Name : ______________________
Class : 12 MT___

KW
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AW

CHERRYBROOK TECHNOLOGY HIGH SCHOOL

2001 AP4

YEAR 12 TRIAL HSC

MATHEMATICS

[2/3 UNIT]
Time allowed - 3 hours
(plus 5 minutes reading time)

DIRECTIONS TO CANDIDATES:

- Attempt ALL questions.
- All questions are of equal value
- Standard Integrals are provided.
- Approved calculators may be used.
- All necessary working should be shown in every question. Full marks may not be awarded for careless or badly arranged work.
- Each question attempted is to be returned on a new page clearly marked Question 1, Question 2, etc on the top of the page.
- Each page must show your class and your name.

Students are advised that this is a school based Trial Examination *only* and cannot in any way guarantee the complete content nor format of the Higher School Certificate Examination.

QUESTION 1 **Use a new page** **Marks**

(a) Factorise $3x^2-2x-1$. **2**

(b) Solve and graph the solution of $|2x+1| < 2$ on a number line **2**

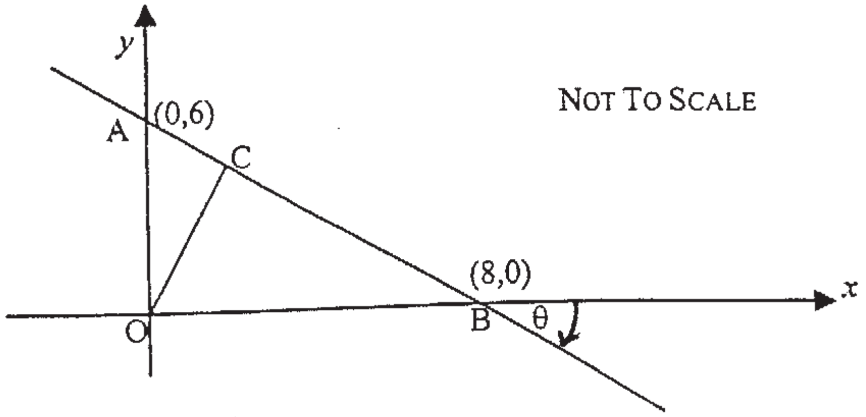
(c) Find the value of $8^{\frac{1}{2}}$ correct to 3 decimal places. **2**

(d) Find the primitive function for $x^{-2}+6$. **2**

(e) Find the exact value of $\tan 60^\circ + \tan 150^\circ$. **2**

(f) Solve $\tan\alpha = \sqrt{3}$ for $0^\circ \leq \alpha \leq 360^\circ$ **2**

QUESTION 2 **Start a new page** **Marks**



(a) Find the gradient of the line AB **1**

(b) Show that the equation of AB is $3x+4y-24=0$ **2**

(c) Calculate the angle θ to the nearest degree. **2**

(d) Given that OC meets AB at right angles, calculate the distance OC. **2**

(e) (i) Show OC has the equation $4x-3y=0$ **2**

(ii) Find the distance of BC. **2**

(iii) Show that $\dfrac{OC}{BC}=\dfrac{OA}{OB}$. **1**

QUESTION 3 **Use a new page** **Marks**

(a) Obtain all solutions to $9^x - 28 \times 3^x + 27 = 0$. **2**

(b) Find the indefinite integrals for:

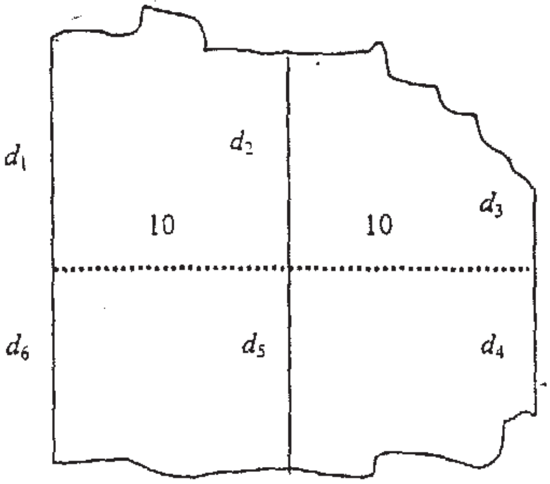
(i) $\int \frac{4x}{x^2 - 7} dx$ **1**

(ii) $\int \frac{3x^2 - 7x + 2}{x^2} dx$ **2**

(c) Evaluate $\int_0^1 2x.e^{(3x^2-5)} dx$

Give your answer in scientific notation to 3 significant figures. **3**

(d) The diagram shows the face of a vertical cliff.
The distances $d_1 \overset{\text{to}}{\rightarrow} d_6$ are given in the table.



d_1	d_2	d_3	d_4	d_5	d_6
15	14	5.4	8.8	15	14.4

(i) Find an estimate for the area of the cliff face using the trapezoidal rule.
Give your answer to the nearest square metre. **2**

