ST ANDREW'S JUNIOR COLLEGE

COMMON TEST

MATHEMATICS	**HIGHER 2**	**9758**
Wednesday	**03 July 2019**	**2h 30 min**

Candidates answer on the Question Paper.
Additional Materials: List of Formulae (MF26)

NAME:______________________________(___) **C.G.:** __________

TUTOR'S NAME: ____________________________

SCIENTIFIC / GRAPHIC CALCULATOR MODEL: ____________________

READ THESE INSTRUCTIONS FIRST

Write your name, civics group, index number and calculator models on the cover page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions. Total marks : **80**

Write your answers in the spaces provided in the question paper.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
The use of an approved graphing calculator is expected, where appropriate.
Unsupported answers from a graphing calculator are allowed unless a question specifically states otherwise.
Where unsupported answers from a graphing calculator are not allowed in a question, you are required to present the mathematical steps using mathematical notations and not calculator commands.
You are reminded of the need for clear presentation in your answers.

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

Q	1	2	3	4	5	6	7	8	9					TOTAL
M														

This document consists of **32** printed pages and **2** blank pages including this page.

[Turn over

1 A local telco company SAtel charges for voice call, number of short messages (SMS-es) sent and data used by every individual customer.

Three customers, Alice, Betty and Carol subscribed to a particular SAtel's price plan and their usage as well as the bill for July 2019 is shown below:

	Usage			Total Bill ($)
	Duration of voice call (min)	No. of SMS-es sent	Data used (GB)	
Alice	450	50	10.5	116.50
Betty	250	0	8.9	94
Carol	140	135	12	129.55

(i) Find the unit price for voice call, SMS-es and data usage respectively by SAtel. [4]

(ii) In lieu of the bi-centennial celebrations of the country, SAtel decides to run a promotion on the price plan found in part **(i)** in the month of August 2019. SAtel decides that the charges on voice call and SMS-es sent are each given a 45% discount and charges for data usage is given a 10% discount. Suppose that Carol has the same usage in August 2019 as in July 2019, find the percentage reduction in the bill for Carol in August 2019 compared to July 2019. **[3]**

2 It is given that $\mathrm{f}(r) = \dfrac{1}{r+1}$.

(i) Show that $\mathrm{f}(r+1) - 2\mathrm{f}(r) + \mathrm{f}(r-2) = \dfrac{ar+b}{(r+2)(r+1)(r-1)}$, where a and b are constants to be determined. **[2]**

[Turn Over

(ii) Hence, evaluate $\sum_{r=3}^{n} \frac{2r+10}{(r-1)(r+1)(3r+6)}$, expressing your answer in the form

$\frac{p}{q} + \mathrm{g}(n)$, where $p, q \in \mathbb{Z}$ and $\mathrm{g}(n)$ is a single rational function in terms of n. **[4]**

[Turn Over

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(iii) Deduce that $\sum_{r=3}^{n} \frac{2r+10}{(r+2)^3}$ is less than $\frac{7}{6}$. **[3]**

[Turn Over

3 **(i)** Show that $x^2 - x + 1$ is always positive for all real values of x. **[2]**

(ii) Hence, without using a calculator, solve the inequality $\dfrac{2x+5}{4+3x-x^2} \leq 1$. **[3]**

(iii) Deduce the solution of the inequality $\dfrac{2|x|+5}{4+3|x|-x^2} \le 1$. **[3]**

[Turn Over

4 It is given that

$$\mathrm{h}(x)=\begin{cases}\cos x & \text{for } -\dfrac{\pi}{2}\le x\le\dfrac{\pi}{2}\\[2ex] \pi-2x & \text{for } \dfrac{\pi}{2}<x<\pi\end{cases}$$

and that $\mathrm{h}\left(x+\dfrac{3\pi}{2}\right)=\mathrm{h}(x)$.

Sketch the graph of $y=\mathrm{h}(x)$ for $-\pi\le x\le\dfrac{11\pi}{4}$. **[3]**

5 A curve C is defined by the equation $y = \dfrac{-4x^2 + 8kx - 5k^2 + 4}{x - k}$, $x \neq k$.

(i) Find the range of values of k such that C has two stationary points. **[5]**

(ii) It is given that C has an oblique asymptote which cuts the y-axis at the point $(0 , 4)$. Find the value of k. **[2]**

(iii) Using the value of k in **(ii)**, sketch the curve C, stating the equations of asymptote(s), exact coordinates of turning point(s) and axial intercept(s), if any.

[3]

[Turn Over

(iv) A curve C_1 is defined by the following parametric equations

$$x = 1 + \tan t \ , \ y = b\sec t, \ 0 \le t \le 2\pi, \ b > 0 \ .$$

Find the cartesian equation of the curve C_1. **[2]**

(v) Find the range of values of b such that there are at most two intersection points between the curves C and C_1. **[2]**

6 **(a)** Determine the horizontal asymptote for the graph of $y = 2^{3-x^2} - 4$. **[1]**

(b) The function g is defined by

$$g : x \mapsto 2^{3-x^2} - 4 \quad \text{for } x \in \mathbb{R}.$$

(i) By drawing a suitable graph, find the range of g and show that g does not have an inverse. **[3]**

[Turn Over

[Turn Over

(ii) If the domain of g is now restricted to the subset of $\mathbb{R}$ for which $x \leq A$, state the maximum value of A for which g^{-1} exists. Define g^{-1} in a similar form. **[5]**

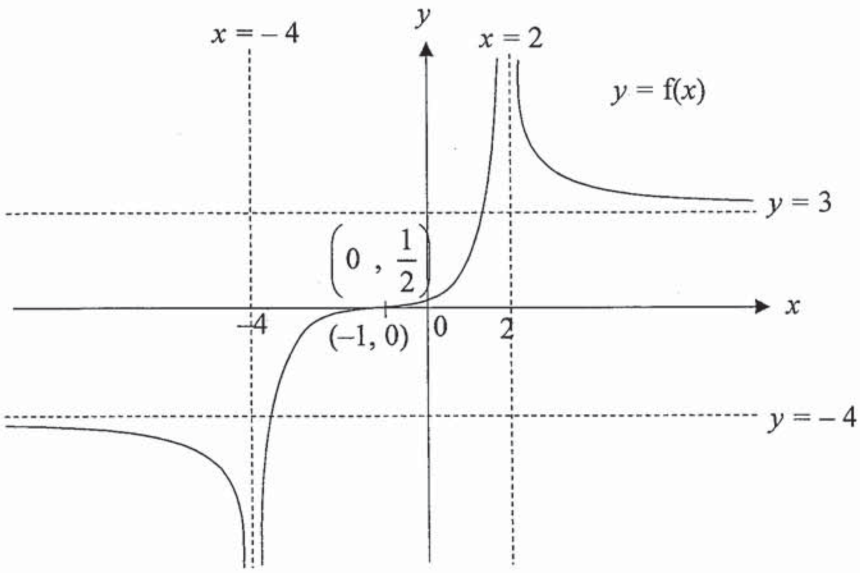
(iii) The function f is defined by

$$\mathrm{f}: x \mapsto x^2 - x - \frac{25}{4}, \quad x \in \mathbb{R}, \; x > -4.$$

Show that the function fg exists and find the exact range of fg. **[3]**

7 **For this question, you should state clearly the equations of the asymptote(s) and the coordinates of the stationary point(s) where appropriate for all your graphs.**

The diagram below shows the graph of $y = \mathrm{f}(x)$. The graph has asymptotes $y = -4$, $y = 3$, $x = -4$ and $x = 2$, a y-intercept at $\left(0\ ,\ \dfrac{1}{2}\right)$ and a stationary point at (–1, 0).



