NEW UPPER CURRICULUM MATH ITEMS

CONTACT ME FOR ASSISTANCE

PAPER 1, 2

ITEM 1

Bosco is a project manager at a construction company, and he's working on a new building project. The project's progress is modeled by the equation $x^2 + 2x - 5 = 0$,where x represents the project's completion rate. The roots of this equation, $\alpha \; and \; \beta$, represent the critical points in the project timeline.

Bosco's team is now tasked with analyzing the inverse of these critical points, which represent the rates at which the project's resources are being utilized. Bosco needs to come up with a new equation that models these inverse critical points.

TASK:

a. Write the inverse of each of the critical points $\alpha \; and \; \beta$.
b. Help Bosco come up with an equation that models the inverse critical points.

ITEM 2

Monalisa shopping malls around the country are experiencing a massive turnout of customers, leading to a critical shortage of enough attendants in the various malls. To address this challenge, the mall's management has planned an innovative solution: - an allowance paid to the available attendants basing on the number of customers served, the table below shows the distribution of allowance paid to 500 mall attendants in various outlets across the country.

Allowance (Dollars)	0 – 1 0	10 – 20	20 – 40	40 – 45	45 – 60	60 – 100
Frequency density	0.8	1.0	1.5	4.4	2.8	0.4

TASKS: As a student of Sub Mathematics,

a) Assist the mall's management in identifying the Standard deviation, the mode and the mean Allowance paid to the attendants
b) Create two graphical representations on paper and help mall's management accurately visualize and understand the:
   i) Number of attendants who were paid an allowance of atleast 50 dollars.
   ii) The decile deviation.
   iii) Inter quartile range

ITEM 3

Mr. Tunetune invest his money into three different types of financial instruments: Stocks, Bonds and Mutual Funds. The total amount invested is shs.100,000. The returns from those investments vary as follows;

- Stocks give a 10% return per year.
- Bonds give a 5% return per year.
- Mutual Funds give an 8% return per year.

At the end of the year, the total return from all investments is shs.8,000. Additionally, Mr. Tunetune invested shs.20,000 more in Stocks than in Bonds.

TASK: Find the amount invested in stocks, Bonds and Mutual Funds.

ITEM 4

A store sells three types of fruit baskets: small, medium and large. The cost of each basket depends on the fruits inside. The store owner sets up the following price equations based on the recent sales.

- 3 small, 2 medium and 1 large basket cost Shs.5,000
- 2 small, 3 medium and 2 large baskets cost Shs.6,000
- 1 small, 1 medium and 1 large basket cost Shs.2,500

TASK: Using matrices, find the cost of each type of basket

ITEM 5

Over a period of time, Nancy finds that on a long-distance flight, he flies economy class on 82% of the flights and the rest of the flights, he flies first class. When he flies economy class, the probability that he gets a good night sleep is x. when he flies first class, the probability that he gets a goodnight sleep is 0.9. The probability that Nancy gets a good night sleep on a random flight is 0.285.

Nancy also has two boxes A and B, box A contains 1 red ball, 3 green balls and 1 blue ball. Box B contains 2 red balls, 1 green ball and 2 blue balls. A balanced die is thrown and if the throw is a six, box A is chosen otherwise box B is chosen. Nancy picked a ball at random from the chosen box.

TASK:

a. Help Nancy to find the value of x.
b. Given on a particular flight, Nancy does not get a good night sleep, find the probability that he is flying economy class.
c. Given that the ball Nancy picked was green, find the probability that the ball came from box A.

ITEM 6

VJ KB wants to construct a regular pentagonal film hall ABCDE of sides 4m. he wishes to put the walls under tensional forces to ensure its stability and durability. To do achieve this, four forces of magnitude: 2N, 3N, 5N and 7N have to be applied alongside AB, BC, CD and EB respectively, With AB being the horizontal. He also wants to know the number of bricks he will have to buy in order to have its foundation completed. VJ KB was told that for a similar foundation on area of 5m2 requires 800 bricks to be completed.

TASK:

a. Write each force as vector.
b. Determine the equivalent force VJ KB would have applied that would do the same work as the four applied forces hence find its direction.
c. Help him to determine the number of bricks required to have his foundation complete.

ITEM 7

Two examination sets were done by 10 students and their scores in the two exams were as in the table below.

Students	A	B	C	D	E	F	G	H	I	J
Test1	60	30	88	71	16	22	47	55	15	60
Test2	55	40	77	59	25	20	50	50	30	49

- The report about the above results was needed where the relationship between the tests was to be established.
- The results were to be considered valid if the magnitude of Spearman's rank correlation coefficient is greater than 0.90.
- Apio who missed both tests due to sickness was given test1 but not test2, and the student was able to score 80% in this test1.