(ii) Is the area greater than or less than the actual area of the cliff?
Justify your answer. **2**

QUESTION 4 **Start a new page** **Marks**

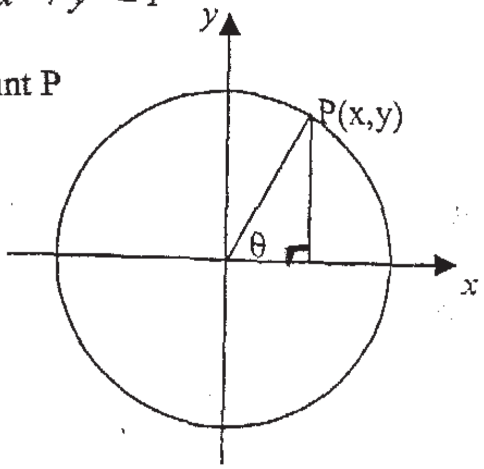
(a) For the quadratic function $f(x) = Ax^2 - 7x + 3$, $f(2) = -3$.

(i) Find the value of A. **1**

(ii) If the two roots of the equation $f(x) = 0$ are α and β,

Find the value of $\alpha^2 + \beta^2$ **2**

(b) The unit circle shown has the equation $x^2 + y^2 = 1$



(i) Write the co-ordinates of the point P In terms of the angle θ. **1**

(ii) Explain why $\sin^2\theta + \cos^2\theta = 1$ **1**

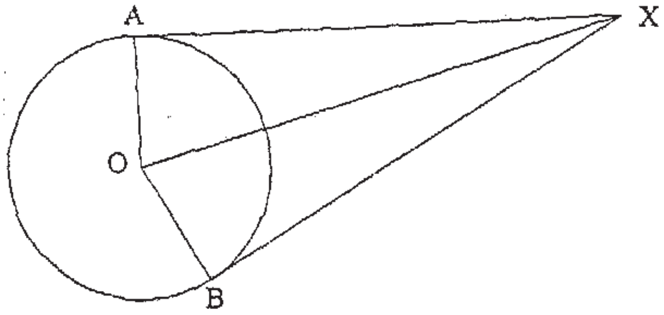
(iii) If $\sin\theta = \frac{8}{17}$ find 2 possible values for $\cos\theta$ **2**

(c) The figure shows a circle, centre O.

AX and BX are tangents to the circle from the external point X.

OA and OB are the radii at the points of contact of the tangents.

AX ⊥ OA and BX ⊥ OB



(i) By considering the triangles AOX and BOX prove that AX = BX. **3**

(ii) If AO = r and $\angle$AOX = θ, show that the area of OAXB = $r^2 \tan\theta$. **2**

QUESTION 5 **Start a new page** **Marks**

(a) In a geometric sequence $T_1 = 27$ and $T_4 = 1$

(i) Find the common ratio, r. 1

(ii) Find the limiting sum. 2

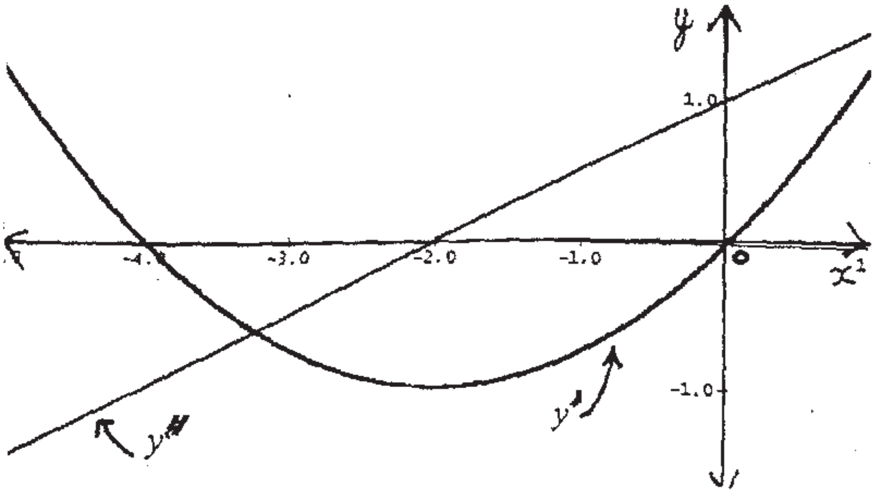
(b) Consider the series 97 + 91 + 85 + 79 + ……

(i) Find the common difference, d 1

(ii) Find the largest n such that $S_n < 0$ 2

(c) The point P moves such that its distance from the point (0,2) is the same as the distance from the line $y = -2$.
What is the equation of the ~~line~~? locus? 3

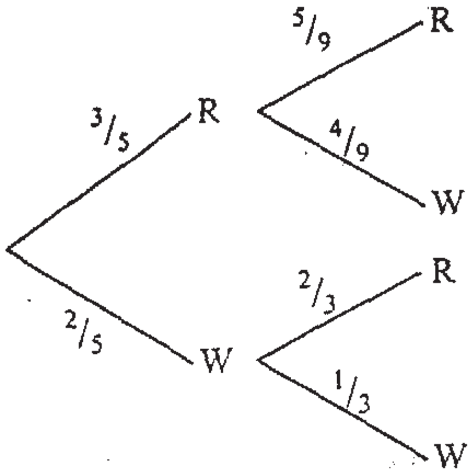
(d) The graph shows y' and y'' for the function $y = f(x)$.



