

CONTEST 1

ROUND 1

PREAMBLE: Select the odd item out of the list and give a reason.

1. Na_2CO_3 , K_2SO_4 , $\text{Mg}(\text{HCO}_3)_2$ and KNO_3 .
ANSWER: $\text{Mg}(\text{HCO}_3)_2$, the rest are normal salts, but $\text{Mg}(\text{HCO}_3)_2$ is an acid salt.
 2. $\text{KAl}(\text{SO}_4)_2$, $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 5\text{H}_2\text{O}$, $\text{K}_2\text{Fe}(\text{SO}_4)_2$ and $\text{NH}_4\text{Al}(\text{SO}_4)_2$.
ANSWER: $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 5\text{H}_2\text{O}$, the rest are double salts, but $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 5\text{H}_2\text{O}$ is a hydrated double salt.
 3. PbCO_3 , Li_2CO_3 , Ag_2CO_3 , and Na_2CO_3
ANSWER: Na_2CO_3 the rest of the salts decompose on heating, but Na_2CO_3 does not decompose on heating.
1. 25.0 cm^3 of 0.15 mol dm^{-3} HCl solution was mixed with 25 cm^3 of deionised water and then titrated against 0.20 mol dm^{-3} solution of NaOH . Calculate the volume of NaOH required to neutralize the HCl solution.
ANSWER: 18.75 cm^3
 2. 25.0 cm^3 of 0.20 mol dm^{-3} NaOH was mixed with 25.0 cm^3 of deionised water and then titrated against H_2SO_4 solution. If 15.0 cm^3 of the H_2SO_4 solution was required for complete neutralization, calculate the concentration of H_2SO_4 solution.
ANSWER: 0.17 mol dm^{-3}
 3. 25.0 cm^3 of 0.15 mol dm^{-3} Na_2CO_3 solution was mixed with 25.0 cm^3 deionised water and the resulting solution titrated against a solution of HCl using phenolphthalein as indicator. If the volume of HCl solution required for complete neutralization is 24.0 cm^3 , calculate the concentration of the HCl solution.
ANSWER: $0.156 \text{ mol dm}^{-3}$ (accept 0.16 mol dm^{-3}).
1. What would be observed when a solution containing Na^+ ions is added to a solution of zinc uranylacetate?
ANSWER: A yellow precipitate forms.
 2. What would be observed when SO_2 gas is bubbled through a solution of Na_2S ?
ANSWER: A yellow precipitate forms.
 3. What would be observed when a few drops of potassium iodide solution is added to an aqueous solution of lead nitrate?
ANSWER: A yellow precipitate forms.

ROUND 2 – SPEED RACE

1. Two elements **A** and **B** combine to form two different compounds A_2B and A_3B_2 . If 0.1 mole of A_2B weigh 10.0 g and 0.05 moles of A_3B_2 weigh 9.0 g, determine the atomic masses of **A** and **B**.
ANSWER: $A = 20$ and $B = 60$
2. The kinetics of a reaction between two substances **A** and **B** were studied at constant temperature and the rate equation was found to be $\text{Rate} = k[\text{B}]$. Explain this observation.

ANSWER: The reaction is zero order with respect to **A** and first order with respect to **B**.

3. Give the element in period 3 of the periodic table that forms neutral oxide, but the oxide reaction with an alkali solution to produce a salt.

ANSWER: Silicon (accept Si)

ROUND 4 – True or False

1. The ionic product of water whose value is 1.0×10^{-14} is best determined at a temperature of 25°C .

ANSWER: False

2. The negative logarithm to base two of the equation of the ionic product of water gives the equation that establishes the relationship between pH and pOH.

ANSWER: False

3. The concentration of hydrogen ions and hydroxide ions in water at 25°C are the same and their product is $1.0 \times 10^{-14} \text{ mol dm}^{-3}$.

ANSWER: True

1. The isotope of a given element may have the same mass number as an isotope of another element even though the atomic numbers are different.

ANSWER: True

2. Two species are described as isotones when they have different atomic numbers with the same mass numbers due to the different proton numbers.

ANSWER: False

3. Isotopes of different elements differ in mass numbers and atomic numbers, but they may contain the same number of neutrons in their nuclei.

ANSWER: True

ROUND 5 – RIDDLE

Words such as *same* and *but different* describe my existence.

I can be twins, triplets, quintuplets, etc

My existence is determined by the use of a meter in a spectroscopic analysis.

I am used to describe atoms of elements.

Can you identify me now, if not, I indicate atoms of an element with the same positive particles in the nucleus, but the weight differ.

WHO AM I?

ANSWER: Isotope

CONTEST 2
ROUND 1

1. A gas was compressed isothermally until the pressure increased by 75%, if the initial volume of the gas is 240 dm^3 , determine the change in volume after the compression.
ANSWER: 102.86 dm^3
2. A fixed quantity of gas at 21°C was compressed until the pressure doubled. What is the new temperature of the gas?
ANSWER: 315°C
3. In an isobaric compression, the temperature of a fixed quantity of gas increased from 25°C to 78°C . Calculate the new volume of the gas if it initially occupied 120 dm^3
ANSWER: 141.34 dm^3

Preamble: Bond energy of a molecule or compound is measured in kJ per mole. State **one** use or application of bond energy.

- Determination of bond strength
 - Comparison of bond strength
 - Determination of stability of the bond
 - Calculation of enthalpy/energy change of a chemical reaction.
1. Define the term *a conjugate base* as applied to Bronsted – Lowry concept of acids and bases.
ANSWER: A conjugate base is the proton acceptor produced after a transfer of a proton by the original acid.
 2. State the expression for the *autroprotolysis of water* at 25°C .
ANSWER: $K_w = [\text{H}_3\text{O}^+][\text{OH}^-]$ or $K_w = [\text{H}^+][\text{OH}^-]$
 3. Define the term *amphoterism*.
ANSWER: It is the property of a base that allows it to react with both acids and bases.
Or It the ability of a base to react with both acids and bases.

ROUND 2 – SPEED RACE

1. A rate equation for a given reaction at a given temperature is given by $\text{Rate} = k[\text{P}]^2[\text{Q}]$, determine the new rate if the concentrations of **P** is doubled and that of **Q** is halved.
ANSWER: Rate increases by 2 or rate doubles
2. What is the hybridization of the carbon atom containing the functional group in alkanolic acids?
ANSWER: sp^2
3. What mass of potassium bicarbonate must be heated to produced 6.72 dm^3 of carbon(IV) oxide gas at s.t.p? Leave your answer in one place of decimal [$\text{KHCO}_3 = 100$, molar volume = 22400 cm^3]
ANSWER: 60.0 g

ROUND 4 – True or False

1. Hybridization as a bonding concept permits the determination of shape of all chemical substances in their ground state as the ground states shows the stability of the compound.
ANSWER: False
 2. The hybridization of N in NH_3 and P in PH_3 are the same, but the molecular structures of NH_3 and PH_3 are not the same.
ANSWER: True
 3. The hybridization of S in SO_2 and C in CO_2 are the same and so SO_2 and CO_2 have the same molecular structure.
ANSWER: False
-
1. Propene and cyclopropane are members of the same homologous series.
ANSWER: False
 2. 2 – methylbutan – 1 – ol and 2 – methylbutan – 2 – ol are both position and functional group isomers.
ANSWER: False
 3. Ethanoic acid and methylmethanoate are functional group and chain isomers.
ANSWER: True

ROUND 5 – RIDDLE

History tells you that I am a summary.

My summary consists of four main ideas.

I am one of the famous theories in chemistry.

I was used in an attempt to describe the structure of an atom.

All the four of us have been disproved, even though we are still relevant in science.

I am the first scientific attempt to describe the basic particle of matter.

I was discovered by John Dalton.

WHO AM I

ANSWER: Dalton's Atomic Theory (Do not accept Atomic Theory)

CONTEST 3

ROUND 1

Preamble: State what would be discharged at each electrode of the following solutions and the fate of the solution.

1. Dilute copper sulphate using carbon electrodes
ANSWER: Cathode – copper and anode – oxygen gas, solution becomes sulphuric acid
2. Dilute sodium sulphate using carbon electrode.
ANSWER: Cathode – hydrogen gas and anode – oxygen gas, solution remains sodium sulphate.
3. Dilute sodium chloride using carbon cathode and copper cathode.
ANSWER: Cathode – copper and anode – none, solution remains as dilute sodium chloride.

Preamble: Determine the percentage by mass of carbon in the following compounds. Leave your answer in 2 places of decimals.

1. $\text{Na}_2\text{C}_2\text{O}_4$ [Na = 23, O = 16, C = 12]
ANSWER: 17.91%
2. $\text{C}_2\text{H}_4\text{O}_2$ [O = 16, C = 12, H = 1]
ANSWER: 40.00%
3. K_2CO_3 [K = 39, O = 16, C = 12]
ANSWER: 8.70%

Preamble: State the hybridization of the specified atom and shape of each of the following molecules.

1. Boron in B_2Cl_4 .
ANSWER: sp^2 and it is trigonal planar
2. Phosphorus in PCl_5 .
ANSWER: sp^3d and it trigonal bipyramid
3. Carbon in C_2H_6 .
ANSWER: sp^3 and it is tetragonal or tetrahedral

ROUND 2 – SPEED RACE

1. What is electrochemical equivalent?
ANSWER: It is the amount or mass deposited by 1 faraday of electricity.
2. 50.0 cm^3 of 0.48 moldm^{-3} solution of NaOH was diluted to 0.12 moldm^{-3} . Determine the volume of deionised water required.
ANSWER: 150.0 cm^3 (do not accept 150 cm^3)
3. What mass of NaCl is required to prepare 500.0 cm^3 of solution whose concentration is 0.25 moldm^{-3} . Leave your answer in 2 places of decimals [NaCl = 58.5]
ANSWER: 7.31 g

ROUND 4 – True or False

1. Rutherford's alpha scattering experiment was used to determine the actual size or volume of the atom.
ANSWER: False
 2. In the Rutherford's alpha scattering experiment, the scattering B and C were used to discover the charge and the location of the atomic nucleus.
ANSWER: True
 3. In the Rutherford's alpha scattering experiment, the scattering A accounted for the space occupied by the negative electrons a large volume.
ANSWER: True
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1. A conjugate base is a proton acceptor after the acceptance of a proton by the conjugate acid.
ANSWER: False
 2. An acid and its conjugate base differ by as many protons as possible considering the number of replaceable hydrogen ions in the acid.
ANSWER: False
 3. When a base accept a proton, it forms a conjugate acid that can form acid – conjugate base pair in the given solution.
ANSWER: True

ROUND 5 – RIDDLE

I am an apparatus found in the laboratory.

My name suggests that I am a funnel.

Unlike me, my cousins that are used to fill containers with liquids.

I am used to separate liquid mixtures.

As a results, you will usually find me in the analytical laboratory.

I have a feature that makes me look like a pregnant piece of glass ware.

I am used extensively in solvent extraction.

WHO AM I?

ANSWER: Separatory funnel

CONTEST 4

ROUND 1

1. Define the term *a nuclear reactor*.
ANSWER: A nuclear reactor is a system in which fission nuclear reaction occurs under controlled conditions.
2. Explain how the nuclear can be used to generate electricity.
ANSWER: The heat energy produced is used to convert water to steam which turns the turbines of a dynamo or generator (to produce electricity).
3. Give **any two** of the controlled conditions in a nuclear reactor.
ANSWER: - Reflectors, control rods, coolants and moderators (any two)

Preamble: An acrylonitrile (C_3H_3N) is produced industrially from propene, ammonia and oxygen according to the reaction: $C_3H_6 + NH_3 + O_2 \rightarrow C_3H_3N + H_2O$

1. Without giving the molecules, give the number of moles that would balance the reaction equation.
ANSWER: 2, 2, 3, 2, 6 respectively
2. What volume of oxygen gas would react completely with 6.72 dm^3 of C_3H_6 ?
ANSWER: 10.08 dm^3 (Do not accept 10.1 dm^3)
3. What mass of C_3H_3N would be formed if 6.72 dm^3 of ammonia reacted completely? Assuming conversion is 100%. [$C_3H_3N = 53$, molar volume = 22.4 dm^3]
ANSWER: 15.9 g
1. What volume would be occupied by 2.2 g of carbon(IV) oxide at s.t.p.? [molar volume = 22400 cm^3]
ANSWER: 1.12 dm^3 or 1120 cm^3
2. Determine the mass of 560 cm^3 of nitrogen gas at s.t.p. [N = 14, molar volume = 22.4 dm^3]
ANSWER: 0.7 g
3. What would the volume occupied by 4.0 g of sulphur(IV) oxide gas at s.t.p? [S = 32, O = 16, molar volume = 22400 cm^3]
ANSWER: 1.4 dm^3 or 1400 cm^3

ROUND 2 – SPEED RACE

1. A nuclide with mass number 32 and atomic number 15 undergoes a nuclear decay by emission of a beta particle. Give the mass and atomic number of the new nuclide produced, and identify the new nuclide.
ANSWER: Mass number is 32, atomic number is 16 and the nuclide is sulphur – 32.
2. A gas was collected over water at a pressure of 37.5 kPa at a temperature of 23°C containing 0.01 moles of the gas. If the vapour of water is 21kPa, determine the volume occupied by the gas. [R = 8.3]
ANSWER: 1.50 dm^3 (Accept 1.5 dm^3)
3. Determine the oxidation number of manganese in KMn_2O_3 .
ANSWER: +2 and +3

ROUND 4 – True or False

1. The general gas law or equation combines Charles' law and Gay Lussac's law of the ideal gas.
ANSWER: False
2. The ideal gas law or equation is combination of Boyle's law and Charles' law of the ideal gas.
ANSWER: True
3. The ideal gas law or equation allows the estimation of all the parameters such as number of moles, volume and pressure of an ideal gas.
ANSWER: False (temperature is included)
1. An acid – base indicator is a large water – soluble organic compound that displays different colours based on the pH changes of an aqueous solution.
ANSWER: True
2. An acid – base indicator changes colour in an acid – base titration depending of the pH of the solution as a factor of the indicator's dissociation constant.
ANSWER: True
3. An acid – base indicator response to only sharp changes in pH near the equivalent point in acid – base titration involving a weak acid and a weak base.
ANSWER: False

ROUND 5 – RIDDLE

Systematic working is my nature.

I am used in the acquisition of knowledge as I help to unravel lots of secrets of natural happenings.

I am a method in science for research works.

To utilize me fully you have to follow a procedure.

I allow making of observations, formulating hypotheses and performing of experiments my central focus.

To find me useful, you have to consider the general framework of a research.

I am always described as being scientific.

WHO AM I?

ANSWER: Scientific Method

CONTEST 5

ROUND 1

Preamble: State what happens during the following nuclear decay processes.

1. An alpha decay.
ANSWER: Part of the parent nuclide of mass 4 a.m.u. and atomic number 2 is taken to form a new or daughter nuclide.
2. A beta decay.
ANSWER: Neutron is converted to a proton (emitting an anti – neutrino).
3. A gamma decay.
ANSWER: The nuclear particles undergo re – arrangement by giving out energy in the form electromagnetic wave (to be stable).

Preamble: The solubility of **A** is 1.50 gdm^{-3} and **B** is 0.60 gdm^{-3} in petroleum – ether at 28°C .

1. If 2.00 g of a mixture of **A** and **B** dissolved in 500 cm^3 of petroleum – ether, what mass of the mixture remains undissolved at 28°C ?
ANSWER: 0.95 g
 2. If 5.00 g of a mixture of **A** and **B** is dissolved in 2000 cm^3 of petroleum – ether, what percentage of the mixture dissolves at 28°C ?
ANSWER: 84%
 3. What mass of each of **A** and **B** will be harvested when 800 cm^3 saturated solution at 28°C is evaporated to dryness?
ANSWER: 1.20 g of **A** and 0.48 g of **B**.
1. What name is given to the ore of iron which is a carbonate salt of the ore?
ANSWER: Siderite
 2. What name is given to the ore of aluminium which is a hydrated oxide?
ANSWER: Bauxite
 3. What name is given to the ore of iron which is an iron(III) oxide monohydrate?
ANSWER: Limonite

ROUND 2 – SPEED RACE

1. What element in group 2 of the periodic table burns in air at a high temperature to produce white dazzling light?
ANSWER: Magnesium (Accept Mg)
2. Give the systematic name of the compound $\text{K}_4[\text{Fe}(\text{SCN})_6]$.
ANSWER: Potassium hexathiocyanoferate(II)
3. Magnesium metal burns in nitrogen gas to produce magnesium nitride according to the reaction equation: $3\text{Mg} + \text{N}_2 \rightarrow \text{Mg}_3\text{N}_2$.
What mass of magnesium metal will burn in nitrogen gas to produce 10.0 of the nitride?

