Name: ____________________

KNOX GRAMMAR SCHOOL

2017

Year 11 Yearly Examination

Teacher: ____________________

Mathematics Extension 1

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using blue or black pen only
- The official NESA Reference sheet is provided
- Board-approved calculators may be used
- In Questions 11 – 14, show relevant mathematical reasoning and/or calculations

Teachers:
Mr Vuletich
Mr Sedgman
Mr Mulray
Mr Willcocks (Examiner)

This paper MUST NOT be removed from the examination room

Total marks – 70

Section I: Pages 3 – 5

10 marks

- Attempt Questions 1-10
- Allow about 15 minutes for this section

Section II: Pages 6 – 11

60 marks

- Attempt Questions 11 – 14
- Allow about 1 hour 45 minutes for this section

Write your full name and your teacher's name on the front cover of each writing booklet

Number of Students in Course: 96

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Section I

10 marks
Attempt questions 1 – 10
Allow about 15 minutes for this section

Use the multiple-choice answer sheet for Questions 1 – 10

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1 If $x+\frac{1}{x}=2$, what is the value of $x^2+\frac{1}{x^2}$?

(A) 2 (B) 4 (C) 6 (D) 8

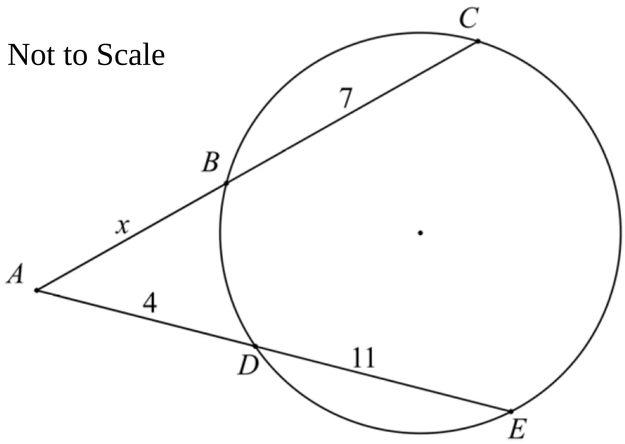
2 What is the natural domain of the function $y=\sqrt{x+1}-\sqrt{x+2}$?

(A) $x \le -2$ (B) $x \ge -1$

(C) $-2 \le x \le -1$ (D) $x \le -2$ or $x \ge -1$

3 In the diagram below, *BC* and *DE* are chords of a circle. *CB* and *ED* are produced to meet at *A*. What is the value of *x*?

Not to Scale



(A) $\frac{28}{11}$ (B) $\frac{11}{28}$ (C) 5 (D) 12

4 What is the inverse function of $f(x)=x^2+1$ for $x \le 0$?

(A) $f^{-1}(x)=-\sqrt{x-1}$, for $x \le 0$ (B) $f^{-1}(x)=\sqrt{x-1}$, for $x \le 0$

(C) $f^{-1}(x)=-\sqrt{x-1}$, for $x \ge 1$ (D) $f^{-1}(x)=\sqrt{x-1}$, for $x \ge 1$

Section I continued on the following page

5 The angle between the lines $2x+y=4$ and $x+y=2$, to the nearest degree, is:

(A) $18°$ (B) $25°$ (C) $45°$ (D) $72°$

6 A parabola has parametric coordinates $\left(6t,-3t^2\right)$. The coordinates of the focus are:

(A) $\left(0,\frac{1}{4}\right)$ (B) $\left(0,-\frac{1}{4}\right)$ (C) $(0,3)$ (D) $(0,-3)$

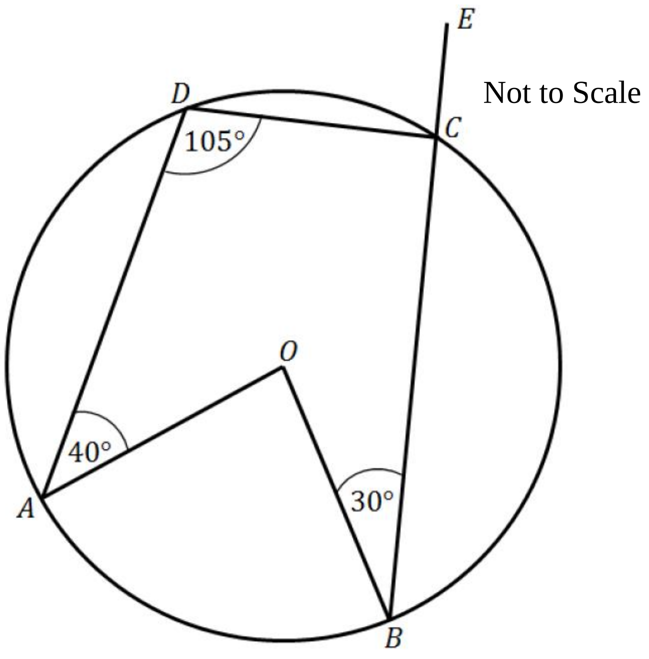
7 At a certain instant, a sphere is of radius 10 cm and the radius is increasing at a rate of 2 cm/s. The rate of increase of the volume of the sphere at that instant, in cm^3/s is:

(A) 80π (B) $\frac{800\pi}{3}$ (C) 800π (D) 400π

8 The domain of $f(x)=\log_e\left[(x-4)(5-x)\right]$ is:

(A) $4<x<5$ (B) $x<4,\ x>5$ (C) $4\le x\le 5$ (D) $x\le 4,\ x\ge 5$

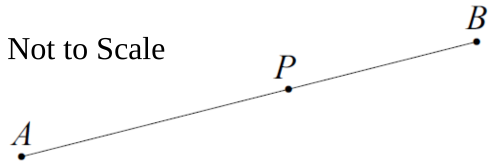
9 In the diagram below, O is the centre of the circle $ABCD$ and BCE is a straight line. If $\angle ADC=105°$, $\angle OBC=30°$ and $\angle OAD=40°$, find the size of $\angle DCE$.



