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Mark Scheme (Results)

January 2012

GCE Mechanics M2 (6678) Paper 1

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

- bod – benefit of doubt
- ft – follow through
- the symbol ⎍ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark
  ⌙

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

General Principals for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q),$ where $|pq| = |c|$, leading to x = ...

$(ax^2 + bx + c) = (mx + p)(nx + q),$ where $|pq| = |c|$ and $|mn| = |a|$, leading to x = …

2. Formula

Attempt to use correct formula (with values for *a*, *b* and *c*), leading to x = …

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c, \quad q \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

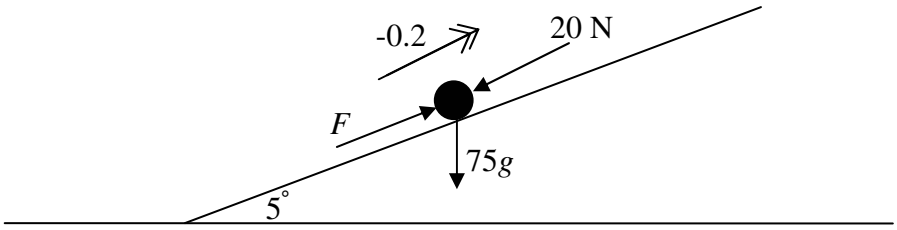
Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Use of a formula

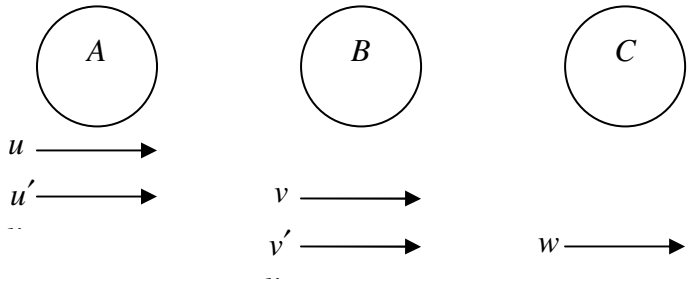
Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.
Normal marking procedure is as follows:
Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.
Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

January 2012
6678 Mechanics M2
Mark Scheme

Question Number	Scheme	Marks
1	Use of $m(\boldsymbol{v} - \boldsymbol{u}) = \boldsymbol{I}$ $0.1 \times (\boldsymbol{v} - 30\mathbf{i}) = -2\mathbf{i} - 4\mathbf{j}$ Solve for $\boldsymbol{v}$: $0.1\boldsymbol{v} = 3\mathbf{i} - 2\mathbf{i} - 4\mathbf{j} = \mathbf{i} - 4\mathbf{j}$ $\boldsymbol{v} = 10\mathbf{i} - 40\mathbf{j}$	M1 A1 DM1 A1 **4**
2 **(a)**	Speed $= \sqrt{8^2 + 48^2} = \sqrt{2368} = 48.7\ (\text{ms}^{-1})$	M1 A1 (2)
(b)	$\mathbf{a} = 2\mathbf{i} - 6t\,\mathbf{j}$ When $t = 4$, $\mathbf{a} = 2\mathbf{i} - 24\,\mathbf{j}\ (\text{ms}^{-2})$	M1 A1 A1 (3)
(c)	$\mathbf{r} = t^2\mathbf{i} - t^3\mathbf{j} + \mathbf{C}$ t = 1, $-4\mathbf{i} + \mathbf{j} = \mathbf{i} - \mathbf{j} + \mathbf{C}$, $\mathbf{C} = -5\mathbf{i} + 2\mathbf{j}$ $\mathbf{r} = (t^2 - 5)\mathbf{i} + (-t^3 + 2)\mathbf{j}$ When $t = 4$, $\mathbf{r} = (16-5)\mathbf{i} + (-64 + 2)\mathbf{j} = 11\mathbf{i} - 62\mathbf{j}$	M1 A1 DM1 DM1 A1 (5) **10**