Sketch the graph of $y = f(x)$ clearly showing the x values of any turning points and points of inflexion. 3

QUESTION 6 **Start a new page** **Marks**

(a)



Some red and white balls are placed in a bag.

The tree diagram shows the probabilities relating to the situation

of two balls from the bag, without replacement.

Find (i) the probability that the two balls are different colours. **2**

(ii) the probability that the two balls are the same colour.. **1**

(iii) the number of red balls and white balls in the bag. **1**

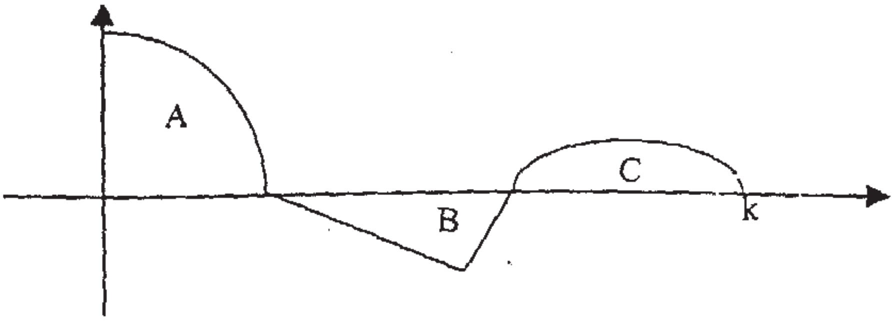
(b) For the function $f(x) = 2x.e^{0.5x}$

(i) Show it has a minimum at $x = -2$ and state the minimum value at this point. **6**

(ii) State the region(s) for where the curve is increasing. **2**

QUESTION 7 **Start a new page** **Marks**

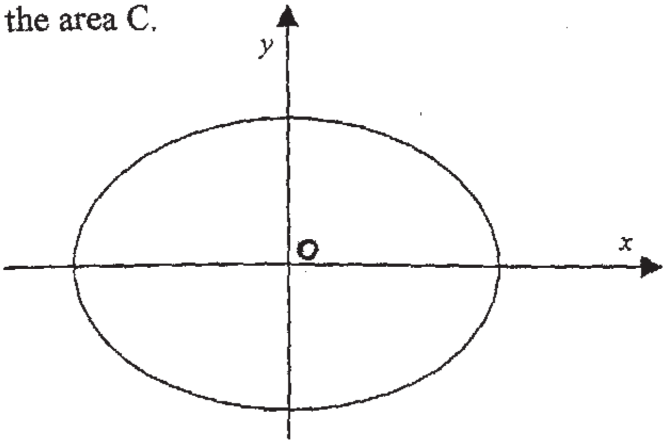
(a) The graph shows $y = f(x)$ for $0 \le x \le k$ **2**



The value of $\int_0^k f(x).dx$ is known to be 3.5 units

If A = 5 and B = 4 find the area C.

(b)



The curve represented on the graph is an ellipse which has the equation $4x^2 + 9y^2 = 36$

(i) Show that the curve crosses the x axis at (3,0) and (-3,0) **1**

(ii) Obtain the volume generated when the curve is rotated around the x axis. **3**

(c) Michael has decided to invest in a superannuation fund. He calculates that he will need \$1 000 000 if he is to retire in 20 years time and maintain his present lifestyle. The superannuation fund pays 12% per annum interest on his investments.

(i) Michael invests \$P at the beginning of each year. Show that at the end of the first year his investment is worth \$P(1.12). **1**

(ii) Show that at the end of the third year his investment is given by the expression $\$P(1.12)(1.12^2 + 1.12 + 1)$. **2**

(iii) Find a similar expression for his investment after 20 years and hence find the value of P needed to realise the total of \$1 000 000 required for his retirement. **3**

QUESTION 8 **Start a new page** **Marks**

(a) (i) Show that the discriminant for the quadratic equation $kx^2+(k+3)x-1=0$ is given by $k^2+10k+9$.
Hence find for what value of k does the equation have real roots. **3**

(ii) For what value of k is the quadratic expression $kx^2+(k+3)x-1=0$ positive definite? 2

(b) (i) Show that $\frac{d}{dx}(x\ln x-x)=\ln x$ **2**

(ii) Hence evaluate $\int_1^{e^2}\ln x.dx$. Leave your answer in exact form. **2**