[Turn Over

On separate diagrams, sketch the graphs of

(i) $y=\dfrac{1}{\mathrm{f}(x)}$, and **[3]**

[Turn Over

(ii) $y=\mathrm{f}\left(-\frac{1}{2}x+2\right)$. [3]

8 **(i)** Find the exact value of a such that $\mathrm{e}^{-ax} = 3^{-x}$. Hence show that

$$3^{3-x}\left(x\ln 3+\frac{1}{3}\right)=9\mathrm{e}^{-(\ln 3)x}\left(3x\ln 3+1\right) .$$ **[2]**

[Turn Over

(ii) Describe a series of transformations that maps the graph of $y = \mathrm{e}^{-x}(3x+1)$ onto the graph of $y = 3^{3-x}\left(x\ln 3+\frac{1}{3}\right)+1$. **[3]**

9 For an art lesson, each student is given a piece of wire of length 200 cm. They are instructed to cut and bend the wire to form 10 squares of decreasing sizes, with the largest square having side of 8 cm.

(a) Albert designs the squares such that their perimeters form an arithmetic progression with common difference d.

(i) Find the exact value of d. **[2]**

(ii) Find the area of the smallest square. **[3]**

(b) On the other hand, George designs the squares such that the areas of the squares form a geometric progression with common ratio r.

(i) Show that the sides of the squares also follow a geometric progression and find its common ratio in terms of r. **[3]**

[Turn Over

(ii) By considering the sum of the perimeters of squares formed by George, show that $4r^5 - 25\sqrt{r} + 21 = 0$. **[3]**

(iii) Explain why the common ratio, r, cannot be 1 even though $r = 1$ is a solution to the equation in **(b) (ii)**. Hence, find the other value of r correct to 5 decimal places. **[2]**

(iv) In order to form more than 10 squares, George extended the original wire by L cm. Assuming that all the areas of the squares follow a geometric progression with the same common ratio r found in **(b) (iii)**, find the least integer value of L so that he will never run out of wire to form any number of squares. **[3]**

End of Paper

St Andrew's Junior College
2019 JC1 H2 Mathematics (9758) Common Test
Examiner's Comments

General Comments:

In general, students are reminded to write all solutions in pen, except for graphs. Also, with the new format of the paper, students need to copy their answers and information carefully as well as manage the space provided for solutions well. Many students also did not grasp the basic Mathematical language which is expected of them at A-level.

Most students could have done better given that for problems examined in this paper tested concepts and skills which were taught in lectures and tutorials. For most questions except Questions 5 and 8, gap in conceptual understanding and lack of mastery of skills and techniques are ubiquitous throughout the paper.

For certain questions which require the use of O-level Additional Math assumed knowledge such as differentiation techniques, law of indices and long division etc, it was obvious that there is still a lack of mastery. The lack of knowledge in the Additional Mathematics content was evident in the various questions throughout the paper (such as Q3, 5 and 6). These skills included algebraic manipulations and those related to specific content taught at O-level.

It was observed that students are still inadequate in reading/interpreting questions, solving non-routine problems, observing patterns and deducing results.

Where time management is concerned, it was apparent that a number of students struggled to finish the paper within the stipulated time. That resulted in them losing a substantial number of marks due to the relatively heavier weightage carried by the questions at the end of the paper.

Q	Solution	Comments
1(i)	Let x, y and z be the unit price charged for the voice call per minute, per SMS sent and data usage per GB by SAtel, in dollars. For Alice: $450x+50y+10.5z=116.50$ ---(1) For Betty: $250x+0y+8.9z=94$ ---(2) For Carol:	Majority of students did not define the variables precisely, not indicating that the variables represents price or in dollars. Unknown quantities will need to be properly defined in order for equations formed to make sense. A small number of students did not form equations before giving answers.

	$140x+135y+12z=129.55 ---(3)$ Using the GC to solve (1), (2) and (3), $x=0.02,\ y=0.05\ ;\ z=10$ Hence, SAtel charges \$0.02 per minute of voice call made, \$0.05 per SMS sent and \$10 per GB of data used.	A small number of students were careless when using GC, formed correct equations but obtained wrong answers.
	Carol's total bill in August 2019 $=140(0.02\times0.55)+135(0.05\times0.55)+12(10\times0.9)$ $=\$113.25$ % reduction in bill $=\frac{129.55-113.25}{129.55}\times100\%$ $=12.6\%$ (to 3 sf)	Mistakes are generally caused by misreading questions. Example: Some students used the wrong % discount for each component. A small number of students used Alice's data instead.
2 (i)	$\mathrm{f}(r+1)-2\mathrm{f}(r)+\mathrm{f}(r-2)$ $=\frac{1}{r+2}-\frac{2}{r+1}+\frac{1}{r-1}$ $=\frac{(r+1)(r-1)-2(r+2)(r-1)+(r+2)(r+1)}{(r+2)(r+1)(r-1)}$ $=\frac{r^2-1-2(r^2+r-2)+r^2+3r+2}{(r+2)(r+1)(r-1)}$ $=\frac{r^2-1-2r^2-2r+4+r^2+3r+2}{(r+2)(r+1)(r-1)}$ $=\frac{r+5}{(r+2)(r+1)(r-1)}$ $\therefore a=1,\ b=5$	Majority of the students had no issue with this question. However, some students did not state the values of a and b as required by the question. There were some who made some algebraic manipulations when combining the fractions. When simplifying $-2(r+2)(r-1)$, please work out $(r+2)(r-1)$ first (which is equal to r^2+r-2), before multiplying in the factor of -2.

2(ii)	$\sum_{r=3}^{n}\frac{2r+10}{(r-1)(r+1)(3r+6)}=\frac{2}{3}\sum_{r=3}^{n}\frac{r+5}{(r-1)(r+1)(r+2)}$ $=\frac{2}{3}\sum_{r=3}^{n}[f(r+1)-2f(r)+f(r-2)]$ $=\frac{2}{3}[\ f(4)-2f(3)+f(1)$ $+f(5)-2f(4)+f(2)$ $+f(6)-2f(5)+f(3)$ $+f(7)-2f(6)+f(4)$ $+f(8)-2f(7)+f(5)$ $+\ ....$ $+f(n-3)-2f(n-4)+f(n-6)$ $+f(n-2)-2f(n-3)+f(n-5)$ $+f(n-1)-2f(n-2)+f(n-4)$ $+f(n)\quad -2f(n-1)+f(n-3)$ $+f(n+1)-2f(n)\quad +f(n-2)]$ $=\frac{2}{3}[-2f(3)+f(1)+f(2)+f(3)+$ $f(n-1)+f(n)+f(n+1)-2f(n-1)-2f(n)]$ $=\frac{2}{3}[f(1)+f(2)-f(3)+f(n+1)-f(n-1)-f(n)]$	Students should take care in listing the terms when performing MOD: • Terms should be listed out in rows, and • Cancellation of terms must be seen, to justify that MOD has been carried out. Most students were able to see the need to use MOD for this part. It is important to show the following link, $\frac{2}{3}\sum_{r=3}^{n}\frac{r+5}{(r-1)(r+1)(r+2)}=\frac{2}{3}\sum_{r=3}^{n}[f(r+1)-2f(r)+f(r-2)]$ as this connects part (i) to part (ii), satisfying the "Hence" in the question. Moreover, students must remember that the result in (i) can only be used if the expression under summation is the same as what was given in (i) on the LHS of the equation above. Students need to take note that a summation written in sigma notations can begin with any integer value which is not equal to 1. This will also apply to MOD as well since it makes use of summation in sigma notation. **Example (see below):** $\sum_{r=3}^{n}\frac{r+5}{(r-1)(r+1)(r+2)}=\sum_{r=1}^{n}\frac{r+5}{(r-1)(r+1)(r+2)}-\sum_{r=1}^{2}\frac{r+5}{(r-1)(r+1)(r+2)}$ is meaningless as $\frac{r+5}{(r-1)(r+1)(r+2)}$ is undefined when

