

## Combined Science (Chemistry part)

### Report on Student Performance in the Practice Papers

Most questions in the Combined Science (Chemistry part) paper, both Sections A and B, were extracted from the relevant sections of Chemistry Paper 1, with appropriate modifications. In view of the fact that the question types and the skills to be tested were largely the same in both the Chemistry papers and the Combined Science paper, no piloting of the Combined Science (Chemistry part) paper had been conducted. Nevertheless, the following observations and report on student performance in the Chemistry practice papers would be equally useful to students taking Combined Science (Chemistry). Readers are advised to study this report together with the selected samples of students' work from the piloting of the Chemistry practice papers so that they can gain a better understanding of the anticipated high, mid and low performance levels of students in the Combined Science (Chemistry part) practice paper.

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

Section A consisted of 24 questions. Students' performance in the following items helps illustrate some of their misconceptions:

- Q.5 is a straightforward question. However, only about half of the students chose the correct answer, which is option C. Some students failed to draw from their experience that freezing involves liberation of heat and melting involves absorption of heat, and hence they wrongly chose option A.

Q.5 Which of the following processes is endothermic ?

- |     |  |       |
|-----|--|-------|
| A.  | $\text{H}_2\text{O}(\ell) \rightarrow \text{H}_2\text{O}(\text{s})$  | (23%) |
| B.  | $\text{CuSO}_4(\text{s}) + 5\text{H}_2\text{O}(\ell) \rightarrow \text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{s})$    | (14%) |
| C.* | $2\text{H}_2\text{O}(\ell) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$                                   | (53%) |
| D.  | $\text{Ca}(\text{s}) + 2\text{H}_2\text{O}(\ell) \rightarrow \text{Ca}(\text{OH})_2(\text{aq}) + \text{H}_2(\text{g})$ | (10%) |

- Q.7 is a question set on the nature of science and is about the discovery of argon. Students' performance was unsatisfactory. Their failure in choosing the correct answer, which is option B, was probably because they were not familiar with the historical development of chemistry, or they had a poor understanding of the information given. Extensive reading can help students perform well in questions of this type.

Q.7 A scientist extracted a sample of 'nitrogen' from air by removing the oxygen and carbon dioxide. The scientist then compared the mass of a known volume of the 'nitrogen' sample ( $m_1$ ) with that of the same volume of pure nitrogen ( $m_2$ ) under the same set of conditions. The experiment was repeated a number of times. It was found that  $m_1$  was consistently greater than  $m_2$ .

Which of the following gases is likely to be present in the 'nitrogen' obtained to account for the result that  $m_1$  is greater than  $m_2$  ?

- |     |              |       |
|-----|--------------|-------|
| A.  | neon         | (12%) |
| B.* | argon        | (31%) |
| C.  | methane      | (13%) |
| D.  | water vapour | (44%) |

3. In general, students did not perform well in questions involving calculations. In Q.9, less than 40% of students were able to choose the right option for this question. These students probably had a weak understanding of the concept of molarity.

Q.9 When 25 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> NaOH(aq) is mixed with 25 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> HCl(aq), the temperature of the mixture rises by 6°C. Which of the following reactants, when mixed under the same conditions, would give a similar temperature rise ?

- A. 25 cm<sup>3</sup> of 2.00 mol dm<sup>-3</sup> NaOH(aq) and 25 cm<sup>3</sup> of 2.00 mol dm<sup>-3</sup> HCl(aq) (11%)  
 B.\* 50 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> NaOH(aq) and 50 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> HCl(aq) (37%)  
 C. 50 cm<sup>3</sup> of 0.50 mol dm<sup>-3</sup> NaOH(aq) and 50 cm<sup>3</sup> of 0.50 mol dm<sup>-3</sup> HCl(aq) (44%)  
 D. 100 cm<sup>3</sup> of 0.25 mol dm<sup>-3</sup> NaOH(aq) and 100 cm<sup>3</sup> of 0.25 mol dm<sup>-3</sup> HCl(aq) (8%)

4. Some students were weak in correlating chemistry to environmental issues. They did not know that cadmium and its compounds are toxic, and thus the disposal of nickel-cadmium batteries could pose harm to life.

