P425/2
APPLIED MATHEMATICS
PAPER 2
July/August 2011
3 hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

APPLIED MATHEMATICS

Paper 2

3 hours

INSTRUCTIONS TO CANDIDATES:

Answer all the **eight** *questions in section* **A** *and any* **five** *from section* **B**.

All necessary working must be shown clearly.

Begin each answer on a fresh sheet of paper.

Mathematical tables with a list of formulae and squared papers are provided.

Silent, non-programmable scientific calculators may be used.

In numerical work, take g to be $9.8ms^{-2}$.

State the degree of accuracy at the end of each answer given, if a calculator or mathematical table is used and indicate **Cal** *for calculator or* **Tab** *for mathematical tables.*

SECTION A (40 MARKS)

1. The probability that John listens to a certain radio station A is 0.52 and the probability that he listens to A and not another radio station B is 0.45.
   The probability that he listens to neither of the radio stations is 0.20. Find the probability that he listens to radio station B. (Use Venn diagram) (5 marks)

2. Forces PN, 4PN, 2PN and 6PN act along the sides AB, BC, CD and AD of a square ABCD of side a.
   Find the equation of the line of action of the resultant referred to AB as X-axis.
   Find also where the resultant cuts the axis. (5 marks)

3. The following table gives the order in which six Candidates were ranked in mid term exam and final exam.

Mid term score	E	C	B	F	D	A
Final exam score	F	A	D	E	C	C

   Calculate the coefficient of rank correlation and comment on your results. (5 marks)

4. A faulty computer system in a certain school was used to print students' marks on report cards.
   When the teacher fed in 70% the computer printed 50% and instead of 60% it printed 40%. Find;
   (i) the true mark if the computer printed 47%
   (ii) the value printed by the computer if the true value is 52%. (5 marks)

5. A discrete random variable X, has the following probability distribution.

x	0	1	2	3
P(X= x)	$^2/_5$	$^1/_5$	$^1/_{10}$	$^3/_{10}$

   Find;
   (i) E (4X+9)
   (ii) Var (4X + 9) (5 marks)

6. A particle of mass 5kg is placed on a smooth plane inclined at $\tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$ to the horizontal. Find the magnitude of the force acting horizontally required to keep the particle in equilibrium and the normal reaction to the plane. (5 marks)

7. Use the trapezium rule with 6 ordinates to evaluate $\int_0^1 e^{-x^2} dx$ correct to 3 decimal Places. (5 marks)

8. It is rumoured that Mbale clock tower round about whose radius is 8m makes a truck whose distance between the inner and outer wheels is 1.3m and its centre of gravity 0.8m above the ground to topple if the trucks speed exceeds 72Kmh^{-1}.
   Find the angle at which the round about must be inclined and the least coefficient of friction to avoid skidding of any form. (5 marks)

SECTION B (60MARKS)

Attempt any five questions from this section. All questions carry equal marks

9. a) In a certain paper, there are 8 questions each of which has 5 suggested answers and candidates have to choose the right one in question.
   Suppose candidate X choose answers entirely at random, so that he/she is equally likely to choose any one of the answers in each question.
   Calculate the probability that he will score at least 3 correct answers. (3marks)

b) A bag initially contains 2red balls and 3 black balls. A trial consists of selecting a ball at random noticing its colour and replacing it together with an additional ball of the same colour.
Given that three trials are made. Find the probability that
(i) At least two black are drawn (6marks)
(ii) The ball now drawn is the second black. (3marks)

10. (a) A particle is projected at an angle of elevation 60^0 with a speed of $20ms^{-1}$. If the point of projection is 8m above the horizontal ground, find the horizontal distance that the particle travels before striking the ground. (Take $g = 10ms^{-2}$) (5marks)

(b) A and B are two points on level ground. A vertical tower of height 4h has its base at A and a stone is thrown horizontally with speed V from the top of the taller tower towards the smaller tower, it lands at a point X where $AX = \frac{3}{4}AB$. When a stone is thrown horizontally with speed U from the top of the smaller tower towards the taller tower, it also lands at X. show that 3U = 2V. (7marks)

11. The table below shows the marks scored by some students in mathematics test at a certain contest.

Marks	No. of students
10 - < 15	2
15 - < 20	8
20 - < 30	17
30 - < 35	26
35 - < 40	24
40 - < 50	16
50 - < 60	6
60 - < 65	1

a) Calculate the mean and median
b) Draw a histogram and use it to estimate the modal mark.
c) Find the number of students who passed, given that the pass mark was 37.
(12 marks)

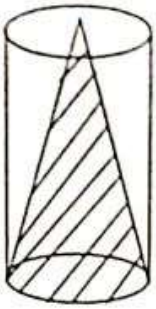
12. a) Show that the Newton Raphson formular for finding the 4^{th} root of a number K is $\times_{n+1} = \frac{3}{4}\left(\times_n + \frac{K}{3\times_n^3}\right)$; n = 0,1,...
b) (i) Draw a flow chart that reads and computes the 4^{th} root of a number K.
(ii) Perform a dry run for finding the forth root of 45.
Correct to two decimal places. (12 marks)

13. A continuous random variable X has p d f

$$f(x)\begin{cases} K; & 0 \le x < 2 \\ K(2x-3); & 2 \le x < 3 \\ 0\ ; & other\ wise \end{cases}$$

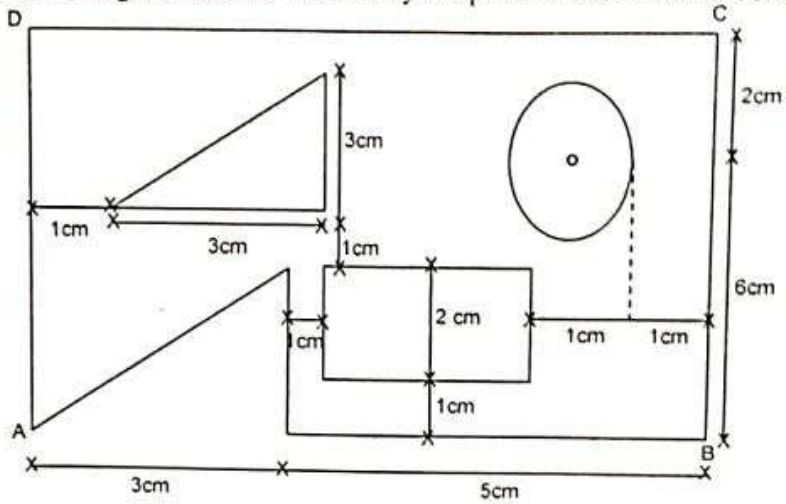
a) Sketch $f(x)$.
b) Find (i) the value of K
(ii) the semi-interquartile range
(iii) the P((0 < X ≤ 2)/(X ≥ 1)). (12 marks)

14. (a) A solid uniform cylindrical piece of metal of height h and radius r has a cone shape removed from it as shown in the diagram. The base of the cone is of radius r and its height of h.



Show that the centre of gravity of the resulting solid is at a distance of $\frac{3}{8}$h from the point at the vertex of the cone. (6marks)

(b) Below is a rectangular lamina with many shapes cut out. Find its centre of gravity.