[Mg = 24, N = 14]

ANSWER: 7.2 g

ROUND 4 – True or False

1. Methane is the only hydride of period 2 elements that is covalent which neither acidic or base and insoluble in water.
ANSWER: True
2. Ammonia is the only non – metallic hydride of the periodic elements of the periodic table which covalent, but soluble in water to give alkaline solution.
ANSWER: True
3. The hydrides of oxygen, fluorine, sulphur, chlorine and iodine are covalent, but dissolve in water to give an acidic solution.
ANSWER: False
1. 20 cm^3 of carbon(IV) oxide gas at 298K and 100 Pa and 20 cm^3 of nitrogen gas at 298K and 100 kPa contain the same number of molecules according Avogadro's law on gases.
ANSWER: False
2. When gases react, they do so with their volumes bearing simple whole number ratios under all conditions and their products also conform to this behaviour.
ANSWER: True
3. In a sealed vessel containing a fixed quantity of a mixture of gas that do not react, the pressure remains the same as the temperature increases because the molecular collisions do not change.
ANSWER: False

ROUND 5 – RIDDLE

I am an outcome of quantitative method of analysis in chemistry.

I deal with numbers in my measurement.

You can also call me a value, because I have something to do with size of volumes.

You can obtain me from the difference in volumes.

I am associated with burette readings.

After a titration, a chemist always find my average and use it for his/her analysis.

WHO AM I?

ANSWER: Titre Value

CONTEST 6

ROUND 1

Preamble: Given the following reversible reactions at equilibrium, state the relationship between the size or values of the equilibrium constants K_c and K_p assuming it is a gaseous homogenous system.

- $2\text{NOCl} \rightleftharpoons 2\text{NO} + \text{Cl}_2$
ANSWER: Value of K_c is less than that of K_p
- $3\text{Cl}_2 + \text{PH}_3 \rightleftharpoons 3\text{HCl} + \text{PCl}_3$
ANSWER: Value of K_c is equal to that of K_p
- $2\text{NO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HNO}_3 + \text{HNO}_2$
ANSWER: Value K_c is greater than that of K_p

Preamble: 400 g of a radioactive nuclide with a half – life of 2 years stored in a sealed container.

- Determine the quantity of the radioactive nuclide left after 6 years?
ANSWER: 50 g
- What quantity will be available in 10 years?
ANSWER: 12.5 g
- Determine the number of decays or half – lives in 8 years.
ANSWER: 4 half - lives

Preamble: During extraction of iron from its ore, a mixture consisting of the iron ore, coke and limestone is fetched into the blast furnace from the top.

- What is the function of the coke?
ANSWER: It reacts to produce carbon(II) oxide that reduces the iron oxide to the metal.
- What is the fate of the limestone as it journeys down the blast furnace?
ANSWER: Decomposes to form calcium oxide that reacts with the impurities to produce slag.
- Slag contains two types of substances. What are they?
ANSWER: Calcium silicate and Calcium aluminium oxide (Calcium tetraoxoaluminate).

ROUND 2 – SPEED RACE

- Two 25.0 cm^3 solutions containing Na_2CO_3 of concentration 0.10 mol dm^{-3} were titrated against a 0.10 mol dm^{-3} solution of HCl using methyl orange and phenolphthalein respectively. What would be the volume of HCl that would neutralize each solution?
ANSWER: 25.0 cm^3 and 12.5 cm^3 respectively
- A student isolated a sample of oil from a given leave. Name the titrimetric method of analysis he could used to determine the relative molecular mass of the oil?
ANSWER: Indirect titration or Back titration
- An x – ray crystallography of an ionic solid indicated that its coordination number is 8:8. What crystal structure is adopted by the ionic compound?

ANSWER: Body – centred cubic (lattice)

ROUND 4 – True or False

1. An acid buffer solution can be used in the same way as a base buffer solution since the two are prepared to resist pH changes.

ANSWER: False

2. An acid buffer solution exist in nature and can also be prepared in the laboratory by mixing a weak acid and any salt in a fixed volume of solution.

ANSWER: False

3. A base buffer solution keeps the pH of a system fairly above 7 and it is prepared by mixing a weak base and a salt containing the conjugate acid of the weak base in a fixed volume of solution.

ANSWER: True

1. The d – orbital occurs at quantum number 3 with angular momentum quantum number 2, with the magnetic quantum number –1 to 1.

ANSWER: False

2. The size and shape of the s – orbital at any given quantum number is the same, but they all can take up to a maximum of two electrons with opposite spin.

ANSWER: False

3. The shape and size of the three p – orbitals is the same, and bear the labels p_x , p_y and p_z because they lie on the respective x, y and z coordinates and each can take a maximum number to two electrons.

ANSWER: True

ROUND 5 – RIDDLE

I am an element discovered in 1863

I was discovered by the German physicist Ferdinand Reich and metallurgist Hieronymus Theodor Richter.

My name derived from indigo for the “*indigo – blue*” line in the element’s spark spectrum.

I was obtained from examining zinc blende.

The sound of my name seems to suggest I come from India.

My atomic number is 49.

WHO AM I?

ANSWER: Indium

CONTEST 7

ROUND 1

Preamble: State the effect of aqueous solution of each of the following on litmus and give reasons for you answer.

1. FeSO_4 .
ANSWER: It turns blue litmus red, because the Fe^{2+} ions undergo hydrolysis producing excess H^+ ions in solution and rendering the solution acidic.
2. $(\text{NH}_4)_2\text{SO}_4$
ANSWER: It turns blue litmus red, because the NH_4^+ ions undergo hydrolysis producing excess H^+ ions in solution and rendering the solution acidic.
3. CH_3COOK
ANSWER: It turns red litmus blue, because the CH_3COO^- ions undergo hydrolysis producing excess OH^- ions in solution and rendering the solution alkaline.

Preamble: 25.0 cm^3 of a solution containing 19.5 g of $\text{Na}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ in 1.0 dm^3 was reacted with 24.0 cm^3 of a $0.025 \text{ mol dm}^{-3}$ of an acidified KMnO_4 solution.

Given that the reaction that took place is $2\text{MnO}_4^- + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O}$

1. Determine the concentration of $\text{Na}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ in mol dm^{-3} .
ANSWER: 0.06 mol dm^{-3}
 2. Determine the relative molecular mass of $\text{Na}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$.
ANSWER: 325
 3. What is the value of x in $\text{Na}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$? [$\text{Na}_2\text{C}_2\text{O}_4 = 134$, $\text{H}_2\text{O} = 18$]
ANSWER: 11
1. What organic substance is formed when 1 – bromopropane is treated with potassium metal in a dry ether?
ANSWER: Hexane
 2. What organic substance is formed when sodium hydroxide is warmed with sodium butanoate?
ANSWER: Propane
 3. What organic substance is formed when the vapour of 1 – butanol is treated with warm fused aluminium oxide?
ANSWER: 1 – butane or But – 1 – ene.

ROUND 2 – SPEED RACE

1. An elemental iron has atomic number 26. Write the electronic configuration for its ion with charge +3.
ANSWER: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
2. 100 cm^3 of a 0.16 mol dm^{-3} of NaOH was diluted with 100 cm^3 of a 0.04 mol dm^{-3} of NaOH . Calculate the pH of the new solution.
ANSWER: 13.0

3. How many elements in period 4 of the periodic table with symbols start with the letter C?
ANSWER: 4

ROUND 4 – True or False

1. The element with the symbol Eu has atomic number 63 in the lanthanide series called Erbium.
ANSWER: False
2. The element with the symbol Y is a second series transition element with atomic number 39 is Yttrium with atomic mass of 88.91.
ANSWER: True
3. The element californium has symbol Cf with atomic number 92 and the mass number of the longest – lived isotope is 251.
ANSWER: True
1. In a reversible reaction at an equilibrium, if the total number of gaseous reactants molecules is greater than the total number of gaseous products molecules increase in pressure shifts equilibrium forward.
ANSWER: True
2. In a reversible reaction at an equilibrium whose enthalpy change of reaction is negative, decrease in temperature shifts equilibrium forward.
ANSWER: True
3. In a reversible reaction at an equilibrium, if the total number of gaseous reactants molecules is greater than the total number of gaseous products molecules increase in concentration of one or more product(s) shifts the equilibrium forward.
ANSWER: False

ROUND 5 – RIDDLE

I am not found in the restaurant, even though I am a dish.

I am actually found in the science laboratory.

I have a cousin in the biology laboratory whose work is to carry specimen that are not too large.

Me in the chemistry laboratory, I carry saturated solutions whose solubility is to be determined.

I am most or normally used in evaporating substances to dryness.

My shape looks like a portion of spherical surface and this feature gives me a large surface area for evaporation.

To know my full name you have to combine the term for “*a liquid turning into vapour*” and dish.

WHO AM I?

ANSWER: Evaporating dish

CONTEST 8

ROUND 1

- Detergents are classified into two. Name them.
ANSWER: Soapy detergents and soapless detergents.
 - What structure of detergents aid their cleansing property?
ANSWER: Possession of ionic or hydrophilic head and a hydrophobic tail.
 - What is the chemical nature of detergents?
ANSWER: They are salts of long chain hydrocarbon of sodium and potassium.
-
- Determine the pH of a 0.01 mol dm^{-3} of a weak acid whose pKa is 4.50.
ANSWER: 3.25
 - What will be the hydrogen ion concentration of an aqueous solution whose pH is 2.5?
[take $10^{0.5} = 3.16$]
ANSWER: $0.00316 \text{ mol dm}^{-3}$ or $3.16 \times 10^{-3} \text{ mol dm}^{-3}$
 - Determine the pH of a $0.025 \text{ mol dm}^{-3}$ sodium hydroxide solution. [take $\log 2.5 = 0.398$]
ANSWER: 12.40
-
- 500 cm^3 of a $0.050 \text{ mol dm}^{-3}$ solutions of CuSO_4 contains what mass of copper? [Cu = 64, S = 32, O = 16]
ANSWER: 1.6 g
 - How many millimoles of sodium ions are present in a solution containing 15.9 g of sodium carbonate dissolved in 2.0 dm^3 solution? [$\text{Na}_2\text{CO}_3 = 106$]
ANSWER: 300 millimoles
 - 200 cm^3 of a $0.050 \text{ mol dm}^{-3}$ solution of ammonium sulphate .How many millimoles of ammonium ions are present in the solution?
ANSWER: 20 millimoles

ROUND 2 – SPEED RACE

- A few drops of aqueous sodium hydroxide was added to a solution containing containing Zn^{2+} ions and precipitate formed was strongly heated and then left to cool. State what would be observed.
ANSWER: A white gel precipitate forms which deposits a yellow residue when heated and the residue turns white when cooled.
- A given deposit of sulphur ore contains 15% of the S_8 mineral. What mass of the ore will be required to obtain 25.6 g of the S_8 ? Leave your answer in 2 places of decimals
ANSWER: 170.67 g
- What mass of calcium would be present in 31.6 g of the salt CaAl_2O_4 . [Ca = 40, Al = 27, O = 16]
ANSWER: 8.0 g

ROUND 4 – True or False

1. The exact quantity of Na_2CO_3 in a sample can be analysed by titration using phenolphthalein than methyl orange indicator.

ANSWER: True

2. The amounts of NaOH and NaHCO_3 in a mixture of NaOH and NaHCO_3 can be determined by titration using either phenolphthalein alone.

ANSWER: True

3. The amount of NaCl and Na_2CO_3 in a mixture of NaCl and Na_2CO_3 can be determined by titration using double indicator only.

ANSWER: False

1. In the group 7/17, chlorine is the only element has shows the highest number oxidation numbers in the various compounds that involve chlorine.

ANSWER: True

2. When iodine gas is bubbled through a solution containing chloride ions, chlorine gas is release and an iodide solution is formed.

ANSWER: False

3. Apart of the oxidation numbers 0 and -1 , all the halogen family have other oxidation numbers in their respective compounds, except fluorine.

ANSWER: True

ROUND 5 – RIDDLE

I am a chemical substance found in the chemistry laboratory.

My behaviour during a chemical reaction is equivalent to that of a referee in sports.

I work well in reactions involving aqueous solutions.

You can also call me a dye of some sort.

There are many types of me, some of which are coloured and others bear no colour.

My operation depends on change in pH of the reaction medium.

Examples of me are methyl red, thymol blue, o-cresol, etc.

I indicate when an acid – base titration reaction comes to an end.

WHO AM I?

ANSWER: Indicator

CONTEST 9

ROUND 1

Preamble: Consider the following transition metal complexes. State the oxidation number and the shape of each complex.

- $[\text{Co}(\text{CN})_4]^{2-}$
ANSWER: Oxidation number is +2 and the shape is tetragonal or tetrahedral.
- $[\text{Au}(\text{CN})_4]^-$
ANSWER: Oxidation number is +3 and the shape is square planar.
- $[\text{Fe}(\text{CN})_6]^{4-}$
ANSWER: Oxidation number is +3 and the shape is octagonal or octahedral

Preamble: The rate law for the reaction $2\text{A} + \text{B} \rightarrow \text{C}$ is given by $\text{Rate} = k[\text{A}][\text{B}]^2$.

- At a given temperature, the rate is $2.15 \times 10^{-3} \text{ moldm}^{-3}$, with the concentrations of **A** and **B** being 0.02 moldm^{-3} and 0.02 moldm^{-3} respectively. What is the rate constant and its unit?
ANSWER: $268.75 \text{ dm}^6\text{mol}^{-2}$
 - What will the rate, if the concentrations of **A** and **B** are 0.15 moldm^{-3} and 0.02 moldm^{-3} respectively?
ANSWER: $0.0172 \text{ moldm}^{-3}$ or $1.72 \times 10^{-2} \text{ moldm}^{-3}$
 - At what concentration of **A** with the rate be $3.44 \times 10^{-2} \text{ moldm}^{-3}$ when the concentration of **B** is 0.01 moldm^{-3} ?
ANSWER: 1.28 moldm^{-3}
- Explain why sucrose is soluble in water, even though the atoms in sucrose are bonded covalently.
ANSWER: The sucrose molecules are able to form hydrogen bonding in water.
 - Sodium chloride is an ionic salt with strong ionic bonds. Explain why it is possible for sodium chloride to dissolve in water.
ANSWER: The hydration energy of water molecules is higher than the lattice energy of the sodium chloride bond, hence water molecules are able to split or break the ionic bonds.
 - Water has relatively small molecular mass than hydrogen sulphide, but whereas water is liquid at room temperature hydrogen sulphide is a gas. Explain the observation.
ANSWER: The small size of oxygen with the lone pairs allows water to form hydrogen bonding, but hydrogen sulphide does not form hydrogen bonding due to the large size of sulphur.

ROUND 2 – SPEED RACE

- A gas **P** has relative molar mass 100 and **W** has relative molar mass of 4. How faster would **W** diffuse than **P** through the same membrane under the same conditions?
ANSWER: **W** diffuse 5 times faster than **P**.
- Gold alloys are measured or given in what term?
ANSWER: Carates

3. The solubility of FeSO_4 at 25° is 0.15 mol dm^{-3} and at 29°C is 0.25 mol dm^{-3} . What mass of FeSO_4 would be recovered from 500 cm^3 of its saturated solution when cooled from 29°C to 25°C ? [$\text{FeSO}_4 = 152$]
ANSWER: 7.6 g

ROUND 4 – True or False

1. The Arrhenius concept of acids, bases and salts is just a classification tool to categorize substances for easy identification based on the behaviour of the substance in any solvent.
ANSWER: False
2. The Bronsted – Lowry concept sought to increase the number of substances that can be classified as either an acid or base depending on the solvent and if proton transfers are possible.
ANSWER: True
3. The Lewis concept of acids and bases considers the formation of coordinate bonding which describes the formation of only transition metal complexes.
ANSWER: False
1. A solution containing a chloride ion will form a white precipitate with both barium nitrate and lead nitrate solutions.
ANSWER: False
2. A solution containing sulphide ion will form a white precipitate with zinc nitrate and iron(III) nitrate solutions.
ANSWER: True
3. When sulphur(IV) oxide gas is bubbled through a solution containing a sulphide ion it will form the same precipitate as adding drops of potassium iodide solution to lead nitrate solution.
ANSWER: True

ROUND 5 – RIDDLE

I am a mineral acid found in the laboratory.
In fact, I am one of the oldest acids known to chemistry.
I am also known to be one of the heavy chemicals produced industrially.
My gaseous form is used to demonstrate the fountain experiment.
I am produced when concentrated sulphuric acid is treated with saturated sodium chloride solution.
One of my common uses is as cleaning agent for metallic surfaces.
I am also used in acid hydrolysis in organic compound synthesis.
My aqueous solution produces a white precipitate with either silver nitrate or lead nitrate.
My molecular weight is 36.5.

