K9E Acids and Alkalis: Depth and Practice

AQA AQA KS3 Science - Chemistry · Calculator allowed · about 80 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 State what an acid is in terms of the ions it produces in water.

(1)

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2 In terms of ions produced in water, give the definition of an alkali. Your answer should state which ion is formed when an alkali dissolves.

(1)

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3 On the pH scale from 0 to 14, which region is acidic and which region is alkaline?

(1)

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4 What colour does universal indicator usually show for a neutral solution (pH 7)?

(1)

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5 Use litmus paper to test two solutions.
Part a) State the colour change on blue litmus paper when it is put into an acidic solution.
Part b) State the colour change on red litmus paper when it is put into an alkaline solution.

(a) Blue litmus in acid: colour change? **(1)**

(b) Red litmus in alkali: colour change? **(1)**

6 Write the word equation for the reaction between an acid and a metal.

(1)

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7 Name one piece of personal protective equipment (PPE) you should wear when handling concentrated acid in the laboratory.

(1)

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8 A small spill of dilute hydrochloric acid is on a bench. Suggest a safe method to neutralise and clear the spill. Include steps and how you would check it is safe to leave.

(3)

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9 Name the piece of apparatus used to add a measured volume of acid slowly during a titration.

(1)

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10 A student carries out a titration and obtains these concordant titres: 9.40 cm3, 9.55 cm3, 9.48 cm3. One of these is an anomaly. Identify the anomalous titre and calculate the best estimate of the titre to use (to 2 decimal places). Include units.

(3)

11 Explain why it is important to rinse the burette with the solution that will be placed inside it before starting a titration. Give two effects that failing to rinse could have on the titre readings.

(3)

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12 In a titration, a student found that exactly 25.0 cm3 of a dilute sodium hydroxide solution was needed to exactly neutralise 20.0 cm3 of a dilute hydrochloric acid. The student repeats the experiment using 40.0 cm3 of the same hydrochloric acid.
Calculate the volume of the same sodium hydroxide solution needed to exactly neutralise this larger volume of acid. Show your working.

(4)

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13 A teacher asks which indicator to use for a titration between a strong acid and a strong alkali. Name a suitable indicator and explain why this indicator is appropriate for a strong acid versus strong alkali titration.

(4)

14 Design an investigation to compare the pH of rainwater, tap water and cola. In your answer give the independent, dependent and control variables, the equipment you would use, the method including safety, how you would record results, and one evaluation point about what could make the results less reliable and how to improve it.

(6)

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15 In a titration, 20.0 cm3 of a dilute hydrochloric acid exactly neutralises 25.0 cm3 of a dilute sodium hydroxide solution (so the ratio needed for exact neutralisation is 20.0 cm3 acid : 25.0 cm3 alkali). A student instead mixes 30.0 cm3 of the same hydrochloric acid with 30.0 cm3 of the same sodium hydroxide solution.

(a) Show that this mixture is not exactly neutralised. State whether it contains excess acid or excess alkali, giving your reasoning. **(3)**

(b) Calculate the extra volume of the sodium hydroxide solution that must be added to exactly neutralise the mixture, and explain why this works. **(3)**

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Mark scheme · K9E Acids and Alkalis: Depth and Practice

Question 1

- **B1** produces hydrogen ions (H+) in water, cao
- Answer: **Produces hydrogen ions (H+) in water.**

Question 2

- **B1** a soluble base that produces hydroxide ions (OH-) in water, cao
- Answer: **A soluble base that produces hydroxide ions (OH-) in water.**

Question 3

- **B1** pH less than 7 is acidic, pH greater than 7 is alkaline; pH 7 is neutral, cao
- Answer: **pH less than 7 is acidic; pH greater than 7 is alkaline.**

Question 4

- **B1** green cao
- Answer: **Green.**

Question 5

- (a) **B1** turns red cao
- (a) Answer: **Turns red.**
- (b) **B1** turns blue cao
- (b) Answer: **Turns blue.**

Question 6

- **B1** acid + metal -> salt + hydrogen, cao
- Answer: **acid + metal -> salt + hydrogen**

Question 7

- **B1** e.g. safety goggles (or acid-resistant gloves, lab coat), accept one, oe
- Answer: **Safety goggles.**

Question 8

- **M1** describe adding a suitable neutraliser a little at a time, e.g. powdered sodium hydrogen carbonate, until bubbling stops
- **A1** state to absorb or wipe up the neutralised liquid with paper towel and dispose safely, oe
- **A1** state to check neutral pH using universal indicator paper or pH paper before leaving (or repeat neutraliser if still acidic)
- Answer: **Add small amounts of sodium hydrogen carbonate until bubbling stops, absorb the neutralised liquid with paper towel and dispose safely, and check with universal indicator paper that the area is neutral before leaving.**