(6 marks)

15. a) a = 1.50, b = -13.3 and c = 9.200, are all rounded off to the given decimal places, find the minimum value of

(i) $\frac{a+b}{c}$ (ii) $\frac{a-b}{c^2}$ (iii) $\frac{1}{a}-\frac{1}{b}+\frac{1}{c}$

(6 marks)

b) The volume of a cone is given by $V = \frac{1}{3}\pi r^2 h$ with errors ∂r and ∂h in radius and height respectively.
Show that the maximum possible relative error in the volume is given by

$$2\left|\frac{\partial r}{r}\right| + \left|\frac{\partial h}{h}\right|.$$

(6marks)

16. a) A particle is acted upon by two forces, $\mathbf{F_1}$ and $\mathbf{F_2}$ where;
$\mathbf{F_1} = 2\boldsymbol{i} - \boldsymbol{j} - t\boldsymbol{k}$ and
$\mathbf{F_2} = \boldsymbol{i} - 4t\boldsymbol{j}, + 3t\boldsymbol{k}$, at a time t, the particle is initially at rest. Find the momentum of the particle 5 seconds later. (6marks)

b) A particle of mass 5kg is suspended from point O by a light inextensible string of length a metres. The particle is projected from the lowest point A with horizontal speed of Ums^{-1}. At the instant when the particle's speed is Xms^{-1} the tension in the string being TN. Show that $x^2 = u^2 - 2ag + 2agcos\theta$ and
T = 15g cosθ + $\frac{5U^2}{a}$ - 10g.
Hence determine the value of θ when the tension in the string is zero given that u = 2.8 and a = 0.2 giving your answer to the nearest degree. (6marks)

END

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All *working must be shown clearly.*

Where necessary assume acceleration due to gravity $g = 9.8ms^{-2}$.

Silent non prdgrammable silent scientific calculators may be used.

Turn Over

SECTION A (40 MAR..

1. Three ministries A, B and C on a certain fundraising, gamble for a prize by rolling an unbiased die. If the winner is the first minister to roll a six and they roll in the order of A then B the C, find the probability that A wins.
(5 marks)

2. Use trapezium rule with 6 ordinates to evaluate $\int_0^1 e^{-x^2} dx$, correct to 3 decimal places.
(5 marks)

3. A stone is thrown vertically upwards with a speed $u ms^{-1}$
A second stone is also projected from the same point with same speed but T seconds later. Prove that they collide at a distance $\left(\frac{4u^2-g^2T^2}{8g}\right)$ above the point of projection.
(5 marks)

4. A discrete random variable x has a probability density function.

$$P(x = x) = \begin{cases} \frac{x}{K}; x = 1, 2, 3 \ldots n \\ 0; \text{ elswhere} \end{cases}$$

K - constant
If $E(x) = 3$
Find;
(i) Value of n *(3 marks)*
(ii) Value of K *(2 marks)*

5. A uniform beam AB of weight 30N is suspended by two strings at A and B. The beam is in equilibrium at 30^0 and 60^0 with the beam respectively.
Find the tensions in the strings.
(5 marks)

6. A continuous random variable x has a probability density function given by

$$F(x) \begin{cases} \frac{x^2}{27}; o \leq x < \alpha \\ \frac{1}{3} \quad \alpha \leq x < \beta \\ 0 \text{ otherwise} \end{cases}$$

Find the value of α and β.

7. A physics -Mathematics teacher is confident that there is a linear relationship between his class in performance in Physics and Mathematics. He marks all papers of physics and two of mathematics.
On realizing that a student who scored 59% in physics scored 72% in Mathematics and one who scored 76% in physics scored 81% in Mathematics, he mathematically predicted the results of the rest of the students.
Find the teachers prediction for 34% and 91%.

8. A particle of mass 6kg is placed on a smooth plane inclined at $tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$ to the horizontal. Find the magnitude of the force acting horizontally required to keep the particle in equilibrium and the normal reaction to the plane.

SECTION B (60MARKS)

9. a) Show that the root of the equation $x^2e^{-x^2} + 3x - 6$ lies between 1 and 2.
b) Derive the Newton Raphson formular for finding the fifth root of a number N. Hence find $\sqrt[5]{72}$ to 4 decimal points.

10. The following table shows results scored by twelve students in building construction drawing (BCD) and studio (s) tests.

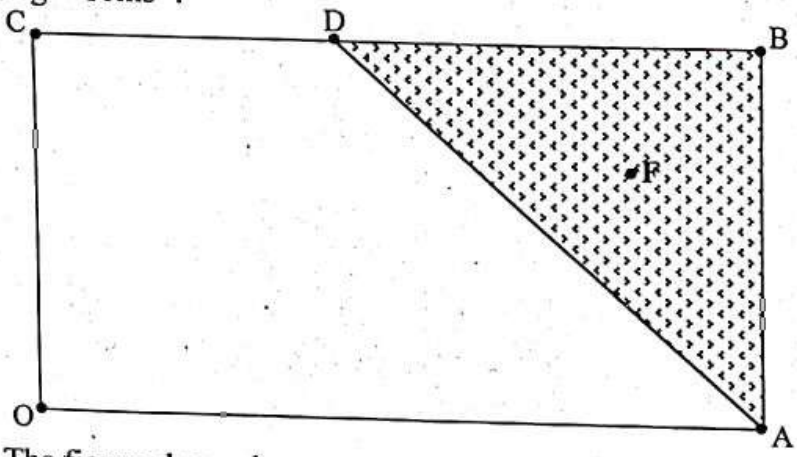
BCD	28	20	40	28	21	22	31	36	29	30	24	25
S	30	20	40	28	22	25	45	35	27	31	23	27

a) Draw a scatter diagram to represent the performance of students in the two course units and comment on the relationship.

b) Calculate the rank correlation coefficient between the marks of the two subjects. Hence comment on your answer. *(12 marks)*

11. a) A uniform ladder weighing 30kg and 8m long rests on a smooth wall and a rough ground with coefficient of friction 0.3 making an angle of 40^0 with the ground. A boy of mass 40kg climbs the ladder carrying a pan of sand weighing 5kg. If the ladder is on the verge of sliding.
i) Calculate the reaction on the ladder. *(3marks)*
ii) Show that the boy climbs approximately 0.69m before it slides. Use $g = 10ms^{-2}$. *(3 marks)*

b)



The figure above shows a square OABC of side a. the mid-point of BC is D. Show that with respect to OA and OC as axes, the coordinates of the centroid F of the triangular region ABC are $\left(\frac{5a}{6}, \frac{2a}{3}\right)$, Hence determine the coordinates of the centre of mass of figure OADC.

