

General Certificate of Education

Mathematics 6360

MFP3 Further Pure 3

Mark Scheme

2007 examination - January series

www.theallpapers.com

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

Copyright © 2007 AQA and its licensors. All rights reserved.

COPYRIGHT

AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334). Registered address: AQA, Devas Street, Manchester M15 6EX Dr Michael Cresswell Director General

Key to mark scheme and abbreviations used in marking

М	mark is for method			
m or dM	mark is dependent on one or more M marks and is for method			
А	mark is dependent on M or m marks and is for accuracy			
В	mark is independent of M or m marks and is for method and accuracy			
Е	mark is for explanation			
or ft or F	follow through from previous			
	incorrect result	MC	mis-copy	
CAO	correct answer only	MR	mis-read	
CSO	correct solution only	RA	required accuracy	
AWFW	anything which falls within	FW	further work	
AWRT	anything which rounds to	ISW	ignore subsequent work	
ACF	any correct form	FIW	from incorrect work	
AG	answer given	BOD	given benefit of doubt	
SC	special case	WR	work replaced by candidate	
OE	or equivalent	\mathbf{FB}	formulae book	
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme	
–x EE	deduct x marks for each error	G	graph	
NMS	no method shown	С	candidate	
PI	possibly implied	sf	significant figure(s)	
SCA	substantially correct approach	dp	decimal place(s)	