TASK:

a. Determine the relationship between the results hence establish whether the examination results were valid or not.
b. Without drawing a scatter diagram, accurately obtain the equation of line of the best fit and use it to estimate the marks Apio would have got if she sat for test2.

ITEM 8

In a certain calendar printing factory, the length of each calendar made has been organized into a cumulative frequency distribution as shown below.

Length(cm)	<20	<30	<35	<40	<50	<60
Cumulative frequency	04	20	32	42	48	50

From the market research team, it has been duly determined that the commonest calendar length sold is the one whose length is at least a half the lengths and the production team will produce more of those.

The factory will also produce more calendars of the mean length in the next production plan if the measure of dispersion from this mean length is less than 5.0

TASK:

a. Help the production team to determine the length of a calendar whose length is at least a half of the lengths.
b. Determine the mean length and mathematically suggest whether the factory should produce more calendar of this length or not in the next production plan.

ITEM 9

Three wires $\overrightarrow{AB} = \begin{pmatrix} 2 \\ -5 \\ 1 \end{pmatrix}, \overrightarrow{AC} = \begin{pmatrix} 6 \\ 4 \\ -4 \end{pmatrix}, and \; \overrightarrow{AD} = \begin{pmatrix} 4 \\ 2 \\ -1 \end{pmatrix}$ are to be painted according to the following criterion:

- If the length of the wire is less than 5 units, the wire will be painted red.
- If the length is greater than 5 units, the wire will be painted pink.

The painter also wanted to paint the fourth wire $\overrightarrow{AE} = \begin{pmatrix} 3 \\ x \\ 4 \end{pmatrix}$ which is perpendicular to wire $\overrightarrow{AB}$ but he has found it difficult determine its length since he can't determine the value of x.

TASK:

a. Help the painter to determine the colors to be painted on wires s $\overrightarrow{AB}$, $\overrightarrow{AC}$, and $\overrightarrow{AD}$.
b. Determine the angles wire $\overrightarrow{AB}$ makes with wire $\overrightarrow{AC}$.
c. Determine the value of x and color that will be painted to wire $\overrightarrow{AE}$.
d. Find the vector of a wire $\overrightarrow{AF}$ which is perpendicular to both wires $\overrightarrow{AC}$ and $\overrightarrow{AD}$.

ITEM 10.

Tom is trying to calculate the Z – score for statistical analysis. The formula he needs to use is $Z = \frac{Y}{X}$. However, he made a few mistakes in his calculations.

Tom's calculations were as follows:

Y = 12+0.5 (error due to rounding off)

X = 4 – 0.2 (error due to measurement)

Tom was tasked to find his relative absolute error but before that, he had to prove that $relative\ absolute\ error = \frac{|\partial x|}{X} + \frac{\partial y}{Y}$.

Tom's father is a teacher and has a faulty computer which uses to print student's marks on report cards. When the teacher fed 60%, the computer printed 40% and instead of 50%, it printed 30%.

TASK:

a. Help Tom to derive the expression for relative absolute error, hence find the percentage of his relative absolute error.
b. Find the true mark the teacher entered if the computer printed 37%
c. If the teacher enters 42%, determine the mark the computer will print.

ITEM 11

An opinion poll was carried out by a group of researchers. These polls were about two candidates A and B in 10 different polling stations

Candidates	Number of votes attained per polling station									
A	67	52	17	90	82	51	83	15	43	111
B	40	45	60	18	34	60	23	73	58	14

The researchers wanted to use this information to present the opinion of the whole district. On a certain polling station, candidate B obtained 53 votes but the team had no time to count those of candidate A.

The information was to be considered valid if the magnitude of spearman's rank correlation coefficient is atmost 0.69.

TASK:

a. As mathematics student, help the team of researchers to determine whether the results were valid or not.
b. Estimate the number of votes candidate A got from a polling station where candidate B got 53 votes.

ITEM 12

A certain district was hit by a certain disease which affected the people in that district as follows:

Age(years)	< 5	<15	<25	<30	<40	<50
Number of patients	01	03	10	05	02	01

The report was to be made from the health facility in order to advise on how to combat the disease.

TASK:

a. Help the team to determine the average age that is likely to be infected by the disease.
b. During the vaccination, the health team started with the oldest patients and by the end of the day, they realized that only a quarter of the patients was vaccinated that day. Help the team to estimate the youngest age that was vaccinated that day.

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ITEM 13.