$$=\frac{2}{3}\left(\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+\frac{1}{n+2}-\frac{1}{n}-\frac{1}{n+1}\right)$$

$$=\frac{2}{3}\left[\frac{7}{12}+\frac{n(n+1)-(n+1)(n+2)-n(n+2)}{n(n+1)(n+2)}\right]$$

$$=\frac{2}{3}\left[\frac{7}{12}+\frac{n^2+n-\left(n^2+3n+2\right)-n^2-2n}{n(n+1)(n+2)}\right]$$

$$=\frac{2}{3}\left[\frac{7}{12}+\frac{n^2+n-n^2-3n-2-n^2-2n}{n(n+1)(n+2)}\right]$$

$$=\frac{2}{3}\left[\frac{7}{12}+\frac{-n^2-4n-2}{n(n+1)(n+2)}\right]$$

$$=\frac{7}{18}+\frac{-2\left(n^2+4n+2\right)}{3n(n+1)(n+2)}$$

$r=1$ (we cannot divide by 0 in mathematics).

The common mistakes made were:

1. Did not list out sufficient rows of terms to see 2 full cancellations on the top and 2 full cancellations at the end of the sum, signifying a pattern of cancellation.
2. Did not show the cancellation of terms or cancel the terms wrongly.
3. Use 'N' or 'r' instead of 'n' when listing out the terms in the MOD.
    a. Students need to take care not to change the questions on their own.
    b. Each unknown letter has a certain significance in an equation or expression.
4. Use $g(r)$ instead of $f(r)$ without defining $g(r)$.
5. Did not put bracket when the general terms consist of the sum or difference terms. Please note that

$$\sum_{r=3}^{n}[f(r+1)-2f(r)+f(r-2)]$$

$$\neq \sum_{r=3}^{n}f(r+1)-2f(r)+f(r-2)$$

6. Wrote

$$\frac{2}{3}\sum_{r=3}^{n}\frac{r+5}{(r-1)(r+1)(r+2)}=\frac{2}{3}\ [f(r+1)-2f(r)+f(r-2)]$$

instead of

$$\frac{2}{3}\sum_{r=3}^{n}\frac{r+5}{(r-1)(r+1)(r+2)}=\frac{2}{3}\ \sum_{r=3}^{n}[f(r+1)-2f(r)+f(r-2)]$$

before doing MOD.

7. Incorrect algebraic manipulation:

		$-\frac{1}{n}-\frac{1}{n+1}+\frac{1}{n+2}=-\left(\frac{1}{n}-\frac{1}{n+1}+\frac{1}{n+2}\right)$ Correct manipulation: $-\frac{1}{n}-\frac{1}{n+1}+\frac{1}{n+2}=-\left(\frac{1}{n}+\frac{1}{n+1}-\frac{1}{n+2}\right)$ $=-\frac{(n+1)(n+2)+n(n+2)-n(n+1)}{n(n+1)(n+2)}$
2(iii)	$\forall r\in\mathbb{Z}^+,\ r\geq 3,$ $0<(r-1)(r+1)(r+2)<(r+2)^3$ $\Rightarrow\frac{1}{(r+2)^3}<\frac{1}{(r-1)(r+1)(r+2)}$ $2r+10>0$, hence, $\frac{2r+10}{(r+2)^3}<\frac{2r+10}{(r-1)(r+1)(r+2)}$ $\sum_{r=3}^{n}\frac{2r+10}{(r+2)^3}<\sum_{r=3}^{n}\frac{2r+10}{(r-1)(r+1)(r+2)}$ $\sum_{r=3}^{n}\frac{2r+10}{(r+2)^3}<3\left[\sum_{r=3}^{n}\frac{2r+10}{(r-1)(r+1)(3r+6)}\right]$ $=3\left[\frac{7}{18}-\frac{2}{3}\left(\frac{n^2+4n+2}{n(n+1)(n+2)}\right)\right]$ Since $n\geq 3$, $\frac{n^2+4n+2}{n(n+1)(n+2)}$ is a proper rational function,	Many students showed partial working, resulting in the loss of marks. Since the lower limit of $\sum_{r=3}^{n}\frac{2r+10}{(r+2)^3}$ and $\sum_{r=3}^{n}\frac{2r+10}{(r-1)(r+1)(3r+6)}$ is 3, the inequality $0<(r-1)(r+1)(r+2)<(r+2)^3$ holds for integer values of r greater than or equal to 3. It is important to state $2r+10>0$ as the inequality signs changes when a negative value is multiplied to it. The common mistakes made were: 1. $(r-1)(r+1)(3r+6)<(r+2)^3$ This is not true for all $r\in\mathbb{Z}^+,\ r\geq 3$. 2. The working shown below is wrong. As $n\to\infty,\frac{n^2+4n+2}{n(n+1)(n+2)}\to 0,$

	$0<\frac{n^2+4n+2}{n(n+1)(n+2)}$, $\sum_{r=3}^{n}\frac{2r+10}{(r+2)^3}<3\left[\frac{7}{18}-\frac{2}{3}\left(\frac{n^2+4n+2}{n(n+1)(n+2)}\right)\right]$ $<3\left(\frac{7}{18}\right)=\frac{7}{6}$ (Shown)	$\sum_{r=3}^{n}\frac{2r+10}{(r-1)(r+1)(3r+6)}\to\frac{7}{18}$. Therefore $\sum_{r=3}^{n}\frac{2r+10}{(r+2)^3}<3\left(\frac{7}{18}\right)=\frac{7}{6}$ The question wants you to show that $\sum_{r=3}^{n}\frac{2r+10}{(r+2)^3}<\frac{7}{6}$ for all $n\in\mathbb{Z}^+$, $n\geq 3$; not for very large values of *n*. It is good to note that : $0<\frac{n^2+4n+2}{n(n+1)(n+2)}<1$ since the expression is a proper rational expression.
3(i)	x^2-x+1 $=x^2-x+\left(-\frac{1}{2}\right)^2-\left(-\frac{1}{2}\right)^2+1$ $=\left[x+\left(-\frac{1}{2}\right)\right]^2+\frac{3}{4}$ $=\left(x-\frac{1}{2}\right)^2+\frac{3}{4}$ Since $(x-\frac{1}{2})^2\geq 0$ for all $x\in\mathbb{R}$, then $(x-\frac{1}{2})^2+\frac{3}{4}>0$ for all $x\in\mathbb{R}$. Hence x^2-x+1 is always positive for all real values of x.	Most of the students were able to complete the square correctly. Some common errors will result in completing the square incorrectly. However, students faltered when trying to explain how the completed square form could help them conclude that the expression is greater than zero for all real values of *x*. In particular, many students state that $(x-\frac{1}{2})^2>0$ without considering the fact that it can be equal to zero too when $x=\frac{1}{2}$. Some students also simply state that $(x-\frac{1}{2})^2+\frac{3}{4}>0$ after completing the square without relating it back to the fact that $(x-\frac{1}{2})^2\geq 0$ for all $x\in\mathbb{R}$. Students also need to take note and write that the results is true for ALL real values of *x*.

