Trinity Grammar School

Mathematics Department

2013

HALF-YEARLY EXAMINATION

PRELIMINARY ASSESSMENT TASK 3

Year 11

Mathematics Extension 1

Board of Studies Student Number
(Year 12 only)

Class Teacher:

……

Name:
(Year 11 students)

……

Do NOT write solutions on this question paper. Any working on this question paper will NOT be marked.

General Instructions

- Reading time – 5 minutes
- Writing time – 2 hours
- Write using black or blue pen
- Only approved calculators for this course are allowed in this task
- A table of Standard Integrals (if required) in this course is supplied
- Show all necessary working
- Write your Board of Studies Student Number (Year 12 HSC) or Name (Year 11) and your Class teacher on the question paper and on any answer sheets or booklets used to write your responses to the questions submitted
- If you do not attempt a question you must submit an answer sheet or writing booklet for that question clearly indicating **N/A** and your Student Number or Name.

- **Preliminary Assessment Weighting:** 30%

Total marks – 70

Section 1

10 marks

- Attemtpt all Questions
- Allow about **15** minutes for this section

Section II

60 marks

- Attempt all Questions
- Allow about **1** hours **45** minutes for this section

Section I **10 marks**

- Circle the correct response on the answer sheet provided
- Each question is worth 1 mark

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1 As a fraction, $2.0\dot{3}6\dot{4}$ is:

(A) $2\frac{91}{2500}$

(B) $2\frac{182}{4995}$

(C) $2\frac{91}{4995}$

(D) $\frac{182}{4995}$

2 If $a=\left(\frac{2}{3}\right)^7$ and $b=\left(\frac{3}{4}\right)^5$, evaluate $\frac{a^9(b^3)^2}{(a^2)^3 b}$.

(A) $\frac{3^4}{2^5}$

(B) $\frac{3^9}{2^{39}}$

(C) $\frac{3^4}{2^{29}}$

(D) $\frac{1}{2^{20}}$

3 Express $x-\frac{1}{x}$ with a rational denominator given that $x=3+\sqrt{2}$.

(A) $\frac{4\sqrt{2}+9}{5}$

(B) $\frac{6\sqrt{2}+27}{7}$

(C) 6

(D) $\frac{8\sqrt{2}+18}{7}$

4 If $S = \dfrac{a(r^n - 1)}{r - 1}$, find the value of n when $S = 765,\ a = 3$ and $r = 2$.

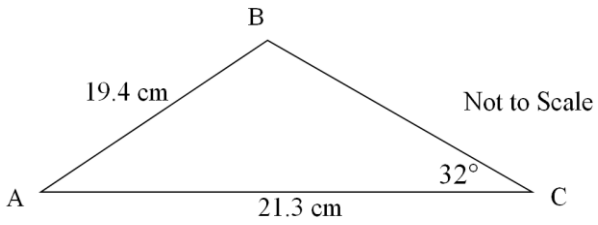
(A) $n = 4$

(B) $n = 9$

(C) $n = 8$

(D) $n = 6$

5 In the diagram below, the obtuse angle ABC to the nearest degree is:



(A) $151°$

(B) $116°$

(C) $36°$

(D) $144°$

6 Find $\lim\limits_{x \to \infty} \dfrac{3x^2 - 4x + 5}{x^2}$.

(A) -1

(B) 0

(C) 3

(D) 8

7 The function $f(x) = \dfrac{1}{2}(2^x - 2^{-x})$ is:

(A) Odd

(B) Even

(C) Both even and odd

(D) Neither odd or even

8 If $\tan[90 - (5x - 40)]° = \tan(3x + 10)°$, then:

(A) $x = 15$

(B) $x = 20$

(C) $x = 25$

(D) $x = 60$

9 Simplify $\cos 3a \cos 2a + \sin 3a \sin 2a$.

(A) $\sin a$

(B) $\cos a$

(C) $\cos 5a$

(D) $\sin 5a$

10 Simplify $\dfrac{\cos(180 - \theta)}{\sin \theta}$.

(A) $\tan \theta$

(B) $-\tan \theta$

(C) $\cot \theta$

(D) $-\cot \theta$

End of Section I

Section II 60 marks

- Begin each question in a new answer booklet.
- Show all necessary working.

