

## 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 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. Without counting the deleted one, the mean score was 23. Candidates' performance was generally good. Some misconceptions of candidates were revealed from their performance in the following items:

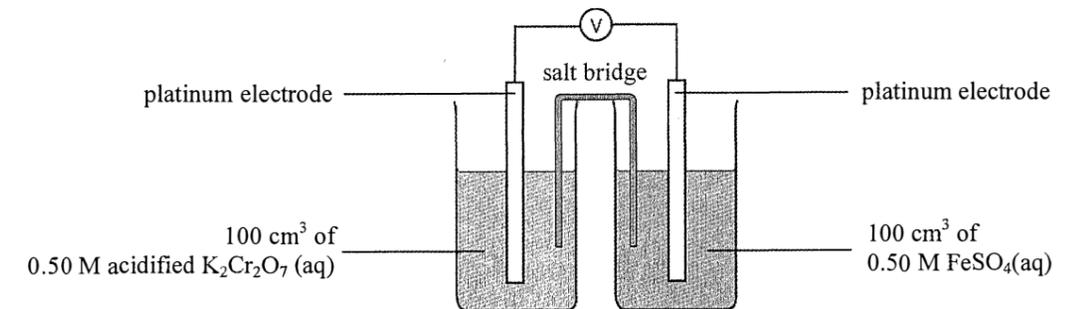
- For Q.1, less than half of the candidates correctly chose the key A which suggests that many candidates did not have a clear understanding of acid solutions. The pH of an acid solution is zero if the concentration of the  $\text{H}^+(\text{aq})$  ions in it equals 1 M. Carbon dioxide is an acidic compound even though it does not contain hydrogen as its constituent element because it ionises in water to give  $\text{H}^+(\text{aq})$  ions. There is no need to display a 'corrosive' hazard warning label on reagent bottles containing very dilute acid solutions.

Q1. Which of the following statements is correct ?

- |     |   |       |
|-----|---|-------|
| A.* | All aqueous solutions contain $\text{H}^+(\text{aq})$ ions.   | (46%) |
| B.  | The pH of all acid solutions is greater than zero.  | (22%) |
| C.  | All acidic compounds contain hydrogen as their constituent elements.                                  | (19%) |
| D.  | A 'corrosive' hazard warning label must be displayed on all reagent bottles containing acid solution. | (13%) |

- For Q.16, more than half of the candidates failed to choose the key D. Candidates should consider the overall equation for the electrochemical reaction of this question. As the mole ratio of ' $\text{Fe}^{2+}(\text{aq})$  to  $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$ ' in the overall equation is '6 : 1', the molarity of  $\text{Fe}^{2+}(\text{aq})$  after that period of time should then be ' $0.5 - 6(0.5 - 0.47)$ ', i.e. the concentration is 0.32 M.

Q16. Consider the following set-up at the start of an experiment :



After a period of time, the concentration of  $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$  drops to 0.47 M. What is the concentration of  $\text{FeSO}_4(\text{aq})$  at that time ?

- |     |        |       |
|-----|--------|-------|
| A.  | 0.53 M | (23%) |
| B.  | 0.47 M | (25%) |
| C.  | 0.41 M | (14%) |
| D.* | 0.32 M | (38%) |

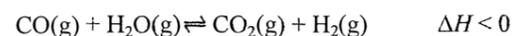
3. For Q.26, the performance of candidates is very poor. As the compound contains two C=C bonds, there may then be 4 kinds of geometric arrangement: **cis-cis**, **trans-trans**, **cis-trans**, **trans-cis**. However, as it is a symmetric compound, the **cis-trans** and **trans-cis** arrangements are in fact of the same geometry, leaving a total of 3 geometrical isomers only

Q26. How many geometrical isomers does  $\text{H}_3\text{C}-\text{CH}=\text{CH}-\text{CH}=\text{CH}-\text{CH}_3$  have ?

- |     |   |       |
|-----|---|-------|
| A.  | 0 | (14%) |
| B.  | 2 | (44%) |
| C.* | 3 | (14%) |
| D.  | 4 | (28%) |

4. For Q.33, the item was deleted due to insufficient discrimination. Candidates might have had different interpretations of the term 'rate of formation of  $\text{H}_2(\text{g})$ ' in the equilibrium reaction system, and hence lowered the discrimination power of the item.

