Hydrogen fluoride

Target level

This is intended primarily for use with groups of post-16 students. It may be used before teaching about energetics to elicit prior conceptions, or after teaching to see if the intended learning has taken place. The probe may also be used to elicit the ideas of students at earlier stages (*ie* 14–16 years olds), although students at this level may not have been taught a scientifically valid explanation for why reactions occur.

Topics

Driving force of chemical reactions: why reactions occur.

Rationale

Research suggests that many students believe that chemical reactions occur to enable atoms to obtain full outer electron shells, or 'octets', and that this belief is so strong that they tend to offer this explanation even when they have been taught more appropriate ideas.

These ideas are discussed in Chapters 9 and 10 of the Teachers' notes.

During piloting, it was reported that some students 'enjoyed' the task, and others found it 'demanding' and 'very challenging', but 'good revision' and 'useful in clarifying ideas'.

Teachers found their students' responses 'thought provoking'. One teacher described how 'students seemed to have searched for the first idea that they come across and tried to make it fit'. Another was 'disappointed' that the 17–18 year old students did not think about the thermodynamics of the question, despite having just studied the topic. Another teacher suggested that the probe showed 'clearly how wedded [the students in the group] are to 'happy' atoms'. The probe was described as 'a useful exercise – if depressing for the teacher'.

Resources

_ Student worksheet
– Why do hydrogen and fluorine react?
Some students may require additional paper to complete a full answer.

Feedback for students

A suitable answer would normally make reference to the free energy change of the reaction (as well as perhaps the activation energy not being prohibitive), and is likely to refer to the bond enthalpies (or strengths) in reactant and product, and the energy changes involved in breaking and forming bonds. A mechanistic answer may refer to the electrical interactions between the cores and electrons in the reactant species. A few students may make reference to the reconfiguration of the charges – *eg* that after reaction the electrons are on the whole more tightly bound in the molecules.

Why do hydrogen and fluorine react?

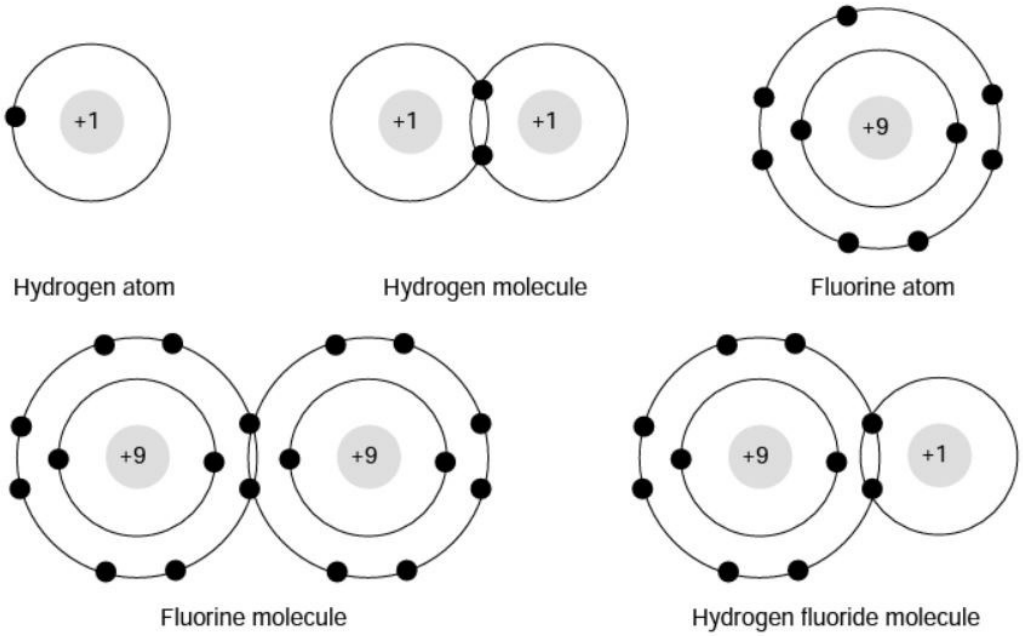
Hydrogen reacts with fluorine to give hydrogen fluoride. The equation for this reaction is:

$$H_2(g) + F_2(g) \rightarrow 2HF(g)$$

The word equation is:

hydrogen + fluorine → hydrogen fluoride

Look at the following diagrams:



In your own words, explain why you think hydrogen reacts with fluorine: