## Candidates' Performance

### Paper 1

Paper 1 consisted of two sections, Section A (multiple-choice questions) and Section B (conventional questions). Sections A and B each comprised two parts, Part I and Part II. Part I contained questions set mainly on Topics I to VIII of the curriculum, while Part II mainly on Topics IX to XII. All questions in both sections were compulsory.

**Section A** (multiple-choice questions)

This section consists of 36 multiple-choice questions. The mean score was 23. Candidates' performance was generally good. Some misconceptions of candidates were revealed from their performance in the following items.

1. For Q. 15, less than half of the candidates were able to choose the key. Many candidates did not realise that reacting carbon with oxygen gives a mixture of products instead of 100% of carbon monoxide, and hence the enthalpy change of formation of CO(g) cannot be determined directly by experiment.

   Q.15 For which of the following reactions must its enthalpy change be determined by INDIRECT methods ?

   | | | |
   |---|---|---|
   | A. | $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$ | (19%) |
   | B.* | $2C(s) + O_2(g) \rightarrow 2CO(g)$ | (47%) |
   | C. | $CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ | (22%) |
   | D. | $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$ | (12%) |

2. For Q. 22, most candidates demonstrated an understanding that sodium sulphite is a reducing agent while sodium sulphate is not. They correctly identified acidified potassium permanganate as a reagent for distinguishing between the two compounds. However, many did not show an understanding that concentrated nitric acid is also an oxidising agent. Hence they wrongly chose option B.

   Q.22 Which of the following reagents can be used to distinguish between sodium sulphite and sodium sulphate ?

   (1) iron(II) chloride solution
   (2) acidified potassium permanganate solution
   (3) concentrated nitric acid

   | | | |
   |---|---|---|
   | A. | (1) only | (13%) |
   | B. | (2) only | (27%) |
   | C. | (1) and (3) only | (11%) |
   | D.* | (2) and (3) only | (49%) |

3. For Q.32, candidates should know that the alkaline hydrolysis of ethanamide would give ammonia. If the reaction mixture is heated under reflux, the ammonia formed will be liberated as a gas. With the loss of ammonia, an equilibrium state cannot be reached.

   Q.32 Which of the following statements about the action of sodium hydroxide solution on ethanamide is/are correct ?

   (1) Sodium ethanoate is formed in the reaction.
   (2) In the reaction, sodium hydroxide acts as a catalyst.
   (3) The reaction attains equilibrium if the reaction mixture is heated under reflux.

   | | | |
   |---|---|---|
   | A.* | (1) only | (41%) |
   | B. | (2) only | (16%) |
   | C. | (1) and (3) only | (27%) |
   | D. | (2) and (3) only | (16%) |

**Section B** (conventional questions)

| Question Number | Performance in General |
|---|---|
| 1 | Good |
| 2 | Good |
| 3 | Satisfactory |
| 4 | Satisfactory |
| 5 | Fair |
| 6 | Fair |
| 7 | Good |
| 8 | Fair |
| 9 | Fair |
| 10 | Fair |
| 11 | Satisfactory |
| 12 | Satisfactory |
| 13 | Fair |
| 14 | Fair |
| 15 | Satisfactory |

1. (a) Some candidates incorrectly drew electron diagrams for water, e.g. electron diagrams with H having 8 electrons while O having only 2. Some wrongly considered $H_2O$ to be an ionic compound.

   (b) (i) Most candidates demonstrated an understanding that water would become steam upon heating. Some did not mention that water vapour condenses on the cold surface of the condenser. Many candidates did not state clearly that the salts in sea water are non-volatile.

   (ii) Some candidates failed to recognise that **S** is anti-bumping granules.

   (c) Many candidates correctly mentioned that ice has an open structure. Some did not correlate this phenomenon to hydrogen bond formation. Some were unable to explain why water has a higher density than ice.

2. (a) The three-dimensional structure of $NH_3$ was correctly drawn in most cases, but not that of $BF_3$. Some candidates wrongly showed the presence of two lone electron pairs instead of one in the outermost shell of the N atom in $NH_3$.