Q33. Consider the following equilibrium reaction system in a closed container of fixed volume :



Which of the following, when applied to the system, would lead to an increase in the rate of formation of  $\text{H}_2(\text{g})$  ?

- (1) adding  $\text{CO}(\text{g})$   
 (2) increasing the temperature  
 (3) adding a suitable catalyst
- A. (1) only  
 B. (2) only  
 C. (1) and (3) only  
 D. (2) and (3) only

### Section B (conventional questions)

Question Number	Performance in General
1	The performance of candidates in this question was good. Around three quarters of the candidates were able to draw the electron diagram for a molecule of argon. However, some wrongly used 'Ag' or 'At' as the symbol. In part (c), some candidates mentioned 'distillation of air' but omitted the key word 'fractional'.
2	The performance of candidates in this question was fair. In part (a), about half of the candidates failed to describe the further change upon the addition of excess $\text{CO}_2(\text{g})$ . Moreover, they were not able to give the correct formulae for $\text{Ca}(\text{OH})_2(\text{aq})$ and $\text{Ca}(\text{HCO}_3)_2(\text{aq})$ , or the required chemical equations. In part (b), slightly more than half of the candidates gave the correct colour change, but many of them were not able to write the correct chemical equation. Quite a number of them erroneously included permanganate solution / $\text{KMnO}_4(\text{aq})$ / $\text{MnO}_4^-(\text{aq})$ in their answers.
3	The performance of candidates in this question was fair. In part (b), about half of the candidates were able to determine the empirical formula required, but many of them did not write a correct chemical equation for the reaction between $\text{Fe}_3\text{O}_4(\text{s})$ and $\text{CO}(\text{g})$ . In parts (c) and (d), more than half of the candidates were able to explain the respective principles on the prevention of corrosion in galvanised iron and anodised aluminium. However, a few failed to distinguish the difference between these two principles.
4	The performance of candidates largely varied in different parts of this question. Candidates' performance in parts (a) and (d)(ii) was very good; in particular, they demonstrated a good mastery of the calculation on molarity. In parts (b) and (c), more than half of the candidates demonstrated a weak understanding about lead-acid accumulators. In part (d)(i), many candidates incorrectly suggested a procedure of using apparatus like a pipette or a volumetric flask for the dilution of concentrated sulphuric acid.
5	The performance of candidates in this question was fair. About two thirds of the candidates were able to state that $\text{NH}_3$ is a weak alkali because it ionises slightly in water, and about half of them were able to give the correct chemical equation. About a third of the candidates were able to suggest an appropriate experimental method for demonstrating that $\text{NH}_3$ is a weaker alkali than $\text{NaOH}$ but, about half made conceptual mistakes. Common mistakes included 'comparing the rates of neutralisation between $\text{HCl}$ and $\text{NH}_3 / \text{NaOH}$ ', 'comparing the amounts of $\text{HCl}$ needed to neutralise a sample of $\text{NH}_3 / \text{NaOH}$ ', and 'comparing the voltages generated by the chemical cells constructed with $\text{NH}_3 / \text{NaOH}$ as the electrolyte', etc. Some candidates stated an incorrect instrument for carrying out measurements, such as using a voltmeter to measure the current of a circuit. Lastly, about a third of the candidates were not able to state the appropriate conditions for carrying out a fair test.
6	The performance of candidates in this question was fair. In part (a), about two thirds of the candidates were able to give the correct answer. However, some of them misspelt the answer 'substitution' as 'subsitution'. Candidates' performance in parts (b) and (c) was very good. In part (d), more than half of the candidates were able to give the correct answer. However, some of them wrongly stated the given bromine atom / radical as a bromide ion ( $\text{Br}^-$ ). The performance of the candidates in part (e)(i) was good, although some candidates wrongly gave ' $\text{CH}_3$ ', ' $\text{CCl}_4$ ' or '1,2-dibromomethane' as the answer. In part (e)(ii), about half of the candidates failed to correctly state that excess amount of methane was needed to meet the requirement.

