u non-zero Accept $\sqrt{74}$ Do not accept -8.6(0) s = 1.2755... 19.8 $\times$ 3.7755.. Or rounds to 8.6	It is common to see the upwards and downwards motion treated separately. Both parts must be attempted for M1, and both parts must be attempted accurately with cvs for the A1
ii	$8.6 = -5 + 9.8t$ Time = 1.39 s OR $9.8t^2 - 10t - 5 = 0$ Time = 1.39 s OR $2.5 = (8.6-5)t/2$ Time = 1.39 s OR $t = 5/9.8 + 8.6/9.8$ Time = 1.39	M1 A1ft A1 [3] M1 A1 A1 M1 A1ft A1 M1 A1ft A1	Uses v(from (i)) = +/-5 +/- 9.8t Cv(8.60 from (i)) +/-2.5 = 5t +/- gt^2/2 2.5 = +/- (5 - Speed from (i)) x t / 2 Cv(8.60 from (i)) Times to top and ground found and added Cv(8.60 from (i))	It is common to see the upwards and downwards motion treated separately. Both parts must be attempted for M1, and both parts must be attempted accurately with cvs for the A1
iii a) b)		B1 B1 B1 B1 [4]	Straight descending line to t axis Continues straight below t axis Inverted "parabolic" curve, starts anywhere on t=0 Ends below t = 0 level, need not be below t axis	Ignore values written on diagrams

4 i	$2 - F = 0.8 \times 0.2$ $F = T\cos 10$ $T = 1.87$ N OR $2 - T\cos 10 = 0.8 \times 0.2$ $T = 1.87$ N	M1 M1 A1 [3] M1 M1 A1	N2L 2 force terms and ma (F = 1.84 N) F = TCorS10 1.8683.. N2L 2 force terms and ma TCorS10	m is the block mass, award if T not F
ii	$R - 0.3 \times 9.8 + T CorS10 = 0$ $R = 0.3 \times 9.8 - 1.87\sin 10$ $R = 2.62$ $T\cos 10 - Fr = 0.3 \times 0.2$ $Fr = 1.78$ $\mu = 1.78 / 2.62$ OR $1.78 = 2.62\,\mu$ $\mu = 0.68$	M1 A1ft A1ft M1 A1ft M1 A1 [7]	3 term equation, vertically cv(T(i)) 2.61(5..) seen or implied N2L 2 forces for P, component of T cv(T(i)) seen or implied both terms same sign	Treat as a mis-read R-0.8x9.8-TCorS10 = 0 leading to R=8.16 (i.e.works on block[2/3] OR N2L 2 forces for P+Q: $2 - Fr = (0.8+0.3) \times 0.2$ R, Fr unequal to T From correct value of T = 1.87 only

5 ia	$s(P) = 4.9T + 0.5 \times 4.9T^2$ $y(Q) = (0) + 0.5 \times 9.8T^2$	M1 A1 A1 [3]	s=ut+0.5at² used along plane or vertically, with u = 4.9 or 0, and a = 4.9 or 9.8 appropriately Accept use of t or T Allow g in Y(Q)	
b	$(m) \times 4.9 = (m)g\sin\theta$ $\theta = 30$	M1* A1 [2]	Allow CorSθ	Sinθ =(0.5x9.8T²)/(4.9T + 0.5x 4.9T²) gets M1, but in ic. Beware circular argument.
c	$y(Q)/s(P) = \sin\theta$ OR $y(Q) = s(P) \sin\theta$ $0.5 \times 9.8(2/3)^2 / (4.9 \times 2/3 + 2.45(2/3)^2) = 0.5$ OR $0.5 \times 9.8T^2 / (4.9T + 2.45T^2) = \sin 30$ $T = 2/3$ s AG	M1 D*M1 A1 [3]	Uses appropriate trigonometry to relate distances Verification needs explicit value of sin(cv(θib)) Ratio of distances considered using cv (30)	This may appear in b) $0.5 \times 9.8(2/3)^2 = (4.9 \times 2/3 + 2.45(2/3)^2) \times 0.5$ OR $0.5 \times 9.8T^2 = (4.9T + 2.45T^2) \times \sin 30$
ii	$v = 4.9 + 4.9 \times 2/3$ OR $v = (0) + 9.8 \times 2/3$ $v = 8.17$ ms⁻¹ $w = 9.8 \times 2/3 = 6.53$ ms⁻¹	M1 A1 A1 [3]	Uses v = u + at, with appropriate u, a values once 8.2 6.5	

