

Safety Bay Senior High School

Chemistry Unit 2

**Test #5:**

**Acids & Bases**

**Precipitation Reactions**

**Kinetic Theory of Gases**

**NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| --- | --- |
| **Section** | **Mark** |
| Multiple Choice | / 12 |
| Short Answer | / 38 |
| **Total** | **/ 50** |

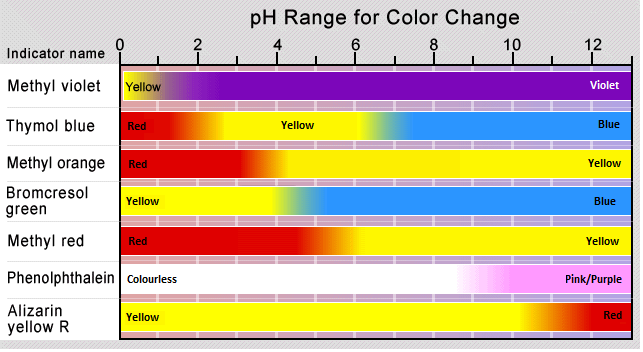
**Section 1: Multiple Choice (12 marks)**

**Questions 1 & 2 refer to the following information:**

The table below shows the relationship between pH values, hydrogen ion concentrations and hydroxide ion concentrations.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| pH | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| H+ concentration  (mol L–1) | 1 | 10–1 | 10–2 | 10–3 | 10–4 | 10–5 | 10–6 | 10–7 | 10–8 | 10–9 | 10–10 | 10–11 | 10–12 | 10–13 | 10–14 |
| OH– concentration  (mol L–1) | 10–14 | 10–13 | 10–12 | 10–11 | 10–10 | 10–9 | 10–8 | 10–7 | 10–6 | 10–5 | 10–4 | 10–3 | 10–2 | 10–1 | 1 |

1. What is the relationship between pHand the concentration of hydrogen ions (H+)?
   1. As the concentration of H+ increases, the pH increases
   2. As the concentration of H+ halves, the pH doubles
   3. As the concentration of H+ decreases, the pH increases
   4. As the concentration of H+ doubles, pH halves
2. What is the relationship between the concentration of H+ and the concentration of OH⁻ in a solution?
   1. As the H+ concentration decreases, the OH⁻ concentration decreases
   2. As the H+ concentration increases, the OH⁻ concentration increases
   3. As the H+ concentration decreases, the OH⁻ concentration increases
   4. The H+ and OH⁻ concentrations are unrelated
3. Which one of the 0.02 mol L-1 solutions below will have the **lowest** pH?
   1. HCℓ
   2. H2SO4
   3. HNO3
   4. CH3COOH
4. Which one of the 0.02 mol L-1 solutions below will have the **highest** pH?
   1. HCℓ
   2. H2SO4
   3. HNO3
   4. CH3COOH
5. The table below shows the colour of various indicators under different pH conditions.



A sample of an unknown solution was tested using three of the above indicators. The following colours were observed with each indicator.

|  |  |
| --- | --- |
| **Indicator** | **Colour** |
| Thymol blue | Yellow |
| Methyl red | Red |
| Phenolphthalein | Colourless |

The pH of the unknown solution is between

* 1. pH = 2.8 and pH = 5.0
  2. pH = 2.8 and pH = 6.2
  3. pH = 6.0 and pH = 8.6
  4. pH = 2.8 and pH = 8.6

1. According to the Arrhenius theory, what is produced when nitric acid is dissolved in water?
2. hydroxide ions
3. electrons
4. water molecules
5. hydrogen ions
6. Which of the following characteristics best explains the compressibility of gases?
   1. Gases have very little attractive or repulsive forces between particles
   2. The average kinetic energy of gases is directly related to their temperature
   3. The size of gas particles is negligible compared to the space between particles
   4. Gases are able to move in random directions and collide with other particles
7. A weather balloon contains 38 g of helium (molecular weight: 4.00 g mol-1). Which calculation below would give the volume of helium at STP?
8. Which of the following statements about gas pressure, volume and temperature is correct?
   1. For a constant mass of a gas at a constant temperature, its volume decreases as its pressure increases.
   2. Equal volumes of gases always contain equal numbers of particles.
   3. For a constant mass of gas at a constant pressure, if its temperature is decreased, its volume will increase.
   4. As the temperature of a gas is decreased, its pressure will increase, thus ensuring the conservation of its energy.
9. How many litres of oxygen are required to react completely with 2.5 L of methane to form water? (assume all values are measured at standard temperature and pressure).

