

2914/102  
2915/102  
MATHEMATICS AND APPLIED SCIENCE  
Oct./Nov. 2019  
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN APPLIED BIOLOGY  
DIPLOMA IN ANALYTICAL CHEMISTRY

MODULE I

MATHEMATICS AND APPLIED SCIENCE

3 hours

### INSTRUCTIONS TO CANDIDATES

*You should have the following for this examination:*

*answer booklet;*

*scientific calculator.*

*This paper consists of TWO sections; A and B.*

*Answer ALL the questions in both sections A and B.*

*Each question in section A carries 4 marks while each question in section B carries 20 marks.*

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

*Candidates should answer the questions in English.*

**This paper consists of 4 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 (60 marks)

Answer ALL the questions in this section.

1. Find the value of  $x$  in the equation;

$$\log_x 20 + \log_x 5 = 2. \quad (4 \text{ marks})$$

2. A swimmer can swim in still waters at 12 metres/ minute. In Tana River, the swimmer swam upstream for 100 m and back to the starting point and he took a total of 20 minutes. Determine the speed of the water downstream. (4 marks)

3. Find the value of  $x$  in  $\frac{2^x \times 3^x}{12^x} = \frac{1}{8}$ . (4 marks)

4. An arithmetic series has the terms 3, 7, 11, 15 ..... 99. Find the sum of all the terms. (4 marks)

$$S_n = 2a + (n-1)d$$

5. Define the following terms as used in statistics:

- (a) mean; (1 mark)
- (b) median; (1 mark)
- (c) assumed mean; (1 mark)
- (d) degrees of freedom. (1 mark)

6. Solve the following simultaneous equations:

(a)  $5x + 184y = 180$

(b)  $\frac{7x}{8} - \frac{2}{1} + \frac{3y}{2} + 6 = \frac{6x}{7} - \frac{3}{1} + \frac{2y}{5}$  (4 marks)

7. Evaluate the following matrix.

$$\begin{pmatrix} 3 & 1 & 1 \\ 4 & 7 & 8 \\ 11 & 9 & 0 \end{pmatrix} \begin{pmatrix} 8 & 4 & 5 \\ 6 & 1 & 2 \\ 0 & 3 & 9 \end{pmatrix}$$

(4 marks)

8. Differentiate the following function from the first principles;

$$f(x) = x^3 + 2x^2 + 7x + 5 \quad (4 \text{ marks})$$

9. Determine dimensionally, whether the equation  $v^2 = u^2 + 2as$  is valid. The symbols  $v$ ,  $u$ ,  $a$  and  $s$  represent final velocity, initial velocity, acceleration and displacement respectively. (4 marks)

10. (a) State the law of conservation of momentum. (1 mark)
- (b) A 3.0 kg object is moving at a speed of 5.0 m/s. Determine:
- (i) the force needed to stop the object in a time of  $6.5 \times 10^{-4}$  seconds; (2 marks)
- (ii) impulse. (1 mark)
11. Figure 1 shows a system at equilibrium. The cylinder on the left side has a mass of 800 kg and cross-section area of  $100 \text{ cm}^2$ . The piston on the right side has a cross-section area of  $32 \text{ cm}^2$  and negligible weight. The apparatus is filled with liquid of density  $0.75 \text{ g/cm}^3$ .

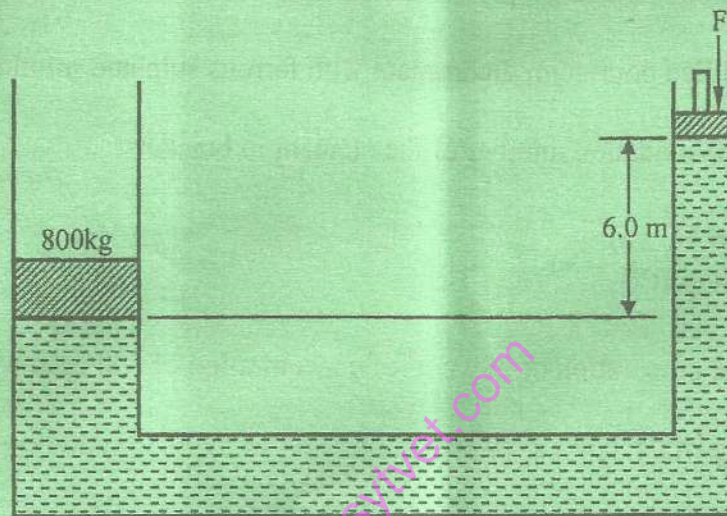


Fig. 1

Determine the force  $F_1$ . (4 marks)

12. A thermo flask contains 300 g of liquid coffee at  $85^\circ\text{C}$ . 25 g of milk at  $10^\circ\text{C}$  is added. Determine the temperature of liquid at equilibrium assuming no heat is lost (Specific heat capacity of coffee and milk are equal). (4 marks)
13. (a) State Newton's law of cooling. (1 mark)
- (b) A spherical body of 3.0 cm diameter is maintained at  $500^\circ\text{C}$ . Assuming that it radiates as if it were a black body, determine the rate of radiation. (stefan constant =  $5.67 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$ ) (3 marks)
14. A wire that has a resistance of  $10\Omega$  is deformed such that the new length is three times the original length. Determine the new resistance. (4 marks)

15. (a) State Lenz's law. (1 mark)
- (b) Determine the critical angle for light passing from glass to water if the refractive index of glass and water are 1.54 and 1.33 respectively. (3 marks)

**SECTION B (40 marks)**

*Answer ALL the questions in this section.*

16. (a) Write balanced ionic equations for the reaction between:
- (i) acidified potassium permanganate with oxalic acid solutions. (2 marks)
- (ii) acidified potassium dichromate with ferrous sulphate solutions. (2 marks)
- (b) Calculate the oxidation number of the element in brackets:
- (i)  $\text{Na}_2\text{S}_3\text{O}_6$  (S) (2 marks)
- (ii)  $\text{KClO}_4$  (Cl). (1 mark)
- (c) Describe the preparation of 200 cm<sup>3</sup> of concentration of 100 ppm with respect to copper using AR  $\text{Cu}(\text{NO}_3)_2$ .  
(Cu = 63.5, N = 14, O = 16)  $\frac{1}{\text{RMM}} \times \text{REM of Cu}(\text{NO}_3)_2$  (9 marks)
- (d) Calculate the molarity of 40% w/v NaOH.  
(Na = 23, O = 16, H = 1) (4 marks)
17. (a) Explain the importance of transpiration in plants. (6 marks)
- (b) Draw a transverse section of a typical dicotyledon leaf as seen under the compound light microscope. (10 marks)
- (c) Illustrate the genetic test-cross of the F<sub>1</sub> of a dominant tall plant and a recessive dwarf plant. (4 marks)

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