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. The mean score was 22.4. Candidates' performance was generally good. Some misconceptions of candidates were revealed from their performance in the following items:

1 For Q.3, it should be noted that the empirical formula of a chemical compound should show the simplest positive integer ratio of the numbers of atoms present in the compound. Option A gives the simplest positive integer ratio of 1:1 for the number of carbon atoms to the number of hydrogen atoms, in contrast to the ratio in option C which is 2:2. Thus option A is the correct empirical formula.

Q.3 A hydrocarbon burns completely in oxygen to give 17.6 g of carbon dioxide and 3.6 g of water. Which of the following is the empirical formula of the hydrocarbon ?

Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

A.*	CH	(43%)
B.	CH_2	(18%)
C.	C_2H_2	(29%)
D.	C_2H_5	(10%)

2. For Q.22, other than knowing what products can be obtained from burning coal under room conditions, the item also requires candidates to analyse those products from various perspectives including acidity, physical states and whether they are poisonous or not. For example, carbon dioxide is acidic while carbon monoxide is not; carbon dioxide is a gas while carbon particle is not; carbon monoxide is poisonous while water is not. As such, all three statements in the item are correct.

Q.22 Which of the following statements concerning burning coal under room conditions are correct ?

(1) Burning coal forms both acidic and non-acidic substances.
(2) Burning coal forms both gaseous and non-gaseous substances.
(3) Burning coal forms both poisonous and non-poisonous substances.

A.	(1) and (2) only	(11%)
B.	(1) and (3) only	(14%)
C.	(2) and (3) only	(25%)
D.*	(1), (2) and (3)	(50%)

3. For Q.34, it should be noted that chemical equilibrium has dynamic nature. That means both the forward and backward reactions are still proceeding and of equal rates. Under this condition, the concentrations of all reactants and products are kept constant but not necessarily equal. Moreover, the stoichiometric coefficients of reactants and products in the equation do not constitute a simple ratio relationship between the concentrations of reactants and products.

Q.34 Consider the following equilibrium system :

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$

Which of the following statements are INCORRECT ?

(1) $[CrO_4^{2-}(aq)]$ must be equal to $[Cr_2O_7^{2-}(aq)]$.
(2) Both the forward reaction and the backward reaction have stopped.
(3) The number of moles of $CrO_4^{2-}(aq)$ must be double the number of moles of $Cr_2O_7^{2-}(aq)$.

A. (1) and (2) only (38%)
B. (1) and (3) only (12%)
C. (2) and (3) only (8%)
D.* (1), (2) and (3) (42%)

Section B (conventional questions)

Question Number	Performance in General
1	The performance of candidates in this question was good. In part (a), about two thirds of the candidates were able to state the correct type of chemical bonding present in barium. A small number of the candidates wrongly stated that the bonding in barium is ionic bond. In part (b)(i), just under half of the candidates were able to give the correct answer. About one third of the candidates wrongly stated that the gas cannot be collected because the apparatus is not covered. In part (b)(ii), about three quarters of the candidates were able to give the correct answer. In part (c)(i), a small number of the candidates wrongly stated that gas bubbles are formed. In part (c)(ii), about half of the candidates were able to give the correct answers. A small number of the candidates wrongly stated that the conductivity increases from **B** to **C** because $BaSO_4$ is soluble in acid, and mobile Ba^{2+} and SO_4^{2-} ions are formed.
2	The performance of candidates in this question was satisfactory. In part (a), about one third of the candidates were able to give a complete and correct answer. A small number of the candidates only compared the chemical property of copper and iron without giving an explanation. There were also a small number of the candidates wrongly used the term 'rusting' to describe the corrosion of copper. In part (b)(i), only a very small number of the candidates were able to state the reason for adding of lead to lower the melting point of the soldering materials. About two thirds of the candidates wrongly stated that lead can inhibit corrosion by sacrificial protection, or increase the hardness of the soldering materials. In part (b)(ii), about three quarters of the candidates were able to give the correct answer. In part (c), just under half of the candidates were able to calculate the answer correctly. About a quarter of the candidates were confused about the conversion of the unit from cm^{-3} to dm^{-3}.
3	The performance of candidates in this question was poor. In part (a), a small number of the candidates only stated that propene is an unsaturated molecule without mentioning it has a C=C double bond. In part (b), only a small number of the candidates were able to give a complete and correct answer. Some candidates confused –COOH group with –OH group, and wrongly stated that $HO_2C(CH_2)_4CO_2H$ has two –OH groups. In part (c), only a small number of the candidates were able to correctly describe the formation of dative covalent bond in H_3O^+. About a quarter of the candidates failed to state that the presence of two lone pairs on the O atom of a H_2O molecule. A small number of the candidates wrongly stated that the bonding electrons of the dative covalent bond are provided by a hydrogen atom.
4	The performance of candidates in this question was very poor. In part (a)(i), about one third of the candidates were able to state that colourless gas is given out at electrode **A** due to preferential discharge of OH^-. Some candidates only stated the expected observation without giving an explanation. In part (a)(ii), only a small number of the candidates were able to give the complete answer. A small number of the candidates only mentioned the colour change of the phenolphthalein indicator without mentioning the formation of colourless gas bubbles due to the discharge of H^+ ions. In part (b), only about a quarter of the candidates were able to give the correct equation of the overall reaction. In part (c)(i), only a small number of the candidates were able to give the correct answer. About one third of the candidates only stated 'no change' without giving any further elaborations. In part (c)(ii), only a small number of the candidates were able to state that the phenolphthalein indicator remains colourless is due to the presence of H_2SO_4, which makes the solution remain acidic.
5	The performance of candidates in this question was satisfactory. About one third of the candidates were able to give a complete and correct answer. About half of the candidates were able to state that the van der Waals' forces between F_2 molecules are stronger than those between H_2 molecules because the molecular size of F_2 is larger than that of H_2. Some candidates wrongly explained the strengths of the forces in terms of the molecular masses of H_2 and F_2. A small number of the candidates wrongly stated that a hydrogen bond is present between the H atom and F atom in a H–F molecule.