Question 11 (15 marks)

(a) State the value of n if $(x+n)^2 = x^2 - 4x + 4$. **1**

(b) Solve the equation $5(x-2)^2 = 8$, giving solutions correct to 3 significant figures. **2**

(c) (i) Write $\tan 15°$ in the form $\tan(A-B)$. **1**

(ii) Hence, calculate the exact value of $\tan 15°$, leaving your answer with a rational denominator. **2**

(d) Solve $7^x = 3$, correct to 2 decimal places. **1**

(e) Solve $\cos x = 2\sin x \cos x$ in the domain $0° \leq x \leq 360°$. **3**

(f) Simplify $\dfrac{125}{(5^n)^6 \times 125^{(1-2n)}}$. **2**

(g) Solve $|a+2| = 2a - 5$ **3**

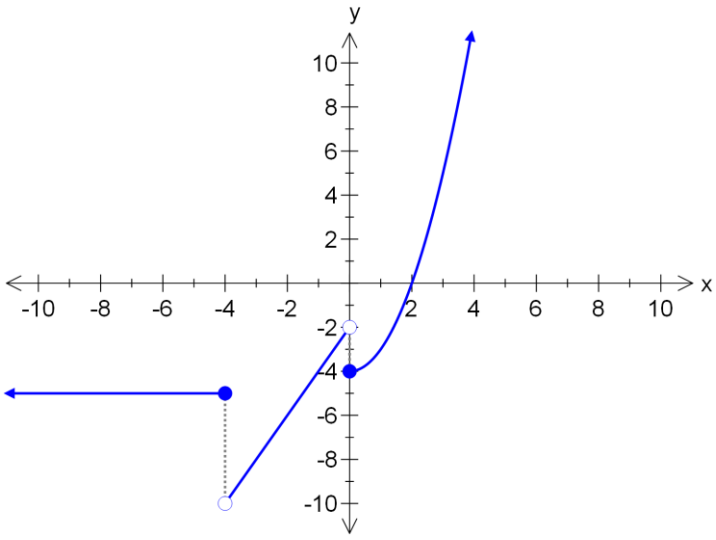
End of Question 11

Question 12 (15 marks) **Begin a NEW answer booklet**

(a) State the domain **and** range of $y = \sqrt{4 - x^2}$. **2**

(b) Solve the simultaneous equation $y = 2x + 3$ and $y = x^2 + 4x + 5$. **3**

(c) The function, $f(x) = \begin{cases} -5 & \text{for } x \le -4 \\ 2x - 2 & \text{for } -4 < x < 0 \\ x^2 - 4 & \text{for } x \ge 0 \end{cases}$ has been graphed below.



(i) Evaluate $f(-4) - f(0)$. **1**

(ii) Find an expression for $f(a^2 + 1)$. **2**

(iii) For what value(s) of x is $f(x) = -5$? **2**

(d) (i) Sketch the graph of $y = x^2 - 6$, and label all intercepts with the axes. **1**

(ii) On the same set of axes, sketch the graph of $y = |x|$. **1**

(iii) Find the coordinates of the two points where the graphs intersect. **2**

(iv) Hence, solve the inequality $x^2 - 6 \le |x|$. **1**

End of Question 12

Question 13 (15 marks) **Begin a NEW answer booklet**

(a) Solve $\frac{2x-8}{3x} \leq 2$. **3**

(b) From a point *O* the point *P* lies on a bearing of $120°$ and is 12·3 km away. The point *Q* is 15·2 km South West of *O*.

(i) Draw a diagram, and mark the relative positions of *O*, *P*, *Q*. **1**

(ii) Calculate the distance *PQ* in kilometres (correct to one decimal place). **2**

(c) Solve $\log_a 3 + \log_a (x-1) = \log_a 21$. **2**

(d) Let $f(x) = \frac{x^2}{x^2-1}$.

(i) For what values of *x* is *f*(*x*) undefined? **1**

(ii) Show that *y* = *f*(*x*) is an even function. **2**

(iii) State the equation of the horizontal asymptote and the two vertical asymptotes. of the function $f(x) = \frac{x^2}{x^2-1}$. **2**

