

SWISS COTTAGE SECONDARY SCHOOL SECONDARY THREE EXPRESS FIRST SEMESTRAL EXAMINATION



Name:	()	Class:
ADDITIONAL I	MATHEMATICS		4047
			Wednesday 9 May 2018
			2 hours
Additional materials:	Answer paper (8 sheets)		

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all the questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

Calculators should be used where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 80.

SUBMIT	SECTION A	ANDR	SEDADA	TEI V
300MIII	SECTION F		SEPARA	NI⊑LT

This document consists of 5 printed pages.

[Turn over

We Nurture Students to **Think**, **Care** and **Lead** with **P.R.I.D.E**.

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

Binomial Theorem

$$(a+b)^{n} = a^{n} + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^{2} + \dots + \binom{n}{r}a^{n-r}b^{r} + \dots + b^{n}$$
where *n* is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!} = \frac{n(n-1).\dots...(n-r+1)}{r!}$.

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\cos ec^2 A = 1 + \cot^2 A$$

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2\sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2\cos^2 A - 1 = 1 - 2\sin^2 A$$

$$\tan 2A = \frac{2\tan A}{1 - \tan^2 A}$$

Formulae for $\triangle ABC$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$
$$a^2 = b^2 + c^2 - 2bc \cos A$$
$$\Delta = \frac{1}{2}bc \sin A$$

Answer all the questions.

Section A (52 marks)

- 1 Find the set of values of x for which $(2x-3)^2 > x$. [3]
- Given that $s = 2 + \sqrt{5}$, express $\frac{s^2 + 3}{s + 1}$ in the form $a + b\sqrt{5}$, where a and b are integers. [5]
- Solve, for x and y, the simultaneous equations

$$81^{x} \times 3^{y} = 1,$$

$$2^{x-5} \div 8^{y} = \frac{1}{4^{x}}.$$
[5]

- Without using a calculator, find the values of the integers a and b for which the solution of the equation $x\sqrt{3} + \sqrt{2} = x\sqrt{18}$ is $\frac{a+\sqrt{b}}{15}$. [5]
- Find the coordinates of the midpoint of the straight line joining the points of intersection of the curve $4x^2 8y^2 = 23y + 28$ and the line 2x = 3y + 4. [6]
- It is given that $x^3 + 6x^2 + 6x + 2 = (x 1)(x + 2)Q(x) + 3Ax + B$ for all values of x, where Q(x) is a polynomial.
 - (i) State the degree of the polynomial Q(x). [1]
 - (ii) Find the value of A and of B. [4]
 - (iii) Hence, using a suitable substitution for x, find the remainder when 1662 is divided by 108. [2]
- 7 (a) The equation of a curve is $y = 2x^2 + 3x + c 7$. Find the value of c for which the line y x = 8 is a tangent to the curve. [3]
 - (b) Find the range of values of k for which the curve $y = 3x^2 + kx + k + 9$ lies completely above the x-axis. [4]

- 8 Given that the roots of $2x^2 4x + 3 = 0$ are α and β , find the quadratic equation whose roots are $\alpha^3 \beta$ and $\beta^3 \alpha$. [7]
- A liquid is heated up till it boils. It is then left to cool at room temperature. The temperature of the liquid, T °C, is given by $T = 25 + 75e^{-kt}$, where k is a constant and t is the time in hours since the liquid started cooling.
 - (i) Find the boiling temperature of the liquid. [1]
 - (ii) Given that the temperature of the liquid was 40 °C after 2 hours, calculate the value of k. [3]
 - (iii) Hence, find the temperature of the liquid after 4 hours. [1]
 - (iv) State the temperature that the liquid will approach after a very long time. [1]
 - (v) The equation $T = 25 + 75e^{-kt}$ is only valid for cooling of the liquid. The value of the constant k can change if the cooling liquid is placed in a different environment. Explain whether it will be possible for the value of k to be negative.

Section B (28 marks)

Begin this section on a fresh sheet of paper.

