

P425/2
APPLIED MATHEMATICS
Paper 2

3 hours.

Uganda Advanced Certificate of Education

APPLIED MATHEMATICS

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INSTRUCTIONS TO CANDIDATES:

Attempt **all** the 8 questions in section **A** and any **five** questions in section **B**.

Any additional question (s) answered will **not** be marked.

Silent non – programmable electronic scientific calculators may be used.

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

All necessary calculations **must** be shown clearly on the answer sheet provided as the rest of the answers, therefore **no** paper should be provided for rough work.

Begin each question on a **fresh** page of the sheet of the answer booklet.

Indicate the degree of accuracy at the end of each question attempted using **Cal** for calculator or **Tab** for mathematical tables.

In numerical work, take acceleration due to gravity g to be $= 9.8\text{ms}^{-2}$.

Turn Over

SECTION A: (40 marks)

Answer **all** questions in this section.

1. Forces of $\begin{pmatrix} -2 \\ -3 \end{pmatrix}N$, $\begin{pmatrix} 7 \\ 4 \end{pmatrix}N$, $\begin{pmatrix} P \\ 2 \end{pmatrix}N$ and $\begin{pmatrix} 1 \\ -Q \end{pmatrix}N$ are in equilibrium. Find the values of P and Q .
(05 marks)

2. The table below shows values of $\sqrt{x}$ for given values of x :

x	0.12	0.13	0.14	0.15
$\sqrt{x}$	0.3464	0.3606	0.3742	0.3873

Using linear interpolation or extrapolation, find

- (a) $\sqrt{0.135}$.
- (b) The value of x corresponding to $\sqrt{x}=0.403$.
(05 marks)
3. Two events X and Y are such that $P(Y)=0.7$, $P(X)=0.4$ and $P(Y/X)=0.3$. Find the probability that neither X nor Y occurs.
(05 marks)
4. Three particles whose masses are m , m and M are fixed to points $(0,0)$, $(2,0)$ and $(1,4)$ respectively. If the centre of mass of the particles is at $(1,1)$, show that: $2m=3M$.
(05 marks)
5. (a) Derive the iterative formula based on Newton – Raphson ($N-R$) process for obtaining the reciprocal of a number N .
- (b) Hence, using the $N-R$ process once, and taking x_0 to be 0.1, find the approximate value of $\frac{1}{11}$, correct to 2 significant figures.
(05 marks)
6. At the end of the Big League, the goals scored by the teams forming the league with their positions are shown below:

Position	1	2	3	4	5	6	7	8	9	10
Number of goals scored	37	19	34	28	26	20	21	18	19	16

Calculate the rank correlation between the position and the goals scored. Comment on your results.

(05 marks)

7. To a passenger in a bus moving at 80kmh^{-1} in the direction $N4^\circ W$, a plane appears to fly from the west at 30kmh^{-1} . Find the true speed and course of the plane.

(05 marks)

8. A box of chalk has 12 pieces of which 3 are broken. If a random sample of 40 such boxes is taken, find the probability that between 9 and 13 boxes have broken pieces of chalk.

(05 marks)

SECTION B: (60 marks)

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

All questions carry **equal** marks.

9. A point O is vertically above a fixed point A on a horizontal plane. A particle P is projected from O with a speed $5V\text{ms}^{-1}$ at an angle $\cos^{-1}\left(\frac{3}{5}\right)$ above the horizontal, and hits the plane at a point B , at a distance $\frac{48V^2}{g}$ metres from A .

(i) Find the distance of P from O when it is directly level with it. *(06 marks)*

(ii) Show that the height of O above A is $\frac{64V^2}{g}$ metres.
(06 marks)

10. (a) Given that a and b are estimated with corresponding errors ΔA and ΔB .

Show that the relative error in the product $|ab|$ is: $\left| \frac{\Delta A}{a} + \frac{\Delta B}{b} \right|$.

(06 marks)

- (b) The values $p=4.7$, $q=80.00$ and $r=15.900$ are rounded off with corresponding percentage errors of 0.5, 0.05 and 0.05. Find the relative error in $\left(\frac{q}{r}-p\right)$.
(06 marks)

11. A random variable Y has a distribution function given by

$$f(y) = \begin{cases} \frac{y}{k}; & y=1, 2, 3, \dots, n, \\ 0; & \text{otherwise} \end{cases}$$

If the mean of Y is 3, find;

- (a) the values of n and k , (07 marks)

- (b) the variance of Y , (03 marks)

- (c) $P(Y=2/Y<3)$. (02 marks)

Turn Over

12. A particle P of weight 49 N rests on a long horizontal table. It is connected by a light inelastic string, passing over a smooth light pulley at the edge of the table; to another particle B of mass 2 kg hanging freely. The system is released from rest, and after 2 seconds P collides and coalesces with a stationary particle of mass 0.1 kg at rest on the table. The coefficient of friction between the table and the weight is 0.25.

- (a) calculate the:
- (i) acceleration of the system just before collision.
(04 marks)
 - (ii) tension in the string just after collision.
(03 marks)
- (b) Find the change in kinetic energy of P immediately after collision.

13. (a) Use the trapezium rule with five sub - intervals to estimate:

$$\int_0^1 5^{2x} dx$$

Give your answer correct to 3 decimal places.

(06 marks)

- (b) Determine the exact value of $\int_0^1 5^{2x} dx$ to 3 decimal places.

(04 marks)

- (c) Find the percentage error in the two calculations in (a) and (b) above.

(02 marks)

14. The table below shows the distribution of the weights of a random sample of mango seedlings.

Weight (grams)	10	15	30	45	55	65
Frequency	25	30	30	18	30	12

- (a) Calculate the mean and standard deviation.
(06 marks)

- (b) Construct a histogram and use it to estimate the modal value of the weight.
(06 marks)

15. (a) A light spring is fixed on a horizontal table in a vertical position. When a weight of W Newtons rests on the spring a compression of a metres is produced in it. Find the constant of the spring.
(03 marks)

- (b) The weight is now held at a height of $\frac{3a}{2}$ metres above the spring, and then let to fall onto it.
- (i) Show that the velocity of the weight just before it lands on to the spring is $\sqrt{3ag} \text{ ms}^{-1}$. (04 marks)
- (ii) Determine the maximum compression of the spring. (05 marks)
16. Box *A* contains 7 yellow and 3 green oranges. Box *B* contains 4 yellow and 5 green oranges. An orange is randomly selected from *A*, and placed in *B*, and then two oranges are randomly selected from *B*, one at a time without replacement, and put in box *A*.
- (a) Calculate the probability that the oranges transferred from *A* to *B* and back to *A* are of the same colour. (04 marks)
- (b) Draw a probability distribution table for the number of green oranges in box *A* after the experiment. (02 marks)
- (c) Find the mean and standard deviation of the number of oranges in box *A* after the experiment. (06 marks)

END