Question Number	Performance in General
7	The performance of candidates in this question was fair. In part (a), about forty percent of the candidates wrongly stated the electroplated object would be contaminated by oily dirt. In part (b), about half of the candidates were able to give the correct answer. Some candidates wrongly stated that electrolytes can conduct electricity by allowing electrons to pass through, or just simply stated that electrolytes can conduct electricity but without any further elaboration. The performance of the candidates in part (c) was very good, although a few of them omitted $H^+$ and $OH^-$ in their answers. In part (d), about half of the candidates were able to give the correct answer. However, some of them were confused about the relative oxidising power of copper(II) ions and hydrogen ions. The performance of the candidates in part (e) was good, although some candidates wrongly gave the half equation of the change occurred at the cathode. The performance of the candidates in part (f) was poor. Only about a third of them were able to give the correct answer. A small number of them wrongly stated the colour of the solution would become deeper or paler. Also, a small number of candidates wrongly stated the expected changes at the electrodes (change in size / reddish-brown substance plated on the surface) without referring to the observable changes that would occur in the solution. In part (g), the performance of the candidates was satisfactory. However, about a third of them failed to recognise that it takes 2 moles of electrons to reduce 1 mole of $Cu^{2+}$ .
8	The performance of candidates in this question was fair. In part (a), more than eighty percent of the candidates were able to give the correct answer. The performance of candidates in part (b) (i) was poor. A small number of candidates wrongly gave the chemical formulae ( $CO_2$ , $H_2O$ ) without explicitly indicating the bonds formed or broken. Some of them missed one or two species in their answers. There were also a small number of candidates who failed to state the double bonds in $O_2$ and $CO_2$ , and wrongly stated the bonds as $O-O$ and $C-O$ . The performance of candidates in part (b)(ii) was very poor. About a quarter of the candidates stated the energy involved in bond forming is larger than that involved in bond breaking, without stating which process releases energy and which absorbs energy. A small number of candidates wrongly stated that energy is released in bond breaking and absorbed in bond forming. The performance of candidates in part (b)(iii) was good. However, some of them failed to give the correct answer because they used the incorrect '+ / -' sign for the energy terms, or missed the coefficient '2' in the term for $\Delta H_f^\ominus [H_2O(l)]$ in the calculation. The performance of candidates in part (c) was very poor. Less than half of the candidates were able to give correct reasons for using more natural gas to generate electricity than coal.
9	The performance of candidates in this question was poor. In part (a), about two thirds of the candidates were able to give the correct answer. However, a small number of the candidates wrongly stated performing the experiment in micro-scale could increase the rate of the reaction. The performance of candidates in part (b) was very poor. Some of the candidates wrongly stated that hydrogen is less dense than air, so placing the tubing at the uppermost position of the inverted measuring cylinder could collect more pure hydrogen from the cylinder. The performance of candidates in part (c) was good. However, some candidates wrongly stated that gas bubbles would be formed in the cylinder. In part (d), about two thirds of the candidates were able to give the correct answer. Some candidates gave the incorrect unit for the answer, such as $6.49 \text{ dm}^3$ or $0.00649 \text{ mol dm}^{-3}$ . The performance of part (e) was poor. Only about a third of the candidates were able to give the correct answer.