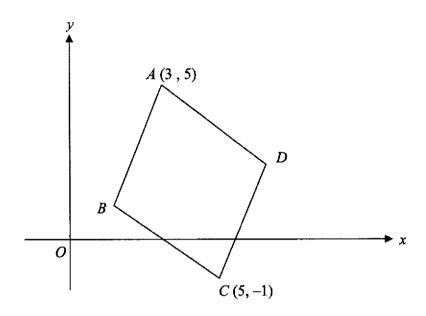
10 Solve the equation

(i)
$$\lg(2y+3) + \lg(3y-4) = \lg 100,$$
 [3]

(ii)
$$\log_x 5 - 2\log_5 x = 3$$
. [5]

- The function $f(x) = x^3 2x^2 + ax + b$, where a and b are constants, is exactly divisible by x 4 and leaves a remainder of 14 when divided by x 2.
 - (i) Find the value of a and of b. [4]
 - (ii) Solve the equation f(x) = 0. [4]
 - (iii) Hence, solve the equation $8x^3 8x^2 + 2ax + b = 0$. [2]

Solutions to this question by accurate drawing will not be accepted. 12



The diagram, which is not drawn to scale, shows a quadrilateral ABCD in which the point A is (3, 5) and the point C is (5, -1). The point B lies on the perpendicular bisector of AC and the equation of the line AB is y = 2x - 1. Find

(i)	the equation of the perpendicular bisector of AC,	[4]
(ii)	the coordinates of B .	[2]
The po	pint D is such that ABCD is a rhombus. Find	
(iii)	the coordinates of D ,	[2]
(iv)	the area of ABCD.	[2]

END OF PAPER

PartnerInLearning

2018 3E AM SA1 Marking Scheme

S/N	Solution	Mark
1	$\left (2x-3)^2 > x \right $	3.51
	$\begin{vmatrix} 4x^2 - 12x + 9 > x \\ 4x^2 - 13x + 9 > 0 \end{vmatrix}$	M1
	(4x-9)(x-1)>0	M1
	$x < 1 \text{ or } x > 2\frac{1}{4}$	A 1
	4	
2	$s^2 + 3$:
	$\sqrt{s+1}$	
	$=\frac{(2+\sqrt{5})^2+3}{(2+\sqrt{5})+1}$	-
	$-\frac{1}{(2+\sqrt{5})+1}$	
	$=\frac{4+4\sqrt{5}+5+3}{(2+\sqrt{5})+1}$	M1
	$(2+\sqrt{5})+1$: :
	$=\frac{12+4\sqrt{5}}{3+\sqrt{5}}$	
	$\frac{1}{3} + \sqrt{5}$	
	$12 + 4\sqrt{5}$ $3 - \sqrt{5}$	M1
	$= \frac{12 + 4\sqrt{5}}{3 + \sqrt{5}} \times \frac{3 - \sqrt{5}}{3 - \sqrt{5}}$	IVII
	$=\frac{36-12\sqrt{5}+12\sqrt{5}-4(5)}{9-5}$	M1: Num
		M1: Deno
	= 4	A1
3	$81^x \times 3^y = 1 - (1)$	****
	$2^{x-5} \div 8^y = \frac{1}{4^x} (2)$	
	From (1),	
	$3^{4x} \times 3^y = 3^0$	M1
	4x + y = 0	
	y = -4x - (3)	
	From (2),	
	$2^{x-5} \div 2^{3y} = 2^{-2x}$	M1
	x - 5 - 3y = -2x	
	3x - 3y = 5 - (4)	
	Subst (3) into (4),	
i	3x - 3(-4x) = 5	M 1
	15x = 5	
	$x = \frac{1}{3}$	Á 1
		A1
	$y = -1\frac{1}{3}$	
	3	A1

