Mark Scheme for June 2010
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1 First 2 terms in expansion = $1 - 5x$

$simp$ to this, now or later

$3^{rd}$ term shown as $-\frac{5}{3} - \frac{5}{2}(3x)^2$

$M1$ $-\frac{8}{3}$ can be $-\frac{5}{3} - 1$

$(3x)^2$ can be $9x^2$ or $3x^2$

$= + 20x^2$

$A1$

$4^{th}$ term shown as $-\frac{5}{3} - \frac{8}{3} \frac{11}{3} (3x)^3$

$M1$ $-\frac{11}{3}$ can be $-\frac{5}{3} - 2$

$(3x)^3$ can be $27x^3$ or $3x^3$

$= -\frac{220}{3} x^3$  ISW

$A1$ Accept $-\frac{440}{6} x^3$  ISW

N.B. If 0, SR B2 to be awarded for $1 - \frac{5}{3} x + \frac{20}{9} x^2 - \frac{220}{81} x^3$. Do not mark $(1 + x)^{\frac{1}{3}}$ as a MR.

2 Attempt quotient rule

$[Show fraction with denom \ (1 - \sin x)^2 \ & \ num \ + - (1 - \sin x)^2 \ + - \sin x \ + - \cos x \ + - \cos x ]$

$A1$ terms in any order

$\{ Product$ symbols must be clear or implied by further work $\}$

Reduce correct numerator to $1 - \sin x$

$A1$ or $- \sin x + \sin^2 x + \cos^2 x$

$A1$ Accept $\frac{1}{\sin x - 1}$

3 $\frac{A}{x - 1} + \frac{B}{(x - 1)^2} + \frac{C}{x - 2}$

$M1$ For correct format

$A(x - 1)(x - 2) + B(x - 2) + C(x - 1)^2 = x^2$

$M1$

$A = -3$

$A1$

$B = -1$

$A1$ (B1 if cover-up rule used)

$C = 4$

$A1$ (B1 if cover-up rule used)

[NB1: Partial fractions need not be written out; correct format + correct values sufficient.

NB2: Having obtained B & C by cover-up rule, candidates may substitute into general expression & algebraically manipulate; the M1 & A1 are then available if deserved.]

These special cases using different formats are the only other ones to be considered

Max

$\frac{A}{x - 1} + \frac{Bx + C}{(x - 1)^2} + \frac{D}{x - 2}$;  $M1$ M1;  $A0$ for any values of $A, B, C, D$;  $A1$ or $B1$ for $D = 4$

$AX + B$  $(x - 1)^2 + \frac{C}{x - 2}$;  $M0$ M1;  $A1$ for $A = -3$ and $B = 2$;  $A1$ or $B1$ for $C = 4$
4. Att by diff to connect \( dx \) & \( du \) or find \( \frac{dx}{du} \) or \( \frac{du}{dx} \) (not \( dx=du \)) M1 no accuracy; not 'by parts'.

\[
dx = 2u \, du \quad \text{or} \quad \frac{du}{dx} = \frac{1}{2}(x+2)^{-\frac{1}{2}} \quad \text{AEF} \quad \text{A1}
\]

Indefinite integral \( \int \left( 2u^2 - 2 \right)^{\frac{1}{2}} \left( \frac{u}{u} \right) \, du \) A1 May be implied later

\[
\{ \text{If relevant, cancel } \frac{u}{u} \text{ and} \} \quad \text{attempt to square out} \quad \text{M1}
\]

\[
\{ \text{dep } \int k \, (du) \quad \text{where } k = 2 \text{ or } \frac{1}{2} \text{ or } 0 \text{ and } 1 = \left( u^2 - 2 \right)^{\frac{3}{2}} \text{ or } \left( 2 - u^2 \right)^{\frac{3}{2}} \text{ or } \left( u^2 + 2 \right)^{\frac{3}{2}} \}
\]

Att to change limits if working with \( f(u) \) after integration M1 or re-subst into integral attempt and use \(-1 \& 7\)

Indef integ \( \frac{2}{5} u^5 + \frac{3}{3} u^3 + 8u \) or \( \frac{1}{10} u^5 + \frac{2}{3} u^3 + 2u \) A1 or \( \frac{1}{5} u^5 + \frac{3}{4} u^3 + 4u \)

\[
\frac{652}{15} \quad \text{or} \quad \frac{43}{7} \quad \text{ISW but no } ^{+c'} \quad \text{A1}
\]

5. \( \frac{d}{dx} \left( xy \right) = x \frac{dy}{dx} + y \quad \text{s.o.i.} \quad \text{B1} \quad \text{Implied by e.g., } 4x \frac{dy}{dx} + y
\]

\[
\frac{d}{dx} \left( y^2 \right) = 2y \frac{dy}{dx} \quad \text{B1}
\]

Diff eqn(=0 can be implied)(solve for \( \frac{dy}{dx} \) and ) put \( \frac{dy}{dx} = 0 \) M1

Produce only \( 2x + 4y = 0 \) (though AEF acceptable) *A1 without any error seen