A man is studying the motion of two objects connected by a string. He places a 5kg block on a smooth inclined plane that makes an angle 300 with the horizontal. The block is connected to a 3kg mass hanging freely by a light inextensible string that passe over a smooth pulley. When the system is released from rest, the block started moving up the inclined plane and the hanging mass starts moving downwards. The mass hits the ground after 4 seconds.

TASK:

a. Draw a diagram showing all the forces acting on the masses.
b. Find the acceleration of the motion and the tension in the string.
c. Find the speed with which the hanging mass hits the ground.
d. Determine the magnitude and the direction of the reaction force exerted on the string by the pulley.

ITEM 14

During Christmas season, Mr. James decided to visit his village for the festivals. He chose to use his Subaru car where he started his journey by travelling at a speed of 90km/hr. Since he never wanted to be late for the festival, he maintained this speed where he accidentally passed a stationary police car. When the policeman realized that the Subaru car was over speeding, he decided to chase it after 3 seconds it passed him by accelerating his car at 4m/s2. On catching him, the policeman tasked Mr. James to pay an over speeding fee of UGX 50,000 and also compensate for his fuel wasted during the run. The officer told him that his police car consumes 2 litres of fuel for every 50 metres covered and that 1 litre of fuel costs UGX 3000.

TASK:

Advise Mr. James on how to determine the total amount of money he has to pay to the police officer.

ITEM 15

Two people were playing a game using two boxes A and B, where A had 5 green balls and 7 red balls, while B had 3 green and 2 red. A first ball was to be picked from A and taken to B before a second ball is picked from B.

TASK:

If success was to be that;

a. A second ball was green.
b. A second ball was red given that the first ball was red.
In both cases above, guide an individual on how to win the game.

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ITEM 16

In an experiment to study the equilibrium and vertical motion of bodies, Okello fixed a stone of mass 30kg at the lower end of a light inextensible string whose other end he fixed on a ceiling leaving the stone hanging freely in the vertical plane, he then pulled the stone in the direction that is normal to the string which kept the stone equilibrium with the string inclined at 300 to the vertical.

He later threw the stone vertically upwards with a velocity of 16m/s from a point, H metres above the ground level. The stone later hit the ground after 4 seconds.

TASK:

a. Help Okello determine the force he applied that kept the system in equilibrium and the tension in the string.
b. Find the value of H and the speed with which the stone hits the ground.

ITEM 17.

During Christmas season, Mr. James decided to visit his village for the festivals. He chose to use his Subaru car where he started his journey by travelling at a speed of 90km/hr. Since he never wanted to be late for the festival, he maintained this speed where he accidentally passed a stationary police car. When the policeman realized that the Subaru car was over speeding, he decided to chase it after 3 seconds it passed him by accelerating his car at 4m/s2. On catching him, the policeman tasked Mr. James to pay an over speeding fee of UGX 50,000 and also compensate for his fuel wasted during the run. The officer told him that his police car consumes 2 litres of fuel for every 50 metres covered and that 1 litre of fuel costs UGX 3000.

TASK:

Advise Mr. James on how to determine the total amount of money he has to pay to the police officer.

ITEM 18.

Calculus is one of the widest branches of principle mathematics which is widely applied in the fields of engineering. Among the parts detailed in calculus there is partial fractions which are used to break down complex expressions into simplified fractions for simplifying further operations like integration, differentiation and so on. Mr Nayebare Brian is a chemical engineer working on a design of a continuous stirred tank reactor (CSTR) whose area can only be obtained by integrating the function $f(x) = \frac{3x-1}{(2-x)(1-x)^2}$. And to locate regions where to put reactants in the (CSTR) he is required to base on the inequality $\frac{x}{x-4} < 5$

@KB LEGACY 0703055914

TASK

Help Mr. Nayebare Brian

Simplify the process of integration by expressing $f(x)$ into partial fractions.

Find regions where to put reactants in the (CSTR).

ITEM 19

Three friends Jane, Joy and Jolly went for shopping towards the beginning of first term 2025 and bought the following scholastic materials for the candidate class.

Jane bought one pen, four graph books and four pencils, Joy bought three pens, two pencils and two graph books while Jolly bought six graph books, two pencils and nine pens. Their other friend Jesi also wants to purchase the similar requirement for the new term but she asked for the price of each so as to know how much amount request from parents.

