2.3 Chemical Changes: Test Pack

AQA 8462 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 An acid is a substance that can release hydrogen ions when in water.

(a) Define the term 'acid' in terms of ions produced in water. **(1)**

(Total for Question 1 is 1 mark)

2 Indicators change colour depending on the pH of a solution.

(a) Name an indicator that gives a different colour for acids and alkalis and is commonly used to show the pH range (not just litmus). **(1)**

(Total for Question 2 is 1 mark)

3 A student carries out displacement reactions by adding small pieces of four metals (magnesium, zinc, iron and copper) to separate test tubes of dilute hydrochloric acid. She records how vigorously each metal reacts.

(a) State the general trend in reactivity of the four metals shown by this test. **(1)**

(b) Use the reactivity series to put these four metals in order, from most reactive to least reactive. **(2)**

(Total for Question 3 is 3 marks)

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4 A metal displacement reaction can form a salt from a metal and a solution containing another metal ion.

(a) Predict what happens when a strip of iron is placed in copper(II) sulfate solution. **(2)**

(Total for Question 4 is 2 marks)

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5 Neutralisation between an acid and an alkali produces a salt and water.

(a) Give the two products formed when hydrochloric acid reacts with sodium hydroxide. **(2)**

(Total for Question 5 is 2 marks)

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6 A student says a soluble salt can be made by reacting an acid with an insoluble base and filtering off excess base.

(a) Explain why the student filters the mixture after reacting an acid with an insoluble base when making a salt. **(2)**

(Total for Question 6 is 2 marks)

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7 Iron is extracted from iron oxide by heating with carbon in a blast furnace. Aluminium is extracted from aluminium oxide by electrolysis.

(a) Name the type of chemical reaction that occurs when iron oxide reacts with carbon to form iron. **(1)**

(b) Explain why aluminium cannot be extracted from its oxide by heating with carbon, but iron can. **(3)**

(c) Give one reason, other than reactivity, why extracting aluminium is more expensive than extracting iron. **(1)**

(Total for Question 7 is 5 marks)

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8 A student reacts 2.00 g of magnesium with excess oxygen to form magnesium oxide. Relative atomic masses: Mg = 24.3, O = 16.0.

(a) Calculate the moles of magnesium used. Give your answer to 3 significant figures. **(2)**

(b) Using the balanced equation $2Mg + O_2 \rightarrow 2MgO$, calculate the mass of magnesium oxide produced, to 3 significant figures. **(2)**

(Total for Question 8 is 4 marks)

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9 A student adds four metals (A, B, C and D) to solutions of salts of the other metals and records whether a displacement reaction occurs.

Metal A added to a solution of a salt of B: reaction occurs
Metal B added to a solution of a salt of C: reaction occurs
Metal B added to a solution of a salt of D: reaction occurs
Metal D added to a solution of a salt of C: reaction occurs
Metal C added to a solution of a salt of A: no reaction

(a) Use the results to deduce the order of reactivity of metals A, B, C and D, from most to least reactive. **(3)**

(b) Explain, in terms of particles, why metal A is able to displace metal B from a solution of B's salt. **(2)**

(Total for Question 9 is 5 marks)

10 Chromium can form ions with different charges. A sample contains Cr^{2+} and Cr^{3+} ions.

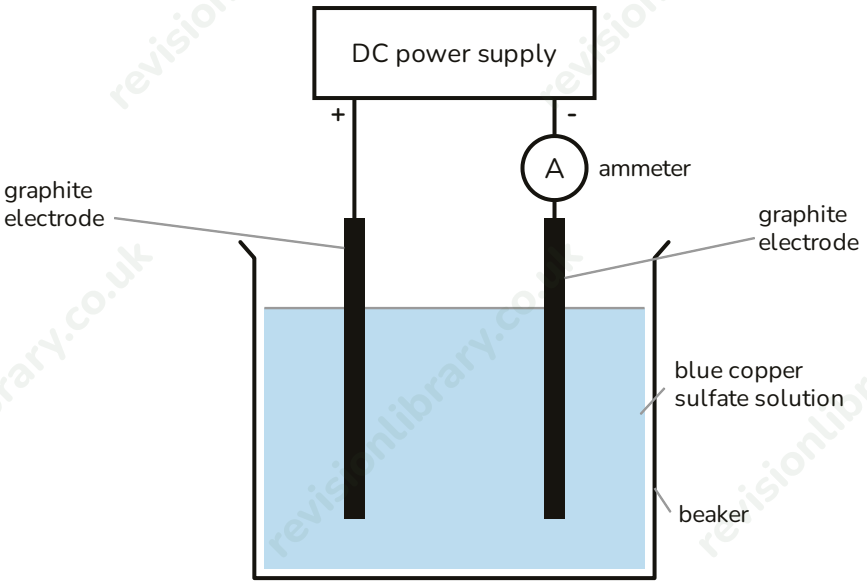
(a) Explain, in terms of electron transfer, what happens when a Cr^{2+} ion is converted into a Cr^{3+} ion, and state what type of reaction this is. **(3)**

