

Review of the subject curriculum

1. Are the learning outcomes and educational content appropriate for the developmental age of students?			
1 – inappropriate	2 – appropriate to a certain extent	3 – mostly appropriate	4 – completely appropriate
<p>Please explain what should be modified if Your answer is 1, 2 or 3.</p> <p>I thought this was generally impressive, and pleased to see the inclusion of social / environmental issues as a priority. I was not sure there was enough explicit emphasis on the nature of chemistry. There was much opportunity for this. There was a good emphasis on enquiry and experiment (although I suspect many teachers will set standard practical to show... to demonstrate... etc. i.e. these are not experiments if the outcome is already known. There was much reference to models and laws: but where are students taught about the nature of scientific models (and the role of teaching models so they do not confuse the two) and the nature of chemical theory and law (and the conjectural nature of all scientific knowledge)?</p>			

2. Are the learning outcomes and educational content appropriate for the number of lessons?			
1 – inappropriate	2 – appropriate to a certain extent	3 – mostly appropriate	4 – completely appropriate
<p>Please explain what should be modified if Your answer is 1, 2 or 3.</p>			

3. Are the learning outcomes and educational content relevant and based on scientific knowledge of the subject area?			
1 – no	2 – to a certain extent	3 - mostly	4 – completely
<p>Please explain what should be modified if Your answer is 1, 2 or 3.</p> <p>But please see comments under 1.</p>			

4. Are the domains that are necessary for the subject area well represented?			
1 – no	2 – to a certain extent	3 - mostly	4 – completely
<p>Please explain what should be modified if Your answer is 1, 2 or 3.</p> <p>See comments under 1.</p>			

5. Does the curriculum contain an adequate ratio of the breadth and depth of knowledge, skills, and attitudes in the subject area?

1 – no	2 – to a certain extent	3 - mostly	4 – completely
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Please explain what should be modified if Your answer is 1, 2 or 3.

I am not sure the descriptors offer good guidance for teachers or students on developing attitudes (there is reference to environmental issues) – this could be more explicit. There are opportunities in the programme of material to be covered – but more explicit reference to the development of scientific values would be useful.

Although I am sure a strong teacher can find opportunities to use this specification to support “the development of fundamental socio-cultural values and competences” listed on p.4, I suspect many teachers will not see much helpful support for this in the document.

6. Does the curriculum, especially as regards the proposals in chapters F and G (Learning and teaching, Assessment), enable the acquisition of the listed learning outcomes?

1 – no	2 – to a certain extent	3 - mostly	4 – completely
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Please explain what should be modified if Your answer is 1, 2 or 3.

Potentially, yes. But, please see comments below.

7. Are the proposed learning outcomes and other elements of the curriculum in line with the European and global recommendations?

1 – no	2 – to a certain extent	3 - mostly	4 – completely
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Please explain what should be modified if Your answer is 1, 2 or 3.

I would expect to see more explicit connections with the nature of science. The reference to “proof” (see below), at least in English, is inappropriate in a science discipline – this is outmoded language.

Should IUPAC recommended names be used where possible? (e.g., Not blue vitriol? carbon tetrachloride, etc.)

8. Are the learning outcomes and educational content comparable with those in Your country?

Generally, yes.

9. Please suggest other modifications if You consider them necessary.

“All industrial and biochemical important processes consist of a chain of elementary chemical reactions” (p.4). All biochemical, perhaps – but *all* industrial processes? Most steps in the manufacture of a car (or a DVD, or a television, or...), after the initial preparation of the materials, are mechanical, not chemical.

“Although Chemistry has a more prominent interdisciplinary character... (p.4),” than? (it is not clear what chemistry is being contrasted with.

“In a sample, particles are moving (kinetic energy) and react with each other (potential energy)” (p.6). Best not to use ‘react’ here – substances react (molar/macroscopic level) when particles (submicroscopic level) interact.

“Ozone holes” (p.12). This term (holes) should not be used as it is unscientific and encourages misconceptions. Ozone depletion.

“distinguish between reversible and irreversible reactions” (p.13) – okay, but teachers should emphasise this is not an absolute distinction (in principle there are no irreversible reactions). I would make a similar point about chemical and physical changes – this is not a completely clear-cut distinction – even dissolving is ambiguous in this

“energy is bonded” (p.16) Perhaps this is a mistranslation – I do not know what it means / is meant to mean (energy cannot be bonded).

“cellular breathing” (p.16 & p.24) In English (but perhaps not in the original) this term should not be used: breathing is the mechanical process of gaseous exchange – the term should be cellular respiration.

“proves the law of conservation of mass” (p.17) – the term ‘proves’ should be avoided. Proof applies in mathematics, but in science all conclusions are provisional – nothing is ‘proved’.

