

Item 1

A certain betting company wants to analyze the predictions of its bettors on two teams A and B that qualified for the finals in a popular tournament in a certain country, so that it can fix the money to be betted on how many goals that will be scored in that match. The betting company experts have collected the following data to help in the analysis.

No of goals predicted in the match	No of bettors
0	6
1	15
2	26
3	39
4	25
5	16
6	4

The betting company wants to determine the median number of goals scored. It also wants to determine the standard deviation for the data and if the median is below two goals, the betting company will fix an amount that is 10000 times the standard deviation shillings per prediction or else it will fix an amount that is less by 5000.

The betting company experts have determined that the chance of team A scoring a goal in any match is 0.6 and the chance of team B scoring a goal in a given match is 0.45. The company wishes to know the expected number of teams to score a goal and if it exceeds 1.5, the company will reduce the amount per prediction.

The next day, Kintu, Kitata and Kinene fixed a bet at the same company. The probability that each wins the bet is 0.32, 0.46 and 0.55 respectively. The company wishes to know the probability that exactly one wins the bet given that atmost one wins the bet so that if this probability exceeds 0.75, the company will get a small profit margin.

Task:

- (a) Help the betting company to make informed decisions.

Item 2

A non-government organization seeks to research about the poor education standard in some district of a country and then help the country's government in addressing the problem. Experts from the organization gathered information about the number of students attending A-level and the corresponding number of schools in the area as shown below.

Number of students in A-level	Number of schools.
1 -10	4
11- 20	11
21-25	20
26-35	31
36-40	19
41-60	13
61-70	2

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The organization wants to determine the standard deviation and graphically analyze the data and estimate the modal number of students in A-level in the district. The organization wishes that if this modal number of students in A-level is less than 30, it will give half bursaries to students joining A-level in the district next term worth 10000 times the standard deviation per student. Otherwise, the organization will finance the schools directly.

The organization wants the schools in the region to join an association targeting improvement in sciences at A-level. The organization experts have modelled the distribution that gives the probabilities of the number of schools willing to join the association as; $f(x) = \begin{cases} kx, & x = 10, 15, 28, 30 \\ k(70 - x), & x = 35, 38, 45, 60 \\ 0, & \text{else where} \end{cases}$

Where x is the number of schools willing to join the association.

The organization wants to determine the probability that between 20 to 50 schools will join the association also determine the expected number of schools that will join the association and if this probability exceeds 0.5, then the organization will boost the association by an amount of money that equals to the expectation multiplied by one million shillings.

The organization experts have also noted that the variance of the number of schools in the region to join. The manager also needs to know about the median number and the most likely number of schools to join the association.

Task.

Help the organization obtain the information it needs to make informed decisions about the education standards of this area.

Item 3

The ministry of health is analyzing the efficiency, timely delivery of essential drugs by National medical stores (NMS) and cases of stock outs and expiry of drugs to different hospitals in the country. The table below shows the delivery times (in hours) to different hospitals:

Delivery times	5 - <10	10 - <20	20 - <30	30 - <40	40 - <60
No. of hospitals	10	15	25	40	25

For timely delivery of essential drugs, NMS must have coefficient of variation less than 50% (indicating a lower degree of variation or more consistent delivery of drugs to hospitals) and the most frequent delivery time (using a suitable graph).

Two drivers of NMS, John and William used the same route to deliver medicines to Arua Hospital. John is thrice likely to be used to deliver medicine as William. The chance for the drivers to be timely is 0.65 for John and 0.3 for William. The efficiency of the drivers would not cause stock out of medicines and cases of expiry in Arua Hospital if the chance for John to be used given that the drivers are timely should be greater than 0.7.

Task

(a) Is NMS timely in delivery of essential drugs to hospitals? Justify.

(b) Analyze the efficiency of drivers to ascertain whether there are likely cases of expiry and stock out of medicines.

Item 4

Arua city authorities are investigating the cases of crime committed by students during ballgames. The table below shows the record of crimes at the central police station by students of different age groups in 2026.