Q.23 Which of the following statements about lithium-ion batteries is/are correct ?

- (1) In lithium-ion batteries, the electrolyte is a lithium salt in water.  
 (2) Lithium-ion batteries are rechargeable.  
 (3) The disposal of lithium-ion batteries causes less harm to the environment than that of nickel-cadmium batteries.

- A. (1) only (6%)  
 B. (2) only (34%)  
 C. (1) and (3) only (9%)  
 D.\* (2) and (3) only (51%)

### Section B (conventional questions)

Section B consists of eight compulsory questions. The performance of students in the relevant items in Chemistry Paper 1 Section B is shown in the table below:

Question Number	Performance in General
1	<p>Part (a) was generally well answered, indicating that students had a good understanding of the principles underlying the preparation.</p> <p>Performance was fair in part (b). Some students were not aware that undissolved solute could be seen when a hot saturated solution of the salt is allowed to cool.</p> <p>Parts (c), (d) and (e) were generally well answered. In (d), some students suggested heating the crystals in an oven so as to dry them. They did not realise that dehydration might occur.</p>
2	<p>Part (a) was well answered. The word 'unpalatable' was unfamiliar to some students. However, most of them could guess that the taste of the wine had turned bad and were able to produce reasonable explanations based on oxidation of the ingredients in wine by atmospheric oxygen.</p> <p>Part (b) (i) was well answered. Some students confused the words 'denser' and 'heavier'. They stated wrongly that 'argon is heavier than air' or 'helium is lighter than air' in parts (b) (ii) and (iii).</p> <p>Part (c) was poorly answered. Most students did not realise that pumping air out from the bottle could also remove the volatile organic substances which give the wine its pleasant odour.</p>

Question Number	Performance in General
3	Most students were able to draw the correct electron diagrams in parts (a) (i) and (b) (i), and to recognise that the reaction in (a) (ii) is not a redox.
4	<p>Performance was fair. In part (a), most students knew the procedures for preparing standard solutions in volumetric analysis, such as the use of a volumetric flask and the need to add deionised water to the volumetric flask up to the graduation mark. However, some students failed to mention that the beaker which was used to contain the carbonate solution needed to be washed a few times, and all of the washings had to be transferred to the volumetric flask before adding deionised water.</p> <p>Part (c) was well answered, except that some students wrongly included the unit 'g' in the formula mass of <math>M_2CO_3</math>, which should bear no units.</p>
5	In part (a), most students knew the correct method for working out the empirical formula of <b>X</b> . However, many did not use the general formula of alkanes, i.e. $C_nH_{2n+2}$ , to deduce the molecular formula of <b>X</b> . Part (b) was well answered. In part (c), most students recognised the advantage of using <b>X</b> as a fuel, while some did not know that burning kerosene produces a luminous flame.
6	Parts (a) and (b) were well answered. In (c), some students were not aware that the shape of propan-1-ol molecules allows them to have greater area of contact as compared with the case of propan-2-ol molecules, and hence the density of propan-1-ol is greater than that of propan-2-ol. Students' performance in part (d) was fair. The weaker students were unable to correlate the rate at which steel balls fall to the viscosity of the liquids.
7	<p>Part (a) was satisfactorily answered. Most students knew how to calculate <math>\Delta H</math> of the reaction. However, some students did not include a negative sign in their final answers for this exothermic reaction.</p> <p>Students' performance in part (b) (i), which is a question set to test the rationale behind the choice of materials for particular purposes, was good. In part (b) (ii), some students failed to mention that the reaction of <math>CaO(s)</math> with water is <i>highly</i> exothermic or <math>CaO(s)</math> is an <i>inexpensive</i> material.</p>
8	<p>Part (a) was set to test students' ability in writing balanced half-equations. Students' performance was unsatisfactory, especially in writing the half-equation for the oxidation of <math>CH_3OH(l)</math> to <math>CO_2(g)</math>.</p> <p>Students' performance in part (b) (i) was fair. Students should recognise that mobile ions have to be present in order for an electrochemical reaction to occur. In part (b) (ii), most students knew that concentrated methanol solutions are toxic and flammable. Students' performance in part (c), which is an open-ended question, was fair.</p>