WHO AM I?

ANSWER: Hydrogen chloride or Hydrochloric acid. (Do not accept HCl)

CONTEST 10
ROUND 1

Preamble: Give the major constituents of the following alloys

1. Magnalium
ANSWER: Magnesium and aluminium
 2. Steel
ANSWER: Carbon and iron
 3. Duralumin
ANSWER: Copper and aluminium
-
1. Determine the quantity of electricity required to discharge 6.4 g of oxygen gas at the anode during electrolysis of dilute sodium chloride using carbon electrodes.
ANSWER: 0.8 faradays
 2. Determine the quantity of electricity required to discharge 6.4 g of sulphur at the anode during electrolysis of molten sodium sulphide using platinum electrodes.
ANSWER: 0.4 faradays
 3. Determine the quantity of electricity required to discharge 1.12 dm³ of chlorine gas at the anode during electrolysis of saturated sodium chloride solution using carbon electrodes. [molar volume = 22.4 cm³]
ANSWER: 0.1 faradays
-
1. Give the structure of amino acid molecule in a neutral solution.
ANSWER: NH₃⁺CHR⁻COO⁻
 2. What is the structure of an amino acid molecule in an acidic medium?
ANSWER: NH₃⁺CHR⁻COOH
 3. When amino acid molecules undergo condensation polymerization to form proteins the amino acid units are held by.....
ANSWER: Peptide bonds

ROUND 4 – True or False

1. 3.2 g of oxygen gas would contain the same number of oxygen molecules as 0.2 g of hydrogen gas in a sealed vessel.
ANSWER: True
2. 10.0 g of calcium carbonate contains the same quantity of calcium atoms as in 7.2 g of calcium hydroxide.
ANSWER: False
3. The moles of potassium ions in a solution of potassium carbonate is the same as the moles of sodium ions in a solution of sodium carbonate if the concentrations are the same.
ANSWER: True

1. When propene is treated with an acidified potassium permanganate two different molecules of an alkanonic acid is formed.
ANSWER: True
2. When 2 – methylpropene is treated with an acidified potassium permanganate a ketone and an alkanonic acid are formed.
ANSWER: True
3. If ethene is treated with acidified potassium permanganate, the products formed will be the same as using an acidified potassium dichromate.
ANSWER: False

ROUND 5 – RIDDLE

I am a penta-atomic inorganic salt.

I may occur in nature or I may be produced in the laboratory.

I exist as solid, and when grinded, I form powdery white substance.

You can called me an oxo – acid salt.

I am made up of atoms from groups 2, 4 and 6.

At the laboratory, my powdery form is used to prepare carbon dioxide.

My common name suggests I am a stone that has something to do with lime.

You may also call me marble chip.

WHO AM I?

ANSWER: Calcium carbonate or Calcium trioxocarbonate(IV)/CaCO₃

CONTEST 11
ROUND 1

1. The gram formula mass of a hydrated compound is 224, if the anhydrous compound has a gram formula mass of 134, what is the number of water crystallisation of the compound?
ANSWER: 5
 2. An hydrous compound has a gram formula mass of 168, if it forms a hydrated compound containing 7 molecules of water, what is the gram formula mass of the hydrated compound?
ANSWER: 294
 3. A hydrated compound has a gram formula mass of 355, calculate the gram formula mass of the anhydrous compound, the water of crystallisation is 6.
ANSWER: 243
1. How many elements in the first twenty elements of the periodic table have symbols beginning with the letter “C”?
ANSWER: 3
 2. How many elements in period 4 of the periodic table have symbols beginning with the letter “C”?
ANSWER: 4
 3. How many elements in group 6/16 of the periodic table have symbols ending with the letter “e”?
ANSWER: 2
1. What volume of an iodine solution of concentration 0.040 moldm^{-3} would be required to react completely with 25.0 cm^3 of 0.010 moldm^{-3} of sodium thiosulphate solution? The mole ratio of iodine to sodium thiosulphate is 1:2.
ANSWER: 12.5 cm^3
 2. What volume of a solution containing 0.010 moldm^{-3} of an acidified permanganate ions would be required to react completely with 25.0 cm^3 of a 0.030 moldm^{-3} of iron(II) solution? The mole ratio of permanganate to iron(II) is 1:5.
ANSWER: 15.0 cm^3 (Do not accept 15 cm^3)
 3. What volume of a solution containing 0.060 moldm^{-3} of oxalate ions would be required to react completely with 25.0 cm^3 of a 0.025 moldm^{-3} solution of acidified permanganate ions. The mole ratio of oxalate ions to permanganate ions is 5:2.
ANSWER: 26.0 cm^3 (Accept 26.04 cm^3)

ROUND – SPEED RACE

1. A weak acid **P** has $k_a = 2.5 \times 10^{-3} \text{ moldm}^{-3}$ and another weak acid **R** has $k_a = 9.1 \times 10^{-5} \text{ moldm}^{-3}$. Which of the acids is stronger? Explain.
ANSWER: **P** is stronger than **R**. The higher the k_a value the higher the degree of dissociation and the stronger the acid. From the values of k_a , **P** has a higher value than **R**.
2. Silicon hydride (SiH_4) reacts with sodium hydroxide in the presence of water to form sodium trioxosilicate(IV) and hydrogen gas. Write a balanced chemical equation for the reaction.
ANSWER: $\text{SiH}_4 + 2\text{NaOH} + \text{H}_2\text{O} \rightarrow \text{Na}_2\text{SiO}_3 + 4\text{H}_2$

3. 3.0 g of magnesium metal burns in 2.24 dm³ of oxygen gas. What is the excess reagent? What quantity makes up the excess? [Mg = 24, molar volume 22.4 dm³]

ANSWER: Magnesium metal and is 0.5 g in excess.

ROUND 4 – True or False

1. Chemical industry deals with the use of chemical means to convert raw materials into useful and waste products.

ANSWER: True

2. Chemical industries have five major groups that see to the production of the same substances from different raw materials.

ANSWER: False

3. There are three types of products obtained from a given chemical industry depending on their consumption.

ANSWER: True

1. The oxidation number of Cl in ClO⁻ ion is the same as the oxidation of Br in NaOBr.

ANSWER: True

2. The oxidation number of F in F₂O is +1.

ANSWER: False

3. When I₂ dissolves in KI solution to form the KI₃ complex. The oxidation number of I in I₂ after the dissolution to form the complex is -1?

ANSWER: False

ROUND 5 – RIDDLE

I am a property associated with the elements found between group II and group III elements of the periodic table.

As a property, I am measured by the number unpaired electrons in the valence orbitals.

I am a chemical property that considers myself as being more of physical property.

The splitting effect of the d – orbital accounts for my persistence.

Perhaps, I may have been the basis of photochemistry.

WHO AM I?

ANSWER: Colour formation.

CONTEST 12
ROUND 1

Preamble: A mixture of Na_2CO_3 and NaHCO_3 was dissolved in 1.0 dm^3 solution.

1. If 25 cm^3 of the solution requires 9.5 cm^3 of a 0.10 mol dm^{-3} HCl solution using phenolphthalein as indicator, calculate the concentration of Na_2CO_3 in the mixture.

ANSWER: $0.038 \text{ mol dm}^{-3}$

2. If 25 cm^3 of the solution requires 9.5 cm^3 of 0.10 mol dm^{-3} HCl solution using phenolphthalein followed by methyl orange requires 13.5 cm^3 of the HCl solution. What is the concentration of NaHCO_3 in the mixture?

ANSWER: $0.012 \text{ mol dm}^{-3}$

3. If 25 cm^3 of the solution requires 5.5 cm^3 of 0.10 mol dm^{-3} HCl to neutralize only NaHCO_3 in the mixture, what mass of NaHCO_3 is in the mixture? [$\text{NaHCO}_3 = 84$]

ANSWER: 1.85 g

1. State what would be observed when aqueous barium chloride is added to a solution containing Na_2SO_4 followed by addition of dilute HCl.

ANSWER: A white precipitate forms, the precipitate does not dissolve/disappear in dilute HCl.

2. State what would be observed when an aqueous silver nitrate is added to a solution containing Na_2CO_3 followed by addition of dilute nitric acid.

ANSWER: A white precipitate is formed, the precipitate dissolves/disappears in dilute nitric acid.

3. State what would be observed when an aqueous lead nitrate is added to a solution containing NaI and the mixture is warmed and allowed to cool.

ANSWER: A yellow precipitate forms, which dissolves/disappears on warming and reappears on cooling.

Preamble: Write a balanced equation for the following reactions.

1. Silicon hydride reacts with a solution of sodium hydroxide to form sodium trioxosilicate(IV) and hydrogen gas.

ANSWER: $\text{SiH}_4 + 2\text{NaOH} + \text{H}_2\text{O} \rightarrow \text{Na}_2\text{SiO}_3 + 4\text{H}_2$

2. Ammonia gas reacts with oxygen gas to form nitrogen(IV) oxide and water.

ANSWER: $4\text{NH}_3 + 7\text{O}_2 \rightarrow 4\text{NO}_2 + 6\text{H}_2\text{O}$

3. Fluorine gas reacts with sodium hydroxide to form sodium fluoride, fluorine oxide and water.

ANSWER: $2\text{F}_2 + 2\text{NaOH} \rightarrow 2\text{NaF} + \text{F}_2\text{O} + \text{H}_2\text{O}$

ROUND 2 – SPEED RACE

1. 45.0 cm^3 of H_2SO_4 was dissolved in 115.0 cm^3 of water at 25.1°C and the temperature rises to 26.2°C . Calculate the heat of solution of H_2SO_4 , leave your answer in 3 places of decimals. [Density = 0.90 g cm^{-3} , specific heat capacity = $4.2 \text{ J g}^{-1}\text{K}^{-1}$]

ANSWER: 0.665 kJ

2. “The enthalpy of combustion of ethene gas is -2753 kJmol^{-1} .” Explain the statement.
ANSWER: When one of mol of ethene gas is burnt completely in excess oxygen 2753 kJ of heat energy is given out.
3. Explain why all reactions belong to either exothermic or endothermic reaction, but not neither.
ANSWER: The energy of the reactant(s) and product(s) always differ.

ROUND 4 – True or False

1. In a reaction involving calcium oxide and ammonium chloride to produce calcium chloride, ammonia gas and water, the progress of the reaction can be followed by measuring the change in pressure with time.
ANSWER: True
2. In a reaction involving the decomposition of nitrogen oxychloride (NOCl) gas to form nitrogen(II) oxide gas and chlorine gas, the progress of the reaction can be followed by monitoring the characteristic absorbed spectrum.
ANSWER: True
3. In a reaction involving ammonia gas with chlorine gas to form nitrogen trichloride and hydrochloric acid, the progress of the reaction can be followed by monitoring only the pH of the reaction.
ANSWER: False
1. If two elements have negative reduction potentials, they are reducing agents and the one with the least negative value is the stronger reducing agent.
ANSWER: False
2. If two elements have negative and positive reduction potentials respectively then they are oxidizing and reducing agents in that order.
ANSWER: False
3. If two elements have positive reduction potentials then they are all oxidizing agents, but the element with the higher positive reduction potential is the stronger oxidizing agent.
ANSWER: True

ROUND 5 - RIDDLE

I am an equation.

My parameters come together to determine a system in aqueous solution is acidic or not.

You may be tempted to call me pH equation, but when you do, what happens to buffers?

I actually express the pH of an aqueous as dependent on some constant and, an acid and its conjugate base.

I am mostly useful in acid – base titration.

WHO AM I?

ANSWER: Henderson – Hasselbalch equation.

CONTEST 13

ROUND 1

Preamble: Consider the following acid – base indicators: methyl orange and phenolphthalein. State whether you would only one, both or none in the following acid – base titrations. If you would use only one, give the specific indicator. Also give reason(s) for your answer.

1. Titration of H_2CO_3 solution versus NH_3 solution.
ANSWER: None. This is because the titration is between weak acid and a weak base.
2. Titration of H_2CO_3 solution against KOH solution.
ANSWER: Only one – which is phenolphthalein, because it is a titration between a weak acid and a strong base.
3. Titration of H_2SO_4 and KOH .
ANSWER: Both. This is because the titration is between a strong acid and a strong base.

Preamble: A stock solution of HCl has the following label:

Mass per $\text{cm}^3 = 1.16$

Percentage purity = 37

Relative molecular mass = 37

1. What volume of water is required to prepare 1000 cm^3 of 0.10 mol dm^{-3} HCl solution from the stock?
ANSWER: 991.38 cm^3 (Do not accept 991.4)
 2. What volume of the stock solution is required to prepare 1000 cm^3 of 0.05 mol dm^{-3} HCl solution?
ANSWER: 4.31 cm^3 (Do not accept 4.3 cm^3)
 3. What will be the pH of HCl solution prepared by dissolving 0.43 cm^3 of the stock in 498.80 cm^3 ?
ANSWER: 2.00 (Accept 2)
1. Which allotrope of carbon is the strongest with pure insulator property? Give its use that depends on the refractive index.
ANSWER: Diamond, it is used in jewellery or in space probe
 2. Which isotope of carbon is described as the most unstable nuclide? Give one use of the nuclide
ANSWER: Carbon – 14, it is used in dating by archeologists to determine the age of a fossil
 3. What is the shape of the allotrope of sulphur with molecular formula S_8 ?
ANSWER: Crown shape

ROUND 2

1. Calculate the mass of Fe in 23.2 g of iron(II)iron(III) oxide. [Fe = 56, O 16]
ANSWER: 16.8 g
2. Oxygen gas was collected over water at 27°C and 98000 Pa, if the mass of the oxygen gas is 3.2 g determine the volume occupied by the gas. [Vapour pressure = 21000 Pa, Oxygen gas = 32, R = 8.3]
ANSWER: 3.22 dm^3 or 3220 cm^3
3. State *Gay Lussac's law on reacting gases*.

ANSWER: When gases react they do so with their volumes that bear simple whole number ratios between themselves and their products, if gases.

ROUND 4 – True or False

1. When a vapour of an alkanol is passed over fused heated aluminium oxide an alkene is produced.
ANSWER: True
2. Treatment of alkylhalides with PCl_3 produces the same substances as using Grignard's reagent.
ANSWER: True
3. Lucas' reagent as well as acidified potassium permanganate can be used to classify alkanols into primary alkanols, secondary alkanols and tertiary alkanols.
ANSWER: False
1. In an iodine titration, the starch indicator is added at the tail end of the titration because the starch – iodine complex formed increases the titre value.
ANSWER: False
2. In an iodine titration, the starch indicator turns blue – black at the end of the titration only when the starch is added at the right point in the titration.
ANSWER: False
3. In a titration between oxalate ions solution and acidified permanganate ions solution starch can be used as the indicator.
ANSWER: False

ROUND 5 – RIDDLE

I am an inorganic substance or compound.

My component elements are found in group 3 and group 6.

I am a white solid and I do not dissolve in water.

I react with both acids and bases.

My hydrated form that exists in nature is called bauxite.

My metal atom is important in the engineering construct of airplanes, cars, electricity transmission, roofing of houses, etc

My relative molecular weight is 102

WHO AM I

ANSWER: Aluminium oxide OR Al_2O_3

CONTEST 14
ROUND 1

- Given the bond energies in kJ/mol: H – H = 432, O = O = 495 and H – O = 467. Determine the energy change for the reaction: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
ANSWER: –509 kJ
- Given the bond energies in kJ/mol: H – O = 467, Cl – Cl = 239, O – Cl = 203, H – Cl = 427. Calculate the energy change for the reaction: $\text{H}_2\text{O} + \text{Cl}_2 \rightarrow \text{HCl} + \text{HOCl}$
ANSWER: +76 kJ
- Given the bond energies in kJ/mol: C – H = 413, Cl – Cl = 239, C – Cl = 339, H – Cl = 427. Calculate the energy change for the reaction: $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
ANSWER: –114 kJ

Preamble: Give the systematic names of the following complexes.

