JINJA MODERN SENIOR SECONDARY SCHOOL

Uganda Advanced Certificate of Education
S5 END OF TERM TWO 2024
CHEMISTRY
Paper 1
P525/1
2 hours 45 minutes

Name……

Combination……

INSTRUCTIONS :

Answer **all** *questions in section* **A** *and* **six** *questions in section* **B**
All questions must be answered in the spaces provided

The Periodic Table, with relative atomic masses, is supplied.

Mathematical tables (3 – figure tables) are adequate or non-programmable scientific electronic calculators may be used

Illustrate your answers with equations where applicable.

Where necessary, use the following:

Molar gas constant R = 8.31 JK^{-1} mol^{-1}

Molar volume of a gas at s.t.p is 22.4 litres.

Standard temperature = 273 K

Standard pressure = 101325 N m^{-2}

For Examiner's Use Only																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

SECTION A (46 MARKS)

1 (a) The label on a nitric acid bottle reads as follows:

Relative molecular mass = 63.01
70% m/v nitric acid
Relative density 1.42 g cm^{-3}

(i) Calculate the molarity of nitric acid *(1½marks)*

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(ii) 12.5 cm^3 of nitric acid was diluted to 250 cm^3 of solution in a volumetric flask. What volume of that solution will neutralise 20 cm^3 of 0.1 M sodium carbonate solution. *(3 marks)*

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2. 20cm^3 of a gaseous hydrocarbon (**Y**) was ignited with 205cm^3 of oxygen in excess. On cooling to room temperature the volume of the residual gas was found to be 185cm^3. When the residual gas was treated with concentrated potassium hydroxide solution, there was a volume contraction to 125cm^3.

(a) Calculate the molecular formula of **Y** *(02 marks)*

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(b) Y reacts with Tollen's reagent to form a white precipitate. Suggest the structure of **Y** and give its IUPAC name *(01 mark)*

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(c) Write equation(s) for synthesis of Y from magnesium *(01½ marks)*

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3. Explain the following observations,

(a) Relative stability of +2 oxidation state in group(IV) increases down the group whereas that of +4 decreases. *(2 marks)*

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(b) The determination of molecular mass of polymers, osmotic pressure is used instead of ebullioscopic and cryoscopic methods.

(1 mark)

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c) Calcium compounds have higher melting points than aluminium compounds.

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(d) The acid strength of oxoacids of chlorine decreases in the order $HClO_4 > HClO_3 > HClO_2 > HClO$

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4. Complete the following equations and in each case name the main organic product.

(a) $CH_3CH_2I \xrightarrow[\text{dry ether}]{\text{Na}}$ ..... *(1½ marks)*

Name of product

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(b) $CH_3CH{=}CH_2 + HBr \xrightarrow{\text{ROOR}}$ ..... *(1½ marks)*

Name of product

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(c) $CH_3CH_2Br \xrightarrow[\text{heat}]{CH_3CH_2OH/KOH}$ ..... *(1½ marks)*

Name of product

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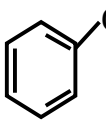
(d) CH_3CH_2OH +  $\xrightarrow[\text{heat}]{H^+}$ .....*(1½ marks)*

Name of product

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5. (a) (i) What is meant by the term diagonal relationship?

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(ii) State **three** properties in which beryllium and aluminium are similar.

(1½ marks)

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(b) Write equation(s) for the reaction(s) between the following

(i) Aluminium and sodium hydroxide. *(1½ marks)*

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(ii) Beryllium carbide and water. *(1½ marks)*

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6. (a) Define the term **hydration energy**. *(02 marks)*

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(b) State **two** factors which affect the magnitude of hydration energy. *(01 mark)*

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(c) The table below shows enthalpies of hydration of Ca^{2+} and Cl^{-} ions.