4	$x\sqrt{3} + \sqrt{2} = x\sqrt{18}$ $x\sqrt{3} + \sqrt{2} = 3x\sqrt{2}$	M1
	$\sqrt{2} = 3x\sqrt{2} - x\sqrt{3}$	
	$\sqrt{2} = x(3\sqrt{2} - \sqrt{3})$	M1
		1441
	$x = \frac{\sqrt{2}}{3\sqrt{2} - \sqrt{3}}$	
	$x = \frac{\sqrt{2}}{3\sqrt{2} - \sqrt{3}} \times \frac{3\sqrt{2} + \sqrt{3}}{3\sqrt{2} + \sqrt{3}}$	M1
	$3\sqrt{2} - \sqrt{3} 3\sqrt{2} + \sqrt{3}$	1,11
	$x = \frac{6 + \sqrt{6}}{9(2) - 3}$	M1
		IVII
	$x = \frac{6 + \sqrt{6}}{15}$	
	a=6, b=6	A1
5	$4x^2 - 8y^2 = 23y + 28 - (1)$	
	2x = 3y + 4 (2) Subst (2) to (1),	
	$\begin{array}{l} \text{Subst (2) to (1),} \\ (3y+4)^2 - 8y^2 = 23y + 28 \end{array}$	M1
	$9y^2 + 24y + 16 - 8y^2 = 23y + 28$	
	$y^2 + y - 12 = 0$	M1
	(y+4)(y-3) = 0 y = -4 or $y = 3$	
	$\begin{aligned} y &= 4 \text{ of } y = 3 \\ \text{When } y &= -4 \end{aligned}$	A1: y values
	2x = 3(-4) + 4	
	x = -4	
	When $y = 3$	
	2x = 3(3) + 4 x = 6.5	A1: x values
	Points of intersection: $(-4, -4)$ and $(6.5,3)$	
	$Midpoint = \left(\frac{-4+6.5}{2}, \frac{-4+3}{2}\right)$	M1
	=(1.25, -0.5)	A1
6i	Degree = 1 $\frac{3}{3} + \frac{6}{3} + \frac{2}{3} + 2$	B1
6ii	$x^3 + 6x^2 + 6x + 2 = (x - 1)(x + 2)Q(x) + 3Ax + B$ When $x = 1$,	
	$\begin{array}{c} \text{when } \lambda = 1, \\ 15 = 3A + B (1) \end{array}$	
	When $x = -2$,	
	-8 + 24 - 12 + 2 = -6A + B	M1 for aither
	6 = -6A + B - (2)	M1 for either
	(1) - (2): 9A = 9	M1
	A = 9 $A = 1$	A1
	15 = 3(1) + B	
	B=12	A1
6iii	$x^{3} + 6x^{2} + 6x + 2 = (x - 1)(x + 2)Q(x) + 3x + 12$	
	When $x = 10$, 1000 + 600 + 60 + 2 = (9)(12)Q(x) + 30 + 12	M1
	1000 + 600 + 60 + 2 = (9)(12)Q(x) + 30 + 12 $1662 = 108Q(x) + 42$	
	Remainder = 42	A1