(iv) Hence, sketch the $y = f(x)$. **2**

End of Question 13

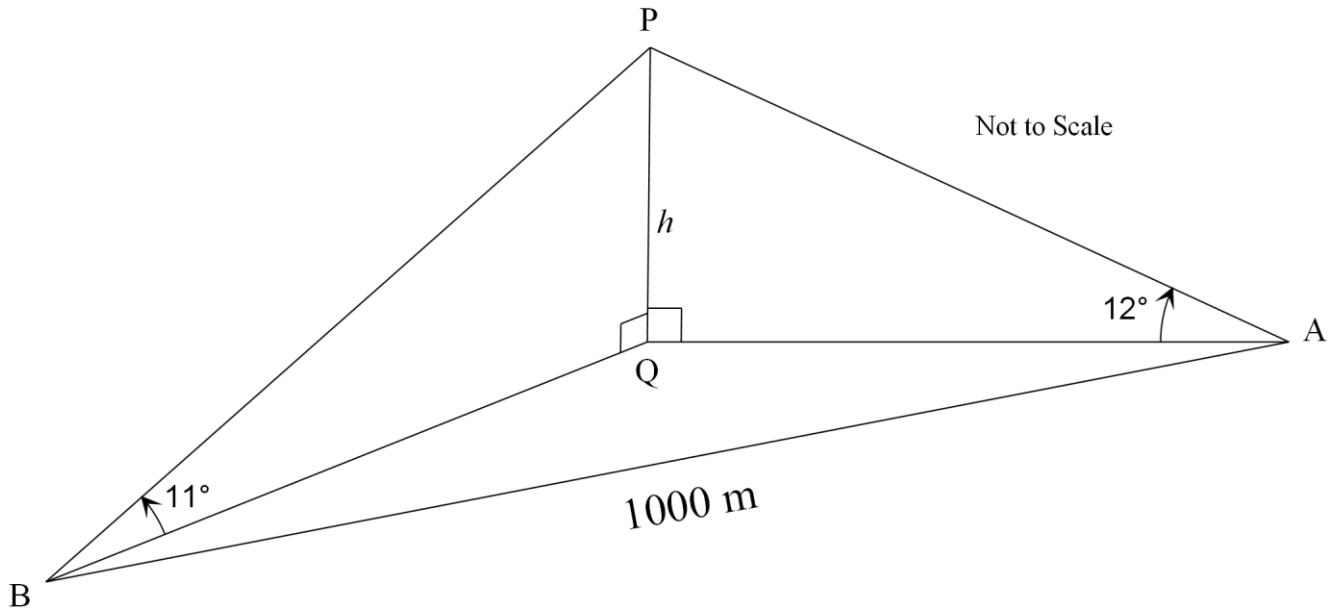
Question 14 (15 marks) **Begin a NEW answer booklet**

(a) If $\log_a 3 = 0.477$ and $\log_a 4 = 0.602$, find:

(i) $\log_a 12$ **1**

(ii) $\log_a 3a^2$ **2**

(b)



The angle of elevation of a tower *PQ* of height *h* metres at a point *A* due east of it is 12^o. From another point *B*, the bearing of the tower is 051^oT and the angle of elevation is 11^o. The points *A* and *B* are 1000 metres apart and on the same level plane as the base *Q* of the tower.

(i) Explain why $\angle AQB = 141^o$. **1**

(ii) Show that $AQ = h\tan 78°$. **2**

(iii) Write down an expression for *BQ* in terms of *h*. **1**

(iv) Hence, show that $h^2 = \dfrac{1000^2}{\left(\tan^2 78^o + \tan^2 79^o - 2\tan 78^o \tan 79^o \cos 141^o\right)}$ **2**

(v) Using the sine rule, or otherwise, find to the nearest degree, the size of $\angle QAB$. **3**

(c) Show that $\dfrac{\cos x - \cos(x+2\theta)}{2\sin\theta} = \sin(x+\theta)$. **3**

End of Section II

End of Examination

Trinity Grammar School

Mathematics Department

2013

HALF-YEARLY EXAMINATION

PRELIMINARY ASSESSMENT TASK 2

Year 11

Mathematics Extension 1

Board of Studies Student Number
(Year 12 only)

Class Teacher:

……

Name:
(Year 11 students)

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60 marks

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(D) $\frac{182}{4995}$

2 If $a=\left(\frac{2}{3}\right)^7$ and $b=\left(\frac{3}{4}\right)^5$, evaluate $\frac{a^9(b^3)^2}{(a^2)^3 b}$.

(A) $\frac{3^4}{2^5}$

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(D) 6

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(D) $n = 6$

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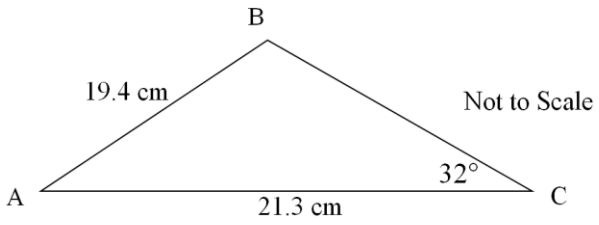

(A) $151°$

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(A) -1

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(D) 8

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(A) Even

(B) Odd

(C) Both even and odd

(D) Neither odd or even

8 If $\cot(5x - 40)° = \tan(3x + 10)°$, evaluate x.

(A) $x = 25$

(B) $x = 15$

(C) $x = 20$

(D) $x = 60$

9 Simplify $\cos 3a \cos 2a + \sin 3a \sin 2a$.

(A) $\cos 5a$

(B) $\cos a$

(C) $\sin a$

(D) $\sin 5a$

10 Solve $\frac{2x-8}{3x} \leq 2$.

(A) $-2 \leq x \leq 0$

(B) $x \leq -2$, or $x > 0$

(C) $-2 < x < 0$

(D) $x < -2$, or $x > 0$

End of Section I

Section II 60 marks

- Begin each question in a new answer booklet.
- Show all necessary working.