(A) $80°$ (B) $85°$ (C) $90°$ (D) $95°$

Section I continued on the following page

10 In the diagram below the point P divides the interval AB in the ratio $3:2$. In what ratio does the point A divide the interval BP?



(A) $-5:3$ (B) $-5:2$ (C) $-3:5$ (D) $-2:5$

End of Section I

Section II

60 marks
Attempt Questions 11 – 14
Allow about 1 hour and 45 minutes for this section

Answer each question in a SEPARATE writing booklet. Extra writing booklets are available.

In Questions 11 – 14, your responses should include relevant mathematical reasoning and/or calculations.

Question 11 (15 marks) Use a SEPARATE writing booklet.

Marks

(a) Write $\sqrt{\dfrac{3^{5k+2}}{27^{k}}}$ in simplest index form. **2**

(b) Sketch the parabola $y^2+8x-2y+25=0$, clearly showing the location of the vertex, focus and directrix. **3**

(c) The point $(6,k)$ is 8 units from the straight line $3x+4y+2=0$. Find the value(s) of *k*. **2**

(d) The points $P(2ap,ap^2)$ and $Q(2aq,aq^2)$ lie on the parabola $x^2=4ay$. If the tangents at *P* and *Q* intersect at $45°$ show that $|1+pq|=|p-q|$. **2**

(e) Given that α and $m\alpha$ are the roots of the equation $x^2+px+q=0$, show that $mp^2=(m+1)^2 q$. **2**

(f) By eliminating θ from $x=5\sin\theta$ and $y=5\cos\theta+1$, find the Cartesian equation of the locus of the points relating *x* and *y*. **2**

(g) Show that the series $\log_2 x+\log_4 x+\log_{16} x+...$ is geometric and find the sum of the series for infinite terms. **2**

End of Question 11

Question 12 (15 marks) Use a SEPARATE writing booklet.

Marks

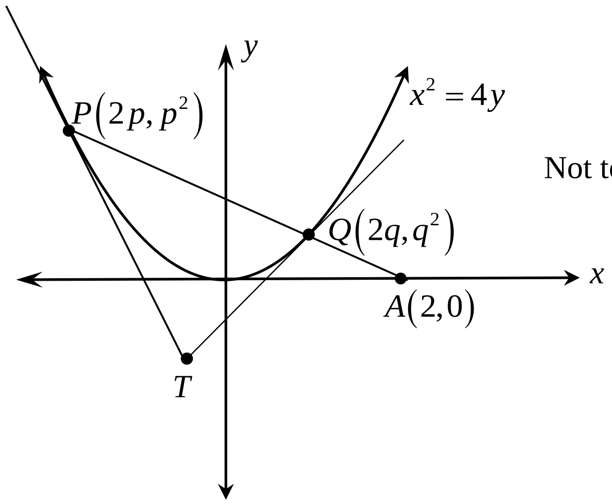
(a) Consider the function $f(x) = \frac{2x}{x^2 - 9}$.

(i) Show that $f(x)$ is odd. **1**

(ii) By first finding $\lim_{x \to \infty} \frac{2x}{x^2 - 9}$, give the equation of any horizontal asymptotes. **2**

(iii) Without the use of Calculus and using about half a page, sketch a neat graph of $f(x)$, clearly labelling all intercepts and asymptotes. **2**

(b) Let $P(2p, p^2)$ and $Q(2q, q^2)$ be two points on the parabola $x^2 = 4y$. The tangents to the parabola at P and Q intersect at T. The secant PQ passes through the point $A(2,0)$.



Not to Scale

(i) Show that $p + q = pq$. **3**

(ii) Assuming that the equations of the tangents at P and Q are $y = px - p^2$ and $y = qx - q^2$ respectively, determine the Cartesian equation of the locus of T. **2**

(c) (i) Sketch the graph of $g(x) = \left|x^2 - 2x - 8\right|$, labelling the x and y intercepts. **2**

(ii) Hence or otherwise, find the **number** of solutions to $g(x) = 9$. **1**

(iii) Show that $g(x)$ is continuous but not differentiable at $x = 4$. **2**

End of Question 12

Question 13 (15 marks) Use a SEPARATE writing booklet.

Marks

(a) Solve the inequation $\frac{x}{2x+1} \leq 2$. **3**

(b) Find $\frac{d}{dx}\left(\frac{2x-1}{\sqrt{2x-1}}\right)$. **2**

(c) $PQRS$ is a square inscribed in the isosceles ΔABC with $AB = AC$ and $PQ = a$.

