

# Mark Scheme (Results) Summer 2010

GCE

## Core Mathematics C3 (6665)

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at [www.edexcel.com](http://www.edexcel.com).

If you have any subject specific questions about the content of this Mark Scheme that require the help of a subject specialist, you may find our **Ask The Expert** email service helpful.

Ask The Expert can be accessed online at the following link:

<http://www.edexcel.com/Aboutus/contact-us/>

Summer 2010

Publications Code UA023702

All the material in this publication is copyright

© Edexcel Ltd 2010

June 2010  
6665 Core Mathematics C3  
Mark Scheme

Question Number	Scheme	Marks
1.	<p>(a) <math display="block">\frac{2 \sin \theta \cos \theta}{1 + 2 \cos^2 \theta - 1}</math>  <del><math>\frac{2 \sin \theta \cos \theta}{2 \cos \theta \cos \theta}</math></del> = <math>\tan \theta</math> (as required) <b>AG</b></p> <p>(b) <math>2 \tan \theta = 1 \Rightarrow \tan \theta = \frac{1}{2}</math>  <math>\theta_1 = \text{awrt } 26.6^\circ</math>  <math>\theta_2 = \text{awrt } -153.4^\circ</math></p>	<p>M1</p> <p>A1 cso</p> <p style="text-align: right;">(2)</p> <p>M1</p> <p>A1</p> <p>A1 <math>\sqrt{\quad}</math></p> <p style="text-align: right;">(3) [5]</p>
	<p>(a) M1: Uses <b>both</b> a correct identity for <math>\sin 2\theta</math> <b>and</b> a correct identity for <math>\cos 2\theta</math>.  Also allow a candidate writing <math>1 + \cos 2\theta = 2 \cos^2 \theta</math> on the denominator.  Also note that angles <b>must be consistent</b> in when candidates apply these identities.  A1: Correct proof. No errors seen.</p> <p>(b) 1<sup>st</sup> M1 for either <math>2 \tan \theta = 1</math> or <math>\tan \theta = \frac{1}{2}</math>, seen or implied.  A1: awrt 26.6  A1 <math>\sqrt{\quad}</math>: awrt <math>-153.4^\circ</math> or <math>\theta_2 = -180^\circ + \theta_1</math></p> <p><b>Special Case:</b> For candidate solving, <math>\tan \theta = k</math>, where <math>k \neq \frac{1}{2}</math>, to give <math>\theta_1</math> and <math>\theta_2 = -180^\circ + \theta_1</math>, then award M0A0B1 in part (b).  <b>Special Case:</b> Note that those candidates who writes <math>\tan \theta = 1</math>, and gives ONLY two answers of <math>45^\circ</math> and <math>-135^\circ</math> that are inside the range will be awarded SC M0A0B1.</p>	

Question Number	Scheme	Marks
2.	<p>At <math>P</math>, <math>y = 3</math></p> $\frac{dy}{dx} = \frac{3(-2)(5-3x)^{-3}(-3)}{(5-3x)^3} \left\{ \text{or } \frac{18}{(5-3x)^3} \right\}$ $\frac{dy}{dx} = \frac{18}{(5-3(2))^3} \{ = -18 \}$ $m(\mathbf{N}) = \frac{-1}{-18} \text{ or } \frac{1}{18}$ $\mathbf{N}: y - 3 = \frac{1}{18}(x - 2)$ $\mathbf{N}: \underline{x - 18y + 52 = 0}$	<p>B1</p> <p>M1A1</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p style="text-align: right;">[7]</p>
	<p>1<sup>st</sup> M1: <math>\pm k(5-3x)^{-3}</math> can be implied. See appendix for application of the quotient rule.</p> <p>2<sup>nd</sup> M1: Substituting <math>x = 2</math> into an equation involving their <math>\frac{dy}{dx}</math>;</p> <p>3<sup>rd</sup> M1: Uses <math>m(\mathbf{N}) = -\frac{1}{\text{their } m(\mathbf{T})}</math>.</p> <p>4<sup>th</sup> M1: <math>y - y_1 = m(x - 2)</math> with 'their NORMAL gradient' or a "changed" tangent gradient and their <math>y_1</math>. Or uses a complete method to express the equation of the tangent in the form <math>y = mx + c</math> with 'their NORMAL ("changed" <b>numerical</b>) gradient', their <math>y_1</math> and <math>x = 2</math>.</p> <p><b>Note:</b> To gain the final A1 mark all the previous 6 marks in this question need to be earned. Also there must be a completely correct solution given.</p>	