12. The table below gives survey data for land ownership in squaremetres owned in shisakhulu trading center.

Landsize (m^2)	Frequency
21 – 25	5
26 – 30	10
31 – 35	25
36 – 40	45
41 – 50	10
51 – 65	30
66 – 75	10

a) Draw a cummulative frequency curve and use it to estimate the semi-interquartile range.

b) Find i) Mode
ii) Standard deviation of the sizes. *(12marks)*

13. a) Find the range within which the value of the expression $\frac{2.471-38.2^2}{-49.3252\ x23.17}$ lies.

b) The sum, S_n, of the first n terms of a certain series is given by
$S_n = Ax^{n-1} + A\frac{(1-x^{n-1})}{(1-x)}$ where A and x are constants and n = 1,2,3,...
Draw a flow chart that reads A and x and print S_n.
a) If A = 5 and x = 2, perform a dry run for the flow chart. *(12 marks)*

14. a) A particle is travelling in a straight-line with SHM of period 4 seconds. If the greatest speed is $2ms^{-1}$, find the amplitude of the path and the speed of the particle when it is $\frac{3}{\pi}$ m from the centre.

b) There are two possible angles of projection α and β for which a particle projected with speed of $30ms^{-1}$ from point (O,O) to pass through another point (40,10). Show that $\tan(\alpha+\beta) = \frac{36}{25}$. (use $g = 10ms^{-2}$)

15. A continuous random variable X has a probability distribution function given by

$$F(x)\begin{cases} 0\ ;\ x<0 \\ = \frac{x^2}{4};\ o \le x \le 1 \\ qx - \frac{1}{4};\quad 1 \le x \le 2 \\ P(5-x)(x-1) \qquad 2 \le x \le 3 \\ 1 \qquad\qquad x \ge 3 \end{cases}$$

a) Find the value of P and q.
b) Determine: i) f(x)
ii) E(x)

16. a) Forces of 7N, 6N, 10N, 13N, and 15N act along lines BA,BC,DC,DA and AC respectively of the rectangle. Their directions are in order of their letters with AD as the horizontal if $\overline{AB} = 3a$, $\overline{BC} = 4a$,
Find the resultant of the system of forces and the distance from A at which its line of action cuts AD. *(06 marks)*

b) At time 9:00am, the position vectors and velocity of two particles A and B are as follows;

$\underset{\sim}{R_A} = \begin{pmatrix}1\\2\\3\end{pmatrix}$m, $\underset{\sim}{V_A} = \begin{pmatrix}-6\\0\\1\end{pmatrix} ms^{-1}$

$R_B = \begin{pmatrix}4\\-14\\1\end{pmatrix}$ m, $\underset{\sim}{V_B} = \begin{pmatrix}-5\\1\\7\end{pmatrix} ms^{-1}$

(i) Find the position vectors of B relative to A at any time t seconds *(01 marks)*
(ii) the value of t when A and B are closest together. *(03 marks)*
(iii) the least distance between A and B. *(02marks)*

END

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Turn Over

SECTION A (40 MARKS)

1. A die is tossed 15 times and the probability of getting a four on any one toss is 0.25. Estimate the probability of getting;
   (i) between 3 and 8 fours.
   (ii) at most 7 fours *(5marks)*

2. The initial velocity of a particle moving with constant acceleration is $(3\mathbf{i} - 5\mathbf{j})\ ms^{-1}$. After 2 seconds the velocity of the particle is of magnitude $6ms^{-1}$ and parallel to $(\mathbf{i} + \mathbf{j})$. Find the acceleration of the particle. *(5marks)*

3. The quantity of water (in litres) remaining in a leaking drum carried through distances (in km) of 3, 5, 10, 15 and 20 from a well are 54, 39 25 12 and 8 litres respectively. Find the;
   (i) quantity of water remaining in the drum after a distance of 24km from the well.
   (ii) distance covered when 30 litres remains in the drum. *(5marks)*

4. In a particular month, the volume of rainfall ml followed a uniform distribution between 4 ml and b ml. If the mean volume of rain for that month is 4.5, find the;
   (i) value of b
   (ii) standard deviation of the volume of rain. *(5marks)*

5. A person whose weight is 7W climbed a uniform ladder AB of weight 2W whose end A is in contact with a rough horizontal ground and B resting against smooth vertical wall. When he is a fifth of the way up, the ladder is about to slide. If coefficient of friction between the ladder and the ground is $\frac{4}{15}$ find the angle that the ladder makes with the ground.

6. (a) (i) Round off 6.00213,
   (ii) truncate 5415000 to the 3 significant figures.

   (b) Given that; x = 2.79, y = 1.375 and z = 1.4, find the limits written which $\frac{y}{z} - x$ lies. Correct to 4 significant figures. *(5marks)*

7. The table below shows the distribution of wages of employees and the time taken to do the job.

Time (hours)	5	6	13	7	9	22	14	7	6	8
Wage (U.shs.)	10,000	12,000	15,000	12,000	13,000	16,000	13,000	10,000	9,000	11,000

   Calculate the rank correlation coefficient and comment on the relationship between wage and hours. *(5marks)*

8. A car of mass 750kg moves along a horizontal road against a total resistance of 240N. If the car engine is working at a constant rate of 12kN, find the;
   (i) maximum velocity of the car.
   (ii) acceleration of the car when its velocity is $30ms^{-1}$. *(5marks)*

SECTION B (60MARKS)

Answer any **five** *questions from this section.*

9. The table below shows the length of leaves in (cm) of a certain type of plant sampled from a forest reserve.

5.4	5.5	8.1	6.0	6.5	8.4	6.3	7.0	7.5	7.8
5.7	5.6	5.1	6.6	6.7	6.1	7.2	6.6	7.9	6.7
7.4	7.1	5.7	6.7	8.6	6.9	7.3	6.3	7.5	5.9
6.4	7.1	6.8	5.3	6.7	6.4	7.4	6.4	7.9	6.7
7.4	6.4	8.2	6.3	6.8	6.8	5.8	6.7	8.6	8.4

a) Form a frequency table with class intervals of 0.5 starting with 5.0 as the lowest. *(2 marks)*

b) Calculate the;
   (i) mean
   (ii) standard deviation of the leaves *(6 marks)*

c) Draw a histogram to represent the above data and use it to estimate modal length. *(4 marks)*

10. a) Use the trapezium rule with six ordinates to estimate $\int_1^3 x^2 \ln x \, dx$
Give your answer correct to three decimal places. *(6 marks)*

b) Hence find the percentage error in your estimate and suggest how it can be reduced. *(6 marks)*

11. The lengths of iron sheets produced in a certain factory are normally distributed. Given that 10% of the sheets are of lengths less than 2.4m and 20% are of lengths more than 2.68m, find; *(6 marks)*
   (i) the mean and variance of the distributed
   (ii) the percentage of iron sheets that would be expected to be of lengths less than 2 55m. *(6 marks)*

12. (a) A car of mass 300kg moving at $144kmh^{-1}$ collides with a stationary trailer of mass 900kg thereby losing its momentum by 15%. If the car decelerates at $6ms^{-2}$ after collision, calculate the; *(4 marks)*
   (i) trailer's velocity after collision, *(4 marks)*
   (ii) distance the car would have to move before stopping, *(4 marks)*
   (iii) deceleration force.