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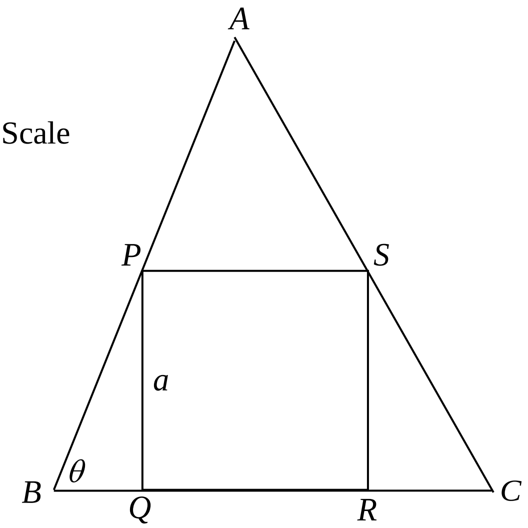


Find the length of AB in terms of a , $\sin\theta$ and $\cos\theta$. **2**

(d) The point R divides the interval joining $P(a, 2b)$ and $Q(3a, -b)$ externally in the ratio $2:3$. What are the coordinates of R ? **2**

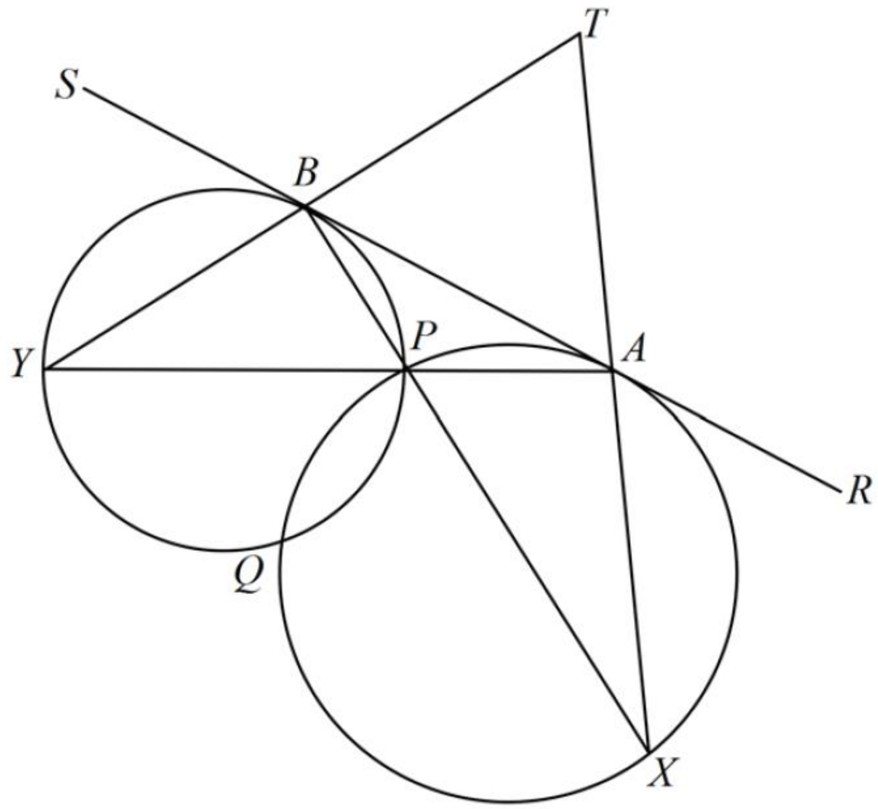
(e) Show that the sum of the series: **2**

$\log_{10}(x-2) + \log_{10}(x-2)^2 + \log_{10}(x-2)^3 + \cdots + \log_{10}(x-2)^n$ is equal to $\frac{n}{2}\log_{10}(x-2)^{n+1}$.

Question 13 continued on the following page

Marks

(f)



In the diagram above, the line *SR* is tangent to circles *AXQP* and *BPQY* at *A* and *B* respectively. The chords *YB* and *XA* when produced, meet at *T*. The points *A*, *P* and *Y* are collinear and similarly for the points *B*, *P* and *X*.

Refer to your separate answer booklet for this question.

(i) Explain why $\angle SBY = \angle BPY$. **1**

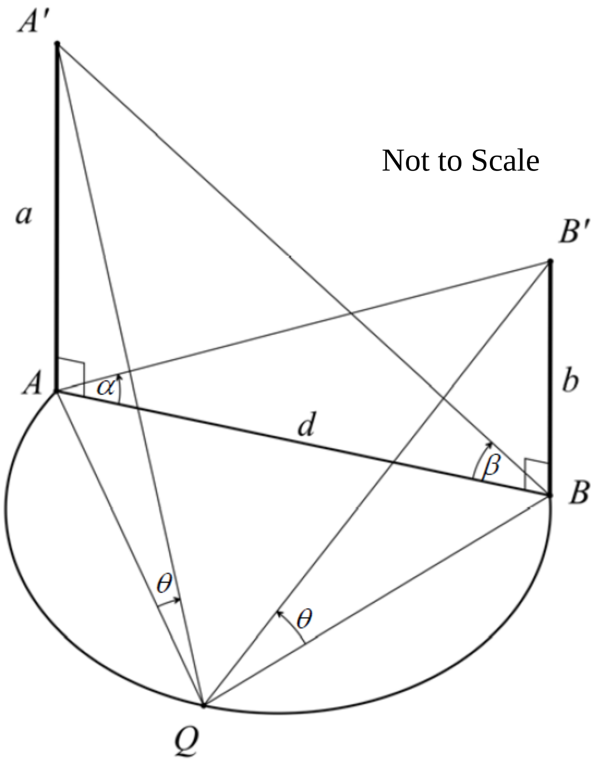
(ii) Prove that $AT = TB$. **3**

End of Question 13

Question 14 (15 marks) Use a SEPARATE writing booklet.

