**2023 Unit 2 Chemistry trial exam**

**Name**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Total: \_\_\_\_\_\_/92

**Section A: Multiple Choice section**

**Question 1**

The conjugate base of NH4+ is

**A**. NH2-

**B**. NH3

**C**. NH3-

**D**. NH5

**Question 2**

Which of the following will require the most energy?

**A**. heating 60 g of water from 60 ºC to 80 ºC

**B**. heating 20 g of water by 60 ºC

**C**. heating 80 g of olive oil by 22 ºC

**D**. heating 80 g of water by 22 ºC

**Question 3**

Which of the following will require the most energy?

**A**. converting 100 g of water at 100 0C to steam

**B**. raising 100 g of water from 0 0C t o100 0C

**C**. converting 100 of ethanol liquid at 78 0C to a gas

**D**. converting 100 g of ice to 100 g of water

**Question 4**

Select the correct statement about the properties of water.

**A**. Energy is released when steam condenses to water.

**B**. The density of water will increase as it turns to ice.

**C**. Water will always boil at exactly 100 ºC.

**D**. All ionic solids will dissolve in water.

**Question 5**

Which of the following solutions will have the lowest pH?

**A**. 5 M NaOH

**B**. 10 mL of 2 M HCl

**C**. 10 mL of 2 M H2SO4

**D**. 500 mL of 1 M ethanoic acid

*Use the following photograph to answer Questions 6 and 7*

The meter shown is a portable electrical conductivity sensor.

**Question 6**

If salt is dissolved in a water sample being tested,

**A**. the electrical conductivity of the solution will be a constant and not vary with salt concentration.

**B**. the sample will not conduct electricity as water is not ionic.

**C**. the sample will conduct electricity due to the flow of electrons to both electrodes.

**D**. the sample will conduct electricity due to the flow of ions to both electrodes.

**Question 7**

Emissions from industry can impact upon the electrical conductivity of ocean water. The main reason for this is

**A**. the gaseous water emissions from vehicles is increasing the ocean volume.

**B**. the CO2 emissions increase the self-ionisation of water.

**C**. the CO2 emissions will dissolve in the ocean to form ions.

**D**. CO2 is highly soluble in water and it has a high electrical conductivity.

**Question 8**

The products of a reaction are potassium chloride and water. The reactants were

**A**. KOH and HCl

**B**. K2CO3 and HCl

**C**. K and HCl

**D**. KOH and H2SO4

**Question 9**

In which of the following is the oxidation number of sulfur highest?

**A**. S8

**B**. H2SO4

**C**. SO2

**D**. H2S

**Question 10**

Which alternative is a correctly balanced half-equation?

**A**. O2 + 2e- 🡪 O2-

**B**. MnO4-  + 2H2 + 2e- 🡪 Mn2+ + 4OH-

**C**. 2FeCl2  + Cl2 🡪 2FeCl3

**D**. ClO3- + 6H+ + 6e- 🡪 Cl- + 3H2O

**Question 11**

The oxidising agent in a redox reaction

**A**. will lose electrons as it is reduced.

**B**. will gain electrons as it is oxidised.

**C**. will gain electrons as it is reduced.

**D**. will always be a non-metal atom as it will gain electrons.

*Use the following solubility curves to answer questions 12 and 13.*

The following metals are listed in order of most reactive to least reactive:

 zinc cadmium lead copper silver

They all form ions with a charge of 2+ except silver, which forms an Ag+ ion.

**Question 12**

Which of the following will react spontaneously?

**A**. Ag(s) + Zn(NO3)2(aq)

**B**. Pb(s) + Zn(NO3)2(aq)

**C**. Cu(s) + Cd(NO3)2(aq)

**D**. Cd(s) + Cu(NO3)2(aq)

**Question 13**

When a cadmium half-cell is connected to a silver half-cell,

**A**. cadmium ions will form cadmium metal at the positive electrode.

**B**. cadmium ions will be the oxidising agent.

**C**. electrons will move from the cadmium electrode to the positive silver cathode.

**D**. electrons will move from the cadmium electrode to the negative silver anode.

**Question 14**

The following three solutions are added to the one beaker – silver nitrate, potassium chloride and sodium nitrate.

