2.3 Chemical Changes: 1-hour Pack

AQA 8462 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Universal indicator can be used to estimate the pH of a solution.

(a) State the pH value of a neutral solution. **(1)**

(b) A solution turns universal indicator red. State whether this solution is a strong acid, weak acid, strong alkali or weak alkali, and give its approximate pH. **(2)**

(Total for Question 1 is 3 marks)

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2 A student adds a small piece of magnesium ribbon to dilute hydrochloric acid in a test tube and observes bubbles and heat.

(a) Write the symbol equation for the reaction between magnesium and hydrochloric acid. **(1)**

.....

(b) State two observable changes that would support the student's report of bubbles and heat. **(2)**

(Total for Question 2 is 3 marks)

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3 A student titrates 25.0 cm^3 of 0.100 mol/dm3 hydrochloric acid with 0.100 mol/dm3 sodium hydroxide. The equation is HCl + NaOH -> NaCl + H_2O.

(a) Calculate the number of moles of HCl in the 25.0 cm^3 sample. **(1)**

.....

(b) Calculate the volume of 0.100 mol/dm3 NaOH needed to neutralise this acid. **(2)**

.....

(Total for Question 3 is 3 marks)

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4 Sulfuric acid reacts with different bases.

(a) Complete the word equation: copper oxide + sulfuric acid -> ___ + ___ **(2)**

(b) Write the balanced symbol equation for the reaction between sodium hydroxide and sulfuric acid, given the products are sodium sulfate and water. **(3)**

(c) Write the ionic equation for neutralisation that applies to any strong acid reacting with any alkali. **(2)**

(Total for Question 4 is 7 marks)

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5 Describe how to make a pure, dry sample of potassium chloride crystals starting from aqueous potassium hydroxide and dilute hydrochloric acid. Your answer should include how you would carry out the neutralisation, how to purify the salt, and one safety precaution.

(Total for Question 5 is 6 marks)

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6 Aqueous copper(II) sulfate is electrolysed using inert electrodes. The ions present are Cu^{2+}, SO_4^{2-}, H^+ and OH^- from water.

(a) State which species is reduced at the cathode and give the half equation for its reduction. **(2)**

(b) State what is observed at the cathode during the electrolysis. **(1)**

(Total for Question 6 is 3 marks)

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7 Lead bromide, $PbBr_2$, is a solid at room temperature but conducts electricity and can be electrolysed when molten.

(a) Explain why solid lead bromide does not conduct electricity, but molten lead bromide does. **(2)**

(b) Name the product formed at the cathode (negative electrode) during electrolysis of molten lead bromide, and explain why it forms there. **(2)**

(c) Write the half equation for the reaction at the anode. **(2)**

(Total for Question 7 is 6 marks)

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8 0.24 g of magnesium ribbon is reacted with excess dilute sulfuric acid. $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$. Relative atomic mass of Mg = 24. The molar volume of a gas at room temperature and pressure is 24000 cm^3/mol.

(a) Show that the volume of hydrogen gas produced is 240 cm^3. **(3)**

(Total for Question 8 is 3 marks)

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9 A student adds sodium hydroxide solution, a little at a time, to 25 cm^3 of hydrochloric acid and measures the pH after each addition using a pH probe. The table shows her results.
Volume of NaOH added (cm3): 0, 5, 10, 15, 20, 25
pH: 1, 2, 3, 7, 11, 12

(a) Identify the volume of sodium hydroxide needed to exactly neutralise the acid. **(1)**

(b) Describe the shape of the graph of pH (y-axis) against volume of NaOH added (x-axis) that these results would produce. **(2)**

(Total for Question 9 is 3 marks)

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10 A student reacts 3.0 g of magnesium ribbon with excess dilute hydrochloric acid. $Mg + 2HCl \rightarrow MgCl_2 + H_2$. Relative atomic masses: H = 1, Mg = 24, Cl = 35.5. The molar volume of a gas at room temperature and pressure is 24 dm3 (24000 cm^3).

(a) Calculate the number of moles of magnesium in 3.0 g. **(2)**

(b) Calculate the mass of magnesium chloride, $MgCl_2$, produced. **(3)**

(c) Calculate the volume, in dm3, of hydrogen gas produced at room temperature and pressure. **(2)**

(d) Describe a test to confirm the gas produced is hydrogen, including the result. **(2)**

(Total for Question 10 is 9 marks)

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Mark scheme · 2.3 Chemical Changes: 1-hour Pack

Question 1

(a) 7 cao **B1**

(a) Answer: 7

(b) strong acid **B1**

(b) approximately pH 0-2 (accept awrt 1) **B1**

(b) Answer: Strong acid, approximately pH 0-2.

Question 2

(a) $Mg + 2HCl \rightarrow MgCl_2 + H_2$ cao **B1**

(a) Answer: $Mg + 2HCl \rightarrow MgCl_2 + H_2$

(b) bubbling or effervescence (hydrogen gas produced) **B1**

(b) temperature of the mixture increases or test tube gets warm (exothermic), oe **B1**

(b) Answer: Bubbling (effervescence) and the test tube gets warm (exothermic).

