CHEMISTRY

Paper 0620/11
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**C**	22	**C**
3	**C**	23	**C**
4	**B**	24	**C**
5	**C**	25	**C**
6	**B**	26	**D**
7	**A**	27	**C**
8	**C**	28	**D**
9	**B**	29	**D**
10	**C**	30	**A**
11	**A**	31	**B**
12	**D**	32	**B**
13	**D**	33	**D**
14	**C**	34	**C**
15	**A**	35	**D**
16	**D**	36	**B**
17	**D**	37	**D**
18	**C**	38	**C**
19	**B**	39	**B**
20	**D**	40	**A**

General comments

Question **9** proved to be the most straightforward for candidates.

Candidates found Questions **5**, **8**, **10**, **11**, **17**, **22**, **25**, **26**, **28** and **30** to be the most challenging.

<u>Comments on specific questions</u>

Question 3

Response **A**. Candidates linked to 50 cm^3 with a burette, but did not take due account of the word “quickly”.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 7

Response **D**. Candidtaes knew that bonds sometimes involve sharing electrons, but this question involved ionic bonding.

Question 8

Response **B**. This was more popular than the correct answer.

Question 11

Response **C**. Candidates were unfamiliar with energy level diagrams and did not fully understand the term “exothermic”.

Question 13

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 14

Response **B**. Candidates may have answered with respect to curve “S” itself.

Question 19

Response **A**. Candidates chosing response **A** may have done so based on the reason for step 3 without thinking sufficiently about step 4.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 22

Response **A**. Candidates perhaps did not appreciate that “explosively” is more reactive than “vigorously”.

Question 25

Candidates did not appear to know that copper does not react with acids.

Question 32

Response **C**. Candidates did not know the effects of oxides of nitrogen.

CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**A**	22	**A**
3	**C**	23	**D**
4	**A**	24	**B**
5	**C**	25	**B**
6	**B**	26	**C**
7	**A**	27	**A**
8	**C**	28	**A**
9	**B**	29	**D**
10	**B**	30	**A**
11	**C**	31	**B**
12	**D**	32	**B**
13	**D**	33	**C**
14	**B**	34	**D**
15	**B**	35	**D**
16	**B**	36	**C**
17	**D**	37	**D**
18	**D**	38	**C**
19	**D**	39	**B**
20	**C**	40	**D**

General comments

Question **6** proved to be the most straightforward for candidates.

Candidates found questions **6**, **20** and **26** to be the most challenging.

Comments on specific questions

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 8

Response **B**. This response was more popular than the correct answer.

Question 10

Response **D**. This was a common incorrect response.

Question 13

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 26

Response **A**. This response was more popular than the correct answer.

Question 27

Response **B**. Candidates may have recognised that calcium oxide is a basic oxide, but the question refers to it removing “acidic oxides”.

Question 28

Response **C**. Copper is a good conductor of electricity but this has no bearing on its use in cooking utensils.

Question 32

Response **A**. Candidates did not know the effects of oxides of nitrogen.

CHEMISTRY

Paper 0620/13
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**C**	22	**A**
3	**C**	23	**A**
4	**D**	24	**D**
5	**C**	25	**C**
6	**A**	26	**C**
7	**A**	27	**B**
8	**C**	28	**C**
9	**B**	29	**D**
10	**C**	30	**A**
11	**B**	31	**C**
12	**D**	32	**B**
13	**D**	33	**C**
14	**C**	34	**D**
15	**A**	35	**D**
16	**D**	36	**B**
17	**D**	37	**B**
18	**B**	38	**D**
19	**C**	39	**B**
20	**D**	40	**B**

General comments

Questions **14, 28** and **36** proved to be particularly straightforward for candidates.

Candidates found questions **5**, **7**, **17** and **38** to be the most challenging.

Comments on specific questions

Question 3

Response **A**. Candidates linked to 50 cm^3 with a burette, but did not take due account of the word “quickly”.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 6

Response **D**. This response was a common incorrect response.

Question 7

Respnses **B** and **C**. Both of these responses were more popular than the correct answer.

Question 8

Response **B**. This response was more popular than the correct answer.

Question 11

Response **C**. Candidates were unfamiliar with energy level diagrams and did not fully understand the term “exothermic”.

