OCR
RECOGNISING ACHIEVEMENT

FSMQ

Additional FSMQ

Free Standing Mathematics Qualification

6993: Additional Mathematics

Mark Scheme for June 2011

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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.

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1. Subject-specific Marking Instructions

1. **M** (method) marks are not lost for purely numerical errors.
   A (accuracy) marks depend on preceding **M** (method) marks. Therefore **M0 A1** cannot be awarded.
   B (independent) marks are independent of **M** (method) marks and are awarded for a correct final answer or a correct intermediate stage.

2. Subject to 1, two situations may be indicated on the mark scheme conditioning the award of **A** marks or **B** marks:
   i. Correct answer correctly obtained (no symbol)
   ii. Follows correctly from a previous answer whether correct or not (**FT** on mark scheme and on the annotations tool).

3. Always mark the greatest number of significant figures seen, even if this is then rounded or truncated in the answer.

4. Where there is clear evidence of a misread, a penalty of 1 mark is generally appropriate. This may be achieved by awarding **M** marks but not an **A** mark, or awarding one mark less than the maximum.

5. For methods not provided for in the mark scheme give as far as possible equivalent marks for equivalent work. If in doubt, consult your team leader.

6. Where a follow through (**FT**) mark is indicated on the mark scheme for a particular part question, you must ensure that you refer back to the answer of the previous part question 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.

2. Abbreviations

The following abbreviations are commonly found in Mathematics mark schemes.

- Where you see **oe** in the mark scheme it means **or equivalent.**
- Where you see **cao** in the mark scheme it means **correct answer only.**
- Where you see **soi** in the mark scheme it means **seen or implied.**
- Where you see **www** in the mark scheme it means **without wrong working.**
- Where you see **rot** in the mark scheme it means **rounded or truncated.**

- Where you see **seen** in the mark scheme it means that you should award the mark if that number/expression is seen anywhere in the answer space, even if it is not in the method leading to the final answer.

- Where you see **figs 237**, for example, this means any answer with only these digits. You should ignore leading or trailing zeros and any decimal point e.g. 237000, 2·37, 2·370, 0·00237 would be acceptable but 23070 or 2374 would not.

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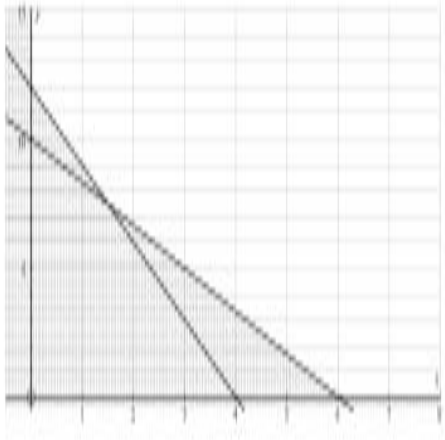
Section A

Question			Answer	Marks	Part Marks and Guidance	
1			For (5, 2) use $x^2 + y^2$ = 29 so inside	**M1** **A1** **A1** **3**	Substitute or use Pythagoras **soi** or $\sqrt{29}$ Conclusion (dependent on M1A1 awarded)	As usual only award A marks if the M mark has been awarded. **Alternative method:** Sub of $x = 5$ or $y = 2$ in $x^2 + y^2 = 30$ to find y or x **M1** $y = \sqrt{5}$ or $x = \sqrt{26}$ **A1**
2			$\frac{dy}{dx} = 3x^2 - 2x - 2$ At $x = 3$ gradient $= 27 - 6 - 2 = 19$ $\Rightarrow y - 9 =$ "their" 19$(x - 3)$ $\Rightarrow y = 19x - 48$ oe	**M1** **A1** **A1** **M1** **A1** **5**	Differentiate All three terms correct 19 **isw** (**dep** on first **M1**) Find line using correct point and *their* 19	At least one power decreased by 1. "*their*" 19 means: the value of the derivative Only 3 terms
3	i		eg $\cos P = \frac{8^2 + 7^2 - 9^2}{2.8.7}$ oe $\Rightarrow P = 73.4°$	**M1** **A1** **M1** **A1** **4**	Cosine formula correctly used to find any angle Anything that rounds to 73.4°, 48.2° or 58.4° For identifying correct angle	 Anything that rounds to 73.4°

