Name _____ Index No. _____

2528/304
2922/304
ENVIRONMENTAL ANALYTICAL TECHNIQUES
Oct/Nov 2013
Time: 3 hours

Candidate's Signature _____

Date _____

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY MODULE III

ENVIRONMENTAL ANALYTICAL TECHNIQUES

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided above.
Sign and write the date of examination in the spaces provided above.
You should have a non-programmable scientific calculator for this examination.
This paper consists of TWO sections; A and B.
Answer ALL questions from section A and any THREE questions from section B in the spaces provided in this question paper.
Each question in section A carries 4 marks while each question in section B carries 20 marks.
Candidates should answer the questions in English

For Examiner's Use Only

Section A

Questions	1	2	3	4	5	6	7	8	9	10	TOTAL SCORE
Candidate's Score											

Section B

Questions	11	12	13	14	15	TOTAL SCORE
Candidate's Score						

GRAND TOTAL

This paper consists of 16 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 questions from this section in the spaces provided.

1. Define the following terms:

(a) oxidation: (2 marks)

(b) oxidizing agent. (2 marks)

2. Classify the following redox solutions either as oxidants or reductants:

(a) potassium permanganate:

(b) iodine:

(c) sodium thiosulphate:

(d) potassium dichromate.

(4 marks)

3. State **four** factors that influence EDTA titrations. (4 marks)

4. 50 ml of 0.10 M NaCl is titrated with 0.10 M $AgNO_3$. Calculate the chloride ion concentration after adding 10 ml of the $AgNO_3$. (4 marks)

5. (a) Define precipitation titration. (2 marks)

(b) Name any two basic requirements of precipitation reactions. (2 marks)

6. Describe using equations the reactions that take place when iron sheets rusts. (4 marks)

7. A solution of $Na_2S_2O_3$ was standardized by dissolving 0.121 g KIO_3 (Mwt = 214 g/mol) in water, adding a large excess of KI and acidifying with HCl. The liberated iodine (I_2) required 41.64 ml of the $Na_2S_2O_3$ to decolorize the blue starch-iodine complex. Calculate the molarity of the $Na_2S_2O_3$ solution. (4 marks)

8. Explain the basic principle of metal ion indicator in EDTA titrations. (4 marks)

9. Define the following terms:

(a) coagulation; (2 marks)

(b) peptization. (2 marks)

10. A sample of slag from a blast furnace is analyzed for SiO_2 by decomposing a 0.5003 g sample with HCl leaving a residue with a mass of 0.1414 g. After treating with HF and H_2SO_4, and evaporating the volatile SiF_4, a residue with a mass of 0.0183 g remains. Calculate the % w/w SiO_2 in the sample. (3 marks)

SECTION B (60 marks)

Answer any *THREE* questions from this section in the spaces provided after question 15

11. (a) You are provided with the following:
- Standard $KMnO_4$
- large beaker
- balance
- $KMnO_4$ solid
- deionised water
- watch glass
- hot plate
- fume chamber
- stop watch
- filter crucible
- Concentrated HCl
- dark stoppered bottle.

Explain how to prepare and standardize a 0.02 M $KMnO_4$ solution. (10 marks)

(b) State any five advantages of conductometric titrations. (10 marks)

12. (a) Define the following:

(i) standard enthalpy change; (2 marks)

(ii) standard enthalpy of formation. (2 marks)

(b) 250 ml of 0.1 M HCl and 250 ml of 0.1 M NaOH are mixed at 298 K. If the rise in temperature during the experiment was 0.0078 K, calculate the molar heat of neutralization. Density of water at 4 °C=1 g/cm³, & specific heat capacity =4200 Jkg⁻¹K⁻¹ (8 marks)

(c) Explain any four practical methods of conserving energy. (8 marks)

13. (a) Distinguish between the following terms:

(i) titrant and titrand; (4 marks)

(ii) end point and equivalence point. (4 marks)

(b) Construct a titration curve for the titration of 25.0 ml of 0.125 M NaOH with 0 ml, 10 ml, 50 ml, 70 ml and 100 ml of 0.0625 M HCl ($k_w = 10^{-14}$) clearly indicating the equivalence point. (12 marks)

14. (a) A mixture containing only $FeCl_3$(fw=162.2) and $AlCl_3$(fw = 133.34) weighs 5.95 g. The chlorides are converted to hydroxides and ignited to Fe_2O_3(fw = 159.7) and Al_2O_3(fw = 101.96). If the oxide mixture weighed 2.26 g, calculate the % Fe (fw = 55.85) and % Al (fw = 26.98) in the mixture. (12 marks)

(b) Explain any four precautions undertaken when determining a chloride as AgCl from a soluble sample. (8 marks)

15. (a) Define the following terms:

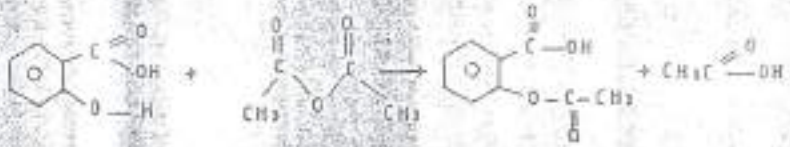
(i) adsorption; (2 marks)

(ii) absorption. (2 marks)

(b) 25 ml of 0.002 M K_2CrO_4 are mixed with 75 ml of 0.000125 M $Pb(NO_3)_2$. Determine whether a precipitate forms or not. (K_{sp} for $PbCrO_4$ = 1.8 X 10^{-14}). (8 marks)

(c) A sample of aspirin was prepared by reacting 2.20 g of salicylic acid with 4.20 ml of ethanoic anhydride in a conical flask. After heating for 20 minutes, the reaction mixture was cooled and white crystals precipitated, collected, dried to constant mass and weighed.

The reaction equation is as follows:



Given the following information:

Mass of product	=	2.25 g
Molar mass of aspirin	=	180
Molar mass of salicylic acid	=	138
Molar mass of ethanoic anhydride	=	102
Specific density of ethanoic anhydride	=	1.08

calculate the % yield of aspirin. (8 marks)