- $[\text{Au}(\text{CN})_4]^-$
ANSWER: Tetracyanoaurate(III) ion.
- $[\text{Cu}(\text{C}_2\text{O}_4)_2]^{2-}$
ANSWER: Dioxalatocuprate(II) ion.
- $[\text{Ni}(\text{NO})_2(\text{Cl})_4]^-$
ANSWER: Tetrachlorodinitrosylnickelate(III) ion.

Preamble: Given the reaction $2\text{S}_2\text{O}_3^{2-} + \text{I}_2 = \text{S}_4\text{O}_6^{2-} + 2\text{I}^-$, the rate of consumption of I_2 at a given temperature is $2.44 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$.

- Find the rate of formation of $\text{S}_4\text{O}_6^{2-}$ at that temperature.
ANSWER: $2.44 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$
- What would be the change in concentration of $\text{S}_2\text{O}_3^{2-}$ ions in 10 seconds?
ANSWER: $0.0488 \text{ mol dm}^{-3}$
- What would be the change in concentration of I^- ions in 20 seconds?
ANSWER: $0.0976 \text{ mol dm}^{-3}$.

ROUND 2 – SPEED RACE

- A swimming pool has to be made disinfected with chlorine gas. The pool has a depth of 4 m, width of 15 m and length of 50 m is filled to the brim with water. If 380.8 dm^3 of chlorine gas is bubbled through, determine the concentration of chlorine in the pool. [molar volume 22.4 dm^3].
ANSWER: $5.67 \times 10^{-4} \text{ mol dm}^{-3}$
- Define the term *rusting of iron*.
ANSWER: Rusting is the oxidation of iron(II) to iron(III) by molecular oxygen in the presence of moisture.
- A vessel contains 0.5 moles of oxygen gas, 1.7 moles of neon gas and 0.8 moles of nitrogen gas at a total pressure of 390 kPa. Calculate the partial pressure of oxygen gas in the vessel.

ANSWER: 65 kPa

ROUND 4 – True or False

1. Aqueous solutions of NH_4Cl and $\text{CH}_3\text{COONH}_4$ will turn blue litmus red because the NH_4^+ ion undergoes hydrolysis producing acidic solution.

ANSWER: False

2. A buffer solution prepared by dissolving a mixture of NH_3 and NH_4Cl in a given volume of solution is a base buffer whose buffer activity is provided for by the NH_3 , NH_4^+ and OH^- in solution.

ANSWER: False

3. A buffer solution containing acetic acid and sodium acetate is an acid buffer because it stabilizes the pH of the system below 7.

ANSWER: True

1. In a Thomson atom, the spherical particle has the positive materials and the negative corpuscles mixed up within the entire structure.

ANSWER: True

2. In the Thomson's cathode ray tube experiment, the structure of the atom because establish as negative particles called electrons were discovered.

ANSWER: False

3. The Thomson atom had a structure described as plum – pudding because the negative particles scattered in the positive materials were like plums in a pudding.

ANSWER: True

ROUND 5 – Riddle

I am a tetra – atomic binary, inorganic compound.

I have only covalent bonds, but soluble in water to form acidic mixtures.

My central element with +3 oxidation number, is a group V or 15 element.

I have trigonal pyramidal structure with bond angles of 90° .

I react with water to form an oxo – acid with basicity of 2 even though you may mistake the basicity to be 3 with another acid common acid with molecular weight of 36.5.

The oxo – acid obtained from my reaction with water is an example of a non – metallic hydroxide.

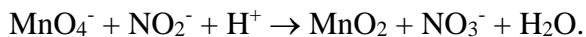
I react with alkanols to produce alkylhalides.

WHO AM I?

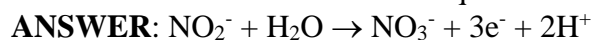
ANSWER: PCl_3

CONTEST 15
ROUND 1

Preamble: KMnO_4 reacts with HNO_2 according to the following ionic reaction equation:



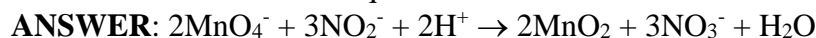
1. Give the balanced oxidation half equation for the reaction.



2. What is the total number of electrons transferred during the reaction?

ANSWER: 6 electrons

3. Give the overall balanced equation for the reaction.



1. State the real gas equation for n moles/molecules of real gas

ANSWER:
$$\left(P + \frac{an^2}{v^2}\right)(v - nb) = nRT$$

2. What does the parameter $\frac{an^2}{v^2}$ represent?

ANSWER: It represents the attraction/repulsion between the gas particles.

3. What is the similarity and the difference between “a” and “R” in the real gas equation?

ANSWER: “a” and “R” are all proportionality constants. “a” is a characteristic gas constant that differ from one gas to another, but “R” is combined gas constant which is the same for all gases.

1. Arrange the following in the order of increasing bond angles: BCl_3 , NH_3 , PH_3 and H_2O .

ANSWER: PH_3 , H_2O , NH_3 , BCl_3

2. Arrange the following bond in the order of increasing polarization: C – F, N – F, P – F and O – F.

ANSWER: O – F, N – F, C – F, P – F.

3. Arrange the bond length in ethane, ethyne, benzene and ethene in increasing order.

ANSWER: ethyne, ethene, benzene, ethane

ROUND 2 – SPEED RACE

1. A gas **H** diffuses 5 times faster than the gas **P** under the same conditions. What is the rate of diffusion of **H**, if 800 cm^3 of **P** diffuse through a porous membrane in 1 minute, 40 seconds.

ANSWER: $40 \text{ cm}^3/\text{sec}$

2. Give the major constituent of quartz glass

ANSWER: Silica/ SiO_2

3. Calculate, to the nearest whole number, the percentage by mass of oxygen in potassium trioxochlorate(V). [K = 39, Cl = 35.5, O = 16]

ANSWER: 39%

ROUND 4 – True or False

1. An atomic orbital with quantum number 4 will contain an angular momentum quantum numbers whose values range from -3 to 3 .

ANSWER: False

2. In an atomic orbital of quantum number 4 the magnetic quantum number whose values are -2 to 2 .

ANSWER: False

3. In an atomic orbital of quantum number 4 the angular momentum quantum number will have the values of $0, 1, 2, 3$.

ANSWER: True

1. Ethanoic acid and methylmethanoate are both structural isomers.

ANSWER: True

2. Ethanol and methoxymethane are position isomers under the structural isomerism.

ANSWER: False

3. 2 – methylpropanol, 2 – butanol and 1 – butanol are positions isomers.

ANSWER: False

ROUND 5 –Riddle

My name suggests that I have something to do with living organisms.

Mind you, I am not a structural unit of a living organism neither am I a functional unit of a living organism.

I am not microscopic, hence you do not need an electron microscope or an ordinary hand lens to see me.

To me, cytoplasm and nucleus are not relevant.

I am not a citizen of the Eastern – most part of Ghana, yet my name suggests everything about that region.

Actually, I am a system for converting chemical energy into electrical energy.

WHO AM I?

ANSWER: Voltaic cell

CONTEST 16
ROUND 1

Preamble: What name is given to the following;

1. The bonds holding the units of amino acids in proteins.

ANSWER: Peptide bonds.

2. The bonds holding the unit of glucose in starch.

ANSWER: Glycosidic bonds

3. The bonds holding the units or codons in DNA.

ANSWER: Hydrogen bonds

1. 25 cm³ of 0.01 mol dm⁻³ HCl solution was mixed with 25 cm³ of 0.015 mol dm⁻³ NaOH solution. Determine the pH of the resulting solution

ANSWER: 11.40 (Accept 11.4)

2. Calculate the pH when 50 cm³ of 0.015 mol dm⁻³ HCl solution was mixed with 50 cm³ of 0.005 mol dm⁻³ HCl solution.

ANSWER: 2.00 (Do not accept 2)

3. What is the pH of a solution containing 0.6 g of ethanoic acid in 1 dm³, if the pK_a is 4.54 and the relative molecular weight of ethanoic acid is 60

ANSWER: 3.27

Preamble: Given the equilibrium reaction: $\text{NH}_3(\text{g}) + 3\text{Cl}_2(\text{g}) \rightleftharpoons \text{NCl}_3(\text{g}) + 3\text{HCl}(\text{g}) \quad \Delta H = +403\text{kJ}$

- x. What is the direction of shift in equilibrium when pressure is increased by 98 kPa?

ANSWER: No change/shift

- x. What is the direction of shift in equilibrium if temperature of the reaction reduced by 15°C?

ANSWER: Equilibrium shifts to the left

- x. What is the relationship between k_p and k_c ?

ANSWER: $k_p = k_c$

ROUND 2 – SPEED RACE

1. What volume of oxygen gas would be collected at s.t.p. when 8.5 g of NaNO₃ completely decomposes on heating, if the molar volume is 22400 cm³.

ANSWER: 1.12 dm³ or 1120 cm³

2. Calculate the percentage of oxygen in methyl ethanoate (CH₃COOCH₃)

ANSWER: 43.24%

3. The transfer of a proton from one molecule to another of the same substance is called

ANSWER: autoprotolysis or autoionisation

ROUND 4 – True or False

1. The aqueous solution of the salt FeSO_4 turns blue litmus paper red because the SO_4^{2-} ion undergoes hydrolysis producing acidic solution.
ANSWER: False
 2. The aqueous solution of the CH_3COOK turns blue litmus paper red because the CH_3COO^- ion undergoes hydrolysis producing an alkaline solution.
ANSWER: False
 3. The aqueous solution of the salt AlCl_3 turns blue litmus red because the Al^{3+} ion act as a conjugate acid that donates protons in solution.
ANSWER: True
-
1. A quantity of sodium oxalate can be dissolved in a fixed volume of solution to give primary standard solution.
ANSWER: True
 2. Both sodium hydroxide and sulphuric acid cannot be used to prepare a primary standard solution because the two substances absorb only water from the atmosphere to add to its mass.
ANSWER: False
 3. 84.0 g of NaHCO_3 in 2000 cm^3 solution will give a primary standard solution whose concentration which is exactly $\frac{1}{2} \text{mol dm}^{-3}$.
ANSWER: True

ROUND 5 – Riddle

I am one of the many diatomic molecular binary compounds.

My atoms are derived from the extreme ends of the periodic table.

Mind you, am not a salt, but am an acid.

Each element of mine has something unique, either in terms of mass or electronegativity.

At room temperature in Ghana, I am gaseous, but I condense at about 20°C to form a colourless liquid.

Even in the gaseous state, I exist in the associated form which my molecules are held by very strong hydrogen bonds.

One of my atoms has the smallest or lowest possible atomic number and the other has the highest possible electronegativity.

WHO AM I?

ANSWER: Hydrogen fluoride or Hydrofluoric acid or HF

CONTEST 17
ROUND 1

Preamble: Arrange N_2^{2+} , N_2^+ , N_2 in order of the property given;

1. Increasing bond energy.
ANSWER: $N_2^{2+} < N_2^+ < N_2$
2. Increasing bond length.
ANSWER: $N_2^{2+} < N_2^+ < N_2$
3. Increasing paramagnetism.
ANSWER: $N_2 = N_2^{2+} < N_2^+$

Preamble: The equilibrium constant $K_c = 1.4 \times 10^{-3}$ for the equilibrium $A_{(aq)} \rightleftharpoons B^+_{(aq)} + C^-_{(aq)}$. In what direction will the reaction proceed when

1. $[A] = 0.100 \text{ mol dm}^{-3}$, $[B^+] = [C^-] = 0.050 \text{ mol dm}^{-3}$?
ANSWER: To the left ($Q_c = 2.5 \times 10^{-2}$ which is greater than K_c)
2. $[A] = 1.000 \text{ mol dm}^{-3}$, $[B^+] = [C^-] = 0.030 \text{ mol dm}^{-3}$?
ANSWER: To the right ($Q_c = 9.0 \times 10^{-4}$ which is less than K_c)
3. $[A] = 0.050 \text{ mol dm}^{-3}$, $[B^+] = 1.4 \times 10^{-3} \text{ mol dm}^{-3}$, $[C^-] = 0.050 \text{ mol dm}^{-3}$?
ANSWER: At equilibrium or no shift ($Q_c = K_c$)

Preamble: Give the coordination number and determine the oxidation number of the metal ion in each of the following complexes.

1. $[\text{Cr}(\text{H}_2\text{O})_6]\text{Br}_3$.
ANSWER: Coordination number is 6 and oxidation number is +3.
2. $\text{Pt}(\text{NH}_3)_2\text{Cl}_4$.
ANSWER: Coordination is 6 and oxidation number is +4.
3. $[\text{Cu}(\text{en})_2]$, where en is ethylenediammine
ANSWER: Coordination number is 4 and oxidation number is +2

ROUND 2 – SPEED RACE

1. What is the maximum number of phases that can be at equilibrium with each other in a three – component mixture?
ANSWER: 5
2. A radioactive isotope which used in diagnostic imaging has a half – life of 6.0 hours. If a quantity of this isotope has an activity of 150 μCi when it is delivered to a hospital, how much activity will remain 24 hours after delivery?
ANSWER: 9.4 μCi
3. Given the following solutions, state which one will have the highest ionic strength. (Assume complete dissociation;

0.050 mol dm⁻³ of AlCl₃, 0.100 mol dm⁻³ of NaCl, 0.050 mol dm⁻³ of CaCl₂, 0.100 mol dm⁻³ of HCl and 0.050 mol dm⁻³ of Ca(NO₃)₂.

ANSWER: 0.050 mol dm⁻³ of AlCl₃

ROUND 4 – True or False

1. The density of a gas increases with temperature.
ANSWER: False
2. Attractive forces do not exist between real gas molecules.
ANSWER: False
3. A cube of sugar spread through hot coffee by Brownian motion.
ANSWER: False
1. The H – C = O bond angle in HCOOH is exactly 120°.
ANSWER: False
2. Lone pair electrons tend to compress bond angles.
ANSWER: True
3. AsH₃ molecule is trigonal planar in shape.
ANSWER: False (91.8° hence it is pyramidal)

ROUND 5 – Riddle

I am an organic compound.

I have three different kinds of atoms in my molecules.

I am classified as a general depressant.

I am likely to cause the death of a person at about 0.4% concentration in the human body.

Despite these, when I am diluted with various amounts of water and some flavor, I am one of the delightful beverages.

In the laboratory as well as industry, I am made by hydration of ethene.

WHO AM I?

ANSWER: Ethanol

CONTEST 18
ROUND 1

1. Arrange the following elements in order of increasing atomic size: Ba, Mg, Sr.
ANSWER: Mg < Sr < Ba
2. Rank the following elements in order of increasing first ionization energy: P, Na, Al.
ANSWER: Na < Al < P
3. Rank the following elements in order of decreasing electronegativity: In, Rb, I.
ANSWER: I > In > Rb

Preamble: Indicate the factor(s) by which the initial volume must be multiplied to find the final volume for each of the following changes. Assume the other variables remain constant.

1. Pressure is halved.
ANSWER: 2
2. Number of moles is doubled.
ANSWER: 2
3. Temperature is increased from 0°C to 27°C.
ANSWER: 1.1 or 300/273

Preamble: State whether each of the following is a physical or chemical change. Identify the reactants in each if it is a chemical change.

1. NO from supersonic jet exhaust combines with ozone (O₃) to form NO₂ and O₂.
ANSWER: Chemical change: NO and O₃ are the reactants.
2. Lakes dissolve more air in the cold weather than in the hot weather.
ANSWER: Physical change
3. Carbon monoxide combines with hemoglobin to that the hemoglobin cannot combine with oxygen.
ANSWER: Chemical change: CO and hemoglobin are the reactants.