B8.1 To my reading:

‘explains’ physical and chemical changes described by chemical names and symbols

is a higher level/more demanding task than

‘applies’ physical and chemical changes described by chemical names and symbols (p.21)

“when covering the ionic bonding, attention is to be paid to the symbolic inscription (chemical reaction equation) of the formation of monoatomic cations and anions” (p.33) – **I really think this is poor practice.** Ionic bonding is not generally related to the formation of ions. Associating ionic bonding with ion formation is not only unnecessary (ionic bonding forms in precipitation/double decomposing reactions - of silver chloride, lead iodide, etc. - and when salt solutions are evaporated after neutralisation of acid and alkali – the ions are present in the reagents so how they might have formed, perhaps millions of years ago, is not relevant), but leads to common misconceptions. There is a similar problem on p.70 “when covering the ionic bond, attention is to be paid to the symbolc [sic] inscription (chemical reaction equation) of the formation of monoatomic cations and anions” – NO THIS SHOULD NOT HAPPEN. Ionic bonding is an electrical interaction between ions. The formation of ionic bonds involves the coming together of charged ions. ***The formation of cations and anions is not part of the process.*** Even if considering binary synthesis from the elements – if sodium is combusted in chlorine - the reagents are a metal (cations in a lattice with delocalised electrons) and molecules – **no chemical process students at this level are likely to study or meet starts from isolated atoms.** The only isolated atoms they will come across are in noble gases which have few reactions (and none usually studied at school). I know this teaching model is commonly found in textbooks, but it is scientifically invalid and educationally inappropriate. Either students should be taught how ionic bonds actually form (e.g. in precipitation reactions or after neutralisation) or do not teach them any mechanism. There is no scientific or pedagogic basis to teach them misleading nonsense that is known to be a barrier to understanding the nature of the ionic bond and the properties of ionic compounds. (I can send references to research on this if asked.)

“when studying physical changes, attention should be paid to the equations relating to formation of cations and anions from neutral atoms” (p.33) – this confuses me (and so might confuse teachers). Ionisation/electron affinity could be considered physical changes BUT normally ‘physical changes’ refers to things like phase changes: melting, evaporating, crystal phase transitions, sublimation – what has this to do with ion formation? Ions might be formed in some reactions (heterolytic bond fission, for example in some mechanisms) but these are parts of chemical changes.

“- links the kinetic energy to average velocity of atoms and molecules in the system and to temperature” (p.34). This is confused (it may be the translation). The kinetic energy is linked to the actual (not average) velocity of a molecule. The average kinetic energy, and the average velocity, are linked to temperature.

‘– chemical changes of organic molecules are to be ended with halogenoalkanes;...’ (p.41) Unclear what this means (translation issue?)

Perhaps: Chemical reactions to synthesise halogenoalkanes are to be taught?

But perhaps: Teaching about halogenoalkanes is no longer required?

“– explains the reactions of inorganic and organic substances by an experiment” (p.51) I do not understand what teachers are being asked to do here – perhaps ‘explains’ is the wrong word?

“OUTSTANDING...anticipates changes in energy during chemical changes of selected compounds using enthalpies of reaction or bond enthalpies” (p.61) – same descriptor as SATISFACTORY – not anticipates?

“observes laws by generalizing the data presented by means of diagrams, tables and graphs and describes them verbally” (p.63-64). This should not be ‘observes’ (this might be a matter of translation) – but something like infers, or deduces, or suggests. The same occurs on p.72.

“VERY GOOD...explains kinetic energy of particles in the system by means of their average velocity and temperature”, and

“OUTSTANDING...links kinetic energy of particles in the system and their average velocity and temperature” (p.71)

I do not see how ‘links’ requires a higher level of understanding than ‘explains’ (perhaps links is not the best translation, but another word seems appropriate here).

10. Your conclusion about the proposed curriculum.

I was generally impressed with the document, which seemed well thought-out.

I do however think it is important to make explicit how students can learn about the nature of chemistry/science through the curriculum – e.g. in relation to chemistry as an empirical science that progresses by an ongoing iterative dialogue between empirical observations and theoretical inventions; and so the conjectured nature of chemical knowledge, and the role of models and their relationship with laws and theories.

One major flaw in the content: Ionic bonding should be taught through an authentic model (e.g. consider the bond formed (i) when lead iodide or silver chloride or barium sulphate (or etc.) form by precipitation; or (ii) when sodium chloride solution obtained by neutralisation is subject to evaporation, so the ions come out of solution and clump together), and any discussion of the

formation of ions from (chemically unlikely) discrete atoms should be avoided as scientifically dubious and educational unhelpful.