Question 11 (15 marks)

(a) Find the value of n if $x + n\ ^2 = x^2 - 4x + 4$. **1**

(b) Solve the equation $5\ x - 2\ ^2 = 8$, giving solutions correct to 3 significant figures. **2**

(c) Find the exact value of $\tan 15°$. **2**

(d) Solve $7^x = 3$, correct to 2 decimal places. **2**

(e) Solve $2\cos x = \sin x \cos x$ in the domain $0 \leq x \leq 360$. **3**

(f) Simplify $\dfrac{125}{(5^n)^6 \times 125^{(1-2n)}}$. **2**

(g) Solve $2a - 5\ +\ a + 1\ = 8$. **3**

End of Question 11

Question 12 (15 marks) **Begin a NEW answer booklet**

(a) State the domain and range of $y = \sqrt{4 - x^2}$. **2**

(b)

i. Sketch the graph of $y = x^2 - 6$, and label all intercepts with the axes. **1**

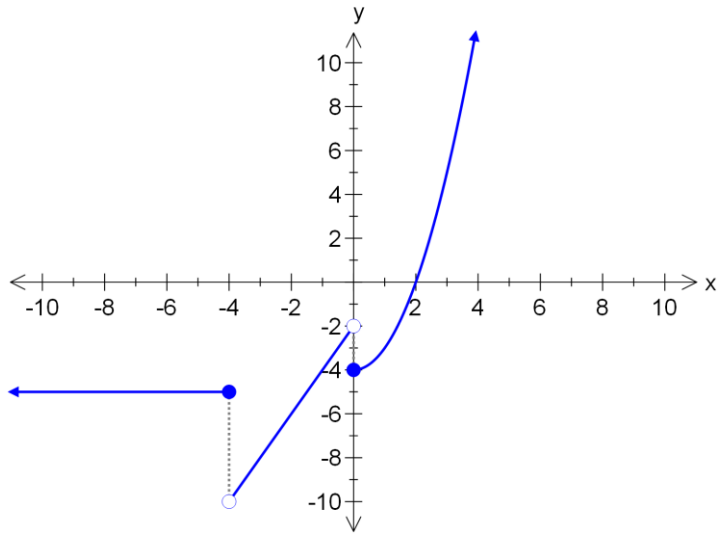
ii. On the same set of axes, sketch the graph of $y = |x|$. **1**

iii. Find the coordinates of the two points where the graphs intersect. **2**

iv. Hence solve the inequality $x^2 - 6 \leq |x|$. **1**

(c) Solve simultaneously $x^2 + y^2 = 4$ and $12x - 5y - 26 = 0$. **3**

(d) The function, $f(x) = \begin{cases} -5 & \text{for } x \leq -4 \\ 2x - 2 & \text{for } -4 < x < 0 \\ x^2 - 4 & \text{for } x \geq 0 \end{cases}$ has been graphed below.



i. Evaluate $f(-4) - f(0)$. **1**

ii. Find an expression for $f(a^2 + 1)$. **2**

iii. For what value(s) of x is $f(x) = -5$? **2**

End of Question 12

Question 13 (15 marks) **Begin a NEW answer booklet**

(a) Find all positive values of x for which $\frac{6}{x} > x - 1$. **3**

(b) From a point O the point P lies on a bearing of $120°$ and is 12·3 km away. The point Q is 15·2 km South West of O.

i. Draw a diagram and mark the relative positions of O, P, Q **1**

ii. Calculate the distance PQ in kilometres (rounded off correct to one decimal place). **2**

(c) If $\log_a 3 + \log_a (x-1) = \log_a 21$ **2**

(d) Let $f(x) = \frac{x^2}{x^2 - 1}$.

i. For what values of x is $f(x)$ undefined? **1**

ii. Show that $y = f(x)$ is an even function. **2**

iii. Find the horizontal asymptote(s) of the function $f(x) = \frac{x^2}{x^2 - 1}$ and hence sketch the graph. **4**