Marks

(a) AQB is a semi-circle in the horizontal plane with diameter AB of length d metres. There are two vertical posts AA' and BB' of heights a and b respectively. From Q, the angle of elevation to the tops of both posts A' and B' is θ. From A the angle of elevation to B' is α and from B the angle of elevation to A' is β.



(i) Prove that $d^2 = \dfrac{a^2 + b^2}{\tan^2 \theta}$. **3**

(ii) Show that $\tan^2 \alpha + \tan^2 \beta = \tan^2 \theta$. **2**

(b) Mason makes a deposit of \$5000 at the start of each year into a savings account. He earns monthly compound interest on his savings account at 4·8% per annum. Let A_n be the value of the account at the end of n years.

(i) Show that $A_1 = \$5245.35$. **1**

(ii) Show that $A_2 = \$5000\left(1.004^{12} + 1.004^{24}\right)$. **1**

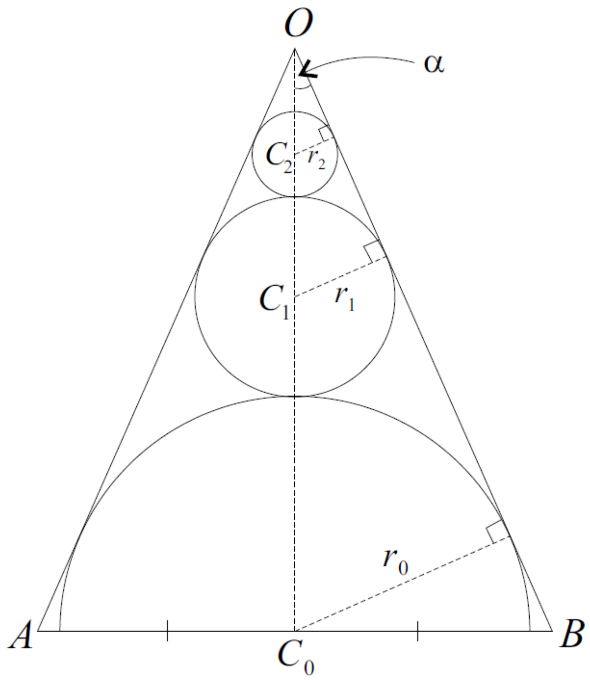
(iii) Show that $A_n = \dfrac{\$5000 \times 1.004^{12} \times \left(1.004^{12n} - 1\right)}{1.004^{12} - 1}$. **2**

(iv) By the end of which year will Mason have over \$100 000 in his account? **2**

Question 14 continued on the following page

Marks

(c) In the diagram below ΔOAB is isosceles, with $OA = OB$ and $\angle AOB = 2\alpha$. The semicircle of radius r_0 has centre C_0, the midpoint of AB and the sides OA and OB are tangents. Infinitely many circles are stacked on top of the semicircle so that each circle is tangent to the circles immediately above and below it, and also tangent to OA and OB. The circles have radii $r_1, r_2, r_3, \ldots$ and centres $C_1, C_2, C_3, \ldots$ The semicircle and the first two circles are shown in the diagram.



(i) Write down an infinite series for OC_0 in terms of $r_0, r_1, r_2, \ldots$ and write down a similar series for OC_1. **1**

(ii) Prove that $\dfrac{r_1}{r_0} = \dfrac{1 - \sin\alpha}{1 + \sin\alpha}$. **3**

End of Examination

Suggested Solution (s)	Comments	Suggested Solution (s)	Comments

Section I

1. $x^2 + \frac{1}{x^2} = \left(x + \frac{1}{x}\right)^2 - 2$

$= 2^2 - 2$

$= 2 \Rightarrow A$

2. $x + 1 \geqslant 0$ and $x + 2 \geqslant 0$

$\therefore \quad x \geqslant -1 \Rightarrow B$

3. $x(x+7) = 4(4+11)$

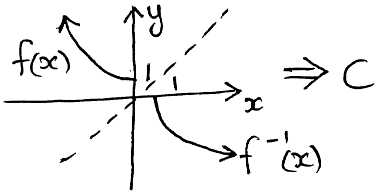
Intercepts on intersecting chords

$x^2 + 7x - 60 = 0$

$(x+12)(x-5) = 0$

$\therefore \; x = 5, \; x > 0 \Rightarrow C$

4.



$\Rightarrow C$

5. $\tan\theta = \left|\frac{-2 - -1}{1 + 2}\right|$

$\tan\theta = \frac{1}{3}, \; \theta = 18°26' \Rightarrow A$

6. $x = 6t \qquad y = -3t^2$

$t = \frac{x}{6} \qquad y = -3\left(\frac{x}{6}\right)^2$

$-12y = x^2$

$x^2 = -4(3)y \Rightarrow D$

7. $V = \frac{4}{3}\pi r^3$

$\frac{dV}{dr} = 4\pi r^2$

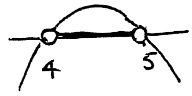
$\frac{dV}{dt} = \frac{dV}{dr} \cdot \frac{dr}{dt}$

when $\frac{dr}{dt} = 2\text{cm/s}$ and $r = 10\text{cm}$

$\frac{dV}{dt} = 4\pi \, 10^2 \times 2$

$= 800\pi \Rightarrow C$

8. $(x-4)(5-x) > 0$



$\Rightarrow A$

9. $\angle ABC = 75°$ (opposite angles cyclic quadrilateral)

$\angle ABO = 45°$

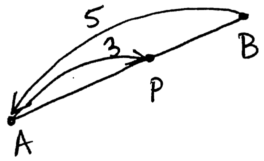
$= \angle BAO$ (angles opposite equal radii)

$\angle DAB = 85°$

$= \angle DCE$ (exterior angle of cyclic quadrilateral)

$\Rightarrow B$

10. $-5 : 3 \Rightarrow A$



Section II

Question 11.