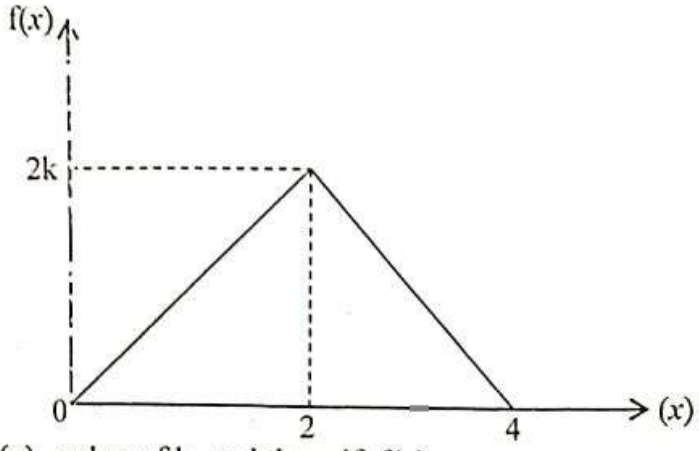
13. (a) Derive the simplest iterative formular based on Newton Raphson method for finding the fourth root of a given number A. *(2 marks)*

(b) Draw a flow chart that;
   (i) reads A and the initial approximation x_0
   (ii) computes and prints the fourth root of A correct to three decimal places. *(6 marks)*

(c) Perform a dry run for A = 150.10 and $x_0 = 3.2$ *(4 marks)*

Turn Over

14. The probability mass function of a random variable x is as shown in the graph below.



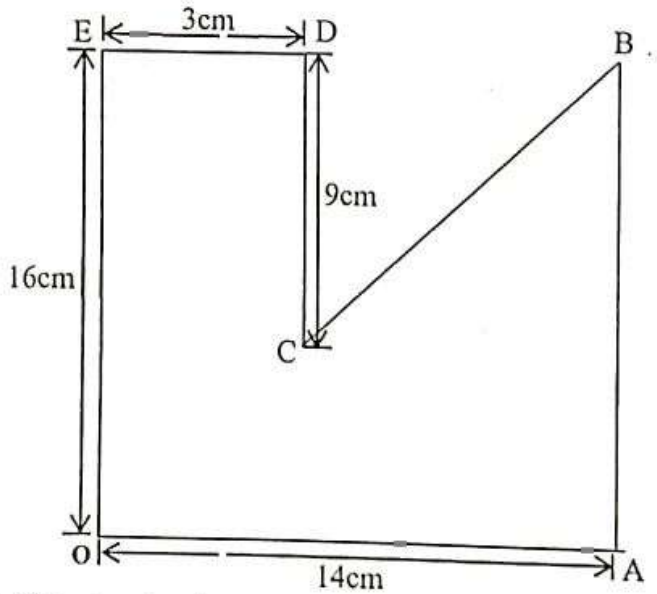
Find the; (a) value of k. and the pdf f(x). *(5 marks)*

(b) cummulative probability function F(x) and use F(x) to find P($1 \leq x < 3$) *(7 marks)*

15. (a) A particle is projected horizontally from a point 2.5m above a horizontal surface. The particle hits the surface at a point which is horizontally 10m from the point of projection. Find the initial speed of projection. *(5 marks)*

(b) A and B are two points such that B is h m vertically above A. From A, a particle is projected vertically upwards with velocity U at the same time another particle is projected with velocity V vertically upwards from B. If the particles collide at C above B, prove $\overline{AC} = \frac{Uh}{U-V} - \frac{gh^2}{2(U-V)^2}$ *(7 marks)*

16. (i) Find the centre of gravity of the lamina shown below.



(ii) If the lamina is suspended from O, find the angle that OB makes with the vertical. *(12 marks)*

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1. A die is tossed 15 times and the probability of getting a four on any one toss is 0.25. Estimate the probability of getting;
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2. The initial velocity of a particle moving with constant acceleration is $(3\mathbf{i} - 5\mathbf{j})\ ms^{-1}$. After 2 seconds the velocity of the particle is of magnitude $6ms^{-1}$ and parallel to $(\mathbf{i} + \mathbf{j})$. Find the acceleration of the particle. *(5marks)*

3. The quantity of water (in litres) remaining in a leaking drum carried through distances (in km) of 3, 5, 10, 15 and 20 from a well are 54, 39 25 12 and 8 litres respectively. Find the;
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   (i) value of b
   (ii) standard deviation of the volume of rain. *(5marks)*

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7. The table below shows the distribution of wages of employees and the time taken to do the job.

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Wage (U.shs.)	10,000	12,000	15,000	12,000	13,000	16,000	13,000	10,000	9,000	11,000

   Calculate the rank correlation coefficient and comment on the relationship between wage and hours. *(5marks)*

8. A car of mass 750kg moves along a horizontal road against a total resistance of 240N. If the car engine is working at a constant rate of 12kN, find the;
   (i) maximum velocity of the car.
   (ii) acceleration of the car when its velocity is $30ms^{-1}$. *(5marks)*

SECTION B (60MARKS)

Answer any **five** *questions from this section.*

9. The table below shows the length of leaves in (cm) of a certain type of plant sampled from a forest reserve.

5.4	5.5	8.1	6.0	6.5	8.4	6.3	7.0	7.5	7.8
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7.4	7.1	5.7	6.7	8.6	6.9	7.3	6.3	7.5	5.9
6.4	7.1	6.8	5.3	6.7	6.4	7.4	6.4	7.9	6.7
7.4	6.4	8.2	6.3	6.8	6.8	5.8	6.7	8.6	8.4

a) Form a frequency table with class intervals of 0.5 starting with 5.0 as the lowest. *(2 marks)*

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   (i) mean
   (ii) standard deviation of the leaves *(6 marks)*

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Give your answer correct to three decimal places. *(6 marks)*

b) Hence find the percentage error in your estimate and suggest how it can be reduced. *(6 marks)*

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   (i) the mean and variance of the distributed *(6 marks)*
   (ii) the percentage of iron sheets that would be expected to be of lengths less than 2.55m. *(6 marks)*

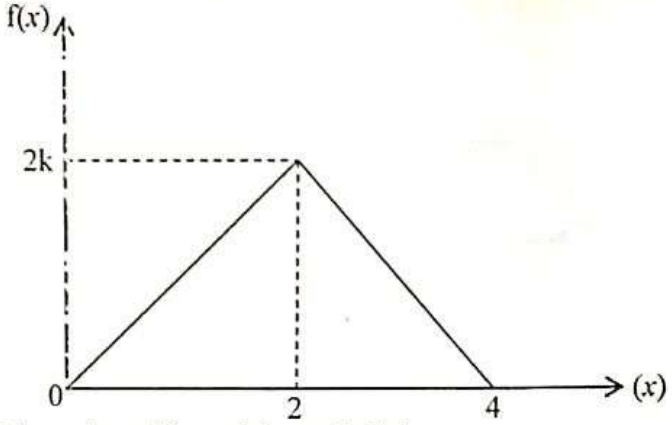
12. (a) A car of mass 300kg moving at 144kmh^{-1} collides with a stationary trailer of mass 900kg thereby losing its momentum by 15%. If the car decelerates at 6ms^{-2} after collision, calculate the;
   (i) trailer's velocity after collision, *(4 marks)*
   (ii) distance the car would have to move before stopping, *(4 marks)*
   (iii) deceleration force. *(4 marks)*

13. (a) Derive the simplest iterative formular based on Newton Raphson method for finding the fourth root of a given number A. *(2 marks)*

(b) Draw a flow chart that;
   (i) reads A and the initial approximation x_0
   (ii) computes and prints the fourth root of A correct to three decimal places. *(6 marks)*

(c) Perform a dry run for A = 150.10 and $x_0 = 3.2$ *(4 marks)*

14. The probability mass function of a random variable x is as shown in the graph below.



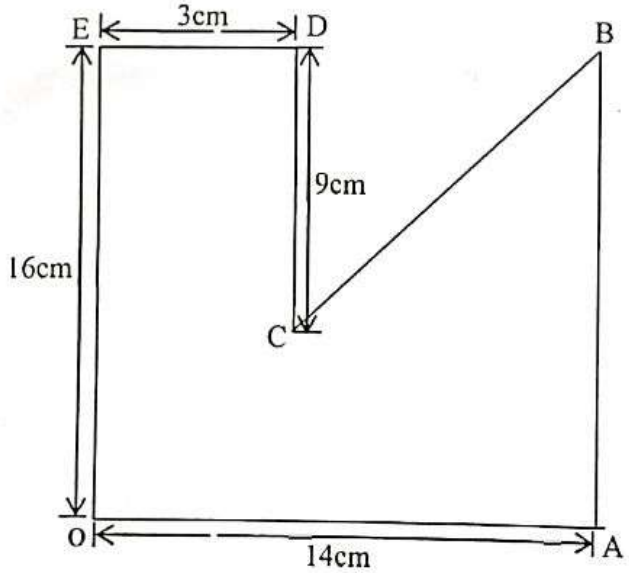
Find the; (a) value of k. and the pdf f(x). *(5 marks)*