CH4(g) + 2O2(g) → CO2(g) + 2H2O(g)

* 1. 1.25 L
  2. 0.625 L
  3. 2.50 L
  4. 5.00 L

1. Which of the answers below is an ionic representation of the reaction between calcium nitrate and sodium sulfide solutions?

* 1. Ca2+(aq) + NO3⁻(aq) + Na+(aq) + S2- (aq) → CaS(s) + NaNO3(s)
  2. Ca2+(aq) + NO3⁻(aq) + Na+(aq) + S2- (aq) → CaS(s) + Na+(aq) + NO3⁻(aq)
  3. Ca2+(aq) + 2 NO3⁻(aq) + 2 Na+(aq) + 2 S2-(aq) → CaS(s) + 2 Na+ (aq) + 2 NO3⁻(aq)
  4. Ca2+(aq) + 2 NO3⁻(aq) + 2 Na+(aq) + S2-(aq) → CaS(s) + 2 Na+ (aq) + 2 NO3⁻(aq)

1. The spectator ions in Question 11 are:
   1. Ca2+ and NO3⁻
   2. Na+ and S2-
   3. Ca2+ and S2-
   4. Na+ and NO3⁻

**Section 2: Short Answer (38 marks)**

The Arrhenius model can be used to explain the behaviour of a range of acids and bases in aqueous solutions.

1. Give a definition for ‘acids’ and ‘bases’ using the Arrhenius model. (2 marks)

**Acids:** H+ in solution

* **Contain H (½ mark) and release H+ ions when dissolved in water(½ mark)**

**Bases:** OH- in solution

* **Contain OH (½ mark) and release OH- ions when dissolved in water (½ mark)**

1. Potassium hydroxide is an example of a strong base. Give an equation for the dissociation of potassium hydroxide, and explain what the term ‘strong’ means in this context. (2 marks)

KOH fully dissociates in water (1)

Equation (1)

1. Lemons are acidic due to the presence of citric acid, C6H8O7. Citric acid is an example of a weak monoprotic acid. Write an equation for the ionisation of citric acid, and explain what the term ‘weak’ means in this context. (3 marks)

Only partially ionises (1) and therefore lower concentration of H+ (1)

Equation (1) needs to show reversible arrow

1. **(14 marks)**

For each of the following combinations,

* + 1. Write a balanced molecular equation, including state symbols
    2. Write an ionic equation. In the ionic equations you should only show reacting species.
    3. Give a full set of observations for the reaction, including the colours of solutions and solids, and colour and odour of any gases formed.

If no reaction occurs you should state this. If no visible reaction occurs write “no visible reaction” for the observation.

1. A small amount of solid copper(II) hydroxide is added to a solution of nitric acid.

|  |  |
| --- | --- |
| **Molecular equation** |  |
| **Ionic equation** | **Cu(OH)2(s) + 2 H+(aq) 🡪 Cu2+(aq) + 2 H2O(ℓ)**  2 marks. (Balanced molecular = 1 mark. Unbalanced ionic = 1 mark) |
| **Observations** | **Blue solid dissolves (½ mark)**  **Solution turns blue (½ mark)** |

1. A solution of sodium hydroxide is mixed with a solution of phosphoric acid.

|  |  |
| --- | --- |
| **Molecular equation** |  |
| **Ionic equation** | **3 OH-(aq) + H3PO4(aq) 🡪 3 H2O(ℓ) + PO43-(aq)**  2 marks. (Balanced molecular = 1 mark. Unbalanced ionic = 1 mark) |
| **Observations** | **(Two colourless solution mix) No visible reaction (1 mark)** |

1. Potassium chloride solution is added to copper(II) nitrate solution

|  |  |
| --- | --- |
| **Molecular equation** | No reaction **(1/2 mark)** |
| **Ionic equation** | No reaction (1/2 mark) |
| **Observations** | No visible reaction (1) |