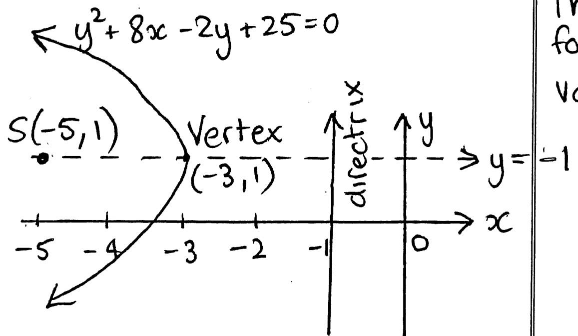
(a) $\left(3^{5k+2} \div 3^{3k}\right)^{\frac{1}{2}}$ ✓

$= \left(3^{2k+2}\right)^{\frac{1}{2}}$

$= 3^{k+1}$ ✓

(b) $y^2 - 2y + 1 = -8x - 25 + 1$

$(y-2)^2 = -8(x+3)$ ✓



1 mark for focus, vertex, directrix

Suggested Solution (s)	Comments	Suggested Solution (s)	Comments

(c) $\dfrac{|3(6)+4(k)+2|}{\sqrt{3^2+4^2}}=8$

$|20+4k|=40$

$20+4k=40$ or $20+4k=-40$

$4k=20$ or $4k=-60$

$k=5$ or $k=-15$

Comment: one mark for each value of k

(d) $\tan 45^\circ = \left|\dfrac{p-q}{1+pq}\right|$ ✓

$1=\dfrac{|p-q|}{|1+pq|}$ ✓

$\therefore |p-q|=|1+pq|$ QED.

Comment: must show $\left|\dfrac{a}{b}\right|=\dfrac{|a|}{|b|}$ for second mark.

(e) $\alpha+\alpha m=-p$, $\alpha^2 m=q$ ✓

Comment: both.

$\alpha(1+m)=-p$

$\alpha=\dfrac{-p}{m+1}$

$\dfrac{p^2}{(m+1)^2}m=q$ ✓

$\therefore mp^2=(m+1)^2 q$ QED.

(f) $x=5\sin\theta$

$y-1=5\cos\theta$

$\therefore x^2+(y-1)^2=(5\sin\theta)^2+(5\cos\theta)^2$ ✓

$x^2+(y-1)^2=25(\sin^2\theta+\cos^2\theta)$

$x^2+(y-1)^2=25$ ✓

or

$x^2+y^2=25\sin^2\theta+25\cos^2\theta+10\cos\theta+1$ ✓

$x^2+y^2=26+10\cos\theta$

$x^2+y^2=26+2y-2$ $(\because 5\cos\theta=y-1)$

$x^2+y^2-2y-24=0$ ✓

(g) $\log_2 x+\log_4 x+\log_{16} x+\ldots$

$=\dfrac{\log x}{\log 2}+\dfrac{\log x}{\log 2^2}+\dfrac{\log x}{\log 2^4}+\ldots$ ✓

$=\dfrac{\log x}{\log 2}+\dfrac{1}{2}\left(\dfrac{\log x}{\log 2}\right)+\dfrac{1}{4}\left(\dfrac{\log x}{\log 2}\right)+\ldots$

$=\dfrac{\log x}{\log 2}\left(1+\dfrac{1}{2}+\dfrac{1}{4}+\ldots\right)$

$=\log_2 x\left(\dfrac{1}{1-\frac{1}{2}}\right)$

$=2\log_2 x$ ✓

Question 12

(a)(i) $f(-x)=\dfrac{2(-x)}{(-x)^2-9}$

$=\dfrac{-2x}{x^2-9}$

$=-f(x)\ \therefore$ odd. ✓

(ii) $\lim\limits_{x\to\infty}\dfrac{2x}{x^2-9}$

$=\lim\limits_{x\to\infty}\dfrac{\frac{2x}{x^2}}{\frac{x^2}{x^2}-\frac{9}{x^2}}$ dividing through by the highest power of x in denominator ✓

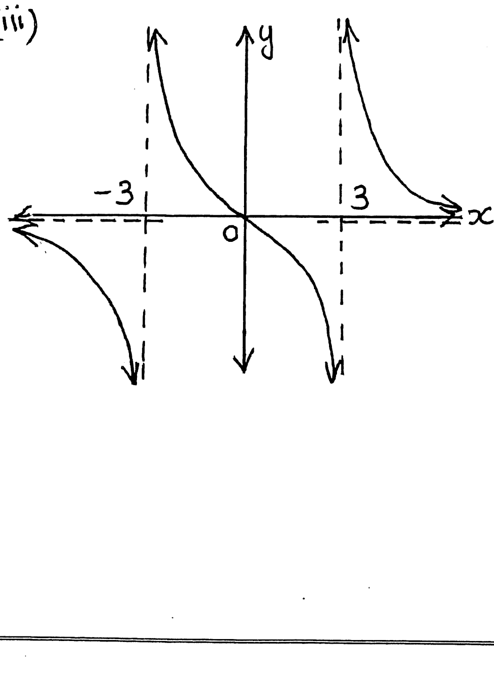
Comment: must be stated.