Question 13

Response **B**. This response was a popular incorrect response.

Question 16

Response **A**. Candidates may have assumed that the reactions were not reversible.

Question 17

Response **B**. Candidates knew the litmus test but not the reaction between alkalis and ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 25

Response **D**. Candidates placed too much emphasis on the high melting point and did not consider the other information given.

Question 30

Response **D**. Candidates did not know the percentages of gases in the air.

Question 31

Response **B**. Candidates chosing this response knew that carbon monoxide was produced but did not take the rest of the question into account.

Question 35

Response **A**. Candidates recognised the three unnamed fractions but did not read further to find the alternative that put them in the correct order.

Question 38

Response **B**. Candidates knew that fermentation was correct but may not have read the rest of the responses carefully.

CHEMISTRY

Paper 0620/21
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**A**
2	**C**	22	**C**
3	**D**	23	**C**
4	**B**	24	**C**
5	**C**	25	**B**
6	**C**	26	**C**
7	**A**	27	**D**
8	**D**	28	**D**
9	**C**	29	**D**
10	**A**	30	**A**
11	**D**	31	**A**
12	**C**	32	**B**
13	**C**	33	**D**
14	**D**	34	**D**
15	**A**	35	**D**
16	**B**	36	**B**
17	**C**	37	**A**
18	**D**	38	**D**
19	**D**	39	**B**
20	**A**	40	**C**

General comments

Candidates performed well on this paper.

Candidates found Questions **1**, **11**, **19**, **24**, **25**, **36** and **39** to be particularly straightforward.

Comments on specific questions

Question 4

Response **D**. Candidates did not recognise that isotopes have the same chemical properties.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 12

Some candidates were unfamiliar with the content of this question.

Question 13

Responses **B** and **D**. Some candidates appeared to guess the answer rather than working it out.

Question 14

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 15

Candidates did not appear to know that heat has two different effects on a reaction rate.

Question 16

Responses **A** and **C**. Some candidates appeared to guess, rather than working out the answer.

Question 18

Response **B**. Some candidates knew the reaction with litmus but were unsure of the reaction with ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 22

Response **A**. Candidates perhaps did not appreciate that "explosively" is more reactive than "vigorously".

Question 27

Response **C**. Candidates did not seem to pay attention to the reasons but only to the uses.

Question 31

Response **D**. Some candidates may have selected response **D** because it was a reaction which they were less familiar with.

Question 33

Response **B**. Candidates may have misread the question and thought it related to yield as well as rate.

Question 38

Response **A**. Candidates may have thought "purer" referred to it being a natural product, rather than to the percentage of alcohol present.

CHEMISTRY

Paper 0620/22
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**A**	22	**A**
3	**D**	23	**D**
4	**B**	24	**B**
5	**C**	25	**A**
6	**C**	26	**B**
7	**D**	27	**A**
8	**B**	28	**B**
9	**D**	29	**D**
10	**A**	30	**A**
11	**D**	31	**C**
12	**D**	32	**D**
13	**B**	33	**A**
14	**D**	34	**D**
15	**C**	35	**D**
16	**B**	36	**C**
17	**C**	37	**D**
18	**D**	38	**D**
19	**D**	39	**A**
20	**A**	40	**B**

General comments

Candidates performed well on this paper.

Candidates found Questions **7**, **11**, **19**, **24**, **26** and **36** to be particularly straightforward.

Comments on specific questions

Question 4

Response **D**. Candidates did not recognise that isotopes have the same chemical properties.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 9

Response **A**. Some candidates did not read the questions carefully and assumed the unit was dm^3.

Question 14

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 15

Response **A**. Many candidates did not read the question carefully and assumed that it was about the rate of reaction and not the energy of collision.

Question 18

Response **B**. Some candidates knew the reaction with litmus but were unsure of the reaction with ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 23

Responses **A** and **B**. Some candidates assumed Q was a transition element because of its coloured compounds but did not take account of its melting point.

Question 25

Response **C**. Candidates wrongly assumed that magnesium nitrate decomposed in the same way as alkali metal nitrates.

Question 37

Response **B**. A common mistake was identifying propyl ethanoate.

Question 39

Response **C**. Some candidates did not realise that the "CH_3" group should be a branch from the chain.

