2014 HIGHER SCHOOL CERTIFICATE EXAMINATION
Mathematics General 2

Section II

75 marks
Attempt Questions 26–30
Allow about 1 hour and 55 minutes for this section

Answer the questions in the spaces provided.

Your responses should include relevant mathematical reasoning and/or calculations.

Extra writing space is provided on pages 33 and 34. If you use this space, clearly indicate which question you are answering.

Please turn over
**Question 26** (15 marks)

(a) Expand \( 4x \left( 7x^4 - x^2 \right) \).
\[
4x \left( 7x^4 - x^2 \right) = 28x^5 - 4x^3
\]

(b) Calculate the value of \( h \) correct to two decimal places.

\[
\sin 28^\circ = \frac{5}{h}
\]
\[
h \cdot \sin 28^\circ = 5
\]
\[
h = \frac{5}{\sin 28^\circ} \Rightarrow h \approx 11.33
\]

(c) Solve the equation \( \frac{5x + 1}{3} - 4 = 5 - 7x \).
\[
\frac{5x + 1}{3} - 4 = 5 - 7x
\]
\[
5x + 1 - 4 \cdot 3 = 5 - 7x \Rightarrow \frac{5x + 1}{3} - 4 + 7x = 5
\]
\[
3 \ (v)
\]
\[
5x + 1 - 4 \cdot 3 = 15
\]
\[
17x + 2 = 15 \ (ii)
\]
\[
12x = 13 \ (iii)
\]
\[
x = 1.08
\]

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**Question 26 continues on page 15**

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Office Use Only – Do NOT write anything, or make any marks below this line.
Question 26 (continued)

(d) Solve these simultaneous equations to find the values of $x$ and $y$.

\[
\begin{align*}
  y &= 2x + 1 \\
  x - 2y - 4 &= 0
\end{align*}
\]

\[
\begin{align*}
  x - 2(2x + 1) - 4 &= 0 \\
  x - 2 &= 0 \\
  x &= 2
\end{align*}
\]

\[
\begin{align*}
  y &= 2(-2) + 1 \\
  y &= -3
\end{align*}
\]

(e) The times taken for 160 music downloads were recorded, grouped into classes and then displayed using the cumulative frequency histogram shown.

On the diagram, draw the lines that are needed to find the median download time.

\[\text{Question 26 continues on page 16}\]
Question 26 (continued)

(f) The weight of an object on the moon varies directly with its weight on Earth. An astronaut who weighs 84 kg on Earth weighs only 14 kg on the moon.

A lunar landing craft weighs 2449 kg when on the moon. Calculate the weight of this landing craft when on Earth.

\[ W = k \cdot E \]

\[ 84 = k \cdot 14 \]

\[ k = \frac{84}{14} \]

\[ k = 6 \]

\[ e = 6 \cdot e \]

\[ e = 6 \times 2449 \]

\[ e = 14694 \text{ kg} \]

The weight of the craft on Earth is 14694 kg.

Question 26 continues on page 17
Question 26 (continued)

(g) Singapore is located at 1°N 104°E and Sydney is located at 34°S 151°E.

What is the time difference between Singapore and Sydney? (Ignore daylight saving.)

\[1^\circ = 4\text{ min}\]

\[1^\circ N \to 34^\circ S = 35^\circ \text{ difference}\]

\[35 \times 4 = 140\text{ min}\]

The time difference is 140 min.

End of Question 26

Please turn over
**Question 27** (15 marks)

(a) Alex is buying a used car which has a sale price of $13,380. In addition to the sale price there are the following costs:

<table>
<thead>
<tr>
<th>Transfer of registration</th>
<th>$30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stamp Duty</td>
<td>......</td>
</tr>
</tbody>
</table>

(i) Stamp Duty for this car is calculated at $3 for every $100, or part thereof, of the sale price.

Calculate the Stamp Duty payable.

\[
\text{Sale Price} = \frac{13,380}{100} = 133.80 \\
\times 3 = 39,140 \times 0.03 = 1,174.20 \\
\text{Stamp Duty} = 133,800 \times 0.03 = 4,014.00
\]

(ii) Alex borrows the total amount to be paid for the car including Stamp Duty and transfer of registration. Interest on the loan is charged at a flat rate of 7.5% per annum. The loan is to be repaid in equal monthly instalments over 3 years.

Calculate Alex’s monthly repayments.

\[
\text{Total Amount} = 13,311.40 \\
\times 0.075 = 998.35 \\
\times 3 = 3,994.05 \\
\text{Total Amount} = 13,311.40 + 3,994.05 = 17,305.45 \\
17,305.45 - 310.75 = 169,18,97 \\
169,18,97 \div 36 = 4,69,97
\]

\[
\text{Monthly Payments} = 4,69,97
\]

**Question 27 continues on page 19**
Question 27 (continued)

(iii) Alex wishes to take out comprehensive insurance for the car for 12 months. The cost of comprehensive insurance is calculated using the following:

<table>
<thead>
<tr>
<th>Base rate</th>
<th>$845</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Service Levy (FSL)</td>
<td>1% of base rate</td>
</tr>
<tr>
<td>Stamp Duty</td>
<td>5.5% of the total of base rate and FSL</td>
</tr>
<tr>
<td>GST</td>
<td>10% of the total of base rate and FSL</td>
</tr>
</tbody>
</table>

Find the total amount that Alex will need to pay for comprehensive insurance.

..\[ BR = 845 \]

..\[ FSL = \frac{1}{12} \times 845 = 8.45 \quad \rightarrow \quad \text{TOTAL} = 845 + 8.45 = 853.45 \]

..\[ SD = 0.05 \times 853.45 \approx 42.67 \]

..\[ GST = \frac{1}{12} \times 42.67 \approx 3.55 \]

..\[ \text{TOTAL} = 845 + 8.45 + 42.67 + 3.55 = 900.71 \]

(iv) Alex has decided he will take out the comprehensive car insurance rather than the less expensive non-compulsory third-party car insurance.

What extra cover is provided by the comprehensive car insurance?

- Extra cover for your car, your passengers, other cars (in the case of an accident).

Question 27 continues on page 20
Question 27 (continued)

(b) Xuso is comparing the costs of two different ways of travelling to university.

Xuso’s motorcycle uses one litre of fuel for every 17 km travelled. The cost of fuel is $1.67/L and the distance from her home to the university car park is 34 km. The cost of travelling by bus is $36.40 for 10 single trips.

Which way of travelling is cheaper and by how much? Support your answer with calculations.

\[
\begin{align*}
\text{Motorcycle} &: \quad 2 \times \frac{34}{17} \times 1.67 = 21.67 \text{L} \\
\text{Bus} &: \quad 36.40 \text{ for 10 trips}
\end{align*}
\]

\[
\text{per trip} = \frac{36.40}{10} = 3.64
\]

\[
\Rightarrow \text{motorcycle is cheaper for 10 trips.}
\]

(c) The base of a water tank is in the shape of a rectangle with a semicircle at each end, as shown.

The tank is 1400 mm long, 560 mm wide, and has a height of 810 mm.

![Diagram of tank](image)

NOT TO SCALE

What is the capacity of the tank, to the nearest litre?

\[
\begin{align*}
\text{Rectangular prism} &:\quad A = 0.84 \times 0.86 \\
&= 0.7236 \\
V &= Ah = 0.4704 \times 0.86 \\
&= 0.409508664 \text{ m}^3 \\
&= 580.5 \text{ L, or } 581 \text{ L}
\end{align*}
\]

End of Question 27
Question 28 (15 marks)

(a) James plays a game involving a spinner with sectors of equal size labelled A, B and C, as shown.

He pays $2 to play the game. He wins $5 if the spinner stops in A and 50 cents if it stops in B or C.

Calculate James's financial expectation for the game.

\[
\text{Financial expectation} = \left(5 \times \frac{1}{3}\right) + \left(0.5 \times \frac{2}{3}\right)
\]

\[
= 2
\]

If it costs $2 to play the game, the financial expectation is $2, so he is expected to break even.

Question 28 continues on page 22
(b) A radial compass survey of a sports centre is shown in the diagram.

(i) Show that the size of angle $AOB$ is $114^\circ$.

As $B$ is $074^\circ$ and $A$ is $320^\circ$.

$A$ is $40^\circ$ away from north (from south) and $B$ is $74^\circ$ away.

