

2705/102 2709/102
2707/102 2710/102
**MATHEMATICS I AND PHYSICAL
SCIENCE**
June/July 2020
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

**DIPLOMA IN BUILDING TECHNOLOGY
DIPLOMA IN CIVIL ENGINEERING
DIPLOMA IN ARCHITECTURE**

MODULE I

MATHEMATICS I AND PHYSICAL SCIENCE

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Mathematical tables/Scientific calculator.

This paper consists of EIGHT questions in TWO sections; A and B.

Answer FIVE questions choosing TWO questions from section A, TWO questions from section B and ONE question from either section.

All questions carry equal marks.

Maximum marks for each part of a question are as indicated.

Candidates should answer the questions in English.

This paper consists of 5 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: MATHEMATICS I

Answer at least **TWO** questions from this section.

1. (a) Given the numbers 60, 84 and 96, determine their:

- (i) LCM; 3360
- (ii) GCD. 12

(5 marks)

(b) Solve the equation $16^{2x+1} = 8^{4x-1}$.

$$2^{4(2x+1)} = 2^{3(4x-1)}$$

$$8x+4 = 12x-3$$

$$-4x = -7$$

$$x = 1.75$$

(5 marks)

(c) The cost of drilling a twenty five metre borehole is charged as follows: The first ten metres are drilled at a cost of Ksh 20,000 per metre. The cost of drilling the next 15 metres follow a geometrical progression with a common ratio of 10.5. Determine the total cost of drilling the borehole.

$$a(r^{n-1})$$

$$20,000(10.5 - 1)$$

$$437,663$$

$$= 437,663 + 20,000$$

$$= 457,663$$

(5 marks)

(d) A construction site sits on a piece of land of area 4800 m^2 and perimeter 280 m. Calculate the dimensions of the land.

$$A = L \times W$$

$$4800 = L(140 - L)$$

$$L^2 - 140L + 4800 = 0$$

$$L = 80 \text{ m}$$

(5 marks)

2. (a) A tank is in the form of a frustum of a cone with end radii of 2.0 m and 1.2 m. If the depth of the tank is 3.0 m, determine its volume.

(7 marks)

(b) Solve the equation $6 \sin^2 \theta - \cos \theta - 5 = 0$ for values of θ between 0° and 360° inclusive.

(6 marks)

(c) A sea vessel travels from town A ($30^\circ \text{N } 40^\circ \text{W}$) due East for 120 hours to town B. The average speed of the vessel is 30 knots. Calculate the:

- (i) speed of the vessel in km/h;
- (ii) distance between towns A and B;
- (iii) position of town B.

(7 marks)

(Take radius = 6370 km and 1 nautical mile = 1.853 km)

3. (a) Show that the polar form of the equation $\frac{x^2}{25} + \frac{y^2}{9} = 1$, is given by $r = \frac{15}{\sqrt{9 + 16 \sin^2 \theta}}$.

(5 marks)

(b) (i) Plot the graph of the equation $y = 3x^2 - 5x - 5$ between $x = -3$ and $x = 3$.

(ii) Hence solve the equation $3x^2 - 5x - 7 = 0$.

(10 marks)

(c) Given the vectors $\underline{a} = 2\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}$ and $\underline{b} = 3\mathbf{i} + \mathbf{j} + 4\mathbf{k}$, determine the angle between them.

(5 marks)

4. (a) A cylinder has a radius of 10 cm and height 18 cm. Errors of 0.02 cm and -0.03 cm are made in the measurements of the dimensions of the cylinder. Use binomial expansion to determine the approximate error made in the calculation of its volume. (6 marks)
- (b) A pack of 20 screws contain 4 defective ones. Two screws are picked at random from the pack without replacement. Determine the probability that:
- both are defective;
 - only **one** is defective.
- (5 marks)
- (c) Table 1 show the distribution of the masses of 65 building blocks in kilograms.

Table 1

Mass kg	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49	50 - 54
Frequency	6	15	20	13	9	2

Determine the:

- mean mass;
- variance;
- median.

(9 marks)

SECTION B: PHYSICAL SCIENCE

Answer at least **TWO** questions from this section.

5. (a) State **two** properties of the images formed by:
- plane mirrors;
 - convex mirrors.
- (4 marks)
- (b) (i) State the laws of reflection.
 (ii) A man of height 176 cm stands in front of a plane mirror. If his eye level from the feet is 166 cm, determine the:
- minimum size;
 - lowest level of the mirror needed for him to view the full size of his image.

