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ENVIRONMENTAL CHEMISTRY AND APPLIED SCIENCE
June/July 2019
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 question 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.

Turn over

SECTION A (40 marks)

Answer ALL the questions in this section.

1. Explain each of the following types of reactions:

   (a) redox reaction; (2 marks)

   (b) acid-base reaction. (2 marks)

2. (a) Write the chemical formula of the following chloroflourocarbon (CFC) compounds:

   (i) CFC - 11; (1 mark)

   (ii) CFC - 12. (1 mark)

   (b) State **two** uses of CFCs. (2 marks)

3. The vapour pressure of water at $100\,^{\circ}C$ is $1.01 \times 10^5\ N/m^2$ and the enthalpy of vaporization is 40.7 kJ/mol. Using Clausius-Clapeyron equation, determine the vapour pressure at $200\,^{\circ}C$. (4 marks)

$$\ln\frac{P_1}{P_2} = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

4. Solve the quadratic equation $2x^2 + 9x + 8 = 0$ using completing the square method. (4 marks)

5. Calculate the volume of a metal tube whose outside diameter is 8 cm and inside diameter is 6 cm. The length of the tube is 4 cm. (4 marks)

6. A flagpole stands on the edge of the top of a building. At a point 200 m from the building, the angles of elevation of the top and bottom of the pole are 32° and 30° respectively. Calculate the height of the flag pole. (4 marks)

7. Solve the equation $2 - 4Cos^2\theta = 0$ for values of θ in the range $0^{\circ} < \theta < 360^{\circ}$. (4 marks)

8. State **four** advantages of using a cathode ray oscilloscope as a voltmeter in comparison to conventional meters. (4 marks)

9. (a) Define the term 'refractive index' as used in optics. (2 marks)

   (b) Light passes through glass at an incidence angle of 45°. Determine the angle of refraction given that the refractive index of glass is 1.5. (2 marks)

10. A steel bar 6.0 m long with a rectangular cross section of 5.0 cm by 2.5 cm supports a mass of 2000 kg. Determine the change in the length of steel resulting from the force. The Young's modulus of steel is $20.0 \times 10^{10}\ N/m^2$. (4 marks)

SECTION B (60 marks)

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

11. (a) Define each of the following terms:

(i) environmental chemistry; (2 marks)
(ii) acquatic chemistry; (2 marks)
(iii) atmospheric chemistry. (2 marks)

(b) State the following as used in chemical equilibria:

(i) Henry's law; (2 marks)
(ii) Le chatelier's principle. (2 marks)

(c) For the reaction $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$, $K_c = 4.24$ at 800 K, CO and H_2O are initially present at concentration of 0.1 M each. Calculate the equilibrium concentration of each chemical species. (10 marks)

12. (a) Define each of the following as used in circular motion:

(i) angular displacement; (2 marks)
(ii) centripetal acceleration. (2 marks)

(b) A child is sitting on a chair placed at the equator of the earth. The earth makes a rotation about its axis in 24 hours and the equator is 6.5×10^6 m in circumference. Calculate:

(i) angular velocity of the earth in rad/s; (3 marks)
(ii) centripetal acceleration. (2 marks)

(c) A stone of mass 0.4 kg is attached to an inextensible string and whirled in a vertical circle of diameter 1.2 m at a constant speed of 7.0 m/s. Calculate:

(i) centripetal acceleration of the stone; (2 marks)
(ii) minimum tension in the string; (3 marks)
(iii) maximum tension in the string; (2 marks)
(iv) linear velocity at which the string cuts if the maximum tension it can withstand is 20 N. (4 marks)

13. (a) (i) Describe photoelectric effect. (2 marks)

(ii) State **three** factors that affect photoelectric effect. (3 marks)

(b) The minimum frequency of light that will cause photoelectric emission from lead surface is 6.10×10^{14} Hz. When the surface is irradiated from a certain source, photoelectrons are emitted with a speed of 8.0×10^{5} m/s. Given that Plancks' constant is 6.63×10^{-34} Js and the mass of electrons emitted is 9.1×10^{-31} kg, calculate the:

(i) work function of lead; (2 marks)

(ii) maximum kinetic energy of the photoelectron; (2 marks)

(iii) frequency of the source of irradiation. (3 marks)

(c) State any **four** applications of radioactivity. (4 marks)

(d) The half-life of a certain radioactive element is 16 years. Determine:

(i) fraction of the element remaining after 48 years; (2 marks)

(ii) fraction of the element decayed after 64 years. (2 marks)

14. (a) A straight line passes through the coordinates (2,2) and $(5, \frac{1}{2})$. Determine:

(i) the equation in the form, $y = mx + c$; (3 marks)

(ii) the y-intercept. (1 mark)

(b) A tennis court measures 24 m by 11 m. A border of constant width surrounds the court as shown in figure 1. The total area of the court and its border is 950 m^2. Determine the width, X_m. (5 marks)

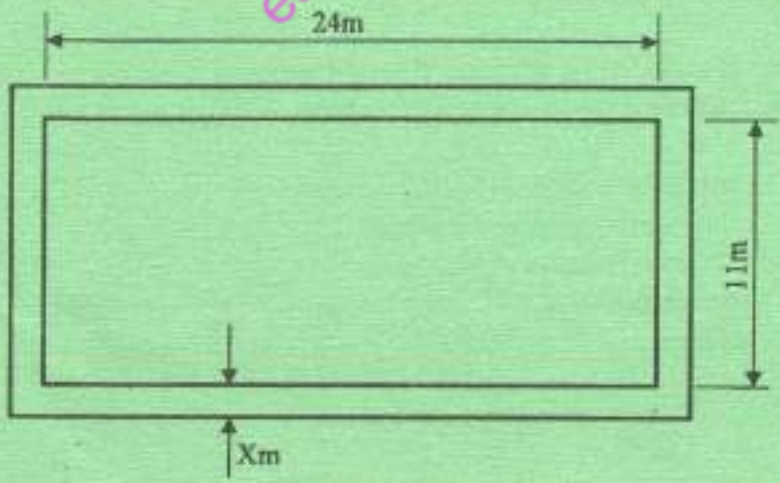

Fig. 1

(c) Solve the simultaneous equations: (6 marks)

$$y = x^2 + x + 1$$

$$y = 4 - x$$

(d) Solve the equation $\log(x-1) + \log(x+1) = 2\log(x+2)$. (5 marks)

15. (a) Differentiate the following equations:

(i) $y = \frac{4}{\sqrt{x}}$ (2 marks)

(ii) $y = 3x^2 \sin x$ (3 marks)

(b) The distance x metres moved by a car in a time t seconds is given by

$$x = 3t^3 - 2t^2 + 4t - 1.$$

Determine:

(i) velocity after two seconds; (3 marks)
(ii) acceleration after three seconds. (3 marks)

(c) (i) Locate the turning point on the curve given by the equation $y = 3x^2 - 6x$. (5 marks)

(ii) Determine the nature of the turning point in c (i). (4 marks)

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