Ion	**Enthalpy of hydration (kJ mol^{-1})**
Ca^{2+}	1577
Cl^{-}	381

(i) State whether the values of enthalpies of hydration given in the table above are positive or negative. Give a reason for your answer. *(1 ½ mark)*

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(ii) Calculate the enthalpy of hydration of calcium chloride

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7. (a) State what would be observed and write an equation(s) for the reaction(s) that would take place when to a solution of iron(II) sulphate was added.

(i) aqueous sodium hydroxide drop wise until in excess. *(3½ marks)*

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(ii) a few drops of concentrated nitric acid and the mixture boiled. *(2½ marks)*

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8. The first ionization energies of some group II metals of the periodic table and melting points of their chlorides are given in the table below

Metal	**Mg**	**Ca**	**Sr**	**Ba**
1st ionization energy kJ mol^{-1}	738	590	549	505
Melting point of chlorides	708	772	873	967

Briefly explain the variation in trends of:

(a) the first ionization energy. *(2 ½ marks)*

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(b) melting points of the chlorides *(2 ½ marks)*

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9 (a) Write the electronic configuration of element Gallium (Ga) *(½ marks)*

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(b) Natural gallium consists of isotopes ^{69}Ga and ^{71} Ga in atomic ratio 3**:**2. The relative isotopic masses of ^{69} Ga and ^{71}Ga are 68.9 and 70.9 respectively. Calculate the approximate relative atomic mass of Gallium. *(1½ marks)*

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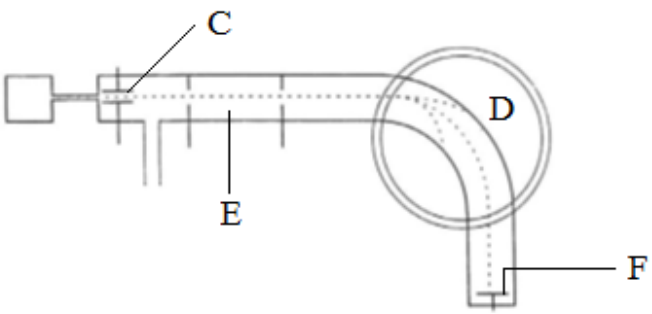
(c) The figure below represents a mass spectrometer.



Name and state the function of parts
(2marks)

C ……

D …….

E ……..

F ……..

SECTION B: (54 MARKS)

Answer **six** *questions from this section.*
Additional questions answered will **not** *be marked.*

10. (a) State **three** methods used in determining rates of chemical reactions.
(01½ marks)

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(b) The following experimental results were obtained for the reaction

Experiment No.	Initial concentrations /mol dm^{-3}		Initial rate of increase of NO*Cl*/mol dm^{-3} s^{-1}
	[Cl_2]	[NO]	
1	0.10	0.10	1×10^{-4}
2	0.10	0.20	4×10^{-4}
3	0.30	0.10	3×10^{-4}

(i) Deduce the order of reaction with respect to

- Chlorine (Cl_2) *(01½ marks)*

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- Nitrogen(II) oxide (NO) *(01½ marks)*

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(ii) Calculate the overall order of reaction. *(01 mark)*

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(a) (i) Write the rate equation for the reaction *(01 mark)*

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(ii) Calculate the value of the rate constant (K) and give its units. *(02½ marks)*

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12. (a) State the type of bond that exists in:

(i) lead(II) chloride: .....*(1 mark)*

(ii) lead(IV) chloride: .....*(1 mark)*

(iii) silicon(IV) chloride: .....*(1 mark)*

(iv) Aluminium oxide: .....*(1 mark)*

(b) State two physical properties which show that lead(II) chloride has the type of bond you have stated in (a)(i) above. *(02 marks)*

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(c) Write an ionic equation for the reaction between aqueous sodium hydroxide solution and.

(i) Aluminium oxide: *(1½ marks)*

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(ii) Silicon(IV) oxide: *(1½ marks)*

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13 A compound P contains 60.0% carbon,13.3% hydrogen and the rest oxygen.

