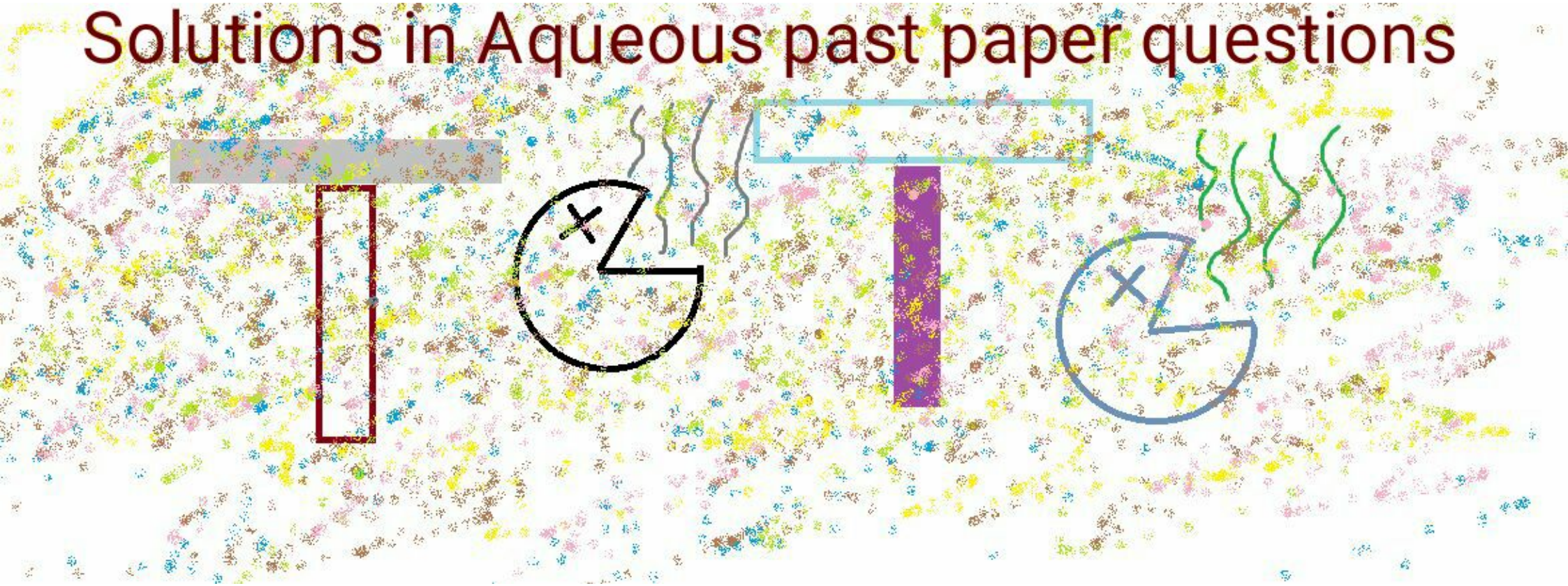
Solutions in Aqueous past paper questions



QUESTION THREE (REACTION IN AQUEOUS SOLUTION) [25 Marks]

a) Predict whether mixing each pair of the following solutions will result in the formation of a precipitate. If so, identify the precipitate. [5]

i. $KOH_{(aq)}$ and $H_3PO_{4(aq)}$
ii. $K_2CO_{3(aq)}$ and $BaCl_{2(aq)}$
iii. $Ba(NO_3)_{2(aq)}$ and $Na_2SO_{4(aq)}$

2023 test 1

b) Calculate the oxidation state of each of the following:

i. Cr in $Cr_2O_7^{2-}$ [2]
ii. S in H_2SO_4 [2]

c) Given the following reaction:

$$CuS(s) + NO_3^-{}_{(aq)} \rightarrow Cu^{2+}{}_{(aq)} + SO_4^{2-}{}_{(aq)} + NO_{(g)}$$

i. Identify the oxidizing and reducing agents [4]
ii. Write the two half reaction equations specifying which one is the oxidation half reaction and which one is the reduction half reaction. [4]
iii. Balance each of the two half reaction equations. [4]
iv. Considering that the reaction is taking place in acidic medium, write the overall balanced equation for this redox reaction. [4]