CHEMISTRY

Paper 0620/23
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**A**
2	**C**	22	**A**
3	**B**	23	**A**
4	**B**	24	**D**
5	**C**	25	**C**
6	**C**	26	**A**
7	**C**	27	**C**
8	**B**	28	**D**
9	**A**	29	**D**
10	**A**	30	**A**
11	**D**	31	**B**
12	**B**	32	**C**
13	**A**	33	**B**
14	**D**	34	**D**
15	**A**	35	**D**
16	**B**	36	**B**
17	**C**	37	**C**
18	**D**	38	**D**
19	**D**	39	**B**
20	**D**	40	**C**

General comments

Candidates performed well on this paper.

Candidates found Questions **1, 2, 10, 11, 15, 24, 27** and **36** to be particularly straightforward.

Questions **9, 13** and **18** proved to be particularly challenging for candidates.

Comments on specific questions

Question 3

Response **D**.

Question 4

Response **D**. Candidates did not recognise that isotopes have the same chemical properties.

Question 5

Response **B**. Candidates were not aware of the differences between ionic and covalent bonds.

Question 7

Response **B**. Candidates knew about the conductivity of graphite but not about lack of metallic bonding.

Question 12

Response **C**. Some candidates assumed that because copper is unreactive, it could not produce the highest voltage.

Question 13

Response **B**. Candidates divided the energy of the triple bond by three instead of carrying out the intended calculation.

Question 14

Response **B**. Candidates did not realise that the cotton wool would allow gas to escape and so it would not enter the syringe.

Question 16

Some candidates mistakenly thought that the question was asking about rate rather than yield of product.

Question 18

Response **B**. Some candidates knew the reaction with litmus but were unsure of the reaction with ammonium sulfate.

Question 21

Response **B**. Candidates knew metals appear on the left but not that they become more metallic at the bottom of a group.

Question 25

Response **D**. Candidates ignore the “burns in oxygen” statement.

Question 32

Some candidates assumed that the absence of the 'reversible arrow' symbol meant that the reaction was not reversible.

Question 38

Response **A**. Candidates may have thought “purer” referred to it being a natural product, rather than to the percentage of alcohol present.

CHEMISTRY

Paper 0620/31
Theory (Core)

Key messages

- Many candidates need more practice in questions involving qualitative analysis.
- It is important that candidates read the questions carefully in order to understand what exactly is being asked.
- Interpretation of data from tables was generally well done.

General comments

Many candidates tackled this paper well, showing a good knowledge of chemistry. Some candidates need more practice in reading and interpreting questions, for example the instructions were misinterpreted by many candidates in **Question 5(a)**.

Many candidates need more practice in answering extended questions such as **Questions 2(c)** and **Question 5(a)**. Other candidates need practice in answering questions relating to practical procedures involving rates of reaction and in drawing and labelling chemical apparatus. Knowledge of chemical tests involving colour changes, e.g. the aqueous bromine test for unsaturation and the test for water, was often poor.

Many candidates were able to undertake simple calculations, extract information from tables and graphs and balance symbol equations; others need to revise these areas more thoroughly.

Comments on specific questions

Question 1

(a) (i) The commonest error was to suggest that potassium chloride has diatomic molecules.

(ii) Many candidates correctly identified potassium chloride as having an ionic structure. The commonest errors were to suggest structure **A** or structure **E**.

(iii) Some candidates gave a suitable definition of an element. Other candidates used vague terms or confused atoms with molecules. A considerable minority of candidates disadvantaged themselves by referring to mixtures of atoms. A few candidates thought that potassium chloride is an element.

(iv) Common errors included $C_3H_3F_2Cl_2$ or writing a part structural formula e.g. $CH_2CHF_3Cl_2$.

(b) (i) Some candidates correctly referred to the numbers of neutrons. A large proportion of candidates suggested that there were different numbers of protons or electrons or referred to atomic masses.

(ii) Many candidates calculated the number of neutrons correctly. The commonest errors involved adding or multiplying the atomic numbers and atomic masses.

(iii) Most candidates realised that there are seven electrons in the outer shell of a chlorine atom. Many candidates drew the structure of a chlorine molecule instead of a chlorine atom. Some candidates made errors in the number of inner shell electrons; the commonest was to miss out the 8 electrons in the second shell.