(a) Calculate the empirical formula of P *(1½ marks)*

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(b) 0.698g of P in 100g of solvent lowered the freezing point of solvent by $0.190^{O}C$ (Kf for solvent is 1.63 $^{o}C\ Mol^{-1}K^{-1}$)

(i) Determine the molecular formula of P. *(03 marks)*

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(ii) P reacted with aqueous iodine and sodium hydroxide solution forming a yellow precipitate. Write the structural formula and name of P *(02 marks)*

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(c) Write the mechanism for the reaction between P and hot concentrated orthophosphoric acid *(02½ marks)*

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13 (a) State **three** reasons why fluorine differs in its properties from the other elements of group VII *(03 marks)*

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(b) Write equations for reactions of fluorine with

(i) Water

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(ii) Cold dilute sodium hydroxide

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(iii) Hot dilute sodium hydroxide

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(c) Write an equation for the reaction between hydrofluoric acid and silicon dioxide. *(01½ marks)*

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14. Nitrogen and hydrogen react to form ammonia according to the following equation.

$$3H_{2(g)} + N_{2(g)} \rightleftharpoons 2NH_{3(g)} \Delta = -92kJ$$

(a) State the industrial conditions used to obtain maximum yield of ammonia. *(01½ marks)*

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(b) During the manufacture of nitric acid ammonia is catalytically oxidized to P which is further oxidized to Q. Q is then reacted with water to produce nitric acid.

(i) Name P and Q

P is.....*(½ marks)*

Q is.....*(½ marks)*

(ii) Write equations for the formation of P, Q and nitric acid.

Equation for the formation of P: *(01½ marks)*

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Equation for the formation of Q: *(01½ marks)*

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Equation for the formation of nitric acid: *(01½ marks)*

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(c) Write equations for the reaction of concentrated nitric acid and
(i) carbon *(01½ marks)*

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(ii) copper *(01½ marks)*

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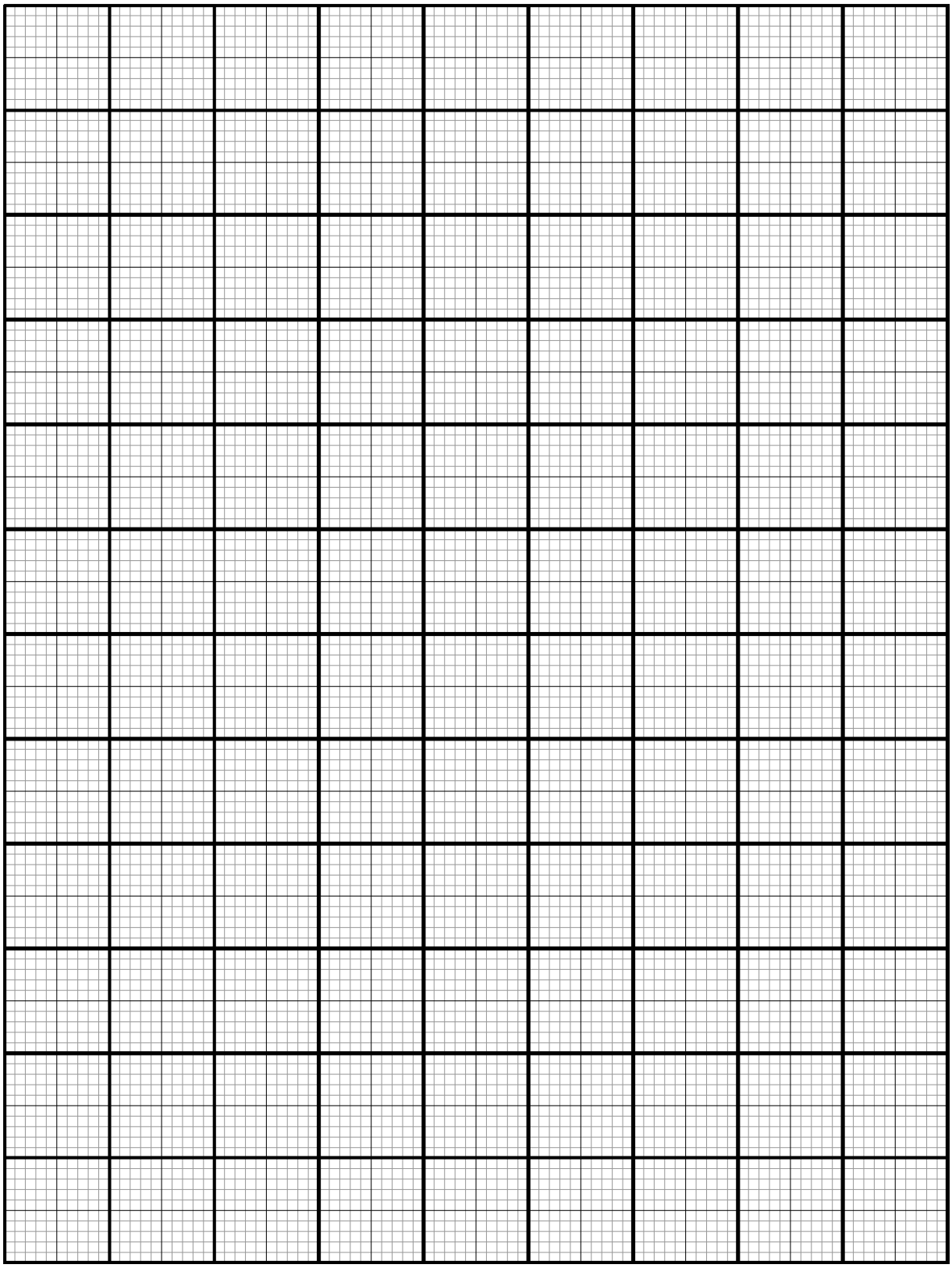
15. The kinetic data for the reaction between P and sodium hydroxide is shown in the table below.