Eliminate \( x \) or \( y \) from curve eqn & eqn(s) just produced M1

Produce either \( x^2 = 36 \) or \( y^2 = 9 \) dep* A1 Disregard other solutions

\((\pm 6, \pm 3) \quad \text{AEF, as the only answer ISW} \quad \text{dep* A1 Sign aspect must be clear}
\]

6 (i) State/implies scalar product of any two vectors = 0 M1

Scalar product of correct two vectors = \( 4 + 2a - 6 \) A1 \( (4 + 2a - 6 = 0 \rightarrow M1\text{A1}) \)

\( a = 1 \) A1 3

(ii) (a) Attempt to produce at least two relevant equations M1 e.g. \( 2t = 3 + 2s \) ....

Solve two not containing 'a' for \( s \) and \( t \) M1

Obtain at least one of \( s = -\frac{1}{3} \), \( t = 1 \) A1

Substitute in third equation \& produce \( a = -2 \) A1 4

(b) Method for finding magnitude of any vector M1 possibly involving 'a'

Using \( \cos \theta = \frac{a \cdot b}{|a||b|} \) for the pair of direction vectors M1 possibly involving 'a'

\( 107, 108 \) (107,548) or 72, 73, 72,4, 72,5 (72,4516) c.o.o. A1 3 1.87, 1.88 (1.87707) or 1.26 10
7 (i) Differentiate \( x \) as a quotient, \( \frac{y \, du - u \, dv}{v^2} \) or \( \frac{u \, dv - v \, du}{v^2} \) \( \text{M1} \) or product clearly defined

\[
\frac{dx}{dt} = -\frac{1}{(t+1)^2} \quad \text{or} \quad -\frac{1}{(t+1)^2} \quad \text{or} \quad -(t+1)^{-2} \quad \text{A1} \quad \text{WWW} \rightarrow 2
\]

\[
\frac{dy}{dt} = \frac{2}{(t+3)^2} \quad \text{or} \quad \frac{-2}{(t+3)^2} \quad \text{or} \quad -2(t+3)^{-2} \quad \text{B1}
\]

\[
\frac{dy}{dx} = \frac{\frac{dv}{dt}}{\frac{dx}{dt}} \quad \text{M1 quoted/implied and used}
\]

\[
\frac{dy}{dx} = \frac{2(t+1)^2}{(t+3)^2} \quad \text{or} \quad \frac{2(t+3)^2}{(t+1)^2} \quad \text{(dep 1st 4 marks) *A1} \quad \text{ignore ref} \ t = -1, t = -3
\]

State squares \( \text{+ve} \) or \( (t+1)^2 \) & \( (t+3)^2 \) + ve : \( \frac{dy}{dx} \)\( \text{+ve} \) dep*A1 6 or \( \left(\frac{t+1}{t+3}\right)^2 \) + ve . Ignore \( \geq 0 \)

(ii) Attempt to obtain \( t \) from either the \( x \) or \( y \) equation \( \text{M1} \) No accuracy required

\[
t = \frac{2-x}{x-1} \quad \text{AEF} \quad \text{or} \quad t = \frac{2}{y-3} \quad \text{AEF} \quad \text{A1}
\]

Substitute in the equation not yet used in this part \( \text{M1} \) or equate the 2 values of \( t \)

Use correct meth to eliminate (‘double-decker’) fractions \( \text{M1} \)

Obtain \( 2x + y = 2xy + 2 \) \( \text{ISW} \quad \text{AEF} \quad \text{A1 5 but not involving fractions} \)

8 (i) Long division method

<table>
<thead>
<tr>
<th>Evidence of division process as far as 1st stage incl sub</th>
<th>Identity method</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Quotient = ) ( x - 4 ) ( \text{M1} ) = ( Q(x-1) + R )</td>
<td>( Q = x - 4 )</td>
</tr>
</tbody>
</table>
| (Remainder =) 2 \( \text{ISW} \) | \( R = 2 ; \ N.B. \ might be \ B1 \)

(ii) (a) Separate variables; \( \int \frac{1}{y-5} \, dy = \int \frac{x^2 - 5x + 6}{x - 1} \, dx \) \( \text{M1} \) \( \left( \int \right) \) may be implied later

Change \( \frac{x^2 - 5x + 6}{x-1} \) into their (Quotient + \( \frac{\text{Rem}}{x-1} \)) \( \text{M1} \)

\( \ln (y-5) = \sqrt{\text{(integration of their previous result) (+c)ISW}} \) \( \sqrt{\text{A1 3 f.t. if using Quot + \( \frac{\text{Rem}}{x-1} \)}} \)

(ii) (b) Substitute \( y = 7, x = 8 \) into their eqn containing ‘c’ \( \text{M1} \) & attempt ‘c’ (\( -3.2, \ln \frac{2}{365} \))

Substitute \( x = 6 \) and their value of ‘c’ \( \text{M1} \) & attempt to find \( y \)