Question 2

(a) Many candidates chose stainless steel for the bicycle frame and many gave three suitable reasons for its use. The commonest errors were related to imprecise terminology or quoting values from the table without adding comments such as "high strength" or "cheap".

(b) (i) A minority of candidates gave the correct answer. The commonest incorrect answers were hematite, aluminium oxide (which is not an ore) or aluminium ore.

(ii) Few candidates gave a suitable explanation. Common errors included "aluminium reacts with carbon", "aluminium conducts electricity" or an unqualified statement about the reactivity of aluminium.

(iii) Many candidates gave the correct electrode products. Some candidates gave the two correct products at the wrong electrodes. Other candidates gave only one product, usually at the cathode, or gave incorrect products such as hydrogen or nitrogen or chlorine, which are not present in aluminium oxide.

(c) Many candidates tackled this free response question well. The main errors were: lack of clarity about what states were being referred to when writing about changes of state; comments about atoms being some distance apart in the liquid state; or comments about atoms moving from place to place in the solid state. Better-performing candidates clearly stated the motion and distance apart of the particles in the gases, liquids and solids.

Question 3

(a) (i) Many candidates linked the trend in boiling points with the direction up or down the group. Other candidates just gave the unqualified answer "goes down", which was not sufficiently detailed. A considerable number of candidates linked the boiling point to the density or melting point and not to the position in the group.

(ii) The majority of the candidates predicted the density of caesium correctly.

(iii) Many candidates realised that caesium is a solid at 20 °C but few gave a suitable reason. Many candidates just referred to the value of the melting point without reference to 20 °C being below the melting point while others gave reasons which referred to the boiling point instead of the melting point. A considerable number of candidates thought that caesium is a liquid at 20 °C.

(b) A minority of candidates gave the correct products of the reaction. The commonest error was to suggest that rubidium oxide was formed. Water or carbon dioxide were often seen as an incorrect products instead of hydrogen. A considerable minority of candidates gave the names of compounds which did not include rubidium, hydrogen or oxygen.

(c) Many candidates calculated the relative molecular mass of indigotin correctly. Other candidates filled in just one of the lines correctly. Some candidates made errors in the addition.

(d) (i) Many candidates correctly suggested why the base line in chromatography is drawn in pencil. The commonest error was to suggest that the ink reacts.

(ii) A majority of the candidates identified mixture **K** as not moving. The commonest error was to suggest mixture **J**.

(iii) A majority of the candidates identified mixture **J** as containing both dyes **X** and **Y**. The commonest error was to suggest mixture **K**.

(iv) Nearly all candidates recognised that mixture **J** did not contain dye **Z**. The commonest error was to suggest mixture **K**.

Question 4

(a) (i) Many candidates identified the alcohols; others gave reasons about the alcohol structure which were far too vague, e.g. "they contain hydrogen and oxygen".

(ii) Some candidates gave the correct answer **Q** and **T**; others either wrote only one of these letters or repeated **S** and **U** from **part (i)**.

(b) The commonest errors were to put the word "elements" in the first blank space and / or to put the word "compounds" in the last blank space.

(c) (i) Few candidates drew the structure of ethene correctly. Common errors were: to draw the structure of ethane; to draw carbon atoms with five bonds; or to include –OH groups. A number of candidates drew the correct structure of pentene instead of ethene.

(ii) Few candidates knew the aqueous bromine test. Common errors were: ethene turns colourless; no reaction; stating why the change occurred rather than giving a description of the colour change; or suggesting that the colour change was to "clear" or "to a different colour". A significant number of candidates did not respond to this question.

(iii) Many candidates realised that heat is needed for cracking. Fewer mentioned the need for a catalyst.

(iv) Many candidates were able to balance the equation correctly. The commonest errors involved simple errors of subtraction, e.g. $C_{13}H_{26}$ or $C_{12}H_{28}$. Other candidates incorrectly added $C_{16}H_{34}$ to C_3H_6.

Question 5

(a) The stem of the question was ignored by many candidates who did not appear to take notice of the essential words "trends" and "physical properties". Common errors included: lack of identification of trends; stating properties of individual halogens; and misunderstanding displacement reactions. Few candidates were able to write a relevant word equation for the displacement of a less reactive halogen from a halide salt by a more reactive one. Very often, incorrect products such as chlorine iodide were seen. Many candidates wrote products identical to the reactants.

