Answers to Sec 4 Pure Chemistry prelim 2024

Qn	Ans	Explanation
1	C	**Strength of acids can be tested by measuring the temperature change during acid-metal reaction.** Hence, thermometer would be required. pH is measured using the Universal Indicator or pH meter. Volume of sodium hydroxide needed for neutralisation and final volume of gas produced during acid-metal reaction will be similar, given that the concentrations of the unknown acid and hydrochloric acid are the same.
2	D	Sodium hydroxide solution will neutralise the acidic carbon dioxide, concentration sulfuric acid will dry the gases, and copper will react with oxygen. Hence, nitrogen gas will remain.
3	B	Rf values of the 3 spots are 0.3, 0.6 and 0.9 – distance travelled by ink divided by distance travelled by solvent front. Hence, only diethanolamine and oxybenzone are present.
4	A	Mr of CH_3Cl = 12 + 3 + 35.5 = 50.5 Mr of SO_2 = 32 + 16x2 = 64 CH_3Cl will travel the fastest due to its lower mass, on the hot day.
5	D	S to T is where the sample will freeze and change from liquid to solid. Hence, this will result in a change in movement from moving around each other to vibrating about in fixed positions.
6	D	P^{3-} has 16 neutrons, 15 protons and 18 electrons. O^{2-} has 8 neutrons, 8 protons and 10 electrons. Mg^{2+} has 12 neutrons, 12 protons and 10 electrons. Ne has 10 neutrons, 10 protons and 10 electrons.
7	C	32.1% x 64 + 56.4% x 66 + 11.5% x 67 = 65.5 54.6% x 64 + 6.6% x 66 + 38.8% x 67 = 65.3 **56.3% x 64 + 31.3% x 66 + 12.6% x 67 = 65.1** 53.5% x 64 + 25.5% x 66 + 21.2% x 67 = 65.3
8	B	**J has a charge of +2 – hence, it could be magnesium which is in Group 2.** K has 5 valence electrons – hence, it should be in Group 15. L has 1 valence electron – hence, it should be hydrogen. It cannot be Group 1 metals as metals do not form covalent bonds. **K and L shared 2 electrons – hence, they formed a covalent bond.**
9	B	Chloroacetone is a covalent compound, which **will not be able to conduct electricity in any state**, and has low melting and boiling points. There are 10 covalent bonds, hence there are 20 electrons involved in bonding. Chlorine shares one electron and **has 6 valence electrons not involved in bonding**.
10	D	Based on the coordination number, each Y is surrounded by 6Z while each Z is surrounded by 4Y. This means that the **ratio between Y and Z is 2:3**. Hence, formula is Y_2X_3.
11	D	**Calcium hydroxide reacts with ammonium carbonate to give off ammonia gas**, resulting in a loss in overall mass.

		A and C show neutralisation reaction with no gas produced, while copper does not react with acid.
12	A	Hydrogen reacts with oxygen to form **water, which is neutral.** Aluminium oxide is amphoteric, magnesium oxide is basic and sulfur dioxide is acidic.
13	A	**Lead(II) nitrate, calcium chloride and calcium nitrate are soluble.** Lead(II) sulfate, lead(II) chloride and calcium sulfate are insoluble.
14	D	**Potassium is a very reactive metal**, hence will react explosively with acid. Reaction is unsafe to proceed.
15	D	Test for **ammonium ions** with reaction 1 and **nitrate ions** with reaction 3 could produce ammonia gas, which will turn moist red litmus paper blue. Hydrochloric acid is used to test for carbonate ions, which produces carbon dioxide gas.
16	A	Displacement by chloride produces brown solution – iodine is produced. Precipitation of yellow precipitate – silver iodide is produced. No ppt with aqueous ammonia and sodium hydroxide – sodium, potassium or ammonium ions possible Hence, P is KI.
17	C	R is copper(II) sulfate, which can be produced by reacting copper(II) carbonate with sulfuric acid. Copper is a transition metal with variable oxidation states. Q is copper(II) oxide which reacts with acids to give salt and water. Copper(II) ions give a blue ppt insoluble in excess sodium hydroxide.
18	B	Number of moles of gases = 1.8 / 24 = 0.075 Number of moles of salt = 0.075/3 x 2 = 0.05 Mr of salt = 8.5 / 0.05 = 170 Ar of salt = 170 – 14 – (16x3) = 108
19	B	Number of moles of ammonia = 17 000 000 / 17 = 1 000 000 Number of moles of ammonium nitrate = 1 000 000 / 2 = 500 000 Maximum mass of ammonium nitrate = 500 000 x (2x14 + 4 + 3x16) = 40 000 000 g = 40 tonnes
20	C	$2NaOH + MgSO_4 \rightarrow Mg(OH)_2 + Na_2SO_4$ Number of moles of magnesium sulfate = 1.20 / (24 + 32 + 4x16) = 0.01 Mass of magnesium hydroxide = 0.01 x (24 + 2x16 + 2) = 0.58g Percentage yield = 0.32/0.58 x 100 = 55.2%
21	C	Combustion and condensation are exothermic. Boiling/vapourisation is endothermic.
22	B	P has lower energy level, hence R gives out energy to form P in the backward reaction – exothermic. Step 1 is endothermic but step 2 is exothermic. While step 1 has higher activation energy than step 2, it is because the amount of energy needed to break bonds is