\( y = 5.00 \) \( (5.002529) \) Also \( 5 + \frac{50}{36} e^{-6} \) \( \text{A2 4 Accept 5, 5.0,} \)

Beware: any wrong working anywhere \( \rightarrow \) A0 even if answer is one of the acceptable ones.
(i) Attempt to multiply out \((x + \cos 2x)^2\)  

Finding  
\[\int 2x \cos 2x \, dx\]  

Use \(u = 2x, \, dv = \cos 2x\)  
M1 1st stage \(f(x)^{+/-} - \int g(x) \, dx\)  

1st stage \(x \sin 2x - \int \sin 2x \, dx\)  
A1  

\[\therefore \int 2x \cos 2x \, dx = x \sin 2x + \frac{1}{2} \cos 2x\]  
A1  

Finding  
\[\int \cos^2 2x \, dx\]  

Change to \(k\int +/- -1 +/- \cos 4x \, dx\)  
M1 where \(k = \frac{1}{2}, 2\) or 1  

Correct version  
\[\frac{1}{2}\int 1 + \cos 4x \, dx\]  
A1  

\[\int \cos 4x \, dx = \frac{1}{4} \sin 4x\]  
B1 seen anywhere in this part  

Result  
\[\frac{1}{2} x + \frac{1}{8} \sin 4x\]  
A1  

(i) ans  
\[\frac{1}{3}x^3 + x \sin 2x + \frac{1}{2} \cos 2x + \frac{1}{2} x + \frac{1}{8} \sin 4x \ (\pm c)\]  
A1 9 Fully correct  

(ii) \(V = \pi \int_0^{\frac{1}{2}\pi} (x + \cos 2x)^2 \, dx\)  
M1  

Use limits 0 & \(\frac{1}{2}\pi\) correctly on their (i) answer  
M1  

(i) correct value  
\[= \frac{1}{24} \pi^3 - \frac{1}{2} + \frac{1}{4} \pi - \frac{1}{2}\]  
A1  

Final answer  
\[= \pi \left( \frac{1}{24} \pi^3 + \frac{1}{4} \pi - 1 \right)\]  
A1 4 c.a.o. No follow-through  

[4]  

Alternative methods  

2  
If \(y = \frac{\cos x}{1 - \sin x}\) is changed into \(y(1 - \sin x) = \cos x\), award  
M1 for clear use of the product rule (though possibly trig differentiation inaccurate)  
A1 for \(-y \cos x + (1 - \sin x) \frac{dy}{dx} = -\sin x\) AEF  

B1 for reducing to a fraction with \(1 - \sin x\) or \(-\sin x + \sin^2 x + \cos^2 x\) in the numerator  
A1 for correct final answer of \(\frac{1}{1 - \sin x}\) or \((1 - \sin x)^{-1}\)  

If \(y = \frac{\cos x}{1 - \sin x}\) is changed into \(y = \cos x(1 - \sin x)^{-1}\), award  
M1 for clear use of the product rule (though possibly trig differentiation inaccurate)  
A1 for \((1 - \sin x) = \cos^2 x(1 - \sin x)^{-2} + (1 - \sin x)^{-1} - \sin x\) AEF
B1 for reducing to a fraction with $1 - \sin x$ or $-\sin x + \sin^2 x + \cos^2 x$ in the numerator

A1 for correct final answer of $\frac{1}{1 - \sin x}$ or $(1 - \sin x)^{-1}$

6(ii)(a) If candidates use some long drawn-out method to find ‘a’ instead of the direct route, allow

M1 as before, for producing the 3 equations

M1 for any satisfactory method which will/does produce ‘a’, however involved

A2 for $a = -2$

7(ii) Marks for obtaining this Cartesian equation are not available in part (i).

If part (ii) is done first and then part (i) is attempted using the Cartesian equation, award marks as follow:

Method 1 where candidates differentiate implicitly

M1 for attempt at implicit differentiation

A1 for $\frac{dy}{dx} = \frac{2y - 2}{1 - 2x}$ AEF

M1 for substituting parametric values of $x$ and $y$

A2 for simplifying to $\frac{2(y+1)^2}{(y+1)^2}$

A1 for finish as in original method

Method 2 where candidates manipulate the Cartesian equation to find $x = \text{or} y = \text{'}$

M1 for attempt to re-arrange so that either $y = f(x)$ or $x = g(y)$

A1 for correct $y = \frac{2-2x}{1-2x}$ AEF or $x = \frac{2-y}{2-2y}$ AEF

M1 for differentiating as a quotient

A2 for obtaining $\frac{dy}{dx} = \frac{-2}{(1-2x)^2}$ or $\frac{(2-2y)^2}{2}$

A1 for finish as in original method

8(ii)(b) If definite integrals are used, then

M2 for $\left[ \int_5^7 \right]_y = \left[ \int_5^7 \right]_x$ or equivalent or M1 for $\left[ \int_5^7 \right]_y = \left[ \int_5^7 \right]_x$ or equivalent

A2 for 5, 5.0, 5.00 (5.002529) with caveat as in main scheme dep M2
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