(b) (i) Some candidates identified nitrogen dioxide as the problem; others just stated that a gas was given off. The effect of nitrogen dioxide on health was not well known. Many candidates just wrote "harmful" or "poisonous", rather than suggesting an effect on respiration, the throat or the eyes.

(ii) This part was well answered by the majority of candidates**.** The commonest error was to suggest pH 13.

(iii) Some candidates gave zinc nitrate and water as the correct answer. Other candidates suggested zinc or zinc oxide in place of zinc nitrate, or hydrogen or oxygen instead of water. A minority of candidates suggested substances containing elements that were not present in the reactants, e.g. lead.

Question 6

(a) Most candidates were able to describe the role of a catalyst.

(b) A majority of candidates were able to write the sign for a reversible reaction. Common errors were to write just a backward arrow or a forward arrow.

(c) The reaction was incorrectly labelled to be endothermic by the majority of the candidates, even though they went on to state that the energy level of the products was less than that of the reactants.

(d) (i) Many candidates correctly described the change in the percentage yield. The commonest errors were either to state that increasing temperature increases rate, or to omit reference to temperature altogether.

(ii) Most candidates gave the correct percentage. The commonest error was misreading from the graph to give 41%.

(e) The test for ammonia was not well known. A minority of candidates mentioned red litmus paper. Many candidates suggested other test reagents including copper(II) sulfate, aqueous bromine or silver nitrate. Some candidates suggested smelling the gas, which is not a good idea for safety reasons.

(f) Some candidates described the dipping the indicator paper or referenced a correct colour change. Few candidates mentioned comparison with a colour chart or pH chart.

(g) The equation was well balanced by some candidates. The stoichiometry of the ammonia was often correct but the stoichiometry of HCl was often incorrect. Common errors were $2HCl$ or $3HCl$.

Question 7

(a) Common errors in drawing the diagram included unidentifiable apparatus; a tube immersed in the reactants; and inappropriate apparatus. Many candidates did not label their apparatus. It was often difficult to distinguish a gas syringe from a measuring cylinder. When drawing pieces of glassware for measuring, the graduation marks should also be drawn. A significant number of candidates did not respond to this part.

(b) (i) This question was fairly well answered. Common errors were medium or large pieces or that less carbon dioxide was produced by small pieces. A considerable number of candidates wrote about particle theory, rather than referring to the graph.

(ii) Some candidates drew neat lines which met the line already present some time before 200 seconds. Other candidates finished their line too far above the 45 cm^3 level or made their line plateau after or at 200 seconds.

(iii) Many candidates did not look closely enough at the curve to see where it first hit the 45 cm^3 line. Consequently, many suggested the incorrect answer of 200 seconds.

(c) (i) Few candidates gave a correct use for calcium oxide. The commonest incorrect answers involved foods or drinks, making limestone or the vague “for construction”. Making iron was not accepted because it is calcium carbonate rather than calcium oxide that is put into the blast furnace. Steelmaking was, however, acceptable. A significant number of candidates did not respond to this question.

(ii) Some candidates realised that calcium oxide is a basic oxide. Others either wrote that it is “a metal oxide” (which is only sufficient for the second marking point) or did not respond to the second part of the question. Many candidates suggested that calcium oxide is an acidic oxide. A significant number of candidates did not respond to this question.

Question 8

(a) Many candidates wrote vague answers about reduction and often did not relate their answers to the equation given. A common error was to suggest that copper is reduced instead of copper(II) oxide. Very often, the copper being referred to was that on the right-hand side of the equation. Reduction of hydrogen was also commonly seen.

(b) (i) Many candidates gave the correct answer. The commonest error was to suggest either that the mass increases or to give an answer that did not refer to mass at all.

(ii) Very few candidates referred to the flammability of the hydrogen. Most candidates referred to the Bunsen burner or the gas coming from this.