Question Number	Performance in General
10	The performance of candidates in this question was satisfactory. About half of the candidates were able to give the correct answers in part (a)(i). Some candidates wrongly gave a "covalent-like" electron diagram for $Na_2O$ . Some candidates failed to give the correct number of the outermost shell electrons or correct ionic charge for the $O^{2-}$ ion. A small number of candidates wrongly stated that the reaction of sodium oxide with water would give sodium hydroxide and hydrogen gas. In part (a) (ii), about two thirds of the candidates were able to give the correct electron diagram for $Cl_2O$ . Some candidates omitted the lone pair electrons on the oxygen atom. About a quarter of the candidates only stated whether $Cl_2O$ is soluble in water without mentioning its acidic property. A small number of candidates wrongly stated that the reaction of $Cl_2O$ with water would give $HCl(aq)$ or a mixture of $HCl(aq)$ and $HOCl(aq)$ . The performance of candidates in part (b) was satisfactory. Some candidates failed to give specific examples to illustrate their answers. Some candidates misspelt the term 'Haber Process' as 'Habour Process' or 'Harbour Process'.
11	The performance of candidates in this question was very poor. In part (a)(i), only about half of the candidates were able to give the correct answer. Some candidates failed to give the correct unit for the answer. The performance of candidates in part (a)(ii) was very poor. Only about a third of the candidates were able to recognise that the concentrations of $H^+$ and $OH^-$ were equal in water. A high proportion of candidates failed to give the answer with a correct unit. In part (b), less than twenty percent of the candidates were able to give the correct answer. Many of them wrongly stated 'water is only a solvent so $[H_2O]$ is a constant'. The performance of candidates in part (c) was very poor, and only a very small number of the candidates were able to give the correct answer. About half of them wrongly stated that although the equilibrium position shifted to the right and $[H^+]$ increased, as $[H^+]$ was still equal to $[OH^-]$ and the water was then still neutral. Therefore, the pH would remain as 7.
12	The performance of candidates in this question was poor. About half of the candidates omitted either the oxidation (oxidation of benzaldehyde to give benzoic acid) or reduction (reduction of benzaldehyde to give phenylmethanol) step in their answers. Some candidates omitted 'acidified' for potassium dichromate solution. In the esterification step, some candidates gave the incorrect catalyst ( $H^+$ or $H_2SO_4(aq)$ ) or omitted 'heating' for the reaction.
13	The performance of candidates in this question was fair. Less than half of the candidates were able to give the correct answer in a systematic way and with appropriate / correct terminologies. Common mistakes included 'a molecule having a chiral carbon atom which connected to four different molecules', 'the molecules rotate to different directions under plane-polarised light' and 'the molecule is superimposable with its mirror image'. Many candidates failed to recognise the correct meaning of the term 'superimposable', or spell the word correctly. There were also a high proportion of candidates who failed to demonstrate an accurate understanding of the optical activities of chiral molecules.

## Paper 2

Paper 2 consisted of three sections. Section A contained questions set on Topic XIII 'Industrial Chemistry', Section B on Topic XIV 'Materials Chemistry' and Section C on Topic XV 'Analytical Chemistry'. Candidates were required to attempt all questions in two of the sections.

Question Number	Popularity (%)	Performance in General
Section A: 1	49	The performance of candidates in part (a) was satisfactory. However, about a third of the candidates were not able to write the rate equation from the given information, while about half of them were not able to give a chemical equation for the Haber process, and most of them were not able to calculate the activation energy. The performance of candidates in part (b) was poor. Many candidates were not able to draw the energy profiles in the same sketch and only about a third of them were able to suggest that the catalyst may be poisoned upon prolonged usage. Moreover, many candidates were not able to suggest reasons for considering the fermentation route as a green process. The performance of candidates in part (c) was fair. Eighty percent of the candidates were able to point out that a mercury electrolytic cell is not considered as environmentally friendly owing to the poisonous nature of mercury. Moreover, just under half of the candidates were able to suggest that brine or concentrated sodium chloride solution as the raw material for the chloroalkali industry and about two thirds of the candidates were able to suggest a criterion in choosing a site for building the plant. However, only about a quarter of candidates were able to give an overall equation for the electrolysis and state the advantage of a membrane electrolytic cell over a diaphragm electrolytic cell.
Section B: 2	3	The performance of candidates in part (a) was very poor. Ninety percent of the candidates failed to explain the meaning of the term 'unit cell', and seventy percent of them were not able to deduce the number of copper atoms in the given unit cell. The incorrect answer '14' was common, suggesting that candidates had not sufficiently mastered the topic. The performance of candidates in part (b) was poor. About half of the candidates were able to draw the structure of styrene, but more than forty percent of them did not give the correct name of the type of polymerisation involved. Incorrect answers like 'condensation polymerisation' were common. The performance of candidates in part (c) was very poor. Only about ten percent of the candidates were able to describe how molecules in the smectic phase of liquid crystal are arranged, and to explain why the pixel appears black when voltage is applied.
Section C: 3	48	The performance of candidates in part (a) was very poor. Only forty percent of the candidates were able to give a chemical test for the presence of $\text{Br}^-$ (aq), and twenty percent of them correctly suggested chromatography as the instrumental technique for determining the octane content in a petrol sample. Sixty percent of the candidates were not able to suggest a practical method in obtaining copper powder from a mixture of copper powder and iron(III) oxide. Most of them wrongly suggested adding dilute nitric acid or concentrated sulphuric acid to the mixture, or heating the mixture with carbon. The performance of candidates in part (b) was satisfactory. About two thirds of the candidates were able to give the observation upon treatment of X and Y with 2,4-dinitrophenylhydrazine and outline a distinguishing chemical test between X and Y. Lastly, about sixty percent of the candidates were not able to state how X and Y could be distinguished from one another by mass spectrometry but not by infra-red spectroscopy. The performance of candidates in part (c) was fair. More than two thirds of the candidates were able to write the chemical equations in Step (2). Just below half of the candidates were able to state the colour change at the end-point. However, many of them failed to calculate the percentage of nitrogen in the milk powder sample.