ROUND 2 – SPEED RACE

1. Cobalt – 60 is used in the radiation therapy of cancer and can be produced by bombardment of cobalt – 59 with which particle?
ANSWER: Neutrons
2. At 25°C, the maximum amount of PbI₂ that can be dissolved in 1.00 dm³ of pure water is 1.0 milimoles. Assuming complete dissociation, what would be the solubility product, *K_{sp}*, for lead iodide at 25°C?
ANSWER: 4.0 × 10⁻⁹
3. What is the anhydride of Ba(OH)₂?
ANSWER: BaO

ROUND 4 – True or False

1. At equilibrium the rates of the forward reaction and backward reaction are zero.
ANSWER: False
2. At equilibrium the concentrations of reactants and products become constant.
ANSWER: True
3. Change in pressure changes the value of the equilibrium constant.
ANSWER: False
1. The sign of the cathode in a galvanic cell is positive and the sign of the anode is negative.
ANSWER: True
2. In a galvanic cell cations migrate towards the anode.
ANSWER: False
3. In an electrolytic cell, the polarity of the anode is negative and the polarity of the cathode is positive.
ANSWER: False

ROUND 5 – Riddle

We belong to a homologous series.

We can be manufactured in the laboratory not by elimination, but substitution reactions.

We are described as being chemically amphoteric, that is we can protonate and be protonated.

We have a property that makes us reducing agents to acidified dichromate or permanganate.

We react with alkanolic acids in the presence of concentrated sulphuric acid and heat to produce sweet scented substances.

Structurally, we contain a hydroxyl group bonded to an sp^3 carbon.

We are detected using iodoform test and you can distinguish between our other forms using zinc chloride in hydrochloric acid called Lucas reagent.

WHO ARE WE?

ANSWER: Monohydric Alkanols (Do not accept alkanols)

CONTEST 19
ROUND 1

1. A concentrated copper(II) chloride solution is electrolysed using carbon electrodes. What is the product at the anode?

ANSWER: Chlorine gas (Cl_2)

2. A concentrated copper(II) chloride solution is electrolysed using copper electrodes. Name the product at the anode.

ANSWER: Copper dissolves.

3. A concentrated solution of sodium chloride is electrolysed using carbon electrodes. What is the product at the cathode?

ANSWER: Hydrogen gas (H_2)

1. The toughness of a rubber is increased by addition of.....

ANSWER: Sulphur

2. Benzoic acid, an organic solid can be purified by

ANSWER: Crystallization

3. Which of the following acids contain an alkyl group? Benzoic acid, ethanoic acid, methanoic acid.

ANSWER: Ethanoic acid

1. How many electrons would fit in the first five shells of an atom, if the shells filled to their capacity in numeric order.

ANSWER: 110 ($2 + 8 + 18 + 32 + 50$)

2. What is the maximum number of electrons in the third shell of an atom in which there are electrons in the fourth shell?

ANSWER: 18

3. What is the maximum number of electrons in the third shell of an atom in which there is no electrons in the higher shells?

ANSWER: 8

ROUND 2 – SPEED RACE

1. Which group 3 or 13 element has the +1 oxidation state more stable than the +3 oxidation state?

ANSWER: Thallium (Tl)

2. A 0.217 g sample of HgO reacts with excess iodine ions according to the equation:

$\text{HgO} + 4\text{I}^- + \text{H}_2\text{O} \rightarrow \text{HgI}_4^{2-} + 2\text{OH}^-$. Titration of the resulting solution requires what volume of 0.10 mol dm^{-3} HCl to reach equivalent point? [$\text{HgO} = 217$]

ANSWER: 20 cm^3

3. All proteins absorb electromagnetic radiation of wavelength around 190 nm, which corresponds to a $\pi \rightarrow \pi^*$ excitation in the protein molecule. In which region of the spectrum is this wavelength found?

ANSWER: Ultraviolet

ROUND 4 – True or False

1. The melting points of representative metals tend to decrease from top to bottom in a group.
ANSWER: True
2. One measure of the strength of a metallic bond is the enthalpy of ionization.
ANSWER: False (Sublimation)
3. Most metals form basic oxides, but the oxides of boron is acidic.
ANSWER: True
1. The Dow process is a pretreatment method for obtaining aluminium.
ANSWER: False (Magnesium)
2. Smelting is the heating of a mineral in dry air.
ANSWER: False (Roasting)
3. Aluminium is the only p – block metal that has no d- orbital electrons.
ANSWER: True

ROUND 5 – Riddle

I am element found in the first series of the transition metals.
My name was derived from the AngloSaxon term of unknown origin.
I am known element from the pre – historic times.
I play crucial role in the building industry in these current times.
I am extracted thermally from oxides using coke and limestone.
My metallic form has different names depending on my use as wrought, pig and caste.
I have many alloys popularly called steel.
My atomic number is 26.
WHO AM I?
ANSWER: Iron or Fe

CONTEST 20
ROUND 1

Preamble: Arrange the following organic compounds in increasing order of property given

1. $\text{CH}_3\text{CH}_2\text{OH}$, $(\text{CH}_3)_2\text{CHOH}$ and $(\text{CH}_3)_3\text{COH}$; reactivity with ZnCl_2/HCl (Lucas reagent).
ANSWER: $\text{CH}_3\text{CH}_2\text{OH} < (\text{CH}_3)_2\text{CHOH} < (\text{CH}_3)_3\text{COH}$

2. $\text{CH}_3\text{CH}=\text{CH}_2$, $\text{CH}_2=\text{CHCOOH}$ and $\text{CH}_2=\text{CH}_2$; reactivity with HBr .
ANSWER: $\text{CH}_2=\text{CHCOOH} < \text{CH}_2=\text{CH}_2 < \text{CH}_3\text{CH}=\text{CH}_2$

3. $\text{C}(\text{CH}_3)_4$, $\text{CH}_3(\text{CH}_2)_3\text{CH}_3$ and $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_3$; boiling point.
ANSWER: $\text{C}(\text{CH}_3)_4 < (\text{CH}_3)_2\text{CHCH}_2\text{CH}_3 < \text{CH}_3(\text{CH}_2)_3\text{CH}_3$

1. A sample of gas with an initial volume of 32.5 dm^3 at a pressure of 755 mmHg and a temperature of 315 K is compressed to a volume of 15.8 dm^3 and warmed to a temperature of 395 K . What is final pressure of the gas?
ANSWER: 1900 mmHg or $1.9 \times 10^3 \text{ mmHg}$

2. A scuba diver takes a 2.8 dm^3 balloon from the surface where the pressure is 1.0 atm and the temperature is 34°C to a depth of 25 m , where the pressure is 3.5 atm and the temperature is 18°C . What is the volume of the balloon at this depth?
ANSWER: 0.76 dm^3

3. A gas sample with a volume of 5.3 dm^3 has a pressure of 735 mmHg at 28°C . What is the pressure of the sample if the volume remains at 5.3 dm^3 , but the temperature rises to 86°C ?
ANSWER: 877 mmHg

1. What values of l (subsidiary quantum number) are permitted for an electron with principal quantum number $n = 3$?
ANSWER: $0, 1, 2$

2. What values are permitted for magnetic quantum number for an electron in which the subsidiary quantum number, l , value is 2 ?
ANSWER: $-2, -1, 0, 1, 2$

3. What values are permitted for the spin quantum number for an electron in which $n = 2$, $l = 1$ and $m_l = 0$?
ANSWER: $-\frac{1}{2}$ and $+\frac{1}{2}$

ROUND 2 – SPEED RACE

1. In the electrolysis of dilute copper sulphate solution, state the substance produced at the cathode when the cathode is copper?
ANSWER: Copper metal

2. 200 cm^3 of 0.175 moldm^{-3} solution of KOH are added to 300 cm^3 of 0.120 moldm^{-3} ethanoic acid solution. What is the concentration of the K^+ ions in the new solution?
ANSWER: 0.070 moldm^{-3}

3. Give a balanced equation for the reaction of fluorine gas with cold dilute sodium hydroxide solution.



ROUND 4 – True or False

1. Temporary hardness of water is usually removed in a small scale by boiling a quantity of the hard water.

ANSWER: False

2. Water is a stable compound of oxygen and hydrogen in the ratio of 2:1 and described as a universal solvent due to its ability to dissolve almost all substances.

ANSWER: False

3. Sea water contains about 3.6% by mass of dissolved substances or solids.

ANSWER: True

1. Alkanals and alkanones are organic compounds contain carbonyl groups which can act as reducing agents in the production alkanolic acids and oxidizing agents in the production of alkanols.

ANSWER: True

2. Ethylene gas helps in the ripening of fruits.

ANSWER: True

3. Ethylene is obtained as a by – product of cracking of petroleum or action of water on carbides.

ANSWER: True

ROUND 5 – Riddle

I am a tri – atomic binary compound.

I may consists of discrete molecules or not.

On paper, I am presented as a binary compound with tri – atomic molecules.

In reality, I am described as a giant 3 – dimensional molecule with covalent bonds.

I could be the cheapest and most abundant industrial raw material.

One of my constituent elements is neither a metal nor a non – metal.

How can wrist watches, glass, mortar and concretes be made without me?

WHO AM I?

ANSWER: Silica or Sand or SiO_2 .

CONTEST 21
ROUND 1

1. The pK_b of a weak acid is 9.62. Find the pH of 0.10 mol dm^{-3} solution of the acid.
ANSWER: 2.69
2. Find the pH of $0.005 \text{ mol dm}^{-3}$ of a solution of Ca(OH)_2 .
ANSWER: 12.00
3. Find the pK_b of a weak acid with a pH of 2.13, if the concentration of the acid is 0.10 mol dm^{-3} .
ANSWER: 10.74

Preamble: Identify the mass law that each of the following observations demonstrates, and give a reason for your answer.

1. A sample of pure potassium chloride from Chile contains the same percent by mass of potassium as potassium chloride from Poland.
ANSWER: Law of Define composition or Law of Constant Proportion. The composition by mass of a pure substance is independent of the source or where is prepared.
2. A flush bulb contains magnesium and oxygen before being used and magnesium oxide afterwards, but its mass does not change.
ANSWER: Law of Conservation of mass – the total quantity of matter does not change in a reaction.
3. Arsenic and oxygen form one compound that is 62.5% by mass of Arsenic and another that is 75.8% by mass of Arsenic.
ANSWER: Law of Multiple Proportion – Both material pure, but one pair of the elements can combine in two different proportions.

Preamble: Give the electrodes (anode and cathode) and electrolyte used in each of the following cells.

1. Le Clanche dry cell.
ANSWER: Anode: Zinc – Cathode: Carbon rod and Electrolyte: NH_4Cl paste (ammonium chloride)
2. Alkaline accumulator.
ANSWER: Anode: Iron – Cathode: Nickel hydroxide and Electrolyte: Potassium hydroxide
3. Daniel Cell.
ANSWER: Anode: Zinc rod – Cathode: Copper rod and Electrolyte: dilute sulphur acid (H_2SO_4)

ROUND 2 – SPEED RACE

1. The solubility product, k_{sp} , of AlCl_3 is $4.32 \times 10^{-14} \text{ mol}^4 \text{ dm}^{-12}$. Find the solubility of the salt (AlCl_3).
ANSWER: $2.0 \times 10^{-4} \text{ mol dm}^{-3}$
2. What is the name of the ore of iron that contain carbon, hence give its chemical formula.
ANSWER: Siderite, FeCO_3
3. Name the product formed when benzene reacts with excess bromine in the presence of ultraviolet light.
ANSWER: 1,2,3,4,5,6 – hexabromocyclohexane

ROUND 4 – True or False

1. Deliquescent substance absorbs water from the atmosphere, but they absorb so much water to become wet in it.
ANSWER: False
2. Copper(II) oxide is a hygroscopic substance.
ANSWER: True
3. Borax is a deliquescent substance and therefore absorbs so much water from the atmosphere such that it dissolves to form a solution.
ANSWER: False
1. The hydrogen bonding in H₂O is stronger than that of HF and this accounts for why H₂O is less volatile than HF at the same temperature.
ANSWER: True
2. Naphthalene crystals are held together by Van der Waal's forces.
ANSWER: True
3. Metals can be stretch into wires because they have high melting points and can expand appreciably.
ANSWER: False

ROUND 5 – Riddle

I am a member of the main group elements.
Greeks knew I am a bearer of light.
I am an element widely distributed in nature, but always in the combined state.
My name is also an ancient name for the planet Venus.
I am a good candidate for a lesson in allotropy.
My atomic number is 15.
WHO AM I?
ANSWER: Phosphorus

CONTEST 22
ROUND 1

1. A 2.0 dm³ of 1.50 moldm⁻³ of KOH solution is mixed with 3.0 dm³ of 2.00 moldm⁻³ of KOH solution. What is the concentration of the resulting solution?
ANSWER: 1.80 moldm⁻³
2. If 20.0 cm³ of 0.10 moldm⁻³ HNO₃ solution is neutralized by 18.0 cm³ of KOH solution. Determine the concentration of KOH solution, leave your answer in three places of decimals.
ANSWER: 0.111 moldm⁻³
3. If 100 cm³ of 0.10 moldm⁻³ of NaOH solution and 100 cm³ of 0.15 moldm⁻³ of NaOH solution were mixed together, what would be the concentration of the resulting solution?
ANSWER: 0.125 moldm⁻³

Preamble: Give the IUPAC names of the following compounds

1. [Cu(NH₃)₄]SO₄.
ANSWER: Tetraamminecopper(II) tetraoxosulphate(VI)
2. K₃[Fe(CN)₆].
ANSWER: Potassium hexacyanoferrate(III)
3. Na₂S₂O₃·5H₂O
ANSWER: Sodium trioxosulphursulphate(IV) pentahydrate

Preamble: Give the formula of the compound produced in the following processes;

1. Oswald's process.
ANSWER: HNO₃
2. Contact process.
ANSWER: H₂SO₄
3. Solvay process.
ANSWER: Na₂CO₃

ROUND 2 – SPEED RACE

1. Write a balanced equation for the reaction between SiCl₄ and Water.
ANSWER: SiCl₄ + 2H₂O → SiO₂ + 4HCl
2. What substance should be mixed with 0.500 moldm⁻³ of H₃PO₄ to make it a buffer solution? Name the type of buffer solution in this case.
ANSWER: NaH₂PO₄ and it is an acid buffer.
3. Calculate the pH of a buffer solution made by dissolving 0.005 moles of methanoic acid of pK_a 3.75 and 0.005 moles of sodium ethanoate in 1.0 dm³ aqueous solution.
ANSWER: 3.75

ROUND 4 – True or False

1. Metals are mostly used in the building construction due to their high tensile strengths which accounts for why they are able to withstand high stress and loads.
ANSWER: True
 2. The malleability of metals is responsible for their thermal conductivities and being able to be mould into differ shapes.
ANSWER: False
 3. The metallic property of a metal accounts for its ability for form cation easily while the metallic strength depends on the atomic size of the metal atom and the number valence electrons delocalized.
ANSWER: True
1. HCO_3^- reacts with both acids and bases while CO_3^{2-} reacts with acids only.
ANSWER: True
 2. Chemically, HCO_3^- and CO_3^{2-} can be distinguished in laboratory using MgSO_4 solution as a reagent.
ANSWER: True
 3. The SO_3^{2-} and CO_3^{2-} ions can be distinguished in the laboratory by using BaCl_2 as a reagent.
ANSWER: False

ROUND 5 – Riddle

I am an element found in group 4/14 of the periodic table.

I was first prepared by the French chemist Henri Sainte – Claire Deville in 1854.

My amorphous form was discovered by Jons Jakob Berzelius.

My name suggests that I was originally thought to be a metal, but this happened to be incorrect and so it was changed to mean “*flint*” from the Latin “*silex*”.

I react with oxygen at very high temperature to form a neutral oxide that react with aqueous alkaline solutions such as sodium hydroxide to form oxo – acid salt.

In earth’s crust, I am the second most abundant element.

I am very useful in electronics.

WHO AM I?

ANSWER: Silicon

CONTEST 23
ROUND 1

Preamble: Given the following reduction potentials

- D^{2+}/D is +0.64 eV and $E^{3+}/E^+/Pt$ is -0.47 eV, give the cell reaction and potential of the electrochemical cell containing the electrodes.
ANSWER: $D^{2+} + E^+ \rightarrow D + E^{3+}$, emf = 1.11 eV.
- A^{3+}/A is -1.44 V and $B_2/2B^-/Pt$ is +0.14 V, give the cell reaction and the emf of the cell when it is in operation.
ANSWER: $2A + 3B_2 \rightarrow 2A^{3+} + 6B^-$, emf = 1.58 V.
- B^{2+}/B is -0.13 V and D^{3+}/D is -1.72 V, give the cell reaction and the emf of the electrochemical cell when it is in operation.
ANSWER: $2D + 3B^{2+} \rightarrow 2D^{3+} + 3B$, emf = 1.59 V.