$=\lim\limits_{x\to\infty}\dfrac{2/x}{1-9/x^2}$

$=0^+\ \therefore$ horizontal asymptote

Comment: $y=0$ ✓

(iii)



Comment: 1 vertical asymptotes at $x=\pm 3$

1 shape through origin and approaching asymptotes correctly.

 3/5

Suggested Solution (s)	Comments	Suggested Solution (s)	Comments

(c)(i) $m_{PQ} = \dfrac{q^2-p^2}{2q-2p}$

$= \dfrac{q+p}{2}$ ✓ gradient

$PQ \Rightarrow \quad y-p^2 = \dfrac{p+q}{2}(x-2p)$

$y = \dfrac{p+q}{2}(x) - p^2 + p^2 - pq$

$y = \frac{1}{2}(p+q)x - pq$ ✓

sub in $A(2,0)$: $0 = p+q-pq$ ✓

$p+q = pq$ QED.

1 mark substitution of $A(2,0)$

(ii) $px-p^2 = qx-q^2$

$px-qx = p^2-q^2$

$x = \dfrac{(p+q)\cancel{(p-q)}}{\cancel{(p-q)}}$

$x = p+q$ ✓

$y = p(p+q) - p^2$

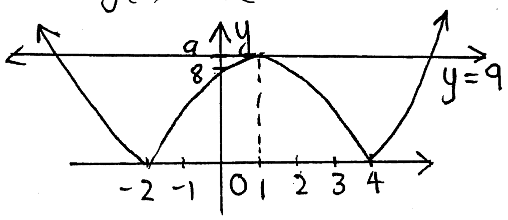
$y = pq$

$T(p+q, pq)$

from part (i) $y=x$ ✓

1 mark for x and 1 mark for $y=x$

(d)(i) $g(x) = |(x-4)(x+2)|$



1 shape

1 x & y intercepts

(ii) 3 solutions ✓

(iii) $\lim\limits_{x\to 4^-} g(x) = \lim\limits_{x\to 4^+} g(x) = 0$ ✓

$\therefore$ continuous at $x=4$

$g'(x) = \begin{cases} 2x-2 & \text{for } x<-2, x>4 \\ 2-2x & \text{for } 2<x<4 \end{cases}$

$\therefore \lim\limits_{x\to 4^-} g'(x) = -6$ ✓

$\lim\limits_{x\to 4^+} g'(x) = +6$ and $\lim\limits_{x\to 4^-} g'(x) \neq \lim\limits_{x\to 4^+} g'(x)$

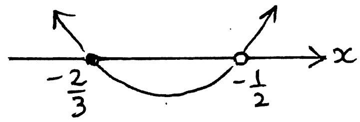
not differentiable at $x=4$.

Question 13

(a) $\dfrac{x}{\cancel{(2x+1)}}(2x+1)^{\cancel{2}} \leq 2(2x+1)^2$

$(2x+1)\left[2(2x+1)-x\right] \geq 0$

$(2x+1)(3x+2) \geq 0$



$x \leq -\frac{2}{3}$ or $x > -\frac{1}{2}$

1 mark 2 critical points

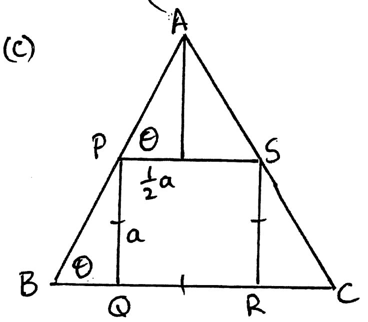
1 mark interval

1 mark excluding $x = -\frac{1}{2}$

(b) $= \dfrac{d}{dx}(2x-1)^{\frac{1}{2}}$ ✓

$= (2x-1)^{-\frac{1}{2}}$ or $\dfrac{1}{\sqrt{2x-1}}$ ✓

(c)



$\sin\theta = \dfrac{a}{PB} \quad \therefore PB = \dfrac{a}{\sin\theta}$

$\cos\theta = \dfrac{\frac{1}{2}a}{AP} \quad \therefore AP = \dfrac{a}{2\cos\theta}$

1 mark for one correct ratio.

$AB = AP + PB$

$= a\left(\dfrac{1}{\sin\theta} + \dfrac{1}{2\cos\theta}\right)$ ✓

doesn't have to be factorised.