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

MFP3

$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Q	Solution	Marks	Total	Comments
(b) $k_1 = 0.05 \times \ln (1+1+0.6) = 0.0477(75)$ M1 A1F $k_2 = 0.05 \times \ln (1+1.05^2 + 0.6477)$ M1 $ = 0.050 \times \ln (1+1.05^2 + 0.6477)$ M1 $ = 0.050 \times \ln (1+1.05^2 + 0.6477)$ M1 = 0.0505(85) A1F $y(1.05) = y(1) + \frac{1}{2}[k_1 + k_2]$ m1 $= 0.6 + 0.5 \times 0.09836$ = 0.6492 to 4dp A1F 6 Must be 4 dp ft one slip $2 \frac{r - r \sin \theta = 4}{r - y - 4}$ M1 r - y - 4 A1 $x^2 + y^2 = (y + 4)^2$ M1 $x^2 + y^2 = y^2 + 8y + 16$ A1F $y = \frac{x^2 - 16}{8}$ A1 6 $7 \frac{1}{8}$ A1 6 $7 \frac{1}{8}$ CSO AG be convinced $\frac{1}{9} \frac{1}{9} \frac{1}{2} \frac$	-		M1A1		
$ \begin{array}{c cccc} AIF & AIF & If candidate's evaluation in (a) \\ A_{2} = 0.05 \times f(1.05, 0.6477) & MI \\ = 0.05 \times ln(1+1.05^{2} + 0.6477) & MI \\ = 0.0505(85) & AIF & PI \\ y(1.05) = y(1) + \frac{1}{2}[k_{1} + k_{2}] & mI \\ = 0.6 + 0.5 \times 0.09836 & PI \\ \hline y(1.05) = y(1) + \frac{1}{2}[k_{1} + k_{2}] & mI \\ = 0.6492 to 4dp & AIF & 6 & Must be 4 dp ft one slip \\ \hline r - rsin \theta = 4 & MI \\ r - y = 4 & BI \\ r = y + 4 & AI \\ x^{2} + y^{2} = (y + 4)^{2} & MI \\ x^{2} + y^{2} = y' + 8y + 16 & AIF & ft one slip \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} & MIA \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A & MI \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline y = yx^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline y = yx^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \right) \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \right) \\ \hline x = x^{2} + x^$		= 0.6477 (7557) = 0.6478 to 4dp	A1	3	Condone >4 dp
$ \begin{array}{c cccc} AIF & AIF & If candidate's evaluation in (a) \\ A_{2} = 0.05 \times f(1.05, 0.6477) & MI \\ = 0.05 \times ln(1+1.05^{2} + 0.6477) & MI \\ = 0.0505(85) & AIF & PI \\ y(1.05) = y(1) + \frac{1}{2}[k_{1} + k_{2}] & mI \\ = 0.6 + 0.5 \times 0.09836 & PI \\ \hline y(1.05) = y(1) + \frac{1}{2}[k_{1} + k_{2}] & mI \\ = 0.6492 to 4dp & AIF & 6 & Must be 4 dp ft one slip \\ \hline r - rsin \theta = 4 & MI \\ r - y = 4 & BI \\ r = y + 4 & AI \\ x^{2} + y^{2} = (y + 4)^{2} & MI \\ x^{2} + y^{2} = y' + 8y + 16 & AIF & ft one slip \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} & MIA \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A & MI \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline y = yx^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline y = yx^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \right) \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \right) \\ \hline x = x^{2} + x^$					
$ \begin{array}{c cccc} AIF & AIF & If candidate's evaluation in (a) \\ A_{2} = 0.05 \times f(1.05, 0.6477) & MI \\ = 0.05 \times ln(1+1.05^{2} + 0.6477) & MI \\ = 0.0505(85) & AIF & PI \\ y(1.05) = y(1) + \frac{1}{2}[k_{1} + k_{2}] & mI \\ = 0.6 + 0.5 \times 0.09836 & PI \\ \hline y(1.05) = y(1) + \frac{1}{2}[k_{1} + k_{2}] & mI \\ = 0.6492 to 4dp & AIF & 6 & Must be 4 dp ft one slip \\ \hline r - rsin \theta = 4 & MI \\ r - y = 4 & BI \\ r = y + 4 & AI \\ x^{2} + y^{2} = (y + 4)^{2} & MI \\ x^{2} + y^{2} = y' + 8y + 16 & AIF & ft one slip \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & 6 \\ \hline t & to tal & to tal & to tal \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = \frac{x^{2} - 16}{8} & AI & AI \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} & MIA \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A & MI \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A \\ \hline y = yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline y = yx^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline y = yx^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \right) \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \\ \hline x = y = x^{-2} \left(\frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \right) \\ \hline x = x^{2} + x^$	(b)	$k_1 = 0.05 \times \ln(1 + 1 + 0.6) = 0.0477(75)$	M1		Ы
