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**chemistry  
 Unit 2 – Written examination**

## Reading time: 15 minutes

Writing time: 1 hour and 30 minutes

### **QUESTION & ANSWER BOOK**

**Structure of book**

|  |  |  |  |
| --- | --- | --- | --- |
| *Section* | *Number of questions* | *Number of questions to be answered* | *Number of marks* |
| A | 20 | 20 | 20 |
| B | 8 | 8 | 67 |
|  |  | Total 87 | |

* Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
* Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
* One approved scientific calculator is permitted in this examination.
* Data sheet provided.

**Materials supplied**

* Question and answer book of 16 pages.

**Instructions**

* Print your name in the space provided on the top of this page.
* All written responses must be in English.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.**

**SECTION A – Multiple-choice questions**

**Instructions for Section A**

Answer **all** questions.

Choose the response that is **correct** or **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

**Question 1**

Aluminum reacts with hydrochloric acid according to the equation

2Al(s) + 6HCl(aq) → 2AlCl3(aq) + 3H2(g)

The number of mol of aluminium required to react with 1.74 mol of HCl would be:

1. 0.58
2. 1.74
3. 3.31
4. 5.22

**Question 2**

A sample of solid fertilizer, containing phosphate ions, was weighed then mixed with water to dissolve it. The next step in the gravimetric analysis is:

1. Filter the solution
2. Add excess reagent to form a precipitate
3. Dry the precipitate in the oven
4. Filter the precipitate formed and wash with water

**Question 3**

A 10 mL solution of HCl has a pH of 1. The volume of water, in mL, that must be added to it to change the pH to 3 is:

1. 90
2. 99
3. 990
4. 1000

**SECTION A** - continued

**Question 4**

The following reaction occurs in a blast furnace:

Fe2O3(s) + 3CO(g) 🡪 2Fe(l) + 3CO2(g)

In this reaction

1. iron ions are the oxidising agent.
2. CO is the oxidising agent.
3. carbon is reduced.
4. oxygen atoms are oxidised.

**Question 5**

*temperature*

B

A

*time*

The graph shown is of a sample of ice in a beaker being heated.

The horizontal sections of the graph at point A and point B respectively are known as the:

1. Latent Heat of Fusion and Latent Heat of Vaporisation
2. Latent Heat of Vaporisation and Latent Heat of Condensation
3. Latent Heat of Condensation and Latent Heat of Fusion
4. Latent Heat of Fusion and Latent Heat of Condensation

**Question 6**

Water has some unique properties. Select the alternative that best describes these properties.

1. Low melting point, low density, polar
2. Relatively high melting point, polar, slight electrical conductivity
3. Relatively high melting point, non-polar, non-conductive
4. Low melting point, non-polar, solid at room temperature

**SECTION A** - continued

**TURN OVER**

**Question 7**

Which list consists of amphiprotic substances only?

**A**. H2CO3, H2O and HSO4-

**B**. HCO3-, H2O and H2SO4

**C**. H2CO3, H2O and SO42-

**D**. HCO3-, H2O and HSO4-

**Question 8**

The concentration, in mg L-1, of a 0.0025 M NaOH solution is:

1. 0.0025
2. 2.5
3. 0.1
4. 100

**Question 9**

A saturation solution of potassium nitrate at 30 0C has a concentration of 86 g/100 g of water. The maximum mass of potassium nitrate that will dissolve in 5 g of water at 30 0C is, in g,

1. 4.3
2. 8.6
3. 17.2
4. 43

**Question 10**

A piece of magnesium is dropped into a beaker of 1.0 M CuSO4.Which one of the following would you expect to occur?

1. Zinc nitrate would precipitate from the solution.
2. The blue colour in the solution would lighten.
3. No visible change will occur.
4. The blue colour of the solution will intensify.

**Question 11**

A 750 mL bottle of wine is labelled as containing 14.0 % (v/v) alcohol. What volume of alcohol would there be in this bottle?

1. 53.6 mL
2. 75 mL
3. 105 mL
4. 140 mL

**SECTION A** - continued

**Question 12**

In a gravimetric analysis, the precipitate was weighed before it was completely dried. The likely impact of this error on the final calculated results is:

1. Higher result than actual value
2. Lower result than actual value
3. No impact at all
4. Minimal because water doesn’t weigh much

*Use the following information to answer Questions 13 and 14.*

A student investigates the concentration of ethanoic acid, CH3COOH, in vinegar using a titration against 0.30 M NaOH. She adds 10 mL of vinegar to a flask and makes it up to 100 mL with water. She adds the diluted vinegar to the burette. In the titration, 25.0 mL aliquots of NaOH are used and the average titre is 14.6 mL.

