2.4 Acids and Alkalis: 1-hour Pack

Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student adds a small amount of sodium hydroxide solution to beaker X containing universal indicator. The indicator colour changes from yellow to green. What does this change tell you about the pH of the solution in beaker X after the addition? Explain briefly.

(3)

2 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)

3 In a titration, a student found that exactly 25.0 cm^3 of a dilute sodium hydroxide solution was needed to exactly neutralise 20.0 cm^3 of a dilute hydrochloric acid. The student repeats the experiment using 40.0 cm^3 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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4 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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5 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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6 What colour does universal indicator usually show for a neutral solution (pH 7)?

(1)

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7 Use litmus paper to test two solutions.

(a) State the colour change on blue litmus paper when it is put into an acidic solution. **(1)**

(b) State the colour change on red litmus paper when it is put into an alkaline solution. **(1)**

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

(1)

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9 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)

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

(1)

11 The pH scale runs from 0 to 14 and is used to classify solutions as acidic, neutral or alkaline.

(a) State the pH number that represents a neutral solution. **(1)**

(b) State the range of pH values that represents an acidic solution. **(1)**

(c) State the range of pH values that represents an alkaline solution. **(1)**

12 Callum adds dilute hydrochloric acid to a spatula of calcium carbonate powder in a boiling tube. Fizzing occurs straight away.

(a) Complete the word equation for this reaction: calcium carbonate + hydrochloric acid -> ____ + ____ + ____ **(2)**

(b) Describe how Callum could test that the gas given off is carbon dioxide. **(1)**

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13 PRACTICAL INVESTIGATION. A KS3 class carries out an investigation to find the pH of five household solutions (lemon juice, milk, tap water, soap solution and oven cleaner) using universal indicator solution and a pH colour chart.

(a) State one piece of PPE (personal protective equipment) that must be worn when testing the oven cleaner. **(1)**

(b) Put these steps of the method into the correct order by writing 1, 2, 3 and 4: (i) record the colour and compare it to the pH colour chart to find the pH number, (ii) add a few drops of universal indicator to the sample, (iii) place a small sample (about 2 cm^3) of the solution into a clean test tube, (iv) swirl gently to mix. **(2)**

(c) Results: lemon juice pH 2, milk pH 6.5, tap water pH 7, soap solution pH 9, oven cleaner pH 13. Using these results, identify (i) the most strongly acidic solution and (ii) the most strongly alkaline solution. **(2)**

(d) Suggest why the test tube must be rinsed with distilled water between testing each solution. **(1)**

14 A group of pupils repeated a neutralisation experiment three times, adding acid to 25 cm^3 of alkali until the indicator just changed colour. Their volumes of acid added were: trial 1 = 18.2 cm^3, trial 2 = 18.3 cm^3, trial 3 = 21.6 cm^3.

(a) Identify which of the three results is anomalous. **(1)**

(b) Calculate the mean volume of acid needed, using only the two concordant (closely agreeing) results. **(2)**

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15 Explain how you could carry out an investigation to find the volume of dilute hydrochloric acid needed to exactly neutralise 25 cm^3 of sodium hydroxide solution. In your answer, include: the equipment and method you would use, how you would know when the solution is neutral, and how you would make your results more reliable.

(6)

16 A group's neutralisation investigation gave volume readings that varied a lot between repeats (a range of 4 cm^3 between the highest and lowest reading). Suggest two improvements to the method that would make the results more precise, and explain how they would help.

(3)

17 Jamal says: 'Alkalis are always safe to touch because they are not acids.' Evaluate this statement using your knowledge of pH and hazard symbols.

(4)

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Mark scheme · 2.4 Acids and Alkalis: 1-hour Pack

Question 1

state that green indicates pH about 7 or slightly alkaline **M1**

pH is around 7 to 8 cao **A1**

explain that sodium hydroxide is alkaline so it raised the pH from acidic/yellow towards neutral/green **B1**

Answer: **pH about 7 to 8; the sodium hydroxide raised the pH from acidic (yellow) towards neutral so the indicator turned green**

Question 2

state rinse with the same solution to remove water or residue so concentration inside burette matches the solution used **M1**

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) **A1**

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 3

state that because neither solution's concentration has changed, the ratio of volumes needed for neutralisation stays the same **B1**

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 **M1**

give final answer 50.0 cm^3 cao **A1**

Answer: **50.0 cm^3**

Question 4

Level 3 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. **5-6**

Level 2 Clear method with variables and apparatus named, basic safety and recording explained, some reference to repeats or reliability but limited detail. **3-4**

Level 1 Simple idea or incomplete method; variables or safety may be missing or unclear; little or no consideration of reliability or improvements. **0-2**

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 cm^3) 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 5

a soluble base that produces hydroxide ions (OH^-) in water, cao **B1**

Answer: **A soluble base that produces hydroxide ions (OH^-) in water.**

Question 6

green cao **B1**

Answer: **Green.**

Question 7

(a) turns red cao **B1**

(a) Answer: **Turns red.**

(b) turns blue cao **B1**

(b) Answer: **Turns blue.**

Question 8

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

Answer: **acid + metal -> salt + hydrogen**

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Question 9

describe adding a suitable neutraliser a little at a time, e.g. powdered sodium hydrogen carbonate, until bubbling stops — **M1**