<table>
<tr><td></td><td></td><td>The method of proof using discriminant is discouraged for such questions as there are other factors to consider other than just the discriminant.</td></tr>
<tr><td>(ii)</td><td>$\frac{2x+5}{4+3x-x^2} \le 1$
$\frac{2x+5-(4+3x-x^2)}{4+3x-x^2} \le 0$
$\frac{2x+5-4-3x+x^2}{4+3x-x^2} \le 0$
$\frac{x^2-x+1}{4+3x-x^2} \le 0$
$\frac{x^2-x+1}{(4-x)(x+1)} \le 0,\ x \ne 4,\ x \ne -1$

Since $x^2-x+1>0$ for all $x \in \mathbb{R}$,
$(4-x)(x+1)<0$
$(x-4)(x+1)>0$

$x<-1$ or $x>4$</td><td>A fair number of students did not understand the following:

1. Cross multiplication of the denominator $4+3x-x^2$ is not allowed since $4+3x-x^2$ can be either positive or negative which may result in a sign change. For example, when $x=-2$, $4+3(-2)-(-2)^2=-6$.

2. Be careful when factorising $4+3x-x^2$ because $4+3x-x^2=(4-x)(x+1)=-(x-4)(x+1)=(-x-1)(x-4)$
But $4+3x-x^2 \ne (x-4)(x+1)$.

• Students are advised not to just adjust the factorisation blindly from the values obtained by using the scientific calculators. It is **important** to note that the factorsation should **match** the expression given.

3. $(x^2-x+1)(4+3x-x^2) \le 0$ or $\frac{x^2-x+1}{4+3x-x^2} \le 0$ means that the multiplication or division of both terms result in a number lesser or equal to zero. It is incorrect to state that $(x^2-x+1) \le 0$ or $(4+3x-x^2) \le 0$.

4. This is a hence question, so result from previous part: x^2-x+1 is always positive for all real values of x must be used.</td></tr>
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7

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<tr><td></td><td></td><td>5. For any rational function, the denominator cannot be zero. Therefore $x=4$ and $x=-1$ must be excluded from the solution. In particular,
$\frac{x^2-x+1}{(4-x)(x+1)} \le 0,\ x \ne 4,\ x \ne -1$
would mean that $(4-x)(x+1)<0$ not $(4-x)(x+1)\le 0$ since $x^2-x+1>0$ for all $x \in \mathbb{R}$.</td></tr>
<tr><td>(iii)</td><td>$\frac{2|x|+5}{4+3|x|-x^2} \le 1$
As $x^2=|x|^2$, replacing x with $|x|$, from part (ii)
$\frac{2|x|+5}{4+3|x|-|x|^2} \le 1$ has solution $|x|<-1$ or $|x|>4$
$|x|<-1$ (no solution since $|x|\ge 0$ for all $x\in\mathbb{R}$) or
$|x|>4$
Therefore, $x<-4$ or $x>4$</td><td>Students need to state explicitly that they are replacing x with $|x|$ and the relationship $x^2=|x|^2$ SHOULD be stated explicitly.

As this is a deduction question, students should deduce their answers from the results of the previous part and not rework out the entire solution again.

Many students rejected the inequality $|x|<-1$. Students must note that the aim of the question is to solve the inequality, i.e. finding the range of values of x which satisfy the given inequality. Hence, it is meaningless to reject an inequality which you need to solve. However, the solution to an inequality is either providing the range of values satisfying it or explaining why there is no solution to the inequality.

Students need to explain $|x|<-1$ has no solution 'since $|x|\ge 0$ for all $x\in\mathbb{R}$'. It is incorrect to state that $|x|>0$.

A number of students were unable to solve $|x|>4$ correctly. Common errors include $x>4$ or</td></tr>
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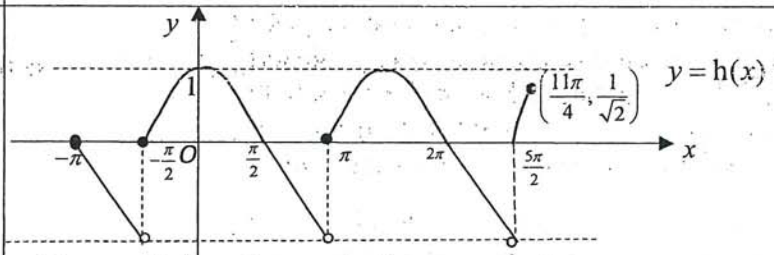
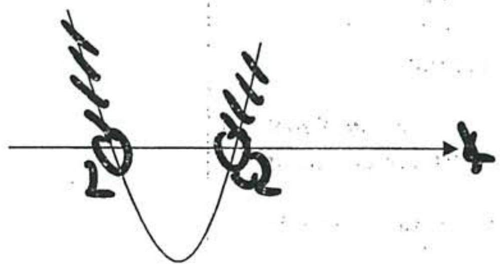
		$-4 < x < 4$. Do note that the correct result to be used is $\lvert x \rvert > b \Leftrightarrow x < -b$ or $x > b$.
4	 $\mathrm{f}(\frac{11\pi}{4}) = \mathrm{f}(\frac{11\pi}{4} - (2\times\frac{3\pi}{2})) = \mathrm{f}(-\frac{\pi}{4}) = \cos(-\frac{\pi}{4}) = \frac{1}{\sqrt{2}}$ $\mathrm{f}(-\pi) = \mathrm{f}(-\pi + \frac{3\pi}{2}) = \mathrm{f}(\frac{\pi}{2}) = \cos(\frac{\pi}{2}) = 0$	Many students either drew piecewise but not periodic functions, or periodic but not piecewise functions. Students ought to understand that the definition of the function provided in this question required comprehension of both piecewise and periodic function. For the handful of students who successfully drew the graph of $h(x)$, there were some who did not label the end points. Students should be mindful that the domain has been provided in the question and is an essential aspect of functions. Many candidates did not draw shaded and hollow circles to represent inclusion and exclusion (respectively) at the end points of each segment, e.g. $x = -\frac{\pi}{2}, \pi, \frac{5\pi}{2}$.
5(i)	Given $y = \frac{-4x^2 + 8kx - 5k^2 + 4}{x - k}$ $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{(x-k)(-8x+8k) - (-4x^2 + 8kx - 5k^2 + 4)(1)}{(x-k)^2}$ $= \frac{-8x^2 + 8kx + 8kx - 8k^2 + 4x^2 - 8kx + 5k^2 - 4}{(x-k)^2}$ $= \frac{-4x^2 + 8kx - 3k^2 - 4}{(x-k)^2}$	There was a significant number of students who regurgitated the solution from the lecture or tutorials without the full understanding of the question. The question asked for the 'range of values of k such that C has two stationary points'. However, many students did not even attempt to differentiate the equation of the graph. Essentially, the question was asking for the range of values of k for which there will be two distinct and real solutions to the equation $\frac{\mathrm{d}y}{\mathrm{d}x} = 0$. **Common errors/misconceptions:**

	Solution	Comments
*	must write For stationary points, $\frac{dy}{dx}=0$. $\frac{-4x^2+8kx-3k^2-4}{(x-k)^2}=0$ $\Rightarrow -4x^2+8kx-3k^2-4=0 \text{---(1)}$ Since there are two stationary points, there are two distinct real roots for the equation (1). Hence, discriminant >0 $64k^2-4(-4)(-3k^2-4)>0$ $64k^2+16(-3k^2-4)>0$ $64k^2-48k^2-64>0$ $16k^2-64>0$ $k^2-4>0$ $(k-2)(k+2)>0$	1. Poor technical skills such as incorrect application of Differentiation by Quotient Rule or Product Rule. a. In this question, the application of Quotient Rule is preferred. 2. In differentiating the equation given, students did not realise that k was to be treated as a constant. 3. Poor algebraic skills: Students were unable to simplify the algebraic expressions accurately. 4. Some candidates had the following logic: $\frac{dy}{dx}=\frac{-4x^2+8kx-3k^2-4}{(x-k)^2}=0$ right after differentiating. However, this is not true for all values of x. $\frac{dy}{dx}=0$ only occurs at the stationary point(s) of the curve. 5. Some students did not know the correct discriminant condition when forming the inequality. a. When a curve has two stationary points, it is clear that there has to be two distinct stationary points on the curve. b. This results in having two distinct and real roots for the equation labelled (1) in the solution. This implies that the discriminant has to be larger than 0. c. Students should also bear in mind that