Concentration of P (mol l^{-1})	1.05	0.88	0.74	0.51	0.37	0.26	0.16	0.10
Time	0.0	3.5	7.0	14.5	20.0	27.0	35.5	45.0

(a) Plot a graph of Concentration of P against Time *(03 marks)*



Determine

(i) the half life of P *(03 marks)*

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(ii) the order of the reaction. *(01 mark)*

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(iii) the rate constant for the reaction *(02 marks)*

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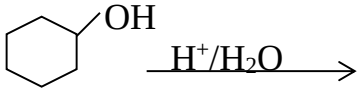
16 Complete the following organic reactions and write the accepted mechanisms.

(a) 

……*(3 marks)*

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(b)$(CH_3)_2C=CH_2 \xrightarrow[\text{Warm}]{H^+/H_2O}$ ……*(3 marks)*

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(c) $CH_3C\equiv CH \xrightarrow[H_2SO_4(aq)/\ HgSO_4(aq)]{H_2O,\ \text{heat } 60^oC}$ …… *(3 marks)*

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17. (a) Draw the structure and name the shape adopted by the following molecules. *(4 marks)*

Molecule	**Structure**	**Shape**
$BeCl_2$		
H_2S		

(b) Explain why the molecules adopt the shapes you have stated in (a) above.

(i) $BeCl_2$ *(2½ marks)*

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(ii) H_2S *(2½ marks)*

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PERIODIC TABLE

2											3	4	5	6	7
															1 H 1.0
4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0
12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.4
20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9
38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.9	44 Ru 101	45 Rh 103	46 Pd 103	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127
56 Ba 137	57 La 139	72 Hf 178	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 Ti 204	82 Pb 207	83 Bi 209	84 Po (209)	85 At (210
88 Ra (226)	89 Ac (227)														
		57 La 139	58 Ce 140	59 Fr 141	60 Nd 144	61 Pm (145)	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 162	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173
		89 Ac (227)	90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf 251	99 Ea (254)	100 Fm (257)	101 Mv (256)	102 No (254

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1. **H – indicates Atomic number**

2. **H – indicates relative Atomic mass**
   1.0

END