## School-based Assessment

All school candidates have to participate in School-based Assessment (SBA). There were 15487 students from 429 schools submitted their SBA marks this year. This is the fourth year of implementation of SBA for the Hong Kong Diploma of Secondary School Education (HKDSE). With the experience acquired over the past three years, the implementation was generally smooth in most of the participating schools.

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 and group meetings were held in October 2014. The conference and group meetings 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 Education Bureau and the Hong Kong Examinations and Assessment Authority collaboratively provided training courses and useful resources for 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 75.1% of schools fall into the 'within the expected range' category, while the marks of 15.8% of schools are higher than expected, and 9.1% lower than expected. It was observed that the majority of schools with deviations only differed 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 were a total 24 district coordinators to address enquiries from teachers about SBA implementation, and to ensure that schools were running the scheme within the stipulated guidelines. Phone calls, email correspondences, district group meetings and school visits were conducted to establish close connections between the district coordinators and the teachers. The said communication channels between the supervisors / district coordinators / teachers can enhance mutual understanding. Based on the feedback from various sources, both teachers and students have a better understanding of 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

Even though there is no strict stipulated requirement on the types of experiments selected for SBA tasks besides including volumetric analysis and qualitative analysis in the task list, it is definitely beneficial to students' learning if they are exposed to a wider variety of experiment types. It is encouraging to see experiments from different topics like 'Chemistry reactions and energy', 'Rate of reaction' and 'Chemical equilibrium' have been commonly used. It was observed, however, that not many schools carried out preparative experiments (in particularly those involving organic reactions) for SBA tasks. Due to the lack of this kind of experience, many students have limited understanding about the correct procedures of carrying out an organic reaction and isolating the product from the reaction mixture. Conducting these types of experiments can strengthen students' abilities on basic laboratory skills.

### 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 their own performance in carrying out experiments and related written tasks. Teachers can provide students with written and other forms of feedback to promote learning through School-based Assessment.
4. Students' performance in observing and presenting the appearance of common ionic substances  
It was observed that some students were confused about the colours of common ionic substances, and whether these substances are soluble in water at room temperature which may be due to limited hands-on experience students lack in handling these compounds. More coverage of this topic area and some relevant experiments in class are recommended.
5. Students' performance in recording and analysing the data obtained from experiments  
It was observed that students frequently made mistakes in recording the experimental data, performing calculations and drawing set-up diagrams. These mistakes include using incorrect significant figures in data recording and calculations, using incorrect units for numerical data, and carrying out the calculations incorrectly. In particular, it was observed that quite a number of students recorded the burette readings in one decimal place in titrations, instead of writing down the burette reading in two decimal places by estimating the values of the second digit after decimal. Students are encouraged to pay more attentions in these areas.
6. 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](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

For the implementation of SBA in the HKDSE 2015, students' performance is generally satisfactory, and teachers have expressed a smooth running of the SBA in their lessons. With the experience acquired in the first three cohorts, most teachers have a clear understanding about the requirements and expected goals of SBA. Teachers are also more experienced in selecting appropriate practical tasks for their classes and assessing the abilities of their students. Finally, it is observed that most of the queries and challenges that teachers and students encountered were generally handled successfully.