Preamble: A reagent bottle contains 0.20 mol dm⁻³ NaC₂H₃O₂ solution.

- What substance could be added to make the mixture a buffer solution?
ANSWER: CH₃COOH or HC₂H₃O₂
 - What type of buffer solution could the mixture be?
ANSWER: An acid buffer
 - What species is or are responsible for the buffer activity?
ANSWER: CH₃COOH and CH₃COO⁻ or HC₂H₃O₂ and C₂H₃O₂⁻
- Which property of water accounts for its inability to mix or dissolve liquids such as kerosene and oils?
ANSWER: Polar nature.
 - Which property of water accounts for its high surface tension?
ANSWER: Hydrogen bonding between its molecules.
 - Explain why sucrose whose atoms are bonded covalently dissolves in water.
ANSWER: It is able to form hydrogen bond with water molecules.

ROUND 2 – SPEED RACE

- Consider the enthalpies of formation measure in kJ/mol: NH₃ = -46.0, H₂O = -242.0, NO₂ = -33.0
Calculate the enthalpy change for the reaction: $2NO_2 + 6H_2O \rightarrow 2NH_3 + 5O_2$
ANSWER: -1426 kJ
- Which compound in the human body is iodine found?
ANSWER: Thyroxin
- Calculate the pK_b of a weak base, if its 0.10 mol dm⁻³ solution has a pH of 10.6.
ANSWER: 5.8

ROUND 4 – True or False

1. In a Le Clanche dry cell, the electrolyte is ammonium chloride paste and the anode is carbon rod.
ANSWER: False
 2. When a lead acid accumulator is fully charged, it has a density of 1.25 gdm^{-3} and emf of 2.2 volts.
ANSWER: False
 3. A fuel cell is said to be scalable because the amount of hydrogen gas used can be regulated at any point in time.
ANSWER: False
-
1. The systematic name of the compound HClO_3 is trioxochlorate(IV) acid.
ANSWER: False
 2. The systematic name of the compound Cl_2O_7 is chlorine(VII) oxide.
ANSWER: True
 3. The systematic name for $\text{Mg}(\text{ClO})_2$ is magnesium oxochlorate(I).
ANSWER: True

ROUND 5 – Riddle

I am one of the classes of chemical industry.

I am well known and loved process in biochemistry

I am also associated with food science.

I am in demolition business because I break down big molecules into smaller ones.

I usually need the assistance of some living organisms.

Heat and a gas are my constant by – products.

The preparation of bread, kenkey, banku, gari and pitoe all make use of me.

My well – known and loved product is ethanol called alcohol.

WHO AM I?

ANSWER: Fermentation

CONTEST 24
ROUND 1

1. Name the two of elements from the first 19 elements in the periodic table whose symbols end with the letter "I" and state the period they are found.

ANSWER: Aluminium and Chlorine. They are in period 3

2. How many elements are there in there in group 2 of the periodic talble?

ANSWER: 6

3. What is the highest oxidation number or state that chlorine can attain?

ANSWER: +7

1. Calculate the mass of hydrogen gas required to reduce 2.00 moles of benzene to cyclohexane.

[H = 1]

ANSWER: 12.0 g (Do not accept 12 g)

2. What volume of carbon dioxide gas would be collected at s.t.p. when 3.2 g of methane gas burns completely in excess oxygen? [C = 12, H = 1, molar volume = 22.4 dm³]

ANSWER: 4.48 dm³

3. In the extraction of magnesium metal, magnesium oxide is reacted with graphite according to the reaction: $\text{MgO} + \text{C} \rightarrow \text{Mg} + \text{CO}$. Determine the mass of magnesium metal produced when 5.6 dm³ of carbon monoxide gas is collected at s.t.p. [Mg = 24, O = 16, C = 12, molar volume = 22.4 dm³]

ANSWER: 6.0 g

1. What type of reaction takes place when O^{2-} ions combines with SO_3 molecules to form SO_4^{2-} ions?

ANSWER: Acid – base reaction

2. What type of reaction takes place when HCO_3^- ion decomposes in aqueous solution to produce OH^- ion?

ANSWER: Hydrolysis

3. Explain why the reaction between HCO_3^- ions and water molecules is described as a Bronsted – Lowry acid base reaction.

ANSWER: HCO_3^- accepts a proton from H_2O or water (to produce H_2CO_3 and OH^- ions).

ROUND 2 – SPEED RACE

1. A gas **Y** diffuses through a porous membrane at a rate of 2 cm³/s under the same conditions, hydrogen gas diffuses at a rate of 11.9 cm³/s. Determine the vapour density of the gas **Y**.

ANSWER: 35.2 gcm⁻³

2. Crystals of efflorescent substances loose water into the atmosphere to form

ANSWER: Amorphous powder (Do not accept anhydrous because of the term crystals).

3. In the oxidation of ethanol to ethanoic acid, 230 g of ethanol produced 270 g of ethanoic acid. What is the percentage yield of the reaction? [O = 16, C = 12, H = 1]

ANSWER: 90%

ROUND 4 – True or False

1. Calcium chloride solution will give a white precipitate with dilute H_2SO_4 as well as lead nitrate.
ANSWER: True
 2. A solution of sodium chloride can be used to distinguish between barium nitrate and lead nitrate solutions.
ANSWER: True
 3. A aqueous ammonia can be used to distinguish between zinc chloride and aluminium chloride solutions based the gas they produce on addition of excess aqueous ammonia.
ANSWER: False
-
1. In principle, it is possible to calculate the value of the gas constant, R, from the gradient of a graph of the volume of a given amount of gas against the reciprocal of the pressures at constant temperature.
ANSWER: True
 2. Boyle's law states that at constant temperature, the pressure of a given amount of an ideal gas is proportional to its volume.
ANSWER: False
 3. A graph of the measure of a mole of a gas at different temperatures at constant volume give a straight line.
ANSWER: True

ROUND 5 – Riddle

I am one of the gases prepared in the laboratory.
I have odourless, colourless and tasteless property and described as being light.
I exist in nature in the uncombined with other elements.
My absence from the environment is noticed by all animals.
I have great ability to support life.
I form an explosive mixture with hydrogen gas.
My compounds constitute 50% of the earth's crust.
WHO AM I?

ANSWER: Oxygen gas (O_2 gas) – Do not accept oxygen or O_2 without gas.

CONTEST 25

ROUND 1

PREAMBLE: Given the following reaction, state whether the reaction is acid – base or redox or none. Give reason(s) for your answer.



ANSWER: It is a redox reaction. The oxidation number of nitrogen changes from +3 in NCl_3 to –3 in NH_3 or the oxidation of chlorine changes from –1 in NCl_3 to +1 in OCl^-



ANSWER: It is acid – base reaction because SiO_2 accepted O^{2-} to form SiO_3^{2-} .



ANSWER: It is a redox reaction because the oxidation number of Hg changes from +2 in $\text{Hg}(\text{CN})_2$ to +1 in Hg_2Cl_2 .

1. Calculate the mass of an anhydrous salt that can be obtained from 200 cm^3 of its saturated solution at 30°C . The molar mass of the salt is 105 gmol^{-1} and its solubility at 30°C is $0.050 \text{ mol dm}^{-3}$.

ANSWER: 1.05 g

2. 400 cm^3 of a solution of a salt contains 5.0 g of the salt. If the solubility of the salt at 30°C is 0.12 mol dm^{-3} and its molar mass is 115 gmol^{-1} . How much more mass in grams of the salt must be added to the 400 cm^3 solution to obtain a saturated solution?

ANSWER: 0.52 g

3. 300 cm^3 hot solution at 70° of an organic compound contains 34.0 g of the compound. If the solution is cooled to 30°C . How much solid crystals may be obtained assuming the solubility of the organic compound at 30°C is 50.0 g dm^{-3} .

ANSWER: 19.00 g

1. Name the substance whose presence changes the rate of a chemical reaction, but does not change the size of an equilibrium constant.

ANSWER: Catalyst

2. There are two types of catalysts. Name them.

ANSWER: Promoters and inhibitors.

3. What is the function of a promoter in a reaction?

ANSWER: It speeds up the rate of reaction by creation of a new reaction pathway of lower activation energy.

ROUND 2 – SPEED RACE

1. Consider the following half cells and their corresponding electrode potentials:

1. $\text{A}^{3+}/\text{A} = -0.50 \text{ V}$

2. $\text{D}^{2+}/\text{D} = -0.30 \text{ V}$

3. $\text{C}^+/\text{C} = +0.90 \text{ V}$

Give the cell reaction and the voltage of the cell that would give the highest voltage from the three half cells.

ANSWER: $\text{A} + 3\text{C}^+ \rightarrow \text{A}^{3+} + 3\text{C}$ $\text{EMF} = 1.4 \text{ V}$

2. Arrange the following gases in the order increasing rate of diffusion: SO_3 , CH_4 and CO_2
ANSWER: SO_3 , CO_2 , CH_4
3. Two **A** and **B** of relative molecular masses 2 and 50 respectively. Determine how fast A diffuses than **B**.
ANSWER: 5 times

ROUND 4 – True or False

1. If the first ionization energy of nitrogen is 1402 kJ/mol then a value of 1012 kJ/mol for phosphorus may be right.
ANSWER: True
2. Since the first ionization energy of elements increases from left to right of the periodic table, the value for nitrogen should be greater than the value for carbon.
ANSWER: False
3. The electron affinity of all the elements in period 2 of the periodic table is negative.
ANSWER: False
1. Toluene is partly aromatic and partly aliphatic.
ANSWER: True
2. Propanone can be oxidized with acidified potassium permanganate to form propanoic acid.
ANSWER: False
3. 3 – methyl – 2 – butanol can be oxidized to give an alkanone.
ANSWER: True

ROUND 5 – Riddle

I am one of the elements belonging to the family of noble elements.
Even though my family is tagged as unreactive, my compounds are known.
I am an element whose name in Greek means “hidden”.
I was discovered by Sir William Ramsay and Sir Morris M. Travess in 1898.
In the movie superman, I was the element that make superman weak and the name of the place was born he was born.
My atomic number is square of 6
WHO AM I?
ANSWER: Krypton

CONTEST 26
ROUND 1

1. Define an *exothermic reaction*.
ANSWER: It is a reaction in which heat/energy is lost by the system to the surrounding.
2. What are the values of the enthalpies of formation of elements and why?
ANSWER: 0/zero and it is by conventions.
3. Why is enthalpy change of neutralization always negative?
ANSWER: The only energy involved is the formation of water from its ions.

Preamble: Calculate the formula mass of each of the following;

[Pb = 207, Br = 80, Fe = 56, S = 32, O = 16, N = 14, C = 12, H = 1]

1. Iron(III) trioxonitrate(V) hexahydrate.
ANSWER: 350
2. Iron(II) tetraoxosulphate(VI) pentahydrate.
ANSWER: 242
3. Lead(II) trioxobromate(V) monohydrate.
ANSWER: 481

PREAMBLE: There are three ways of improving on the octane rating of low grade petrol. Give one each.

- ANSWER:**
- Cracking
 - Addition of anti – knocking agents
 - Reforming

ROUND 2 – SPEED RACE

1. If the half – life of a first order reaction is 10 minutes, calculate the rate constant of the reaction and give its unit.
ANSWER: 1.61×10^{-3} per sec.
2. Define the *collision theory*.
ANSWER: It states that in order for a reaction to occur the reactants molecules must collide the energy equal or greater than the activation energy and with the correct or proper orientation.
3. Calculate the number of millimoles of sodium ions in 500 cm³ of 0.025 moldm⁻³ solution of Na₂CO₃.
ANSWER: 25 millimoles

ROUND 4 – True or False

1. Since there are 18 elements in period 4 of the periodic table, there should be 28 elements in period 5.
ANSWER: False
2. In period 4 both 5*d* and 4*f* sub – orbitals are filled so there is a total of 36 elements.
ANSWER: False
3. The last element in the first lanthanide series is Ytterbium.

ANSWER: False

1. Hess' law states that the total heat change during a chemical reaction is constant.

ANSWER: False

2. The energy summation of bond energies of the reactants and bond energies of the products give the energy change for the reaction.

ANSWER: True

3. A typical Born – Haber cycle contains more than 5 energy changes and it deal with formation of ionic compounds from their elements.

ANSWER: True

ROUND 5 – Riddle

I am an element found in class 1 of the periodic table.

I was discovered by the English chemists Humphry Davy in 1807.

All my compounds are soluble in water.

My ions burn to produce golden yellow flame.

I was first isolated by electrolysis of caustic soda.

My name is derived from Latin word for “*headache remedy*” sodanum.

My chemical symbol is derived from the Latin word “*natrium*”.

My atomic number 11 with the symbol Na.

WHO AM I?

ANSWER: Sodium (Do not accept Na)

CONTEST 27
ROUND 1

Preamble: State what happens to the following carbonates when strongly heated.

1. Sodium trioxocarbonate(IV).
ANSWER: Nothing happens

2. Zinc(II) trioxocarbonate(IV).
ANSWER: It decomposes to produce zinc oxide and carbon dioxide/carbon(IV) oxide.

3. Silver(I) trioxocarbonate(IV).
ANSWER: It decomposes to form silver metal, carbon(IV) oxide and oxygen gas.

1. A salt of relative molar mass 54 has solubility of $0.080 \text{ mol dm}^{-3}$ at 30°C . What mass of the salt is needed to saturate 800 cm^3 of its solution at 30°C ? Your answer must be in 2 places of decimal.
ANSWER: 3.46 g

2. The solubility of a salt at 30°C is $0.075 \text{ mol dm}^{-3}$ and it is $0.150 \text{ mol dm}^{-3}$ at 45°C . What mass of the salt can be recovered from 800 cm^3 of its saturated solution when cooled from 45°C to 30°C , if the relative molecular mass of the salt is 84?
ANSWER: 5.04 g

3. The relative molecular mass of a salt is 60 with solubility of $0.090 \text{ mol dm}^{-3}$ at 30°C . What volume of the saturated solution would dissolve 1.89 g of the salt?
ANSWER: 0.35 dm^3 or 350 cm^3

1. What use of the mass spectrometer contradicted John Dalton's theory that atoms of the same element have the same mass and volume?
ANSWER: Detection of isotopes.

2. What name is given to the atomic structure proposed by J. J. Thomson?
ANSWER: Plum – pudding atom

3. What relationship exists between potassium – 39 and calcium – 40?
ANSWER: They are isotones

ROUND 2 – SPEED RACE

1. Calculate the formula mass of ammonium hexacyanoferrate(III). [Fe = 56, N = 14, C = 12, H = 1]
ANSWER: 266

2. A mass spectrum of a naturally occurring element *Q* shows two peaks at isotopic masses 64 and 66. The abundance of the heavier isotopic mass is 30%. Determine the relative atomic mass of *Q*.
ANSWER: 64.6

3. “The enthalpy of solution of a substance is -28.5 kJ/mol .” Explain the statement.
ANSWER: When one mole of the substance is dissolved in large volume of the solvent 28.5 kJ of heat/energy is given out.

ROUND 4 – True or False

1. 9650 coulombs of electrical charge contains 0.10 moles of electrons.
ANSWER: True
 2. 4825 coulombs of electrical charge will deposit 1.2 g of magnesium metal from a solution containing Mg^{2+} ions.
ANSWER: True
 3. 9650 coulombs of electrical charge will liberate 2.24 dm³ of oxygen gas at s.t.p. from a molten alumina.
ANSWER: False
-
1. Hydrolysis of an ester can be either acid or base catalysed.
ANSWER: True
 2. Ethanoic acid can eliminate water molecules to form an acid hydride.
ANSWER: True
 3. Alkanols can eliminate water molecules to form ethers.
ANSWER: True

ROUND 5 – Riddle

I am an element found in the p – block of the periodic table.
The origin of my name is obscure, hence I have English name and American name.
I was originally known as the brenne stone for “*combustible stone*”.
I exist in nature uncombined in two forms: monoclinic or rhombic.
I can be obtained by Frasch process or by roasting of pyrite ores.
I am used extensively in the manufacturing of pharmaceuticals since I actively fight bacteria.
Industrially, I am the main raw material for the production of sulphuric acid.
On the periodic table, I am found just below oxygen.