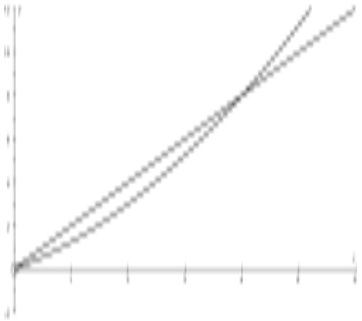
Question			Answer	Marks	Part Marks and Guidance	
3	ii		Area $= \frac{1}{2} \times 7 \times 8 \times \sin(\textit{their angle P})$ $= 26.8$	**M1** **A1** **A1** **3**	Use of formula Correct substitution from *their* **(i)** Anything that rounds to 26.8	Can be at any vertex Accept complete alternative methods
4			$5\sin 2x = 2\cos 2x$ $\Rightarrow \tan 2x = 0.4$ $\Rightarrow 2x = 21.8,\ 201.8$ $\Rightarrow x = 10.9,\ 100.9$ Also $x = 190.9, 280.9$	**M1** **A1** **A1** **A1** **A1** **5**	Use of tan 0.4 10.9 Any 2nd value 3rd and 4th values (*ignore extra solutions)*	allow tan$x$ = 0.4 for **M1A1** **Alternative method** Use of Pythagoras to get $\sin 2x = \frac{2}{\sqrt{29}}$ or $\cos 2x = \frac{5}{\sqrt{29}}$ **M1A1** *and the last three marks are still available, ignore extra solutions*
5	a		*M is* $\left(\frac{-2+4}{2}, \frac{1+9}{2}\right)$ *which is* $(1,5)$	**B1** **1**		
5	b		Gradient of AC is $\frac{9-1}{4+2} = \frac{4}{3}$ Gradient of BM is $\frac{2-5}{5-1} = -\frac{3}{4}$ $\frac{4}{3} \times -\frac{3}{4} = -1$ oe	**B1** **B1** **B1** **3**	One gradient Second gradient *Their* $m_1 \times m_2 = -1$	 Eg One is the negative reciprocal of the other
5	c	i	Isosceles	**B1** **1**	Allow right-angled isosceles	Accept wrong spelling Do not accept right-angled triangle

Question			Answer	Marks	Part Marks and Guidance	
5	c	ii	$AB^2 = 7^2 + 1^2 = 50$ $BC^2 = 7^2 + 1^2 = 50$ $\Rightarrow$ two sides equal in length	**M1** **A1** **2**	Using Pythagoras on AB and BC Or fully labelled diagram with correct sides shown	Attempt by vectors **AB** and **BC M1** **Alternative** If answer to **(c)(i)** was right-angled, then accept proof that it is (requires all three lengths.) **Alternative:** If **(c)(i)** was equilateral or scalene then **M1** (only) for attempt at all three sides. NB If nothing is written in **(i)** then no credit in this part.
6			$(x \pm 5)(x \pm 7)$ Boundaries $x = 5, x = 7$ $\Rightarrow 5 \le x \le 7$	**M1** **A1** **B2** **4**	Or use of correct formula (allow one error in substitution) or correct shaped graph seen **soi** Accept $x \ge 5$, $x \le 7$ for **B1, B1**	 Condone < or >
7	a	i	Attempt to find f(2) by substitution of 2 = 0, So Yes	**M1** **A1** **2**	Remainder theorem or attempt to divide (justification is sight of $x^3 - 2x^2$) Or: attempt to factorise, justification is sight of $(x^2 \ldots 3)$ Correct working only	
7	a	ii	f(−1) = −1 + 7 + 6 = 12 so no.	**B1** **1**	Sight of 12 or correct evidence, conclusion required	
7	b	i	f(x) = (x − 2)(x^2 +2x −3) = (x − 2)(x + 3)(x − 1)	**M1** **A1** **A1** **3**	Attempt to factorise or use long division (justifications as in **(a)(i)**) Sight of correct quadratic **soi** Answer	**Alternative:** Use of Remainder theorem **M1** Sight of 2nd factor **A1** All correct **A1**
7	b	ii	x = 1, 2, –3	**B1** **1**	**FT** their brackets	Must be three roots