6 i	$x = \int t^2 - 9 \, dt$	M1*	Uses integration of v(t)	
	$x = t^3/3 - 9t$ (+c)	A1	Award if +c omitted	
	Finds x(2)	D*M1	Allow + c or c omitted	
	Displacement = 15⅓ m	B1	Accept 15.3, 46/3. Must be +ve	Awarded if c omitted or assumed 0
	OR	[4]		
	$x(2) = [t^3/3 - 9t]_0^2$	D*M1	Uses limits[]$_0^2$ on integrated x(t)	
	Displacement = 15⅓ m	B1	Must be +ve	
ii	t=0 s=0 or s=46/3 hence x(0) or c= 0 or 46/3	B1*	Needs explanation, may be seen in part i	B1* awarded if limits 0 and 3 used correctly
	Solves $t^2 - 9 = 0$	M1*	May be implied	
	t = (±)3	A1	Value of t when direction of motion changes	
	x(3) = $3^3/3 - 9 \times 3$ (+ 15.3)	D*M1	Substitutes cv(t) >2 in integrated x(t)	
	x(3) = -18 (or -2.67)	M1	Evaluates c – 18 may be implied award if ..	Awarded if limits used correctly
	Dist = 18 m	D*B1	Accept 18(.0) [c=0 assumed]	
		[6]		
iii	$a = d(t^2 - 9)/dt$	M1*	Uses differentiation of v(t)	
	a = 2t	A1		
	10 = 2t	D*M1		
	t = 5	A1		
	x(5) (= $5^3/3 - 9 \times 5 + 15.3$) = 12 m	A1		
	OR	[5]		
	$[t^3/3 - 9t]_2^5$ = 12 m	A1		

7 i	Wt cmpts: // plane 0.6gsin30	B1	+/-2.94	
	Perp plane 0.6gcos30	B1	+/-5.09(22.) = R	
		M1	N2L // plane, 2 force terms and ma (allow no g)	
	0.6gsin30 +/- X = 0.6x10	A1ft	Both weight cmpt and accn signs same	Accept Fr for X
	X = +/-3.06	A1	May be implied (Fr =0.6x10-0.6gsin30 used)	
	μ = 3.06 / 5.09(22..)	M1	Uses μ = Fr/R both terms same sign	Accept Fr = |X|
	μ = 0.601	A1	0.6	
	OR	[7]		
	3.06 = μ x 5.09(22..)	M1	Uses Fr = μR both terms same sign	Accept Fr = |X|
	μ = 0.601	A1	0.6	
ii a)	$C^2 = 3.06^2 + 5.09^2$	M1	Pythagoras with Fr and R, to find hypotenuse	
	C = 5.94 N	A1	Accept 5.9, 5.95 but not 6(.0)	
	tanθ = 3.06/5.09(22..)	M1*	Or tanθ = μ	
	Angle = (31) + 90	D*M1		
	Angle = 121°	A1	Not 120	
	OR	[5]		
	tanφ = 5.09(22..)/3.06	M1*	tanφ = 1/ μ	
	Angle = 180 – (59)	D*M1		
	Angle = 121°	A1	Not 120	
b)	C (= 0.6x9.8) = 5.88 N	B1	5.9	No working needed as C is vertical
	Angle = 60°	B1		No working needed as C is vertical
		[2]		

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

OCR Customer Contact Centre

14 – 19 Qualifications (General)
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