Measuring pH as a solid base is added

Pearson Edexcel 1CH0 Separate Chemistry · Foundation and Higher

Show your working where needed. Check the worked answers when you finish.

Name _____ Date _____

1. A missing entry

A student adds portions of powdered calcium hydroxide to a fixed volume of dilute hydrochloric acid. Their first pH reading is after the first portion. Which starting result is missing, and where would it go in the results table?

2. Compare two readings

Two samples near neutral look the same colour on a universal indicator chart marked in whole pH units. A student says the samples have exactly the same pH. Explain why the evidence is insufficient and suggest a better measurement.

3. Read the results

Total mass of calcium hydroxide added (g): 0.00, 0.20, 0.35, 0.37, 0.39, 0.45

pH: 1.0, 1.3, 2.3, 3.9, 11.7, 12.3

Between which masses does the mixture pass through neutral? Explain why these readings cannot give the exact mass.

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4. A changing display

After a student adds one portion of powder, the pH meter reading is still changing. They want to add the next portion at once. Describe what they should do first and explain why.

5. An explanation for the readings

In another test the pH rises from 1.4 to 2.8 as calcium hydroxide is added. After several more additions it reaches 10.9. Explain the first rise and why the final mixture is alkaline.

6. A different powder

A class uses calcium oxide instead of calcium hydroxide. Write the word equation for calcium oxide reacting with dilute hydrochloric acid. Would you expect the reaction to give off a gas? Explain.

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7. Compare the two acids

Two beakers contain hydrochloric acid, X and Y. The same powdered base is used. X reaches pH 7 after 0.30 g is added. Y reaches pH 7 after 0.60 g. Decide which beaker initially contained more acid. Explain using the results.

8. A better second run

A class finds that pH 7 is reached between 0.40 g and 0.50 g of powder. They start a fresh run to narrow that interval. Suggest a change to the masses added near pH 7 and one condition to keep the same.

9. Extra challenge · Compare the results from two bottles

A student compares dilute hydrochloric acid from bottles A and B using the same powdered calcium hydroxide. They use 20.0 cm^3 of A and 40.0 cm^3 of B.

For A, the pH goes from below 7 to above 7 between 0.36 and 0.38 g. For B, this happens between 0.72 and 0.76 g.

Assess the claim that B is twice as concentrated because it needs about twice as much powder. Use the readings and describe a test that would give a fairer comparison.

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Worked answers

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1. A missing entry

Measure the pH of the acid before adding any powder. Record it against a total mass added of 0.00 g. The starting pH can then be compared with later readings.

2. Compare two readings

Two pH values can give colours that are difficult to distinguish. Use a calibrated pH meter to measure both samples. It can resolve a smaller difference than the chart.

3. Read the results

It passes through pH 7 between 0.37 g and 0.39 g. One reading is below 7 and the next is above 7. No measurements within that interval show exactly where pH 7 is reached.

4. A changing display

Stir to mix the solid with the acid and record the pH once the reading settles. If they add more powder while the pH is changing, they cannot tell what pH the earlier mass produced.

5. An explanation for the readings

Hydroxide ions from the base react with hydrogen ions from the acid to form water. The mixture becomes less acidic, so pH rises. At pH 2.8 the mixture is still acidic.

Once the acid has been neutralised, there are excess hydroxide ions in the final mixture, so its pH is above 7.

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Worked answers

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6. A different powder

Calcium oxide + hydrochloric acid → calcium chloride + water.

No gas is formed by this reaction. Calcium oxide is a metal oxide acting as a base, and its reaction with the acid makes a salt and water.

7. Compare the two acids

Y contained more acid. It needed a larger mass of the same base to reach pH 7, so there was more acid to neutralise.

8. A better second run

Use smaller additions near the steep pH change so more measurements fall within the interval, for example every 0.01 g if the balance can measure that reliably. Keep the initial volume and concentration of acid the same, or keep the powder the same.

9. Extra challenge · Compare the results from two bottles

The student used twice the volume of B. From the data, A needs 0.36-0.38 g in 20.0 cm^3 and B needs 0.72-0.76 g in 40.0 cm^3. Both give the same interval, 0.018-0.019 g of powder per cm^3. These readings are consistent with equal concentrations.

Start with the same volume from each bottle. Use the same powder and take smaller mass steps near pH 7 to improve the resolution. Repeat with fresh equal volumes.

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