SECTION I (50 marks)

Answer all the questions in this section in the spaces provided.

1 In this question, show all the steps in your calculations, giving the answer at each stage. Use logarithms correct to 4 decimal places, to evaluate

\[
\frac{\log_{10} 0.048}{\sqrt{0.004636}}
\]  

(3 marks)

2 Make \( h \) the subject of the formula

\[
q = \frac{1 + rh}{1 - ht}
\]

(2 marks)

3 Line AB given below is one side of triangle ABC. Using a ruler and a pair of compasses only:

\[A \quad B\]

(i) Complete the triangle ABC such that BC = 5 cm and \( \angle ABC = 45^\circ \).  

(1 mark)

(ii) On the same diagram construct a circle touching sides AC, BA produced and BC produced.  

(2 marks)

4 The position vectors of points A and B are \( \begin{pmatrix} 3 \\ -1 \\ -4 \end{pmatrix} \) and \( \begin{pmatrix} 8 \\ -6 \\ 6 \end{pmatrix} \) respectively. A point P divides AB in the ratio 2:3.

Find the position vector of point P.  

(3 marks)

5 The top of a table is a regular hexagon. Each side of the hexagon measures 50.0 cm. Find the maximum percentage error in calculating the perimeter of the top of the table.  

(3 marks)

6 A student at a certain college has a 60% chance of passing an examination at the first attempt. Each time a student fails and repeats the examination, his chances of passing are increased by 15%.

Calculate the probability that a student in the college passes an examination at the second or at the third attempt.  

(3 marks)

7 An aeroplane flies at an average speed of 500 knots due East from a point P(53.4°N, 40°E) to another point Q. It takes 2\(\frac{1}{2}\) hours to reach point Q.

Calculate:

(i) the distance in nautical miles it travelled;  

(1 mark)

(ii) the longitude of point Q to 2 decimal places.  

(2 marks)

8 (a) Expand and simplify the expression

\[
\left( 10 + \frac{2}{x} \right)^5.
\]

(2 marks)

(b) Use the expansion in (a) above to find the value of \(14^5\).  

(2 marks)
In the figure below, angles BAC and ADC are equal. Angle ACD is a right angle. The ratio of the sides AC : BC = 4 : 3.

Given that the area of triangle ABC is 24 cm\(^2\), find the area of triangle ACD. (3 marks)

Points A(2,2) and B(4,3) are mapped onto A'(2,8) and B'(4,15) respectively by a transformation T.
Find the matrix of T. (4 marks)

The equation of a circle is given by 4x\(^2\) + 4y\(^2\) – 8x + 20y – 7 = 0.
Determine the coordinates of the centre of the circle. (3 marks)

Solve for y in the equation \(\log_{10}(3y + 2) - 1 = \log_{10}(y - 4)\). (3 marks)

Without using a calculator or mathematical tables, express \(\frac{\sqrt{3}}{1 - \cos 30^\circ}\) in surd form and simplify. (3 marks)

The figure below represents a triangular prism. The faces ABCD, ADEF and CBFE are rectangles. AB = 8 cm, BC = 14 cm, BF = 7 cm and AF = 7 cm.

Calculate the angle between faces BCEF and ABCD. (3 marks)

A particle moves in a straight line from a fixed point. Its velocity \(V\) m/s\(^{-1}\) after \(t\) seconds is given by \(V = 9t^2 - 4t + 1\)
Calculate the distance travelled by the particle during the third second. (3 marks)

Find in radians, the values of \(x\) in the interval \(0^\circ \leq x \leq 2\pi^\circ\) for which \(2 \cos^2 x - \sin x = 1\).
(Leave the answers in terms of \(\pi\)) (4 marks)
SECTION II (50 marks)

Answer any five questions in this section.

17 A trader deals in two types of rice; type A and type B. Type A costs Ksh 400 per bag and type B costs Ksh 350 per bag.

(a) The trader mixes 30 bags of type A with 50 bags of type B. If he sells the mixture at a profit of 20%, calculate the selling price of one bag of the mixture. (4 marks)

(b) The trader now mixes type A with type B in the ratio $x : y$ respectively. If the cost of the mixture is Ksh 383.50 per bag, find the ratio $x : y$. (4 marks)

(c) The trader mixes one bag of the mixture in part (a) with one bag of the mixture in part (b) above. Calculate the ratio of type A rice to type B rice in this mixture. (2 marks)

18 Three variables $p$, $q$ and $r$ are such that $p$ varies directly as $q$ and inversely as the square of $r$.

(a) When $p = 9$, $q = 12$ and $r = 2$.