	 Therefore, $k < -2$ or $k > 2$.	$b^2 - 4ac$ is **NOT** the discriminant for this equation, since a, b and c are not the coefficients of the equation (1). 6. Students were unable to clearly articulate how some of the equations or inequalities were formed. 7. Incorrect approach in solving inequalities: a. Some candidates wrote: $k^2 - 4 > 0$ $k^2 > 4$ $k > \pm 2$ (incorrect) b. There is a need to familiarise oneself with the approach of solving a polynomial inequality, a skill to be learnt in Chapter 7.
(ii)	Working for long division: $x - k \overline{) -4x^2 + 8kx + (4 - 5k^2)}$ quotient: $-4x + 4k$ $-)\ -4x^2 + 4kx$ $4kx + (4 - 5k^2)$ $-)\ 4kx - 4k^2$ $4 - k^2$ $y = \dfrac{-4x^2 + 8kx - 5k^2 + 4}{x - k} = -4x + 4k - \dfrac{k^2 - 4}{x - k}$	Poor algebraic manipulations were noticed in this question. There was a need to be mindful and careful in performing long division with unknown constants within the expression. Many students wrote down an incorrect expression as the answer to the long division. **Common Misconceptions:** 1. Many students did not read the question carefully and substituted the point (0 , 4) into the equation of the curve. a. Students have to read the question and the information given, sieving out important key

	Oblique asymptote: $y=-4x+4k$ Since the oblique asymptote cuts the y-axis at (0,4), $4k=4$ $k=1$	points before starting to solve the question.
(iii)	Since $k=1$, there is no turning points for the curve C. $y=\dfrac{-4x^2+8x-1}{x-1}=-4x+4+\dfrac{3}{x-1}$ * **Asymptotes:** Vertical: $x=1$ Oblique Asymptote: $y=-4x+4$ * **Intercepts:** When $x=0$, $y=\dfrac{-1}{-1}=1$ $\therefore$ $(0,1)$ When $y=0$, $-4x^2+8x-1=0$ $4x^2-8x+1=0$	**Common mistakes/misconceptions:** 1. There was a lack of systematic process in drawing the graph required. 2. There was a lack in knowledge to manage the space given for the solutions. 3. Graphs drawn by candidates do not fulfil the requirements of the question, there were missing coordinates of axial intercepts in **EXACT** form. Some students gave it as non-exact values. 4. Some students gave the incorrect graph despite having the correct value of k. a. Students should make use of the original equation given as a check with the resulting equation that was obtained via long division. There was a lack of applying checking mechanisms at this stage. 5. Many students spent a great deal of time trying to find the stationary points of this graph. a. Students should have made connection with

$$x=\frac{8\pm\sqrt{64-4(4)(1)}}{2(4)}$$
$$=\frac{8\pm\sqrt{48}}{8}$$
$$=1\pm\frac{\sqrt{16\times3}}{8}$$
$$=1\pm\frac{4\sqrt{3}}{8}$$
$$=1\pm\frac{\sqrt{3}}{2}$$

$\left(1+\frac{\sqrt{3}}{2}\ ,\ 0\right)$ or $\left(1-\frac{\sqrt{3}}{2}\ ,\ 0\right)$

part (i) of the question and inferred that there was no stationary points for this graph to be drawn since the value of k do not lie in the range of values found for the graph to have two stationary points.

6. Many students did not simplify surds fully.

    a. Students should remember in subsequent exams to simplify surds as far as possible by using prime factorisation and law of indices

$$\sqrt{48}=\sqrt{4\times12}$$
$$=2\sqrt{12}$$
$$=2\sqrt{4\times3}$$
$$=4\sqrt{3}$$

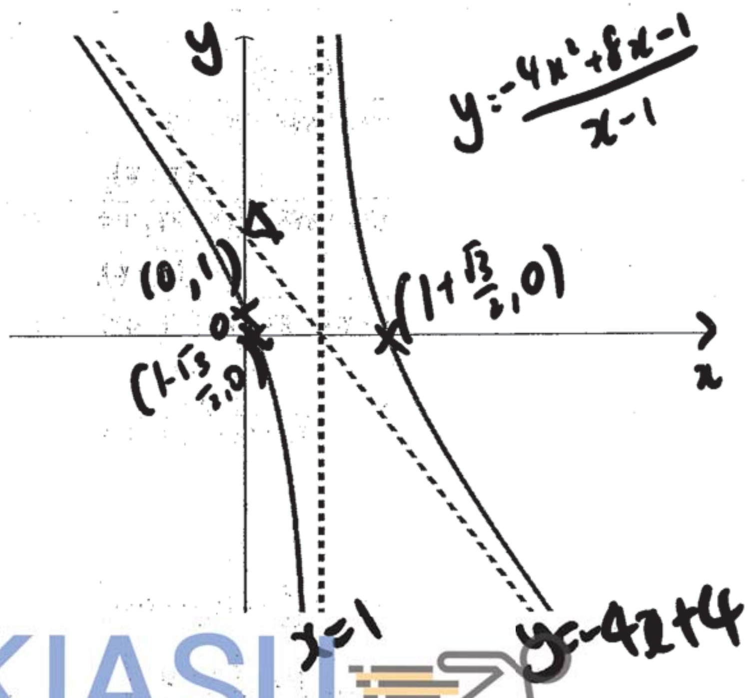
7. Equation of graph in (iii) should be given in terms of the values found in (ii).

8. Some students did not realise that the y-intercept of the oblique asymptote was (0,4) as given by the question in (ii).

9. Some students also placed the point (0 , 1), which is the y – intercept of the graph C very near to the point (0 , 4).

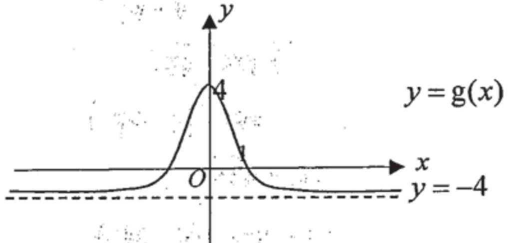
Note the following for sketches of graphs:

1. All elements in the graphs should be sketched in pencil.
2. Axes should be perpendicular to each other.

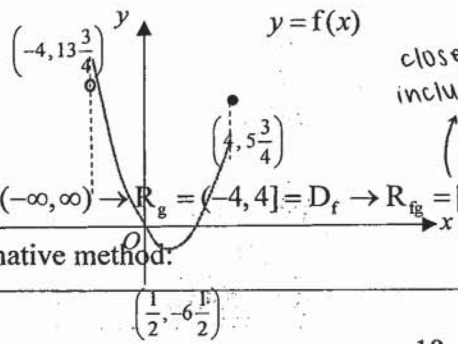
		3. The origin should be labelled. 4. All elements in the graph should be as long as the axes and as wide as the axes. 5. In marking out points, a cross should be used. Make it a habit to mark out essential points (such as stationary points and intersection with axes) as coordinates. 6. Asymptotes MUST be drawn in dotted lines. 7. Equations of asymptotes need to be written. 8. Graphs MUST be labelled with its equations, not the name (ie C). 9. The graph should be at least TWO-THIRDS a page. To draw a proper graph, students should note the following: 1. Calculate the (A)symptotes, (I)ntercepts with axes, and (S)tationary points in a systematic manner. 2. Emplace the characteristics of the graphs in the order of A, I followed by S. This will allow the general positions of important features to be fixed, relative to one another.
(iv)	By using the trigonometric identity: $\tan^2 t+1=\sec^2 t$ $1+\tan^2\theta=\sec^2\theta$ $(x-1)^2+1=\left(\frac{y}{b}\right)^2$ $\left(\frac{y}{b}\right)^2-(x-1)^2=1$	Some students do not know that Cartesian equations only consist of x and y. Many students do not seem to know that there are more than one way to convert a parametric equation into a Cartesian equation. Many students tried to write t in terms of x or y using the inverse trigonometric functions instead of using the trigonometric identities for this question. For some students, they took the square root of the