7a $y = 2x^2 + 3x + c - 7 - c(1)$ $y = x + 8$ $y = x + 8 - c(2)$ Subst (2) to (1), $x + 8 = 2x^2 + 3x + c - 7$ 2 $x^2 + 2x + c - 15 = 0$ For lime to be tangent to the curve, $b^2 - 4ac = 0$ 2 $^2 - 4(2)(c - 15) = 0$ 4 $- 8c + 120 = 0$			
$\begin{array}{c} y = x + 8 - (2) \\ \text{Subst}(2) \text{ to}(1), \\ x + 8 = 2x^2 + 3x + c - 7 \\ 2x^2 + 2x + c - 15 = 0 \\ \text{For ine to be tangent to the curve,} \\ b^2 - 4ac = 0 \\ 2^2 - 4(2)(c - 15) = 0 \\ 4 - 8c + 120 = 0 \\ c = 15\frac{1}{2} \\ \text{A1} \\ \end{array}$ $\begin{array}{c} 7b \\ y = 3x^2 + kx + k + 9 \\ \text{For curve to lie completely above } x - axis, \\ b^2 - 4ac < 0 \\ k^2 - 4(3)(k + 9) < 0 \\ k^2 - 12k - 108 < 0 \\ (k - 18)(k + 6) < 0 \\ -6 < k < 18 \\ \end{array}$ $\begin{array}{c} 8 \\ 2x^2 - 4x + 3 = 0 \\ \alpha + \beta = -\frac{4}{2} = 2 \\ \alpha \beta \frac{3}{2} \\ \text{New S.O.R.}: \\ \alpha^3 \beta + \beta^3 \alpha \\ = \alpha\beta((\alpha + \beta)^2 - 2\alpha\beta) \\ = \frac{3}{2} \\ \text{New P.O.R.}: \\ \alpha^3 \beta \times \beta^3 \alpha \\ = \alpha^4 \beta^4 \\ = (a\beta)^4 \\ = (a\beta)^4 \\ = (a\beta)^4 \\ = (\frac{3}{2})^4 \\ = \frac{31}{16} \\ \text{Required equation: } x^2 - \frac{3}{2}x + \frac{51}{16} = 0 \\ \text{M1} \\ \text{M2} \\ \end{array}$ $\begin{array}{c} 9i \\ T = 25 + 75e^{-2k} \\ 40 = 25 + 75e^{-2k} \\ 40 = 28 + 100 \\ \text{M1} \\ \frac{1}{5} \\ e - 2k \\ \text{In} \\ \frac{1}{5} \\ k = 0.80472 \\ \end{array}$	7a	· ·	
Subst (2) to (1), $x + 8 = 2x^2 + 3x + c - 7$ $2x^2 + 2x + c - 15 = 0$ For lime to be tangent to the curve, $b^2 - 4ac = 0$ $2^2 - 4(2)(c - 15) = 0$ $4 - 8c + 120 = 0$ $c = 15\frac{1}{2}$ A1 Tb $y = 3x^2 + kx + k + 9$ For curve to lie completely above x-axis, $b^2 - 4ac < 0$ $k^2 - 4(3)(k + 9) < 0$ $k^2 - 4(3)(k + 9) < 0$ $k^2 - 12k - 108 < 0$ $(k - 18)(k + 6) < 0$ $-6 < k < 18$ 8 $2x^2 - 4x + 3 = 0$ $a + \beta = -\frac{4}{2} = 2$ $a\beta = \frac{3}{2}$ New S.O.R.: $a^3\beta + \beta^3\alpha$ $= a\beta((\alpha + \beta)^2 - 2a\beta)$ $= \frac{3}{2}$ New P.O.R.: $a^3\beta + \beta^3\alpha$ $= a\beta((\alpha + \beta)^2 - 2a\beta)$ $= \frac{3}{2}$ New P.O.R.: $a^3\beta + \beta^3\alpha$ $= a^4\beta^4$ $= (\alpha\beta)^4$ $= $			
$\begin{array}{c} x+8=2x^2+3x+c-7\\ 2x^2+2x+c-15=0\\ \\ \text{For line to be tangent to the curve,} \\ b^2-4ac=0\\ 2^2-4(2)(c-15)=0\\ 4-8c+120=0\\ c=15\frac{1}{2} \\ \text{Al} \\ \end{array}$ $\begin{array}{c} 7b \\ y=3x^2+kx+k+9\\ \text{For curve to lie completely above } x\text{-axis,} \\ b^2-4ac<0\\ k^2-4(3)(k+9)<0\\ k^2-12k-108<0\\ (k-18)(k+6)<0\\ -6 \begin{array}{c} 8 \\ 2x^2-4x+3=0\\ a+\beta=-\frac{4}{2}=2\\ a\beta\frac{3}{2}\\ \text{New S.O.R.:} \\ a^3\beta+\beta^3\alpha\\ =a\beta((a+\beta)^2-2a\beta)\\ =\frac{3}{2}((2)^2-2\left(\frac{3}{2}\right))\\ =\frac{3}{2}\\ \text{New P.O.R.:} \\ a^3\beta\times\beta^3\alpha\\ =a^4\beta^4\\ =(a\beta)^4\\ =(a\beta)^4\\ =\frac{3}{16}\\ \text{Required equation: } x^2-\frac{3}{2}x+\frac{81}{16}=0\\ \end{array} \begin{array}{c} 9i \\ 7=25+75e^{-6}t\\ 40=25+75e^{-2k}\\ 40=25+75e^{-2k}\\ -2k=\ln\left(\frac{1}{5}\right)\\ k=0.90472\\ \end{array} M1$		y = x + 8 - (2)	
		Subst (2) to (1),	
For line to be tangent to the curve, $b^2 - 4ac = 0$ $2^2 - 4(2)(c - 15) = 0$ $4 - 8c + 120 = 0$ $c = 15\frac{1}{2}$ A1 To $y = 3x^2 + kx + k + 9$ For curve to lie completely above x-axis, $b^2 - 4ac < 0$ $k^2 - 4(3)(k + 9) < 0$ $k^2 - 12k - 108 < 0$ $(k - 18)(k + 6) < 0$ $-6 < k < 18$ 8 $2x^2 - 4x + 3 = 0$ $a + \beta = -\frac{4}{2} = 2$ $a\beta = \frac{3}{2}$ New S.O.R.: $a^3\beta + \beta^3\alpha = a\beta(a^2 + \beta^2) = a\beta((a + \beta)^2 - 2a\beta) = \frac{3}{2}(2)^2 - 2(\frac{3}{2})$ $= \frac{3}{2}$ New P.O.R.: $a^3\beta + \beta^3\alpha = a^2 + a^2\beta + a^2\beta = a^2\beta + a^2\beta + a^2\beta + a^2\beta = a^2\beta + a^$		$x + 8 = 2x^2 + 3x + c - 7$	M 1
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7b $y = 3x^2 + kx + k + 9$ For curve to lie completely above x-axis, $b^2 - 4ac < 0$ $k^2 - 4(3)(k + 9) < 0$ $k^2 - 4(3)(k + 9) < 0$ $k^2 - 12k - 108 < 0$ $(k - 18)(k + 6) < 0$ $-6 < k < 18$ 8 $2x^2 - 4x + 3 = 0$ $a + \beta = -\frac{4}{2} = 2$ a			