   (b) Some candidates failed to demonstrate a good mastery of the concepts 'electronegativity' and 'bond polarity'.

   (c) Some candidates wrongly stated that hydrogen bond is formed between $BF_3$ and $NH_3$. Not many candidates were able to mention that the B atom in $BF_3$ needs to accept an electron pair in order to attain an octet electronic structure.



3. (a) The calculation is quite straightforward. However, many candidates were unable to do it correctly. Some gave only the molecular formula of **W**, and did not show any calculation steps.

   (b) Some candidates gave incorrect chemical structures for **W** with a smaller/greater number of O atoms.

4. (a) Most candidates were weak in chemical nomenclature. Some suggested incorrect names such as 'ethandioic acid' or 'ethanoic acid'.

   (b) Very few candidates were able to provide an explanation based on incomplete ionisation of ethanedioic acid. Many used the terms 'ionisation' and 'dissociation' interchangeably. Some overlooked the fact that ethanedioic acid is a dibasic acid, and wrongly calculated the pH of 0.05 M $H_2C_2O_4(aq)$ as 1.3.

   (c) A few candidates wrongly mentioned that NaOH(s) reacts with water to give an explosive gas.

   (d) (i) The titration mixture changes from colourless to pink. However, some candidates wrongly mentioned 'from clear to red'. Some simply stated a pink colour is observed.

   (ii) In general, candidates were weak in handling chemical calculations. Some were not able to demonstrate an understanding that $H_2C_2O_4(aq)$ reacts with NaOH(aq) in 1:2 mole ratio.

   (e) (i) Some candidates wrongly mentioned that the residual acid affects the concentration of the acid in the conical flask instead of its volume.

   (ii) Well answered.

5. (a) (i) Most candidates were unable to find the greatest temperature drop of the solution by extrapolating the data plot.

   (ii) Many candidates wrongly used the mass of $NH_4NO_3(s)$ instead of that of $NH_4NO_3(aq)$ in calculating the heat absorbed by the mixture ($mc\Delta T$), and thus were unable to arrive at the correct answer.

   (b) Most candidates did not know the drying agents commonly used in desiccators. Many suggested using $CuSO_4(s)$ or $CoCl_2(s)$ which, in fact, are inappropriate.

6. Some candidates wrongly considered propene to be present in naphtha in significant amounts, and proposed using fractional distillation to obtain propene from naphtha. For those who suggested cracking of naphtha, some failed to mention that fraction distillation needs to be carried out in order to isolate propene from the product mixture. Some candidates even wrongly stated that polypropene can be obtained directly from the product mixture from cracking by fractional distillation. Some candidates omitted the reaction conditions for the polymerisation process.

7. (a) (i) Some candidates were unable to give the correct reaction products. For those who did, many failed to balance the chemical equation.

(ii) Some candidates misread the question. They wrongly drew a reaction profile or an energy cycle instead of an enthalpy level diagram.

(b) Copper cannot reduce $Fe_2O_3(s)$ because copper is less reactive than iron. Some candidates gave answers which were incomplete, such as only stating that copper is less reactive than aluminium.

(c) (i) Some candidates failed to consider the cost factor, i.e. aluminium is more expensive than carbon.

(ii) Well answered.

8. (a) Some candidates were unable to give a correctly balanced chemical equation for the reaction.

(b) (i) Many candidates failed to draw the structure of CsCl(s) showing each $Cs^+$ ion surrounding by 8 $Cl^-$ ions, and vice versa.

(ii) Fair performance.

(c) Most candidates correctly mentioned that Cs is more reactive than Na. However, some failed to mention that for the Group I elements, chemical reactivity increases as the position of the element decreases down the group.

9. (a) Iodine liberated at **A** dissolves in KI(aq) to give a brown solution. However, some candidates wrongly mentioned that a brown solid or a brown gas is formed. Some did not explain the preferential discharge of $I^-(aq)$ ions over $OH^-(aq)$ ions based on concentration effect.