$k_{2} = 0.05 \times f(1.05, 0.6477)$ = 0.05 × ln (1+1.05 ² + 0.6477) = 0.0505 (85) y(1.05) = y(1) + $\frac{1}{2}[k_{1} + k_{2}]$ = 0.6 + 0.5 × 0.09836 = 0.6492 to 4dp 10 F 6 Must be 4 dp ft one slip 2 $r - r \sin \theta = 4$ r - y = 4 r - y = 4 r = y + 4 $x^{2} + y^{2} = (y + 4)^{2}$ $x^{2} + y^{2} = (y + 4)^{2}$ $x^{2} + y^{2} = (y + 4)^{2}$ $x^{2} + y^{2} = y^{2} + 8y + 16$ $y = \frac{x^{2} - 16}{8}$ 6 7 Cotal 6 7 Sin $\theta = y$ stated or used r = y + 4 $x^{1} + y^{2} = y^{2} + 8y + 16$ $y = \frac{x^{2} - 16}{8}$ A1F 6 7 Cotal 6 7 Sin $\theta = y$ stated or used r = y + 4 A1 $x^{2} + y^{2} = y^{2} + 8y + 16$ A1F A1 6 7 Cotal 6 7 Sin $\theta = y$ stated or used $(b) \frac{d}{dx} [yx^{2}] = 3x^{2}(x^{3} + 1)^{\frac{1}{2}}$ M1A1 $= yx^{2} = \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A$ A1 $y = x^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A$ A1 $y = x^{2} - \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} + A$ A1 $y = x^{2} \left\{ \frac{2}{3}(x^{3} + 1)^{\frac{1}{2}} - 14 \right\}$ A1 A1 A1 A1 A1 A1 A1 A1 A1 A1	()				
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		$k_2 = 0.05 \times f (1.05, 0.6477)$			
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		$\dots = 0.05 \times \ln(1 + 1.05^2 + 0.6477)$	M1		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $			A 1E		DI
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		– 0.0505(85)	AIF		PI
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		$y(1.05) = y(1) + \frac{1}{2}[k_1 + k_2]$	m1		Dep on previous two Ms and numerical
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					
Image: Description of the systemTotal92 $r - r \sin \theta = 4$ M1B1 $r \sin \theta = y$ stated or used $r - y = 4$ A1B1 $r^2 = x^2 + y^2$ used $x^2 + y^2 = (y + 4)^2$ M1 $r^2 = x^2 + y^2$ used $x^2 + y^2 = y^2 + 8y + 16$ A1Fft one slip $y = \frac{x^2 - 16}{8}$ A163(a)IF is $\exp\left(\int \frac{2}{x} dx\right)$ M1 $= e^{2inx}$ A1A1 $= x^2$ A13(b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ M1A1 $\Rightarrow yx^2 = \frac{2}{3}(x^3 + 1)^{\frac{3}{2}} + A$ M1 $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ M1 $\Rightarrow 4 = -14$ $x^2 + y^2 - 14^{\frac{3}{2}}$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3 + 1)^{\frac{3}{2}} - 14 \right\}$ A16Any correct form					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		-	A1F		Must be 4 dp ft one slip
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	2	$r - r\sin\theta = 4$	M1	У	
Total63(a)IF is $\exp\left(\int \frac{2}{x} dx\right)$ M1And with integration attempted $= e^{2\ln x}$ A1A13CSO AG be convinced $= x^2$ A13CSO AG be convinced(b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ M1A1PI $\Rightarrow yx^2 = \frac{2}{3}(x^3 + 1)^{\frac{3}{2}} + A$ m1 $k(x^3 + 1)^{\frac{3}{2}}$ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ m1Use of boundary conditions to find constant $\Rightarrow y = x^{-2} \{\frac{2}{3}(x^3 + 1)^{\frac{3}{2}} - 14\}$ A16	-	r - y = 4			$r\sin\theta = v$ stated or used
Total63(a)IF is $\exp\left(\int \frac{2}{x} dx\right)$ M1And with integration attempted $= e^{2\ln x}$ A1A13CSO AG be convinced $= x^2$ A13CSO AG be convinced(b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ M1A1PI $\Rightarrow yx^2 = \frac{2}{3}(x^3 + 1)^{\frac{3}{2}} + A$ m1 $k(x^3 + 1)^{\frac{3}{2}}$ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ m1Use of boundary conditions to find constant $\Rightarrow y = x^{-2} \{\frac{2}{3}(x^3 + 1)^{\frac{3}{2}} - 14\}$ A16		r = y + 4			