Question Number	Scheme	Marks
3.	<p>(a) <math>f(1.2) = 0.49166551\dots</math>, <math>f(1.3) = -0.048719817\dots</math>                      Sign change (and as <math>f(x)</math> is continuous) therefore a root <math>\alpha</math> is such that <math>\alpha \in [1.2, 1.3]</math></p> <p>(b) <math>4\operatorname{cosec}x - 4x + 1 = 0 \Rightarrow 4x = 4\operatorname{cosec}x + 1</math>  <math>\Rightarrow x = \operatorname{cosec}x + \frac{1}{4} \Rightarrow x = \frac{1}{\sin x} + \frac{1}{4}</math></p> <p>(c) <math>x_1 = \frac{1}{\sin(1.25)} + \frac{1}{4}</math>  <math>x_1 = 1.303757858\dots</math>, <math>x_2 = 1.286745793\dots</math>  <math>x_3 = 1.291744613\dots</math></p> <p>(d) <math>f(1.2905) = 0.00044566695\dots</math>, <math>f(1.2915) = -0.00475017278\dots</math>                      Sign change (and as <math>f(x)</math> is continuous) therefore a root <math>\alpha</math> is such that  <math>\alpha \in (1.2905, 1.2915) \Rightarrow \alpha = 1.291</math> (3 dp)</p>	<p>M1A1 (2)</p> <p>M1 A1 * (2)</p> <p>M1 A1 A1 (3)</p> <p>M1 A1 (2)</p> <p>[9]</p>
	<p>(a) M1: Attempts to evaluate both <math>f(1.2)</math> and <math>f(1.3)</math> and evaluates at least one of them correctly to awrt (or truncated) 1 sf.                      A1: both values correct to awrt (or truncated) 1 sf, sign change and conclusion.</p> <p>(b) M1: Attempt to make <math>4x</math> or <math>x</math> the subject of the equation.                      A1: Candidate must then rearrange the equation to give the required result. It must be clear that candidate has made their initial <math>f(x) = 0</math>.</p> <p>(c) M1: An attempt to substitute <math>x_0 = 1.25</math> into the iterative formula                      Eg <math>= \frac{1}{\sin(1.25)} + \frac{1}{4}</math>.                      Can be implied by <math>x_1 = \operatorname{awrt} 1.3</math> or <math>x_1 = \operatorname{awrt} 46^\circ</math>.                      A1: Both <math>x_1 = \operatorname{awrt} 1.3038</math> and <math>x_2 = \operatorname{awrt} 1.2867</math>                      A1: <math>x_3 = \operatorname{awrt} 1.2917</math></p> <p>(d) M1: Choose suitable interval for <math>x</math>, e.g. <math>[1.2905, 1.2915]</math> or tighter and at least one attempt to evaluate <math>f(x)</math>.                      A1: both values correct to awrt (or truncated) 1 sf, sign change and conclusion.</p>	