(b) cummulative probability function F(x) and use F(x) to find P($1 \leq x < 3$) *(7 marks)*

15. (a) A particle is projected horizontally from a point 2.5m above a horizontal surface. The particle hits the surface at a point which is horizontally 10m from the point of projection. Find the initial speed of projection. *(5 marks)*

(b) A and B are two points such that B is h m vertically above A. From A, a particle is projected vertically upwards with velocity U at the same time another particle is projected with velocity V vertically upwards from B. If the particles collide at C above B, prove $\overline{AC} = \frac{Uh}{U-V} - \frac{gh^2}{2(U-V)^2}$ *(7 marks)*

16. (i) Find the centre of gravity of the lamina shown below.



(ii) If the lamina is suspended from O, find the angle that OB makes with the vertical. *(12 marks)*

END

P425/2
APPLIED MATHEMATICS
PAPER 2
July/August 2014
3hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

APPLIED MATHEMATICS

Paper 2

3 hours

INSTRUCTIONS TO CANDIDATES:

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- *In numerical work, take g to be* $9.8ms^{-2}$.

Turn Over

SECTION A (40 MARKS)

1. Events A and B are such that $P(A) = \frac{3}{5}$.

   $P(B/\overline{A}) = \frac{1}{3}$ $\quad$ $P(A \cap B) = \frac{9}{20}$

   Find: (i) P(B)

   (ii) $P(A \cup B)$ (05marks)

2. Two inextensible strings AC and BC are used on a body of 30N at C. If the string AC makes angle of 3.6° with the downward vertical and string BC makes an angle of 31.2° with the downward vertical, find the tensions in the strings. (05marks)

3. Given that for a function f(x), f(0.9) = 0.2661, f(1.0) = 0.2420 and f(1.1) = 0.2179, use linear interpolation or lines extrapolation to estimate;
   (i) f(0.96)
   (ii) $f^{1}(0.2082)$ (05marks)

4. The following table gives the marks (x) obtained by 12 students A,B,C,D…..,L in an examination in statistics at the end of a term together with the marks (y) obtained at the beginning of the term.

Students	A	B	C	D	E	F	G	H	I	J	K	L
Marks (x)	53	74	48	71	66	60	47	72	48	65	80	40
Marks (y)	41	50	44	38	41	48	45	57	36	46	50	47

   Calculate the rank correlation coefficient and comment on the results. (05marks)

5. Four forces $a\mathbf{i} + (a-1)\mathbf{j}, 3\mathbf{i} - 2a\mathbf{j}, 5\mathbf{i} + 6\mathbf{j}$ and $-\mathbf{i} - 2\mathbf{j}$ Newtons have their resultant acting in the direction making an angle of 45° with the horizontal.
   Find the value of a. Hence determine the magnitude of the resultant force. (05marks)

6. Given that $x = 2.876, y = 2.31$ and $z = 8.6$ are rounded off to the given number of decimal places. Find the interval within which the exact value of $x - \frac{y}{z}$ lies correct to 4 significant. (06marks)

7. Box A contains 3 red and 4 black balls, and box B contains 3 red and 2 black balls. One ball is selected from A at random and placed into B. A ball is then selected at random from B and placed into A. If thereafter, a ball is randomly picked from A, find the probability that both balls picked from A are black. (04marks)

8. A body of mass 60kg in contact with a smooth plan inclined at $\sin^{-1}\left(\frac{1}{40}\right)$ to the horizontal is released from rest. If the resistance to the motion is $\frac{1}{15}$ N per kg, calculate the;
   (i) acceleration of the body,
   (ii) speed of the body 6 seconds after release. (05marks)

SECTION B.

9. a) Given the equation $px^2 + qx + r = 0$, show that the simplest iterative formula based on Newton Raphson method for finding a better approximation to the root of the equation is

$$\frac{px_n^2 - r}{2px_n + q}, \quad n = 0,1,2,\ldots$$ (03marks)

b) Construct a flow chart that
(i) reads the values of r, p, q and the initial approximation a,
(ii) computes and prints the root and number of iterations with an error of less than 0.0001. (05marks)

c) Use your diagram to calculate the positive square root of 20, for a = 4. (04marks)

10. The table below shows the distribution of a random sample of 100 sales of unleaded petrol at a petrol station.

Volume (in litres) of petrol	Number of sales.
0-9	15
10-19	38
20-29	22
30-39	15
40-49	8
50-59	2

a) Calculate the;
(i) mean volume of petrol sold.
(ii) standard deviation.

b) Draw a cumulative frequency curve for the data and use it to estimate the;
(i) median volume of unleaded petrol sold.
(ii) 40^{th} percentile of the volume of unleaded petrol sold. (12marks)

11. A uniform ladder of length 2L and weight W rests in a vertical plane with one end against a rough vertical wall and the other on a rough horizontal surface, the angles of friction at each end being $\tan^{-1}\left(\frac{1}{3}\right)$ and $\tan^{-1}\left(\frac{1}{2}\right)$ respectively.

a) Find θ, the angle of inclination of the ladder to the horizontal.

b) A man of weight 10W begins to ascend the ladder, how far will he climb before the ladder slips? (12marks)

12. By drawing graphs x^3 and 3x - 4 on the same axes, show that the root of the equation $x^3 - 3x + 4 = 0$ lies between ¯3 and ¯2.

b) Use linear interpolation two times to find the root of the equation $x^3 - 3x + 4 = 0$ correct to 2 decimal places. (12marks)

13. The weekly demand for petrol in thousands of units in a house is a continuous random variable x with a probability density function of the form;

$$f(x) = \begin{cases} ax^2(d-x) \ ; \ 0 \leq x \leq 1 \\ \\ 0 \qquad\qquad \text{elsewhere} \end{cases}$$

a) Given that the average demand per week is 600 units, determine the values of a and d.

b) Find $P(0.9 < x < 1)$ (12marks)

14. a) A particle moving in a straight line with simple harmonic motion between two points A and B has periodic time $\frac{\pi}{4}$ seconds. If AB =1m Find the;
   i) velocity of the particle when at a distance of 25cm from A.
   ii) maximum acceleration of the particle. (05marks)

   b) A particle of mass 2kg is suspended from the end of a light elastic string of natural length 1.2m and modulus of elasticity 60N. The particle is then pulled vertically downwards through a distance of 20cm and released from rest.
   i) Find the extension in the string when the particle is at equilibrium point.
   ii) Show that the subsequent motion is simple harmonic and find the periodic time.
   iii) Find the distance of the particle from equilibrium point 2 seconds after being released. (07marks)