Question			Answer	Marks	Part Marks and Guidance	
8	i			**B1** **B1** **B1** **B1** **B1** **5**	for one line for correct shading for other line for correct shading for correct shading to give $x \geq 0$, $y \geq 0$ NB If intercepts are within 1 small square of the correct points then give the marks for the lines	*If there is work here that is not crossed out, then mark it and ignore anything on Page 18.* Helpful hint: Lines go through (0, 12) and (4,0) (0, 10) and (6, 0) Intersection at (1.5, 7.5) If **B0** for a line allow **B1** for shading if negative gradient and lines intersect
8	ii		$6x + y$ is minimum at (0, 12) *(can be implied by correct answer)* So is 12	**B1** **B1** **2**		
9			$\frac{dy}{dx} = 3x^2 - 2x + 4 \Rightarrow (y) = x^3 - x^2 + 4x + c$ (2,2) satisfies $\Rightarrow 2 = 8 - 4 + 8 + c$ $\Rightarrow c = -10$ $\Rightarrow y = x^3 - x^2 + 4x - 10$	**M1** **A1** **M1** **A1** **4**	Integrate Ignore c (**dep** on 1st **M1** mark) Substitute **cao**	At least one term with power increased by 1. (NB do not accept multiplying throughout by x) (ie must be $y =$ ….)
10			$\sin\theta = \frac{2}{5} \Rightarrow \sin^2\theta = \frac{4}{25} \Rightarrow 0.16 + \cos^2\theta = 1$ $\cos^2\theta = \frac{21}{25}$ $\Rightarrow \cos\theta = \frac{1}{5}\sqrt{21}$ oe	**M1** **A1** **A1** **3**	Use of Pythagoras $\cos^2\theta$ eg $\sqrt{0.84}$ or $\sqrt{\frac{21}{25}}$ **isw**	Sight of a triangle with sides 2, 5, $\sqrt{21}$ acceptable for **M1** Then **A2** for $\cos\theta$ NB **M0** if calculator used to find θ in order to find $\cos\theta$

Section B

Question			Answer	Marks	Part Marks and Guidance	
11	**i**		$P(0) = (0.95)^6$ $= 0.735(09189\ldots)$	**M1** **A1** **2**	Correct *p* plus correct power	Not 2sf
11	**ii**		$P(1) = 6 \times (0.95)^5 \times (0.05)^1$ $= 0.232(134281\ldots)$	**M1** **B1** **B1** **A1** **4**	Correct *p* and *q* and powers add to 6 Coefficient **soi** Correct powers for correct *p* and *q* **soi**	Coefficient may be missing
11	**iii**		$P(1^{st}$ box contains 2 or more eggs) = 1 − (their**(i)** + their **(ii)**) = 1 − (0.7351 + 0.2321) =1 − 0.9672 = 0.0328 $P(2^{nd}$ box has any cracked eggs) = 1 − *their* **(i)** = 0.2649 P(consignment is rejected) = 0.0328 + 0.2649 × their **(ii)** = 0.0328 + 0.0615 = 0.0943	**M1** **A1** **M1** **A1** **M1** **A1** **6**	 Accept anything rounding to 0.033 Accept anything rounding to 0.265 In either method, accept answers which lie between 0.094 and 0.095	Alternative P(accepted) **M1** Ans**(ii)** × Ans**(i)** **A1** 0.1706 **soi** (Accept 0.171) **M1(dep)** Add to this Ans**(i)** **A1** 0.9057 (Accept 0.906) **M1** P(consignment is rejected) = 1 − 0.9057 **A1** = 0.09428