**Question 13**

The equation for the reaction occurring in the titration is

1. CH3COOH(aq) + H2O(l) 🡪 CH3COO-(aq) + H3O+(aq)
2. CH3COOH(aq) + NaOH(aq) 🡪 NaCH3COO(aq) + H2O(l)
3. CH3COOH(aq) + NaOH(aq) 🡪 NaCH3COO(aq) + H3O+(l)
4. CH3COOH(aq) + NaOH(aq) 🡪 NaCH3(aq) + CO2(g) + H2O(l)

**Question 14**

The concentration of the ethanoic acid, before it was diluted, should be, in M,

1. 0.26
2. 0.51
3. 1.04
4. 5.10

**SECTION A** - continued

**TURN OVER**

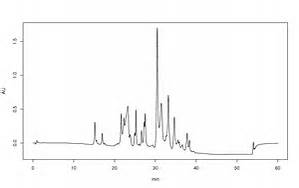
**Question 15**

The mercury concentration in a 5.0 mL sample of waste-water is determined by atomic absorption to be 104 mg L-1. The mass, in mg, of mercury in the sample is:

1. 0.520
2. 5.20
3. 1.04
4. 0.104

*Use the following information to answer Questions 16 and 17.*

Some soluble organic compounds can be identified in water samples by using HPLC. The following chromatogram was obtained from the analysis of a water sample.

[](http://www.bing.com/images/search?q=hplc+chromatogram&view=detailv2&&id=522EE52EA08D5DE556E3D2D81552061515548314&selectedIndex=1&ccid=99NRqBsD&simid=608023634550850646&thid=OIP.Mf7d351a81b034201779c366006fef1d9o0)

**Question 16**

The identity of the organic compounds can be determined by measuring

1. Their retention times
2. The temperature of the column
3. The flow rate of the solvent
4. The area under each of the peaks

**Question 17**

The relative amounts of each of the organic compounds can be determined by measuring

1. Their retention times
2. The temperature of the column
3. The flow rate of the solvent
4. The area under each of the peaks

**SECTION A** - continued

*Use the following information to answer Question 18 and 19.*

When sodium chloride is added to silver nitrate solution a precipitate of silver chloride is formed.

**Question 18**

The correctly balanced partial ionic equation for the above reaction is:

1. Ag+ (aq) + Cl- (aq) → AgCl (aq)
2. Ag+ (aq) + 2Cl- (aq) → AgCl2 (s)
3. 2Ag+ (aq) + Cl- (aq) → Ag2Cl (aq)
4. Ag+ (aq) + Cl- (aq) → AgCl (s)

**Question 19**

When 25.00 mL of 0.400 M silver nitrate is added to 20.00 mL of 0.750 M sodium chloride, the mass, in g, of precipitate formed is:

1. 1434
2. 1.43
3. 2.15
4. 0.88

**Question 20**

The pH of a 0.001 M solution of Mg(OH)2 would be:

1. 3.0
2. 2.7
3. 11.3
4. 11.0

**END OF SECTION A**

**TURN OVER**

**SECTION B - Short-answer questions**

|  |
| --- |
| **Instructions for Section B**  Answer all questions in the spaces provided. Write using blue or black pen.  To obtain full marks for your responses, you should:   * give simplified answers, with an appropriate number of significant figures, to all numerical questions; unsimplified answers will not be given full marks * show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working   make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, H2 (g), NaCl (s) |

**Question 1 (5 marks)**

20.00 mL of a 0.750 M solution of NaOH neutralised 50.00 mL of a HCl solution.

1. Write a balanced equation for this reaction.

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 1 mark

1. Determine the concentration of the HCl solution.

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2 marks

1. Calculate the mass of NaOH that was needed to make the 20 mL 0.750 M solution.

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2 marks

**SECTION B** - continued

**Question 2 (8 marks)**

The concentration of lead ions (Pb2+) in a polluted water sampleis determined gravimetrically by adding sodium sulfate solution (Na2SO4) to 500.00 mL of polluted water. The lead is present in the polluted water as Pb(NO3)2.

1. Write the:
2. Balanced, full equation for the reaction occurring.

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1. Ionic equation

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1 + 1 = 2 marks

1. The mass of the precipitate obtained was 0.987 g.
2. Calculate the number of mole of the precipitate.

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1. Calculate the concentration (M) of the Pb2+ ions (the lead nitrate) in the water sample.

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1 + 2 = 3 marks

1. If the water sample had another ion which formed a precipitate with the sulfate ions, how would this affect the calculated results of the lead nitrate concentration?

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2 marks

1. Suggest another method of analysis that would be suitable for determining the concentration of lead ions in a water sample.