Question 3

(a) uses n = concentration x volume (in dm3) and calculates 0.100 x 0.0250 = 0.00250 mol **B1**

(a) Answer: 0.00250 mol

(b) uses stoichiometry: n NaOH = n HCl = 0.00250 mol **M1**

(b) volume = n / concentration = 0.00250 / 0.100 = 0.0250 dm3 = 25.0 cm^3 cao **A1**

(b) Answer: 25.0 cm^3

Question 4

(a) copper sulfate **B1**

(a) water **B1**

(a) Answer: copper sulfate + water

(b) correct formulae for all species: NaOH, H_2SO_4, Na_2SO_4, H_2O **M1**

(b) correctly balanced with 2NaOH and $2H_2O$ **M1**

(b) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ fully correct cao **A1**

(b) Answer: $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(c) $H^+(aq)$ and $OH^-(aq)$ shown as reactants **M1**

(c) $H_2O(l)$ shown as product with correct state symbols cao **A1**

(c) Answer: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Question 5

Level 3 Detailed description of the method, including accurate steps for neutralisation with correct indicators or measurement, purification by evaporation/crystallisation and drying, and a safety precaution. Logical sequence and reasons given. **5-6**

Level 2 Basic description with most steps present: neutralisation and crystallisation described but lacking some detail or reasoning; includes a safety point. **3-4**

Level 1 Limited or incomplete description. Missing important steps such as neutralisation, purification or safety. **0-2**

Indicative content:

- Measure a known volume or amount of potassium hydroxide solution.
- Add dilute hydrochloric acid slowly to the alkali while stirring, using universal indicator or phenolphthalein to know when neutral (colour change), or add until neutral measured by pH meter.
- Alternatively, add acid until neutralisation and then add a little excess alkali and filter off if using insoluble reagents (not applicable here), so state careful addition and checking of pH.
- Once neutral, evaporate some water by gentle heating until crystals start to form, then leave to cool to crystallise the potassium chloride.
- Filter off the crystals, wash with a small amount of cold distilled water, then dry on filter paper or in a warm oven to obtain a pure dry sample.
- Include a safety precaution such as wearing safety goggles, handle acids carefully, and do not boil to dryness.

Question 6

(a) identifies that Cu^{2+} is reduced at the cathode **M1**

(a) $Cu^{2+} + 2e- \rightarrow Cu$ cao **A1**

(a) Answer: Cu^{2+} is reduced; $Cu^{2+} + 2e- \rightarrow Cu$

(b) brown/red solid copper deposits on the cathode **B1**

(b) Answer: Brown/red copper metal deposits on the cathode.

Question 7

(a) in the solid, the ions are held in a fixed lattice/position and cannot move **M1**

(a) when molten, the ions are free to move and can carry charge/current **M1**

(a) Answer: Solid ions are fixed in place; molten ions are free to move and carry charge.

(b) lead (metal) forms at the cathode **M1**

(b) positive Pb^{2+} ions are attracted to the negative electrode (cathode) (oe) **M1**

(b) Answer: Lead forms at the cathode because Pb^{2+} ions are attracted to the negative electrode.

(c) correct species shown: $2Br^-$ and Br_2 **M1**

(c) $2Br^- \rightarrow Br_2 + 2e-$ correctly balanced cao **A1**

(c) Answer: $2Br^- \rightarrow Br_2 + 2e-$

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Question 8

(a) moles of Mg = 0.24 / 24 = 0.01 (mol) **M1**

(a) moles of H_2 = 0.01 mol (1:1 ratio with Mg) **M1**

(a) volume = 0.01 x 24000 = 240 cm^3 cso **A1**

(a) Answer: 240 cm^3 (as given)

Question 9

(a) 15 cm^3 cao **B1**

(a) Answer: 15 cm^3

(b) pH stays low and rises slowly at first, while acid is in excess **M1**

(b) pH rises very steeply/sharply around the neutralisation point (15 cm^3) then levels off at high pH as alkali becomes in excess (oe) **M1**

(b) Answer: A shallow rise, then a steep rise around 15 cm^3, then levelling off at high pH.

Question 10

(a) correct substitution: 3.0 / 24 **M1**

(a) 0.125 mol cao **A1**

(a) Answer: 0.125 mol

(b) Mr of $MgCl_2$ = 95 (24 + 2 x 35.5) **M1**

(b) moles of $MgCl_2$ = moles of Mg = 0.125 (mol) (ft from part a, 1:1 ratio) **M1**

(b) 11.875 g or 11.9 g (awrt 11.9) **A1**

(b) Answer: 11.9 g (11.875 g)

(c) moles of H_2 = 0.125 (mol) (ft from part a, 1:1 ratio with Mg) x 24 **M1**

(c) 3.0 dm3 cao **A1**

(c) Answer: 3.0 dm3

(d) hold a lit (burning) splint at the mouth of the test tube/near the gas **B1**

(d) a squeaky pop is heard **B1**

(d) Answer: Lit splint held near the gas produces a squeaky pop.

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