TASK:

a) Using the concept of row reduction to echelon, help this friend determine the price of each requirement if Jane, Joy and Jolly spent UGX.7000, UGX.6000 and UGX.14000 respectively.
b) How much money should Jesi request from for, from her parents if she needs only a graph book and 3 pens

ITEM 20

Odong Simon Henry is a senior five student at St. Mary's SS Namaliga-Bombo trying to master content in trigonometry a topic in principle Mathematics. Why opening Backhouse one of the reference books suggested to the class members by the class teacher Mr. Senjala Steven, he came across $tan2x = \frac{2tanx}{1-tan^2x}$. On further reading Simon finds out that this relation can be used to obtain an expression for $tan4x$ interms of $tanx$ and it can be used to solve the equation $t^4 + 4t^3 - 6t^2 - 4t + 1 = 0$.

TASK

Help Odong Simon Henry;

a) Prove that $tan2x = \frac{2tan}{1-tan^2x}$.
b) Express $tan4x$ in terms of $tanx$.
c) Solve the equation $t^4 + 4t^3 - 6t^2 - 4t + 1 = 0$.
d) Solve the equation $tan2x = \frac{2ta}{1-tan^2x}$.

ITEM 21

In a certain pharmaceutical company, a certain product is produced by using a process function which depends on the thickness t, of the tablet in mm produced given $f(t) = 3t^2 + 4t + 1$, at a certain instant when $f(t) = 0$, tablets of thickness V and U were produced. However, the company started facing a problem of varying in thickness of tablets produced due to mechanical problems. In the production machine. However, the company has no money to import a better machine but after analysis, it has been observed that tablets produced differ from the previous ones by 2mm.
Your father is a process engineer in this company and he is stuck on what to do and has approached you.
Task
As attendant of mathematics use mathematical concepts to come up with a new process function that can be used by your father to continue tablet production using the available machine.

ITEM 22

In a certain chemical processing company product X is formed by combining reactants A, B and C according to the reaction equation below.$aA + bB + cC \rightarrow X$. Where a, b, and c are different ratios that vary with time. The company produces product X in shifts morning, evening and nights shifts. The table below shows how different shifts combined reactants A, B and C to produce x on Friday.

Shift	Ratios used			Quality of X produced in grams
	A	B	C	
Morning	3	-2	-1	5
Evening	1	3	-1	4
Night	2	-1	4	13

Your Aunt is working with the company and would like to know the quantities of each reactants used previous and has approached you for assistance.
Task
As a student of mathematics use your mathematical knowledge to help your Aunt to know the amount of A, B and C used on that Friday.

ITEM 23

The ministry of health is analyzing data on malaria cases across different districts in Uganda to allocate resources effectively and plan intervention strategies. Below is the data on monthly malaria cases reported in 12 health centers (HC) in northern Uganda?

Health Centre	Monthly cases
HC1	145
HC2	187
HC3	203
HC4	168
HC5	227
HC6	192
HC7	254
HC8	176
HC9	219
HC10	238
HC11	182
HC12	209

TASK

a) Organize the data into a suitable table and use it to draw a suitable graph hence find most likely number of cases.
b) Determine;
   (i) The average number of cases
   (ii) Median number of cases
   (iii) Variance
c) If resources are allocated proportionally to the number of cases, and the total of UGX 60 million is available, how much will be allocated to each category.

ITEM 24

In the school games and sports champions, there were a lot of competitions among different schools; this was shown by different techniques among the players. At a certain occasion during netball semifinals, Jenifer threw a ball and it took a parabolic path given by the equation:
$f(x) = 2\sec^2 x - 3 - \tan x$ directly to the target in the last minutes, this created joy and happiness in the team including the team coach. On their way back, the coach asked Jennifer to explain to the team the direction the ball took to hit the target but she couldn't explain clearly.
Task:
As a student of mathematics use mathematical concepts to help the team identify any four possible directions the ball would have taken to hit the target from Jenifer's hand (Hint: The ball hits the target when $f(x) = 0$).

ITEM 25

In final MDD competitions at BOMBO ARMY SS, results are fed in the computer by data entrant basing on the function $f(x) = P(x) + Q(x)$ The entrant entered the above function and the computer displayed $f(x) = \frac{x+2}{(x+1)(x-3)}$ where x the number of students is. Due to the increase in the number of students, the entrant wants to edit the function entered by changing $P(x)$ and $Q(x)$ to a new functions but because of absence of electrical power the computer couldn't display and he doesn't remember the functions he put initially.
Task
As a mathematics student, use mathematical concepts to come up with the functions $Q(x)$ and $P(x)$ the entrant placed in the system initially.