$74 + 40 = 114 \Rightarrow \text{making } \angle AOB 114^\circ$

Question 28 continues on page 23
Question 28 (continued)

(ii) Calculate the length of the boundary $AB$, to the nearest metre.

\[ c = \sqrt{a^2 + b^2 - 2ab \cos \theta} \]
\[ c = \sqrt{287^2 + 211^2 - 2 \times 287 \times 211 \times \cos 114^\circ} \]
\[ c \approx 223.07 \]

**boundary $AB \approx 223$ m**

(iii) Find the area of triangle $AOB$ in hectares, correct to two significant figures.

\[ A = \frac{1}{2} \times a \times b \times \sin C \]
\[ = \frac{1}{2} \times 287 \times 211 \times \sin 114^\circ \]
\[ = 227.47 \text{ m}^2 \]
\[ 1 \text{ ha} = 10000 \text{ m}^2 \Rightarrow 227.47 \div 10000 \]
\[ A = 0.023 \text{ ha} \]

(c) A fair coin is tossed three times. Using a tree diagram, or otherwise, calculate the probability of obtaining two heads and a tail in any order.

\[ P(\text{HH}T) = \frac{3}{8} \text{ or } 37.5\% \]

Question 28 continues on page 24
Question 28 (continued)

(d) An aerial diagram of a swimming pool is shown.

The swimming pool is a standard length of 50 metres but is not in the shape of a rectangle.

(i) By measuring the length $AB$, determine the scale of the diagram.

\[
\frac{AB}{50 \text{ m}} = \frac{xy}{8 \text{ cm}}
\]

\[
50 \div 8 = 6.25 \text{ m}
\]

\[
1 \text{ cm} = 6.25 \text{ m}
\]

(ii) Using this scale, calculate the length $XY$ of the car park, in metres.

\[
5.1 \times 6.25 = 31.875
\]

\[
\therefore \text{length car park} = 32 \text{ m}
\]

Question 28 continues on page 25
Question 28 (continued)

(iii) In the diagram of the swimming pool, the five widths are measured to be:

\[ \begin{align*}
CD &= 21.88 \text{ m} \\
EF &= 25.63 \text{ m} \\
GH &= 31.88 \text{ m} \\
IJ &= 36.25 \text{ m} \\
KL &= 21.88 \text{ m}
\end{align*} \]

The average depth of the pool is 1.2 m.

Calculate the approximate volume of the swimming pool, in cubic metres. In your calculations, use TWO applications of Simpson’s Rule.

\[ \begin{align*}
V &= \frac{1}{3} \left( 21.88 \left( \frac{1}{3} \left( 21.88 + 5 \cdot 25.63 + 5 \cdot 31.88 \right) \right) + 21.88 \right) \\
V &= \frac{1}{3} \left( 650.33 \right) \\
V &= 191.33 \text{ m}^3
\end{align*} \]

End of Question 28
Question 29 (15 marks)

(a) The cost of hiring an open space for a music festival is $120,000. The cost will be shared equally by the people attending the festival, so that $C$ (in dollars) is the cost per person when $n$ people attend the festival.

(i) Complete the table below by filling in the THREE missing values.

<table>
<thead>
<tr>
<th>Number of people $(n)$</th>
<th>500</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>2500</th>
<th>3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per person $(C)$</td>
<td>240</td>
<td>120</td>
<td>80</td>
<td>60</td>
<td>48</td>
<td>40</td>
</tr>
</tbody>
</table>

(ii) Using the values from the table, draw the graph showing the relationship between $n$ and $C$.

(iii) What equation represents the relationship between $n$ and $C$?

\[ C = \frac{120,000}{n} \]

---

Question 29 continues on page 27
Question 29 (continued)

(iv) Give ONE limitation of this equation in relation to this context.

Ill only includes the cost of the space
Is not the food, drinks, pans
Workers' BK

(v) Is it possible for the cost per person to be $94? Support your answer with appropriate calculations.

\[ \frac{20}{X} = \frac{120000}{1,000} \]

\[ n = 1276.6 \]

...it is not possible...as it is a decimal...

and in represents people...cannot be a decimal.

(b) What is the maximum number of standard drinks that a male weighing 84 kg can consume over 4 hours in order to maintain a blood alcohol content (BAC) of less than 0.05?

\[ \text{BAC} = \frac{10(6)}{6.3(84)} \]

\[ = 0.057 \rightarrow 100 \text{ high} \]

\[ \times \text{Supps} = 5 \]

\[ \text{BAC} = \frac{10(5)}{6.8(84)} \]

\[ = 0.0350 \]

\[ \text{max of 5 standard drinks.} \]

Question 29 continues on page 28
(c) Terry and Kim each sat twenty class tests. Terry’s results on the tests are displayed in the box-and-whisker plot shown in part (i).

(i) Kim’s 5-number summary for the tests is 67, 69, 71, 73, 75.

Draw a box-and-whisker plot to display Kim’s results below that of Terry’s results.

Terry

Kim

65 66 67 68 69 70 71 72 73 74 75 76 77

(ii) What percentage of Terry’s results were below 69?

