Adapting text-based questions to computer-based assessments:a geochemistry case study

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Problem:

•Introductory geochemistry unit to be used for distance learning.

•Assessment was 5 paper-based marked 'homeworks' of 6 or 7 items: used summatively with some written feedback.

How to adapt to a distance learning module?

Solution to learning resources was CD.This was authored in Acrobat by Karen Hudson-Edwards, Birkbeck Earth Sciences, who also provided the assessment materials.

But how to adapt paper-based assessment?

Examples of paper-based questions

Homework1 Q5 (10 marks) The diameter of an atomic nucleus is about 10^{-14} m, whereas the diameter of an atom is 10^{-10} m. If an atom is represented by a cricket field of diameter 100 m, what is the diameter of the ball which represents the nucleus of the atom?

Better as Flash demonstration?

Homework 1 Q8 (10 marks) Explain in your own words why there are 10 transition metals in the fourth Period, and 14 actinide elements in the seventh Period.

Very much an essay answer

Homework 3 Q2 (10 marks) In an experiment one gram of salt [NaCl] is burned in a closed pressure vessel (bomb). Is this a closed or open system? What are the phases involved in the reaction? Note – ignore the product of the reaction when answering this question.

Too few alternatives or meaningful distractors

These we decided could not be made into useable CBA items.

So first conclusion – accept some questions can't be adapted.

Computer-based assessments

All using TRIADS with

•Left hand information area – context of question presented first

•Continue

•Question presented with interaction area – text entry, hotspot, move label, radio button

•Additional information can be called by button operated windows

•Calculator available on screen where required

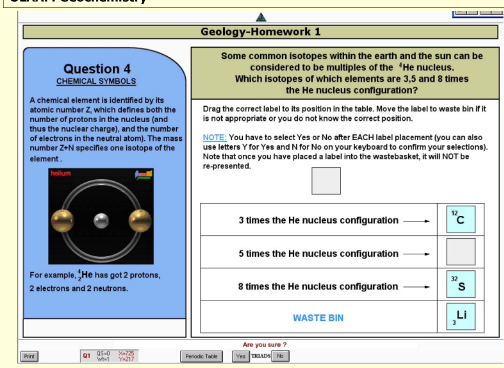
•Feedback window on left presenting guidance - not answers

Homework 1 Q4 (10 marks) Some common isotopes within the Earth and Sun can be considered to be multiples of the ^4He nucleus. Which isotopes of which elements are 3 times, 5 times and 8 times the He nucleus configuration?

•used move label with random presentation

•the original question was about simple multiples of atomic number in isotopes

•modified question - used atomic mass as distractor to assess comprehension of the difference between them in their usual symbolic form.



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Homework 2 Question 1 . In each of the following pairs, choose the one in which the chemical bond would have more covalent character:

KCl and KI; KCl and $BaCl_2$; Li_2S and Cs_2S; Cu_2O and Cu_2S; $BaCl_2$ and $HgCl_2$; B_2O_3 and Al_2O_3

- Supplied a electronegativity table within the question
- Changed from simple choices of original question to an application question where computation necessary; calculator provided
- Plus a diagnosis based on computations
- Consequently needed text entry rather than the radio button alternatives which original invited.
- Feedback provided on how to do computations and guidance on diagnosis. Answers not given.

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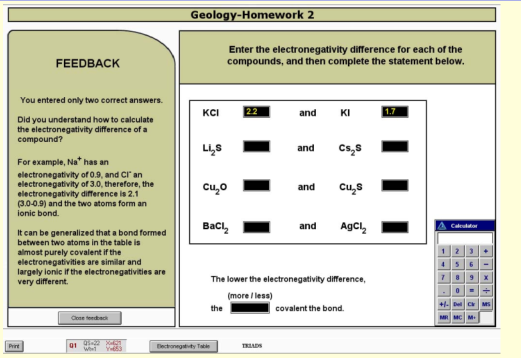

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Homework 2 Question 2

(a) Given a metallic element whose atoms are very large and a non-metallic element whose atoms are very small. Would you expect bonding between these two elements to be mainly ionic or mainly covalent? Explain your answer.

(b) Consider the opposite case of a small atom for the metallic element and a large atom for the non-metallic element. Which type of bonding would you expect? Explain your answer.

