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ENVIRONMENTAL CHEMISTRY AND  
APPLIED SCIENCE  
Oct./Nov. 2018  
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL  
DIPLOMA IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY  
MODULE I

ENVIRONMENTAL CHEMISTRY AND APPLIED SCIENCE

3 hours

INSTRUCTIONS TO CANDIDATES

*You should have the following for this examination:*

*answer booklet;*

*non-programmable scientific calculator.*

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

*Answer ALL the questions in Section A and any THREE questions from Section B in the answer booklet provided.*

*Each question in Section A carries 4 marks while each questions in Section B carries 20 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 (40 marks)



Answer ALL the questions in this section.

1. Derive the SI unit for  $K$  in the equation  $\frac{Q}{t} = KA(\Delta T)/x$  where  $Q$ ,  $t$ ,  $A$ ,  $\Delta T$  and  $x$  represent quantity of heat, time, cross section area, change in temperature and thickness respectively. (4 marks)
2. A fish weighing 25 kg swimming at 1.20 m/s suddenly swallows a 5 kg fish that was initially stationary. Neglecting any drag effect of water, determine the speed of the large fish just after swallowing the smaller one. (4 marks)
3. A nylon rope used by mountaineers elongates 1.2 m under the weight of a 68.0 kg climber. If the rope is 45.0 m in length and 7.0 mm in diameter, determine its Young modulus. (4 marks)
4. An incompressible fluid of density  $800 \text{ kg m}^{-3}$  was pumped through a cylindrical pipe at a rate of 10 litres per second. If the section of the pipe has a diameter of 8.0 cm, determine the:
  - (a) flow speed; (2 marks)
  - (b) mass flow rate of the fluid. (2 marks)
5. (a) State Henry's law. (1 marks)  
(b) State **three** causes of deviation from Henry's law. (3 marks)
6. 25  $\text{cm}^3$  dilute sulphuric acid completely neutralizes 16.1  $\text{cm}^3$  of a solution containing 1.8 g sodium carbonate in 250  $\text{cm}^3$  of water. Calculate the molarity of the dilute sulphuric acid. (f.wt. of sodium carbonate = 106). (4 marks)
7. (a) Name **two** sources of energy for the earth. (2 marks)  
(b) Describe the big band theory of the origin of the solar system. (2 marks)
8. Solve the quadratic equation  $x^2 - x - 20 = 0$  by the method of completing the squares. (4 marks)

9. Solve the following simultaneous equations.

$$x - y = 7 - 3x$$

$$2y + 8x - 6 = 2x - 3y + 5$$

(4 marks)

10. Solve the following equation without using a calculator or mathematical table.

(4 marks)

$$\log_5 x = \frac{\log_{10} 5 \times \log_{10} x}{\log_{10} 125 + x}$$

**SECTION B (60 marks)**

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

11. (a) Water enters a house at speed of 2.0 m/s through a pipe with a diameter of 3.0 cm at an absolute pressure of  $6.0 \times 10^5$  pascals. The water then flows through a 1.2 cm diameter pipe to a second floor bathroom 5.5 metres above the ground. Determine at the bathroom pipe the:

- (i) flow speed; (3 marks)  
(ii) pressure; (2 marks)  
(iii) volumetric flow rate. (2 marks)

- (b) A conical pendulum is such that a bob of mass 1 kg is attached to a string 120 cm long and made to revolve in a horizontal circle of radius 50 cm. Determine:

- (i) tension of the string; (3 marks)  
(ii) period of motion. (4 marks)

- (c) The resistance of a metal is  $2.56 \Omega$  at ice point and  $2.86 \Omega$  steam point. Determine the temperature when resistance is  $2.75 \Omega$ . (2 marks)

- (d) Determine the magnitude of the resultant force acting on a body as shown in Figure 1. (4 marks)