Total63(a)IF is $\exp\left(\int \frac{2}{x} dx\right)$ M1And with integration attempted $= e^{2\ln x}$ A1A13CSO AG be convinced $= x^2$ A13CSO AG be convinced(b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ M1A1PI $\Rightarrow yx^2 = \frac{2}{3}(x^3 + 1)^{\frac{3}{2}} + A$ m1 $k(x^3 + 1)^{\frac{3}{2}}$ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ m1Use of boundary conditions to find constant $\Rightarrow y = x^{-2} \{\frac{2}{3}(x^3 + 1)^{\frac{3}{2}} - 14\}$ A16		$x^{2} + y^{2} = (y+4)^{2}$	M1		$r^2 = x^2 + y^2$ used
Total63(a)IF is $\exp\left(\int \frac{2}{x} dx\right)$ M1And with integration attempted $= e^{2\ln x}$ A1A13CSO AG be convinced $= x^2$ A13CSO AG be convinced(b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ M1A1PI $\Rightarrow yx^2 = \frac{2}{3}(x^3 + 1)^{\frac{3}{2}} + A$ m1 $k(x^3 + 1)^{\frac{3}{2}}$ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ m1Use of boundary conditions to find constant $\Rightarrow y = x^{-2} \{\frac{2}{3}(x^3 + 1)^{\frac{3}{2}} - 14\}$ A16		$x^2 + y^2 = y^2 + 8y + 16$	A1F		ft one slip
Total63(a)IF is $\exp\left(\int \frac{2}{x} dx\right)$ M1And with integration attempted $= e^{2\ln x}$ A1A13CSO AG be convinced $= x^2$ A13CSO AG be convinced(b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ M1A1PI $\Rightarrow yx^2 = \frac{2}{3}(x^3 + 1)^{\frac{3}{2}} + A$ m1 $k(x^3 + 1)^{\frac{3}{2}}$ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ m1Use of boundary conditions to find constant $\Rightarrow y = x^{-2} \{\frac{2}{3}(x^3 + 1)^{\frac{3}{2}} - 14\}$ A16		$x^2 - 16$			
3(a) IF is $\exp\left(\int \frac{2}{x} dx\right)$ $= e^{2\ln x}$ $= x^2$ And with integration attempted (b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ And with integration attempted (b) $\frac{d}{dx} [yx^2] = 3x^2(x^3 + 1)^{\frac{1}{2}}$ And And with integration attempted M1A1 PI $k(x^3 + 1)^{\frac{3}{2}}$ Condone missing 'A' $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ $\Rightarrow 4 = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3 + 1)^{\frac{3}{2}} - 14 \right\}$ And And with integration attempted CSO AG be convinced H1A1 PI $k(x^3 + 1)^{\frac{3}{2}}$ Condone missing 'A' Use of boundary conditions to find constant $\Rightarrow x = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3 + 1)^{\frac{3}{2}} - 14 \right\}$ And And with integration attempted And with integration attempted H1A1 PI $k(x^3 + 1)^{\frac{3}{2}}$ $(x^3 + 1)^{\frac{3}{2}} - 14$ $(x^3 + 1)^{\frac{3}{2}}$ $(x^3 + 1)^{\frac{3}{2}} - 14$ $(x^3 + $		$y = \frac{1}{8}$	A1	6	
(b) $ \frac{d}{dx} [yx^2] = 3x^2(x^3+1)^{\frac{1}{2}} $ $\Rightarrow yx^2 = \frac{2}{3}(x^3+1)^{\frac{3}{2}} + A $ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A $ $\Rightarrow A = -14 $ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3+1)^{\frac{3}{2}} - 14 \right\} $ M1A1 PI $k(x^3+1)^{\frac{3}{2}} $ Condone missing 'A' Use of boundary conditions to find constant Use of boundary conditions to find constant A1 6 Any correct form				6	
(b) $ \frac{d}{dx} [yx^2] = 3x^2(x^3+1)^{\frac{1}{2}} $ $\Rightarrow yx^2 = \frac{2}{3}(x^3+1)^{\frac{3}{2}} + A $ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A $ $\Rightarrow A = -14 $ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3+1)^{\frac{3}{2}} - 14 \right\} $ M1A1 PI $k(x^3+1)^{\frac{3}{2}} $ Condone missing 'A' Use of boundary conditions to find constant Use of boundary conditions to find constant A1 6 Any correct form	3(a)	IF is exp $\left(\int_{-\infty}^{\infty} dx\right)$	M1		And with integration attempted