(iii) The test for water was not well known. The commonest errors were blue copper(II) sulfate goes pink; blue copper(II) sulfate goes white; using the wrong test reagent; or not mentioning that the copper(II) sulfate or cobalt(II) chloride used in the test was anhydrous. A significant number of candidates did not respond to this part.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Questions requiring simple answers about atomic theory and organic structures were usually answered well, as were questions involving balancing equations and reaction rates.
- Questions requiring more detailed answers about kinetic particle theory needed to contain more focused explanations and attention to detail.
- Some candidates need more practice in answering questions requiring extended answers. Questions involving extended writing need to contain the same number of relevant points as the number of marks available. This principle also applies to any question that has more than one mark available.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked. Practice of reading off graphical scales is also a skill which candidates need to be confident with.
- Questions relating to practical techniques such as chromatography need to be concentrated on and practised. In comparison questions, candidates need to mention both sources in the comparison.

General comments

Many candidates tackled this paper well, showing a good knowledge of chemistry. It was evident that some candidates are now using past paper practice as part of their revision programme; although more revision is needed on some aspects of the syllabus. Candidates had clearly practised balancing and completing equations as part of their revision. Some candidates wrote their answers as short phrases or bullet points; candidates were less likely to write vague statements or to contradict themselves if this was done.

Candidates tended to perform less well on the one-mark recall questions. The answers to questions on uses of different substances in **Questions 3(e)** and **7(c)** and knowledge of chemical tests in **Questions 2(c) and 3(d)** indicated a lack of revision by some candidates. Candidates found **Questions 6(b)**, **7(d)** and **8(d)** to be the most challenging on the paper. Many did not read the questions properly and the vast majority of candidates did not know how to do a flame test.

Comments on specific questions

Question 1

(a) (i) This question was attempted reasonably well; some candidates were not looking out for the charges and combination of metal and non-metal elements.

(ii) Some candidates could recognise the element but explanations were generally very poor. Many candidates used the word "element" in their explanation, for example, "contains one type of element", instead of "contains one type of atom".

(iii) Candidates did not take note of the word "simplest" in the question. Ionic charges were sometimes incorrectly included in candidates' responses.

(b) (i) Some candidates incorrectly answered 15.

(ii) This question was mostly well answered; some candidates need more practice with electronic configurations.

(iii) Candidates struggled with this part and many different answers were seen.

(c) Many candidates did realise that it was an acidic oxide; some did not realise this when talking about type of oxide and merely stated "covalent". Better-performing candidates made it clear which element they were referring to in their answer. For example, "phosphorus is a non-metal" was correct, whereas "it is a non-metal" was not specific enough.

Question 2

(a) Many candidates did not read the question carefully, and did not put the *metals* into the order of reactivity but ordered the metal oxides instead. Some candidates inverted the order. Candidates should be encouraged to read the question carefully before answering.

(b) This electrolysis question was done reasonably well and it was obvious that many candidates had been practising this style of question. Some candidates wrote the ions and not the final products and some candidates got the products the wrong way round.

(c) The chemical tests were not well known. The most common error was not writing down the word "precipitate" and just writing "green".

(d) (i) This part was answered very well by most candidates.

(ii) Most candidates could describe one method of rust prevention but were not able to explain how it works.

Question 3

(a) Most candidates answered this question correctly.

(b) Candidates found this question to be quite challenging and "endothermic" was seen frequently as an answer, showing a misunderstanding of the energy level diagram. Candidates that managed to get the correct "exothermic" response usually then managed to give the correct reason as well.

(c) (i) This part was answered reasonably well and the correct answer was seen in many cases. Some candidates just wrote "decreases" which was insufficient.

(ii) The majority of candidates answered this question well.

(d) This question was very poorly answered and was omitted by many candidates.

(e) Candidates were not confident with this question. "Fertiliser" was a common wrong answer.

(f) Candidates who correctly named sulfur dioxide invariably got the correct explanation for this question. Many candidates answered that the sulfur was reduced instead of the sulfur dioxide.

(g) This part was very well done.

Question 4

(a) The definition for homologous series was poorly answered. Many candidates were confused with the definition of isomers.

(b) (i) Candidates struggled with the concept of saturated hydrocarbons. Some candidates answered "has single bonds" instead of "*only* has single bonds".

(ii) This question was well answered.

(iii) This question was very well answered.

(iv) This was question very well answered.

(c) (i) A very high percentage of candidates answered this question correctly.