(b) (i) Well answered.

(ii) Many candidates wrongly mentioned that copper is oxidised to give blue $Cu^{2+}(aq)$ ions.

10. (a) Well answered.

(b) Some candidates did not read the question carefully and gave wrong half equations.

(c) (i) Some candidates wrongly stated that hydrogen can be obtained from air by fractional distillation. Some suggested electrolysis of water. However, answers merely stating the fact would receive no marks because the question required comments from environmental aspects. For example, if hydrogen is produced from electrolysis of water, the process needs electricity. However, the generation of electricity can also pose harm to our environment.



(ii) Well answered. Many candidates correctly stated that only water is emitted from the fuel cells, or that the fuel cells do not emit pollutant gases such as $CO_2$, CO and $NO_x$.

11. (a) Some candidates failed to point out that increasing the surface area of reactants would lead to an increase in the reaction rate.

(b) Many candidates correctly calculated the amount of $N_2(g)$ produced from the decomposition of $NaN_3(s)$, i.e. the 1st reaction. However, many failed to recognise that Na(s) is the limiting reagent in the 2nd reaction. They wrongly calculated the amount of $N_2(g)$ produced in the 2nd reaction based on the mass of $KNO_3(s)$ used in the airbag.

(c) Many candidates failed to recognise that the $KNO_3(s)$ in airbags can, through reaction, remove the sodium metal produced from the decomposition of $NaN_3(s)$, because sodium is flammable and can cause severe skin burns.

(d) (i) The calculation was done correctly in most cases. However, some candidates failed to assign the correct unit to their final answers.

(ii) Well answered.

12. (a) Some candidates failed to recognise that the volume of the reaction container is 10.0 $dm^3$, and were unable to arrive at the correct answer for the reaction quotient.

(b) Some candidates were able to give the correct equilibrium constant expression. However, some were unable to solve the quadratic equation involved, and thus failed to arrive at the correct numerical answer.

(c) Some candidates might have overlooked the fact that extra $Cl_2(g)$ had been introduced into the system, and thus the final $[Cl_2(g)]$ cannot be lower than the initial $[Cl_2(g)]$.

13. Most candidates correctly arranged the elements in increasing order of melting point. However, many candidates failed to use the correct chemical terminology. Mistakes made by the candidates include:
- lithium molecules are present in lithium metal;
- the interparticle attraction in elemental lithium or beryllium is ionic bond; and
- graphite has a simple molecular structure.

14. (a) Some candidates wrongly proposed using NaOH(aq) as reagent, possibly mistaking the reaction would involve the hydrolysis of ester. Some candidates only gave $H_2(g)$ but without stating the catalyst needed.

(b) (i) Some candidates gave incorrect structures for the glycerol formed. Again, candidates were weak in balancing chemical equations.

(ii) **G** reacts with methanol to give an ester. However, some candidates wrongly gave the structure of a fatty acid.

(c) Some candidates failed to recognise that **G** is more volatile than **F** as **G** has a smaller relative

molecular mass than **F**. Although the question explicitly stated that **F** is a vegetable oil, some candidates still mentioned that **F** is a solid.

15. (a) Most candidates were able to suggest a correct chemical test.

(b) Most candidates knew that $LiAlH_4$ should be used.

(c) Some candidates wrongly drew the structures of the *cis/trans*-isomers. They gave chemical structures with a smaller/larger number of carbon atoms in comparing with the correct one. Some wrongly mentioned that the alkenes are positional isomers.

(d) Some candidates wrongly gave $CH_3CH_2CHClCH_2CH_3$, which is not optically active, as answer.

**Paper 2**

| Question Number | | Popularity (%) | Performance in General |
|---|---|---|---|
| 1 | (a) | 48 | Good |
| | (b) | | Fair |
| | (c) | | Satisfactory |
| 2 | (a) | 5 | Satisfactory |
| | (b) | | Fair |
| | (c) | | Poor |
| 3 | (a) | 47 | Satisfactory |
| | (b) | | Satisfactory |
| | (c) | | Good |

**Section A**

1. (a) (i) (1) Not many candidates were able to give the correct labels for the two axes. The *x*-axis should be molecular kinetic energy. Some candidates simply put down energy, which is not precise enough.

