Problem 6: Acid erosion

Curriculum links;
titration, pH curves, strong and weak acids, pK_a

Practical skills;
Titration

A dentist has contacted the students to determine which of three drinks is the least acidic, and hence which is the least likely to cause tooth enamel erosion.

Pre-Lab questions
(Remember to give full references for any information beyond A-level that you find out)

1. White wine, lemonade and orange juice are all known to be acidic. Find out the name and chemical structure of the main acids found in each of the drinks?
2. For each of the acids in question 1, indicate if they are strong or weak acids. For the weak acids give a pKa value for all possible deprotonation sites.
3. Many students get confused when describing the difference between a strong and a weak acid and a concentrated and a dilute acid. Explain the difference as clearly and succinctly as you can.
4. An acid-base titration can be used to determine the concentration of an unknown acid or base. When adding a base to an acid in a titration, the pH changes from acidic (pH < 7) to basic (pH > 7). Sketch the titration curves obtained in the following titrations;
    a) addition of a strong base to a strong acid
    b) addition of a strong base to a weak acid
    c) addition of a weak base to a strong acid
    d) addition of a weak base to a weak acid
5. In order to correctly identify the exact point of neutralisation, an indicator must change colour quickly in the pH range at which neutralisation occurs. For each of the titrations in question 4 a-d above, indicate a suitable indicator.

Denby Road Dentist Practice
Denby Road
Hinckley
Leicestershire
LE11 3LE

Dear scientist,

I have recently read two different newspaper reports advising on the effect of acidic drinks on patient's teeth resulting in the erosion of tooth enamel (White wine rots your teeth….and brushing makes it worse, Daily Mail, 21st October 2009; Fruit drinks 'can be as acidic as vinegar and rot away teeth enamel, dentists say, Daily Mail, 20th May 2012). In order to correctly advise my patients on the best liquids to drink, I would like to be provided with some data on the acid content in some common everyday drinks.

Drinks popular with my patients include orange juice, lemonade and white wine. Please provide me with a full report outlining your analysis method, data and conclusions, including an evaluation of the accuracy of your data. I am also somewhat confused between the strength of an acid and its concentration. Is the type of the acid present in the different drinks likely to be important? Any information you can provide to help with my confusion would be much appreciated.

Many thanks

A. Malgam

Dr A. Malgam