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1 mark

**SECTION B -** continued

**Question 3 (9 marks)**

A standard galvanic cell is set up as shown below:

V

salt bridge

Zn(s)

Zn2+(aq)

Mg (s)

Mg2+(aq)

1. Write the equations for the following:
2. Oxidation half-equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Reduction half-equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Overall \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1 + 1 + 1 = 3 marks

1. Label the following on the cell diagram to show what is happening when the cell is operating:
2. Direction of electron flow in the external circuit
3. Polarity of the electrodes in the circles next to the electrodes
4. The anode and the cathode in the boxes

1 + 1 + 1 = 3 marks

1. Identify if there will be an increase or decrease in mass at each of the electrodes:

Anode: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cathode: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1 mark

1. The salt bridge contains KNO3 solution. Explain the direction of the movement of the ions in the salt bridge.

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2 marks

**SECTION B** –**-** continued

**Question 4 (8 marks)**

Water is an excellent solvent and used for many applications. It can form many different bond types with a variety of substances.

1. All nitrates are described as being very soluble.
2. In the space below, sketch how the particles of water and NaNO3 will align when it dissolves in water. Label any bonds formed.
3. Write an equation for the reaction occurring.

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1. Will this solution conduct electricity? Explain.

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2 + 1 + 2 = 5 marks

1. Ethanol (CH3CH2OH), an alcohol, is also water soluble.
2. Name the major bonds formed between water and ethanol.

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1. Draw a labelled diagram to show where these bonds form between water and ethanol.

1 + 2 = 3 marks

**SECTION B -** continued

**Question 5** (12 marks)

**a**. Label the following as acid, base or neutral:

Ca(OH)2 \_\_\_\_\_\_\_ HBr \_\_\_\_\_\_\_ HNO3 \_\_\_\_\_\_\_ LiOH \_\_\_\_\_\_ CH4 \_\_\_\_\_\_

2 marks

**b**. Calculate the pH of

**i**. 0.05 M HCl \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ii**. 0.01 M NaOH

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1 + 2 = 3 marks

**c**. Write balanced equations for the following reactions:

**i**. calcium + hydrochloric acid

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**ii**. calcium carbonate + sulfuric acid

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1 + 2 = 3 marks

**d**. Water is an example of an amphiprotic substance.

Complete the following equations to show water acting as

**i**. acid HBr(aq) + H2O(l) 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ii**. base HCO3-(aq) + H2O(l) 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1 + 1 = 2 marks

**e**. Identify two acid/base conjugate pairs in the equation below.

NH3(aq) + H2O(l) 🡪 NH4+(aq) + OH-(aq) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2 marks

**SECTION B -** continued

**Question 6 (7 marks)**

The specific heat capacity of water is quite high when compared to similar molecular substances. It has a value of 4.18 J g-1 K-1.

1. Calculate how much energy would be required to heat 1.00 kg of water by 20 ̊ C.

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2 marks

1. Water has several unique properties which can be attributed to its intermolecular bonding.
2. Draw an electron dot diagram of a water molecule.
3. It is described as a polar substance. What does that mean?

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1. What type of bonds form between water molecules?

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1. Describe how these bonds lead to water having a high specific heat capacity when compared to a similar substance such as hydrogen sulfide which only has a specific heat capacity of 1.003 J g-1 K-1.

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1 + 1 + 1 + 2 = 5 marks

**Question 7 (12 marks)**

A sample of water is tested with a HPLC machine and the chromatogram obtained from the sample is shown below.

Chart, histogram

Description automatically generated

**a. i**. Explain what retention time is.

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**ii**. Why do substances have different retention times?

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1 + 2 = 3 marks

**b**. What conclusions can you draw from the chromatogram above?

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2 marks

*…question 7 continues…*

**c**. You suspect one of the peaks is due to the presence of vinegar.

**i**. How could you test whether one of these peaks is due to the presence of vinegar?

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**ii**. What extra testing would be required to determine the concentration of vinegar, not just

its presence?

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1 + 2 = 3 marks

**A picture containing diagram

Description automatically generatedd**. Strontium compounds produce a red colour when placed in a flame.

**i**. Explain why metal ions produce a colour in a flame.

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**ii**. How can this effect be used in the testing of water quality?

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2 + 2 = 4 marks

**Question 8** (6 marks)

The equation for the reaction between aluminium and oxygen gas is

2Al + 3O2(g) 🡪 Al2O3(s)

**a**. If you need to make 16 mol of aluminium oxide, how many mole of

**i**. aluminium is required \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ii**. oxygen is required \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1 + 1 = 2 marks

**b**. Determine the mass of aluminium oxide that could be formed from 2.50 g of aluminium.

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2 marks

**c**. Calculate the volume of water that needs to be added to 45 mL of 5.0 M HCl for its

concentration to drop to 0.80 M.

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2 marks

**END OF QUESTION AND ANSWER BOOK**