End of Question 13

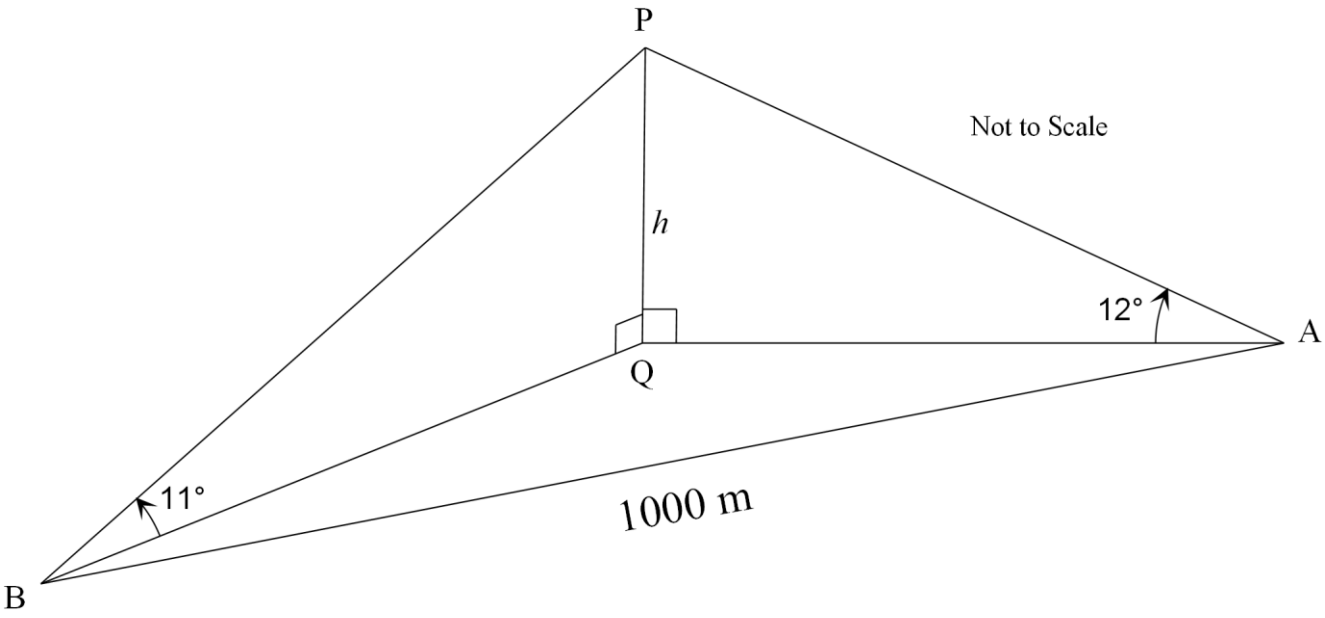
Question 14 (15 marks) **Begin a NEW answer booklet**

(a) If $\log_a 3 = 0.477$ and $\log_a 4 = 0.602$, find:

i. $\log_a 12$ **1**

ii. $\log_a 3a^2$ **2**

(b)



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i. Show that $\angle AQB = 141^o$. **1**

ii. Show that $AQ = h\tan 78°$. **2**

iii. Write down an expression for *BQ* in terms of *h*. **1**

iv. Hence, show that $h^2 = \dfrac{1000^2}{\tan^2 78^o + \tan^2 79^o - 2\tan 78^o \tan 79^o \cos 141^o}$ **2**

v. Using the sine rule, or otherwise, find to the nearest degree, the size of $\angle QAB$. **3**

(c) Show that $\dfrac{\cos x - \cos(x+2\theta)}{2\sin\theta} = \sin(x+\theta)$. **3**

End of Section II

End of Examination

SOLUTIONS 2013

Extension 1 Half-Yearly Examination

Section 1

1. B

2. $\dfrac{\left(\frac{2}{3}\right)^{63} \times \left(\frac{3}{4}\right)^{25}}{\left(\frac{2}{3}\right)^{42}\left(\frac{3}{4}\right)^{8}}$

$\dfrac{2^{21}}{3^{21}} \times \dfrac{3^{29}}{2^{29}}$

$\dfrac{3^4}{2^{29}}$ C

3. D

$3+\sqrt{2} - \dfrac{1}{(3+\sqrt{2})(3-\sqrt{2})}(3-\sqrt{2})$

$\dfrac{7}{7} \times \dfrac{(3+\sqrt{2})}{1} - \dfrac{(3-\sqrt{2})}{7}$

$\dfrac{21+7\sqrt{2}-3+\sqrt{2}}{7}$

$\boxed{\dfrac{18+8\sqrt{2}}{7}}$

4. $765 = \dfrac{3(2^n-1)}{1}$ C

$255 = 2^n - 1$

$256 = 2^n$

$2^8 = 2^n \Rightarrow \boxed{n=8}$

5. $\dfrac{\sin B}{21.3} = \dfrac{\sin 32}{19.4}$ D

$B = 180 - 36$

$= 144°$

6. $\lim\limits_{x\to\infty} \dfrac{\frac{3x^2}{x^2} - \frac{4x}{x^2} + \frac{5}{x^2}}{\frac{x^2}{x^2}}$