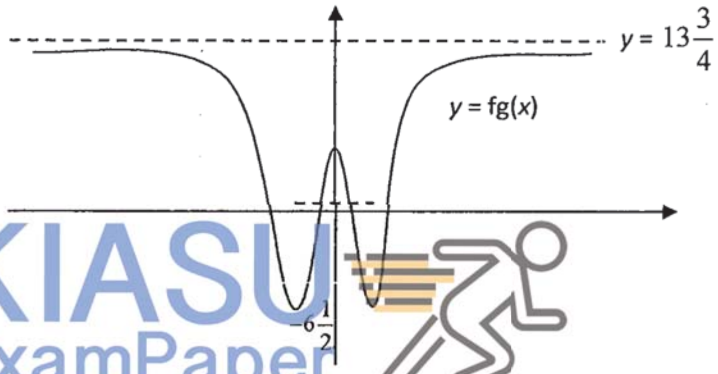
		expression, resulting in the loss of equations. Based on the equation and range of parameters, the parametric equation describes a full hyperbola. i.e. $y=\sqrt{b^2\left[(x-1)^2+1\right]}$ is incorrect for this question.
(v)	The asymptotes of the hyperbola in (iv) are $y=\pm b(x-1)$ and centre is (1,0). The asymptotes of the hyperbola $y=\pm b(x-1)$ passes through the point (1, 0) and will therefore pivot around the point. Hence, for the hyperbola to intersect the curve C at most twice, $b \geq 4$.	Many students did not realise that they should be looking at how the hyperbola will interact with the original graph that was drawn. Hence, many did not try to find the asymptotes of the hyperbola found in (iv). At the same time, some attempt should have been given to explain the relationship between the two graphs in terms of the asymptotes in order for the two curves to intersect at most twice.
6(a)	As $x \to \pm\infty$, $2^{3-x^2}=2^3 2^{-x^2} \to 0$ Hence, $2^{3-x^2}-4 \to -4$ Hence, the horizontal asymptote is $y=-4$	Although most students could get the correct equation for the asymptote, some did not show the working for finding the asymptote. Students are reminded to show clear working instead of stating the answer without working as they are asked to "DETERMINE" the asymptote. There were a handful of students who attempted to apply the natural logarithmic (ln) function on both sides of the equation of the graph, these students often made mistakes in applying the laws of logarithm or made the expressions more complicated. Some students also have the misconception that $2^{3-x^2}>-4$ means $y=-4$ is the asymptote. These students

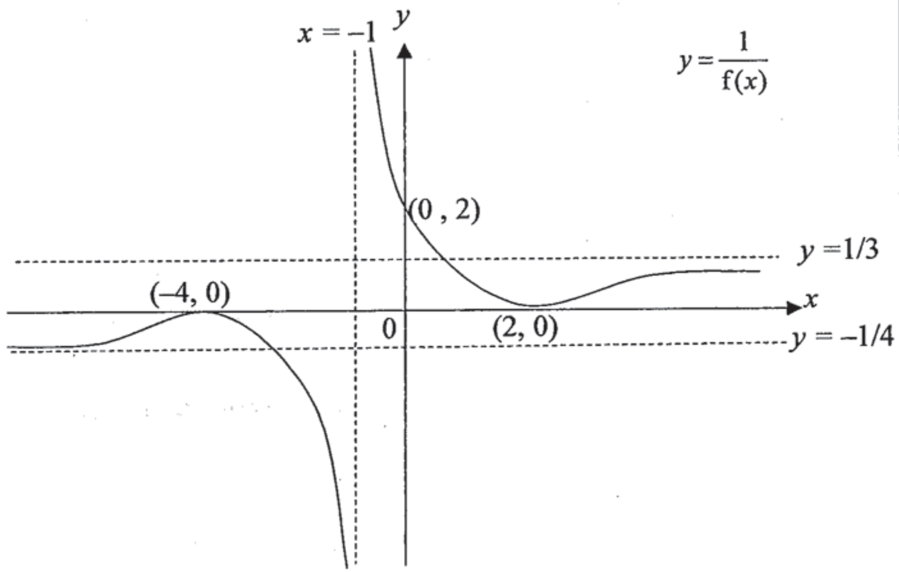
slightly difficult

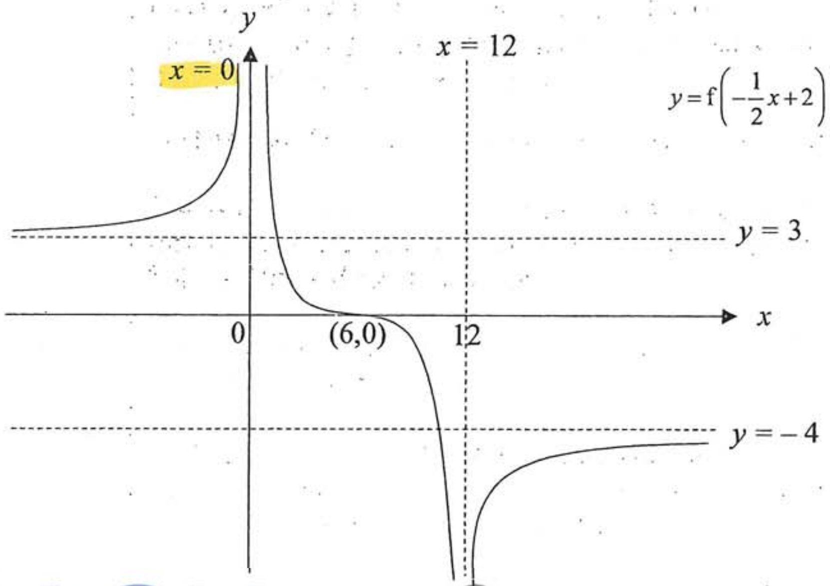
		need to understand that the correct method for finding horizontal asymptote is to find the value that y tends to (approaches) when $x \to \infty$ or $x \to -\infty$.
(b) (i)	as $x \to \pm\infty, y \to -4$  Range of g is $(-4, 4]$. The horizontal line $y = 0$ (or any other possible lines from $(-4, 4]$) cuts the graph at 2 distinct points (or at more than one point). Therefore g is not one-to-one and so g^{-1} does not exist.	In the sketch of the graph of g, students who missed out the horizontal asymptote failed to see the link between this part to part (i). Some students did not state the range of g. These students should read the question carefully and note that there are 3 parts to this question. Moreover, students must remember that a graph representing the function needs to be drawn before the range can be determined. To show that g does not have an inverse, students are expected to explain that g is not one-to-one by showing that there exists (at least) one specific horizontal line which cuts the graph of g more than once.
ii	Maximum value of $A = 0$ Let $y = 2^{3-x^2} - 4$, $x \le 0$	There were many errors in the use of laws of indices and logarithms. In particular, students should note that: $\ln(y+4) \neq \ln y + \ln 4$ $\frac{\ln(y+4)}{\ln 2} \neq \ln\left(\frac{y+4}{2}\right)$ Many students missed out the $\pm$ sign when solving for x at the step $x^2 = 3 - \frac{\ln(y+4)}{\ln 2}$. Students are reminded to explain why $x = \sqrt{3 - \frac{\ln(y+4)}{\ln 2}}$