(b) $ \frac{d}{dx} [yx^2] = 3x^2(x^3+1)^{\frac{1}{2}} $ $\Rightarrow yx^2 = \frac{2}{3}(x^3+1)^{\frac{3}{2}} + A $ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A $ $\Rightarrow A = -14 $ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3+1)^{\frac{3}{2}} - 14 \right\} $ M1A1 PI $k(x^3+1)^{\frac{3}{2}} $ Condone missing 'A' Use of boundary conditions to find constant Use of boundary conditions to find constant A1 6 Any correct form		$-\left(\mathbf{J}\mathbf{x}\right)$			The will integration attempted
(b) $ \frac{d}{dx} [yx^2] = 3x^2(x^3+1)^{\frac{1}{2}} $ $\Rightarrow yx^2 = \frac{2}{3}(x^3+1)^{\frac{3}{2}} + A $ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A $ $\Rightarrow A = -14 $ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3+1)^{\frac{3}{2}} - 14 \right\} $ M1A1 PI $k(x^3+1)^{\frac{3}{2}} $ Condone missing 'A' Use of boundary conditions to find constant Use of boundary conditions to find constant A1 6 Any correct form		$= e^{2\pi i x}$		3	CSO AG be convinced
(b) $\frac{d}{dx} \left[yx^2 \right] = 3x^2 (x^3 + 1)^{\frac{1}{2}}$ $\Rightarrow yx^2 = \frac{2}{3} (x^3 + 1)^{\frac{3}{2}} + A$ $\Rightarrow 4 = \frac{2}{3} (9)^{\frac{3}{2}} + A$ $\Rightarrow 4 = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3 + 1)^{\frac{3}{2}} - 14 \right\}$ M1A1 PI $k (x^3 + 1)^{\frac{3}{2}}$ Condone missing 'A' Use of boundary conditions to find constant $y = x^{-2} \left\{ \frac{2}{3} (x^3 + 1)^{\frac{3}{2}} - 14 \right\}$ A1 6 Any correct form Tatel		= x		-	
(b) $\overline{dx} \lfloor yx^2 \rfloor = 3x^2(x^3 + 1)^2$ $\Rightarrow yx^2 = \frac{2}{3}(x^3 + 1)^{\frac{3}{2}} + A$ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ $\Rightarrow A = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} (x^3 + 1)^{\frac{3}{2}} - 14 \right\}$ M1A1 M1 A1 M1A1 M1 A1 M1A1 M1 A1 M1A1 M1 A1 M1A1 M1 A1 M1A1 M1 A1 M1A1 M1 M1 M1 M1 M1 M1 M1 M1 M1 M		$d = 2 = 2 + 3 + 1 = \frac{1}{2}$			
$\Rightarrow yx^{2} = \frac{2}{3}(x^{3}+1)^{\frac{3}{2}} + A$ $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ $\Rightarrow A = -14$ $\Rightarrow y = x^{-2}\left\{\frac{2}{3}(x^{3}+1)^{\frac{3}{2}} - 14\right\}$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$	(b)	$\frac{1}{\mathrm{d}x}\left[yx^2\right] = 3x^2(x^3+1)^2$	M1A1		PI
$\Rightarrow yx = \frac{3}{3}(x + 1) + A$ A1 $\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ $\Rightarrow A = -14$ $\Rightarrow y = x^{-2}\left\{\frac{2}{3}(x^3 + 1)^{\frac{3}{2}} - 14\right\}$ A1		$\Rightarrow vr^2 = \frac{2}{2}(r^3 + 1)^{\frac{3}{2}} + 4$	m1		$k(r^{3}+1)^{\frac{3}{2}}$
$\Rightarrow 4 = \frac{2}{3}(9)^{\frac{3}{2}} + A$ $\Rightarrow A = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} \left(x^3 + 1 \right)^{\frac{3}{2}} - 14 \right\}$ A1 Condone missing A Use of boundary conditions to find constant A1 A1 A A A A A A A A A A A A A A A A		$\rightarrow y^{n} - 3^{(n+1)} + 2^{n}$			
$\Rightarrow 4 = \frac{2}{3}(9)^{2} + A$ $\Rightarrow A = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} \left(x^{3} + 1 \right)^{\frac{3}{2}} - 14 \right\}$ A1 Build Matrix Use of boundary conditions to find constant A1		$2^{\frac{3}{2}}$	AI		Condone missing A
$\Rightarrow A = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} \left(x^3 + 1 \right)^{\frac{3}{2}} - 14 \right\}$ A1 6 Any correct form Total		$\Rightarrow 4 = \frac{2}{3}(9)^{\overline{2}} + A$	m1		Use of boundary conditions to find
$\Rightarrow A = -14$ $\Rightarrow y = x^{-2} \left\{ \frac{2}{3} \left(x^3 + 1 \right)^{\frac{3}{2}} - 14 \right\}$ A1 6 Any correct form Total 9		, 4 14			constant
$\Rightarrow y = x^{-2} \left\{ \frac{2}{3} \left(x^3 + 1 \right)^{\frac{3}{2}} - 14 \right\}$ A1 6 Any correct form		$\Rightarrow A = -14$			
$\frac{1}{3} \left(\frac{1}{3} \left(\frac{1}{3} \right)^{-14} \right) = 14 \int A_1 = 0$ Total = 0		$\rightarrow v - v^{-2} \int \frac{2}{2} (r^3 + 1)^{\frac{3}{2}} - 14$			
Total 0		$ y = x \left\{ \frac{3}{3} \begin{pmatrix} x + 1 \end{pmatrix} \right\}^{-14}$	A1	6	Any correct form
1 ULAI Y		Total		9	