(d) $(a, 2b) \quad (3a, -b)$

$-2 \quad 3$

$\dfrac{3a-6a}{1}, \dfrac{2b+6b}{1}$

$(-3a, 8b)$ ✓

1 mark for setting up with a minus sign

(e) $= \log_{10}(x-2), 2\log_{10}(x-2), 3\log_{10}(x-2), \ldots$

$T_2 - T_1 = T_3 - T_2 = \log_{10}(x-2) \therefore AP$ ✓

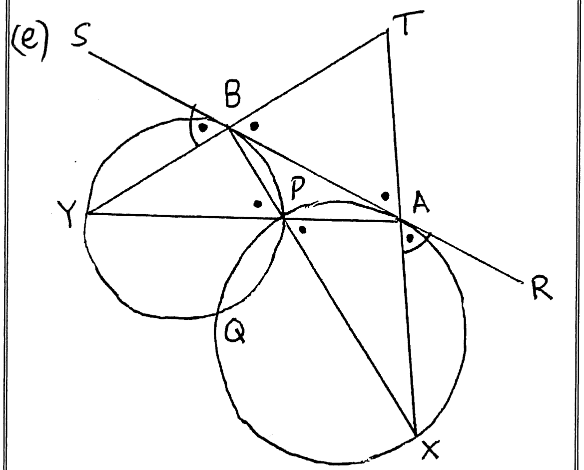
$S_n = \frac{n}{2}\left(\log_{10}(x-2) + n\log_{10}(x-2)\right)$

$= \frac{n}{2}(n+1)\left(\log_{10}(x-2)\right) = \frac{n}{2}\log_{10}(x-2)^{n+1}$ QED.

1 mark for taking out $(n+1)$

Suggested Solution (s)	Comments	Suggested Solution (s)	Comments

(e)



(i) Alternate segment theorem ✓

(ii) $\angle TBA = \angle SBY$ (vertically opposite)

$\angle SBY = \angle BPY$ (part(i))

$\angle BPY = \angle APX$ (vertically opposite)

Comment: 1 mark 2 applications of vertically opposite

$\angle APX = \angle RAX$ (the angle between a tangent and a chord through the point of contact is equal to the angle in the alternate segment.

$\angle RAX = \angle TAB$ (vertically opposite)

$\therefore \angle TAB = \angle TBA$

$AT = TB$ (equal sides opposite equal angles in ΔABT) ✓

Question 14

(a)(i) $\angle AQB = 90^\circ$ (angle in semi-circle) ✓

let $AQ = x$ and $BQ = y$

$d^2 = x^2 + y^2$

in $\Delta AQA'$, $\tan\theta = \frac{a}{x}$, $x = \frac{a}{\tan\theta}$

in $\Delta BQB'$, $\tan\theta = \frac{b}{y}$, $y = \frac{b}{\tan\theta}$

Comment: 1 mark

$\therefore d^2 = \left(\frac{a}{\tan\theta}\right)^2 + \left(\frac{b}{\tan\theta}\right)^2$ ✓

$d^2 = \frac{a^2+b^2}{\tan^2\theta}$

(ii) in $\Delta ABA'$, $\tan\beta = \frac{a}{d}$

in $\Delta BAB'$, $\tan\alpha = \frac{b}{d}$

$LHS = \tan^2\alpha + \tan^2\beta$

$= \frac{a^2+b^2}{d^2}$ ✓

$= a^2+b^2 \div \frac{a^2+b^2}{\tan^2\theta}$

$= \frac{\cancel{a^2+b^2}}{1} \times \frac{\tan^2\theta}{\cancel{a^2+b^2}}$

$= \tan^2\theta$

$= RHS$

Comment: 1 mark for showing substitution of d.

(b) 4.8% pa $= 0.004$/month

(i) $A_1 = \$5000(1+R)^{12}$

$= \$5000(1.004)^{12}$ ✓

$= \$5245.35$

(ii) $A_2 = (A_1 + 5000) \times 1.004^{12}$ ✓

$= 5000(1.004)^{12}(1.004)^{12} + 5000(1.004)^{12}$

$= 5000(1.004)^{24} + 5000(1.004)^{12}$

$= 5000(1.004^{12} + 1.004^{24})$

(iii) $A_3 = 5000(1.004^{12} + 1.004^{24} + 1.004^{36})$

$A_n = 5000(1.004^{12} + \ldots + 1.004^{12n})$

Comment: 1 mark for A_n

$A_n = 5000(1.004^{12})\frac{1((1.004^{12})^n - 1)}{1.004^{12}-1}$

Comment: 1 mark for S_n with $a=1$, $r = 1.004^{12}$.

$A_n = \frac{5000(1.004)^{12}(1.004^{12n}-1)}{1.004^{12}-1}$

(iv) $10^5 = \frac{5000(1.004^{12})(1.004^{12n}-1)}{1.004^{12}-1}$

$1.004^{12n} = \frac{10^5 \times (1.004^{12}-1)}{5000(1.004^{12})} + 1$

$n = \frac{\log\left(\frac{10^5(1.004^{12}-1)}{5000(1.004^{12})} + 1\right)}{12\log(1.004)}$

$n \doteqdot 13.785$ $\therefore$ at end of 14 years ✓

5/5

Suggested Solution (s)	Comments	Suggested Solution (s)	Comments
(c)(i) $OC_0 = r_0 + 2r_1 + 2r_2 + \ldots$ $OC_1 = r_1 + 2r_2 + 2r_3 + \ldots$	1 mark both		
(ii) $OC_0 - OC_1 = (r_0 + 2r_1 + 2r_2 + \ldots) - (r_1 + 2r_2 + 2r_3 + \ldots)$ $= r_0 + 2r_1 - r_1$ $= r_0 + r_1$ — (A)	✓		
from the diagram $\sin\alpha = \frac{r_0}{OC_0} = \frac{r_1}{OC_1}$ $OC_0 = \frac{r_0}{\sin\alpha}$, $OC_1 = \frac{r_1}{\sin\alpha}$ — (B)	✓		
substituting from (B) into (A) $\frac{r_0}{\sin\alpha} - \frac{r_1}{\sin\alpha} = r_0 + r_1$ $r_0 - r_1 = r_0\sin\alpha + r_1\sin\alpha$ $r_0(1-\sin\alpha) = r_1(1+\sin\alpha)$	✓		
$\frac{r_1}{r_0} = \frac{1-\sin\alpha}{1+\sin\alpha}$ End of Assessment Task			

Marker Analysis

Y11 Ext 1 Yearly Examination 2017

Question 11 (WAC)

(a) Quite well done however a few students didn't simplify completely.

