**2023 chemistry Unit 2 exam solutions**

**Section A: Multiple choice**

**Question 1**

B. When NH4+ loses a proton it forms NH3

**Question 2**

D. It takes more energy to heat water than olive oil due to its high specific heat capacity. Option D has the largest product of mass and ∆T

**Question 3**

A. The latent heat of vaporisation of water is relatively high, certainly much higher than the latent heat of fusion. It is also more difficult to boil water away than to heat it up. Ethanol will have a lower latent heat of vaporisation than water based on its lower boiling point.

**Question 4**

A. Energy will be released when gases condense or liquids freeze.

**Question 5**

C. The most acidic solution will have the lowest pH. This will be H2SO4 as it is diprotic. HCl is monoprotic.

**Question 6**

D. The electrical conductivity of a salt solution is the result of a flow of sodium and chloride ions through the solution.

**Question 7**

C. Some CO2 will dissolve in the ocean to form hydronium ions and carbonate ions, CO32-. These ions will increase the conductivity of sea water.

**Question 8**

A. The reaction of KOH and HCl is neutralisation reaction that forms a salt and water.

**Question 9**

B.  The oxidation number of sulfur in H2SO4 is +6.

**Question 10**

D. Option D is the only correctly balanced half-equation. You don’t have to be able to write the equation, just check the balancing.

**Question 11**

C. The oxidising agent is reduced, meaning it will gain electrons.

**Question 12**

D. Option D is the only alternative where a more reactive metal is placed in a solution of a less reactive metal.

**Question 13**

C. Cadmium is more reactive than silver. Cadmium atoms will be oxidised, releasing electrons that can travel to the silver electrode.

**Question 14**

C. The only insoluble ionic compound that can form is silver nitrate.

**Question 15**

B. n(AlCl3) = 0.9x 2/3 = 0.6 mass = 0.6 x 133.5 = 80.1 g

**Question 16**

D. n(Cl2) = 8x3/2 = 12 mol. V = 12 x 24.8 = 298 L

**Question 17**

B. Red is the complementary colour of green. Therefore the green solution will absorb it well.

**Question 18**

A. Methane is a far more potent greenhouse gas than the other gases listed.

**Question 19**

C. The precipitate is AgCl. A precipitate of 0.02 mol indicates a number of mol of MgCl2 of 0.01 mol.

The number of mol of MgCl2 in the whole solution will be ten times the sample = 0.1 mol.

**Question 20**

A. n(NaOH) = 0.2 x 0.02 = 0.004 mol n(H2SO4) = 0.002 mol c = 0.002/0.015 = 0.13 M

**Section B: Short answer questions**

**Question 1** (10 marks)

**a. i.** The solubility of NaNO3 is far more temperature dependent than NaCl 1 mark

 **ii**. The solubility of gases decreases as temperature increases. This is different from ionic solids. 2 marks

**b. i**. supersaturated solution: has more solute dissolved in a certain amount of water than can be dissolved at that temperature. 1 mark

 **ii**. Sample answer – add 100 g of KNO3 to 100 g of water. Heat until about 65 0C to dissolve all the solid. Cool carefully – the solution will be supersaturated under 55 0C. 3 marks

**c**. i. From the graph, 28 g dissolves in 100g => 28 x 40/100 dissolves in 40 = 11.2 g. 1 mark

 **ii**. 44 g dissolving in 50 g = 88 g dissolving in 100g. This corresponds to sodium nitrate. 2 marks

**Question 2**  (5 marks)

**a**. The dipoles in water are much stronger than the dipoles in H2S due to the higher electronegativity of the oxygen atom. The stronger dipoles influence the properties of these substances. 3 marks



**b**. The volume of the solid ice will be greater than the volume of the solid ethanol. Water expands when it freezes but other liquids do the reverse. 2 marks