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) — **A1**

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 10

burette, cao — **B1**

Answer: **Burette.**

Question 11

(a) 7 cao — **B1**

(a) Answer: **7**

(b) 0 to 6 oe (accept 'less than 7') — **B1**

(b) Answer: **0 to 6 (less than 7)**

(c) 8 to 14 oe (accept 'more than 7') — **B1**

(c) Answer: **8 to 14 (more than 7)**

Question 12

(a) calcium chloride — **B1**

(a) water and carbon dioxide (both needed) — **B1**

(a) Answer: **calcium carbonate + hydrochloric acid -> calcium chloride + water + carbon dioxide**

(b) bubble the gas through limewater; limewater turns cloudy/milky if carbon dioxide is present — **B1**

(b) Answer: **Bubble the gas through limewater. If carbon dioxide is present, the limewater turns cloudy (milky).**

Question 13

(a) safety goggles / eye protection — **B1**

(a) Answer: **safety goggles (eye protection)**

(b) iii then ii (sample placed in tube, then indicator added) — **M1**

(b) iv then i (swirl to mix, then read colour against chart) — **M1**

(b) Answer: **iii, ii, iv, i**

(c) lemon juice (i) — **B1**

(c) oven cleaner (ii) — **B1**

(c) Answer: **(i) lemon juice, (ii) oven cleaner**

(d) to prevent contamination/carry-over from the previous solution, which would give an inaccurate pH reading for the next solution — **B1**

(d) Answer: **So the previous solution does not contaminate the next sample and cause an inaccurate reading.**

Question 14

(a) 21.6 cm^3 (it does not agree with the other two close results) — **B1**

(a) Answer: **21.6 cm^3**

(b) 18.2 + 18.3 = 36.5 ft excludes candidate's identified anomaly from (a) — **M1**

(b) 18.25 cm^3 (awrt 18.3 cm^3) cao — **A1**

(b) Answer: **18.25 cm^3 (awrt 18.3 cm^3)**

Question 15

Level 1 Basic or isolated statements about equipment or a single step in the method are given, with little logical structure and limited use of scientific terms. — **1-2**

Level 2 A method with some relevant steps in a logical order is described, including reference to measuring volumes and using an indicator, but with limited detail on how the exact neutralisation point is identified and/or reliability is not addressed. — **3-4**

Level 3 A clear, logically ordered method is described: measuring a fixed volume of alkali, adding acid gradually with a suitable indicator to identify the exact neutralisation point, and repeating the experiment to obtain a reliable mean. Relevant safety precautions are included. — **5-6**

Indicative content:

- Measure a fixed volume of sodium hydroxide solution (e.g. 25 cm^3) into a conical flask using a pipette or measuring cylinder.
- Add a few drops of a suitable indicator (e.g. phenolphthalein or universal indicator) to the alkali.
- Note the initial colour of the solution in the flask.
- Fill a burette with the dilute hydrochloric acid and record the starting volume.
- Add the acid to the flask a little at a time, swirling the flask continuously to mix.
- Slow down and add the acid drop by drop as the colour starts to change, to avoid overshooting the end point.
- Stop adding acid at the point where the indicator just changes colour, showing the solution is neutral.
- Record the volume of acid used (final burette reading minus starting reading).
- Repeat the experiment at least twice more and calculate a mean volume from concordant results, ignoring any anomalous readings, to improve reliability.
- Wear eye protection throughout, since acids and alkalis can irritate skin and eyes.

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Question 16

named improvement, e.g. use a burette instead of a measuring cylinder to add the acid, or add acid drop by drop near the expected end point, or use a pH probe for an objective reading **B1**

explanation linking the improvement to greater precision, e.g. a burette measures to 0.1 cm^3 rather than the nearest 1 cm^3, reducing the uncertainty in identifying the exact neutralisation point **B1**

a second distinct valid point, e.g. repeat the experiment and take a mean of concordant results to reduce the effect of random error **B1**

Answer: **Use a burette (measures to 0.1 cm^3) instead of a measuring cylinder, and add acid drop by drop near the end point; this reduces uncertainty and the chance of overshooting, giving more precise, closely agreeing results.**

Question 17

the statement is incorrect / not fully correct **B1**

alkalis can also be corrosive or irritant, especially when concentrated, e.g. concentrated sodium hydroxide can burn skin and damage eyes, shown by the corrosive hazard symbol **B1**

the further the pH is from 7 (towards 0 or towards 14), the more hazardous the substance is generally likely to be, for both acids and alkalis **B1**

safety depends on concentration and identity of the substance, not simply on whether it is an acid or an alkali, e.g. dilute vinegar (a weak, dilute acid) is safe to eat, but concentrated sodium hydroxide (an alkali) is highly corrosive **B1**

Answer: **The statement is incorrect: alkalis can be just as hazardous as acids, especially when concentrated (e.g. sodium hydroxide is corrosive), and hazard depends on concentration/identity, not simply on being an acid or alkali.**

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