

**Year 11 ATAR Chemistry 2024**

**Test 4 – Gases & Solutions**

**Weighting: 3.75%**

**Time: 55 min**

**Marks: / 52 %**

**Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Section One: Multiple-choice (10 Marks)**

This section has **10** questions. Circle the correct ans. No marks will be given if more than one answer is completed for any question.

Suggested working time: 10 minutes.

**­­­­­­­­­­­­­­­­**

1. Which of the following statements is not one of the assumptions used in the development of the ideal gas model:

a) Collisions between molecules in a gas are perfectly elastic.

b) The volume occupied by a molecule is negligible compared to the space between molecules in the gas.

c) Equal volumes of gases (measured under the same conditions of temperature and pressure) have equal masses.

d) There are no attractive forces between molecules in the gas.

2. Real gases are most likely to behave ideally at:

a) low temperatures and low pressures.

b) high temperatures and low pressures.

c) high temperatures and high pressures.

d) low temperatures and high pressures.

3. What is -20°C on the absolute temperature scale?

a) -293.15K

b) -20.15K

c) 253.15K

d) 293.15K

4. At S.T.P., 2.5 moles of sulfur dioxide has a volume of

a) 9.0 L

b) 56.75 L

c) 1.0 L

d) 22.7 L

**Questions 5 and 6 relate to the information below.**

Examine the graph below, which shows how the aqueous solubility of four (4) different salts (KNO3, K2Cr2O7, KCℓ and NaCℓ) vary with water temperature.

Chart, line chart

Description automatically generated

5. What trend can be summarised from this data, with regard to the solubility of salts?

1. The solubility of a salt increases with increasing molecular weight.
2. The solubility of a salt increases linearly with increasing temperature.
3. Salts with identical cations have very similar patterns of solubility.
4. The solubility of a salt increases with increasing temperature.

6. Which of the following would constitute a supersaturated solution?

1. Dissolving 30 g of NaCℓ in 100 g of water at 70 °C.
2. Dissolving 50 g of KNO3 in 100 g of water at 40 °C.
3. Dissolving 60 g of K2Cr2O7 in 100 g of water at 80 °C.
4. Dissolving 40 g of KCℓ in 100 g of water at 50 °C.

7. Which of the following lists contain only strong electrolytes?

**I** BaSO4, AgCℓ, HCℓ

**II** glucose, ethanol, tartaric acid

**III** HCℓ, CH3COOH, HNO3

**IV** NH3, NaCℓ, KNO3

1. IV only
2. II and III
3. I and III and IV
4. I only

8. Which of the following aqueous solutions would be the best conductor of electricity?

1. 0.1 mol L-1 Al(NO3)3(aq)
2. 0.2 mol L-1 Cr2(SO4)3(aq)
3. 0.3 mol L-1 KCH3COO(aq)
4. 0.4 mol L-1 LiCl(aq)

9. 0.20 moles of sodium hydroxide (NaOH) was dissolved in a little water and then more water was added to make a total volume of 500mL. What is the concentration of this solution

a) 0.04 mol L−1

b) 0.10 mol L−1

c) 0.40 mol L−1

d) 1.00 mol L−1

10. The label on a 500.0 mL bottle of mineral water shows it contains 120 mg of calcium ions. Which one of these is the correct concentration of calcium ions in ppm?

a) 0.120

b) 0.240

c) 120

d) 240

**Section Two: Short answer (42 Marks)**

This section has **seven (7)** questions. Answer all questions. Write your answers in the spaces provided.

Suggested working time: 45 minutes.

11. a) Explain the difference between strong and weak electrolytes. Give an example of each.

(4 marks)

Strong electrolytes completely ionise/dissociate when dissolved in water. (1)

Example: any strong acid, strong base or ionic salt. (1)

Weak electrolytes partially ionise/dissociate when dissolved in water. (1)

Examples weak acids and bases such as hydrofluoric acid, acetic acid, carbonic acid,

phosphoric acid, hydrogen sulfide, nitrous acid, ammonia, ammonium hydroxide etc. (1)

b) Explain the difference between a dilute and concentrated solution, including examples.

(4 marks)

A concentrated solution contains a large amount of solute per litre of solution. Example: many possible answers e.g. 18M H2SO4, 12.4M HCl etc.