QUESTION TWO (Stoichiometry and Aqueous Solutions). **[20 Marks]**

a) Calculate the volume of 16.0 M H_2SO_4 that must be used to prepare 1.5 L of a 0.10 M H_2SO_4 solution? **[4]**

b) Balanced the following reaction ionic in basic media. **[8]**

$$MnO_4^- + I^- \longrightarrow MnO_2 + I_2$$

c) Aqueous barium nitrate is added to dilute sulfuric acid to form a barium sulphate precipitate plus aqueous nitric acid. For this reaction:

i) Write the balanced chemical equation **[3]**

ii) Write the net ionic equation **[3]**

d) Determine the oxidation state of each of the following:

i) Mn in $KMnO_4$

ii) O in Na_2O_2 **[2]**

QUESTION 3: REACTIONS IN SOLUTION 2022 test 1 [25 MARKS]

a) A redox reaction is defined as a reaction in which oxidation and reduction take place simultaneously. Identify the following changes as either oxidation or reduction: [6]

(i) BiO_3^- to Bi^{3+}

(ii) N_2O_4 to N_2O

(iii) SO_2 to SO_3

b) Identify the oxidizing and reducing agents in each of the following reactions [4]

(i) $I_2O_5 + 5CO \rightarrow 5CO_2 + I_2$

(ii) $2Fe^{2+} + H_2O_2 + 2H^+ \rightarrow 2Fe^{3+} + 2H_2O$

c) One litre of solution is prepared by dissolving 125.6 g of NaF in it. If you took 180.0 mL of that solution and diluted it to 500 mL determine the molarity of the resulting solution [5]

d) Sodium chloride, NaCl, reacts with lead (II) nitrate, $Pb(NO_3)_2$, to form lead (II) chloride, ($PbCl_2$) and sodium nitrate, $NaNO_3$. For this reaction write [10]

(i) Balanced molecular Equation,

(ii) Complete Ionic Equation

(iii) Net Ionic Equation:

Assume all reactions occur in aqueous solution. Include states of matter in your equations

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3: REACTIONS IN AQUEOUS SOLUTIONS & STOICHIOMESTRY [20 Marks]

a) The oxidation number of an element is the "charge" the element would have if all of its bonds were completely ionic, that is, if the electron pairs of each bond were transferred to the more electronegative atom. Determine the oxidation state of: [2]

i) Chromium in $K_2Cr_2O_7$

ii) Lead in $Pb(OH)_4^{2-}$

b) Identify the oxidizing and reducing agent in the following reaction [2]

$$2Fe^{2+} + H_2O_2 + 2H^+ \rightarrow 2Fe^{3+} + 2H_2O$$

c) Nickel nitrate, $Ni(NO_3)_2$ reacts with sodium hydroxide (NaOH) to produce sodium nitrate ($NaNO_3$) and a solid nickel (II) hydroxide, $Ni(OH)_2$ Write balanced *molecular*, *ionic*, and *net ionic* equations for the reaction. Assume all reactions occur in aqueous solution. Include states of matter in your balanced equation. [6]

d) Solid sodium and iron (III) oxide are involved in a reaction that is one of many reactions responsible for inflating a car airbag. [10]

$$6Na + Fe_2O_3 \rightarrow 3Na_2O + 2Fe$$

If 100.0 g Na and 100.0 g Fe_2O_3 are used, determine:

i) limiting reactant

ii) moles excess reactant

iii) mass of solid iron produced

iv) mass of excess reactant left over

v) what is the percent yield if 58.8 g of solid iron were produced?

QUESTION 3: REACTIONS IN SOLUTION 2021 test 1 [25 MARKS]

a) In the table below, indicate the solubility of the given species. Giving your answer as; Soluble, insoluble or slightly soluble.

Specie (s)	Solubility
NO_3^-	
NH_4^+	
AgCl	
SO_4^{2-}	
CO_3^{2-}	

[5]

b) A standard solution is prepared by dissolving 10 g of NaCl in 500 mL of water.

i. Calculate the molar concentration of the standard solution, [5]

ii. From the standard solution, calculate volume required to prepare a dilute solution with a concentration of 0.05 M in a 100 mL volumetric flask. [3]

c) In the reaction;

$$CuSO_4\,(aq) + Zn\,(s) \rightarrow ZnSO_4\,(aq) + Cu\,(s)$$

Give the reduction and oxidation half equations. [2]

d) Balance the following redox equation in acidic solution;

$$SO_3^{2-}{}_{(aq)} + MnO_4^-{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + Mn^{2+}{}_{(aq)}$$ [10]

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QUESTION 2: REACTIONS IN AQUEOUS SOLUTIONS [20 MARKS]

a) Assign oxidation numbers to the elements whose atoms are underlined in each of the following compounds or ions:

$$C = \frac{5}{9}(F - 32)$$

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Compound/ion	Element: Oxidation Number
$K\underline{N}O_3$	N:
$\underline{Al}H_3$	Al:
$\underline{N}H_4^+$	N:
$H_2\underline{P}O_4^-$	P:

$2KBr + Cl_2 \rightarrow Br_2 + 2KCl$

[4]

b) Bromine trifluoride ($BrCl_3$) is a strong ionizing inorganic solvent. It is also used for manufacturing uranium hexafluoride (UF_6) while processing and reprocessing nuclear fuel.

i. Write a balanced chemical equation for the dissociation of liquid Bromine trifluoride to form chlorine and bromine in solution, [2]

ii. If 3.54 moles of $BrCl_3$ reacts according to the equation, how many moles of Cl_2 will be formed? How many moles of Br_2 will be formed? [4]

iii. To ensure stability of uranium hexafluoride (UF_6), an 8.19 g compound of C, H, and O is burned in a cylinder. From this, 20.3 g of CO_2 and 10.1 g of H_2O are formed. What is the empirical formula of the compound? [10]

QUESTION THREE [25 MARKS]

2019 test 2

REACTIONS IN AQUEOUS SOLUTIONS

(a) A solution is prepared by dissolving 36.4 g CaI_2 in 750 mL of water. What is the molarity of the solution?

(b) Identify each of the following changes as either oxidation or

Reduction. Recall that e- is the symbol for an electron.

(i) $I_2 + 2e^- \rightarrow 2I^-$ (ii) $Fe^{2+} \rightarrow Fe^{3+} + e^-$

(c) Identify what is oxidized and what is reduced in the following process.

$$2Ce + 3Cu^{2+} \rightarrow 3Cu + 2Ce^{3+}$$

(d) Identify the oxidizing agent and the reducing agent in the above process. Explain your answer.

(e) Use the oxidation number method to balance the following redox reaction.

$$Cu + HNO3 \rightarrow Cu(NO_3)_2 + NO_2 + H_2O$$

QUESTION 2: REACTIONS IN SOLUTIONS **[20 MARKS]**

(a) Order the following molecules from lowest to highest oxidation state of the nitrogen atom: HNO_3, NH_4Cl, N_2O, NO_2, $NaNO_2$. [2.5]

(b) List the three important types of solution reactions. [½ mark/correct answer] [1.5]

(c) Which of the following statements is (are) true? For the false statements, correct them. [1 mark per correct answer]

(i) A concentrated solution in water will always contain a strong or weak electrolyte.

(ii) A strong electrolyte will break up into ions when dissolved in water.

(iii) An acid is a strong electrolyte.

(iv) All ionic compounds are strong electrolytes in water. [4]

(d) A 1.42 g sample of a pure compound, with formula M_2SO_4, was dissolved in water and treated with an excess of aqueous calcium chloride, resulting in the precipitation of all the sulphate ions as calcium sulfate. The precipitate was collected, dried, and found to weigh 1.36 g. Determine the atomic mass of M, and identify M. [5]

(e) What volume of 0.100*M* HCl will react with 50.00mL of 0.200*M* NaOH? [3]

(f) Metallurgy, the process of producing a metal from its ore, always involves redox reactions. In the metallurgy of galena (PbS), the principal lead-containing ore, the first step is the conversion of lead sulphide to its oxide (a process called *roasting*):

$$2PbS(s) + 3O_2(g) \rightarrow 2PbO(s) + 2SO_2(g)$$

The oxide is then treated with carbon monoxide to produce the free metal:

$$PbO(s) + CO(g) \rightarrow Pb(s) + CO_2(g)$$

For each reaction, identify the atoms that are oxidized and reduced, and specify the oxidizing and reducing agents. [4]

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QUESTION 3 2018 test 1 **25 MARKS**

(a) Name three examples of nonelectrolytes apart from sugar and alcohol. [3]

(b) Spanner Zulu, from Mutenguleni University made 10.0 L of 1.2 M Sobo drink. What was the initial molarity of the Sobo drink if he used only 2.5 L of it? [2]