(6 marks)

$$16 \div 4.5 = 8^{\circ}$$

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Turn over

(c) The side mirror of a truck has a focal length of 20 cm. A car approaching from behind is 20 metres away. Calculate the:

- (i) position;
- (ii) magnification of the car's image. (5 marks)

(d) A convex lens of focal length 10 cm forms an image of an object which is magnified two times. If the image stands upright, determine the:

- (i) image position;
- (ii) nature of the image. (5 marks)

6. (a) (i) Define the terms:

- (I) frequency;
- (II) wavelength of a sound wave.

(ii) A sound wave travels in aluminium at 5100 m/s. If its wavelength is 0.4 m, calculate its:

- (I) frequency;
- (II) period. (8 marks)

(b) An ultra frequency sound signal is transmitted towards a cliff from an echo sounder. The signal is received back from the cliff after 2.45. Determine the distance of the cliff from the echo-sounder.

(Take speed of sound as 330 m/s). (4 marks)

(c) (i) Differentiate between a concentrated load and a varying load.

(ii) A uniform concrete beam in a structure sits on two vertical supports at the ends A and B. The beam is loaded as in figure 1. Calculate the reactions at the ends.

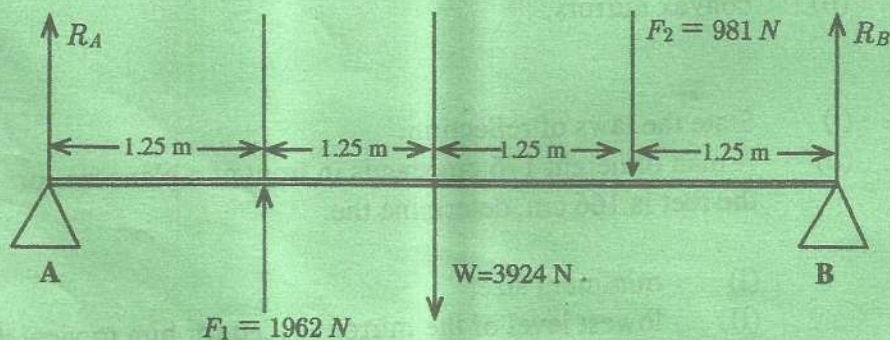


Fig. 1

(8 marks)

7.

(a) (i) Define the terms:

- (I) element; consist of two or more atom bonded chemically
- (II) compound. consist of two or more element bonded chemically

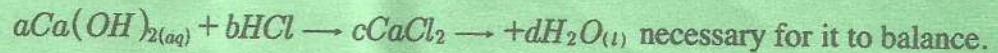
(ii) Use a diagram to explain the formation of a covalent bond.

(6 marks)

(b) (i) Define the processes:

- (I) reduction; - reaction where electron are added to an element or compound during chemical reaction
- (II) oxidation. - reaction where there is removal of electrons from an element during chemical reaction

(ii) Determine the values of a, b, c and d in the redox reaction equation:



(8 marks)

(c) (i) Define the terms:

- (I) acid; substance which dissociate in water to give hydrogen ion
- (II) base; substance which dissociates in H₂O to form hydroxide ions
- (III) alkali. - is a soluble base.

(ii) State three properties of alkalis.

soluble in water
 react with both acids and bases when are strong (6 marks)

8.

(a) (i) Differentiate between soft and hard water.

soft - contains no dissolved salts and readily lather with water
 hard - contains dissolved salts and does not readily lather with water

(ii) Describe the following types of hardness of water: Soap but forms a scum

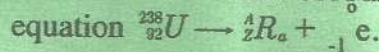
- (I) temporary;
- (II) permanent.

(iii) Explain how temporary hardness of water is removed.

- Boiling
 - Distillation
 - Addition of Sodium carbonate
 - Addition of Calcium hydroxide (8 marks)

(b) (i) State three radiations which can be emitted in a radioactive process.

(ii) Determine the values of A₀ and Z which will balance the nuclear reaction



(6 marks)

(c) Define the terms:

- (i) monomers; - simple molecules that ~~combine~~ form center
- (ii) polymers. - monomer joined together to form large chain (2 marks)

(d) Calculate the concentration of sodium hydroxide solution if 120 g of the solute is dissolved in 2 litres of water.

(Na = 23, H = 1, O = 16)

(4 marks)

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