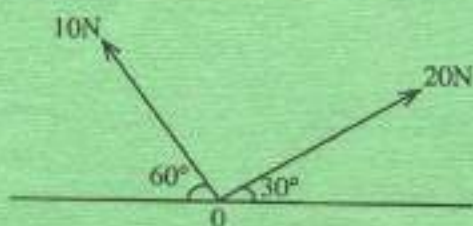


Figure 1

12. (a) The arrangement of two lenses in microscope are such that objective lens and eye piece lens of focal length 10 cm and 8 cm respectively, are placed 66 cm apart. An object 2 cm high is placed 12.0 cm to the left of objective lens. Determine, for the image viewed through the eye piece lens:
- (i) position from both objective and eye piece lenses. (5 marks)
  - (ii) size; (4 marks)
  - (iii) nature. (3 marks)
- (b) The temperature of 4.50 litres of ideal gas drops from 375 K to 275 K. If the volume remains constant and the initial pressure is atmospheric, determine:
- (i) the final pressure; (2 marks)
  - (ii) number of moles of gas. (2 marks)
- (c) Calculate the temperature at which a tungsten filament that has an emissivity of 0.90 and a surface area of  $2.5 \times 10^{-5} \text{ m}^2$  will radiate energy at the rate of 25 watts in a room. (2 marks)
- (d) Calculate the force on a conductor of length 75 cm carrying a current of 2 A in a magnetic field of 3 Tesla. (2 marks)

13. (a) Table 1 shows the molar conductivities of some ions at infinite dilution.

Table 1

Ion	H <sup>+</sup>	Li <sup>+</sup>	Na <sup>+</sup>	Ag <sup>+</sup>	Cl <sup>-</sup>	NO <sub>3</sub> <sup>-</sup>
$\Lambda_m^\infty \text{ Sm}^2 \text{ mol}^{-1}$	350	39	50	62	76	71

- (i) Name two factors that affect molar conductivity of an ion at infinite dilution. (2 marks)
- (ii) If the molar conductivity of sodium ethanoate at infinite dilution is  $91 \text{ Sm}^2 \text{ mol}^{-1}$ , calculate the molar conductivity of ethanoic acid at infinite dilution. (6 marks)
- (iii) In a conductometric titration,  $10 \text{ cm}^3$  of  $0.01 \text{ M AgNO}_3$  solution was added in  $5.0 \text{ cm}^3$  portions to  $30.000 \text{ cm}^3$  of  $0.02 \text{ M HCl}$  solution.
  - (I) Draw a labelled sketch graph of the titration curve. (4 marks)
  - (II) Explain the shape of the curve in (I). (6 marks)



- (b) The variations in molar conductivity with concentration for aqueous solutions of two monobasic acids X and Y are as shown in table 2. Explain these variations. (2 marks)

**Table 2**

Concentration in mol/dm <sup>3</sup>		10 <sup>-10</sup>	0.5	1.0	10	100
Molar conductivity in Sm <sup>2</sup> mol <sup>-1</sup>	For X	0.0426	0.423	0.0421	0.0412	0.0391
	For Y	0.0400	0.0068	0.0049	0.0016	0.0005

14. (a) (i) State the law of mass action. (2 marks)
- (ii) State **two** instances when the law of mass action is not obeyed. (2 marks)
- (b) (i) Name **four** factors that affect the position of equilibrium for a system in a state of dynamic equilibrium. (4 marks)
- (ii) Name **two** types of chemical equilibria. (2 marks)
- (c) In an experiment 8.10 moles of hydrogen gas is mixed with 2.94 moles of iodine at 448 °C in a three litre vessel. At equilibrium, 5.64 moles of hydrogen iodide is present in the reaction vessel. Calculate the value of the equilibrium constant. (10 marks)

15. (a) Determine the turning points of the curve  $y = 2x^3 - 7x^2 + 4x + 9$ . (8 marks)
- (b) Determine the derivative of  $y = 2x^3 - 5x^2 + 12x - 7$  from the first principles. (7 marks)
- (c) Simplify the equation:

$$\frac{2^2 \times 64^2}{5^2} = \frac{16 \times 25^2}{8^2 \times 4^{3r}}$$

(5 marks)



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