International Advanced Level
Subject: Chemistry
The need for Transferable Skills

Sources: Cognitive/Intrapersonal and Interpersonal skills adapted and taken from the NRC framework

In recent years, higher education institutions and employers have consistently highlighted the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work. The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning'.

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, the team identified the National Research Council's (NRC) framework as the most evidence-based and robust skills framework, and have used this as a basis for our adapted skills framework.

The framework includes cognitive, intrapersonal skills and interpersonal skills. These skills have been interpreted to ensure they are appropriate for this subject. All of the skills listed are evident or accessible in the teaching, learning and/or assessment of the qualification.

Identifying and highlighting these skills in International Advanced Level qualifications ensures that it is not only the academic and cognitive skills that are developed, but those broader elements that universities highlight as being essential for success. Skills such as self-directed study, independent research, self-awareness of own strengths and weaknesses and time-management are skills that students cannot learn from a textbook but have to be developed through the teaching and learning experience that can be provided through an international curriculum.

In the tables below, we have taken the NRC framework skills and provided definitions of how each skill can be interpreted for this subject. This will enable teachers and learners to understand examples of how they can develop each skill through an International Advanced Level qualification.

NRC framework skill	Skill interpretation in this subject	Where the skill is covered in content	Where the skill is explicitly assessed in examination	Opportunity for the skill to be developed through teaching and learning approach
Cognitive skills				
Cognitive Processes and Strategies				
Critical thinking	Discuss uncertainty of measurements in practical work.	8.22, 16.16	Unit 2 Q19b Criticising an incorrect student's suggested mechanism. Unit 4 Q5b Measurement uncertainty in experiment. Unit 6 Q4b,d Identification of errors and calculation of uncertainties.	This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Problem solving	Calculate formulae from data.	1.6, 1.10, 20.1	Unit 1 Q23b Predicting an unfamiliar reaction mechanism. Unit 1 Q20c Rearrange a formula and convert data in to appropriate units. Unit 5 Q18b Calculation of mass of products from combustion of butan-2-ol (a reverse calculation). Unit 5 Q16c Interpretation of standard electrode potential data. Unit 5 Q19c Calculate the percentage of copper in Prince's metal from data and equations.	All six topics provide opportunities to manipulate data.

Analysis	Interpret mass spectra, infrared spectra and nmr spectra.	10.21, 10.22, 15.17, 15.18, 15.19, 15.20, 20.1	Unit 1 Q5 Interpretation of data from mass spectrum. Unit 1 Q20bii Drawing a mass spectrum from data. Unit2 Q22a,c Interpreting infrared and mass spectra. Unit 3 Q3 Interpretation of an infrared spectrum. Unit 4 Q19b Interpretation of IR spectrum of chemical responsible for the smell of bananas. Unit 4 Q19c,d Interpretation of nmr spectra. Unit 6 Q2d Analysis of nmr spectrum.	Analysing spectra occur in all six units.
Reasoning/argumentation	Analysis of unknown organic and inorganic compounds.	CP15 19.12	Unit 3 Q2 Identification of unknown inorganic compounds. Unit 6 Q1abc Identification of inorganic compounds.	There are opportunities for suggesting explanations for observed phenomena in all six units.
Interpretation	Ability to interpret graphs.	2.17, 6.3, 9.3, 9.8, 11.2, 11.5, 11.10, 12.13, 14.15	Unit 1 Q19b,c Interpretation of graph of ionisation energies. Unit 2 Q17a,b Interpretation of Maxwell-Boltzmann graph. Unit 3 Q1aii Interpretation of a cooling curve graph. Unit 4 Q20bi,ii Interpretation of pH graph. Unit 4 Q22ai,ii Interpretation of Born-Haber cycle diagram. Unit 5 Q7a,b Interpretation of enthalpy profile diagram. Unit 5 Q8 Interpretation of rates of reaction graphs. Unit 5 Q15d Ability to draw chromatogram.	Interpretation of graphical data and the plotting of suitable graphs occur in all six units.
Decision making	Plan organic reaction schemes (with up to 4 steps).	20.3ii	Unit 1 Q23a reaction sequence of propene. Unit 3 Q3 Interpreting a reaction sequence. Unit 5 Q17b Devise a reaction sequence to make phenylethanone. Unit 5 Q18a Devise a four step reaction sequence.	Choosing appropriate chemicals and reaction sequences occur in all six units.
Adaptive learning	Predictions from data. Select equipment and methods for carrying out practical work.	3.19. 7.4, 8.28, 9.10, 11.6, 13.9 11.3	Unit 1 Q22c Make predictions on formula and boiling temperature from data. Unit 2 Q20c Describing how to obtain reliable results in a titration. Unit 3 Q4e Devising a titration experiment. Un it 4 Q22aiii Interpretation of data on lattice energy.	Selecting appropriate apparatus and making predictions from data occur in all six units.
Executive function				