(c) Find the equation of the tangent to the curve $y=\ln(\sqrt{x})$ when $x=e$. **3**

QUESTION 9 **Start a new page** **Marks**

(a) For the parabola $8x=y^2$ find

(i) The Vertex **1**

(ii) The Focus **1**

(iii) The Directrix **1**

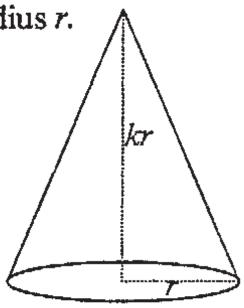
(b) If $\log_x a=3.6$ and $\log_x b=2$ find:

(i) $\log_x \sqrt[3]{a}$ **1**

(ii) $\log_x ab$ **1**

(iii) $\log_x \frac{a}{b}$ **1**

(c) The diagram represents a right conical container, with radius r. The height of the container = kr. Also the sum of the radius and the height = 1m.



(i) Show that the volume of the cone is given by $V=\frac{\pi}{3}.\frac{k}{(1+k)^3}$ **2**

(ii) Find the value of k which maximises the volume of the cone. **3**

(iii) Calculate the maximum volume. **1**

QUESTION 10 **Start a new page** **Marks**

(a) Sketch $y = 2\sin x - 1$ for $0^0 \le x \le 180^0$ **3**

(b) To comply with regulations, a factory must make hourly measurements of the quality of fumes produced by its furnaces. The measured quantity of fumes, L litres, that has been produced by each of its furnaces t hours after the furnace has been lit is given by the expression $L = t + 1.2^t$.

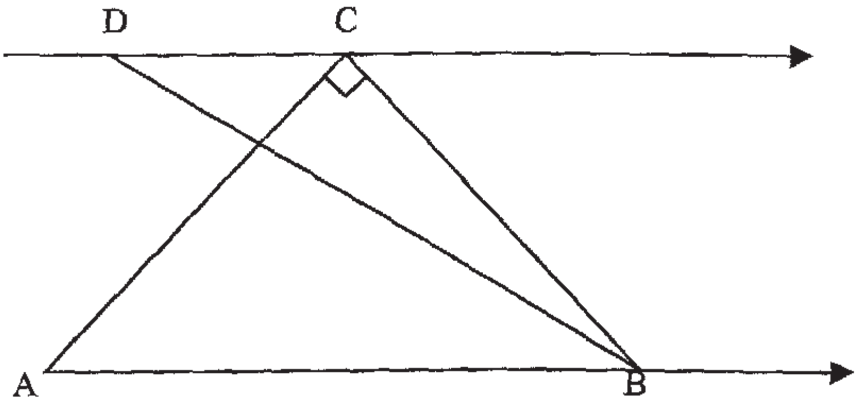
(i) A furnace is lit at 6 a.m.What is the measured quantity of fumes from the furnace after one hour? **1**

(ii) A second furnace is lit at 7 a.m. Show that the total measured quantity of fumes from the two furnaces by 8.~~45~~ a.m. is 5.64 litres. **1**

(iii) At the beginning of each hour of the day, an additional furnace is lit. Write an expression to find the total measured quantity of fumes from the furnaces after n hours, where n is a positive whole number. **2**

(iv) On a given day, the first furnace is lit at 6 a.m. and an additional furnace is lit every hour, until the last furnace is lit at 4 p.m. Using the formulas for the sum of an arithmetic series and the sum of a geometric series, calculate the total measured quantity of fumes produced by 5 p.m. **2**

(c) A, B and C are the vertices of an isosceles triangle with a right angle at C. D is a point such that DB = AB and angle DBA is acute DC ∥ AB. 3



Find the size of $\angle DBC$

Question 1

CTHS TRIAL MATHEMATICS SOLUTIONS 2001
MARKING GUIDELINES.

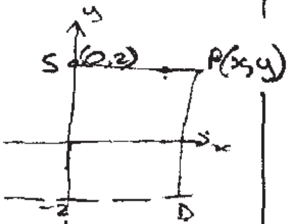
a) $(3x+1)(x-1)$	2
b) $2\|x - -\frac{1}{2}\| < 2$ $\|x - -\frac{1}{2}\| < 1$  or $2x+1<2$ $-2x-1<2$ $2x<1$ $-2x<3$ $x<1$ $x>-1\frac{1}{2}$ or * $-2<2x+1<2$ $-3<2x<1$ $-1\frac{1}{2}<x<\frac{1}{2}$ *	2
c) $8^{\frac{1}{2}} = \sqrt{8} \doteqdot 2.828$	1 for answer 1 for correct to 3 d.p.
d) $\int x^{-2}+6 \, dx = -1x^{-1}+6x+c$ $= \frac{-1}{x}+6x+c$	2
e) $\tan 60 = \sqrt{3}$ $\tan 150 = \frac{-1}{\sqrt{3}}$ $\sqrt{3} - \frac{1}{\sqrt{3}}$ $\frac{3-1}{\sqrt{3}} = \frac{2}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$	1 for exact ratio 1 for simplifying. 2
f) $\tan\alpha = \sqrt{3}$  $\tan 60 = \sqrt{3}$ $\alpha = 60° \text{ or } 180° + 60°$ $\therefore \alpha = 60° \text{ \& } 240°$	1 for 60° 1 for 240° /12

