P425/2
APPLIED MATHEMATICS
Paper 2
December 2020
3 hours

JINJA JOINT EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS – DECEMBER 2020

APPLIED MATHEMATICS

Paper 2

3 hours

INSTRUCTIONS TO CANDIDATES:

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

Any additional question (s) answered will not be marked

All *necessary working* **must** *be shown clearly*

Begin each answer on a fresh sheet of paper

Squared paper is provided

Silent non-programmable scientific calculators and mathematical tables with a list of formulae may be used.

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

Answer **all** *questions in this section.*

1. A biased die is tossed such that the probability of obtaining a six is $\frac{1}{10}$. If it is tossed 120 times, find the probability that there are less than 15 sixes.

(05 marks)

2. A particle moving with an acceleration given by $\boldsymbol{a} = 3e^{-t}\boldsymbol{i} + 5\cos t\boldsymbol{j} - 4\sin t\boldsymbol{k}$ has the velocity $\mathbf{v} = 6\boldsymbol{i} - 2\boldsymbol{j} + 3\boldsymbol{k}$ at $t = 0$. Calculate the speed of the particle after 2 seconds.

(05 marks)

3. Given that and $x = 4.3$, and $z = 84.001$ are rounded off with corresponding percentage errors of 0.5, and 0.05. Find the relative error in $x - z$, correct your answer to **3** significant figures. *(05 marks)*

4. A particle of mass 0.2 kg moving with velocity $5\boldsymbol{i} + 7\boldsymbol{j}$ collides with a particle of mass 0.3 kg moving with a velocity $2\boldsymbol{i} - 3\boldsymbol{j}$. If the particles coalesce, calculate the;

(i) common speed *(02 marks)*

(ii) loss in Kinetic energy *(03 marks)*

5. A random variable Y has a probability distribution function given by

$$P(Y = y) = \begin{cases} cy; & y = 1, 2, 3, \ldots, N \\ 0; & elsewhere \end{cases}$$

If $P(Y = 2) = \frac{2}{15}$, find the values of c and N.

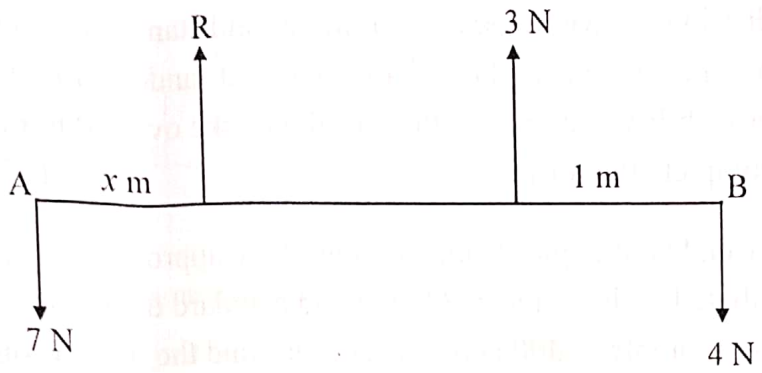
(05 marks)

6. Use the trapezium rule with six ordinates to evaluate, giving your answer truncated to ***three*** significant figures.

$$\int_0^{\frac{\pi}{2}} e^{\sin x} dx$$

(05 marks)

7. The diagram below shows forces acting on a rod AB of length 5m.



Find the values of R and x if the forces;

(a) are in equilibrium.

(b) reduce to a couple of moment 4mm. (*05 marks*)

8. The data below was obtained in a survey to establish the age distribution of teachers in secondary schools in a certain district.

Age (years)	Number of teachers
20 – 29	20
30 – 39	61
40 – 49	35
50 – 59	29
60 – 69	5

Calculate the

(i) modal and

(ii) median age of the workers. (*05 marks*)

SECTION B (60 MARKS)

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

9. (a) The time taken to complete an application form is normally distributed with mean 17.2 minutes and standard deviation 3.6 minutes. If five applicants are chosen at random, find the probability that exactly three of them take over 20 minutes to complete the form. *(07 marks)*

(c) The weights of apples from an orchard are approximately normally distributed with the mean 82.36 g and standard deviation 15 g. If a random sample of 400 apples is chosen, find the 97.5% confidence limits for the mean weight of all the apples in the orchard. *(05 marks)*

10. A ball is kicked with a velocity of 10 ms^{-1} at an angle of 40° to the horizontal towards a wall, which is 7 m away.

