RS•C

Chemistry NOW

This is a series of four leaflets which present modern aspects of chemistry in a way accessible to school students and directly usable by teachers. Each leaflet consists of four pages of information interspersed with questions to test student's understanding of what they are reading, to help them to link what they have read to the chemistry they already know and to help them to understand the text.

The leaflets could be used to support existing workschemes, to develop comprehension skills or as meaningful exercises to be used in the case of teacher absences (planned or unplanned).

The leaflets are:

•Chemistry and sport

This is aimed at 14–16 year olds and deals with the chemistry of aerobic and anaerboic respiration in the context of athletics and looks at a number of ways in which athletes can manipulate (legally!) the chemistry of this process to their advantage by monitoring the concentration of lactic acid in their blood.

•Chemistry of the atmosphere

This is aimed at 14–16 year olds. This looks at the way that the Earth's present atmosphere has evolved from possible earlier atmospheres. Some of the available evidence for different scenarios is presented and critically discussed.

•Computational chemistry

This is aimed at the post-16 age group. It presents a case study of the development of derivatives of cinnamic acid as a repellent to dissuade birds from eating crops treated with it. It explains how chemists develop relationships between structural features and particular types of activity and how computer modelling programmes are used in this work.

•Combinatorial chemistry

This is also aimed at the post-16 age group. Combinatorial chemistry is a group of techniques for synthesising large arrays of related chemicals. These can be easily automated by the use of robot syringes controlled by computers to carry out repetitive processes. The resulting arrays of chemicals called 'libraries' can then be screened for potential drug activities. Combinatorial chemistry is increasingly being used by pharmaceutical companies in their search for new drugs.

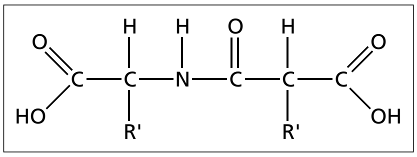
Electron distribution of cinnamamide

Answers

For the use of teachers, answers to the questions on the leaflets are presented overleaf.

Answers...

•Combinatorial chemistry

1. ROH + R′COCl → R′COOR + HCl
2. Ethyl propanoate
3. HCl
4. 
5. The corresponding tripeptide, tetrapeptide *etc.*
6. Based on A-level chemistry, students might suggest the following:

a) Converting the $-CO_2H$ group into an ester

b) Converting the $-NH_2$ group into an N-substituted amine or an amide

However, neither of the compounds in (b) is really suitable as neither is easily removable.

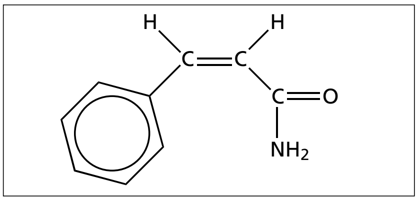
7. Remove water as it is formed
8. Resin-A–C, resin–B–C and resin–C–C
9. 20^4 (160 000)
10. 3.6×10^9
11. a) High throughput screening for biological activity.
    b) Robotic techniques for synthesis. and sensitive analytical techniques

•Computational chemistry

1. React cinnamic acid with ammonia and then heat to dehydrate the ammonium salt produced.
2. Derivatives might include: ester, acid chloride, anhydride, salts and the parent alcohol, addition products of the double bond *etc.*
3. The $-CONH_2$ group can hydrogen bond with water but the rest of the molecule is non-polar so the solubility is not great.
4. $PhCHCHCONH_2 + H_2O \rightarrow PhCHCHCOOH + NH_3$

   A nucleophilic substitution reaction.
5. a ~120°, b ~105°, c ~121°, d = 120°
6. a) This is a benzene ring and undergoes electrophilic substitution reactions.

   b) This is an alkene and undergoes electrophilic addition reactions.