(ii) Candidates found this question very challenging with many not answering it at all. Many candidates did not realise that the data needed to be used to answer the question. Candidates need to practice using data provided in the question in their answers for this type of question.

(iii) This was a well-answered question.

(d) (i) This question was well answered by candidates.

(ii) Some candidates were confused and answered in terms of other hazardous chemicals and not carbon monoxide.

Question 5

(a) Candidates struggled with this question. Some candidates could identify that the state was "liquid" but many could not explain why. Some candidates referred to bout room temperature instead of +6 °C.

(b) (i) Candidates answered this question well.

(ii) More practice is needed on the difference between the halogens and their halides.

(c) This question was done well by most candidates. The main error was using atomic numbers instead of mass numbers.

(d) (i) Generally, this question was answered well. The main error in this question was putting the cross in the solvent or on the edge of the paper.

(ii) This part was answered well; some candidates misread the question and answered "dye".

(iii) Candidates struggled with this part.

Question 6

(a) Some candidates could say that sodium had metallic properties like solid, shiny and heat conductor. Many candidates then struggled to add chemical properties to this. Candidates mainly described the reaction with water and this was generally answered well.

Word equations were sometimes missing. Often chemical equations were used and these were not always written correctly. Some candidates thought that sodium oxide is a product when sodium reacts with water.

(b) Many candidates could not describe how a flame test is carried out and most thought that the flame test should be done on sodium itself and not on a sodium compound. The colour of the flame was generally correctly identified.

(c) (i) Candidates did very well on this question.

(ii) This question was well answered. Candidates had a good knowledge of the colour changes involved.

(d) Candidates could identify why this reaction is carried out in a fume cupboard. Many candidates did not know what adverse effect on health could be caused.

Question 7

(a) Candidates did very well labelling the apparatus shown.

(b) (i) Most candidates could identify the correct concentration but did not correctly explain themselves. Some candidates did very well here and referred to the volumes of gases given off in the first 60 seconds to compare both concentrations.

(ii) This part was answered very well and most candidates were able to draw the curve on the graph well. Most candidates realised that the same volume of gas would be produced at the end of the experiment, which showed even more understanding.

(c) This question was answered poorly. The most popular answer was “as a fuel”. The most popular wrong answer was “to make water”.

(d) Many candidates did not answer this question.

Question 8

(a) Some candidates did not mention that an alloy is a mixture.

(b) Some candidates just wrote down the name of a metal, for example aluminium.

(c) Candidates struggled with this longer question about the kinetic particle model. Candidates were not detailed enough in their answers. They preferred to talk about the particles “moving fast” and “moving far apart”, rather than the “particles sliding over each other” or that the “particles are close together” in a liquid. Candidates also spent too much time describing the function of the iron plate.

(d) Only a few candidates answered this question correctly. Many candidates did not answer this question at all, and those that did talked mainly about the particles in a gas and not in terms of a general property.

CHEMISTRY

Paper 0620/33
Theory (Core)

Key messages

- Many candidates need more practice in answering free response questions.
- Some candidates need further practice in drawing diagrams of apparatus.
- Interpretation of data from tables and graphs was generally well done.

General comments

Some candidates tackled this paper well, showing a good knowledge of chemistry. Some candidates need more practice in reading and interpreting questions, for example the instructions were misinterpreted by a minority of candidates in a few questions, such as **Question 5(b)**. The command word "deduce" did not appear to be known by many candidates (see Section 8.3 of the syllabus).

Many candidates need more practice in answering extended questions, such as **Question 4(b)** and **Question 5(a).** More practice is needed in reading the key points in the question, as well as in selecting relevant information and organising ideas in a logical fashion. Other candidates need practice in answering questions relating to practical procedures, such as chromatography and electrolysis, especially where the drawing of apparatus is required.

Many candidates were able to extract information from tables and graphs and balance symbol equations. Other candidates need more practice in writing word equations for the reactions of halogen with halides. Many candidates were able to undertake simple calculations of relative formula mass; others need to revise this area.

Comments on specific questions

Question 1

(a) (i) Most candidates identified diamond and graphite. The commonest error was to suggest the ionic giant structure, **A**.

(ii) Some candidates correctly identified structure **B** (ethene). The commonest error was to suggest structure **D**, through thinking about a displacement reaction rather than an addition reaction.