**A**. No precipitate will form as all solutions are soluble.

**B**. The only precipitate to form is sodium chloride.

**C**. The only precipitate to form is silver chloride.

**D**. Precipitates of silver chloride and potassium nitrate will form.

*Use the following information to answer questions 15 and 16.*

The equation for the reaction between aluminium metal and chlorine gas is

2Al(s) + 3Cl2(g) 🡪 2AlCl3(s)

**Question 15**

The mass of AlCl3 that can be formed from 0.90 mole of chlorine gas is, in g,

**A**. 60.1

**B**. 80.1

**C**. 120.2

**D**. 133.5

**Question 16**

The volume of the Cl2 at SLC needed to react completely with 8.0 mole of aluminium is, in L,

**A**. 102

**B**. 130

**C**. 198

**D**. 298

**Question 17**

Nickel sulfate forms a green coloured solution in water. What colour filter should a colorimeter use for the most accurate determination of the concentration of a nickel sulfate solution?

**A**. green

**B**. red

**C**. blue

**D**. yellow

**Question 18**

Which of the following emission releases is likely to impact the Earth’s atmosphere the most?

**A**. 50 litres of methane, CH4

**B**. 100 litres of steam (water)

**C**. 100 litres of CO2

**D**. 500 litres of oxygen gas

**Question 19**

A student uses gravimetric analysis to determine the concentration of a 100 mL solution of MgCl2. She takes a 10 mL sample from the solution and adds excess AgNO3 solution to it. The number of mole of precipitate formed is 0.02 mol. The number of mole of MgCl2 in the original solution is

**A**. 0.01

**B**. 0.02

**C**. 0.1

**D**. 0.2

**Question 20**

A 0.20 M NaOH solution is used in a titration to determine the concentration of a sulfuric acid solution. 20.0 mL aliquots of NaOH are used and the mean titre of sulfuric acid is 15.0 mL. The concentration of the sulfuric acid solution is, in M,

**A**. 0.13

**B**. 0.15

**C**. 0.20

**D**. 0.26

**Section B: Short answer questions Total 72 marks**

**Question 1** (10 marks)

The graph below provides information on the solubility of a range of substances in water.



**a. i.** What conclusion can you draw by comparing the graph for NaNO3 with that of NaCl? 1 mark

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 **ii**. What conclusion can you draw by comparing the graph for NaNO3 with the graph for SO2 gas? 2 marks

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**b. i**. What is a supersaturated solution? 1 mark

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 **ii**. Explain how you would prepare a supersaturated solution of KN03. Include in your response the actual masses

 and volumes you would use. 3 marks

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**c**. i. Determine the mass of KClO3 that will dissolve in 40 g of water at 60 0C. 1 mark

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 **ii**. 44 g of a substance is able to be dissolved in 50 g of water at 20 0C. Identify the substance. 2 marks

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**Question 2**  (5 marks)

**a**. H2O and H2S are molecules with a similar shape. The boiling point of water is significantly higher than that of H2S

 Refer to the bonding in these molecules to explain why. 3 marks

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**b**. A 10 mL sample of water and a 10 mL sample of ethanol are both placed in cold storage until both liquids solidify.

 How will the volume of the solid water (ice) compare to that of the solid ethanol? Explain your answer. 2 marks

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**Question 3** (10 marks)

**a**. What is the oxidation number of the element in bold? 4 marks

 **i**. **N**2O4 \_\_\_\_\_\_\_\_ **ii**. **N**H3 \_\_\_\_\_\_\_\_\_ **iii**. **Br**O3- \_\_\_\_\_\_\_\_\_ **iv**. **S**O32- \_\_\_\_\_\_\_\_\_\_\_\_\_

**b**. Complete the following half-equations and label each as oxidation or reduction. 4 marks

 **i**. Fe2+  🡪 Fe3+ Oxidation or reduction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **ii**. Br- 🡪 Br2 Oxidation or reduction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

  **iii**. MnO4- + H+  🡪 Mn2+ Oxidation or reduction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**c**.  **i**. Which one of the following reactions will occur spontaneously? 1 mark

 Ca + ZnCl2 🡪

 Zn + CaCl2 🡪

 **ii**. Explain how you arrived at your decision. 1 mark

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**Question 4** (8 marks)

A galvanic cell can be formed when a nickel half cell (Ni2+/Ni) is connected to a zinc half-cell (Zn2+/Zn).