(2) Some candidates just stated that the collision frequency of the reactant molecules would increase with temperature, but without making reference to the graph provided.

(ii) Very few candidates were able to correctly calculate the activation energy of the reaction. Their common mistakes include:

- confusing '*ℓ*og k' with '*ℓ*n k' (both 'l' or '*ℓ*' are accepted for writing the relevant terms),
- writing '*ℓ*n k' as 'In k', and
- mis-interpreting the unit of the *x*-axis as '/$10^{-3}$ $K^{-1}$' instead of '$10^{-3}$ $K^{-1}$'.



(b) (i) Some candidates wrongly mentioned that a catalyst lowers the activation energy of a reaction instead of providing an alternative pathway with a lower activation energy.

(ii) Many candidates failed to demonstrate an understanding that the reaction is a reversible one and hence were unable to provide an explanation based on the shifting of the equilibrium position. Some candidates wrongly mentioned that concentrated $H_2SO_4$ can provide more $H^+(aq)$ ions than dilute $H_2SO_4$ to catalyse the reaction, without noticing that a catalyst can increase the rate of the forward reaction and that of the backward reaction to the same extent.

(iii) Some candidates were able to suggest an advantage of using a heterogeneous catalyst, but few were able to suggest an advantage of using a homogeneous catalyst in the synthesis of eugenol benzoate.

(c) (i) The production of $Cl_2$ and NaOH involves the electrolysis of brine (i.e. concentrated sodium chloride solution). Some candidates wrongly wrote the electrolysis of sea water or electrolysis of sodium chloride solution. Other mistakes include:

- the failure to mention the type of electrolytic cell used, and
- the failure to mention at which electrodes $Cl_2(g)$ and $H_2(g)$ are liberated respectively.

(ii) Many candidates were unable to calculate the atom economy. Some had difficulty in calculating the formula mass of propylene oxide. Some paid no attention to significant figures and gave answers with a long string of numerals.

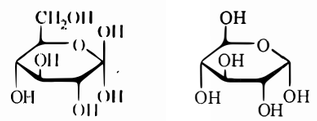
(iii) Many candidates were unable to decide, with reference to the given information, whether Method 1 or Method 2 is greener. Some discussions were just based on economic, political, financial and/or societal considerations instead of green chemistry.

(iv) Many candidates were unable to differentiate between the terms 'atom economy' and 'reaction yield'.

**Section B**

2. (a) (i) (1) Most candidates did not demonstrate the understanding that the formation of condensation polymers would involve the elimination of small molecules.

(2) The structure of glucose was correctly drawn in many cases. A few candidates drew the following incorrect structures for glucose:



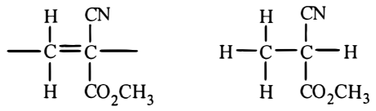
(ii) Some candidates gave irrelevant explanations based on 'isomers' or 'isotopes'.

(iii) Some candidates erroneously considered the dissolution of a substance to be a chemical change. They wrongly mentioned that chemical bonds are broken in the

process.

(b) (i) Some candidates confused the terms 'melting' and 'dissolving'. Some mistakenly considered the melting of the glue to be a chemical change.

(ii) (1) Some candidates gave the following incorrect structures for the monomer:





(2) Again, some candidates wrongly considered dissolving superglue as a chemical change.

(iii) Poor performance. Some candidates confused –CN group with $CN^-$ ions. They wrongly mentioned that poly(methyl 2-cyanoacrylate) is toxic to microorganisms.

(c) (i) A few candidates were able to demonstrate a good understanding of the phases of liquid crystals.

(ii) Many candidates wrongly chose **B**.

(iii) A few candidates wrongly stated that a liquid crystal would become a liquid/gas at very low temperatures.