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For curve to lie completely above x-axis, $b^2 - 4ac < 0$ $k^2 - 4ac < 0$ $k^2 - 4(3)(k+9) < 0$ $k^2 - 12k - 108 < 0$ $(k-18)(k+6) < 0$ $-6 < k < 18$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M3. $b^2 - 4ac$ M4. $b^2 - 4ac$ M5. $b^2 - 4ac$ M6. $b^2 - 4ac$ M6. $b^2 - 4ac$ M7. $b^2 - 4ac$ M8. $b^2 - 4ac$ M8. $b^2 - 4ac$ M9. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M1. $b^2 - 4ac$ M2. $b^2 - 4ac$ M3. $b^2 - 4ac$ M4. $b^2 - 4ac$ M5. $b^2 - 4ac$ M6. $b^2 - 4ac$ M7. $b^2 - 4ac$ M8. $b^2 - 4ac$ M9. $b^2 - 4ac$ M9. $b^2 - 4ac$ M9. $b^2 - 4ac$ M9. $b^2 - 4ac$ M9		· · · · · · · · · · · · · · · · · · ·	Ai
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$k^{2} - 4(3)(k+9) < 0$ $k^{2} - 12k - 108 < 0$ $(k-18)(k+6) < 0$ $-6 < k < 18$ $2x^{2} - 4x + 3 = 0$ $\alpha + \beta = -\frac{4}{2} = 2$ $\alpha\beta = \frac{3}{2}$ New S.O.R.: $\alpha^{3}\beta + \beta^{3}\alpha = \alpha\beta((\alpha + \beta)^{2} - 2\alpha\beta)$ $= \frac{3}{2}((2)^{2} - 2(\frac{3}{2}))$ $= \frac{3}{2}$ New P.O.R.: $\alpha^{3}\beta \times \beta^{3}\alpha = \alpha^{4}\beta^{4} = (\alpha\beta)^{4}$ $= (\alpha\beta)^{4}$ $= (\frac{3}{2})^{4}$ $= \frac{81}{16}$ Required equation: $x^{2} - \frac{3}{2}x + \frac{81}{16} = 0$ M1 Pi T = 25 + 75e^{0} = 100 °C Pii T = 25 + 75e^{-2k} $40 = 25 + 75e^{-2k}$ $-2k = \ln(\frac{1}{5})$ $k = 0.80472$ M1 M1.b2 - 4ac			
$k^{2} - 12k - 108 < 0$ $(k - 13)(k + 6) < 0$ $-6 < k < 18$ $2x^{2} - 4x + 3 = 0$ $\alpha + \beta = -\frac{-4}{2} = 2$ $\alpha\beta = \frac{3}{2}$ $New S.O.R.:$ $\alpha^{3}\beta + \beta^{3}\alpha$ $= \alpha\beta(\alpha^{2} + \beta^{2})$ $= \alpha\beta((\alpha + \beta)^{2} - 2\alpha\beta)$ $= \frac{3}{2}((2)^{2} - 2(\frac{3}{2}))$ $= \frac{3}{2}$ $New P.O.R.:$ $\alpha^{3}\beta \times \beta^{3}\alpha$ $= \alpha^{4}\beta^{4}$ $= (\alpha\beta)^{4}$ $= (\alpha\beta)^{4}$ $= (\frac{3}{2})^{4}$ $= \frac{81}{16}$ $Required equation: x^{2} - \frac{3}{2}x + \frac{81}{16} = 0 9i T = 25 + 75e^{-6} = 100 ^{\circ}C 9ii T = 25 + 75e^{-2k} 40 = 25 + 75e^{-2k} -2k = \ln(\frac{1}{5}) k = 0.80472 M1$		$b^2 - 4ac < 0$	
$k^{2} - 12k - 108 < 0 (k - 18)(k + 6) < 0 -6 < k < 18$ $2x^{2} - 4x + 3 = 0 \alpha + \beta = -\frac{4}{2} = 2$ $\alpha\beta = \frac{3}{2}$ New S.O.R.: $\alpha^{3}\beta + \beta^{3}\alpha = \alpha\beta(\alpha^{2} + \beta^{2}) = \alpha\beta((\alpha + \beta)^{2} - 2\alpha\beta) = \frac{3}{2}\left((2)^{2} - 2\left(\frac{3}{2}\right)\right)$ $= \frac{3}{2}$ New P.O.R.: $\alpha^{3}\beta \times \beta^{3}\alpha = \alpha^{4}\beta^{4} = (\alpha\beta)^{4} = (\alpha\beta)^{4} = \frac{3}{16}$ Required equation: $x^{2} - \frac{3}{2}x + \frac{81}{16} = 0$ A1 9i $T = 25 + 75e^{-6} = 100 ^{\circ}\text{C}$ 9ii $T = 25 + 75e^{-2k} = 100 ^{\circ}\text{C}$ 9ii $\frac{1}{5} = e^{-2k} - 2k = 10 ^{\circ}\text{C}$ M1 M1 M1 M2 M1 M3 M4 M1 M1 M1 M1 M1 M1 M1 M1 M1		$k^2 - 4(3)(k+9) < 0$	$M1:b^2-4ac$
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		$k^2 - 12k - 108 < 0$	
8 $2x^2 - 4x + 3 = 0$ $\alpha + \beta = -\frac{-4}{2} = 2$		(k-18)(k+6) < 0	M1
8 $2x^2 - 4x + 3 = 0$ $\alpha + \beta = -\frac{-4}{2} = 2$ M1 $\alpha\beta = \frac{3}{2}$ M1 New S.O.R.: $\alpha^3\beta + \beta^3\alpha$ $= \alpha\beta(\alpha^2 + \beta^2)$ $= \alpha\beta((\alpha + \beta)^2 - 2\alpha\beta)$ M1 $= \frac{3}{2}(2)^2 - 2(\frac{3}{2})$ M1 $= \frac{3}{2}$ New P.O.R.: $\alpha^3\beta \times \beta^3\alpha$ $= \alpha^4\beta^4$ $= (\alpha\beta)^4$ M1 $= (\frac{3}{2})^4$ M1 $= (\frac{3}{2})^4$ M1 Required equation: $x^2 - \frac{3}{2}x + \frac{81}{16} = 0$ M1 9i $T = 25 + 75e^{-6x}$ M1 $\frac{1}{5} = e^{-2k}$ M1 $\frac{1}{5} = e^{-2k}$ M1 $\frac{1}{5} = e^{-2k}$ M1 $\frac{1}{5} = e^{-2k}$ M1			A1