15. a) The number of people infected by a certain type of disease is normally distributed with mean 5.6 people and variance 2.25. If a random sample of 100 people is taken, find the probability that the mean number of people infected
   i) lies between 5 and 6.1
   ii) is greater than 5.7

   b) The chance that a tree leaves are eaten up by the army caterpillars in one day is 0.72. If 100 trees are choosen at random, find the 95% confidence limits for the mean number of tree leaves that will be eaten up. (12marks)

16. a) Four uniform rods AB, BC, CD and DA are each 4 metres in length and have masses of 2kg, 3kg, 1kg and 4kg respectively. If they are joined together to form a square frame work ABCD, find the position of its centre of gravity from AB. (05marks)

   b) A body consists of a solid hemisphere of radius r joined to a right circular cone of base radius r and perpendicular height h. The plane surfaces of the cone and hemisphere coincide and both solids are made of the same uniform material.
   Show that the centre of gravity of the body lies on the axis of symmetry at a distance $\frac{3r^2-h^2}{4(h+2r)}$ from the base of the cone. (7marks)

END

P425/2
APPLIED MATHEMATICS
PAPER 2
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3hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

APPLIED MATHEMATICS

Paper 2

3 hours

INSTRUCTIONS TO CANDIDATES:

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- *Begin each answer on a fresh sheet of paper.*
- *Silent non programmable scientific calculators and mathematical tables with a list of formulae may be used.*
- *In numerical work, take g to be* $9.8ms^{-2}$.

SECTION A (40 MARKS)

Answer **all** questions in this section.

1. Given that $P(B/A) = {}^1/_3$, $P(B/A^l) = {}^5/_8$ and $P(A^l \cap B^l) = {}^3/_{20}$

   Find:
   (i) P(A)
   (ii) $P(A \cap B^l)$ (5 marks)

2. Points A, B and C lie along a straight line. A particle accelerating uniformly at $0.5ms^{-2}$ is projected from A towards C with a velocity of $2ms^{-1}$ and after 1 second another particle is projected from C towards A with a velocity of 6 ms^{-1} and a constant retardation of $2ms^{-2}$. Given that the particles passed each other at B while moving with the same speed, find the distance BC. (5 marks)

3. The heights of a sample of seedlings when 200grams, 300grams, 350 grams and 450grams of fertilizers where applied on similar seedlings of the same initial heights were 1.6cm, 1.9cm, 2.4cm and 2.8cm respectively. Use linear interpolation or linear extrapolation to estimate the;
   (i) length of a seeding when 272 grams of fertilizer is applied,
   (ii) amount of fertilizer required if the height of the seedling is to be 3.1cm. (5 marks)

4. A batch of 10 nails is drawn from a machine output which is 40% defective.
   Find the probability that the batch contains:
   (i) no defective nails.
   (ii) more than five defective nails. (5marks)

5. Initially a particle is projected with a velocity $2\underset{\sim}{i}\ ms^{-1}$ from a point with position vector $(10\underset{\sim}{i} + 90\underset{\sim}{j})$ m. Find the distance of the particle from the origin after 4 seconds. (5 marks)

6. The table below shows the number of children in 100 families in a certain village during the 2014 Uganda National Population Census.

No. of children	1	2	3	4	5	6	7	8
No. of families	8	9	16	25	20	12	6	4

   Calculate the (i) mean number of children per family.
   (ii) Standard deviation. (5 marks)
   Use trapezium rule with 6 ordinates

7. Estimate the value of $\int_0^1 \frac{dx}{1+x^2}$
   give your answer correct to 3 decimal places. (5 marks)

8. A rod AB 1m long has a weight of 20N acting at a point 60cm from A. It rests horizontally with A against a rough vertical wall. A string BC is fastened to the wall at C, 75cm vertically about A. Find the;
   (i) tension in the string
   (ii) frictional force at A

   (5 marks)

SECTION B: (60 MARKS)

Answer any **five** questions from this section. **All** questions carry equal marks.

9. (a) The dimensions of a rectangle are 8cm and 4.26cm.
   (i) State the maximum possible error in each dimension.
   (ii) Find the range within which the area of the rectangle lies. (correct to 2 decimal places) (05marks)

   (b) The radius r and height h of a cylinder are measured with corresponding errors Δr and Δh respectively. Show that the maximum possible error in the volume is
   $\left|\frac{\Delta h}{h}\right| + 2\left|\frac{\Delta r}{r}\right|$ (07marks)

10. A smooth hollow cylinder of radius a and centre O is fixed with its axis horizontal. A particle P of mass M is projected from the point on the inside surface of the cylinder, level with O, with speed $\sqrt{14ga}$ vertically down ward. When P reaches the lowest point of the surface it collides with and adhere to a stationary particle Q also of mass M. Find the height above the centre of the cylinder at when the combined mass leaves the surface of the cylinder. (12 marks)

11. A random variable x has a cumulative distribution function given below.

$$f(x) = \begin{cases} 0, & x \leq 0 \\ ax, & 0 \leq x \leq 1 \\ \frac{x}{3} + b, & 1 \leq x \leq 2 \\ 1, & x \geq 2 \end{cases}$$

Find;
(a) the value of a and b,
(b) $P(x < 1.5/x > 1)$,
(c) Mean of x. (12 marks)

12. Obtain graphically the root of the equation $x^3 = 4$.
(a) Derive the simplest ilerative formula based on Newton Raphson method that can be used to find a better approximation to the root of the equation above.
(b) Using the value from the graph as initial approximation, find the root of the equation correct to four significant figures.

(12 marks)

13. (a) A lorry of mass 800kg is pulling a trailer of mass 200kg up a hill of 1 in 14. When the total force of 1KN is exerted by the engine, the lorry and the trailer move up the hill at a steady speed. Find the total frictional resistance to the motion of the lorry and the trailer during the motion.

   (b) When the lorry and the trailer are traveling at a speed of $10m^{-1}$ up the hill, the power exerted by the engine is instantaneously changed to 2kw. Calculate the:
   (i) instantaneous acceleration.
   (ii) instantaneous tension in the coupling between the trailer and the lorry given that the total frictional resistance on the trailer is 70N.

(12 marks)

14. The mock examination and average final examination marks of a certain school are given in the following table.

Mock Marks (x)	28	34	36	42	48	52	54	60
AV. Final Marks (y)	54	62	68	70	76	66	76	74

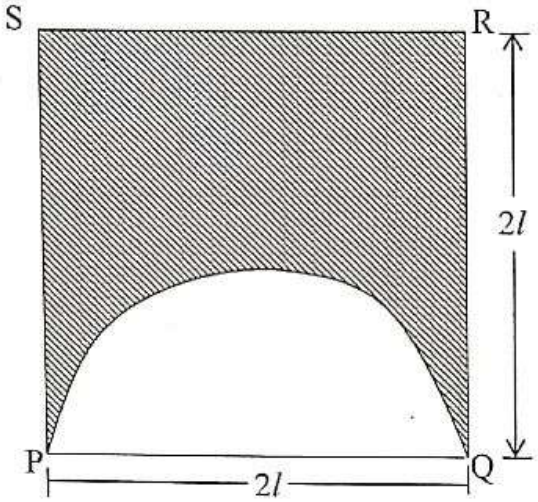
(a) (i) Plot the marks on the scatter diagram and comment on the relationship between the two marks.

(ii) Draw a line of best fit and use it to predict the average final mark of a student whose mock mark is 50.