(c) What volume in mL of 0.250 M potassium hydroxide solution is needed to react completely with a solution containing 1.00 g of phosphoric acid? [4]

(d) Kombe Chileshe from Lubushi University in Kasama was asked to prepare an insoluble salt called calcium phosphate from the reaction of calcium chloride and sodium phosphate.

i) What name is given to the type of reaction above? [1]

ii) Write the balanced chemical equation for the formation of calcium phosphate [2]

iii) Write the net ionic equation to show the formation of calcium phosphate [2]

(e) Identify the species that are reducing and oxidizing agents in each of the following reaction.

i) $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$ [2

ii) $CO_3^{2-} + 2H^+ \rightarrow CO_2 + H_2O$ [

$x + (-6) = 6$ $x + (2 \times 2) =$

(f) Consider the redox reaction below

$$Cr_2O_7^{2-}(aq) + HNO_2(aq) \rightarrow Cr^{3+}(aq) + NO_3^-(aq)$$

i) Write the balanced oxidation half reaction of the equation above

ii) Write the balanced reduction half reaction of the equation above

iii) Write the balanced overall reaction in basic medium of the equation above

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QUESTION 6: REACTIONS IN SOLUTION **[20 MARKS]**

(a) Define the following

(i) Titrant [1]

(ii) Standard solution [1]

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(b) Answer the following questions

(i) What is the difference between an end point and the equivalence point in a titration? [2]

(ii) What is the difference between a direct titration and a back titration? [2]

(c) Answer the questions below

(i) Calculate the molarity of silver nitrate solution when 117.40 g of silver nitrate is dissolved in a litre of solution. [3]

(ii). Calculate the amount of sodium hydroxide in milligrams for a 0.500 mol/L sodium hydroxide solution whose volume is 100 mL. [3]

(d) A 0.500 g sample containing sodium dihydrogen phosphate is titrated with sodium hydroxide:

$$OH^- + H_2PO_4^- \rightarrow HPO_4^{2-} + H_2O$$

If 23.06 mL of 0.0985 M sodium hydroxide is required for the titration, what is the percentage of NaH_2PO_4 in the sample? [4]

(e) A 0.3147 g sample of primary standard grade $Na_2C_2O_4$ was dissolved in dilute H_2SO_4 and titrated with a solution of $KMnO_4$. The end point was observed after the addition of 31.67 mL of the titrant. Use the unbalanced reaction in acidic media is given below to write the balance redox reaction. [4]

$$C_2O_4^{2-} + MnO_4^- \rightarrow Mn^{2+} + CO_2 + H_2O$$

The Periodic Table

1	2											3	4	5	6	7	0
1 **H** 1.01				Atomic Number **Element** Atomic Mass													2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.21	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (281)	111 **Rg** (272)	112 **Cn** (285)	113 **Uut** (284)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (291)	117 **Uus** (Unknown)	118 **Uuo** (294)

58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

TABLE OF FUNDAMENTAL CONSTANTS

Quantity	symbol	Value	Power of ten	Units
Speed of light	c	2.9979	10^{8}	m s^{-1}
Elementary charge	e	1.602	10^{-19}	C
Faraday's constant	$F=N_Ae$	9.6485	10^{4}	C mol^{-1}
Boltzmann's constant	k	1.380 65	10^{-23}	J K^{-1}
Gas constant	$R=N_Ak$	8.314 47 8.314 47 8.205 74 6.236 37	 10^{-2} 10^{-2} 10	J K^{-1} mol^{-1} L bar K^{-1} mol^{-1} L atm K^{-1} mol^{-1} L Torr K^{-1} mol^{-1}
Planck's constant	h	6.626 08	10^{-34}	Js
Avogadro's constant	N_A	6.022 14	10^{23}	mol^{-1}
Atomic mass unit	m_u	1.660 54	10^{-27}	Kg
Mass				
Electron	m_e	9.109 38	10^{-31}	Kg
Proton	m_p	1.672 62	10^{-27}	Kg
neutron	m_n	1.674 93	10^{-27}	kg
Rydeberg constant	R_H	1.097 37	10^{7}	m^{-1}
1 atm = 760 mmHg = 760 Torr = 1.01325 x 10^5 Nm^{-2} = 1.01325 x10^5 Pa= 1.01325 bar				