		higher – not because more bonds are broken. Step 1 involves breaking stronger bonds.
23	D	**Ammonia is formed via a reversible reaction, hence it will decompose when heated to a high temperature.** Ammonia is alkaline, and will be formed when ammonium salts are heated with bases. Ammonia is made from hydrogen – obtained from cracking of petroleum, and nitrogen – obtained from fractional distillation of air.
24	C	Experiment 1 is shown by curve Z – fastest reaction due to the use of powdered calcium carbonate, and greatest change in mass as HCl is used in excess. **Experiment 2 is shown by curve Y – slower reaction due to the use of calcium carbonate in lumps.** Experiment 3 is shown by curve X – slower reaction due to the use of calcium carbonate in lumps, and smaller change in mass due to insufficient HCl used.
25	C	Reaction 1: oxidation state of sulfur **remains the same** (+6). Reaction 2: oxidation state of sulfur changes from +6 in H_2SO_4 to +4 in SO_2 **– change by 2.** Reaction 3: oxidation state of sulfur changes from +6 in H_2SO_4 to -2 in H_2S **– change by 8.** *Comments: badly done. Many chose B.*
26	A	$KMnO_4$ has been reduced as the oxidation state of Mn has decreased from +7 to +2, and acts as an oxidising agent. Ethanol is oxidised and acts as a reducing agent.
27	A	Experiment 1: hydrogen is discharged at cathode and chlorine gas is discharged at anode. Experiment 2: hydrogen is discharged at cathode and chlorine gas is discharged at anode. Experiment 3: lithium is discharged at cathode and iodine gas is discharged at anode.
28	D	**Argon is inert** and is used to prevent the oxidation of strontium. **Molten strontium bromide is used as electrolyte** as its ions act as mobile charge carriers to conduct electricity.
29	C	$Cu \rightarrow Cu^{2+} + 2e$ Number of moles of copper = 4 / 64 = 0.0625 Number of moles of electrons = 0.0625 x 2 = 0.125 $Cr \rightarrow Cr^{n+} + ne$ Number of moles of chromium = 2.17 / 52 = 0.0417 Number of moles of electrons = 0.0.417 x n = 0.0417n Same amount of charge for Cu and Cr: 0.0417n = 0.125 Hence, n = +3.0
30	B	**Cations are discharged at the cathode**, hence the bracelet must be at the cathode. **Silver anode will discharged to give silver ions**, and the electrolyte must contain silver ions.
31	D	Carbon dioxide is not a pollutant. Sulfur dioxide is from volcanic activity, methane from cattle farming, **nitrogen dioxide from lightning flashes and carbon monoxide from incomplete combustion of petrol**.

32	C	Sulfur dioxide, sulfur trioxide, nitrogen dioxide and carbon dioxide are acidic gases that can be removed by calcium carbonate.
33	C	Melting point increases then decreases across the period. Number of protons increases. **Ability to conduct electricity increases then decreases.** The number of electrons involved in bonding increases then decreases.
34	B	**They are soft and melting point decreases down the group.** They are reducing agents and their reactivity increases down the group.
35	C	2 is the most reactive as it reacts with acid and its oxide cannot be reduced by heating with carbon. 3 is the least reactive as it cannot react with acid and its oxide can be reduced by heating with carbon.
36	B	Isomers have the same molecular formula, hence they will also have the same empirical formula. They will have different structural formula and could have different functional group.
37	D	It is methyl ethanoate, a covalent molecule that cannot conduct electricity and has low melting and boiling point. It has 22 electrons involved in bonding to form 11 bonds.
38	D	**Ethene is obtained from the cracking of hydrocarbons**, which is a non-renewable resource. However, glucose is obtained from plants like sugarcane, which is a renewable resource.
39	A	It is propane and Mr is 44 (C_nH_{2n+2}). Hence, it does not decolourise bromine.
40	C	**1 and 4 can undergo addition polymerisation.** **2 can undergo condensation polymerisation.** 3 cannot undergo condensation polymerisation as alcohol and amine group cannot react to form linkage.