(b) Give one chemical test that distinguishes an aqueous solution of Cr^{3+} from one of Cr^{2+}. **(1)**

(Total for Question 10 is 4 marks)

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11 Required practical: A student investigates the electrolysis of copper sulfate solution using inert (graphite) electrodes.



(a) Name the product observed forming at the cathode, and describe what is seen. **(2)**

(b) Explain, in terms of ions present, why oxygen gas (rather than sulfate) is produced at the anode. **(3)**

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

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(d) A different student repeats the experiment using copper electrodes instead of inert electrodes, and finds the blue colour of the solution does not change. Explain this observation, and state a use of this process. **(3)**

(Total for Question 11 is 10 marks)

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12 Hydrochloric acid is a strong acid. Ethanoic acid is a weak acid. Both solutions have the same concentration, 0.1 mol/dm3.

(a) Explain the difference between a strong acid and a weak acid in terms of ionisation. **(2)**

(b) State and explain which of the two solutions would have the lower pH. **(3)**

(c) A solution of hydrochloric acid has a pH of 2. Predict the pH of a solution of hydrochloric acid that has a hydrogen ion concentration 10 times greater. **(1)**

(Total for Question 12 is 6 marks)

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Mark scheme · 2.3 Chemical Changes: Test Pack

Question 1

(a) produces hydrogen ions (H^+) in aqueous solution, oe **B1**

(a) Answer: A substance that produces hydrogen ions (H^+) in water.

Question 2

(a) universal indicator **B1**

(a) Answer: Universal indicator

Question 3

(a) the more reactive the metal, the more vigorous/faster the reaction with the acid (oe) **B1**

(a) Answer: More reactive metals react more vigorously and quickly with the acid.

(b) at least three metals placed in the correct relative order **B1**

(b) fully correct order: magnesium, zinc, iron, copper cao **B1**

(b) Answer: Magnesium > zinc > iron > copper

Question 4

(a) iron will displace copper from solution (if student states iron is more reactive than copper) **B1**

(a) copper metal forms and solution becomes iron sulfate (or solution colour fades), oe **B1**

(a) Answer: Iron displaces copper; copper metal forms and the solution becomes iron sulfate (the blue colour fades).

Question 5

(a) sodium chloride **B1**

(a) water **B1**

(a) Answer: Sodium chloride and water.

Question 6

(a) filtering removes excess insoluble base from the solution **B1**

(a) this leaves a solution containing only the dissolved salt which can then be crystallised, oe **B1**

(a) Answer: Filtering removes the excess insoluble base, leaving a solution of the dissolved salt that can be crystallised.

Question 7

(a) reduction (oe) **B1**

(a) Answer: Reduction

(b) aluminium is more reactive than carbon, but iron is less reactive than carbon **B1**

(b) carbon can only reduce (displace) metals that are less reactive than carbon itself **B1**

(b) so carbon can reduce iron oxide but cannot reduce (remove oxygen from) aluminium oxide **B1**

(b) Answer: Aluminium is more reactive than carbon so carbon cannot displace it; iron is less reactive than carbon so carbon can reduce iron oxide.

(c) e.g. electrolysis requires large amounts of electrical energy, which is expensive; or the aluminium oxide must be melted, which needs a lot of energy (oe, any sensible cost-related reason) **B1**

(c) Answer: Electrolysis uses large amounts of electrical energy, which is costly.

Question 8

(a) uses n = mass / Mr with 2.00 / 24.3 **M1**

(a) 0.0823 mol cao **A1**

(a) Answer: 0.0823 mol

(b) uses mole ratio: 2Mg -> 2MgO so moles MgO = moles Mg = 0.0823 **M1**

(b) mass MgO = 0.0823 x (24.3 + 16.0) = 0.0823 x 40.3 = 3.32 g cao **A1**

(b) Answer: 3.32 g

Question 9

(a) A is more reactive than B (A displaces B; C does not displace A) **M1**

(a) B is more reactive than both C and D (B displaces both C and D); D is more reactive than C (D displaces C) **M1**

(a) correct full order: A, B, D, C (most to least reactive) cao **A1**

(a) Answer: A > B > D > C

(b) atoms of metal A lose electrons more easily than atoms of metal B (A is more reactive) **M1**

(b) A atoms transfer electrons to ions of B, so A is oxidised and B ions are reduced (deposited as the metal) (oe) **M1**

(b) Answer: A atoms lose electrons more readily than B, transferring electrons to B ions, oxidising A and reducing B ions.

Question 10

(a) recalls that oxidation is the loss of electrons (and reduction is the gain of electrons) **B1**

(a) states that a Cr^{2+} ion loses one electron to become a Cr^{3+} ion: Cr^{2+} -> Cr^{3+} + e- **M1**

(a) concludes this is an oxidation reaction, and that something else must gain the electron lost (a reduction must happen at the same time), oe **A1**

(a) Answer: A Cr^{2+} ion loses one electron to form Cr^{3+} (Cr^{2+} -> Cr^{3+} + e-); since oxidation is the loss of electrons, this is an oxidation reaction, and another species must gain that electron at the same time (a reduction).

(b) oxidation of Cr^{2+} to Cr^{3+} with acidified potassium manganate(VII) or other oxidising agent, producing a colour change; or observation that Cr^{2+} is typically pale blue while Cr^{3+} is green, oe **B1**

(b) Answer: Oxidise with acidified $KMnO_4$: Cr^{2+} (pale blue) is oxidised to Cr^{3+} (green), producing a colour change.

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Question 11

(a) copper (metal) **B1**

(a) a pink/orange-brown coating (deposit) forms on the electrode **B1**

(a) Answer: Copper metal is deposited, seen as a pink/orange-brown coating on the electrode.

(b) the ions present in solution include Cu^{2+}, SO_4^{2-}, H^+ and OH^- (from water) **M1**

(b) sulfate ions are not discharged at the anode **M1**

(b) OH^- ions (from water) are discharged in preference, producing oxygen gas and water (oe) **M1**

(b) Answer: Sulfate ions are not discharged; hydroxide ions from water are discharged instead, producing oxygen.

(c) correct species shown: Cu^{2+} and Cu with 2e- **M1**

(c) Cu^{2+} + 2e- -> Cu correctly balanced cao **A1**

(c) Answer: Cu^{2+} + 2e- -> Cu

(d) at the anode, copper atoms dissolve into solution as Cu^{2+} ions **M1**

(d) at the cathode, copper is deposited from Cu^{2+} ions in solution at approximately the same rate, so the concentration of Cu^{2+} ions (and blue colour) stays constant **M1**

(d) this process is used to purify copper (oe) **M1**

(d) Answer: Copper anode dissolves as fast as copper is deposited at the cathode, keeping Cu^{2+} concentration constant; used to purify copper.

Question 12

(a) a strong acid ionises (dissociates) completely in water **M1**

(a) a weak acid only partially ionises (dissociates) in water, an equilibrium exists between the acid and its ions **M1**

(a) Answer: Strong acids fully ionise; weak acids only partially ionise.

(b) hydrochloric acid has the lower pH **M1**

(b) at the same concentration, hydrochloric acid produces a higher concentration of H^+ ions **M1**

(b) because it is a strong acid and ionises fully, whereas ethanoic acid only partially ionises, so produces fewer H^+ ions (oe) **M1**

(b) Answer: Hydrochloric acid has the lower pH because it fully ionises, giving a higher H^+ ion concentration.

(c) pH 1 cao **B1**

(c) Answer: pH 1

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