ITEM 26

A treasure map uses a coordinate grid to help adventures locate hidden treasures in Mubende District. The grid is labelled with coordinates *(x, y),* where each point represents a specific location. Two equations are used for safety of the treasures but the travelers have no knowledge of how to identify the coordinates. The equations are; $5^{x+2} + 7^{y+1} = 3468$ and $7^y = 5^x - 76$

During his first term holiday in senior five Henry decided to visit your uncle in the village having taken long not seeing him. He wishes to plant trees around his plot of land whose length is 2 metres longer than its width. The total area of the plot is 35 square metres according to the land tittle. He plans to use a spacing of 1m from each tree that but doesn't know how much money he will spend on buying the trees. Hint; Each tree costs UGx 2,500

TASK

(a) Help the travelers identify the hidden treasure's location.
(b) Help your uncle to determine the total amount of money needed to be spent on buying trees.

ITEM 27

Tom is a land scape architect designing a new bike path for a local park. The path will connect two points, point A which is at the entrance of the park and point B which is at the top of the hill. The coordinates of point A are (2, 4) and point B is (8, 12). Tom needs to calculate the slope of the bike path to ensure it's not too steep for the riders

Task

As a student of mathematics,

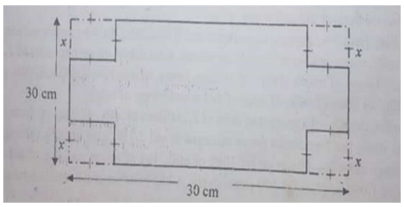
a) Help Tom determine the slope of the slope of the path
b) If Tom wants to mark the midpoint of the path with a banner, help him determine this point so as to ease the work of adjudicators while timing.

ITEM 28

Kasoma is a farmer in Ngoro production limited. He has a task to buy fencing materials to make a rectangular portion of area 450m^2 for cabbage production. The material is meant to cover three sides

since the other side is already covered with a live fence. It has been confirmed that 1m require a fencing material worth UGX. 2000 Kasoma is given UGX. 120000 which is the exact which is the exact amount required to buy the fencing materials to fence the three sides.

Kasoma uses a rectangular piece of card measuring $30cm\ x\ 24cm$ to make an open box he would use to pack the produce. The net of the open box is made by removing a square from each of the corners. And the side of the square removed is $x\ cm$. The area of the net is $576cm^2$



TASK

a) Advise the farmer on how to choose the length and the width of the fencing material for the partition to achieve his objective.
b) Form an equation in x and solve it to help Mr. Kasoma know the height, width and the final length of the open box.

ITEM 29

A water park is designing a new slide that will have a rectangular trench with a length of X meters and width $(\sqrt{2}-\sqrt{7})$ meters. The parks engineer wants to add a triangular section to the end of the trench, wit base equal to the width of the trench and height of $\sqrt{11}+\sqrt{13}$ meters but he is in need of determining the hypotenuse of the triangular section.

Task

Help engineer to;

a) Determine the area of the rectangular trench if the value of $x=\frac{-2}{\sqrt{3}+\sqrt{5}}$
b) Determine the length of the hypotenuse of the triangular section

ITEM 30

Lugazi town is experiencing rapid population growth. The town's population is modeled by the equation $P(t)=2x3^tx2^t$ where P(t) is the population at any time t in years. And t is measured from 2000. The town mayor wants to plan for the future and ensure that there are enough schools to accommodate the growing population. The mayor assumes that each school can accommodate 1000 students. If the school currently has 50 students and the students" population is expected to grow at the same rate as the overall population.

Task

a) Using your knowledge of indices, how many schools will the town need to build by the end of 2030 to accommodate the growing population?
b) If each new school costs $10 million to be build, what is the total cost of building the required schools?

ITEM 31

To address concerns about battery durability, Uganda Batteries Limited (UBL), a trusted manufacturer since 1967, conducted a thorough test on a random sample of 50 batteries. Their experts carefully selected and examined these batteries, yielding the following results (rounded to the nearest minute):

423	369	387	411	393	394	405	369	372	410
371	377	389	409	392	408	409	396	431	391
431	401	363	391	405	382	396	381	438	422
400	381	399	415	428	422	397	399	401	398
396	372	410	419	386	390	362	373	391	402

The director has decided to withdraw batteries with a life equal to or less than the average lifespan of the tested samples and has directed the experts to manufacture only batteries that achieve at least 99 % of the median life of the 50 tested batteries.

TASK

a) Organize the data into intervals of 10 using a statistical table and analyse the trends to recommend the most effective battery replacement strategy to the director
b) Use the assumed mean, $A=404.5$ Calculate the average life span of the tested samples.
c) Develop a graphical display to illustrate the data, allowing the director and their team to estimate the median, visualize and analyse the information.