WHO AM I?

ANSWER: Sulphur

CONTEST 28
ROUND 1

- Which halogen has the highest number of oxidation numbers identified in its various compounds?
ANSWER: Chlorine (Cl)
- What element in the first transitions has the highest number of oxidation numbers identified in its various compounds?
ANSWER: Manganese (Mn)
- Name the elements in the first twenty elements that can react with nitrogen to form a stable metallic nitride.
ANSWER: Beryllium and Magnesium (Do not accept Be and Mg)

Preamble: The table below shows the data obtained from the reaction $2\mathbf{A} + \mathbf{B} \rightarrow \mathbf{C}$ at a given temperature;

Experiment	Conc. $\mathbf{A}/\text{mol dm}^{-3}$	Conc. $\mathbf{B}/\text{mol dm}^{-3}$	Initial rate/ $\text{mol dm}^{-3}\text{s}^{-1}$
1	0.01	0.05	1.25×10^{-3}
2	0.02	0.05	2.51×10^{-3}
3	0.01	0.10	5.00×10^{-3}

- What is the order of reaction with respect to \mathbf{A} and \mathbf{B} ?
ANSWER: $\mathbf{A} = 1$ and $\mathbf{B} = 2$ or \mathbf{A} is first order and \mathbf{B} is second order.
 - Determine the rate constant and give its unit.
ANSWER: $50 \text{ dm}^6\text{mol}^{-2}\text{s}^{-1}$
 - What will be the rate of reaction when the concentration of \mathbf{A} is 0.01 mol dm^{-3} and \mathbf{B} is 0.01 mol dm^{-3} ?
ANSWER: $5.00 \times 10^{-5} \text{ mol dm}^{-3}$
- What is the angular momentum quantum numbers of the fourth orbital?
ANSWER: 0, 1, 2, 3.
 - What is the magnetic quantum number of the third orbital?
ANSWER: -2, -1, 0, 1, 2.
 - An orbital has a 16 sub – orbital, determine the quantum of the orbital.
ANSWER: 4

ROUND 2 – SPEED RACE

- Calculate the percentage mass of H_2O in $\text{Na}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$? [$\text{Na}_2\text{C}_2\text{O}_4 = 134$ $\text{H}_2\text{O} = 18$]
ANSWER: 28.72%
- Give the allotropes of sulphur.
ANSWER: Monoclinic and rhombic
- An \mathbf{M} forms an oxide containing 74% oxygen. Determine the empirical formular of the oxide, if the atomic mass of \mathbf{M} is 14.
ANSWER: $\mathbf{M}_2\text{O}_5$

ROUND 4 – True or False

1. In the extraction of gold from quartz ore, the addition of zinc dust precipitates a pure gold from the soluble gold cyanide complex.
ANSWER: False
2. Bauxite is the only ore of aluminum from which the aluminium metal can be extracted electrolytically.
ANSWER: False
3. During the chemical concentration of aluminium ore the impurity removed using concentrated sodium hydroxide solution is silica.
ANSWER: True
1. The equilibrium law in terms of concentration and partial pressure depends on Le Chatelier's principle.
ANSWER: False
2. For an equilibrium in which the total number of moles of reactants are more than total number of moles of product will have the equilibrium constant K_p being less than K_c .
ANSWER: True
3. For an equilibrium reaction where the total number of reactant molecules is less than the total number of product molecules increase in pressure shifts equilibrium backwards.
ANSWER: True

ROUND 5 – Riddle

I am a colourless gas with odour or scent.

I am very soluble in water to give an acidic solution.

I am a tetra – atomic compound containing elements from the group of the periodic table.

I am an intermediate product in the preparation of sulphuric acid.

My formation gave the name to the process of manufacturing of sulphuric acid.

I am formed from the reversible reaction between SO_2 and O_2 in the presence of V_2O_5 catalyst and heat.

WHO AM I?

ANSWER: SO_3 or Sulphur(VI) oxide

CONTEST 29
ROUND 1

Preamble: An aqueous chlorine(IV) oxide solution oxidizes elemental sulphur to give tetraoxosulphate(VI) acid and chlorine gas. [$\text{ClO}_2 = 66$, $\text{H}_2\text{SO}_4 = 98$, $\text{Cl} = 34$, $\text{S} = 32$]

- Write a balanced chemical equation for the reaction.
ANSWER: $6\text{ClO}_2 + 4\text{S} + 4\text{H}_2\text{O} \rightarrow 4\text{H}_2\text{SO}_4 + 3\text{Cl}_2$
- What mass of sulphur is required to produce 3.36 dm^3 of chlorine gas?
ANSWER: 6.4 g
- If 1.0 dm^3 containing 3.3 g of chlorine(IV) oxide reacted completely with sulphur, what is the concentration of tetraoxosulphate(VI) acid produced? Leave your answer in 4 places of decimals.
ANSWER: $0.0333 \text{ moldm}^{-3}$
- What happens to a solution containing Pb^{2+} ions when a few drops of aqueous potassium iodide is added and the mixture heated and allowed to cool?
ANSWER: A yellow precipitate is formed, the precipitate dissolves/disappears on heating and reappears/recrystalizes on cooling.
- A few drops of dilute sodium hydroxide solution is added to a solution containing Fe^{2+} and NH_4^+ ions and the mixture is warmed. State what would be observed.
ANSWER: A green gel precipitate is formed and on warm a gas that turn red litmus blue or a gas with urine/ammonia scent is produced.
- A few drops of dilute sodium hydroxide solution is added to a solution containing Cu^{2+} ions and the mixture allowed to stand for some minutes. State the observation.
ANSWER: A pale blue gel precipitate is formed which turns black or dark on standing (for some minutes).
- 30.0 cm^3 of a 0.05 moldm^{-3} HCl was reacted with 30.0 cm^3 of a 0.05 moldm^{-3} $\text{Ca}(\text{OH})_2$. What is the pH of the resulting mixture? [$\log 2.5 = 0.398$]
ANSWER: 12.40
- 25.0 cm^3 of 0.60 moldm^{-3} NaOH was diluted with 75.0 cm^3 of 0.04 moldm^{-3} of NaOH solution. What is the pH of the resulting solution? [$\log 1.8 = 0.279$]
ANSWER: 13.26
- 50.0 cm^3 of 0.14 moldm^{-3} of HNO_3 was mixed with 100 cm^3 of 0.06 moldm^{-3} of HNO_3 solution. Calculate the pH of the resulting solution. [$\log 8.67 = 0.94$]
ANSWER: 1.06

ROUND 2 – SPEED RACE

- Explain why the vapour density of AlCl_3 has the same value as its relative molecular mass.
ANSWER: AlCl_3 form a dimer, hence its vapour contains two molecules of the AlCl_3 .
- Which of the period 2 non – metals can form a hydride which is covalent, but dissolves in water to give an alkaline solution?

ANSWER: Nitrogen

3. If the solubility of ZnCl_2 at 30°C is 1.10 mol dm^{-3} , then what mass of ZnCl_2 can be recovered from 500 cm^3 of its saturated solution when heated to dryness? [$\text{Zn} = 64, \text{Cl} = 35.5$]

ANSWER: 74.25 g

ROUND 4 – True or False

1. Nitrogen gas is always collected over water because it is totally insoluble in water.

ANSWER: False

2. A dry oxygen gas is collected over water after it has been passed through concentrated sulphuric acid.

ANSWER: False

3. A gas that is prepared by warming solid reactants is ammonia.

ANSWER: True

1. When 2 – methylpropene is reacted with acidified potassium permanganate an alkanolic acid and an alkanone is formed.

ANSWER: True

2. When 1 – butane is reacted with acidified potassium permanganate a mixture of two different alkanolic acids are formed.

ANSWER: True

3. The product from the reaction between ethanol and concentrated sulphuric acid is the same as the reaction between ethanol and heated fused aluminium oxide.

ANSWER: True

ROUND 5 – Riddle

I am a glass ware found in mostly in the chemistry laboratory.

I am used to measure or dispense a fixed volume of solutions.

Unlike my colleague glass wares, you cannot use me to prepare solutions.

I am calibrated or graduated uniformly like a metre rule, even though I measure about half of a metre.

I am one of the most important glass wares you will think whenever titration experiments are involved.

In titration, the difference in the initial and final readings of me gives the titre value.

WHO AM I?

ANSWER: Burette

CONTEST 30

ROUND 1

1. Calculate the mass of iron metal deposited at the cathode when 1.5A of electricity is maintained through molten iron(II) chloride for 45 minutes. [Fe = 56, 1F = 96500 C]
ANSWER: 1.18 g
2. What mass of copper metal would be deposited at the cathode by the passage of 2.5A of electricity maintained through copper sulphate for 40 minutes? [Cu = 63.5, 1F = 96500 C]
ANSWER: 1.97 g
3. What volume of oxygen gas would be collected at the anode when 4.4A of electricity is maintained through a dilute sulphuric acid for 80 minutes? [1F = 96500C, molar volume = 22400 cm³]
ANSWER: 1,225.6 cm³ or 1.23 dm³

Preamble: To produce solid ammonium chloride from the reaction between ammonia and hydrochloric acid, the ammonia is dissolved in benzene and the hydrochloric acid is also dissolved in benzene. The resulting solutions are then reacted to obtain the solid.

1. Explain why benzene is able to act as the dissolving medium or solvent.
ANSWER: Both ammonia and hydrochloric acid are soluble in benzene because they contain covalent bonds.
2. Explain why benzene is used as the solvent instead of water, even though ammonia and hydrochloric acid are also soluble in water.
ANSWER: Ammonia and hydrochloric acid react to produce ammonium chloride which is insoluble in benzene, hence it precipitates out as solid.
3. Explain the acid – base concept used in the reaction.
ANSWER: It is a Bronsted – Lowry concept because the ammonia accepts a proton from the hydrochloric acid to form ammonium chloride.

Preamble: Give the systematic names of the following compounds;

1. $\text{CH}(\text{CH}_3)_2\text{CH}=\text{CHCH}_2\text{CH}(\text{CH}_3)_2$
ANSWER: 2,6 – dimethylhept – 3 – ene/2,6 – dimethyl – 3 – heptene.
2. $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{COCH}_3$
ANSWER: 4,4 – dimethylpentan – 2 – one/4,4 – dimethyl – 2 – pentanone.
3. $\text{CH}_3(\text{CH}_2)_2\text{COOCH}_2\text{CH}_2\text{CH}_3$.
ANSWER: Propylbutanoate

ROUND 2 – SPEED RACE

1. The compound $\text{Na}_2\text{CO}_3 \cdot y\text{H}_2\text{O}$ contains 54.31% water by mass. Calculate the value of y.
[$\text{Na}_2\text{CO}_3 = 106$, O = 16, H = 1]
ANSWER: 7
2. Explain why addition of concentrated H_2SO_4 to sucrose deposits a black or dark precipitate.
ANSWER: Concentrated H_2SO_4 is a dehydrating agent, it extracts or removes water molecules from sucrose depositing carbon or graphite which is dark or black in colour.

3. What is/are the product(s) when silver nitrate is strongly heated.
ANSWER: Silver metal, nitrogen(IV) oxide gas and oxygen gas.

ROUND 4 – True or False

1. Both mesomerism and isomerism are structural features of compounds that account for the observed properties of molecules or compounds.
ANSWER: True
2. Homolytic and heterolytic cleavages are bond breaking processes that produce the same reactive species in organic reaction.
ANSWER: False
3. Inductive effect accounts for the stabilities and reactivities of organic and that it is used which explains 2 – methylpropene is more reactive than 2 – methylbut – 2 – ene.
ANSWER: True
1. A solution of hydrochloric acid of concentration 10^{-8} moldm⁻³ has a pH less than seven because its hydrogen ion concentration is still higher than the hydrogen ion concentration of water.
ANSWER: False
2. A weak acid whose pKa value is equal to the pKb of a weak base will have the same pH in a solution when they have the same concentration.
ANSWER: False
3. A salt whose cation is conjugate acid of a weak base in solution always undergoes hydrolysis to produce a solution whose pH is less than 7.
ANSWER: True

ROUND 5 – Riddle

If I were a living organism, you may say I am a hermaphrodite.

Actually, I am an organic compound.

My molecules undergo polymerization to give large molecules such as peptides, peptones and polypeptides.

In my molecule, I possess acid group as well as amino group, hence my name.

I am known to have 20 different forms for which 5 of them are described as essential.

I am the final product of the digestion of proteins.

WHO AM I?

ANSWER: Amino acid

CONTEST 31

ROUND 1

Preamble: Consider the reaction equation: $\text{CH}_4 + 2\text{Cl}_2 + 2\text{F}_2 \rightarrow \text{CF}_2\text{Cl}_2 + 2\text{HCl} + 2\text{HF}$. The bond energies in kJ/mol are: C – H = 413, Cl – Cl = 239, F – F = 154, C – Cl = 339, C – F = 485, H – Cl = 427, H – F = 565.

1. Determine the energy required to break all the bonds in the reactants.

ANSWER: +2438 kJ

2. What is the total energy in forming the products?

ANSWER: –3632 kJ

3. Determine the energy change for the reaction.

ANSWER: –1194 kJ

Preamble: Define each of the following terms in chemistry;

1. Henry's law of dissolving gases.

ANSWER: The amount of a gas dissolved in a solution is directly proportional to the pressure of the gas above the solution.

2. Bond length.

ANSWER: It is the distance between the nuclei of the two atoms connected by a bond, the distance where the total energy of a diatomic molecule is minimal.

3. *Gay – Lussac's law* of reacting gases.

ANSWER: When gases react, they do so with their volumes that bear simple whole number ratio with each other and the product(s).

Preamble: Give the bond angle, hence the shapes of the following molecules or ions;

1. SO_3^-

ANSWER: 120° , hence trigonal planar

2. SCl_5

ANSWER: 90° and 120° , hence trigonal bipyramidal or pentagonal

3. BrCl_6

ANSWER: 90° , hence octahedral or octagonal

ROUND 2 – SPEED RACE

1. What product is obtained by reacting methylbenzene with an acidified potassium permanganate?

ANSWER: Benzoic acid or phenylmethanoic acid.

2. What mass of gold nitrate must be heated to produce 5600 cm³ of oxygen gas at s.t.p.?

[Gold nitrate = 294, molar volume = 22.4 dm³]

ANSWER: 49.0 g (Accept 49 g)

3. When propene is treated with dilute sodium hydroxide it was detected that 1 – propanol was formed instead of 2 – propanol. Explain the observation.

ANSWER: The reaction followed an anti – markonikov’s addition reaction.

ROUND 4 – True or False

1. In an acid buffer solution, the species responsible for the buffer activity are the weak acid and its conjugate base form obtained from the dissociation of the salt.
ANSWER: True
2. In the selection of an acid – base indicator to locate the end point of titration, the pH of the resulting solution after a complete reaction of the acid and the base plays a major role.
ANSWER: True
3. An aqueous solution of a salt formed from a weak acid and a weak base turns blue litmus red. This implies the acid dissociation constant of the weak acid is higher than the base dissociation constant of the weak base only.
ANSWER: False
1. When a nucleus undergoes a neutron capture, the mass number and the atomic number of the intermediate nuclide increase by the same amount.
ANSWER: False
2. When a nucleus undergoes a beta capture, the mass number remains the same and the atomic number increases in the intermediate nuclide.
ANSWER: True
3. In a beta decay a proton is converted to a neutron and this leads to an increase in the atomic number, but constant mass number of the nuclide.
ANSWER: False

ROUND 5 – Riddle

I am an inorganic salt.

I am very stable towards heat, meaning I do not decompose on heating.

My anion is an oxo – anion which consists of elements from group 6.

I am very soluble in water to produce a solution that turns blue litmus red.

My anion produces white precipitate with either barium nitrate or lead nitrate that does not dissolve in dilute acids.

My cation is a transition metal.

My cation produces green precipitate with aqueous sodium hydroxide.

My cation has atomic 26

WHO AM I?

ANSWER: FeSO₄ or Iron(II) tetraoxosulphate(VI) (Do not accept iron sulphate).