Age students	10 - 14	15 - 18	19 - 21	22 - 24	25 - 29	30 - 34
No. of cases	9	28	26	34	6	2

Previous year (2025) record indicates that; the cumulative trends in crime cases that included the spread of middle 50% range of the crime cases were 18 years old students. The RCC (Resident City Commissioner) will suspend the ball games if the records of 2026 show an increase in the age of learners who are involved in crime cases. Indicating involvement of mature students and/or old students.

Three Umpires; 1 (Chief), 2 and 3 officiated Netball 2025 Ballgames. The table below shows the points awarded to ten different schools by the three Umpires.

School	A	B	C	D	E	F	G	H	I	J
Umpire 1	72	50	50	55	35	38	82	72	60	45
Umpire 2	60	55	56	50	50	50	73	70	58	51
Umpire 3	50	40	67	70	67	48	67	48	40	62

The organizing committee wants to appoint one Umpire to officiate 2026 ballgames together with the Chief Umpire since few schools turned up for the ballgames in fear of suspension of games by the City Authorities.

An Umpire will be appointed if the performance of the Umpire in 2025 with the Chief Umpire is significant at 1% level.

During the Finals of 2025 Football, the referee picked two balls from the bag (that had 7 green and 5 red cards) successively without replacement from the bag. If the probability that at least one red card is picked, team G will start the game first otherwise team G will start the game.

Tasks

- Analyze the crime cases to ascertain whether the ballgames were suspended or not.
- Recommend the two Umpires that needed to be appointed to Officiate ballgames in 2026. Justify.
- Which team started the Football of 2025? Justify your response.

Item 5

During an inter-university sports tournament, a survey was conducted to gauge the viewing habits of students regarding the two most popular sports: Football and Cricket. The survey results showed the following probabilities:

- 35% watched Football but not Cricket
- 10% watched Cricket but not Football
- 40% did not watch either of the sport

With the next inter-university tournament expected to attract 500 students, and assuming viewing habits remain unchanged, the organizing committee is currently facing a challenge: They need to estimate the number of students that will watch Cricket, given that they do not watch Football such that if the number exceeds 50, they would prepare a separate court outside the university.

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However, a sample of 138 supporters was selected from the previous tournament who watched football. The table below shows the number of supporters and the time taken (in minutes) to enter the stadium, measured from the start of the game until halftime.

Time (minutes)	Number of supporters
$0 < x < 10$	10
$10 < x < 15$	35
$15 < x < 20$	65
$20 < x < 30$	107
$30 < x < 35$	123
$35 < x < 45$	138

The committee wishes to know the number of supporters who will arrive before the most likely time. If this number exceeds 50, they intend to offer a free drink to promote the game.

Task:

(a) Evaluate whether the university will prepare a separate court outside and ascertain whether the committee will offer a free drink to promote football.

Item 6

A school board is reviewing the effectiveness of their Mock Examinations as a predictor of final A-Level success. The Director of Studies (DOS) has selected a sample data for 11 students from last year's performance in Mathematics to check on the relationship between Mock exams and final A level grades:

Marks in mocks	76	41	78	59	14	29	61	86	32	64	51
Grades in A level	A	B	A	B	C	D	E	B	A	D	C

The DOS needs to assess whether mock examination marks provide a true and reliable estimate of students' expected performance in the final A-Level exams.

Task:

(a) Justify whether mock examination marks provide a true and reliable estimate of students' expected performance in the final A-Level exams.

EXCEL STUDY PROGRAM

1. Katumba a farmer in Wakiso harvested bags of beans(m), maize (x) and groundnuts (y) connected by the equations $2\log_8 m = x$, $\log_2 2m = y$ and $y - x = 4$.

Task: Help him determine the number of bags harvested for each crop.

2. Engineers think the equation $y = ax^2 - bx + c$ with turning point $(2, 4)$ and y -intercept 8 either represents a valley or a hill.

Task: By finding the values of a , b and c help them establish whether it is a valley or a hill

3. Real numbers have two square root values the same is with surds, verify this statement by finding the square root of $7 + 4\sqrt{3}$

4. During division of polynomials, it was found out that when $ax^2 + 3x + b$ is divided by $x - 1$ the remainder was 16 but when divided by $x - 2$ the remainder is 34. Determine the values of a and b and the remainder when we divide the same polynomial by $x + 3$.