ITEM 32

ASHIM foundation organizes charity fun runs every year. It is observed that the number of runners increases each day by 5 runners and only 20 runners registered on the first day. The foundation intends

to save at least Ugsh.1.5millions after the run. It incurs certain expenses per day to organize the run, and each runner is to contribute Ugshs.20, 000. The foundation planning committee wants to predict the number of participants will be registered on 30th days and how much should be spent per day in order to meet the target. The runners are to go from the start line at (0, 0) to checkpoint A at (3, 4) and from checkpoint A to finish line at (7, 7), but they are not informed about the displacement from the checkpoint A to finish line. The committee is to design a rectangular gold medal for fast runner measuring an area of 48cm^2, whose longest side being 2cm longer than its width.

TASK

You have been selected as the chairperson ASHIM organizing committee;

(a) Determine;

(i) The number of participants will be registered on the 30th day.

(ii) How much to be spent per day.

(b) Determine the displacement from the checkpoint A to finish line.

(c) Calculate the length and width of the rectangular gold medal

ITEM 33

A wheelchair ramp is to be constructed on a storied building. Mrs. Dibya the owner of the building wishes that the outer side of the ramp be a right-angled triangle of base x metres and height y metre and area of 84m^2 and angle of inclination θ for safety.

TASK

Help Mrs. Dibya

a) Prove that if $x=18(sec\theta+tan\theta)$ and $y=\frac{28}{3}(sec\theta-tan\theta)$ then the area required for the side view of the ramp will be achieved.
b) Determine the base and the height of the triangular side view if $x+y=31$
c) Determine the length and the angle of the lamp.

ITEM 34

While analyzing the variation of volume of a fixed area block St. Mary's SS Senior Five students measured the length of a rectangular block as twice its width, and the total surface area is 108 cm^2.

TASK.

a) Show that if the width of the block is x cm, then volume is $\frac{4}{3}x(27-x^2)$.
b) Find the dimensions of the block if the volume is maximum.
c) Showing steps clearly show that $\frac{d}{dx}(tanx)=sec^2x$ from first principles.

ITEM 35

In Roofings Uganda Limited the variation of lengths of the edges of iron sheets are modelled using a mathematical expression $\frac{2x^2-7x-4}{3x^2-14x+11}>2$ and $f(x)=\frac{5x^2-8x+1}{2x(x-1)^2}$ where x represents the length of the iron sheets in millimeters. Johnpaul is an internee in the company who has been assigned to locate the range of values of x for the above model to be considered real and also Johnpaul was told to simplify the other expression into simpler fractions for simpler further analysis.

TASK.

Help Johnpaul;

a) Locate the ranges of x values for $\frac{2x^2-7x-4}{3x^2-14x+11}>2$ to be real.
b) Express $f(x)=\frac{5x^2-8x+1}{2x(x-1)^2}$ into partial fraction.

ITEM 36

Two aero planes M and N were flown in the sky. Plane M described a path $y=20x-2x^2$ and N described the path $y=4x+14$ where (x,y) is the grid reference of the plane in the sky.

TASK.

a) Using differentiation, sketch the path traced by the two planes.
b) At what points were the two planes at the same level?
c) Find the area enclosed by the path of the two planes.

ITEM 37

The remote village of kijungu relies heavily on its local well for water due to climate change and increasing population, the wells water output is becoming very low, an engineer has developed a model to predict the wells daily water output in liters based on the factor x which accounts for drougt conditions increased demand and underground water table depletition, the model is given by the equation $\mathbf{2^{2x+1} + 2^{x+1} + 1 = 2^x}$.

TASK.

As a mathematics students help in identifying the stress factor x at which the wells water output meets the condition described by the above equation.

ITEM 38

A certain farmer in the village has bought land which he plans to fence, he has contracted a person to fence it and the contractor has been informed that the area of the land is $6300m^2$. this land is rectangular in nature and that the length is $20m$ more than the width.

TASK

(a).by completing the squares determine the actual dimensions of the peace of land.

(b) determine the maximum value of the expression obtained from above.

ITEM 39

A certain city is experiencing social challenges with two distinct population groups having different experiences of urban life, the city planners are trying to understand if there is a common problem affecting both groups, they are modelling the wellbeing of two groups using two separate quadratic equations.$\boldsymbol{x^2 + px + q = 0}$ p represents access to social services and q represents employment opportunities.

and $\boldsymbol{x^2 + mx + k = 0}$**.** The collective wellbeing is given by x , where m represents educational attainment and healthcare access, k represents safety quality. The social challenge exists if $\boldsymbol{(q - k)^2 = (m - p)(pk - mq)}$.

TASK

As a data analyst identify whether the common social challenge exist or not.

ITEM 40.