Creativity				
Creativity	Devising experimental procedures. Identify errors and uncertainties and how to improve outcomes.	CP2 6.7 8.8, 16.16	Unit 2 Q3 Suggesting correct properties resulting from hydrogen bonds. Unit 3 Q4c,d Identifying errors in measurement and practical procedure. Unit 4 Q21b Solving an unfamiliar calculation of activation energy. Unit 4 Q21ci,ii Interpretation of unfamiliar experimental information.	Deducing reaction sequences occurs in the organic topics.
Innovation	Suggest uses of new materials e.g. graphene.	3.12		

NRC framework skill	**Skill interpretation in this subject**	**Where the skill is covered in content**	**Where the skill is explicitly assessed in examination**	**Opportunity for the skill to be developed through teaching and learning approach**
Intrapersonal skills				
Intellectual openness				
Adaptability	This occurs in any practical.		Unit 2 Q23eii Explaining unexpected experimental results. Unit 5 Q14 Interpreting diagram of apparatus for organic practical technique.	This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Personal and social responsibility	Soluble laundry bags. Catalytic converters.	19.8 17.29		
Continuous learning				
Intellectual interest and curiosity	Use of Chemistry in biological systems. E.g. buffers in blood and food. Haemoglobin in blood. Cancer drugs *cis*-platin.	14.22 17.17 17.15	Unit 1 Q22d the toxicity of carbon monoxide. Unit 5 Q1a Structure of *cis*-platin.	

Work ethic/conscientiousness				
Initiative	Investigation of chemical reactions.	CP5 10.11		
Self-direction	Preparations.	CP4 10.14	Unit 6 Q3c,d Able to draw apparatus used in preparations and explain the reasons for various procedures.	
Responsibility	Health and safety and the difference between hazard and risk.	4.1, 4.2	Unit 5 Q19b Identification of hazard and precaution in reacting Prince's metal with concentrated nitric acid.	This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Perseverance	Purification of an organic compound.	20.5 ii, iii and iv	Unit 6 Q4a Explanation of experimental procedure.	This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Productivity	Improving manufacturing processes.	9.7, 17.28	Unit 4 Q11a method for improving yield of industrial process.	
Self-regulation (metacognition, forethought, reflection)	Suggest ways to reduce risks when dealing with chemicals.	4.3	Unit 6 Q1cii Identification of hazard symbol and precaution necessary.	This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Ethics	Use of chromatography in drug testing. Climate change. Carbon neutrality fuels. Pollution. Biodegradable polymers/ incineration of polymers.	15.23 4.15 4.16 4.13 5.8	Unit 1 Q7 renewable fuels.	
Integrity				
Positive Core Self Evaluation				
Self-monitoring/self-evaluation/self-reinforcement	Carrying out practical work individually.	Throughout the course.	Units 3 and 6	This is possible in all core practicals and the specification suggests additional experiments which could be carried out.

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Interpersonal skills				
Teamwork and collaboration				
Communication	This occurs in any practical when working with a partner.			This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Collaboration	This occurs in any practical when working with a partner.	CP 9a,b 11.12		This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Teamwork	Preparation of aspirin in a group.	CP 16 20.3		
Co-operation	This occurs in any practical when working with a partner.	CP6 10.14 CP7 10.20		This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Interpersonal skills	This occurs in any practical when working with a partner.			This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Empathy/perspective taking	This occurs in any practical when working with a partner.	CP 10 11.13		This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Negotiation	This occurs in any practical when working with a partner.			This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Leadership				
Leadership	This occurs in any practical when working with a partner.			This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Responsibility	This occurs in any practical when working with a partner.			This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Assertive communication	This occurs in any practical when working with a partner.			This is possible in all core practicals and the specification suggests additional experiments which could be carried out.
Self-presentation				