$\lim\limits_{x\to\infty} \dfrac{3 - \frac{4}{x} + \frac{5}{x^2}}{1}$

$\dfrac{3}{1} = 3$ C

7. $f(-x) = \frac{1}{2}(2^{-x} - 2^x)$

$= -\left[\frac{1}{2}(2^x - 2^{-x})\right]$

$= -f(x)$ odd A

8. $\tan[90-(5x-40)]° = \tan(3x+10)°$

$90 - 5x + 40 = 3x + 10$

$120 = 8x$

$x = 15°$ A

9. $\dfrac{\cos(3a-2a)}{\cos a}$ B

10. $\cos(18-\theta) = -\cos\theta$

$\dfrac{-\cos\theta}{\sin\theta}$

$= -\cot\theta$ D

Section II

Q11. (a) x^2-4x+4

$=(x-2)^2$

$\therefore n=-2$ (1)

(b) $(x-2)^2=\frac{8}{5}$

$x-2=\pm\sqrt{\frac{8}{5}}$ (1)

$x=2\pm\sqrt{\frac{8}{5}}$

$\therefore x=0.735$ or 3.26 (1)

(c) $\tan 15=\tan(45-30)$

$\frac{\tan 45-\tan 30}{1+\tan 45\tan 30}$ (1)

$\frac{1-\frac{1}{\sqrt{3}}}{1+1\times\frac{1}{\sqrt{3}}}$

$\left(\frac{\sqrt{3}-1}{\sqrt{3}}\right)\times\frac{\sqrt{3}}{\sqrt{3}+1}$ (1) Working

$\frac{(\sqrt{3}-1)(\sqrt{3}-1)}{(\sqrt{3}+1)(\sqrt{3}-1)}$

$\frac{3-2\sqrt{3}+1}{2}$

$\frac{4-2\sqrt{3}}{2}$

$\boxed{2-\sqrt{3}}$ (1) OR ACCEPT $\boxed{\frac{\sqrt{3}-1}{\sqrt{3}+1}}$

(d) $x\ln 7=\ln 3$

$x=\frac{\ln 3}{\ln 7}$

$x=0.56$. (1)

(e) $\cos x=2\sin x\cos x$

$\cos x(1-2\sin x)=0$ (1) Working

$\cos x=0$ $\quad$ $\sin x=\frac{1}{2}$

$x=\underbrace{90,270}$ $\quad$ $x=\underbrace{30,150}$

(1) Mark (1) Mark

$\therefore x=30,90,150,270$

(f) $\frac{5^3}{5^{6n}\times5^{3-6n}}$ ← (1)

$\frac{5^3}{5^{6n+3-6n}}$

$\frac{5^3}{5^3}=\boxed{1}$ (1)

(g) $|a+2|=2a-5$

$\therefore a+2=2a-5$ or $-a-2=2a-5$

$a=7$ or $a=1$

(1) (1)

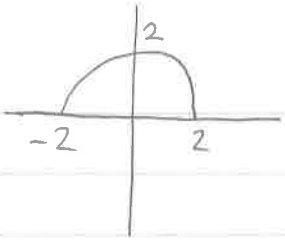
check both answers

when $a=7$ ✓ TRUE

when $a=1$ ✗ LHS ≠ RHS

$\therefore$ the only solution is $\boxed{x=7}$ (1)

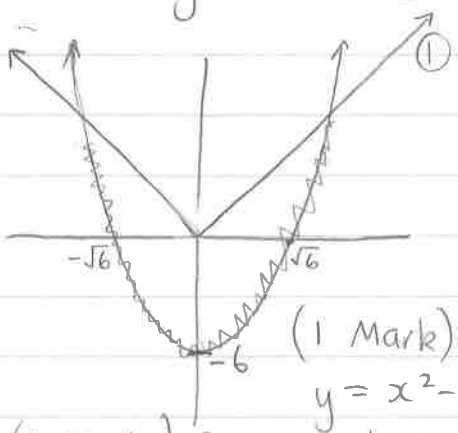
Q12 (a)



D: $-2 \leq x \leq 2$ (1)

R: $0 \leq y \leq 2$ (1)

(d) i.