_

Q	Solution	Marks	Total	Comments
4(a)	Integrand is not defined at $x = 0$	E1	1	OE
(b)	$\int x^{-\frac{1}{2}} \ln x dx = 2x^{\frac{1}{2}} \ln x - \int 2x^{\frac{1}{2}} \left(\frac{1}{x}\right) dx$	M1		= $kx^{\frac{1}{2}} \ln x \pm \int f(x)$, with $f(x)$ not
		A1		involving the 'original' ln x
	= $2x^{\frac{1}{2}} \ln x - 4x^{\frac{1}{2}} (+c)$	A1	3	Condone absence of '+ c '
(c)	$\int_{0}^{e} \frac{\ln x}{\sqrt{x}} dx = \lim_{a \to 0} \int_{a}^{e} \frac{\ln x}{\sqrt{x}} dx$	M1		
	$= -2e^{\frac{1}{2}} - \lim_{a \to 0} \left[2a^{\frac{1}{2}} \ln a - 4a^{\frac{1}{2}} \right]$	M1		F(b) - F(a)
	But $\lim_{a \to 0} a^{\frac{1}{2}} \ln a = 0$	B1		Accept a general form e.g.
				$\lim_{x \to 0} x^k \ln x = 0$
	So $\int_{0}^{e} \frac{\ln x}{\sqrt{x}} dx$ exists and $= -2e^{\frac{1}{2}}$	A1	4	
	Total		8	
5	Auxl. eqn $m^2 - 4m + 3 = 0$	M1		PI
	m = 3 and 1	A1		PI
	CF is $A e^{3x} + B e^{x}$	A1F		
	PI Try $y = a + b \sin x + c \cos x$	M1		Condone 'a' missing here
	$y'(x) = b\cos x - c\sin x$	A1		
	$y''(x) = -b\sin x - c\cos x$	A1F		ft can be consistent sign error(s)
	Substitute into DE gives	M1		
	a = 2 4c + 2b = 5 and $2c - 4b = 0$	B1 A1		
				Que all'a
	b = 0.5, c = 1	A1F A1F		ft a slip ft a slip
	GS: $y = A e^{3x} + B e^{x} + 2 + 0.5 sinx + cosx$	B1F	12	y = candidate's CF and candidate's P
		211	12	(must have exactly two arbitrary
				constants)
	Total		12	

MFP3 (cont)) Solution	Marks	Total	Comments
6(a)(i)	$f'(x) = \frac{1}{2}(1+2x)^{-\frac{1}{2}}(2) = (1+2x)^{-\frac{1}{2}}$	M1A1		
	$f''(x) = -(1+2x)^{-\frac{3}{2}}$	A1F		ft a slip
	$f'''(x) = 3(1+2x)^{-\frac{5}{2}}$	A1	4	
(ii)	$f(x) = (1+2x)^{\frac{1}{2}} \Longrightarrow f(0) = 1;$	B1		
	f'(0) = 1; f''(0) = -1; f'''(0) = 3	M1		All three attempted
		A1F		ft on $k(1+2x)^{'''}$
	$f(x) = f(0) + xf'(0) + \frac{x^2}{2}f''(0) + \frac{x^3}{6}f'''(0)$			
	$\ldots \approx 1 + x - \frac{x^2}{2} + \frac{x^3}{2}$	Al	4	CSO AG
	$e^{x}(1+2x)^{\frac{1}{2}}\approx$			
	$\left(1+x+\frac{x^2}{2}+\frac{x^3}{6}\right)\left(1+x-\frac{x^2}{2}+\frac{x^3}{2}\right)$	M1		Attempt to expand needed
	$\approx 1 + x (1+1) + x^{2}(-0.5 + 1 + 0.5)$	A1		
	$+ x^{3} \left(\frac{1}{2} - \frac{1}{2} + \frac{1}{2} + \frac{1}{6} \right)$			
	$\approx 1 + 2x + x^2 + \frac{2}{3}x^3$	A1	3	CSO
(c)	$e^{2x} = 1 + 2x + \frac{(2x)^2}{2} + \frac{(2x)^3}{6} + \dots$	B1	1	
	$= 1 + 2x + 2x^2 + \frac{4}{3}x^3 + \dots$			
(d)	$1 - \cos x = \frac{1}{2}x^2 + \left\{o(x^4)\right\}$	B1		
	$\frac{e^{x}(1+2x)^{\frac{1}{2}}-e^{2x}}{1-\cos x} =$			
	$1 - \cos x$			
	$\frac{1+2x+x^2+\frac{2}{3}x^3-\left[1+2x+2x^2+\frac{4}{3}x^3\right]}{1}$	M1		Series used
	$\frac{\frac{1}{2}x^{2} + \{o(x^{4})\}}{\frac{1}{2}x^{2} + \{o(x^{4})\}}$			
	$\lim_{x \to 0} = \frac{1}{100} \frac{-x^2 + \{o(x^3)\}}{100} = 1$	A1F		
	$\lim_{x \to 0} \dots = \lim_{x \to 0} \frac{-x^2 + \{o(x^3)\}}{\frac{1}{2}x^2 + \{o(x^4)\}} =$			
	$\lim_{x \to 0} \frac{-1 + o(x)}{\frac{1}{2} + o(x^2)} = -2$	A1F	4	ft a slip but must see the intermediate
	$x \rightarrow 0 \frac{1}{2} + o(x^2)$			stage
	Total		16	