1. Crystals of ammonium chloride are stirred into a solution of potassium hydroxide.

|  |  |
| --- | --- |
| **Molecular equation** |  |
| **Ionic equation** | **NH4Cℓ(s) + OH-(aq) 🡪 NH3(g) + Cℓ-(aq) + H2O(ℓ)**  2 marks. (Balanced molecular = 1 mark. Unbalanced ionic = 1 mark) |
| **Observations** | **White solid dissolved (½ mark)**  **Colourless, pungent gas is formed (½ mark)** |

1. An excess of sodium carbonate solution is added to a small amount of nickel(II) sulphate solution.

|  |  |
| --- | --- |
| **Molecular equation** | State symbols  Na2CO3(aq) + NiSO4(aq) **🡪 NaSO4(aq) + NiCO3(s)** |
| **Ionic equation** | CO32- + Ni2+ **🡪 NiCO3** |
| **Observations** | Clear Solution + green solution gives green ppt in clear solution |

A student wished to distinguish between five colourless solutions. The identities of the solutions were:

* Potassium chloride
* Sodium hydroxide
* Barium hydroxide
* Nitric acid
* Lead(II) nitrate

1. Complete the table below to show the name or formula of each substance identified through the students’ chemical tests. (4 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Chemical test** | **Observation** | **Substance identified** |
| 1 | Blue litmus paper was added to each solution | One of the solutions caused the litmus paper to turn red | **Nitric acid** |
| 2 | Sodium iodide was added to the four remaining solutions | One of the solutions produced a yellow solid | **Lead(II) nitrate** |
| 3 | Sulfuric acid was added to the three remaining solutions | One of the solutions produced a white solid | **Barium hydroxide** |
| 4 | Universal indicator was added to the two remaining solutions | One of the solutions turned dark purple | **Sodium hydroxide**  **(or barium hydroxide if Step 3 answered incorrectly)** |
| One of the solutions turned green | **Potassium chloride**  **(or lead nitrate if Step 2  answered incorrectly)** |

1. Write a balanced equation for the reaction that happened in Step 2. (1 mark)

**Molecular: Pb(NO3)2(aq) + 2 NaI(aq) 🡪 PbI2(s) + 2 NaNO3(aq)**

**OR  
Ionic: Pb2+(aq) + 2 I-(aq) 🡪 PbI2(s)**

***State symbols not required for full marks in ionic equation, but if writing molecular equation must at least show that PbI2 is the solid, not NaCℓ.***

1. Write a balanced equation for the reaction that happened in Step 3. (1 mark)

**Molecular: Ba(OH)2(aq) + H2SO4(aq) 🡪 BaSO4(s) + 2 H2O(ℓ)**

**OR**

**Ionic: Ba2+(aq) + 2 OH-(aq) + 2 H+(aq) + SO42-(aq) 🡪 BaSO4(s) + 2 H2O(ℓ)**

***State symbols not required for full marks***

A metal canister is filled with air and the canister is sealed so that gas cannot escape. The canister is placed in a bath of liquid nitrogen (-210 °C). (4 marks)

As this happens, the pressure in the canister will: ….

Explanation:

|  |  |
| --- | --- |
| **Answer** | **Marks** |
| * Pressure will decrease | **1** |
| * Particles have decreased kinetic energy | **1** |
| * Move slower | **1** |
| * Less collisions with walls of container | **1** |
| **Total marks:** | **4** |

Consider the reaction between hydrochloric acid and magnesium metal.

* 1. Write a balanced chemical equation for this reaction. (2 marks)

Mg + 2HCl → MgCl2 + H2

* 1. How many moles of hydrochloric acid would be required to fully react with 6.22 g of magnesium?   
      (2 marks)

n(Mg) = 6.22/24.31 = 0.256 mol

n(HCl) = 2 x n(Mg)

= 0.512 mol

* 1. The reaction is carried out with 35 mL of 2 mol L-1 hydrochloric acid and an excess of magnesium. What volume of hydrogen gas would be generated if the reaction was carried out at STP? (3 marks)

n(HCl) = v x c

= 0.035 x 2

= 0.070 mol

n(H2) = 0.5 x n(HCl)

= 0.5 x 0.07

=0.035 mol

V(H2) = 0.035 x 22.71 = 0.795 L