Past-paper walk-through

Properties of Solids ▪ 3.2

eXercise

Questions in this set

- 2014 Q1

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 1

2014 ▪ Q1

[Table of experimental data:]
| Mass of KI tablet | 0.425 g | |—|—| | Mass of thoroughly dried filter paper | 1.462 g | | Mass of filter paper + precipitate after first drying | 1.775 g | | Mass of filter paper + precipitate after second drying | 1.699 g | | Mass of filter paper + precipitate after third drying | 1.698 g |

A student is given the task of determining the I^- content of tablets that contain KI and an inert, water-soluble sugar as a filler. A tablet is dissolved in 50.0 mL of distilled water, and an excess of 0.20 *M* $Pb(NO_3)_2(aq)$ is added to the solution. A yellow precipitate forms, which is then filtered, washed, and dried. The data from the experiment are shown in the table above.

(a)(i) For the chemical reaction that occurs when the precipitate forms, write a balanced, net-ionic equation for the reaction.

Question 1

(a)(ii) For the chemical reaction that occurs when the precipitate forms, explain why the reaction is best represented by a net-ionic equation.

Question 1

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(b) Explain the purpose of drying and weighing the filter paper with the precipitate three times.

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2014 ▪ Q1

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(c) In the filtrate solution, is $[K^+]$ greater than, less than, or equal to $[NO_3^-]$? Justify your answer.

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(d) Calculate the number of moles of precipitate that is produced in the experiment.

Question 1

2014 ▪ Q1

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(e) Calculate the mass percent of I^- in the tablet.

Question 1

2014 ▪ Q1

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(f) In another trial, the student dissolves a tablet in 55.0 mL of water instead of 50.0 mL of water. Predict whether the experimentally determined mass percent of I^- will be greater than, less than, or equal to the amount calculated in part (e). Justify your answer.

Question 1

2014 ▪ Q1

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(g)(i) A student in another lab also wants to determine the I^- content of a KI tablet but does not have access to $Pb(NO_3)_2$. However, the student does have access to 0.20 *M* $AgNO_3$, which reacts with $I^-(aq)$ to produce $AgI(s)$. The value of K_{sp} for AgI is 8.5×10^{-17}.

Question 1

Will the substitution of $AgNO_3$ for $Pb(NO_3)_2$ result in the precipitation of the I^- ion from solution? Justify your answer.

(g)(ii) The student only has access to one KI tablet and a balance that can measure to the nearest 0.01 g. Will the student be able to determine the mass of AgI produced to three significant figures? Justify your answer.

Solution 1

(a)(i)

Mark scheme

- Balanced net-ionic equation: $Pb^{2+}(aq) + 2\,I^{-}(aq) \rightarrow PbI_2(s)$. Full credit requires correct formulas/charges and coefficients balanced for both mass and charge.

Solution 1

(a)(ii)

Mark scheme

- The net-ionic equation is best because it shows only the species that actually react to form the precipitate — PbI2(s) forming from Pb2+(aq) and I-(aq) — while omitting the spectator ions that do not participate, K+(aq) and NO3-(aq).

Solution 1

(b)

Mark scheme

- The filter paper and precipitate must be dried and weighed repeatedly (to a constant mass, i.e. until successive weighings agree) to ensure that all of the water/moisture has been driven off, so the recorded mass reflects only the dry PbI2 precipitate.

Solution 1

(c)

Mark scheme

- $[K^+]$ is less than $[NO_3^-]$, because the source of NO3-, the 0.20 M Pb(NO3)2(aq), was added in excess (beyond what was needed to precipitate all the I-), so leftover NO3- remains in solution without a matching amount of K+.

Solution 1

(d)

Mark scheme

- Mass of precipitate = 1.698 g − 1.462 g = 0.236 g PbI2(s). Moles of PbI2 = 0.236 g × (1 mol PbI2 / 461.0 g PbI2) = 5.12×10^{-4} mol PbI2.

Solution 1

(e)

Mark scheme

- Moles I- $= 5.12 \times 10^{-4}$ mol PbI2 $\times$ (2 mol I-/1 mol PbI2) $= 1.02 \times 10^{-3}$ mol I- (1 point for the moles of I-). Mass I- $= 1.02 \times 10^{-3}$ mol $\times$ 126.91 g/mol $=$ 0.130 g I-; mass percent $=$ 0.130 g / 0.425 g KI tablet $= 0.306 = 30.6$

Solution 1

(f)

Mark scheme

- The mass percent of I- will be the same (equal to part e), because Pb2+(aq) was added in excess, ensuring essentially all I- is precipitated regardless of the extra water; the additional water is removed during filtration and drying, leaving the same mass of dried precipitate.

Solution 1

(g)(i)

Mark scheme

- Yes. Addition of excess 0.20 M AgNO3(aq) will precipitate essentially all of the I- ion present in solution because AgI is very insoluble, as shown by its very small Ksp value (8.5×10^{-17}).

(g)(ii)

Mark scheme

- No. Since masses can only be measured to $\pm$0.01 g, and the dry AgI(s) precipitate produced will have a mass less than 1 g, the mass will be known to only two significant figures, not three.