(i) Determine how far up the ball hits the wall. *(06 marks)*

(ii) Find the speed at which the ball hits the wall. *(03 marks)*

(iii) Find the direction in which the ball moves when it hits the wall. *(03 marks)*

11. The information in the table below gives a system of tax calculation for the amount of money, **A** (in pounds) earned annually.

Annual earnings (A)	**Tax (T)**
< £ 2000	0
≥ £ 2000 but < £ 5000	2% of A
£ 5000 ≥ **A**	£ 60 plus 5% of the amount over £ 5000

(i) Draw a flow chart using the above data, given that the process stops when 200 counts (N) are made. *(09 marks)*

(ii) Calculate the tax for a man who earns £ 6000 annually. *(03 marks)*

12. Eight students each took two papers in an examination, one in physics paper 2, and another in practical physics paper 3. Their percentage scores are summarized in the table below;

Students	A	B	C	D	E	F	G	H
Paper 2 (x)	67	73	50	75	42	44	75	40
Paper 3 (y)	82	70	64	78	52	64	80	64

(a) Plot the data on a scatter diagram.

Draw a line of best fit and use it to estimate the mark in physics paper 2 corresponding to 72% in practical physics paper 3.

(06 marks)

(b) (i) Calculate the rank correction coefficient for the data.

(05 marks)

(ii) Comment on the significance of physics paper 2 on practical physics for the students. (Spearman's $\rho = 0.74$ and Kendall's, $T = 0.64$ at 5% level of significance based on 8 observations)

(01 marks)

13. A uniform rod AB of length 2 m and mass 10 kg is hinged to a vertical pole at A. It is supported in a horizontal position by a string attached at B and to a point C vertically about A. If a mass of 2 kg is hanging from B and the reaction at the hinge is at 90° to BC, find the;

(a) Length of the string BC. *(07 marks)*

(b) Tension in the string *(05 marks)*

14. (a) Use a graphical method to show that the equation $e^x - x^2 - 2 = 0$ has only one real root. *(05 marks)*

(b) Using the Newton-Raphson method, find the root of the equation in (a) above correct to ***three*** significant figures. *(07 marks)*

15. (a) Two events A and B are such that $P\left(\frac{A}{B}\right) = \frac{5}{11}$, $P(A \cup B) = \frac{9}{10}$, and $P(B) = x$.

(i) Show that $P(A) = \frac{9}{10} - \frac{6x}{11}$ *(03 marks)*

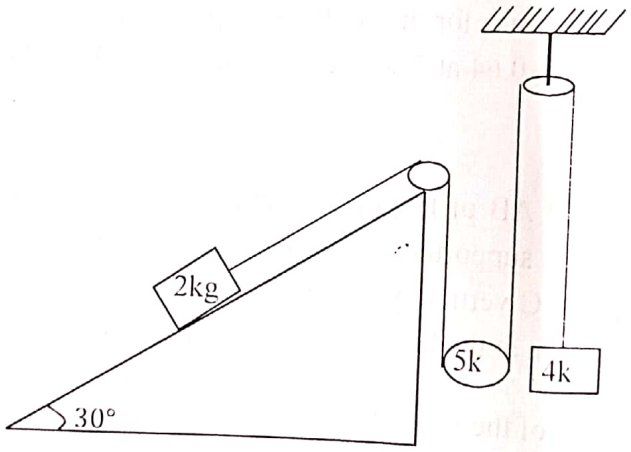
(ii) If $P(A \cap B) = 2P(A \cap B')$, find the value of x. *(03 marks)*

(b) In a survey conducted in a S.6 mathematics class, 35% of the students watched football and not cricket, 10% watched cricket but not football, and 40% did not watch either game. If a student is chosen at random from those in the survey, find the probability that he watches;

(i) football given that he watches cricket *(03 marks)*

(ii) football given that he does not watch cricket *(03 marks)*

16. The figure below shows one end of a light inelastic string attached to a mass of 2 kg which rests on a smooth plane inclined at 30° to the horizontal.



The string passes over a smooth fixed pulley at the edge of the plane, under a second smooth movable pulley of a mass 5 kg and over a third fixed pulley with a mass of 4 kg attached to the other end. Find the:

(a) tension in the string *(06 marks)*

(b) acceleration of the masses and the movable pulley. *(06 marks)*

End