(b) The majority of students scored at least 2 marks. The first mark was awarded for rewriting the equation in $(y-a)^2 = a(x-b)$ form.

1 mark for getting correct shape and vertex from their previous answer.

1 mark for correct focus and directrix based on first answer.

(c) 1 mark for each value of k. Some students only got one value for k.

(d) Most students did not show this step:

must show
$\left|\frac{a}{b}\right| = \frac{|a|}{|b|}$
for second
mark.

therefore only scored 1 out of 2.

(e) Most students managed to get both equations, but struggled to manipulate the equations to show the required answer. Some students made it harder for themselves which increased their chances of error and should refer to the solutions.

(f) Not well done by the majority and missed out completely by some. If they managed to recognise that the locus was a circle and started to write a circle equation with the correct substitution they were awarded one mark. Again some students made it much harder for themselves by forming a quadratic.

(g) Not well done and missed out completely by some. Students who were able to work out the limiting sum of the series but didn't show that it was geometric were awarded 1 mark. If they used $\frac{T_2}{T_1}=\frac{T_3}{T_4}$ and showed it to be $\frac{1}{2}$ they were awarded the "show" mark.

Question 12 (CHS)

(a) (i) Nearly all students proved that $f(x)$ was odd successfully.

(ii) Again, majority of students were able to identify that they needed to divide by x^2 and simplify. Some students forgot to wrote the horizontal asymptote was at $y = 0$ instead just writing 0 which could mean $x = 0$.

(iii) The graph was drawn very well. Students were able to draw a neat graph with all important information like the asymptotes in correctly. Done well by cohort.

(b) (i) Students who calculated the gradient of PQ and then used equation of a straight line tended to be more successful than students using alternate methods. Few students forgot to sub in the point A(2,0) to conclude that $p + q = pq$.

(ii) Majority of students solved that $x = p + q$ but were unable to see that the equation of the locus T was $y = x$. Needed final line to receive the mark.

(c) (i) Students were able to see that the x-intercepts were at $x = -2$ and $x = 4$ but then assumed the turning point was at the y-intercept.

(ii) If part (i) was graphed correctly, then most answered part (ii) correctly as well.

(iii) Students need to read the question carefully. Numerous students only answered one part of the question, either proving that it was continuous or differentiable not both. Will need to revisit this question.

Question 13 (MUL)

A) Most students were able to arrive at a correct quadratic inequality but had difficulty in interpreting the correct solution from their quadratic. Students that used a diagram were usually more successful. Including $x = -1/2$ in their solution was a common error.

B) Many students used the quotient rule to find the derivative and were often unsuccessful in obtaining a correct answer due to difficulty with the algebra. Students who noticed the more efficient method were almost always successful.

C) Most students could find the correct expression for *BP* but not for *AP* and hence finally for *AB*.

D) External division question was done well by most students. The odd careless mistake and some students still don't know the formula.

E) Many students jumped straight into the sum of an *AP* which I accepted and then virtually to the given result. Students need to remember that "show" questions require more detailed working.

F) I) Only reasons I accepted, Alternate segment theorem or the correct theorem.

Ii) Proof, well done by most students. Reasons given on occasions were brief and a number of students failed to link angle *TAB* with angle *TBA* which was crucial to the proof.

Question 14 (SED)

14 a (i) Boys needed to justify the expression$QB^2 + QA^2 = d^2$ with the reference to the theorem

"Angle in a semi-circle is a right angle ". Some missed this important justification with the consequent loss of 1 mark. Otherwise well done.

(ii) This was done well. Boys needed to use the result of part (i) namely $d^2 = \frac{a^2+b^2}{tan^2\theta}$. Once this was realized then the question was completed quite easily.

14b(i) Almost everyone who attempted this were successful. $5245.35

14b(ii) Showing the amount at the end of the second year needed to be established not just written down from the question. Very well done.

14b(iii) Again, establishing a sum by having the expression A_n ready to insert the formula for the sum to n terms of a Geometric Progression was required in order to gain the full 2 marks. Mostly well done.

14b(iv) Surprisingly well done. Answer was in the 14th year that Mason would have in excess of $100,000 in his account. Errors with translating terms from LHS to RHS and improper use of logarithms or failure to read "years" cost some marks. A need to check an answer to such a complex calculation is apparent.

14c. Not done well, but not entirely surprising.

(i) The question said "write down a similar series for OC_1". A number either forgot to do so or began writing OC_1in terms of other variables.

(ii) There was some amazing new mathematics developed to try and fudge the final answer. Some were passionate that the expression was a GP and others were convinced it represented an AP. Erroneous formulae were hastily thrown in to justify a final answer. About 15 boys had the correct method and solution. It was easy to manage if the proof was carried out by showing LHS = RHS.

FINIS