Bonding and conductivity

Posted by Anonymous on Mon, 2016-02-22 15:43

Bonding and conductivity: Our Year 11s had an electrical conductivity practical demonstrated to them, and the molten silver nitrate did not register a charge on the ammeter. The sodium hydroxide did this beautifully. It was not what we were expecting to see. Do you have any suggestions?

Also, once the silver nitrate cooled, it was very difficult to remove it from the crucible. Have you got any suggestions? Also, how should I dispose of the silver nitrate once I manage to get it out of the crucible, bearing in mind it is a tiny amount.

Voting:
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Year Level:
Senior Secondary
Laboratory Technicians:
Laboratory Technicians

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Bonding and conductivity

Submitted by sat on 02 March 2016

Answer reviewed 20 February 2023

Without direct knowledge of your actual activity and how it was conducted, it is very difficult for us to define your problem and identify a solution. Our response is therefore somewhat speculative.

Summary Response

We assume from your question that you have set up a simple series electrical circuit of a power supply, a meter (ammeter or voltmeter) and two electrodes that are able to be dipped into the molten liquid that is being heated in a crucible.

As silver nitrate is an ionic crystalline salt, we would expect, as you did, that as a solid it would not be an electrical conductor, but upon melting, the dissociation of the ions from the crystal lattices would allow them to move, and for the liquid to then become an electrical conductor.

As your investigation did not produce this expected result, then perhaps you could check other possible factors.

- Are you sure that the tested substance was in fact silver nitrate? Was it correctly labelled? Suggestion: Dissolve a small sample of the silver nitrate in tap water; because tap water contains chloride ions the solution will appear cloudy due to the formation of an insoluble white precipitate of silver chloride.
- Was your electrical circuit properly set up? Was the ammeter/voltmeter set to the appropriate range so as to measure a small current?
- Was the heated silver nitrate obviously liquid at the time of measurement? Crystalline silver nitrate has a melting point of 212 deg C,1 which is readily achieved by heating in a crucible.

Regarding your second question about the management and disposal of the remaining silver nitrate.

- Best practice for disposal would be to store waste silver nitrate for collection and disposal by a licenced waste disposal contractor. If the silver nitrate is too difficult to remove from the crucible then perhaps you could save it in its entirety for disposal.
- Alternatively, it is suggested that when you successfully conduct this activity, rather than dispose of the silver nitrate, that you consider keeping the crucible with its solidified silver nitrate for reuse in following years. You could easily store it in a dark container, alongside your other oxidisers, and thereby avoid your disposal issue.
- Dissolve waste silver nitrate in a solution of sodium chloride, the chloride ions will react with the silver ions to form insoluble silver chloride. Filter out the white precipitate of silver chloride and stored in a labelled container for disposal through a chemical disposal company.2

If you are not able to identify a problem from the suggestions, we then recommend repeating the activity using a new sample of silver nitrate, or purchasing new silver nitrate if your old stock is contaminated.

Alternatively, you could use another (more stable) ionic salt with a suitably low melting point for this activity. Zinc chloride ($ZnCl_2$), which melts at 293 deg C, is a possible alternative.3

Further information

Silver nitrate has a melting point of 212 deg C. This is much below that of sodium hydroxide (318 deg C),4 which you say you successfully tested. This suggests that failure to adequately melt the silver nitrate may not be the problem.

Upon further heating and after melting to 440 deg C, a temperature easily achieved with a burner, silver nitrate decomposes.1 There are two chemical steps.

Silver nitrate decomposes to silver nitrite, liberating oxygen gas

$2AgNO_3 (l) = 2AgNO_2 (l) + O_2 (g)$

Silver nitrite further decomposes to silver metal and brown nitrogen dioxide gas (toxic)

$AgNO_2 (l) = Ag (s) + NO_2 (g)$

Therefore, it is suggested that the silver nitrate be heated cautiously in a fume cupboard to above its melting point, but not so strongly as to lead to its decomposition.

The contact details for licenced waste disposal contractors can be found in Science ASSIST's list of School science suppliers.

References

1 Chem-Supply. 2020 *Silver nitrate*, Safety Data Sheet. Search https://shop.chemsupply.com.au/ to source the latest Safety Data Sheet via the product information page.

2 Science ASSIST. (2018). *Chemical Management Handbook for Australian Schools – Edition 3*, Retrieved from the Science ASSIST website: https://assist.asta.edu.au/resource/4193/chemical-management-handbook-australian-schools-edition-3

3 Royal Society of Chemistry. (nd), *Electrolysis of molten zinc chloride*, Retrieved (20 February 2023) from the Royal Society of Chemistry website: https://edu.rsc.org/experiments/electrolysis-of-molten-zinc-chloride/826...

4 Chem-Supply. 2019 *Sodium hydroxide*, Safety Data Sheet. Search https://shop.chemsupply.com.au/ to source the latest Safety Data Sheet via the product information page.