5. We can confidently say that 4 is a perfect square of 2, $a^2 + 2ab + b^2$ is a perfect square of $a + b$, what values of p and q make $x^4 + 6x^3 + 13x^2 + px + q$ a perfect square?

6. Daniel a s.3 student placed his calculator and obtained $\sin 165^\circ$ as 0.258819045, now what troubles him is how this can be done without using tables or calculators and even the answer simplified but not in decimals. As an advanced mathematician guide Daniel.

7. Root analysis is a major concept when studying quadratic equations

Without obtaining the roots themselves and stating a valid condition predict the type of roots in the following equations.

(i) $2x^2 + 3x + 7 = 0$ (ii) $x^2 - 7x = 12$ (iii) $25x^2 + 4 = 20x$

8. Your school has participated in a mathematics context and they only have one task to handle in order to win the prize. The task goes if one root of the equation

$ax^2 + bx + c = 0$ is the square of the other, show that $c(a - b)^3 = a(c - b)^3$. Help the school win the prize because everyone is counting on you

9. A security drone launched in Haiti has arms given by the parametric equations $x = 3\cos 2\theta$ and $y = 8\sin \theta \cos \theta$ where θ is the reflex angle of projection.

The maximum height H in metres reached by the drone is given by the equation

$$H = x + y$$

Tasks

(a) Show that $16x^2 + 9y^2 = 144$

(b) Find the maximum height reached by the drone and the corresponding reflex angle of projection

10. A father wants to share shs2,800,000 among his two children Peter and John.

The mother suggested that the portions to be received by John(x) and Peter (y) be obtained from the equation $2x^2 - 13xy + 20y^2 = 0$

Task: As a mathematician assist this family in establishing the possible ratios in which the children can share the money and the exact amount each will be getting in each case

11. During the construction of an electric railway project in Kabale region of Uganda, it was found out that the railway line represented by the equation $y = x + 1$ had to pass through a hill given by the equation $y = 2 + x - x^2$. But this is possible if the area enclosed by the railway line and the upper regions of the hill is greater than 0.45 square units

Tasks: As a mathematician use the necessary working to help the engineers

(a) sketch a simple illustration of this railway line passing through the hill at certain points

(b) determine if this project will be possible or not

12. A, B and C are vertices of a triangle and during Peter's research about triangles he found a statement $\cos 4A - \cos 4B - \cos 4C = 4 \sin 2B \sin 2C \cos 2A$ but does not know how this can be proved. As Peter was still making his research online, in few minutes the VPN showed that he was in Ukraine and this enabled him to have access to a secret Ukraine army information that was sent to some soldiers reading we are to project tomorrow through the smallest angle in the range $0^\circ \leq x \leq 180^\circ$ after solving the equation $8 \cos^4 x - 10 \cos^2 x = -3$.

Task: Help Peter to prove the statement about the triangles and obtain the angle that was supposed to be used in the projection.

13. In an analysis about fractions usually adding many simpler ones to obtain a complex fraction is considered to be easy compared to splitting a complex one back to simple ones.

Task: The research panel has done different workings on simplifying fractions but want you to help them split $\frac{x^3 + 5x^2 - 6x + 6}{(x-1)^2(x^2+2)}$ into its simplest forms in order for them to make a conclusion.

14. Coffee is one of the main cash crops in Uganda, during the recent NRM party primaries in Masaka a contestant suggested that a land of 946400 Km^2 can be used following the partial fractions of $\frac{11x+12}{(2x+3)(x+2)(x-3)}$. That the two positive partial fractions should be added and used for growing coffee and the remaining one has a negative sign meaning it is not for farming but house construction.

Tasks

- Express the fraction above into its partial fractions
- Put $x = 5$ and obtain the real fractions for growing coffee and house construction
- Determine the exact land in Km^2 meant for growing coffee and house construction
- Obtain the remaining land in Km^2 and with a reason suggest any activity that can be done on it

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