2.26 Tests for Ions, Gases and Flame Tests: Test Pack

AQA 8464 · Calculator allowed · about 45 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student suspects a solid sample contains carbonate ions.

(a) Give a simple test and the observation that would show carbonate is present. **(1)**

(Total for Question 1 is 1 mark)

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2 A student wants to test a solution for chloride ions.

(a) Name a reagent that the student should add to the sample to test for chloride ions (after acidifying if needed). **(1)**

(b) State the observation that indicates chloride ions are present. **(1)**

(Total for Question 2 is 2 marks)

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3 Describe a laboratory test to show that sulfate ions are present in a solution.

(a) State the reagent to add (after acidifying if needed) and the observation for a positive test. **(2)**

(Total for Question 3 is 2 marks)

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4 State the test and observation for each of the following gases.

(a) Oxygen **(1)**

(b) Hydrogen **(1)**

(c) Carbon dioxide **(1)**

(Total for Question 4 is 3 marks)

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5 A student gently heats a carbonate and collects the gas evolved. The gas turns limewater cloudy and does not relight a glowing splint. Identify the gas and give one chemical equation for the decomposition or reaction that produced it.

(a) Identify the gas. **(1)**

(b) Give one chemical equation showing how heat produces this gas from a carbonate (use $CaCO_3$ as an example). **(1)**

(Total for Question 5 is 2 marks)

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6 Give the typical flame colours for the following metal ions when tested in a clean flame.

(a) Sodium ion (Na^+) **(1)**

(b) Potassium ion (K^+) **(1)**

(c) Calcium ion (Ca^{2+}) **(1)**

(Total for Question 6 is 3 marks)

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7 Write the ionic equation for the formation of silver chloride precipitate when silver nitrate reacts with sodium chloride.

(a) Ionic equation **(2)**

(Total for Question 7 is 2 marks)

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8 A required-practical style test: A student performs sodium hydroxide tests on three unknown metal ion solutions A, B and C. The observations are shown in the table below.

Observations:
- Solution A: Add NaOH, a blue precipitate forms which does not dissolve in excess NaOH.
- Solution B: Add NaOH, a white precipitate forms that dissolves in excess NaOH to give a colourless solution.
- Solution C: Add NaOH, a green precipitate forms which darkens on standing.

Use these observations to identify the likely metal ion in each solution and state the reasoning.

Solution	Observation
A	Add NaOH, a blue precipitate forms which does not dissolve in excess NaOH.
B	Add NaOH, a white precipitate forms that dissolves in excess NaOH to give a colourless solution.
C	Add NaOH, a green precipitate forms which darkens on standing.

(a) Identify the metal ion in solution A and give the reason. **(1)**

(b) Identify the metal ion in solution B and give the reason. **(2)**

(c) Identify the metal ion in solution C and give the reason. **(1)**

(Total for Question 8 is 4 marks)

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9 A student reports that during several flame tests they sometimes saw an orange flame when testing potassium salts instead of the expected lilac colour.

(a) Give two possible causes for the orange flame and suggest one improvement to the procedure that would reduce this error. **(3)**

(Total for Question 9 is 3 marks)

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10 Predict the observations when a few drops of dilute ammonia solution are added to a solution containing aluminium ions (Al^{3+}). Include the result for initial addition and after adding excess ammonia.

(a) State the observation on initial addition and after excess ammonia is added. **(2)**

(Total for Question 10 is 2 marks)

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11 A 250.0 cm^3 solution contains 0.500 g of potassium chloride (KCl). Calculate the concentration of potassium ions (K^+) in mol/dm3. Ar: K 39.10, Cl 35.45, Mr(KCl) = 74.55.

(a) Show the calculation and give the concentration of K^+ in mol/dm3. **(3)**

(Total for Question 11 is 3 marks)

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12 Explain why the sodium flame colour can make it difficult to observe the flame colours of small amounts of calcium or potassium in the same sample, and give one practical method to overcome this problem.

(a) Explain the masking effect and give one method to reduce it. **(3)**

(Total for Question 12 is 3 marks)

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13 A student investigates the carbonate content of a marble chip sample. A 0.500 g sample of powdered marble is reacted completely with excess dilute hydrochloric acid and the gas collected. The volume of CO_2 collected at room temperature and pressure is 22.4 cm^3. Using 24.0 dm3 per mole as the molar volume at room temperature and pressure, calculate the percentage by mass of calcium carbonate ($CaCO_3$) in the sample. Ar: Ca 40.08, C 12.01, O 16.00, Mr($CaCO_3$) = 100.09.

(a) Show the calculation and give the percentage by mass of $CaCO_3$ in the sample. Include units. **(4)**

(Total for Question 13 is 4 marks)

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Mark scheme · 2.26 Tests for Ions, Gases and Flame Tests: Test Pack

Question 1

(a) add dilute acid and observe effervescence; gas turns limewater cloudy (carbon dioxide), oe **B1**

(a) Answer: Add dilute acid and collect gas; effervescence and limewater turns cloudy (CO_2).

Question 2

(a) silver nitrate ($AgNO_3$) added after acidification with dilute nitric acid, oe **B1**

(a) Answer: Silver nitrate ($AgNO_3$) after acidifying with dilute nitric acid.