A certain city in Uganda is investing in a new smart traffic management system designed to optimize traffic flow and reduce congestion especially during the rush hours. The system caters road density, vehicle capacity and pedestrian movement, the engineers have developed some indicator related to the efficiency of the traffic flow on the major roads. The indicator θ, which relates to a specific traffic cycle parameter which is considered when the following equation is satisfied.$4 + tan^2\theta = sec\theta(7 - sec\theta)$. The system needs to be designed in way such that an optimal traffic flow is achieved.

TASK.

Help to determine the indicator values (θ) at which the system may be efficient.

ITEM 41

The city is facing a challenge in urban planning where by balancing economic development and preservation of green spaces, to model this relationship between economic development and preservation of the green space, the city planner comes up with a simplified systems of logarithms with two indicators x and y, he believes that for optimal urban health, the indicies should satisfy the following two logarithmic relationships.

$\log_{10} x - \log_{10} y = 1.0$ and $\log_{10} x - \log_{10} y = \log_{10} 2.5$

TASK.

Use the above system of simultaneous equations to obtain the indicators of sustainability economic development

ITEM 42

You're designing a pulling mechanism for a new agriculture machine in Fort portal, and it has been observed that when two people apply a force of magnitudes 3N and 7N inclined at an angle of 60^0 to each other, the agriculture manager of the city is uncertain of the single force that can be used to move the machine.

TASK. Help the officer to determine the single force that can be used to move the machine and the direction.

ITEM 43

Your class teacher loses her phone after being stolen by thugs while coming to school. He decides to go to police so that the phone can be tracked using GPS coordinates. The phone's location at different times is recorded and the police are trying to find its movement pattern. The tracking device uses a logical operation given simultaneously as $2^x + 3^y = 5$ and $2^{x+3} - 3^{y+2} = 23$. When they got so close to the phone, they could not tell the coordinates to locate the phone with ease. The coordinates are in meters and one point gives the position of those with the tracking device; the other point gives the position of those with the phone.

TASK.

(a) Help them find the coordinates.

(b) How far is the phone from the police tracking it?

ITEM 44

A robot arm moves such that the positions of its ends are described by $x = 7 + \sqrt{3}\cos\theta$ and $y = 5 + 7\sin\theta$ where $\boldsymbol{\theta}$ is the rotational angle. The robot operator needs to determine the largest reflex angle of rotation of the robot arm if it is known that $x + y = 13$.

TASK.

(a) Show that $49x^2 + 3y^2 = 686x + 30y - 2329$

(b) Help the robot operator get the required rotational angle.

ITEM 45

The number of items ($\boldsymbol{y}$) produced by a company are modelled by the equations $y = 8\sin 2x - 5\cos 2x$ where $\boldsymbol{x}$ represents number of production inputs needed for the company to maximize production.

TASK.

Help the company manager find out the smallest number of inputs(x) needed for the company to maximize production.

ITEM 46

Mutebi a boda-boda rider in Kampala wants to buy land that is expected to be worth $shs2$ $\boldsymbol{million}$ at the end of the year 2025. He has decided to start saving $\boldsymbol{shs2{,}000}$ on day 1, increasing the amount by $\boldsymbol{shs\ 500}$ every day. However, he is not sure whether he will be ready to buy this land by the end of $\boldsymbol{160\ days}$. He wants to tighten his spending on food if by this time, he will not be able to fulfil his goal.

TASK.

Help Mutebi find

(a) Whether his savings will be ready by the stated time.

(b) Number of days needed to raise $\boldsymbol{shs\ 12\ million}$.

ITEM 47

Alice, a farmer in Mbale district is planning to plant sorghum in parallel lines. The first proposed line is to pass through the earth coordinates $(\mathbf{10}, \mathbf{50})$ and $(\mathbf{30},\mathbf{10})$, while the second line is to pass through the earth coordinates $(\mathbf{15}, \mathbf{60})$ and $(\mathbf{25},\mathbf{40})$. However, she is not sure whether these lines are actually parallel to each other. to ensure access to sunlight a reasonable distance between these lines is needed. The minimum distance needed between them is $\boldsymbol{100cm}$, but Alice does not know if the given coordinates do not meet this requirement.

TASK.

Help Alice find

(a) The equations of the first and second lines. Convince Alice that these lines are surely parallel to each other.