Question Number	Scheme	Marks
<p>4. (a)</p> <div data-bbox="280 309 655 701" style="text-align: center;"> </div> <p>(b) <math>x = 20</math>  <math>2x - 5 = -(15 + x) ; \Rightarrow x = -\frac{10}{3}</math></p> <p>(c) <math>fg(2) = f(-3) =  2(-3) - 5  ; =  -11  = 11</math></p> <p>(d) <math>g(x) = x^2 - 4x + 1 = (x - 2)^2 - 4 + 1 = (x - 2)^2 - 3</math>. Hence <math>g_{\min} = -3</math>                      Either <math>g_{\min} = -3</math> or <math>g(x) \geq -3</math>                      or <math>g(5) = 25 - 20 + 1 = 6</math>  <math>-3 \leq g(x) \leq 6</math> or <math>-3 \leq y \leq 6</math></p>	<p>M1A1</p> <p>(2)</p> <p>B1 M1;A1 oe.</p> <p>(3)</p> <p>M1;A1</p> <p>(2)</p> <p>M1</p> <p>B1</p> <p>A1</p> <p>(3)</p> <p>[10]</p>	
	<p>(a) M1: V or  or  graph with vertex on the <math>x</math>-axis.</p> <p>A1: <math>(\frac{5}{2}, \{0\})</math> and <math>(\{0\}, 5)</math> seen and the graph appears in both the first and second quadrants.</p> <p>(b) M1: Either <math>2x - 5 = -(15 + x)</math> or <math>-(2x - 5) = 15 + x</math></p> <p>(c) M1: <b>Full method</b> of inserting <math>g(2)</math> into <math>f(x) =  2x - 5 </math> or for inserting <math>x = 2</math> into <math> 2(x^2 - 4x + 1) - 5 </math>. There must be evidence of the modulus being applied.</p> <p>(d) M1: <b>Full method</b> to establish the minimum of <math>g</math>. Eg: <math>(x \pm \alpha)^2 + \beta</math> leading to <math>g_{\min} = \beta</math>. Or for candidate to differentiate the quadratic, set the result equal to zero, find <math>x</math> and insert this value of <math>x</math> back into <math>f(x)</math> in order to find the minimum.</p> <p>B1: For either finding the correct minimum value of <math>g</math> (can be implied by <math>g(x) \geq -3</math> or <math>g(x) &gt; -3</math>) or for stating that <math>g(5) = 6</math>.</p> <p>A1: <math>-3 \leq g(x) \leq 6</math> or <math>-3 \leq y \leq 6</math> or <math>-3 \leq g \leq 6</math>. <b>Note that:</b> <math>-3 \leq x \leq 6</math> is A0.</p> <p><b>Note that:</b> <math>-3 \leq f(x) \leq 6</math> is A0. <b>Note that:</b> <math>-3 \geq g(x) \geq 6</math> is A0.</p> <p><b>Note that:</b> <math>g(x) \geq -3</math> or <math>g(x) &gt; -3</math> or <math>x \geq -3</math> or <math>x &gt; -3</math> with no working gains M1B1A0.</p> <p><b>Note that for the final Accuracy Mark:</b>                      If a candidate writes down <math>-3 &lt; g(x) &lt; 6</math> or <math>-3 &lt; y &lt; 6</math>, then award M1B1A0.                      If, however, a candidate writes down <math>g(x) \geq -3</math>, <math>g(x) \leq 6</math>, then award A0.                      If a candidate writes down <math>g(x) \geq -3</math> or <math>g(x) \leq 6</math>, then award A0.</p>	