(08 marks)

(b) Calculate the rank correlation coefficient between the marks and comment on your result. (04 marks)

15. The figure below shows a uniform square lamine PQRS of side $2l$ with a semicircular cut off.



(a) Show that the distance of Centre of gravity of the figure from PQ is $\frac{20l}{3(8-\pi)}$

(b) The figure is freely suspended from the point R. Find the angle that RS makes with the vertical.

(12 marks)

16. (a) A random sample of ten packets is taken. These have masses (measured in kg) of $x_1, x_2, \ldots\ldots, x_{10}$ such that;

$\sum_{i=1} x_i = 2.57$ and $\sum_{i=1} x_i^2 = 0.6610$.

Calculate a 95% confidence limits for the mean. (08 marks)

(c) The weights of ball bearings are normally distributed with mean 25grams and standard deviation 4 grams. If a random sample of 16 ball bearings is taken, find the probability that the mean of the sample lies between 24.12 grams and 26.73 grams.

(04 marks)

END

P425/2
APPLIED MATHEMATICS
PAPER 2
July/August 2015
3hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

APPLIED MATHEMATICS

Paper 2

3 hours

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SECTION A (40 MARKS)

Answer **all** questions in this section.

1. Given that $P(B/A) = {}^1/_3$, $P(B/A^I) = {}^5/_8$ and $P(A^I \cap B^I) = {}^3/_{20}$

   Find:

   (i) P(A)

   (ii) $P(A \cap B^I)$ (5 marks)

2. Points A, B and C lie along a straight line. A particle accelerating uniformly at $0.5ms^{-2}$ is projected from A towards C with a velocity of $2ms^{-1}$ and after 1 second another particle is projected from C towards A with a velocity of $6\ ms^{-1}$ and a constant retardation of $2ms^{-2}$. Given that the particles passed each other at B while moving with the same speed, find the distance BC. (5 marks)

3. The heights of a sample of seedlings when 200grams, 300grams, 350 grams and 450grams of fertilizers where applied on similar seedlings of the same initial heights were 1.6cm, 1.9cm, 2.4cm and 2.8cm respectively. Use linear interpolation or linear extrapolation to estimate the;

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7. Estimate the value of $\int_0^1 \frac{dx}{1+x^2}$
   give your answer correct to 3 decimal places. (5 marks)

8. A rod AB 1m long has a weight of 20N acting at a point 60cm from A. It rests horizontally with A against a rough vertical wall. A string BC is fastened to the wall at C, 75cm vertically about A. Find the;

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   (05marks)

   (b) The radius r and height h of a cylinder are measured with corresponding errors Δr and Δh respectively. Show that the maximum possible error in the volume is
   $\left|\frac{\Delta h}{h}\right| + 2\left|\frac{\Delta r}{r}\right|$

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    (12 marks)

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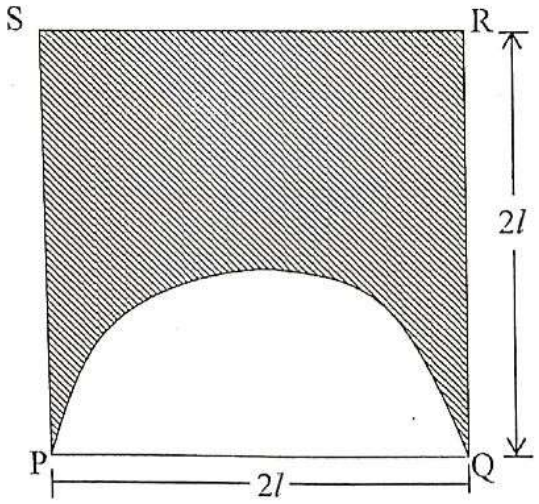
(08 marks)

(b) Calculate the rank correlation coefficient between the marks and comment on your result. (04 marks)

15. The figure below shows a uniform square lamine PQRS of side $2l$ with a semicircular cut off.



(a) Show that the distance of Centre of gravity of the figure from PQ is $\frac{20l}{3(8-\pi)}$

(b) The figure is freely suspended from the point R. Find the angle that RS makes with the vertical.

(12 marks)

16. (a) A random sample of ten packets is taken. These have masses (measured in kg) of $x_1, x_2, \ldots\ldots, x_{10}$ such that;

$\sum_{i=1} x_i = 2.57$ and $\sum_{i=1} x_i^2 = 0.6610$.

Calculate a 95% confidence limits for the mean. (08 marks)

(c) The weights of ball bearings are normally distributed with mean 25grams and standard deviation 4 grams. If a random sample of 16 ball bearings is taken, find the probability that the mean of the sample lies between 24.12 grams and 26.73 grams.

(04 marks)

END

P425/2
APPLIED MATHEMATICS
PAPER 2
July/August 2018
3hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

APPLIED MATHEMATICS

Paper 2

3 hours

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- *In numerical work, take* **g** *to be* $9.8ms^{-2}$.
- *State the degree of accuracy at the end of the answer to each question attempted using a calculator or table and indicate* **Cal** *for calculator, or* **Tab** *for mathematical tables.*

Turn Over

SECTION A (40 MARKS)

Answer all questions in this section.

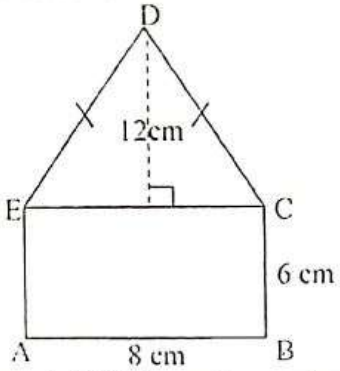
SECTION A

1. The events A and B are such that $P(A/B) = 0.4$, $5P(A) = 8P(B)$ and $P(A \cup B) = 0.12$

   Find:
   (i) P(B) to 3 decimal places.
   (ii) $P(A \cap \overline{B})$. (5marks)

2. The numbers A = 4.2, B = 16.02 and C = 2.5 are rounded off with corresponding errors of 0.5, 0.45 and 0.02. Calculate the absolute relative error in $\frac{A}{B-C}$ correct to 3 decimal places. (5marks)

3. Two uniform laminae made of the same material are joined as shown in the diagram below.



   ABCE is a rectangle and DCE is an isosceles triangle with dimensions as shown. Find the position of the centre of gravity of the composite lamina from AB. (5marks)

4. Ten boys compete in throwing a ball, and the table below shows the height of each boy (xcm) and the distance (ym) to which he can throw the ball.

Boys	A	B	C	D	E	F	G	H	I	J
height(xcm)	122	124	133	138	144	156	158	161	164	168
Distance(ym)	41	38	52	56	29	54	59	61	63	67

   Calculate the rank correlation coefficient and comment on the result at 5% level of significance. (5marks)

5. The table below shows the velocity of a particle during the course of its motion

Time(s)	5	9	12
Velocity(ms^{-1})	10	13	17

   Use linear interpolation or extrapolation to estimate the:
   (i) Velocity when T = 7s
   (ii) Time when the velocity = $19ms^{-1}$ (5marks)

6. A particle of mass 2kg moves under the action of a force which depends on the time t given by force $F = 24t^2\underset{\sim}{i} + (36t - 16)\underset{\sim}{j}$. Given that at t = 0 the particle is located at $3\underset{\sim}{i} - \underset{\sim}{j}$ and has velocity $6\underset{\sim}{i} + 15\underset{\sim}{j}$. Find the kinetic energy of the particle at t = 2. (5marks)

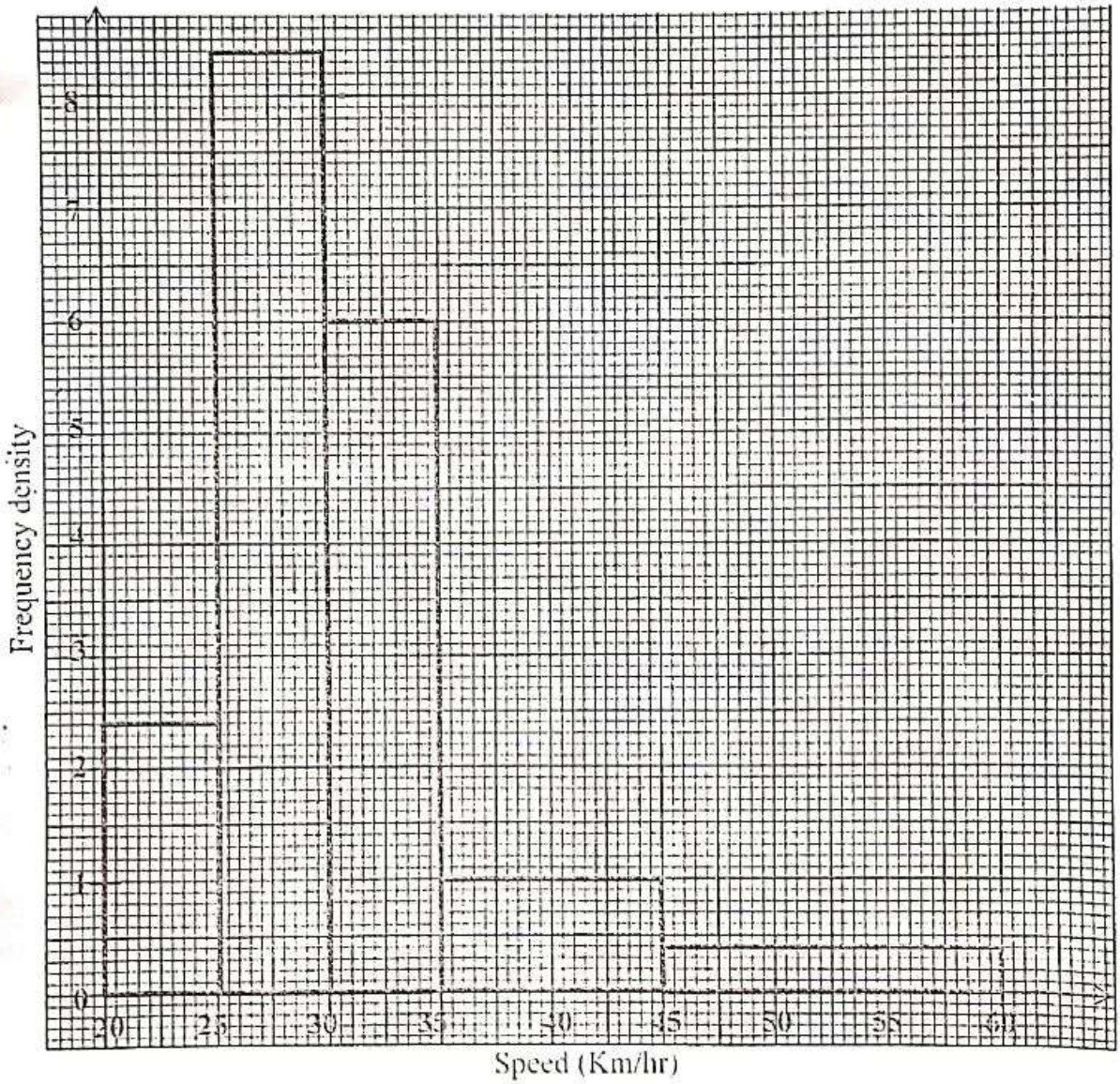
7. A biased coin is tossed 12 times, the coin is such that the ratio of the head to the tail to land on top is 1:3 find the probability of getting;
   (i) utmost 4 heads.
   (ii) between 6 to 10 heads. (5marks)

8. A block of weight 20N rests on a rough plane of inclination 30^0 above the horizontal, the coefficient of friction being 0.25. Find the horizontal force required to prevent it from just slipping down. (5marks)

SECTION B (60 MARKS)

Answer any **five** questions from this section.

9. (a) The speed of cars passing a speed camera are shown in the histogram below. Use the graph to estimate the model speed of cars passing the camera.



Cut out this graph paper and attach it to the answer booklet.

(b) Construct a frequency distributing table and use it to estimate the;
   (i) Average speed
   (ii) Median speed
   (iii) The number of cars passing at $37kmh^{-1}$ and above. (12marks)

Turn Over

10. (a) Use the trapezium rule with 6-ordinates to find the value of $\int_0^{\pi/4}(t+\sin t)dt$ correct to four decimal places. (6marks)

(b) Find the percentage error made in the calculation in (a) above. (5marks)

(c) Suggest how the error can be reduced. (1mark)

11. ABCDE is a regular hexagon of side 4m. Forces of magnitude 1N, 2N, 4N, 3N, 1N and 2N act along the sides AB, BC, CD, ED, FE and AF respectively, the order of the letters indicating the direction of the forces. Taking AB and AE as x and y reference axes respectively, find

(a) The magnitude and direction of the resultant force. (6marks)

(b) The equation of the line of action of the resultant force hence find the distance from A where the resultant force cuts side AB. (6marks)

12. The continuous random variable x is distributed between the values $x = 0$ and $x = 2$ and has a probability density function $ax^2 + bx$ with the mean 1.25

Find; (i) the values of a and b and hence f(x). (8marks)

(ii) the mode of x. (4marks)

13. (a) Obtain graphically the root of the equation $x^3 - 3x + 4 = 0$. (5marks)

(c) Use the newton Raphson method to find the root of equation $x^3 - 3x + 4 = 0$ correct to 2 decimal places. (7marks)

14. An object P passes through a point whose position vector is $3\underset{\sim}{i} - 2\underset{\sim}{j}$ with constant velocity $\underset{\sim}{i} + \underset{\sim}{j}$. At the same instant an object Q moving with constant velocity $4\underset{\sim}{i} - 2\underset{\sim}{j}$ passes through the point with position vector $\underset{\sim}{i} + 4\underset{\sim}{j}$.

Find;

(i) the displacement of P relative to Q after t seconds. (6marks)

(ii) the time when P and Q are closest together and the closest distance at that time. (6marks)

15. (a) It is estimated that on average one match in five in the football league is drawn. If ninety matches are selected at random. What is the probability that between 13 and 20 inclusive of the matches are drawn. (6marks)

(b) The time required to complete a certain car journey has been found from experience to have mean of 2 hours 20 minutes and standard deviation of 15 minutes. What is the probability that on one day chosen at random the journey requires between 1 hour 50 minutes and 2 hours 40 minutes? (6marks)

16. A light inextensible string has a mass of 2 kg attached to one end. The string passes over a fixed pulley, under a moveable pulley of 6 kg, over another fixed pulley and has a 3 kg mass attached to its other end. If the system is released from rest and moves in a vertical position, find the;

(a) acceleration of the masses. (6marks)

(b) tension in the string. (3marks)

(c) distance moved by the movable pulley in 2 seconds. (3marks)

END