(b) a white precipitate of silver chloride (AgCl) forms, oe **B1**

(b) Answer: A white precipitate (silver chloride) forms.

Question 3

(a) add barium chloride solution ($BaCl_2$) after acidifying with dilute hydrochloric or nitric acid, oe **B1**

(a) a white precipitate of barium sulfate ($BaSO_4$) forms, oe **B1**

(a) Answer: Add barium chloride after acidifying; a white precipitate of barium sulfate forms.

Question 4

(a) glowing splint relights in oxygen, oe **B1**

(a) Answer: A glowing splint relights.

(b) popping sound with lighted splint (hydrogen), oe **B1**

(b) Answer: Produces a popping sound with a lighted splint.

(c) turns limewater cloudy (white precipitate of calcium carbonate), oe **B1**

(c) Answer: Turns limewater cloudy.

Question 5

(a) carbon dioxide (CO_2) cao **B1**

(a) Answer: Carbon dioxide (CO_2).

(b) $CaCO_3$ -> CaO + CO_2, cao **B1**

(b) Answer: $CaCO_3$ -> CaO + CO_2

Question 6

(a) bright yellow flame (sodium), cao **B1**

(a) Answer: Bright yellow flame.

(b) lilac (pale violet) flame, oe **B1**

(b) Answer: Lilac flame.

(c) orange-red or brick-red flame, oe **B1**

(c) Answer: Orange-red flame.

Question 7

(a) shows Ag^+ and Cl^- combining to form AgCl(s): Ag^+ + Cl^- -> AgCl(s), oe **M1**

(a) ionic equation correct and state symbol included: Ag^+ + Cl^- -> AgCl(s) cao **A1**

(a) Answer: Ag^+ + Cl^- -> AgCl(s)

Question 8

(a) copper(II) ion, Cu^{2+} (forms a blue precipitate of $Cu(OH)_2$ that is insoluble in excess NaOH), oe **B1**

(a) Answer: Copper(II) ion, Cu^{2+}, because it gives an insoluble blue precipitate with NaOH.

(b) identifies aluminium ion, Al^{3+}, which gives a white precipitate with NaOH and dissolves in excess NaOH (amphoteric behaviour), oe **M1**

(b) states that the white precipitate dissolves in excess to give a colourless solution ($Al(OH)_3$ dissolves), cao **A1**

(b) Answer: Aluminium ion, Al^{3+}: a white precipitate forms and dissolves in excess NaOH to give a colourless solution.

(c) iron(II) ion, Fe^{2+}, which gives a green precipitate that darkens on standing due to oxidation to iron(III), oe **B1**

(c) Answer: Iron(II) ion, Fe^{2+}, because a green precipitate forms and darkens on standing.

Question 9

(a) identifies contamination by sodium (or other metal) as a cause which can mask potassium's lilac with intense sodium yellow, oe **M1**

(a) identifies use of impure wire/loop or residue from previous tests as cause, oe **M1**

(a) suggests improvement such as cleaning the wire loop thoroughly in acid and a clean flame between tests or using a platinum wire or using cobalt glass to filter sodium yellow, cao **A1**

(a) Answer: Possible causes: contamination by sodium giving an orange/yellow colour; dirty wire loop or residue from previous tests. Improvement: clean the loop in acid and heat to a clean flame between tests or use cobalt glass to see the lilac colour.

Question 10

(a) white precipitate forms on initial addition ($Al(OH)_3$), oe **M1**

(a) the white precipitate does not dissolve in excess ammonia (it remains insoluble), cao **A1**

(a) Answer: White precipitate forms initially; the white precipitate does not dissolve in excess ammonia.

Question 11

(a) calculates moles KCl = 0.500 / 74.55 = 0.006707 mol, oe **M1**

(a) calculates concentration = moles / volume (dm3) = 0.006707 / 0.250 = 0.02683 mol/dm3, oe **M1**

(a) gives final value 0.0268 mol/dm3 (to three significant figures) cao **A1**

(a) Answer: 0.0268 mol/dm3

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Question 12

(a) states that sodium produces a very intense yellow emission, oe **M1**

(a) explains that this intense emission overwhelms the weaker emissions from small amounts of calcium or potassium, masking their colours, oe **M1**

(a) uses cobalt glass to filter sodium's yellow emission when observing potassium, or separates the ions before flame testing, oe; do not credit cleaning or replacing the wire alone because sodium is present in the sample **A1**

(a) Answer: Sodium's intense yellow emission overwhelms the weaker colours from small amounts of calcium or potassium in the same sample. Use cobalt glass to filter the yellow when observing potassium, or separate the ions before flame testing.

Question 13

(a) convert volume to moles: moles CO_2 = 22.4 cm^3 = 0.0224 dm3; moles = 0.0224 / 24.0 = 9.333 x 10^{-4} mol, oe **M1**

(a) use 1:1 ratio $CaCO_3$: CO_2 so moles $CaCO_3$ = 9.333 x 10^{-4} mol, oe **M1**

(a) mass $CaCO_3$ = moles x Mr = 9.333 x 10^{-4} x 100.09 = 0.0934 g (ecf), oe **M1**

(a) percentage = (0.0934 / 0.500) x 100 = 18.7% (to three sf) cao **A1**

(a) Answer: 18.7 %

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