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$\begin{array}{c} \alpha^{3}\beta + \beta^{3}\alpha \\ = \alpha\beta(\alpha^{2} + \beta^{2}) \\ = \alpha\beta((\alpha + \beta)^{2} - 2\alpha\beta) \\ = \frac{3}{2}\left((2)^{2} - 2\left(\frac{3}{2}\right)\right) \\ = \frac{3}{2} \\ \text{New P.O.R.}: \\ \alpha^{3}\beta \times \beta^{3}\alpha \\ = \alpha^{4}\beta^{4} \\ = (\alpha\beta)^{4} \\ = \left(\frac{3}{2}\right)^{4} \\ = \frac{81}{16} \\ \text{Required equation: } x^{2} - \frac{3}{2}x + \frac{81}{16} = 0 \end{array} \qquad \begin{array}{c} \text{M1} \\ \text{M1} \\ \text{Required equation: } x^{2} - \frac{3}{2}x + \frac{81}{16} = 0 \end{array}$			7711
$= \alpha\beta(\alpha^{2} + \beta^{2}) = \alpha\beta((\alpha + \beta)^{2} - 2\alpha\beta)$ $= \frac{3}{2}\left((2)^{2} - 2\left(\frac{3}{2}\right)\right)$ $= \frac{3}{2}$ New P.O.R.: $\alpha^{3}\beta \times \beta^{3}\alpha$ $= \alpha^{4}\beta^{4}$ $= (\alpha\beta)^{4}$ $= (\alpha\beta)^{4}$ $= \frac{3}{2}$ M1 $= \frac{3}{2}$ $= \frac{81}{16}$ Required equation: $x^{2} - \frac{3}{2}x + \frac{81}{16} = 0$ M1 $= \frac{3}{16}$ Required equation: $x^{2} - \frac{3}{2}x + \frac{81}{16} = 0$ M1 $= \frac{3}{16}$ $= \frac{3}{16}$ $= \frac{3}{16}$ $= \frac{3}{16}$ $= \frac{3}{16}$ M1			
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$\begin{array}{c} \alpha^{3}\beta \times \beta^{3}\alpha \\ = \alpha^{4}\beta^{4} \\ = (\alpha\beta)^{4} \\ = \left(\frac{3}{2}\right)^{4} \\ = \frac{81}{16} \\ \text{Required equation: } x^{2} - \frac{3}{2}x + \frac{81}{16} = 0 \end{array} \qquad \qquad \text{M1}$ $\begin{array}{c} 9i T = 25 + 75e^{0} = 100 ^{\circ}\text{C} \\ 9ii T = 25 + 75e^{-kt} \\ 40 = 25 + 75e^{-kt} \\ 40 = 25 + 75e^{-2k} \\ -2k = \ln\left(\frac{1}{5}\right) \\ k = 0.80472 \end{array} \qquad \qquad \text{M1}$		New P.O.R. :	
$= \alpha^{4} \beta^{4}$ $= (\alpha \beta)^{4}$ $= \left(\frac{3}{2}\right)^{4}$ $= \frac{81}{16}$ Required equation: $x^{2} - \frac{3}{2}x + \frac{81}{16} = 0$ M1 9i $T = 25 + 75e^{0} = 100 ^{\circ}\text{C}$ B1 9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ $40 = 25 + 75e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ $k = 0.80472$ M1			
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Required equation: $x^2 - \frac{3}{2}x + \frac{81}{16} = 0$ A1 9i $T = 25 + 75e^0 = 100 ^{\circ}\text{C}$ B1 9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ $k = 0.80472$		— (up) 	
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Required equation: $x^2 - \frac{3}{2}x + \frac{81}{16} = 0$ A1 9i $T = 25 + 75e^0 = 100 ^{\circ}\text{C}$ B1 9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ $k = 0.80472$		\2/	1
Required equation: $x^2 - \frac{3}{2}x + \frac{81}{16} = 0$ A1 9i $T = 25 + 75e^0 = 100 ^{\circ}\text{C}$ B1 9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ $k = 0.80472$		$=\frac{\sigma_1}{\sigma_1}$	M1
9i $T = 25 + 75e^{0} = 100 ^{\circ}\text{C}$ B1 9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ M1 $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ $k = 0.80472$		16	
9i $T = 25 + 75e^{0} = 100 ^{\circ}\text{C}$ B1 9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ M1 $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ $k = 0.80472$	1	Required equation: $x^2 - \frac{3}{2}x + \frac{81}{16} = 0$	A 1
9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ k = 0.80472 M1		7 16	
9ii $T = 25 + 75e^{-kt}$ $40 = 25 + 75e^{-2k}$ $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ k = 0.80472 M1	9i	$T = 25 + 75e^0 = 100 ^{\circ}\text{C}$	R1
$40 = 25 + 75e^{-2k}$ $\frac{1}{5} = e^{-2k}$ $-2k = \ln\left(\frac{1}{5}\right)$ $k = 0.80472$ M1	1	$T = 25 \pm 75a - kt$	191
$ \frac{1}{5} = e^{-2k} $ $ -2k = \ln\left(\frac{1}{5}\right) $ $ k = 0.80472 $ M1) JH		N#1
$ \begin{aligned} -2k &= \ln\left(\frac{1}{5}\right) \\ k &= 0.80472 \end{aligned} $ M1			IATT
$ \begin{aligned} -2k &= \ln\left(\frac{1}{5}\right) \\ k &= 0.80472 \end{aligned} $ M1		$\begin{vmatrix} 1 \\ - = e^{-2k} \end{vmatrix}$	
k = 0.80472		[5]	
k = 0.80472		$\begin{vmatrix} -2k = \ln \begin{pmatrix} 1 \\ - \end{pmatrix} \end{vmatrix}$	
		1 10/	M1
1 0 005 (2 - 5)			
= 0.805 (3 s.i.) A1		= 0.805 (3 s.f.)	A1

