Reacting sodium with water

Dropping sodium and the other alkali metals into water is rightly a popular demonstration. Most teachers can and do, carry it out perfectly safely. However, we continue to get occasional reports of avoidable accidents, or near-accidents. So, at the risk of boring experienced teachers, it is worth repeating a few guidelines.

Use a small piece

A 3mm cube is adequate and you should never use a piece bigger than 4mm. Remember that, if the length of each side of a cube is doubled, the volume increases by a factor of 8 – and the violence of any explosion may do so as well. Do *not* allow an increasingly enthusiastic class to egg you on to ever larger pieces!

Do not constrain the sodium in any way

At one time you could buy sodium tongs, a sort of small cage in which a piece of sodium could be held under water and the hydrogen collected. Over the years we have heard of a number of accidents using these tongs. They can no longer be bought and we advise any schools that still possess such tongs to throw them away. Other ways of constraining sodium are equally dangerous, for example reacting sodium in test tubes or small beakers. Use a wide beaker or glass trough. It is, however, possible to float a piece of filter paper on the surface of the water and gently lower the sodium onto that. With luck, the sodium will not rush around. Held thus, in one place, it becomes hot enough to ignite the hydrogen so that it burns just as potassium does without the filter paper. Beware, however, that it usually ends up with quite a violent explosion – all the precautions mentioned here are essential.

Use cold water

Some authorities recommend adding ice to the water. Most teachers don't deliberately use hot water but if the cold water pipe runs close to the hot water pipe, so-called cold water may be surprisingly hot! In addition, if the class is so impressed by the demonstration that they insist on several repeats, the third or fourth piece may contact unexpectedly warm water. Interestingly, many of the accidents we have heard of occur when the demonstration has already been carried out successfully once.

Have the class at a safe distance

Pupils should be at least 2m away, if possible 3m, depending on the layout of the room. Even at that distance, they should wear eye protection. On at least two occasions we have heard of pupils being hit by flying sodium, even when safety screens were in use.

Use safety screens

Use at least two screens, to protect both the teacher and the class, and make sure nobody is exposed to the gaps at the sides. Place the screens very close to the reaction vessel.

Provided the screen is close, if a piece of sodium does jump out, it can only get over the screen if it is travelling almost vertically. If it goes up almost vertically, it must come down almost vertically – and safely into the gap between vessel and pupils. If you have three safety screens, arranged in a triangle, it may be possible to rest a sheet of plastic over the top, acting as a lid. Alternatively, some teachers put a sheet of glass over the reaction vessel. (When doing this, make sure the glass does not have sharp edges.)

Beware potassium

Potassium is even more reactive than sodium, so all the above control measures are even more important. On the other hand, lithium is less reactive and small pieces can, for example, be safely constrained under a test tube of water.

Have some safe – but exciting – science!

Reference:
ASE (1999) *Safe and Exciting Science*. An INSET pack for science department in secondary school and colleges and initial teaching training.

[This item was originally published in *EiS* in April 1999 and was checked by the ASE Health & Safety Group in July 2015 to ensure it still offers valid advice.]

More on sodium and water

Following the article in the April 1999 issue of Education in Science, we received correspondence about an accident recalled from some time past. It occurred when a teacher used a sheet of glass to cover the vessel in which sodium was reacting with water. Our correspondent said that the whole apparatus blew up, showering children with glass and leading to some nasty injuries. The presumed cause of the explosion was the build-up of hydrogen gas which could not escape and was ignited by the hot sodium. Hydrogen / air mixtures will not explode unless there is at least 4% hydrogen.

The Safeguards in Science Committee concluded that the piece of sodium must have been very large. Using a 3mm cube of sodium, as we recommend, we calculate that the amount of hydrogen generated would not be enough to produce an explosive mixture of hydrogen and air unless the reaction vessel was very much smaller than usual. A 3mm cube of sodium will give about 14cm^3 of hydrogen. This would result in an explosive mixture only if there was less than 340cm^3 of air. Even a small trough, half filled with water, will have much more air than this.

We do not believe there are many instances where a teacher would prefer to cover the reaction vessel, rather than the vertical safety screens close to the vessel as recommended in the article in April 1999. If, however, a teacher chooses to cover the reaction dish, then he / she should ensure the cover is made of thick glass and not window glass, which is much more fragile. It is better to use a sheet of acrylic, etc. which will not shatter and being lighter than glass would lift off to release pressure. If this approach is chosen then ensure that the sheet is lifted well clear of the dish between any repetition of the demonstration, to allow any hydrogen to disperse completely.

The fact that accidents with sodium and water continue to happen prompted the article in EiS. However, if teachers follow the advice in the article carefully, then there is virtually no risk of an accident resulting. Teachers can continue to ensure they are delivering safe but exciting science.

[This item was originally published in *EiS* in June 1999 and was checked by the ASE Health & Safety Group in July 2015 to ensure it still offers valid advice.]