Question Number	Scheme	Marks
5.	<p>(a) Either <math>y = 2</math> or <math>(0, 2)</math></p> <p>(b) When <math>x = 2</math>, <math>y = (8 - 10 + 2)e^{-2} = 0e^{-2} = 0</math>  <math>(2x^2 - 5x + 2) = 0 \Rightarrow (x - 2)(2x - 1) = 0</math>                      Either <math>x = 2</math> (for possibly B1 above) or <math>x = \frac{1}{2}</math>.</p> <p>(c) <math>\frac{dy}{dx} = (4x - 5)e^{-x} - (2x^2 - 5x + 2)e^{-x}</math></p> <p>(d) <math>(4x - 5)e^{-x} - (2x^2 - 5x + 2)e^{-x} = 0</math>  <math>2x^2 - 9x + 7 = 0 \Rightarrow (2x - 7)(x - 1) = 0</math>  <math>x = \frac{7}{2}, 1</math>                      When <math>x = \frac{7}{2}</math>, <math>y = 9e^{-\frac{7}{2}}</math>, when <math>x = 1</math>, <math>y = -e^{-1}</math></p>	<p>B1 (1)</p> <p>B1 M1 A1 (3)</p> <p>M1A1A1 (3)</p> <p>M1 M1 A1 ddM1A1 (5) [12]</p>
	<p>(b) If the candidate believes that <math>e^{-x} = 0</math> solves to <math>x = 0</math> or gives an extra solution of <math>x = 0</math>, then withhold the final accuracy mark.</p> <p>(c) M1: (their <math>u'</math>)<math>e^{-x} + (2x^2 - 5x + 2)</math>(their <math>v'</math>)                      A1: Any one term correct.                      A1: Both terms correct.</p> <p>(d) 1<sup>st</sup> M1: For setting their <math>\frac{dy}{dx}</math> found in part (c) equal to 0.                      2<sup>nd</sup> M1: Factorise or eliminate out <math>e^{-x}</math> correctly and an attempt to factorise a 3-term quadratic or apply the formula to candidate's <math>ax^2 + bx + c</math>.                      See rules for solving a three term quadratic equation on page 1 of this Appendix.                      3<sup>rd</sup> ddM1: An attempt to use at least one <math>x</math>-coordinate on <math>y = (2x^2 - 5x + 2)e^{-x}</math>.                      Note that this method mark is dependent on the award of the two previous method marks in this part.                      Some candidates write down corresponding <math>y</math>-coordinates without any working. It may be necessary on some occasions to use your calculator to check that at least one of the two <math>y</math>-coordinates found is correct to awrt 2 sf.                      Final A1: Both <math>\{x = 1\}</math>, <math>y = -e^{-1}</math> and <math>\{x = \frac{7}{2}\}</math>, <math>y = 9e^{-\frac{7}{2}}</math>. <b>cao</b>                      Note that both exact values of <math>y</math> are required.</p>	

Question Number	Scheme	Marks
6. (a) (i) (ii) (b)  (c)  (d)	<p>(3, 4)</p> <p>(6, -8)</p> <p><math>f(x) = (x - 3)^2 - 4</math> or <math>f(x) = x^2 - 6x + 5</math></p> <p>Either: The function <math>f</math> is a many-one {mapping}.                      Or: The function <math>f</math> is not a one-one {mapping}.</p>	B1 B1 B1 B1 (4)  B1 B1 B1  (3) M1A1 (2) B1 (1) [10]
	<p>(b) B1: Correct shape for <math>x \geq 0</math>, with the curve meeting the positive <math>y</math>-axis and the turning point is found below the <math>x</math>-axis. (providing candidate does not copy the whole of the original curve and adds nothing else to their sketch.).                      B1: Curve is symmetrical about the <math>y</math>-axis or correct shape of curve for <math>x &lt; 0</math>.  <b>Note:</b> The first two B1B1 can only be awarded if the curve has the correct shape, with a cusp on the positive <math>y</math>-axis and with both turning points located in the correct quadrants. Otherwise award B1B0.                      B1: Correct turning points of <math>(-3, -4)</math> and <math>(3, -4)</math>. Also, <math>(\{0\}, 5)</math> is marked where the graph cuts through the <math>y</math>-axis. Allow <math>(5, 0)</math> rather than <math>(0, 5)</math> if marked in the "correct" place on the <math>y</math>-axis.</p> <p>(c) M1: Either states <math>f(x)</math> in the form <math>(x \pm \alpha)^2 \pm \beta</math>; <math>\alpha, \beta \neq 0</math>                      Or uses a complete method on <math>f(x) = x^2 + ax + b</math>, with <math>f(0) = 5</math> and <math>f(3) = -4</math> to find both <math>a</math> and <math>b</math>.                      A1: Either <math>(x - 3)^2 - 4</math> or <math>x^2 - 6x + 5</math></p> <p>(d) B1: Or: The inverse is a one-many {mapping and not a function}.                      Or: Because <math>f(0) = 5</math> and also <math>f(6) = 5</math>.                      Or: One <math>y</math>-coordinate has 2 corresponding <math>x</math>-coordinates {and therefore cannot have an inverse}.</p>	