Question Number	Performance in General
6	The performance of candidates in this question was satisfactory. In part (a), about two thirds of the candidates were able to point out the correct warning labels to be used. In part (b)(i), about half of the candidates were able to describe why concentrated sulphuric acid should not be directly titrated. In part (b)(ii), about half of the candidates were able to state the colour change at the end point of the titration. In part (b)(iii), about two thirds of the candidates were able to calculate the concentration of the sample. In part (c), about half of the candidates were able to write the correct chemical equation and the expected observations. Quite a number of candidates wrote the following incorrect chemical equation: $Cu(s) + H_2SO_4(l) \rightarrow CuSO_4(aq) + H_2(g)$
7	The performance of candidates in this question was fair. In part (a), only close to one quarter of the candidates were able to explain why the enthalpy change of formation cannot be determined directly by experiment. In part (b), about one quarter of the candidates were able to state Hess's Law. In part (c)(i), about thirty percent of the candidates were able to draw the required enthalpy change cycle and to provide appropriate labels. In parts (c)(ii), about half of the candidates were able to state the required standard conditions and to calculate the enthalpy change of formation of $C_2H_2(g)$. The most common mistake was the omission or wrong use of state symbols. In addition, many candidates were not able to write the required balanced chemical equations, and hence failed to complete the required calculation.
8	The performance of candidates in this question was fair. In part (a), about one third of the candidates were not able to write the required balanced chemical equation. In part (b), about three quarters of the candidates were able to draw the electron diagram for a molecule of carbon dioxide. In part (c), only a very small number of the candidates were able to provide reasons for the support of the use of electric cars to alleviate global warming. In part (d), only about half of the candidates were able to provide answers like 'insufficient air' or 'insufficient oxygen'. In part (e)(i), only two thirds of the candidates were able to write 'catalytic converter'. In part (e)(ii), just over half of the candidates were able to state the required air pollutant. However, many candidates provided incorrect answers like 'carbon dioxide'.
9	The performance of candidates in this question was fair. About forty percent of the candidates were able to propose appropriate chemical tests to distinguish the four liquids, and correctly stated the expected observations. Some candidates described precisely that the use of bromine for testing the carbon-carbon double bond in propenoic acid should better be carried out in a dark environment. However, some candidates were confused in the expected observations for tests using acidified or non-acidified potassium permanganate solutions. Some candidates erroneously considered that $CH_3CO_2CH_3$ contains a ketone functional group.
10	The performance of candidates in this question was satisfactory. In part (a), just under half of the candidates were able to give the correct answer. A small number of the candidates failed to recognise the correct stoichiometric relationship between the number of moles of oxygen and the number of moles of hydrogen peroxide. In part (b), about a quarter of the candidates were not able to show the decreasing trend for the slope of the curve clearly, and wrongly drew the front portion of the curve close to a straight line. In part (c), just under half of the candidates were able to state that the total volume of gas remains as being 60 cm^3, and to give a correct explanation. Some candidates wrongly considered the reaction as being reversible, and stated how changing the temperature affects the position of the equilibrium. In part (d), about half of the candidates were able to suggest an appropriate alternative method to follow the progress of the reaction.