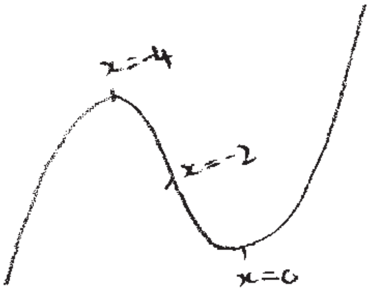
Solutions	Marks/Comments
Q 2(a) $m = \frac{6-0}{0-8}$ $= -\frac{3}{4}$	1.
(b) y intercept $= 6$ $y = -\frac{3}{4}x + 6$ $4y = -3x + 24$ $3x + 4y - 24 = 0$ OR $y - 0 = \frac{3}{4}(x-8)$ $y = \frac{3}{4}x - 6$ $3x + 4y - 24 = 0$	2.
(c) $\theta = \angle ABO$ $\therefore \tan\theta = \frac{6}{8}$ $\theta = 37°$ OR inclination $= \tan^{-1}\left(-\frac{3}{4}\right)$ $= 143°$ $\theta = 180° - 143°$ $= 37°$	2
(d) $d = \left\| \frac{Ax_1 + By_1 + C}{\sqrt{A^2 + B^2}} \right\|$ $= \left\| \frac{0 + 0 - 24}{\sqrt{3^2 + 4^2}} \right\|$ $= \left\| \frac{-24}{5} \right\| = 4 \cdot 8$	2.
e) (1) $OC \perp AB$ $\therefore$ gradient $= \frac{4}{3}$ y intercept is 0 $\therefore y = \frac{4}{3}x$ $4x - 3y = 0$	2

Solutions	Marks/Comments
2(e)(ii) $4x-3y=0$ $y=\frac{4}{3}x$ sub into $3x+4y-24=0$ $3x+4\left(\frac{4}{3}x\right)-24=0$ $\frac{25x}{3}=24$ $x=\frac{72}{25}$ $y=\frac{96}{25}$ $d=\sqrt{\left(8-\frac{72}{25}\right)^2+\left(0-\frac{96}{25}\right)^2}$ $BC=6.4$ OR. $OB=8$ $OC=4.8$ $BC^2=OB^2-OC^2$ $=8^2-4.8^2$ $BC^2=40.96$ $BC=6.4$	2.
(iii) $\frac{OC}{BC}=\frac{4.8}{6.4}=\frac{3}{4}$ $\frac{OA}{OB}=\frac{6}{8}=\frac{3}{4}$ $\therefore\ \frac{OC}{BC}=\frac{OA}{OB}$	1

Solutions	Marks/Comments
Q3a) Let $u = 3^x$. $u^2 - 28u + 27 = (u-27)(u-1) = 0$ when $3^x = 27$ $x = 3$ OR $3^x = 1$ $x = 0$	1 1 for both solutions in x.
b) i) $\int \frac{4x}{x^2-7}\,dx = 2\ln(x^2-7) + c$ ii) $\int \frac{3x^2-7x+2}{x^2}\,dx = \int\left(3 - \frac{7}{x} + \frac{2}{x^2}\right)dx$ $= 3x - 7\ln x - \frac{2}{x} + c$	1 1 1
c) $\int_0^1 2x.e^{(3x^2-5)}\,dx = \left[\frac{1}{3}e^{3x^2-5}\right]_0^1$ $= \frac{1}{3}e^{-2} - \frac{1}{3}e^{-5}$ $= 0.0428657$ $\doteqdot 4.29 \times 10^{-2}$	1 1 1
$A = \frac{10}{2}[d_1 + d_2] + \frac{10}{2}[d_2 + d_3] + \frac{10}{2}[d_6 + d_5] + \frac{10}{2}[d_5 + d_4]$ d)(i) $A \equiv 10\left(\frac{d_1}{2} + d_2 + \frac{d_3}{2} + \frac{d_4}{2} + d_5 + \frac{d_6}{2}\right)$ $= 508\,m^2$	1 ← or equivalent expression 1
ii) Less than actual area. If we connect the ends of $d_1 d_2$, $d_2 d_3$, $d_4 d_5$, $d_5 d_6$ areas of the cliff are not included(	1 1 /12