Question Number	Scheme	Marks
<p>7. (a)</p> <p>(b) (i)</p> <p>(ii)</p> <p>(c)</p> <p>(d)</p>	<p><math>R = \sqrt{6.25}</math> or 2.5</p> <p><math>\tan \alpha = \frac{1.5}{2} = \frac{3}{4} \Rightarrow \alpha = \text{awrt } 0.6435</math></p> <p>Max Value = 2.5</p> <p><math>\sin(\theta - 0.6435) = 1</math> or <math>\theta - \text{their } \alpha = \frac{\pi}{2}; \Rightarrow \theta = \text{awrt } 2.21</math></p> <p><math>H_{\text{Max}} = 8.5</math> (m)</p> <p><math>\sin\left(\frac{4\pi t}{25} - 0.6435\right) = 1</math> or <math>\frac{4\pi t}{25} = \text{their (b) answer}; \Rightarrow t = \text{awrt } 4.41</math></p> <p><math>\Rightarrow 6 + 2.5 \sin\left(\frac{4\pi t}{25} - 0.6435\right) = 7; \Rightarrow \sin\left(\frac{4\pi t}{25} - 0.6435\right) = \frac{1}{2.5} = 0.4</math></p> <p><math>\left\{\frac{4\pi t}{25} - 0.6435\right\} = \sin^{-1}(0.4)</math> or awrt 0.41</p> <p>Either <math>t = \text{awrt } 2.1</math> or awrt 6.7</p> <p>So, <math>\left\{\frac{4\pi t}{25} - 0.6435\right\} = \{\pi - 0.411517... \text{ or } 2.730076...^c\}</math></p> <p>Times = <math>\{14:06, 18:43\}</math></p>	<p>B1</p> <p>M1A1</p> <p>(3)</p> <p>B1 <math>\sqrt{\quad}</math></p> <p>M1;A1 <math>\sqrt{\quad}</math></p> <p>(3)</p> <p>B1 <math>\sqrt{\quad}</math></p> <p>M1;A1</p> <p>(3)</p> <p>M1;M1</p> <p>A1</p> <p>A1</p> <p>ddM1</p> <p>A1</p> <p>(6)</p> <p>[15]</p>
	<p>(a) B1: <math>R = 2.5</math> or <math>R = \sqrt{6.25}</math>. For <math>R = \pm 2.5</math>, award B0.</p> <p>M1: <math>\tan \alpha = \pm \frac{1.5}{2}</math> or <math>\tan \alpha = \pm \frac{2}{1.5}</math></p> <p>A1: <math>\alpha = \text{awrt } 0.6435</math></p> <p>(b) B1 <math>\sqrt{\quad}</math>: 2.5 or follow through the value of <math>R</math> in part (a).</p> <p>M1: For <math>\sin(\theta - \text{their } \alpha) = 1</math></p> <p>A1 <math>\sqrt{\quad}</math>: awrt 2.21 or <math>\frac{\pi}{2} + \text{their } \alpha</math> rounding correctly to 3 sf.</p> <p>(c) B1 <math>\sqrt{\quad}</math>: 8.5 or <math>6 + \text{their } R</math> found in part (a) as long as the answer is greater than 6.</p> <p>M1: <math>\sin\left(\frac{4\pi t}{25} \pm \text{their } \alpha\right) = 1</math> or <math>\frac{4\pi t}{25} = \text{their (b) answer}</math></p> <p>A1: For <math>\sin^{-1}(0.4)</math> This can be implied by awrt 4.41 or awrt 4.40.</p> <p>(d) M1: <math>6 + (\text{their } R) \sin\left(\frac{4\pi t}{25} \pm \text{their } \alpha\right) = 7</math>, M1:</p> <p><math>\sin\left(\frac{4\pi t}{25} \pm \text{their } \alpha\right) = \frac{1}{\text{their } R}</math></p> <p>A1: For <math>\sin^{-1}(0.4)</math>. This can be implied by awrt 0.41 or awrt 2.73 or other values for different <math>\alpha</math>'s. Note this mark can be implied by seeing 1.055.</p> <p>A1: Either <math>t = \text{awrt } 2.1</math> or <math>t = \text{awrt } 6.7</math></p> <p>ddM1: either <math>\pi - \text{their PV}^c</math>. Note that this mark is dependent upon the two M marks. This mark will usually be awarded for seeing either 2.730... or 3.373...</p> <p>A1: Both <math>t = 14:06</math> and <math>t = 18:43</math> or both 126 (min) and 403 (min) or both 2 hr 6 min and 6 hr 43 min.</p>	