(iv) Many candidates failed to demonstrate a correct understanding of the term 'power efficiency'.

**Section C**

3. (a) Many candidates were unaware that water is immiscible with hex-1-ene and octane, and the mixture would appear as two layers of liquids. These candidates just mentioned that hex-1-ene can be isolated from the mixture by fractional distillation. Some suggested using solvent extraction with ether, but without mentioning the removal of the ether by distillation.

(b) (i) Many candidates did not have a good grasp of the principles of quantitative analysis.

(ii) Some candidates failed to recognise that both iodine and sulphur dioxide are volatile.

(iii) The question asked for the colour change. Some candidates just stated 'dark blue' without mentioning the initial colour.

(iv) Some candidates did not express the total concentration of $SO_2$ in 'mg $dm^{-3}$' as required by the question. They just wrongly expressed the answer in 'mol $dm^{-3}$'.

(v) Few candidates were aware that the colour of the red wine would pose difficulty in detecting the titration end point.

(c) (i) Some candidates were unable to calculate the $R_f$ value. Many failed to realise that $R_f$ has no units. Again, some candidates paid no attention to significant figures and



gave answers with a long string of numerals.

(ii) Satisfactorily answered. Many candidates knew that β-carotene would be the first collected fraction, but were unable to provide a correct explanation.

(iii) Some candidates randomly suggested instrumental methods, such as infra-red spectrometry and mass spectrometry.

(iv) Satisfactory performance. The unit for wavenumber in the infra-red spectrum is '$cm^{-1}$'. Some candidates had difficulty in interpreting of the unit as appeared in the IR spectrum and wrongly wrote '/$cm^{-1}$'. Some candidates failed to present clearly how compounds **X**, **Y** and **Z** can be eliminated by making reference to the given characteristic infra-red absorption wavenumber ranges.

General comments and recommendations

1. Candidates were generally weak in answering questions involving chemical calculations and data analysis. These include mass/mole/concentration calculations on reaction stoichiometry, calculations of enthalpy changes, and those involving chemical equilibrium. More practice in this respect is needed.

2. Many candidates seem to have misunderstood the requirements of questions. Some used inappropriate/incorrect data in carrying out the calculations (e.g. Paper 1 Section B Q.5(a)(ii)). Candidates should read the questions more carefully.

3. Candidates should be aware that chemistry is a science which has daily-life relevancy This can help arouse their interest in chemistry and perform better in questions which apply chemistry in daily life.

4. Many candidates did not demonstrate sufficient understanding about some fundamental chemical concepts including structures, bonding and intermolecular forces, physical and chemical changes. Some were unable to use the correct chemical terminology. Reading more books/articles on chemistry can help them improve in this respect.

**School-based Assessment**

All school candidates have to participate in School-based Assessment (SBA). There were 16032 students from 434 schools submitted their SBA marks this year. Despite this being the second year of implementation of SBA for the Hong Kong Diploma of Secondary Education (HKDSE), the implementation was generally smooth in most of the participating schools. With the experience gained in the first year, most teachers were familiar with the requirements and operations of the SBA.

To ensure that teachers have a good understanding of the requirements and the principles of the assessment methods of the SBA, a SBA annual conference was held in October 2012. The conference provided teachers with general comments and summary about the SBA implementation, and up-to-date adjustments of the SBA requirements and administrative operations. The conference also introduced the resources and supports available to help teachers to integrate practical works into chemistry classes. Furthermore, the Curriculum Development Institute of the Education Bureau and the Hong Kong Examinations and Assessment Authority collaboratively provided training courses and useful resources for new teachers, and helped them to enhance knowledge and skill, and build up confidence in implementing SBA in their classes.

Based on the assessment data and samples of students' worksheets and reports submitted by participating schools, students' performance was in general satisfactory and within the expectations of the assessment requirements. To address the potential discrepancies in the marking standard among individual teachers and schools, mark moderation based on both statistical methods and professional judgment was performed. We are happy to report that 58.5% of schools fall into the 'within the expected range' category, while the marks of 24.9% of schools are higher than expected, and 16.6% lower than expected. It is observed that the majority of schools with deviations only differ slightly from the expected range. This is encouraging as the data show that the majority of the teachers have a good understanding of SBA implementation, and hence the marking standards are generally appropriate.