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9iii	$T = 25 + 75e^{-0.80472(4)}$	
7444	$= 28.0 ^{\circ}\text{C} (3 \text{s.f.})$	B1
9iv	25 °C	B1
9v	No the value of k cannot be negative.	
	If k is negative, e^{-kt} will have a positive power and $T = 25 + 75e^{-kt}$ will	
	increase with time and the liquid will not be cooling but heating up.	B 1
10i	$\lg(2y+3) + \lg(3y-4) = \lg 100$	
	$\lg[(2y+3)(3y-4)] = \lg 100$	M1
	$6y^2 + y - 12 = 100$	
	$6y^2 + y - 112 = 0$	
	$y = \frac{-1 \pm \sqrt{1^2 - 4(6)(-112)}}{2(6)}$	M1
	y = -4.40 or y = 4.24	A1
10ii	$\log_x 5 - 2\log_5 x = 3$	
	$\frac{\log_5 5}{\log_5 x} - 2\log_5 x = 3$	N/1
	l 1	M1
	$\frac{1}{\log_5 x} - 2\log_5 x = 3$	
	$\log_5 x$ $1 - 2(\log_5 x)^2 = 3\log_5 x$	M1
	$ \begin{vmatrix} 1 - 2(\log_5 x) - 3\log_5 x \\ 2(\log_5 x)^2 + 3\log_5 x - 1 = 0 \end{vmatrix} $	
	$\log_5 x = \frac{-3 \pm \sqrt{3^2 - 4(2)(-1)}}{2(2)}$	M1
	$\log_5 x = 0.28078 \text{ or } \log_5 x = -1.78078$	M1
	x = 1.57 or x = 0.0569	A1
		111
11i	$f(x) = x^3 - 2x^2 + ax + b$	
	Since $(x-4)$ is a factor, $f(4) = 0$	
	$(4)^3 - 2(4)^2 + a(4) + b = 0$	M1
	4a + b = -32 - (1)	
	Dividing by $(x-2)$ gives remainder of 14, $f(2) = 14$	M1
		1411
	$ \begin{vmatrix} 2a + b = 14 (2) \\ (1) - (2): 2a = -46 \end{aligned} $	M1
	a = -23	
	2(-23) + b = 14	
		A1: a & b
11ii	$b = 60$ $x^3 - 2x^2 - 23x + 60 = (x - 4)(x^2 + cx - 15)$	M1
	Comparing coefficients of x^2 ,	N/1
	-2 = -4 + c	M1
	c = 2 $f(x) = (x - 4)(x^2 + 2x - 15)$	
	$f(x) = (x-4)(x^2+2x-15)$ = $(x-4)(x-3)(x+5)$	M1
	f(x) = 0	
	(x-4)(x-3)(x+5) = 0	
	x = 4 or x = 3 or x = -5	A1