Question Number	Performance in General
11	The performance of candidates in this question was satisfactory. In part (a), a high proportion of the candidates were able to give a correct expression for K_c. In part (b), about two thirds of the candidates were able to show the correct relationship between pH of the solution and $[H^+(aq)]$. Some candidates were careless in carrying out the calculation, and wrongly gave 1 : 50000 for the ratio of $[HA] : [A^-]$ instead of 50000 : 1, which is the correct answer. In part (c), about half of the candidates were able to state that as the equilibrium position of the reaction shifts to the right, the yellow colour of the solution becomes more intense. A small number of the candidates only stated a change in colour but were not able to give a correct explanation. In part (d), about half of the candidates were able to state that 4-nitrophenol can be used as an indicator in acid-base titration. Some candidates wrongly stated that it can be used to measure the pH of a solution.
12	The performance of candidates in this question was poor. In part (a), a very high proportion of the candidates were able to give the correct structural formula for 3-bromopentane. In part (b)(i), about half of the candidates were able to recognise that compound **B** is pentan-3-ol and gave the corresponding structural formula. A small number of the candidates wrongly gave the structural formula of pentan-1-ol for the answer. Only a very small number of the candidates were able to give an appropriate deduction for compound **B**. In part (b)(ii), about half of the candidates were able to give the correct answer. Some candidates wrongly spelt the word 'substitution' as 'subsituation'. Moreover, the following answers are either not correct or not precise enough: 'halogenation', 'bromination' and 'hydrobromination', etc. In part (c)(i), only about a quarter of the candidates were able to give the correct structural formula of compound **A**. Some candidates failed to put the '$*$' symbol in the structural formula. Only a very small number of the candidates were able to give an appropriate deduction for compound **A**. In part (c)(ii), about one third of the candidates were able to give the correct reagents for the conversion of **A** to **B**. Some candidates omitted the required catalyst in the answer. A small number of the candidates were confused about hydrogenation and reduction, and wrongly gave $NaBH_4$ or $LiAlH_4$ as their answers.
13	The performance of candidates in this question was fair. About a quarter of the candidates were able to give a correct and complete synthetic route, and stated the appropriate reagents and reaction conditions in each step. Some candidates failed to recognise that the cyclic ester can be hydrolysed to open the ring, and give a carboxylic acid group and a hydroxyl group. About one third of the candidates were not able to give an appropriate intermediate for the synthetic route. About half of the candidates were able to state the correct reagents ($LiAlH_4$ followed by $H^+(aq)$) for the reduction involved in the second step. However, some candidates wrongly stated that a carboxylic acid group can be reduced into a hydroxyl group by using $NaBH_4$. Common mistakes include omitting the reaction conditions, stating inappropriate reagents for the steps (e.g. using concentrated H_2SO_4 for hydrolysis of ester), and including inappropriate steps (e.g. oxidise the hydroxyl group of the intermediate with acidified $K_2Cr_2O_7(aq)$) in the proposed synthetic route.
14	The performance of candidates in this question was poor. Only a small number of the candidates were able to give a correct and complete answer. Only about one third of the candidates were able to give a correct balanced equation for the reaction. About half of the candidates were able to state at least two correct characteristics of transition metals exhibited by manganese with reference to the information provided in the question. Some candidates were not able to give the correct oxidation numbers of manganese in $MnO_4^-(aq)$ and $Mn^{2+}(aq)$. Some candidates failed to deduce the catalytic property of $Mn^{2+}(aq)$ from the information provided in the question. Some of them wrongly stated that $MnO_2(s)$ or $KMnO_4(aq)$ is the catalyst in the reaction.

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	98	The performance of candidates in part (a) was fair. In part (a)(i), half of the candidates were able to give a chemical equation for the Haber process. However, only a small number of the candidates were able to suggest that ammonia can be separated from the reaction mixture obtained by cooling. In part (a)(ii), just below half of the candidates were able to deduce the order of reaction from the given information. In part (a)(iii), a high proportion of the candidates were able to suggest a potential hazard such as being flammable or toxic for storing methanol in a chemical plant. The performance of candidates in part (b) was fair. In part (b)(i), about half of the candidates were able to draw the energy profiles for the catalysed pathway and uncatalysed pathway for the conversion of sulphur dioxide to sulphur trioxide in the same sketch. Some represented the two pathways in two sketches while some wrongly labeled the axes. In part (b)(ii)(1), about one third of the candidates were able to give the reason for purifying the reactants to avoid the impurities in poisoning the catalyst. In part (b)(ii)(2), around three quarters of the candidates were able to give a reason for not preferring to further increase the conversion percentage by lowering the temperature of the reaction system. A very small number of the candidates were able to suggest that it is not cost effective for increasing the pressure of the reaction system as the conversion percentage will not increase to a high extent. In part (b)(ii)(3), about a quarter of the candidates were able to explain it is preferable to make O_2 in slight excess for the conversion of $SO_2(g)$ to $SO_3(g)$ as O_2 is more readily available. The performance of candidates in part (c) was satisfactory. In part (c)(i), about half of the candidates were able to write a chemical equation showing how CO(g) can be obtained from natural gas. In part (c)(ii), about two thirds of the candidates were able to write the half equation at the anode and explain why the flowing mercury cell process has been gradually phased out owing to the poisonous nature of mercury. About forty percent of the candidates were able to give the half equation at the cathode. In part (c)(iii), just under half of the candidates were able to deduce the order of reaction from the given information. In part (c)(iv), about sixty percent of the candidates were able to explain why the given process would be green based on its high atom economy while about half of the candidates were able to explain why the given process would not be green as the reaction involves poisonous reactants.