The nickel solution will be green in colour.

 Use the template below to 8 marks

* draw this cell
* identify the anode and cathode
* show the direction of electron flow
* write the relevant half-equations
* write the overall equation
* list the observations you can

make of the changes in each

half-cell

 ½ equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Overall equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 observations nickel half-cell: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 observations zinc half-cell: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 5** (12 marks)

**a**. Categorise the following as acid, base or neutral.

 LiOH \_\_\_\_\_\_\_\_ HNO3 \_\_\_\_\_\_\_\_\_\_\_ CH3CH2OH \_\_\_\_\_\_\_\_\_\_ 3 marks

**b**. Calculate the pH of the following solutions: 3 marks

 **i**. 0.001 M HNO3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **ii**. 0.25 M HCl \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 iii. 0.10 M NaOH \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**c**. Pure water is considered to be a neutral substance. Does this mean, it has no hydronium ions? Discuss.

 Include an equation to support your response. 3 marks

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**d**. Write balanced equations for the reactions below: 3 marks

 **i.** barium + nitric acid (HNO3) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **ii**. sulfuric acid (H2SO4) + lithium hydroxide \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **iii**. nitric acid + calcium carbonate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 6** (11 marks)

The photograph below shows a series of copper sulfate (CuSO4) solutions. The concentrations of the first five beakers increases from 0.1 M to 0.5 M. The sixth beaker is a sample of unknown concentration.



 solution 1 solution 5 unknown

**a**. Calculate the concentration of solution 1 in units of g L-1. 2 marks

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**b**. The solutions can be used in a UV-visible spectrophotometer to determine the concentration of the unknown

 sample.

  **i**. How does a UV-visible spectrophotometer differentiate between solutions 1 and 5? 2 marks

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  **ii**. Explain how the concentration of the unknown sample can be determined. 3 marks

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**c**. The concentration of the copper sulfate sample could also be determined gravimetrically, by adding an excess of

 barium nitrate solution to the copper sulfate sample.

 **i**. Write a balanced equation for the reaction between copper sulfate and barium nitrate. 1 mark

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  **ii**. A precipitate of mass 0.860 g is obtained from a 20.0 mL solution of copper sulfate. Use this figure to

 determine the concentration, in molarity, of the copper sulfate solution. 3 marks

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**Question 7** (10 marks)

A 10.0 mL sample of vinegar is diluted to 100 mL. The diluted sample is added to a burette and titrated against a standardised 0.150 M NaOH solution. The acid in vinegar is the weak acid, ethanoic acid, CH3COOH.

The aliquot size of NaOH used is 25.0 mL and the mean titre of diluted vinegar is 16.6 mL.

**a. i**. Write a balanced equation for the reaction. 1 mark

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 **ii**. What should the following items of glassware be rinsed with before titrating? 2 marks

 Burette: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Conical flasks: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **iii**. Discuss the choice of a suitable indicator for the titration. 2 marks

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**b**. Use the data provided to determine the concentration of the

 **i**. diluted vinegar 2 marks

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 **ii**. undiluted vinegar 1 mark

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**c**. Use your results from part b. to explain what precise but not accurate results by the class would look like for

 this experiment. 2 marks

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**Question 8** (6 marks)

The equation for the reaction between ethane and oxygen is:

 2C2H6(g) + 7O2(g) 🡪 4CO2(g) + 6H2O(g)

**a**. Given a sample of 10 mol of ethane, calculate the number of mol of (assuming conditions are constant)

 3 marks

 **i**. oxygen required for the reaction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **ii**. CO2 formed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **iii**. H2O formed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**b**. Given a sample of 64.0 g of O2, calculate the volume of CO2 that can be formed at 100 0C and 100 kPa pressure.

 3 marks

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 **End of exam**

Section A: 20 marks

Section B: 72 marks