0	$x^3 - 8x^2 + 2ax + b = 0$	
"	$x^3 - 8x^2 - 46x + 60 = 0$	
1	$et x = \frac{1}{2}y,$	
8	$\left(\frac{1}{2}y\right)^3 - 8\left(\frac{1}{2}y\right)^2 - 46\left(\frac{1}{2}y\right) + 60 = 0$	M1
1 "	$x^3 - 2y^2 - 23y + 60 = 0$	
	y = 4 or y = 3 or y = -5	
1 1	= 2 or x = 1.5 or x = -2.5	A1
12i C	Fradient of $AC = \frac{5 - (-1)}{3 - 5} = -3$	
	Fradient of perpendicular bisector $=\frac{1}{3}$	M1
N	Midpoint of $AC = \left(\frac{3+5}{2}, \frac{5-1}{2}\right) = (4,2)$	M1
ì	equation of perpendicular bisector:	1411
_ν	$x - 2 = \frac{1}{2}(x - 4)$	
	្ស	M1
y	$y = \frac{1}{3}x + \frac{2}{3}$	A1
12ii y	$y = \frac{1}{3}x + \frac{2}{3}$ (1)	
l y	y = 2x - 1 - (2)	
S	ubst (1) to (2)	
	subst (1) to (2) $x - 1 = \frac{1}{3}x + \frac{2}{3}$	M1
1	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	
	y = 2(1) - 1 = 1	
1 1 -	S = (1,1)	A 1
	Midpoint of $BD = Midpoint$ of $AC = (4,2)$	A1
I I	et D = (x, y)	
	$\left(\frac{x+1}{2}, \frac{y+1}{2}\right) = (4,2)$	
1 1		M1
	O = (7,3)	A1
1 6	Area of ABCD	
=	$=\frac{1}{2}\begin{vmatrix}3 & 1 & 5 & 7 & 3\\5 & 1 & -1 & 3 & 5\end{vmatrix}$	M1
1 (4	
=	$= \frac{1}{2}[(3-1+15+35)-(5+5-7+9)]$ = 20 unit ²	A 1