Question			Answer	Marks	Part Marks and Guidance	
12	a		$s = ut + \frac{1}{2}at^2$ with $u = 0$ and $a = 2$ $\Rightarrow s = t^2$	**M1** **A1** **2**	Constant acceleration formulae or integrate twice – ignore *c*	
12	b		$(v) = \frac{t^2}{4} + t$ $s = \frac{t^3}{12} + \frac{t^2}{2}$ Ignore *c*	**M1** **A1** **M1** **A1** **4**	Integrate Integrate	
12	c	i	$\frac{t^3}{12} + \frac{t^2}{2} = t^2$ $\Rightarrow \frac{t}{12} + \frac{1}{2} = 1$ $\Rightarrow t = 6$	**M1** **A1** **2**	Equate their functions	
12	c	ii	$s = 6^2$ or $s = \frac{6^3}{12} + \frac{6^2}{2}$ Displacement = 36 (m)	**M1** **A1** **2**	Substitute *their non-zero* **(c)(i)** in *their* **(a)** or **(b) soi**	
12	d			**B1** **B1** **2**	One clearly straight line through origin with positive gradient Other clearly a curve through the origin of correct shape with first part below the line as per diagram	Ignore labels

Question			Answer	Marks	Part Marks and Guidance	
13	i		$AO^2 = x^2 + x^2 = 2x^2$ or $AC^2 = (2x)^2 + (2x)^2 = 8x^2$ $h^2 + AO^2 = AE^2 \Rightarrow h^2 + 2x^2 = 25$ $\Rightarrow 2x^2 = 25 - h^2$	**M1** **A1** **2**	Correct application of Pythagoras on the base Algebra must be convincing	 NB Answer is given
13	ii		$V = \frac{1}{3} \times$ base area $\times$ height $= \frac{1}{3} \times 4x^2h$ $= \frac{50h - 2h^3}{3}$	**M1** **A1** **2**	Formula seen including $4x^2$	Care: the answer is given
13	iii		$\frac{dV}{dh} = \frac{50 - 6h^2}{3}$ $= 0$ when $50 - 6h^2 = 0$ $\Rightarrow h^2 = \frac{25}{3}$ $\Rightarrow h = \sqrt{\frac{25}{3}} = \frac{5}{\sqrt{3}} = \frac{5}{3}\sqrt{3} = 2.89$	**M1** **A1** **M1** **A1** **4**	Differentiation **cao** **dep** Set (numerator) = 0 Any of these answers is acceptable	**SC3** h = 2.89 with either $\frac{dV}{dh}$ or $\frac{1}{3}$ missing Numerical value must be 2.89
13	iv		$\frac{d^2V}{dh^2} = -4h$ < 0 so maximum	**M1** **A1** **2**	Or alternatives: Complete method to investigate value of derivative Or: complete method to investigate the value of V either side **and** at the turning point	Accept $-12h$
13	v		At this point sinEAO $= \frac{h}{5} = \frac{1}{3}\sqrt{3}$ $\Rightarrow$ Angle EAO = 35.3°	**M1** **A1** **2**	Use of a correct ratio with *their h* (and/or x) Accept 35.2 which comes from h = 2.88	

Question			Answer	Marks	Part Marks and Guidance	
14	a	i	Max value = 1	B1 1		Not from any use of 0.2 from graph
14	a	ii	Height = 0.2 (m) or 20 cm	B1 1		
14	b		$x^4 - 4x^3 + 6x^2 - 4x + 1$ $\Rightarrow y = \frac{1}{5}\left(4x - 6x^2 + 4x^3 - x^4\right)$	B2 B1 3	-1 each error **Dep on B2** convincing algebra (means sight of an extra correct step **www**)	An error is signs, powers, coefficients, failure to include the 1 at end
14	c		Area = $\int_0^2 \frac{1}{5}\left(4x - 6x^2 + 4x^3 - x^4\right).\mathrm{d}x$ $= \frac{1}{5}\left[2x^2 - 2x^3 + x^4 - \frac{x^5}{5}\right]_0^2$ $= \frac{1}{5}\left(8 - 16 + 16 - \frac{32}{5}\right) = \frac{8}{25}$ $= 0.32$ Area of cross section = 0.32m^2 = 3200cm^2	M1 A3 M1 A1 A1 7	Integrate (ignore c) **A2** if one error, **A1** if two errors (**Dep** on 1st **M1**) Deal with limits correctly (Putting $x = 0$ does not need to be seen) Units	**Alternative method:** Integrate original function is OK, but in dealing with limits $x = 0$ must then be seen. Omission of $\frac{1}{5}$ is one error. Multiply by $\frac{1}{5}x$ or $\frac{1}{5x}$, ie integrating $\frac{1}{5}$ gives **A0**

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