	$y+4=2^{3-x^2}$ $\ln(2^{3-x^2})=\ln(y+4)$ $(3-x^2)\ln 2=\ln(y+4)$ $3-x^2=\frac{\ln(y+4)}{\ln 2}$ $x^2=3-\frac{\ln(y+4)}{\ln 2}$ $x=\pm\sqrt{3-\frac{\ln(y+4)}{\ln 2}}$ $x \le A = 0 \Downarrow x \le 0$ Since $x\le 0$, $x=-\sqrt{3-\frac{\ln(y+4)}{\ln 2}}$. ← $R_{g^{-1}} = D_g$ $g^{-1}: x \mapsto -\sqrt{3-\frac{\ln(x+4)}{\ln 2}}$ for $x\in\mathbb{R}$, $-4<x\le 4$. ("similar form") *Alternative working to get the expressions for x^2 :* $y=2^{3-x^2}-4$, $x\le 0$	was rejected. Many students could not determine the domain of g^{-1} correctly, i.e. recalling the relationship between the $D_{g^{-1}}$ and R_g. Note : $D_{g^{-1}}=R_g=(-4,4]$(one of the answers in part (ii)) Many also did not write their answer in "similar form" as required by the question.

	$y+4=2^3\cdot 2^{-x^2}$ $\frac{y+4}{8}=2^{-x^2}$ $\ln\left(\frac{y+4}{8}\right)=\ln 2^{-x^2}$ $\ln\left(\frac{y+4}{8}\right)=-x^2\ln 2$ $x^2=\frac{-\ln\left(\frac{y+4}{8}\right)}{\ln 2}$ $x^2=\frac{\ln\left(\frac{8}{y+4}\right)}{\ln 2}$ or $\log_2\left(\frac{8}{y+4}\right)$ $x=\pm\sqrt{\frac{\ln\left(\frac{8}{y+4}\right)}{\ln 2}}$	
iii	From (i), $R_g=(-4,4]$ Since $R_g=(-4,4]\subset D_f=(-4,\infty)$ fg exists  close included open excluded $D_g=(-\infty,\infty)\to R_g=(-4,4]=D_f\to R_{fg}=[-6\frac{1}{2},13\frac{3}{4})$ Alternative method:	The part which requires students to show fg exists is quite well done. Many students did not score any mark when asked to find the exact range of fg as they either did not sketch the graph or did not sketch the complete graph with the end points indicated. Some students who drew the graph correctly did not find the minimum point of the graph, hence they could not find the correct range. Students who used the alternative method were often unsuccessful as the graph of the fg has a horizontal

	$\text{fg}(x)=\text{f}\left(2^{3-x^2}-4\right)$ $=\left(2^{3-x^2}-4\right)^2-\left(2^{3-x^2}-4\right)-\frac{25}{4}$ $D_{fg}=D_g=\mathbb{R}$ As $x\to\pm\infty$, $\left(2^{3-x^2}-4\right)^2-\left(2^{3-x^2}-4\right)-\frac{25}{4}\to(-4)^2-(-4)-\frac{25}{4}=13\frac{3}{4}$ Hence, the horizontal asymptote is $y=13\frac{3}{4}$.  $R_{fg}=[-6\frac{1}{2},13\frac{3}{4})$	asymptote(many students missed this out!) and is very complex. Some did not consider the correct domain of the composite function when sketching the graph. Students should use the mapping method to find the range of a composite function when faced with a complicated composition function.

7(i)		Many students made a good attempt for this part of the question, except those who made mistakes with the shape of the graph and not clear about the effect of the reciprocal transformations, especially for the vertical asymptotes. ($x = -1$). Some students lost marks as they did not indicate the stationary points and the axis intercepts as coordinates. Students did not indicate the correct behavior of the graph clearly as the graph should be tending to the horizontal asymptotes. ($y = -\frac{1}{4}$ and $y = \frac{1}{3}$) Few students had mistaken the reciprocal of the function as the reflection of the function in the *x*-axis **or** mixed up with reflection in the y-axis.

(ii)	 $y=f\left(-\frac{1}{2}x+2\right)$ must remain → Step 1 : Translate 2 units in the direction of the negative x-axis inter-changeable { Step 2 : Scale by factor 2 parallel to the x-axis Step 3 : Reflect about the y-axis $x=2\to x=0\to x=0\to x=0$ $x=-4\to x=-6\to x=-12\to x=12$ $(-1,0)\to(-3,0)\to(-6,0)\to(6,0)$	It is a good practice for students to describe the transformations precisely as rough/side work before the students attempted to sketch the graph. Students need to read the question requirement carefully. Few students attempted to solve this part by using scaling first and then translation. It should be translation first and followed by scaling of the graph. Some inappropriate terms like 'transform', 'shift', 'flip' were seen on the answer scripts. Students should learn the proper description for transformation. Common mistakes were 'reflect parallel to y-axis', 'translate towards x-axis by scale factor -1' . Where descriptions of translations are concerned, students are advised to write as 'Translation of the graph by a units in the positive/negative direction parallel to the x/y-axis". It is a good practice to write down the sequence of transformation. It should be indicated clearly by writing 'Step 1….Step 2' or use the phrase '…followed by….'. In addition, the transformations should be guided by how one obtains the equation of $y=f\left(-\frac{1}{2}x+2\right)$. Many students failed to do so before attempting to sketch the graph, resulting in an incorrect graph being drawn.

8(i)	$e^{-ax} = 3^{-x}$ $-ax = -x\ln 3$ * Comparing coefficients of x, $a = \ln 3$ (Alternatively: solving of equations) $y = 3^{3-x}\left(x\ln 3 + \frac{1}{3}\right)$ $= 3^{2-x}(3x\ln 3 + 1)$ $= 9\cdot 3^{-x}(3x\ln 3 + 1)$ $= 9\cdot e^{-(\ln 3)x}(3x\ln 3 + 1)$	Most students were able to find the value of a. However, there were a handful who left the solution to be $\frac{\ln(3)}{\ln(e)}$, which was not accepted as ln(e) could be further simplified. Moreover, there were students who did not give the final solution in the exact form and instead provided solutions to 3 significant figures. Students ought to be mindful when reading question in examinations. A few students found the exact value of a by solving the equation to attain $x = 0$ or $a = \ln 3$ and explicitly stated value of a on the condition that $x \neq 0$. Such mathematical rigour ought to be commended. In the second part of (i), there were many students who did not show the desired relationship by working from expression on left to right, or vice versa. Students need to be mindful that when showing a relationship, they ought to do so in one direction and not find an in-between from both expressions. There were also several students who did not explicitly write the expression given in the question when showing the desired relationship. Many students also simply changed ln(3) to a when attempting to show the relationship, without clearly indicating what the value of a is. Mathematical precision when showing a relationship ought to be recognised.