(1)

(1 Mark) for $y = x^2 - 6$

ii (1 Mark) for $y = |x|$

iii $|x| = x^2 - 6$

$x^2 - x - 6 = 0$

$(x-3)(x+2) = 0$

$x = 3$, -2 no solution

$\therefore x = 3$ and -3 by symmetry

When $x = 3$ $y = 3$

$\therefore (-3, 3)$ and $(3, 3)$ (1)

iv. (1)

$-3 \leq x \leq 3$ (1)

(b) $y = 2x + 3$ ... (1)

$y = x^2 + 4x + 5$ ... (2)

sub (1) $\Rightarrow$ (2)

$2x + 3 = x^2 + 4x + 5$ (1)

$x^2 + 2x + 2 = 0$

$x = \dfrac{-2 \pm \sqrt{4 - 4 \times 1 \times 2}}{2}$

$x = \dfrac{-2 \pm \sqrt{-4}}{2}$ (1)

no real solutions (1)

(c) i. $-5 - (0^2 - 4)$

$= -1$ (1)

ii $f(a^2+1)$ must use $x^2 - 4$

since $a^2 \geq 0$ $a^2 + 1 > 0$

$\therefore f(a^2+1) = (a^2+1)^2 - 4$ (1)

$= a^4 + 2a^2 + 1 - 4$

$= a^4 + 2a^2 - 3$ (1)

iii $y = -5$ for

$f(x) = 2x - 2$ $f(x) = -5$

$-5 = 2x - 2$

$-3 = 2x$

$x = -\frac{3}{2}$ or $-1\frac{1}{2}$ (1)

and $x \leq -4$

$\therefore$ $x = -1\frac{1}{2}$ and $x \leq -4$

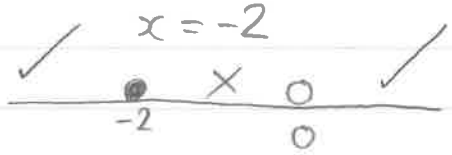
Q13 (a) $\boxed{x \neq 0}$

$$\frac{2x-8}{3x} \leq 2$$

$$2x - 8 = 6x$$

$$-4x = 8$$

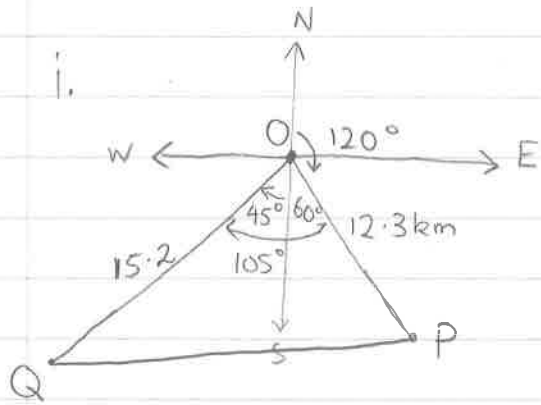
$$x = -2$$



Test $x = 1$ $\quad \frac{2\times1-8}{3\times1} \leq 2$ ✓ True

$\therefore \quad x \leq -2$ or $x > 0$

(b) i.



(1) Mark (1)

ii $PQ^2 = 15{\cdot}2^2 + 12{\cdot}3^2 - 2(15{\cdot}2)(12{\cdot}3)\cos 105°$

$PQ = 21{\cdot}9\text{km}$ (1)

(c) $\log_a 3(x-1) = \log_a 21$ (1)

$3x - 3 = 21$

$x = 8$ (1)

(d) $f(x) = \dfrac{x^2}{(x-1)(x+1)}$

i. $x \neq \pm 1$ (1)

ii. $f(-x) = \dfrac{(-x)^2}{(-x)^2 - 1}$ (1)

$= \dfrac{x^2}{x^2-1} = f(x)$ = even (1)

iii) $\lim\limits_{x\to\infty} \dfrac{\frac{x^2}{x^2}}{\frac{x^2}{x^2} - \frac{1}{x^2}}$