Question 9

- **B1** burette, cao
- Answer: **Burette.**

Question 10

- **M1** identify 9.55 cm3 as the anomalous value (it differs more from the other two)
- **M1** calculate mean of the two concordant titres 9.40 and 9.48: (9.40 + 9.48)/2
- **A1** give final answer 9.44 cm3 cao
- Answer: **9.44 cm3**

Question 11

- **M1** state rinse with the same solution to remove water or residue so concentration inside burette matches the solution used
- **A1** state that failure to rinse can dilute the solution in the burette leading to a larger titre (oe)
- **A1** state that failure to rinse can leave other chemicals that react and give an inaccurate endpoint, altering the titre (oe)
- Answer: **Rinse with the solution to remove water or residue so the burette contains the correct concentration; failing to rinse can dilute the burette solution and give a larger titre and can leave contaminants that react and give an inaccurate endpoint.**

Question 12

- **B1** state that because neither solution's concentration has changed, the ratio of volumes needed for neutralisation stays the same
- **M1** calculate volume of NaOH needed per cm3 of HCl: 25.0 / 20.0 (= 1.25)
- **M1** multiply by the new acid volume: 1.25 x 40.0
- **A1** give final answer 50.0 cm3 cao
- Answer: **50.0 cm3**

Question 13

- **B1** name a suitable indicator, e.g. phenolphthalein or universal indicator
- **M1** state that the indicator has a sharp colour change around pH 7 for strong acid/strong alkali titrations (or that colour change occurs quickly at the equivalence)
- **A1** link to titration: endpoint occurs near neutral so indicator change will be clear and small volume change gives accurate titre
- **A1** if phenolphthalein named, state it changes from colourless to pink around pH 8-10 and is suitable for strong acid vs strong alkali, oe
- Answer: **Phenolphthalein (or universal indicator). Phenolphthalein gives a sharp colour change near the end point for a strong acid versus strong alkali titration so the endpoint is easy to see.**

Question 14

- **Level 3** (5-6): Detailed method and reasoning: clear variables, suitable apparatus and safety, repeat measurements and clear plan to record and compare pH; includes a justified improvement to address reliability.
- **Level 2** (3-4): Clear method with variables and apparatus named, basic safety and recording explained, some reference to repeats or reliability but limited detail.
- **Level 1** (0-2): Simple idea or incomplete method; variables or safety may be missing or unclear; little or no consideration of reliability or improvements.
- **Indicative content:**
  - Independent variable: type of liquid (rainwater, tap water, cola).
  - Dependent variable: pH measured.
  - Control variables: temperature, same volume of sample, same indicator or same pH meter calibration.
  - Apparatus: pH meter or universal indicator paper, beakers or clean labelled containers, pipette or measuring cylinder, safety goggles, gloves, logbook.
  - Method: rinse and label containers, pour equal volumes (e.g. 20 cm3) of each sample into separate beakers, rinse pH probe in distilled water between measurements or use fresh piece of universal indicator paper each time, record pH value, repeat each measurement three times and calculate a mean.
  - Safety: wear goggles and gloves, treat cola as sticky and wash hands afterwards, do not taste samples.
  - Recording: table with three repeats and mean; include any anomalous results.
  - Evaluation: possible contamination of samples or probe; improve by using fresh clean apparatus for each sample, repeat measurements more times, and calibrate pH meter before use.

Question 15

- (a) **M1** calculate the volume of NaOH that would exactly neutralise 30.0 cm3 of the acid, using the ratio 20.0:25.0
- (a) **M1** 30.0 x (25.0/20.0) = 37.5 cm3 required, compared with the 30.0 cm3 actually added
- (a) **A1** since 30.0 cm3 is less than the 37.5 cm3 needed, there is not enough alkali to neutralise all the acid, so the mixture contains excess (unreacted) acid
- (a) Answer: **Excess acid - 37.5 cm3 of the alkali would be needed to neutralise 30.0 cm3 of the acid, but only 30.0 cm3 was added, so acid is left unreacted**
- (b) **M1** extra volume = volume required - volume already added
- (b) **A1** 37.5 - 30.0 = 7.5 cm3 cao
- (b) **B1** explains that adding 7.5 cm3 more brings the total alkali added to 37.5 cm3, matching the volume needed to exactly neutralise the 30.0 cm3 of acid, oe
- (b) Answer: **7.5 cm3**