NAME:_____ STREAM:_____

TIME: 150% HOURS

## MENGO SENIOR SCHOOL

## S.5 MATHEMATICS MOTIVATION TEST 1,2026

**INSTRUCTIONS**

Attempt any **THREE** Items including only **ONE** of Pure Mathematics

1. A forestry researcher is studying the annual timber yield (in thousands of board feet) from 70 different forest plots across a region. The data collected represents the yield from each plot for the year 2024. All measurements are recorded below:

**Forest Plot Yield Data**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5.0 | 7.2 | 6.5 | 8.5 | 5.9 | 7.2 | 7.4 | 5.3 | 8.3 | 7.2 |
| 11.8 | 10.1 | 5.5 | 7.2 | 11.8 | 8.5 | 9.1 | 7.2 | 5.5 | 8.5 |
| 6.2 | 7.2 | 5.5 | 9.3 | 7.1 | 8.5 | 5.6 | 7.2 | 8.4 | 9.3 |
| 9.6 | 7.2 | 5.8 | 10.1 | 7.3 | 9.3 | 6.9 | 11.8 | 8.3 | 10.1 |
| 5.5 | 13.4 | 7.9 | 9.3 | 5.5 | 11.8 | 5.5 | 13.4 | 9.4 | 15.6 |
| 5.5 | 7.2 | 5.8 | 8.5 | 11.8 | 9.3 | 8.3 | 10.1 | 9.8 | 7.2 |
| 5.2 | 8.5 | 5.9 | 9.3 | 10.0 | 8.1 | 9.5 | 12.5 | 14.2 | 16.3 |

*Note: All values are in thousands of board feet..*

### Background

The researcher wants to analyze the yield data but needs to handle it in two different ways:

- Some forest plots represent **common yield patterns** that occur frequently across the region
- Other plots represent **unique or less common yield patterns**

The researcher has decided that any yield value that appears more than 4 times in the dataset represents a "common yield pattern" and should be kept as individual values (ungrouped). All other values represent "uncommon yield patterns" and should be grouped into class intervals of 1500 starting with 5000, for broader trend analysis.

### Tasks

(a) Construct a frequency distribution table for the common yield patterns and use it to:

i. determine any three measures of central tendencies

ii. determine any three measures of dispersion

iii. the limits of the middle 70th percentile

(b) Construct a frequency distribution table for the uncommon yield patterns and use it to;

i. calculate the semi inter quartile range

ii. estimate the mode using a histogram

iii. determine the standard deviation using an assumed mean of 9500

iv. calculate the number of Forest plots with atleast 10800 uncommon yield patterns.

2. An information security analyst designs a system where encryption keys are generated using interactions of periodic functions. One key component satisfies $\cos 2x = \sin 3x$ where $x$ is an acute angle. In addition, the analyst combines two sine waves to create a specific audio effect. The combined signal is modelled by $y = \sin x + 2\cos x$. This signal is used to modulate volume for background alarms.

   a) Determine the possible values of $x$ for the periodic function.

   b) Determine the $x$-values at which the sound waves cross the horizontal axis, for $-180^0 \leq x \leq 180^0$.

   c) As part of a logarithmic encoding scheme, the analyst solves the equation

   $$\log_3(x+2) = \log_9(5x+76).$$

   find the value(s) of $x$ that satisfy this equation.

   d) During the key-derivation phase, the analyst encounters the expression

   $$\sqrt{12 - 6\sqrt{3}}.$$

   Simplify this expression by writing it in the form $m - \sqrt{n}$ , where $m$ and $n$ are rational numbers. Hence, express $\frac{\tan(-780)^0}{\sqrt{12-6\sqrt{3}}}$ in the form of $a + a\sqrt{n}$.

3. A construction company is installing support cables on a tower. A cable exerts a force,$\mathbf{F}$ of 50 N on a joint, acting in the direction of the vector $\mathbf{v} = 24\mathbf{i} + 7\mathbf{j}$.

   At another point, two support cables exert forces $\mathbf{F_1}$ and $\mathbf{F_2}$. Given that $\mathbf{F_1}$ has magnitude $\alpha$ N and acts in the direction $\mathbf{i} - 2\mathbf{j}$, and $\mathbf{F_2}$ has magnitude $\beta$ N and acts in the direction $4\mathbf{i} + 3\mathbf{j}$. The combined effect of these two cables is similar to $\mathbf{F}$.

   ## Tasks

   (a) Find the vector form of $\mathbf{F}$.

   (b) Show that $\alpha = 8\sqrt{5}$.

   (c) Find the value of $\beta$ hence determine the angle between $\mathbf{F_1}$ and $\mathbf{F_2}$.

4. At Mengo Senior School, three important rooms form a triangular layout on the school map:

   A(0,0) (Library), B(6,0) (Science Lab), C(2,6) (Computer Room).

   A drone flying above the school is located at point $P(4,5)$.

   **Tasks**

   (a) The fence lies along the line from the Library to the Computer Room. Find the foot of the perpendicular from the drone $P$ onto this line and calculate the distance of the drone from the fence.

   (b) The Library, Science Lab, and Computer Room form a triangle with three special points: the orthocenter $H$, the circumcenter $M$, and the centroid $G$. Show that these three points are collinear and find the ratio in which $G$ divides the line $MH$.

END

JEREMIAH 29:11