$\dfrac{1}{1-0}$

$= 1$

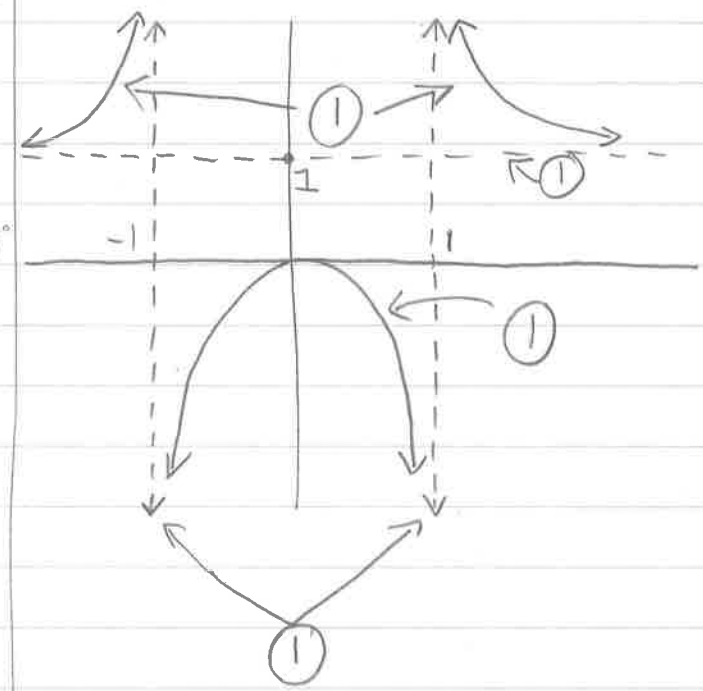
x	-10	-5	-2	-1	-0·9	$-\frac{1}{2}$	$-\frac{1}{4}$
y	1·01	1·04	1·3	X	-4·3	-0·3	-0·08

x-intercepts $\quad y = 0$

$0 = \dfrac{x^2}{x^2-1} \quad \boxed{x = 0}$

y-intercepts $\quad x = 0$

$\boxed{y = 0}$



Q14 (a) i. $\log_a 3x4$

$\log_a 3 + \log_a 4$

$(0.477) + (0.602)$

$= 1.079$

ii. $\log_a 3a^2$

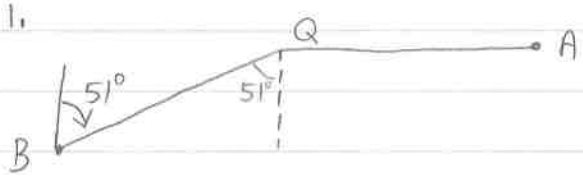
$\log_a 3 + \log_a a^2$

$\log_a 3 + 2\log_a a$ (1)

$0.477 + 2$

$= 2.477$ (1)

(b) i.

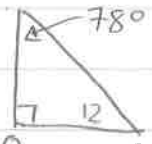


$\angle AQB = 51° + 90$ (alternate)

$= 141°$ (1)

ii.

$\tan 78° = \frac{QA}{h}$ (1)



(1)

$\therefore QA = h\tan 78°$

iii. $BQ = h\tan 79°$ (1)

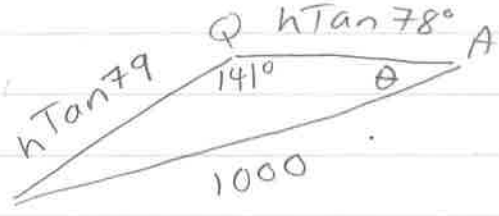
iv.

(1) $1000^2 = (h\tan 79)^2 + (h\tan 78)^2 - 2\,h\tan 78\, h\tan 79\cos 141°$

(1) $1000^2 = h^2(\tan^2 79 + \tan^2 78 - 2\tan^2 78\tan^2 79(\cos 141))$

$\therefore h^2 = \frac{1000^2}{(\tan^2 78 + \tan^2 79 - 2\tan 78\tan 79(\cos 141))}$

v. $h = 107.70$ (1)



$QB = h\tan 79$

$h = 107.6958263$

$\therefore QB = 554.0469959$ (1)

$\frac{\sin\theta}{554} = \frac{\sin 141°}{1000}$

$\theta = \sin^{-1}\left[\frac{554\sin 141}{1000}\right]$

$\theta = 20°$ (1)

(c) LHS $= \frac{\cos x - [\cos x\cos 2\theta - \sin x\sin 2\theta]}{2\sin\theta}$ (1)

$= \frac{\cos x - [\cos x(1 - 2\sin^2\theta) - \sin x(2\sin\theta\cos\theta)]}{2\sin\theta}$

$= \frac{\cos x - \cos x + 2\sin^2\theta\cos x + \sin x\, 2\sin\theta\cos\theta}{2\sin\theta}$ (1)

$= \frac{2\sin\theta[\sin\theta\cos x + \sin x\cos\theta]}{2\sin\theta}$ (1)

$= \sin\theta\cos x + \sin x\cos\theta$

$= \sin(\theta + x)$

$=$ RHS

-END OF SOLUTIONS-