Question Number	Scheme	Marks
3 **(a)**		
	Driving force = F	M1
	Resolving parallel to the plane: $F - 20 - 75g\sin 5 = -75\times 0.2 = -15$	A2 – lee
	$F = 5 + 75g\sin 5°$	
	$P = Fv$ $\therefore$ working at $12\times(5 + 75g\sin 5°) = 828.7.....$	DM1
	≈ 830 W	A1
		(5)
(b)		
	Loss in KE = gain in GPE + work done against resistance	M1
	$\frac{1}{2}\times 75\times 64 = 75\times 9.8\times\sin 5°d + 20d = d\times 84.059....$	A2 – lee
	$d = 28.6$ m	DM1 A1
		(5)
		10

Question Number	Scheme	Marks
4		
(a)	For an appropriate division of the trapezium into standard shapes with:	
	correct ratio of masses	B1
	correct distances of c.o.m. from AB	B1
	e.g three equilateral triangles of height $\sqrt{3}$, mass m kg,	
	com $\frac{\sqrt{3}}{3}$ from bases of each	
	$3md = \left(m\times\frac{2}{3}\times\sqrt{3}\right)+\left(2\times m\times\frac{1}{3}\sqrt{3}\right)=\frac{4\sqrt{3}}{3}m$,	M1 A1
	$d=\frac{4\sqrt{3}}{9}$ **AG**	A1
		(5)
(b)	Horizontal distance of c of m from D = 1m	B1
	Vertical distance $\sqrt{3}-\frac{4\sqrt{3}}{9}=\frac{5\sqrt{3}}{9}$ (0.962….)	B1
	$\tan^{-1}\frac{0.962...}{1}$	M1 A1ft
	Angle = 43.9°	A1
		(5)
		10
5		
(a)	Taking moments about A:	M1
	$4g\times 0.7\times\cos 20° = 1.4T$	A1 A1
	T = 18.4 N	A1
		(4)
(b)	↑ $R + T\cos 20 = 4g$	
	$R = 4g - T\cos 20°$	M1 A1
	→ $F = T\sin 20$	M1 A1
	$F=\mu R \Rightarrow T\sin 20° = \mu(4g - T\cos 20°)$	DM1 A1
	$\mu=\frac{T\sin 20°}{4g - T\cos 20°}=0.29$	A1
		(7)
		11

Question Number	Scheme	Marks
6 **(a)**		
	Momentum: $u = u' + v$	M1 A1
	NEL: $v - u' = eu$	M1 A1
	$2v = u(1 + \frac{2}{3}),\ v = \frac{1}{2}u \times \frac{5}{3} = \frac{5u}{6}$	DM1 A1
	$u' = u - v = \frac{u}{6}$	A1
		(7)
(b)	KE lost $= \frac{1}{2}mu^2 - \left(\frac{1}{2}m \times \frac{25}{36}u^2 + \frac{1}{2}m \times \frac{1}{36}u^2\right)$ their speeds	M1
	$= \frac{1}{2}mu^2 - \left(\frac{1}{2}m \times \frac{26}{36}u^2\right)$	A2 – 1ee
	$= \frac{1}{2}mu^2 \times \frac{10}{35} = \frac{5}{36}mu^2$ **AG**	A1
		(4)
(c)	Speed of C $= \frac{1}{2}\left(\frac{1}{2}u\left(\frac{5}{3}\right)\right)\left(\frac{5}{3}\right) = \frac{1}{2} \cdot \frac{5u}{6} \cdot \frac{5}{3}, = \frac{25}{36}u$	M1 A1 DM1 A1
		(4)
		15

Question Number	Scheme	Marks
7		
(a)	**i** → distance = $6t$	B1
	j ↑ distance = $12t - \frac{1}{2}gt^2$	M1 A1
	At B, $2\left(12t - \frac{1}{2}gt^2\right) = 6t$	M1 A1
	$(24-6)t = gt^2$	DM1
	$18 = gt$, $t = \frac{18}{g} (= 1.84\text{s})$	A1
		(7)
(b)	**i** → speed = 6	B1
	j ↑ velocity = $12 - gt = -6$	M1 A1
	$\therefore$ speed at A	
	$= \sqrt{6^2 + 6^2} = \sqrt{72} = 6\sqrt{2} (= 8.49) (\text{ms}^{-1})$	M1 A1
		(5)
(c)	↑ speed = $12 - gt = +6$	M1 A1 ft
	$t = \frac{6}{g} (= 0.61\text{s})$	A1
		(3)
		15

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