50%

(iii) Terry claims that his results were better than Kim’s. Is he correct? Justify your answer by referring to the summary statistics and the skewness of the distributions.

Terry is incorrect, as:

1. His data is negatively skewed.
2. Only 50% of his test scores were above 69, however 75% of Kim’s test scores were above 69, evidently showing her results were better.
3. Although his highest score was higher than Kim’s, the majority of his were lower than hers.

End of Question 29
Question 30 (15 marks)

(a) Chandra and Sascha plan to have $20,000 in an investment account in 15 years time for their grandchild's university fees.

The interest rate for the investment account will be fixed at 3% per annum compounded monthly.

Calculate the amount that they will need to deposit into the account now in order to achieve their plan.

\[ A = P \left( 1 + \frac{r}{n} \right)^{nt} \]
\[ 20,000 = P \left( 1 + 0.0025 \right)^{180} \]
\[ 20,000 = P \times 1.567481225 \]
\[ 12,759.73 = P \]

They will need to deposit $12,759.73.

To achieve their plan.

Question 30 continues on page 30
Question 30 (continued)

(b) The scatterplot shows the relationship between expenditure per primary school student, as a percentage of a country's Gross Domestic Product (GDP), and the life expectancy in years for 15 countries.

\[
\text{Expenditure per primary school student and life expectancy}
\]

(i) For the given data, the correlation coefficient, \( r \), is 0.83. What does this indicate about the relationship between expenditure per primary school student and life expectancy for the 15 countries?

\[\text{It indicates a positive relationship as the higher the expenditure per primary school student (\% of GDP), the higher the life expectancy.}\]

Question 30 continues on page 31
Question 30 (continued)

(ii) For the data representing expenditure per primary school student, \(Q_L\) is 8.4 and \(Q_U\) is 22.5.

What is the interquartile range?
\[
\begin{align*}
\text{IQR} &= Q_U - Q_L \\ &= 22.5 - 8.4 \\ &= 14.1
\end{align*}
\]

(iii) Another country has an expenditure per primary school student of 47.6\% of its GDP. Would this country be an outlier for this set of data? Justify your answer with calculations.
\[
\begin{align*}
\text{QI} &= 47.6 \times \text{IQR} \\ &= 47.6 \times 14.1 \\ &= 666.88 \\
\therefore \quad \text{Yes, it is an outlier.}
\end{align*}
\]

(iv) The expenditures per primary school student for the 15 countries in the scatterplot are:

5.9, 7, 7.6, 8.4, 11.2, 11.2, 13.7, 17.1, 18.7, 21.1, 22, 22.5, 23.2, 24.9, 27.6

Complete the table below by calculating the mean, \(\bar{x}\), and the standard deviation, \(\sigma_x\), of these data. Calculate both values to two decimal places.

The table also shows the mean, \(\bar{y}\), and the standard deviation, \(\sigma_y\), of life expectancy for the same 15 countries.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenditure per primary school student</td>
<td>(\bar{x} = \underline{16.14})</td>
<td>(\sigma_x = 7.03)</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>(\bar{y} = 70.73)</td>
<td>(\sigma_y = 10.94)</td>
</tr>
</tbody>
</table>

Question 30 continues on page 32
Question 30 (continued)

(v) Using the values from the table in part (iv), show that the equation of the least-squares line of best fit is

\[ y = 1.29x + 49.9. \]

\[
\bar{x} = 16.14 \\
\bar{y} = 70.23 \\
\text{Gradient} = \frac{10.46}{7.03} = 1.49
\]

\[ y = \text{gradient} \times x + y \text{ intercept} \]

\[ y = 1.29x + 49.9 \]

... \[ y = 1.29x + 49.9 \] is the least-squares line of best fit.

(vi) On the scatterplot on page 30, draw the least-squares line of best fit, \[ y = 1.29x + 49.9 \].

(vii) Using this line, or otherwise, estimate the life expectancy in a country which has an expenditure per primary school student of 18% of its GDP.

\[ \text{Between } 70 \text{ and } 80 \]

... \[ \text{So, roughly } 75 \text{ yrs.} \]

(viii) Why is this line NOT useful for predicting life expectancy in a country which has expenditure per primary school student of 60% of its GDP?

\[ \text{As the line would keep ascending,} \]
\[ \text{however, it becomes physically impossible to live to the age that the line would dictate.} \]

End of paper
Section II extra writing space

If you use this space, clearly indicate which question you are answering.
Section II extra writing space

If you use this space, clearly indicate which question you are answering.