(b) Whether Alice should increase the distance between these lines

ITEM 48

A local health clinic is conducting a study on the prevalence of obesity and malnutrition in a community. As part of their assessment, they measured the masses (in kilograms) of 40 individuals randomly selected from the community. The data collected is as follows:

46	**52**	**62**	**55**	**61**	**48**	**57**	**46**	**70**	**60**	**54**	**49**	**47**	**52**
	48	**52**	**60**	**55**	**50**	**53**	**64**	**54**	**54**	**53**	**57**	**58**	**51**
	64	**56**	**61**	**52**	**58**	**41**	**59**	**57**	**44**	**51**	**58**	**68**	**65**

The clinic is particularly concerned about identifying mass ranges that might indicate a higher risk of health issues within the community.

TASK.

Help the clinic to:

(a) Construct a frequency distribution table with equal class intervals, beginning with the 41-45 kg class.

(b) Determine the expected mass.

(c) calculate the standard deviation of the above given information

(c) using an appropriate diagram, determine

(i) the number of individuals above 50kg mass.

(ii) the middle 40^{th} percentile.

ITEM 49

A school administrator at a certain school want to analyses the performance of 10 students in two subjects, mathematics and physics; to identify any potential relationships between their s cores, the following table shows the marks obtained by these 10 students

Student	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mathematics	**40**	**90**	**54**	**32**	**80**	**65**	**55**	**48**	**55**	**30**
Physics	**68**	**40**	**47**	**64**	**55**	**41**	**62**	**76**	**74**	**80.**

TASK.

(a). draw a scatter diagram to represent the data above, based on the trend comment on the re lationship observed between the student's marks.

(b). draw the line of best fit and use it to estimate the mark a student who scored 60 in mathe matics would likely get in physics.

(c). calculate the rank correlation between mathematics and physics, what does this coefficie nt suggest about the relationship between performance in these subjects?

(d). using your results in (c) above comment at 1% and 5% level of significance.

ITEM 50

An agriculture engineer is designing an automated sprinkler for a new precisely shaped crop garden, the field is perfectly hexagonal with a central pump station and the main distribution pumps and the main distribution pumps extended to the vertices, from each vertex a sprinkle r is installed along the sides of the hexagon, the efficiency of the sprinkler system depends o n the force exerted by each sprinkler head, the forces acting along the sides of the hexagon in clude the following, 4N, 2N,10N, 1N, 7N, 3N, and $2\sqrt{3}N$ all the forces are indicated in the

directions represented by letters AB, BC, CD, DE,EF, FA, and AD, the engineer is uncertain of the single force that can be used to pump the Water.

TASK.

Help the engineer in determining the single force that can be used to pump the water, hence d etermine its direction of the resultant force

ITEM 51.

A team of engineers is trying to move a 5kg portable generator on a rough inclined plane, the incline is at 35^0 to the horizontal, to prevent the generator from sliding down, a horizontal fo rce of 20N is applied. the body is found to be on the point of moving up the plane,

TASK.

Determine the coefficient of friction between the generator and the plane.

ITEM 52

A logistic manager at a local depot in fort portal needs to move a 200kg box of electronics ac ross a rough concrete floor to a new storage location, the coefficient of static friction betwee n the box and the floor is 0.5. to minimize the effort and prevent damage, a worker will use a light rope attached to the box to pull it, the manager needs to know the minimum tension req uired in the rope to just get the box moving under two different conditions.

The worker pulls the box at angle of 30^0 above the horizontal

The worker pulls the box at an angle of 30^0 below the horizontal,

TASK.

Determine the tension in the string in both cases and advise the manager on the most efficien t method to use when pulling the box.

ITEM 53

There has been a scout's camp at your school and one of the activities is treasure hunt. To fin d the treasure, the scouts are required to solve the following statements in order to generate a 4-digit passcode key to open the treasure box.

- $2^{2x} + 3 \times 2^x \ldots\ldots\ldots$ ***Statement one***
- $\frac{3\sqrt{2}-2\sqrt{3}}{3\sqrt{2}+2\sqrt{3}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$ ***Statement two***

Rules of the game:

1. Solving for values of $\boldsymbol{x}$ in statement one generates the first two digits of the passcode with the least number in the solution in position one.

2. Expressing the second equation in the form of $\boldsymbol{a - b\sqrt{c}}$ generates the third digit as value of $\boldsymbol{a}$ and fourth digit as value of $\boldsymbol{b}$.

Assuming you manage to open the treasure box and you find the following note; "If $\boldsymbol{\log_a n = x \text{ and } \log_c n = y, prove\ that\ \frac{x-y}{x+y} = \frac{\log_b c - \log_b a}{\log_b c + \log_b a}}$ and to take the treasure"

TASK:

a. As the scout's leader, help your team members to come up with the four-digit passcode key

b. Pave all the possible ways to see that your team takes the treasure.

ITEM 54