Find $p$ when $q = 15$ and $r = 5$. (4 marks)

(b) Express $q$ in terms of $p$ and $r$. (1 mark)

(c) If $p$ is increased by 20% and $r$ is decreased by 10%, find:

(i) a simplified expression for the change in $q$ in terms of $p$ and $r$; (3 marks)

(ii) the percentage change in $q$. (2 marks)

19 (a) Complete the table below, giving the values correct to 2 decimal places.

<table>
<thead>
<tr>
<th>$x^\circ$</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
<th>210</th>
<th>240</th>
<th>270</th>
<th>300</th>
<th>330</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sin $2x$</td>
<td>0</td>
<td>0.87</td>
<td>-0.87</td>
<td>0</td>
<td>0.87</td>
<td>0.87</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>$3\cos x - 2$</td>
<td>1</td>
<td>0.60</td>
<td>-2</td>
<td>-3.5</td>
<td>-4.60</td>
<td>-0.5</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2 marks)

(b) On the grid provided, draw the graphs of $y = \sin 2x$ and $y = 3\cos x - 2$ for $0^\circ \leq x \leq 360^\circ$ on the same axes. Use a scale of 1 cm to represent $30^\circ$ on the $x$-axis and 2 cm to represent 1 unit on the $y$-axis. (5 marks)
(c) Use the graph in (b) above to solve the equation $3\cos x - \sin 2x = 2$.  
(2 marks)

(d) State the amplitude of $y = 3\cos x - 2$.  
(1 mark)

20 In the figure below DA is a diameter of the circle ABCD centre O, radius 10 cm. TCS is a tangent to the circle at C, AB = BC and angle DAC = 38°.

(a) Find the size of the angle:
   (i) ACS;  
   (ii) BCA.  
(2 marks)

(b) Calculate the length of:
   (i) AC;  
   (ii) AB.  
(2 marks) 
(4 marks)

21 Two policemen were together at a road junction. Each had a walkie talkie. The maximum distance at which one could communicate with the other was 2.5 km.
One of the policemen walked due East at 3.2 km/h while the other walked due North at 2.4 km/h.
The policeman who headed East travelled for $x$ km while the one who headed North travelled for $y$ km before they were unable to communicate.

(a) Draw a sketch to represent the relative positions of the policemen.  
(1 mark)
(b)  
(i) From the information above form two simultaneous equations in \(x\) and \(y\). \hspace{1cm} (2 marks)

(ii) Find the values of \(x\) and \(y\). \hspace{1cm} (5 marks)

(iii) Calculate the time taken before the policemen were unable to communicate. \hspace{1cm} (2 marks)

22  
The table below shows the distribution of marks scored by 60 pupils in a test.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>10</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

(a) On the grid provided, draw an ogive that represents the above information. \hspace{1cm} (4 marks)

(b) Use the graph to estimate the interquartile range of this information. \hspace{1cm} (3 marks)

(c) In order to pass the test, a pupil had to score more than 48 marks. Calculate the percentage of pupils who passed the test. \hspace{1cm} (3 marks)

23  
Halima deposited Ksh 109,375 in a financial institution which paid simple interest at the rate of 8% p.a. At the end of 2 years, she withdrew all the money. She then invested the money in shares. The value of the shares depreciated at 4% p.a. during the first year of investment. In the next 3 years, the value of the shares appreciated at the rate of 6% every four months.

(a) Calculate the amount Halima invested in shares. \hspace{1cm} (3 marks)

(b) Calculate the value of Halima’s shares:

(i) at the end of the first year; \hspace{1cm} (2 marks)

(ii) at the end of the fourth year, to the nearest shilling. \hspace{1cm} (3 marks)

(c) Calculate Halima’s gain from the shares as a percentage. \hspace{1cm} (2 marks)
24. The table below shows values of $x$ and some values of $y$ for the curve $y = x^3 + 3x^2 - 4x - 12$ in the range $-4 \leq x \leq 2$.

(a) Complete the table by filling in the missing values of $y$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>-4</th>
<th>-3.5</th>
<th>-3</th>
<th>-2</th>
<th>-1.5</th>
<th>-1</th>
<th>-0.5</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>-4.1</td>
<td>-1.1</td>
<td>-2.6</td>
<td>-9.4</td>
<td>-13.1</td>
<td>-7.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) On the grid provided, draw the graph $y = x^3 + 3x^2 - 4x - 12$ for $-4 \leq x \leq 2$.

Use the scale: Horizontal axis 2 cm for 1 unit and vertical axis 2 cm for 5 units.

(c) By drawing a suitable straight line, on the same grid as (b) above, solve the equation:

$x^3 + 3x^2 - 5x - 6 = 0$. 

(2 marks) (3 marks) (5 marks)