To provide continuing support for teachers and to ensure fair implementation of the SBA, two supervisors are assigned to supervise all the schools, and there is a total 24 district coordinators to address enquiries from teachers about SBA implementation, and to ensure that schools are running the scheme within the stipulated guidelines. Phone calls, email correspondences and school visits were conducted to establish close connections between the district coordinators and the teachers. Beginning from 2012-2013, school visits by supervisors / district coordinators are strengthened to enhance the correspondence between the supervisors / district coordinators and teachers. It aims at providing stronger supports for school teachers on running SBA, and allows the supervisors / district coordinators to have better understanding about how SBA is implemented in the schools. Based on the feedback from various sources, both teachers and students understand the essence and the requirements of the SBA. Nonetheless, some comments and recommendations are given below so that further improvement on the implementation of SBA could be made:

1. Variety of Experiments
   It is appropriate to allow students to carry out assessment task involving volumetric work (such as determination of $SO_2$ content in a red wine sample), and classified it as 'other experiment'. It is also understandable that performing this type of assessment task can help students to develop an in-depth understanding of volumetric analysis, including sample treatment, preparation of a standard solution, data analysis, etc. However, with a view to using a variety of experiments for assessment, it is recommended that teachers make reference to the suggested practical activities in the curriculum and assessment guide, and allow students to do various types of experiments.

2. Variety of Written Work
   Worksheets, quizzes and brief / detailed laboratory reports, etc. are all acceptable formats of written work. Teachers generally designed these tasks in a professional manner. Moreover, it is encouraging that most students can follow the instructions given by teachers in accomplishing the written work. Although there is no stipulated requirements in the SBA guidelines regarding the types of written reports to be submitted by a student, writing laboratory reports is definitely an important part of the training for students studying experimental sciences. Organising a laboratory report in the correct format and presenting the data and experimental findings properly are very important. Previous experience showed that students frequently omitted some essential items (such as date, experimental title, objectives, and reference, etc) in the first few times when they wrote laboratory reports. However, after gaining some experience, students were able to write a laboratory report in a proper manner.



3. Use of 'feedback' to promote learning
   Providing feedback to students through submitted reports is important for facilitating student learning. It also helps students to avoid making the same type of mistakes in the future. Moreover, students are encouraged to discuss with their teachers to understand their own performance in carrying out experiments and finishing the related written tasks.

4. Students' performance in recording and analyzing the data obtained from experiments
   From the samples of students' work submitted by the schools, it was observed that students frequently made some mistakes in recording the experimental data, performing calculations and drawing set-up diagrams. These mistakes include the use of incorrect significant figures in data recording and incorrect units for numerical data. Students are encouraged to have more practices in these areas.

5. Prevention of plagiarism
   Students should complete the assessment tasks honestly and responsibly in accordance with the stipulated requirements. They will be subject to severe penalties for proven malpractice, such as plagiarising others' work. The HKDSE Examination Regulations stipulate that a candidate may be liable to disqualification from part or the whole of the examination, or suffer a mark penalty for breaching the regulations. Students can refer to the information leaflet HKDSE Examination- Information on School-based Assessment (http://www.hkeaa.edu.hk/DocLibrary/Media/Leaflets/SBA_pamphlet_E_web.pdf) for guidance on how to properly acknowledge sources of information quoted in their work.

Conclusion

In this second year of implementation of SBA in the HKDSE, the students' performance is generally satisfactory, and teachers run the SBA smoothly in their lessons. With the experience acquired in the first year, most teachers have a much clearer picture about the requirements and expected goals of SBA. Teachers are more experienced in selecting the appropriate practical tasks for their classes and assessing the abilities of their students. With the experience acquired in the first two cohorts, most of the queries and challenges that teachers and students have encountered will be tackled successively.