Question Number	Scheme	Marks
8.	<p>(a) <math>\frac{(x+5)(2x-1)}{(x+5)(x-3)} = \frac{(2x-1)}{(x-3)}</math></p> <p>(b) <math>\ln\left(\frac{2x^2+9x-5}{x^2+2x-15}\right) = 1</math>  <math>\frac{2x^2+9x-5}{x^2+2x-15} = e</math>  <math>\frac{2x-1}{x-3} = e \Rightarrow 3e-1 = x(e-2)</math>  <math>\Rightarrow x = \frac{3e-1}{e-2}</math></p>	<p>M1 B1 A1 aef (3)</p> <p>M1</p> <p>dM1</p> <p>M1</p> <p>A1 aef cso (4) [7]</p>
	<p>(a) M1: An attempt to factorise the numerator.            B1: Correct factorisation of denominator to give <math>(x+5)(x-3)</math>. Can be seen anywhere.</p> <p>(b) M1: Uses a correct law of logarithms to combine at least two terms. This usually is achieved by the subtraction law of logarithms to give  <math>\ln\left(\frac{2x^2+9x-5}{x^2+2x-15}\right) = 1</math>.</p> <p>The product law of logarithms can be used to achieve  <math>\ln(2x^2+9x-5) = \ln(e(x^2+2x-15))</math>.</p> <p>The product and quotient law could also be used to achieve  <math>\ln\left(\frac{2x^2+9x-5}{e(x^2+2x-15)}\right) = 0</math>.</p> <p>dM1: Removing ln's correctly by the realisation that the anti-ln of 1 is e. Note that this mark is dependent on the previous method mark being awarded.            M1: Collect <math>x</math> terms together and factorise. Note that this is not a dependent method mark.</p> <p>A1: <math>\frac{3e-1}{e-2}</math> or <math>\frac{3e^1-1}{e^1-2}</math> or <math>\frac{1-3e}{2-e}</math>. aef</p> <p>Note that the answer needs to be in terms of <math>e</math>. The decimal answer is 9.9610559...            Note that the solution must be correct in order for you to award this final accuracy mark.</p> <p><b>Note: See Appendix for an alternative method of long division.</b></p>	



Further copies of this publication are available from  
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467  
Fax 01623 450481

Email [publications@linneydirect.com](mailto:publications@linneydirect.com)

Order Code UA023702 Summer 2010

For more information on Edexcel qualifications, please visit [www.edexcel.com/quals](http://www.edexcel.com/quals)

Edexcel Limited. Registered in England and Wales no.4496750  
Registered Office: One90 High Holborn, London, WC1V 7BH