ROUND 3(1)**PROBLEM OF THE DAY**

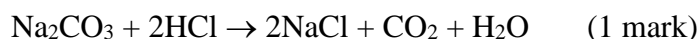
25.00 cm³ of a solution prepared by dissolving a mixture of NaHCO₃ and Na₂CO₃ in 1.0 dm³ was titrated against 0.15 moldm⁻³ of HCl using phenolphthalein followed by methyl orange which gave 7.63 cm³ and 14.80 cm³ respectively as the average titre.

Calculate the;

- (a) mass of Na₂CO₃ in the mixture.
 (b) percentage mass of Na₂CO₃ in the mixture.
 [Na₂CO₃ = 106, NaHCO₃ = 84]

SOLUTION

- (a) Volume of HCl to neutralize Na₂CO₃ = 2V_{ph} = 2(7.63) = 15.26 cm³ (1 mark)

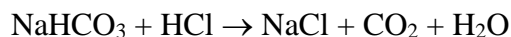


$$\frac{[\text{Na}_2\text{CO}_3] \times 25.00}{[\text{HCl}] \times 15.26} = 1/2$$

$$[\text{Na}_2\text{CO}_3] = \frac{2 \times 0.15 \times 15.26}{25.00} = 0.183 \text{ moldm}^{-3} \quad (2 \text{ marks})$$

$$\begin{aligned} \text{Mass of Na}_2\text{CO}_3 &= \text{concentration} \times \text{rel. molar mass} \times \text{volume} \\ &= 0.183 \times 106 \times 1.0 = 19.40 \text{ g} \quad (1 \text{ mark}) \end{aligned}$$

- (b) Volume of HCl to neutralize NaHCO₃ = V_m – V_{ph} = 14.80 – 7.63 = 7.17 cm³ (1 mark)



$$\frac{[\text{NaHCO}_3] \times 25.00}{[\text{HCl}] \times 7.17} = 1/1$$

$$[\text{NaHCO}_3] = \frac{0.15 \times 7.17}{25.00} = 0.043 \text{ moldm}^{-3} \quad (2 \text{ marks})$$

$$\begin{aligned} \text{Mass of NaHCO}_3 &= \text{Concentration} \times \text{rel. molar mass} \times \text{volume} \\ &= 0.043 \times 84 \times 1.0 = 3.61 \text{ g} \quad (1 \text{ mark}) \end{aligned}$$

$$\begin{aligned} \text{Total mass of the mixture} &= \text{mass of Na}_2\text{CO}_3 + \text{mass of NaHCO}_3 \\ &= 19.40 + 3.61 = 23.01 \text{ g} \end{aligned}$$

$$\text{Percentage mass of Na}_2\text{CO}_3 = \frac{19.40 \times 100}{23.01} = 84.3\% \quad (1 \text{ mark})$$

PROBLEM OF THE DAY

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Calculate the;

- (a) mass of Na₂CO₃ in the mixture.
 - (b) percentage mass of Na₂CO₃ in the mixture.
- [Na₂CO₃ = 106, NaHCO₃ = 84]

PROBLEM OF THE DAY

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- (a) mass of Na₂CO₃ in the mixture.
 - (b) percentage mass of Na₂CO₃ in the mixture.
- [Na₂CO₃ = 106, NaHCO₃ = 84]

ROUND 3(2)**PROBLEM OF THE DAY**

- (a) Define the term *solubility* as applied to solutions.
- (b) A student performed an experiment to determine the solution of an organic compound, **Y**, whose molecular mass is 74 gmol^{-1} as follows;
Mass of evaporation dish = 8.50 g
Mass of evaporation dish + saturated solution of **Y** = 18.60 g
Mass of evaporation dish + crystals of **Y** = 13.70 g
Assuming the density of the saturated solution = 0.098 gcm^{-3}
Calculate the solubility of **Y** in
(i) gdm^{-3}
(ii) moldm^{-3}

SOLUTION

- (a) Solubility is the maximum of quantity or amount of solute in moles or in grams required to saturate 1.0 dm^3 or 1000 cm^3 of the solvent at that temperature. [2 marks]
- (b) Mass of saturated solution = $18.60 - 8.50 = 10.10 \text{ g}$ (1)
Volume of saturated solution = $\frac{\text{mass saturated solution}}{\text{density of solution}} = \frac{10.1}{0.098} = 103.1 \text{ cm}^3 = 0.103 \text{ dm}^3$ (2 marks)
Mass of dry crystals of **Y** = $13.70 - 8.50 = 5.20 \text{ g}$ (1 mark)
- (i) Solubility in $\text{gdm}^{-3} = \frac{\text{mass}}{\text{volume}} = \frac{5.20}{0.103} = 50.49 \text{ gdm}^{-3}$ (2 marks)
- (ii) Solubility in $\text{moldm}^{-3} = \frac{5.20}{74 \times 0.103} = 0.68 \text{ moldm}^{-3}$ (2 marks)

PROBLEM OF THE DAY

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ROUND 3(3)

PROBLEM OF THE DAY

- (a) Explain the statement “*enthalpy of formation of ammonia is -437 kJmol^{-1}* ”.
- (b) 50 cm^3 of ammonia at 25.1°C was dissolved in 450 cm^3 of water at 25.3°C and the final temperature of the solution was found to 27.7°C .
Calculate the
- heat of solution of ammonia.
 - enthalpy of solution of ammonia,
[mol of ammonia = 0.01, density = 1.0 gcm^{-3} , specific heat capacity = $4.21 \text{ Jk}^{-1}\text{g}^{-1}$]

SOLUTION

- (a) When 1 mole of ammonia is formed from hydrogen gas and nitrogen gas 437 kJ of heat or energy is given out. (2 marks)
- (b) Average initial temperature = $\frac{25.1 + 25.3}{2} = 25.2^\circ\text{C}$ (1 mark)

$$\text{Temperature change} = 27.7 - 25.2 = 2.2\text{K} \quad (1 \text{ mark})$$

$$\text{Total volume of solution} = 50 + 450 = 500 \text{ cm}^3 \quad (1 \text{ mark})$$

$$\begin{aligned} \text{Mass of solution} &= \text{density} \times \text{volume} \\ &= 1.0 \times 500 = 500 \text{ g} \quad (1 \text{ mark}) \end{aligned}$$

$$\begin{aligned} \text{(i)} \quad \Delta Q &= \text{mass} \times \text{specific heat capacity} \times \text{temperature change} \\ &= 500 \times 4.21 \times 2.2 = 4631 \text{ J} = 4.631 \text{ kJ} \quad (1 \text{ mark}) \\ \Delta H &= -\Delta Q = -4.631 \text{ kJ} \quad (1 \text{ mark}) \end{aligned}$$

$$\begin{aligned} \text{(ii)} \quad &\text{if } 0.01 \text{ moles of ammonia produce } -4.631 \text{ kJ of energy or heat} \\ &\therefore 1 \text{ mol of ammonia will produce} = \frac{1 \times (-4.631) \text{ kJ}}{0.01} = -463.1 \text{ kJ} \quad (1 \text{ mark}) \end{aligned}$$

PROBLEM OF THE DAY

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ROUND 3(4)
PROBLEM OF THE DAY

A mineral deposit was found to contain iodine crystals. A sample of the mineral has been taken and brought to you for analysis.

- (a) State the method you would use in your analysis.
- (b) Mention three chemical substances you would use in your analysis.
- (c) State the pieces of apparatus and equipments you would use.

SOLUTION

- (a) Iodine titration (1 mark)
- (b) Potassium iodide
Sodium thiosulphate
(Prepared) starch (1 each \times 3) = (3 marks)
- (c) Pipette
Burette
Conical flask
Dropper
Retort stand with clamp
Wash bottle (containing distilled water)
Stirring rod
Volumetric flask
Balance (for weighing) (any 6 \times 1) = (6 marks)

PROBLEM OF THE DAY

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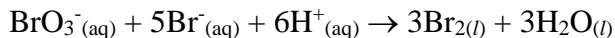
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ROUND 3(5)
PROBLEM OF THE DAY

A teacher need bromine and so he reacted potassium bromated with an acidified potassium bromide. The balanced ionic equation for the reaction is given by;



The table below shows the results of four experiments involving this reaction using the initial concentrations with their respective initial rates measure at a given temperature

EXPT	$[\text{BrO}_3^-]/\text{mol dm}^{-3}$	$[\text{Br}^-]/\text{mol dm}^{-3}$	$[\text{H}^+]/\text{mol dm}^{-3}$	Rate/ $\text{mol dm}^{-3}\text{s}^{-1}$
I	0.10	0.10	0.10	8.00×10^{-4}
II	0.20	0.10	0.10	1.60×10^{-3}
III	0.20	0.20	0.10	3.20×10^{-3}
IV	0.10	0.10	0.20	3.20×10^{-3}

- (a) Determine the order of reaction with respect to BrO_3^- , Br^- and H^+ ions.
(b) Write the rate law expression for the reaction.
(c) Calculate the rate constant.

SOLUTION

- (a) From expt I and II, the order of BrO_3^- is 1
From expt II and III, the order of Br^- is 1
From expt I and IV, the order of H^+ is 2 (2 each \times 3) = (6 marks)

(b) Rate = $k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$ (2 marks)

(c) $k = \frac{\text{Rate}}{[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2}$

From expt I $k = \frac{8.00 \times 10^{-4}}{(0.10) \times (0.10) \times (0.10)^2} = 8.00 \text{ dm}^9\text{mol}^{-3}\text{s}^{-1}$ (2 marks)

PROBLEM OF THE DAY

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II	0.20	0.10	0.10	1.60×10^{-3}
III	0.20	0.20	0.10	3.20×10^{-3}
IV	0.10	0.10	0.20	3.20×10^{-3}

- Determine the order of reaction with respect to BrO_3^- , Br^- and H^+ ions.
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- Determine the order of reaction with respect to BrO_3^- , Br^- and H^+ ions.
- Write the rate law expression for the reaction.
- Calculate the rate constant.

ROUND 3(6)

PROBLEM OF THE DAY

- (a) Give the names of the major organic compound(s) that can be obtained from the following reactions;
- (i) 2 – chloropropane is treated with sodium metal in dry ether.
 - (ii) 2 – butanol treated warmed with concentrated sulphuric acid.
 - (iii) Propanoic acid warmed with excess sodium hydroxide.
 - (iv) Butane heated to about 987°C without oxygen.
 - (v) Propene treated with acidified potassium permanganate solution.
- (b) What name is given to reaction (a).(iv) above?

SOLUTION

- (a) (i) 2,3 – dimethylbutane (1 mark)
- (ii) 1 – butane and but – 2 – ene (2 mark)
- (iii) Ethane (1 mark)
- (iv) Ethene and ethane or methane and propene (2 marks)
- (v) Ethanoic acid and methanoic acid (2 marks)
- (b) Thermal cracking (2 marks)

PROBLEM OF THE DAY

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- (b) What name is given to reaction (a).(iv) above?

ROUND 3(7)
PROBLEM OF THE DAY

Consider the following bond energies given in the table below;

Bond	Energy/kJmol ⁻¹
C = C	614
C – H	413
C – C	347
C – F	485
H – F	565
F – F	154
H – H	432

Calculate the enthalpies of the following reactions;

- (a) $\text{CH}_2=\text{CH}_2 + \text{F}_2 \rightarrow \text{CH}_2\text{FCH}_2\text{F}$
 (b) $\text{H}_2 + \text{F}_2 \rightarrow 2\text{HF}$
 (c) $\text{CH}_3\text{CH}_3 + \text{F}_2 \rightarrow \text{CH}_3\text{CH}_2\text{F} + \text{HF}$

SOLUTION

(a) Energy of the reactants = $4\text{C} - \text{H} + \text{C} = \text{C} + \text{F} - \text{F}$
 $= (4 \times 413) + 614 + 154 = +2420 \text{ kJ}$ (1 mark)

Energy of the product = $4\text{C} - \text{H} + \text{C} - \text{C} + 2\text{C} - \text{F}$
 $= (4 \times 413) + 347 + (2 \times 485) = -2969 \text{ kJ}$ (1 mark)

Enthalpy of reaction = energy of reactants + energy of products
 $= 2420 + (-2969) = -549 \text{ kJ}$ (1 mark)

(b) Energy of reactants = $\text{H} - \text{H} + \text{F} - \text{F}$
 $= 432 + 154 = +586 \text{ kJ}$ (1 mark)

Energy of products = $2(\text{H} - \text{F}) = 2(565) = -1130 \text{ kJ}$ (1 mark)

Enthalpy of reaction = $586 + (-1130) = -544 \text{ kJ}$ (1 mark)

(c) Energy of reactants = $6\text{C} - \text{H} + \text{C} - \text{C} + \text{F} - \text{F}$
 $= 6(413) + 347 + 154 = +2979 \text{ kJ}$ (1 mark)

Energy of products = $5\text{C} - \text{H} + \text{C} - \text{C} + \text{C} - \text{F} + \text{H} - \text{F}$
 $= 5(413) + 347 + 485 + 565 = -3462 \text{ kJ}$ (1 mark)

Enthalpy of reaction = $2979 + (-3462) = -483 \text{ kJ}$ (1 mark)

PROBLEM OF THE DAY

Consider the following bond energies given in the table below;

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PROBLEM OF THE DAY

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(c) $\text{CH}_3\text{CH}_3 + \text{F}_2 \rightarrow \text{CH}_3\text{CH}_2\text{F} + \text{HF}$

ROUND 3(8)

PROBLEM OF THE DAY

Describe how you would prepare 2000 cm³ of 0.339 moldm⁻³ solution of acetic acid in the laboratory from a stock with the following specifications;

Mass per cm³ = 1.048 g

Percent purity = 99

Rel. molecular mass = 60

SOLUTION

$$\text{Concentration of the stock} = \frac{1.048 \times 99 \times 1000}{60 \times 100} = 17.29 \text{ moldm}^{-3} \quad (3 \text{ marks})$$

$$\text{Volume of the stock require for dilution} = \frac{0.339 \times 2000}{17.29} = 39.2 \text{ cm}^3 \quad (2 \text{ marks})$$

- 39.2 cm³ of the stock was carefully or accurately measure using measuring cylinder.
- It was carefully transferred into 2000 cm³ volumetric flask containing some amount of distilled water.
- Measuring cylinder was rinsed and added to the content of the volumetric flask.
- More distilled water added to the volumetric flask to the mark.
- Mixture was corked and shaken well to mix. (1 each × 1) = (5 marks)

PROBLEM OF THE DAY

Describe how you would prepare 2000 cm³ of 0.339 mol dm⁻³ solution of acetic acid in the laboratory from a stock with the following specifications;

Mass per cm³ = 1.048 g

Percent purity = 99

Rel. molecular mass = 60

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TIE – BREAK

1. Calculate, to the nearest whole number, the percentage by mass of oxygen in potassium trioxochlorate(V).
[K = 39, Cl = 35.5, O = 16]
ANSWER: 39%
2. In the industrial production of Na_2CO_3 , the bicarbonate produced in one stage is heated to obtain the carbonate according to the reaction: $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$.
What mass of Na_2CO_3 is produced when 16.8 g of NaHCO_3 is heated?
[H = 1, C = 12, O = 16, Na = 23]
ANSWER: 10.6 g
3. When zinc carbonate is heated, describe what would be observed.
ANSWER: a colourless, odourless gas is given out, and a yellow residue which turns white when cold is formed or left behind.
4. Sucrose has relative molecular weight of 180, if its solubility in petroleum-ether are 0.05 mol dm^{-3} and 0.15 mol dm^{-3} at 15° and 19.5° . What mass of sucrose crystals would be obtained when 500 cm^3 of its saturated solution is cooled from 19.5°C to 15°C ?
ANSWER: 9.0 g [mass = $(0.15 - 0.05) \times 180 \times 0.5 = 9.0$]
5. During laboratory preparation oxygen gas solid potassium chlorate was heated the oxygen gas produced was collected over water at pressure of 754 mmHg. The vapour pressure of water is 21 mmHg. What is the pressure exerted by the oxygen gas in kilopascal, in one place of decimal?
ANSWER: 97.4 Pa
6. The reduction potential of A^{2+}/A and D^+/D are -1.15V and -0.11V respectively. What is the cell reaction of a galvanic cell consisting of A and D electrodes?
ANSWER: $\text{A} + 2\text{D}^+ \rightarrow \text{A}^{2+} + 2\text{D}$ with cell potential of $+1.04\text{V}$