**Question 3** (10 marks)

**a**. **i**. **N**2O4 +4 **ii**. NH3 -3 **iii**. **Br**O3- +5 **iv**. **S**O32- +4 4 marks

**b**. **i**. Fe2+  🡪 Fe3+ + e Oxidation 1 mark

 **ii**. 2Br- 🡪 Br2 + 2e Oxidation 1 mark

  **iii**. MnO4- + 8H+  + 5e 🡪 Mn2+ + 4H2O(l)Reduction 2 marks

**c**.  **i**. Ca + ZnCl2 1 mark

 **ii**. The more reactive metal (calcium) can replace the less reactive metal in solution 1 mark

**Question 4** (8 marks)

 + --

 cathode anode

 Ni2+(aq) + 2e 🡪 Ni(s) Zn 🡪 Zn2+(aq) + 2e

 Zn(s) + Ni2+(aq) 🡪 Zn2+(aq) + Ni(s)

 observations nickel half-cell: deposits will build up on the nickel

 observations zinc half-cell: the zinc electrode will degrade away

**Question 5** (12 marks)

**a**. LiOH base HNO3 acid CH3CH2OH neutral 3 marks

**b**. **i**. 0.001 M HNO3 pH = 3 **ii**. 0.25 M HCl pH = 0.60 iii. 0.1 M NaOH pH = 13 3 marks

**c**. Pure water can dissociate to a small degree as in the equation shown. 2H2O(l) ⇌ H3O+(aq) + OH-(aq) Rather than water having no ions, it has an equal concentration of hydronium and hydroxide ions. 3 marks

**d**. **i.** Ba(s) + 2HNO3(aq) 🡪 Ba(NO3)2(aq) + H2(g) 1 mark

 **ii**. H2SO4 + 2LiOH(aq) 🡪 Li2SO4(aq) + 2H2O(l) 1 mark

 **iii**. 2HNO3(aq) + CaCO3(s) 🡪 Ca(NO3)2(aq) + H2O(l) + CO2(g) 1 mark

**Question 6** (11 marks)

**a**. 0.1 M has 0.1 mol per litre. This is 159.6 g per litre for copper sulfate 2 marks

**b i**. A UV-visible spectrophotometer measures the absorption of light by the sample. The more concentrated the sample, the higher the absorption. 2 marks

  **ii**. The absorbance of the solution is measured and a calibration curve plotted. The absorbance of the unknown is tested next and its absorbance is plotted on the calibration curve. 3 marks

**c**. **i**. CuSO4(aq) + Ba(NO3)2(aq) 🡪 Cu(NO3)2(aq) + BaSO4(s) 1 mark

  **ii**. n(BaSO4) = 0.86/233 = 0.00368 mol = n(CuSO4) c=n/V = 0.00368/0.02 = 0.184 M 3 marks

**Question 7** (10 marks)

**a. i**. CH3COOH(aq) + NaOH(aq) 🡪 CH3COONa(aq) + H2O(l) 1 mark

 **ii**. Burette: diluted vinegar Conical flasks: deionised water 2 marks

 **iii**. Titration is between a weak acid and a strong base. The equivalence point will have a pH around 10 matching phenolphthalein indicator. 2 marks

**b**. **i**. n(NaOH) = c x V = 0.15 x 0.025 = 0.00375 mol = n(CH3COOH) c=n/V= 0.00375/0.0166 = 0.226 M 2 marks

 **ii**. undiluted vinegar = 0.266 x 100/10 =2.66 M 1 mark

**c**. Precise results might see each group obtain a similar concentration. The concentration obtained however is not accurate if it is known to differ from an accepted value. 2 marks

**Question 8** (6 marks)

**a**. **i**. oxygen required 35 mol **ii**. CO2 formed 20 mol **iii**. H2O formed 30 mol 3 marks

**b**. n(O2) = 2 => n(CO2) = 1.14 V = nRT/P = 1.14 x 8.31 x 373/100 = 35 L 3 marks