A dilute solution contains a small amount of solute per litre of solution. Example: many possible

answers e.g. 0.01M HCl

12. For the following precipitation reactions write the balanced ionic equation and describe any observations.

1. When silver nitrate solution is added to sodium chloride solution. (4 marks)

Equation Ag+ (aq) + Cl- (aq) 🡪 AgCl(s)

Correct species (1) Balanced (1)

Observation Two colourless solutions are mixed (1) to produce a white solid (1)

1. When Nickel nitrate solution is added to sodium phosphate solution. (4 marks)

Equation 3 Ni2+(aq) + 2 PO43-(aq) 🡪 Ni3(PO4)2(s)

Correct species (1) Balanced (1)

Observation A green solution mixed with a colourless solution (1) to produce a green solid (1)

13. Barium hydroxide, Ba(OH)2 dissolves in water and it is a good conductor of electricity.

However, when a 0.1 mol L−1 Na2SO4 solution is added to 0.1 mol L−1 Ba(OH)2 a white precipitate

forms, and the electrical conductivity falls dramatically.

Explain this with the aid of an ionic equation. (3 marks)

Ba2+(aq) + SO42-(aq) 🡪 BaSO4(s) (1)

Barium and sulfate ions are being removed from the solution, (1)

thus less ions present.

Less ions therefore means less ions to carry the charge and (1)

thus a drop in electrical conductivity.

14. For the following, determine:

a) the concentration of the resulting solution when 60.50 grams of CuSO4 is dissolved in 250 mL of

water. (3 marks)

M(CuSO4) = 159.61g mol-1 (1)

n(CuSO4) = m/V = 60.50 / 159.61 = 0.379 mol (1)

c(CuSO40 = n/V = 0.379/0.250 = 1.516 mol L-1 (1)

b) the final concentration when 25.0 mL of 12 mol L-1 HCℓ is diluted with water to give a final volume of

100.0 mL. (2 marks)

n(HCl conc.) = cV = 12 x 0.025 = 0.3 mol (1)

c(HCl dil.) = n/V = 0.3/0.100 = 3 mol L-1 (1)

Or

c1V1 = c2V2 (1)

c2 = C1V1/V2 = (12 x 0.025) / 0.1 = 3 mol L-1 (1)

c) the mass of potassium carbonate required to prepare 150.0 mL of 0.250 mol L-1 solution.

(4 marks)

Formula: K2CO3 (1)

n(K2CO3) = cV = 0.250 x 0.1500 = 0.0375 mol (1)

M(K2CO3) = 138.21 g mol-1 (1)

m(K2CO3) = n X M = 0.0375 x 138.21 = 5.183 g (1)

15. Describe a chemical test that will distinguish between solutions of silver nitrate and sodium nitrate. State any observations; if there is no visible reaction write "nvr".

If there is a reaction, write a balanced equation otherwise write no reaction. (5 marks)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **What you would do?** | **What you would observe?** | **Chemical equation**  **(Where there is one)** |
| AgNO3  solution  and  NaNO3  solution | Add a solution  containing:   * chloride * bromide * iodide * hydroxide * carbonate * phosphate * sulfide   (Must give full  name or formula  e.g. KOH)  (1) | with AgNO3 solution  Ag2CO3 yellow ppt  AgI pale yellow ppt  Ag2S black ppt  All others white ppt formed  (1) | with AgNO3 solution  For example  Ag+(aq) + Cℓ- 🡪 AgCℓ(s)  (1) |
| with NaNO3 solution  nvr  (1) | with NaNO3  solution  no reaction  (1) |

16. A sample of methane gas was stored in a chamber at 34 °C and 92 kPa.

a) What changes would need to be made to the storage temperature and volume to achieve STP conditions? (circle your answer for each) (2 marks)

**Temperature Volume**

increase / decrease increase / decrease

The final volume of methane gas, once corrected to STP, was 673.5 mL.

b) Calculate the mass of methane gas present. State your answer to the correct number of significant

figures. (3 marks)

**n(CH4) = V / 22.71**

**= 0.6735 / 22.71**

**= 0.0296565 mol (1)**

**m(CH4) = n x molar mass**

**= 0.0296565 x 16.042**

**= 0.475749573 g (1)**

**= 4.757 x10-1gram (4 SF) (1)**

17. When hydrochloric acid, HCℓ, is added to aluminium sulfide, Aℓ2S3, the highly toxic gas hydrogen sulfide, H2S, is evolved.

The equation for this reaction is

Aℓ2S3(s) + 6HCℓ (aq) → 2AℓCℓ3(aq) + 3H2S(g)

If excess hydrochloric acid is added to 50.0g of aluminium sulfide, then calculate the volume of hydrogen sulfide produced at 125°C and 140kPa. (4 marks)

**M(Al2S3) = 150.14 g mol-1**

**T = 125 + 273.15 = 398.15 K (1)**

**n(Al2S3) = m/M = 50.0 / 150.14 = 0.333 mol (1)**

**n(H2S) = 3/1 x n(Al2S3) = 0.9991 mol (1)**

**V = nRT / P = (0.9991 x 8.314 x 398.15)/140 = 23.623 L (1)**

**End of Test**