- Hotspot question chosen to provide textual alternatives in statements
- Question built on previous ionic radius question in Homework 1 (need for sequential item presentation)
- Question adapted to make assessable the process used by student in constructing an answer
- Customised periodic table provided distinguishing metallic/non-metallic elements (not on CD)
- Customised electronegativity table – modified to meet examples given on CD.

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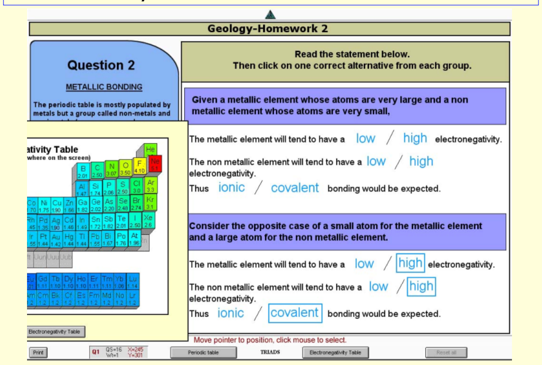

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Homework 4 Q4 (40 marks) Use the following data for a suite of igneous rocks to determine the age of formation, using a graphic method. What is the initial ratio of the suite? What can you deduce from the initial $^{87}Sr/^{86}Sr$ ratio?

Assume that the decay constant of ^{87}Rb is 1.42×10^{-11}/a

	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$
Rock 1	0.200	0.7109
Rock 2	1.926	0.8065
Rock 3	1.053	0.7545
Rock 4	0.223	0.7129
Rock 5	0.802	0.7462

- Text entry chosen so process of computations could be assessed
- Graph of data provided but student has to identify y and x for use in an equation (provided in feedback); must identify value of intercept
- Explicit testing of deduction
- Feedback gives partial answer; intercept provided but remaining feedback is guidance on process not the answer

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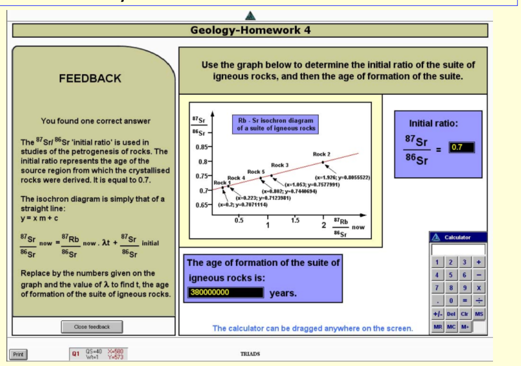

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Learning outcomes matrix

Learning outcomes 3. Bonding	CD section	Homework 1	Homework 2	Homework 3	Homework 4	Homework 5	Total
a) Electronegativity (electronegativity difference)	Lecture 3) Chap 3.		1 A				1*A
b) Ionic bonding	Lecture 3) Chap 6.		2 C 3 R 5 A				1*C 1*R 1*A
c) Covalent bonding	Lecture 4) Chap 2.		1 A 2 C				1*A 1*C
d) Metallic bonding	Lecture 4) Chap 5.		2 C 3 R				1*C 1*R
e) Substitution: Goldschmidt's rules radius ratio coordination number	Lecture 3) Chap 8.		4 A 5 A 6 A				3*A

spread of item types, RECAP, acceptable

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Assessment structures

Lecture 4

Some aspects in Lecture 4 are not tested: covalent bonding (although it is mentioned, it is not the object of a particular question) electrostatic bonding and hybrid orbitals.

Lecture 5:

No testing of **Lecture 5: Mineral chemistry** (Bonding in natural minerals, the major rock forming mineral classes, silicate polymers, crystal defects).

Lecture 7:

Not tested on Le Chatelier's principle and slopes of reaction boundaries.

Lecture 8:

Not tested - chemical kinetics: the rate equation, the Arrhenius equation, diffusion and Fick's first law, catalysts and activation energy.

Some notable gaps!!

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Future improvements

- Plug gaps in assessment structure
- More explicit linkage to learning outcomes
- More explicit links to CD resources; direct links to pages?
- Resolve summative/formative intentions – tutorial and self test versions?

Thanks to Karen Hudson-Edwards for the materials and opportunity to carry out the work.