Question Number	Popularity (%)	Performance in General
Section B: 2	6	The performance of candidates in part (a) was poor. In parts (a)(i) and (a)(ii), only about twenty percent of the candidates were able to use the appropriate bonding / intermolecular forces concepts to explain the properties of the materials. In part (a)(iii), very few candidates were able to make use of the given molecular structure information to predict whether the compound will exhibit liquid crystal behaviour and to give an explanation. The performance of candidates in part (b) was fair. About one third of the candidates were able to correctly name this type of crystal structure. In addition, about three quarters of the candidates were not able to deduce the number of copper atoms in the given unit cell. Incorrect answers like '13' were common. The performance of candidates in part (c) was fair. About ninety percent of the candidates were not able to accurately explain the meaning of the term 'thermoplastic'. Moreover, about two thirds of the candidates failed to state the feature of condensation.
Section C: 3	96	The performance of candidates in part (a) was satisfactory. In part (a)(i), about eighty percent of the candidates were able to suggest flame tests to distinguish between sodium ions and potassium ions. In part (a)(ii), about forty percent of the candidates were able to suggest a chemical test for detecting sulphur dioxide gas based on its reducing property such as turning $Cr_2O_7^{2-}(aq)/H^+(aq)$ from orange to green. In part (a)(iii), about forty percent of the candidates were able to give the structure of **X** while some candidates mis-represented the structure as the cis-isomer. The performance of candidates in part (b) was fair. In part (b)(i), a very small number of the candidates were able to state the colour change at the end point of the titration as from pale yellow to pale pink. For part (b)(ii) and (iii), - about a quarter of the candidates were able to calculate a reasonable average of the volume of $KMnO_4(aq)$ used in titration with two decimal places. - about half of the candidates were able to calculate the mole ratio of $HONH_2(aq) : Fe^{3+}(aq)$. - a small number of the candidates were able to deduce the oxidation number of N in the oxide as +1. - about twenty percent of the candidates were able to suggest a reasonable empirical formula for the oxide as N_2O. The performance of candidates in part (c) was satisfactory. In part (c)(i), - about a quarter of the candidates were able to state an advantage of 'heating under reflux' in the context of the question as without the loss of volatile solvent. - about one third of the candidates were able to draw a labelled diagram for the set-up for simple distillation. Some candidates were not aware of the correct position of the thermometer and the use of a heat source. - a small number of the candidates were able to suggest column chromatography for separating **S** from the impurities. Some of the candidates wrongly suggested the use of liquid-liquid extraction or distillation as the separation method. In part (c)(ii), about two thirds of the candidates were able to deduce the possible structure of artemisinin. Some candidates did not relate the given information to confirm the presence of the carbonyl group and the absence of the carboxyl group.

School-based Assessment

All school candidates have to participate in School-based Assessment (SBA). There were 13053 students from 433 schools submitted their SBA marks this year. This is the sixth year of implementation of SBA for the Hong Kong Diploma of Secondary School Education (HKDSE). With the experience acquired over the past 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 every year. 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 59.4% of schools fall into the 'within the expected range' category, while the marks of 25.2% of schools are higher than expected, and 15.4% 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. Experiments from different topics like 'Chemistry reactions and energy', 'Rate of reaction', 'Chemical equilibrium' and 'Organic Synthesis' can be used as SBA tasks. Conducting these types of experiments can enrich students' practical experience as well as to strengthen students' practical skills.

2. Variety of Written Work
   Practical worksheets, experiment-related 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 important skills.

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 recording and analysing the data obtained from experiments
   It was observed that students frequently made mistakes in recording the experimental data, performing calculations, handling graphs 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. As in the previous years, it was observed that quite a number of students incorrectly recorded the burette readings in titrations using numbers with one decimal place. In addition, students showed little attention to the handling of graphs and drawing set-up diagrams, which are essential expected learning outcomes. Students are encouraged to pay more attentions 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

For the implementation of SBA in the HKDSE 2017, students' performance is generally satisfactory, and teachers have expressed a smooth running of the SBA in their lessons. With the experience acquired in the previous cohorts, most teachers have a clear understanding about the requirements and expected goals of SBA, and have no issues in selecting appropriate practical tasks and assessing the abilities of their students.