Solutions	**Marks/Comments**
Q4(a)(i) $A(2)^2 - 7(2) + 3 = -3$ $4A - 11 = -3$ $4A = 8$ $A = 2$	1
(ii) $2x^2 - 7x + 3 = 0$ $\alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2\alpha\beta$ $= \left(\frac{-b}{a}\right)^2 - \frac{c}{a} \times 2$ 1 $= \left(\frac{7}{2}\right)^2 - \frac{3}{2} \times 2$ $= \frac{49}{4} - 3$ $= \frac{43}{4} = \frac{37}{4} = 9\frac{1}{4}$ 1 OR BY FINDING ROOTS $(3 \text{ and } \frac{1}{2})$ and squaring.	If $\alpha^2+\beta^2$ is calculated correctly using the wrong value of A from (i) give full marks. 2.
(b) (i) $\cos\theta = \frac{x}{1}$ $\sin\theta = \frac{y}{1}$ $x = \cos\theta$ $y = \sin\theta$. $P(\cos\theta, \sin\theta)$	1
(ii) $x^2 + y^2 = 1$ for all points on circle. $P(\cos\theta, \sin\theta)$ lies on circle. $\therefore \cos^2\theta + \sin^2\theta = 1$ $\sin^2\theta + \cos^2\theta = 1$ OR USING PYTHAGORAS THM.	1
(iii) $\cos^2\theta + \left(\frac{8}{17}\right)^2 = 1$ $\cos^2\theta + \frac{64}{289} = 1$ $\cos^2\theta = 1 - \frac{64}{289} = \frac{225}{289}$ $\cos\theta = \pm\frac{15}{17}$	1 for working 1 for answer 2

Solutions	Marks/Comments
Q5a) i) $T_1 = a = 27$, $T_4 = ar^3 = 1$ $r^3 = \frac{1}{27}$ $r = \frac{1}{3}$	1
ii) $a = 27$ $r = \frac{1}{3}$ $\frac{a}{1-r} = S_\infty$ $S_\infty = \frac{27}{2/3}$ $= 40\frac{1}{2}$	1 1
b) i) $d = -6$	1
ii) $S_n = \frac{n}{2}(2a + (n-1)d)$ $0 = \frac{n}{2}(194 - 6n - 6)$ $0 = 94n - 3n^2$ gives $n(94 - 3n)$ $n = 31\frac{1}{3}$ whence $n = 31$ is largest n for which $S_n > 0$	1 1
c) Let $D = (x, -2)$ $S = (0, 2)$ and $PS = PD$  $\therefore PS^2 = PD^2$ $(x-0)^2 + (y-2)^2 = (x-x)^2 + (y--2)^2$ $x^2 + y^2 - 4y + 4 = 0 + y^2 + 4y + 4$ $x^2 = 8y$ $\therefore$ locus of P is $y = \frac{x^2}{8}$	1 for distance statement. 1 for Algebra manipulation 1 for Equation.

Solutions	Marks/Comments
5 d) $x=-4$ is a max ∵ $y''<0$ $y'=0$	1
$x=-2$ is point of inflexion $y''=0$ $y'<0$	1
$x=0$ is min ∵ $y'=0$ $y''>0$	1
	/12

Solutions	Marks/Comments
6 a) i) $P(RW) = \frac{3}{5} \times \frac{4}{9} = \frac{12}{45}$	1
$P(WR) = \frac{2}{5} \times \frac{2}{3} = \frac{4}{15} = \frac{12}{45}$	
$P(2\text{ different}) = \frac{24}{45} = \frac{8}{15}$	1
(iii) $R = 6 \quad W = 4$	①
(ii) $P(2\text{ same}) = 1 - P(\text{diff}) = 1 - \frac{24}{45} = \frac{21}{45} = \frac{7}{15}$	①
(b) $f(x) = 2xe^{0.5x}$	
(i) $f'(x) = 2.e^{0.5x} + 2x \times \frac{1}{2}e^{0.5x}$	1
$= 2e^{0.5x} + xe^{0.5x}$	1
For stationary points $f'(x) = 0$	
$e^{0.5x}(2+x) = 0$	
$2 + x = 0$	
$x = -2$	1
Test NATURE at $x = -2$	

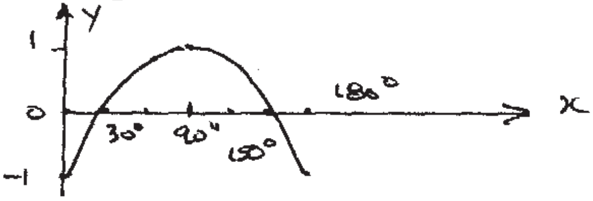
x	$\overset{-2.1}{-2^-}$	-2	$\overset{-1.9}{-2^+}$
$f'(x)$	-0.035	0	$+0.039$
	\	—	/