(ii)	$y = e^{-x}(3x+1)$ ↓ Replace x by $x\ln 3$ $y = e^{-(\ln 3)x}(3(x\ln 3)+1)$ ↓ Replace y by $\frac{y}{9}$ $y = 9 \cdot e^{-(\ln 3)x}(3x\ln 3+1)$ ↓ Replace y by $y-1$ $y = 9 \cdot e^{-(\ln 3)x}(3x\ln 3+1)+1$ A scaling by factor $\frac{1}{\ln 3}$ parallel to the x-axis followed by a scaling by factor 9 parallel to the y-axis followed by a translation of 1 unit in the positive direction of the y-axis. <u>Alternative solution 1 :</u> A scaling by factor 9 parallel to the y-axis followed by a scaling by factor $\frac{1}{\ln 3}$ parallel to the x-axis followed by a translation of 1 unit in the positive direction of the y-axis.	There were many students who did not describe the transformations sequentially through use of phrase like "followed by", or writing "steps 1, 2, …" etc. Solutions without demonstration of order of transformation were not accepted. There were also a large number of students who wrote "scale by … units", without realising that the key phrase should be "scale factor". Moreover, there were many students who wrote "scale/translate x by …", "scale/translate y by …". This demonstrated poor grasp of concept as scaling and translating are performed on the entire graph itself. A common mistake observed was that many students tried to transform the graph by attempting to translate $\frac{2}{3}$ units in the positive x-direction. While this does not give the desired expression within the bracket, what was more severe a mistake observed was that students did not replace the x in e^{-x} with $x-\frac{2}{3}$. Students need to be mindful of such manipulation in future. There were also students who provided too many steps in performing the transformation. Students ought to be reminded that efficient solutions should be provided as far as possible, and in this case, to take hints from (i).

	<u>Alternative solution 2 :</u> A translation of $\frac{1}{9}$ unit in the positive direction of the y-axis followed by a scaling by factor 9 parallel to the y-axis followed by a scaling by factor $\frac{1}{\ln 3}$ parallel to the x-axis. <u>Alternative solution 3 :</u> A translation of $\frac{1}{9}$ unit in the positive direction of the y-axis followed by a scaling by factor $\frac{1}{\ln 3}$ parallel to the x-axis followed by a scaling by factor 9 parallel to the y-axis.	
9(a)(i)	Sum of the perimeters of the 10 squares $=\frac{10}{2}[2(32)+9d]=200$ $\Rightarrow d=-\frac{8}{3}$	For those who used the first term a as 8, they must have considered the sum of **lengths** instead. However, most students failed to realise that the lengths follow an AP with common difference $\frac{d}{4}$. It is important for students to remember that in solving AP (or GP) questions, it is important to identify the first term of the progression, the number of terms in the progression as well as the common difference (or ratio). It is with these information that one will then proceed to make use of the corresponding formula to solve the

		question. Some changed the common difference d to $-d$, leading to the wrong answer $d=\frac{8}{3}$. In the question, the polarity of the value of d has already been considered since the squares are of decreasing sizes. Some did not give the exact value, giving d as -2.67 instead.
(a)(ii)	Perimeter of the smallest square $=32+9d=32+9\left(-\frac{8}{3}\right)=8$ $\therefore$ Area of the smallest square $=\left(\frac{8}{4}\right)^2$ $=4\text{cm}^2$	Some confusion was seen here, as some might have treated the smallest square as the first square. But this wrong consideration would have already been penalised in (a) (i).
(b)(i)	Let the areas of the squares be $A_1, A_2, \ldots, A_{10}$, and the lengths of the squares be $l_1, l_2, \ldots, l_{10}$. For $n=2, 3, \ldots, 10$, $\frac{l_n}{l_{n-1}}$ $=\sqrt{\frac{A_n}{A_{n-1}}}=\sqrt{r}$, which is a **constant independent of *n*.** $\therefore$ The sides of the squares form a geometric progression with common	Some common mistakes include: • Failure to mention that the ratio $\frac{l_n}{l_{n-1}}$ is a **constant independent of *n***. Very often, the phrase "independent of *n*" was omitted. • Finding the common ratio using only a specific pair of terms, e.g. $\frac{l_3}{l_2}$. This is incorrect as it only meant that the ratio was specific to the two terms

	ratio $\sqrt{r}$.	used. • Showing irrelevant working, such as finding the value of r.
(b)(ii)	Sum of the perimeters of the 10 squares $= 4(l_1 + l_2 + \ldots + l_{10})$ $= 4\left(\frac{8[1-(\sqrt{r})^{10}]}{1-\sqrt{r}}\right)$ $\therefore \quad 4\left(\frac{8[1-(\sqrt{r})^{10}]}{1-\sqrt{r}}\right) = 200$ $\Rightarrow \frac{1-r^5}{1-\sqrt{r}} = \frac{25}{4}$ $\Rightarrow 4 - 4r^5 = 25 - 25\sqrt{r}$ $\Rightarrow 4r^5 - 25\sqrt{r} + 21 = 0$ (Shown)	This part was greatly affected if students failed to get $\sqrt{r}$ as the common ratio in (b) (i). However, most students have the right idea of what to do.
(b)(iii)	Using GC, $r = 0.79166$ (5 dp) or $r = 1$ (reject, otherwise all the squares will have the same size)	Many failed to answer according to the context of the question, merely mentioning that the "terms" are the same. They should instead mention that the sizes of the squares are the same. Many mentioned that if $r = 1$. $S_n = \frac{a(1-r^n)}{1-r}$ will be undefined. They failed to realise that this formula cannot even be used if $r = 1$. Moreover, the sum of areas of 10 or fewer squares can never be undefined.

		Some mentioned that we cannot have a GP when $r=1$, which is not true. Also, even though some might not be able to explain why $r=1$ is not a solution, a student should also try to solve for the other value of r since it was a simple technique to employ to obtain the answer.
(b)(iv)	Sum of the perimeters of infinite number of squares $=\frac{32}{1-\sqrt{r}}$ $=\frac{32}{1-\sqrt{0.79166}}$ $=290.3$ $\therefore$ Least integer value of $L=91$	Many of those who attempted this part realised they need to work out the sum to infinity. However they considered the sum to infinity of the areas instead, giving $\frac{64}{1-0.79166}$.

Recommended Follow-up Actions

Foundational Knowledge:

H2 Math requires a mastery of both O-level Additional Mathematics (Assumed knowledge) as well as the A-level H2 Math content and skills. It is noteworthy that H2 Math problems infuse knowledge across topics, and problems are set based on the assumption that there is a perfect mastery of both O and A level Mathematics knowledge. Students are therefore strongly advised to revise and master all these fundamental knowledge in order to achieve good performance in A-level H2 Mathematics.

It is recommended that students should to seek clarifications from their tutors as early as possible whenever they have doubts as a strong understanding of A level concepts are essential to solving problems in H2 Mathematics. More practice should be devoted to Application Questions, which is part of the H2 Math 9758 examination requirements.

Accuracy & Precision in Working Steps:

Students are reminded that careful attention should be given to their working steps and graphs, which should be clear, concise and logical. More effort is required to improve accuracy of the statements and graphs as the quality of solutions and graphs are still far away from the required standard of the A Levels.

A suggested way is for students to write out any solutions, for tutorials, assignments or revision package like the way it is for examinations.

Problem Solving Skills:

It was evident that some students have not mastered fundamental problem solving skills and the ability to make connections within parts of questions. Some questions were not well read enough for the problem to be well answered. Students need to realise that questions for H2 Mathematics are not as direct and straightforward as compared to those seen in O-level Additional Mathematics.

Time Management:

The Revision Sets as well as the Timed Practice papers should be well utilized to help one practice the time management for the examination. The recommended time is set at 1.5 min per mark allocated for the question. Nonetheless, students should also extend this practice to completing any questions be it for tutorials or questions in the Revision Package.

Use of Graphing Calculator as an Examination Tool:

Graphing calculator is a learning tool as well as an examination tool, which students are required to be proficient with all the functions and apps. It was alarming to note that some students still have difficulty with reset of memory resulting in a mass wipe out of the GC Apps installed.

Students should also know how to make use of their GCs to help them solve the questions in an examination efficiently and effectively.