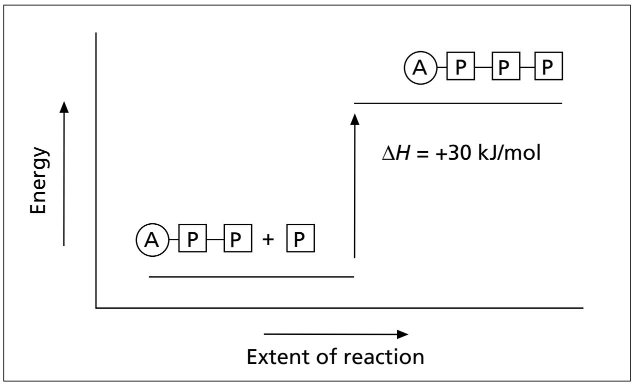
   c) This is a carboxylic acid and undergoes acid-base reactions and nucleophilic substitution reactions
7. *trans*-3-phenylprop-2-enamide.
8. 
9. The $C-CONH_2$ bond, the C–N bond and the C–Ph bonds can rotate, the others cannot.

Answers…

•Chemistry and sport

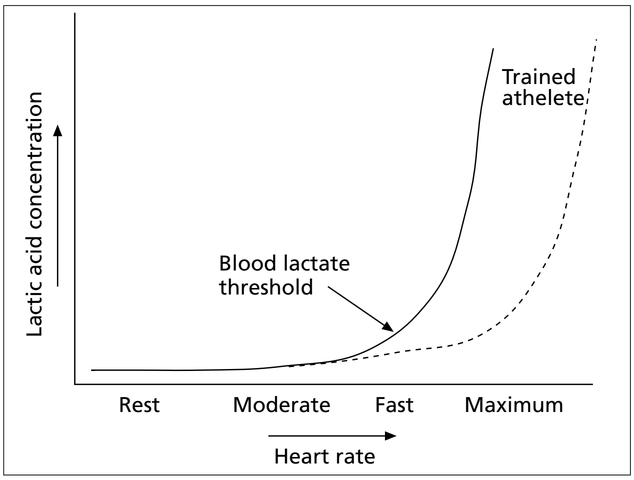
1. **Many factors including weather, health of competitors, psychological state of competitors, equipment.**
2. **Some of the above factors vary from competition to competition plus natural variation amongst competitors.**
3. **Graph plotted by students.**
4. **Improvement in timing methods from hand-operated stop-watches to electronic methods brings about greater accuracy.**
5. **a) (i) exothermic, (ii) endothermic**

   b)



6. **a) 100**

   b) 40
7. **$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_20$**
8. **$C_3H_6O_3$. None – all the atoms are accounted for.**
9. **Carbon dioxide.**
10. **Note:**
    The blood lacatate threshold is a heart rate not a lactic acid concentration.



11. **Athletes will be able to respond faster to the information they get. Some athletes may not be able to afford the sensors and could be put at a disadvantage. Some might think that such reliance on technology is 'not sporting'.**

Note for teachers

Lactic acid is, of course, a weak acid and at the pHs of blood and muscle it exists predominantly as lactate ions. It has not been thought appropriate to stress this point in an article aimed principally at pre-16 students. Teachers using the article with older students might wish to refer to this.

•Chemistry of the atmosphere

1. a) 32, 28, 44;

b) 8, 7, 11

2. **There is more oxygen and nitrogen and less carbon dioxide and water vapour in the modern atmosphere.**
3. **Fossils are the remains of once-living creatures preserved in rocks. Certain fossils are associated with certain eras.**

4. a) Rust

b) $4FeO + O_2 \longrightarrow 2Fe_2O_3$

5. **Lightning might have ignited them - especially in the high level of oxygen present at the time.**
6. **The carbon was originally in the atmosphere as carbon dioxide and was converted into carbohydrate by photosynthesis and later into coal or oil.**
7. **Add acid and test any gas given off with limewater (aqueous calcium hydroxide). If a carbonate is present, carbon dioxide will be given off which will turn limewater milky.**

• Further reading

Chemistry and sport was adapted from Mark Holmes, On track to the Olympic games: Chemistry Giving the Winning Edge in *Australian Chemistry Resource Book,* Charles L Fogliani (ed), p226, Queensland, Royal Australian Chemical Institute, 1998.

*Chemistry of the atmosphere w*as adapted from an article by Alistair Fleming in *Teaching Earth Sciences,* 1998, 23, 130. Teachers may wish to consult the original articles for more information.

Further material on Computational Chemistry and Combinatorial Chemistry can be found in the relevant chapters of the RSC book *The Age of the Molecule* and the post-16 text based on it, *Cutting-Edge Chemistry.*