Solutions	Marks/Comments
	2
$\therefore$ a rel min T.pt at $x = -2$	
at $x = -2$ $f(-2) = 2(-2)e^{0.5\times(-2)}$	
$= -4e^{-1}$	1
$\therefore$ min value $= -4e^{-1}$	
(ii) Increasing function $f'(x) > 0$	
$e^{0.5x}(2+x) > 0$	1
$e^{0.5x} > 0 \quad \forall x$	
so $2 + x > 0$	
$x > -2$	1

Solutions	Marks/Comments
7 a) $3\cdot5 = 5 - 4 + c$ $2\cdot5 = c$	1 1
b) 1) $4x^2 + 9y^2 = 36$ if $y = 0$ $4x^2 = 36$ $x^2 = 9$ $x = \pm 3$ as req^{d}	1 or straight substitution of points
ii) $V = \pi\int_{-3}^{3} y^2\,dx$ $9y^2 = 36 - 4x^2$ $y^2 = 4 - \frac{4}{9}x^2$ $= \pi\int_{-3}^{3} 4 - \frac{4}{9}x^2\,dx$ $= \pi\left[4x - \frac{4}{27}x^3\right]_{-3}^{3}$ $= \pi\left[(12 - 4) - (-12 + 4)\right]$ $= 16\pi$ cubic units	1 for manipulation of y^2 and sub into correct formula 1 for integral. 1 for answer.
c) i) $A_1 = P + (P \times 0\cdot12) = P + 0\cdot12P$ $= P(1 + 0\cdot12)$ $= P(1\cdot12)$	① or equiv. eg: $A_1 = P(1 + \frac{12}{100})'$
ii) $A_2 = (A_1 + P)1\cdot12$ $A_3 = (A_2 + P)1\cdot12$ $A_3 = P(1\cdot12)^3 + P(1\cdot12)^2 + P(1\cdot12)$ $A_3 = P(1\cdot12)(1\cdot12^2 + 1\cdot12 + 1)$	① ①
iii) $A_{20} = P(1\cdot12)(1\cdot12^{19} + 1\cdot12^{18} + \ldots + 1\cdot12 + 1)$ $1000\,000 = P(1\cdot12)\left(\frac{1(1\cdot12^{20} - 1)}{1\cdot12 - 1}\right)$ $P = \frac{1000\,000}{(1\cdot12)\left(\frac{1\cdot12^{20} - 1}{0\cdot12}\right)}$ $\simeq \$12\,391\cdot77$	① GP $a = 1$ $r = 1\cdot12$ $n = 20$ ① ①

Solutions	Marks/Comments
Q8(a) (i) $\Delta = b^2 - 4ac$	
$= (k+3)^2 - 4 \times k \times (-1)$	
$= k^2 + 6k + 9 + 4k$	1
$\Delta = k^2 + 10k + 9$	
For real root $\Delta \geqslant 0$	
so $k^2 + 10k + 9 \geqslant 0$	
$(k+9)(k+1) \geqslant 0$	(1)
	
$\therefore k \leqslant -9$ or $k \geqslant -1$	1 (2)
(ii) PDQF if $\Delta < 0$ and $a > 0$	1
so $(k+9)(k+1) < 0$ and $k > 0$	
	
$-9 < k < -1$ and $k > 0$	
$\therefore$ no solution possible for k	1
$\therefore$ never a PDQF	
(b) (i) $\frac{d}{dx}[x\ln x - x] = 1.\ln x + x.\frac{1}{x} - 1$	1
$= \ln x + 1 - 1$	
$= \ln x$ q.e.d.	1
(ii) $\int_1^{e^2} \ln x \, dx = [x\ln x - x]_1^{e^2}$	
$= (e^2 \ln e^2 - e^2) - (1\times\ln 1 - 1)$	1 for subst.
$= e^2 \times 2 - e^2 - (\ln 1 - 1)$	
$= 2e^2 - e^2 - (0 - 1)$	1 for evaluation
$= e^2 + 1$	
(c) $y = \ln\sqrt{x}$ Grad. of Tang at $x = e$	1 for differe
$\frac{dy}{dx} = \frac{1}{2x}$ $m_T = \frac{1}{2e}$	1 for $(e, \frac{1}{2})$ and $m_T = \frac{1}{2e}$
at $x = e$ $y = \ln\sqrt{e} = \frac{1}{2}$	
11.	
Equ. of Tangent	1 for "equ"
$y - \frac{1}{2} = \frac{1}{2e}(x - e)$	
$\Rightarrow y = \frac{1}{2e}x$	

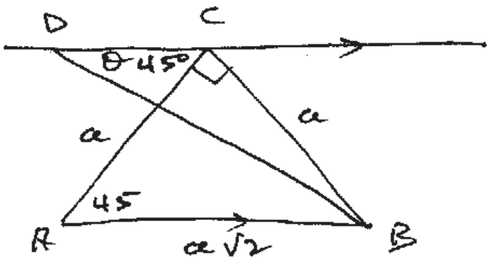
Solutions	Marks/Comments
Q9(a) (i) Vertex = $(0,0)$	1
(ii) $y^2 = 4Ax$, $A = 2$ ∴ focus $S = (2,0)$	1
(iii) Directrix $x = -2$	1
(b) (i) $\log_x \sqrt[3]{a} = \frac{1}{3}\log_x a = \frac{3.6}{3}$ $= 1.2$	1
(ii) $\log_x ab = \log_x a + \log_x b$ $= 3.6 + 2 = 5.6$	1
(iii) $\log_x \frac{a}{b} = \log_x a - \log_x b$ $= 3.6 - 2 = 1.6$	1
(c) (i) $h = kr$ $r + kr = 1 \Rightarrow r = \frac{1}{1+k}$ $V = \frac{\pi}{3}r^2h = \frac{\pi}{3}\cdot\frac{1}{(1+k)^2}\times\frac{k}{1+k}$ $= \frac{\pi}{3}\cdot\frac{k}{(1+k)^3}$ q ed.	1 1
(ii) $\frac{dV}{dk} = \frac{\pi}{3}\left[\frac{1.(1+k)^3 - k\times 3(1+k)^2}{(1+k)^6}\right]$ $= \frac{\pi}{3}\times\frac{(1+k)\,[1+k - 3k]}{(1+k)^6}$ $= \frac{\pi}{3}\times\frac{1-2k}{(1+k)^4}$ when $\frac{dV}{dk} = 0$ when $k = \frac{1}{2}$ Test nature at $k = \frac{1}{2}$ $\begin{array}{c\|\|c\|c\|c} k & \frac{1}{2}^- & \frac{1}{2} & \frac{1}{2}^+ \\ \hline \frac{dV}{dk} & + & 0 & - \\ & / & - & \backslash \end{array}$ ∴ Rel max T.pt at $k = \frac{1}{2}$	1 1 ? 1 for justifying at $k=\frac{1}{2}$ V is max.
(iii) $V_{max} = \frac{\pi}{3}\cdot\frac{\frac{1}{2}}{(1+\frac{1}{2})^3} = \frac{4\pi}{81}$ 1	1

Solutions	Marks/Comments
Q10(a) $y = 2\sin x - 1$ 	1 for $(0,-1) + (90°,1)$ 1 for concavity 1 for 30° and 150°
(b) (i) $F_1 = t + 1.2^t$ when $t=1$ $F_1 = 1 + 1.2^1 = \underline{2.2}$	1
(ii) $L_2 = F_1 + F_2$ $= 1 + 1.2 + 2 + 1.2^2$ $= 3 + 1.2 + 1.2^2$ $\begin{array}{r}3\\1.2\\1.44\\\hline 5.64\end{array}$ $= \underline{5.64}$ q.e.d	1
(iii) $L_n = F_1 + F_2 + F_3 + \ldots + F_n$ $= [1+1.2] + [2+1.2^2] + [3+1.2^3] + \ldots + [n + 1.2^n]$ $= [1+2+3+\ldots+n] + [1.2 + 1.2^2 + 1.2^3 + \ldots + 1.2^n]$ $= \frac{n}{2}(1+n) + 1.2\left(\frac{1.2^n - 1}{1.2 - 1}\right)$	1 1 G.series
(iv) from 6am to 4pm $\underline{n=11}$ so $L_{11} = \frac{11}{2}(1+11) + 1.2\frac{(1.2^{11}-1)}{0.2}$ $= 11 \times 6 + 6(1.2^{11} - 1)$ $= 104.6$ litres (1dp)	1 1
(c) let AC = 1 unit 1. ∴ $DB = \sqrt{2}$ 2. as $\angle CAB = 45°$ $(= \angle CBA)$ so $\angle DCA = 45°$ (Alt ∠s equal as DC∥AB) so $\angle DCB = 135°$ 3. $\frac{\sin\theta}{1} = \frac{\sin 135°}{\sqrt{2}} = \frac{1}{2}$	1 for get to $\sqrt{2}$ 1 getting to 135°

$\angle\theta = 30° \equiv \angle BDC$ 1

so $\angle DBC = 45° - 30° = \underline{15°}$

Q 10.(c)



let $AC = a$

so $CB = a$

1. so $AB = a\sqrt{2}$

so $DB = a\sqrt{2}$ ①

2. $\angle CAB \ (= \angle CBA) = 45°$

so $\angle DCA = 45°$ (Alt ∠s equal as $DC \parallel AB$) ①

3. $$\frac{\sin\theta}{BC} = \frac{\sin 135°}{DB}$$

$$\frac{\sin\theta}{a} = \frac{\sin 135°}{a\sqrt{2}} = \frac{\frac{1}{\sqrt{2}}}{a\sqrt{2}} = \frac{1}{2a}$$

$\therefore \sin\theta = \frac{1}{2}$

$\angle\theta = 30°$ ~~①~~

$\angle BDC = 30°$

$\angle DBC = 45° - 30° = 15°$ ①