_

Q	Solution	Marks	Total	Comments
7(a)	Area = $\frac{1}{2}\int (6+4\cos\theta)^2 d\theta$	M1		use of $\frac{1}{2}\int r^2 d\theta$
	$=\frac{1}{2}\left(\int_{-\pi}^{\pi} 36 + 48\cos\theta + 16\cos^2\theta\right)d\theta$	B1 B1		for correct expansion of $[6 + 4\cos\theta)]^2$ for limits
	$= \left(\int_{-\pi}^{\pi} 18 + 24\cos\theta + 4(\cos 2\theta + 1)\right) \mathrm{d}\theta$	M1		Attempt to write $\cos^2 \theta$ in terms of $\cos 2\theta$
	$= \left[22\theta + 24\sin\theta + 2\sin 2\theta\right]_{-\pi}^{\pi}$	A1F		correct integration ft wrong coefficients
	$=44\pi$	A1	6	CSO
(b)	At P , $r = 4$; At Q , $r = 2$;	B1		PI
	$P \{x = \} r \cos \theta = 4 \cos \frac{2\pi}{3} = -2$ $Q \{x = \} r \cos \theta = 2 \cos \pi = -2$	M1 A1		Attempt to use $r \cos \theta$ Both
	Since <i>P</i> and <i>Q</i> have same 'x', <i>PQ</i> is vertical so QP is parallel to the vertical			
	line $\theta = \frac{\pi}{2}$	E1	4	
(c)(i)	OP = 4; OS = 8;	B1		
	Angle $POS = \frac{\pi}{3}$	B1		or <i>S</i> (4, 4 $\sqrt{3}$) and <i>P</i> (-2, 2 $\sqrt{3}$)
	$PS^2 = 4^2 + 8^2 - 2 \times 4 \times 8 \times \cos \frac{\pi}{3}$ oe	M1		Cosine rule used in triangle <i>POS</i> OE $PS^2 = (4+2)^2 + (4\sqrt{3} - 2\sqrt{3})^2$
	$PS = \sqrt{48} \left\{ = 4\sqrt{3} \right\}$	A1	4	
(ii)	Since $8^2 = 4^2 + (\sqrt{48})^2$, $OS^2 = OP^2 + PS^2 \Rightarrow OPS$ is a right	E1	1	Accept valid equivalents e.g. $PR = 2PQ = 2(2\sqrt{3}) = PS.$
	$OS = OP + PS \implies OPS$ is a fight angle. (Converse of Pythagoras Theorem)			$\angle SRP = \angle RSP = \angle RPO = \frac{\pi}{6}$
				$\Rightarrow OPS$ is a right angle
	Total		15	
	TOTAL		75	