(iii) A minority of the candidates suggested that ethene is a gas at room temperature. A wide variety of incorrect answers were seen, including the structures **A**, **C** and **E**.

(iv) Many candidates identified structure **B** as a hydrocarbon. The commonest error was to suggest structure **D**. A considerable number of candidates suggested diamond or graphite.

(v) Many candidates wrote the formula for **D** correctly. The commonest errors were to miscount the chlorine or hydrogen atoms, leading to incorrect formulae such as C_5H_5Cl or $C_5H_{10}Cl_5$.

(b) (i) Some candidates gave good answers detailing the differences in the structure of the isotopes in terms of different numbers of neutrons or different mass numbers. Others confused neutrons with protons, or suggested that the atomic number was different. Some candidates stated that the relative atomic mass was different. Whilst this is true, it does not reflect the difference in atomic structure in terms of subatomic particles.

(ii) Many candidates deduced the correct number of neutrons. The commonest errors were to give the atomic number or to add together the atomic number and mass number.

Question 2

(a) Most candidates were able to extract relevant information from the table. The commonest errors were to mention density or electrical conductivity.

(b) Some candidates recognised that a solid can be separated from a liquid by filtration. A wide variety of incorrect answers were seen, the commonest being distillation, evaporation, or a membrane method such as osmosis.

(c) (i) Few candidates gave a suitable definition of electrolysis. The commonest error was to suggest the separation of substances by electricity. Many candidates gave very vague statements about electricity or purifying substances. The idea of decomposition or breaking down was rarely encountered. Many candidates did not consider that ions were involved and wrote about molecules.

(ii) Some candidates drew good diagrams showing the external circuit connected to the electrodes. Other candidates did not show the electrodes dipping into a liquid and / or did not label their diagrams. Other common errors were to place + and – signs too far from the electrodes; to show only the electrodes; to omit the power source; and to draw unworkable circuits, including short circuits.

(d) Many candidates did not understand the term recycling. Most candidates referred to reuse rather than recycling. Very few candidates referred to saving resources or reducing the need for mining. The commonest error was to write about reducing cost without qualification.

Question 3

(a) (i) Some candidates suggested a correct colour for astatine. Other candidates gave incorrect colours such as orange, brown or blue.

(ii) Some candidates described the trend in boiling points. Other candidates either did not relate the increase in boiling point to the position of the halogen in the group or tried to link it to the colour or the melting point.

(iii) A minority of the candidates realised that chlorine is a liquid at –50 °C. Most suggested that it is a gas. Many of the candidates who identified the correct state did not go on to reference both melting and boiling point in their explanations. Statements such as "–50 °C is above the melting point" were not sufficient, neither was just quoting melting and boiling points.

(b) (i) Some candidates identified the correct products. Other candidates just repeated the reactants on the right-hand side or gave interhalogen compounds, such as bromine astatide, or the answer potassium.

(ii) Very few candidates realised that the comparison was between the more reactive halogen (chlorine) and the less reactive halogen (bromine). Common errors included reference to: potassium being more reactive; bromine being more reactive; solubility differences; and the halides becoming more reactive down the group.

(c) Many candidates were able to calculate the relative molecular mass of methyl orange correctly. Common errors included: using atomic numbers instead of atomic masses; multiplying the oxygen and chlorine terms together; and omitting one or more of the figures in the last column of the table when doing the final addition.

(d) Few candidates recognised the colour change of methyl orange when placed in acid or in alkali. Many of the colours referred to were those of acids and alkalis in litmus or Universal Indicator. A considerable minority of candidates did not realise that methyl orange is an indicator and gave answers referring to boiling, evaporation or filtration. A significant proportion of candidates did not respond to this question.

(e) Some candidates drew good diagrams of the apparatus used for chromatography but many did not label their diagrams. Common errors were: the chromatography paper not dipping into either the solvent or the beaker; lack of beaker or other receptacle for carrying out the chromatography; incorrectly labelling the solvent as dye; or immersing the chromatography paper entirely in the solvent.

Question 4

(a) Some candidates gave a good definition of a hydrocarbon. Other candidates made simple errors such as omitting the essential word “only” or stated that the hydrocarbons were elements. A few candidates just referred to bonding between carbon atoms. A small number of candidates thought that oxygen was present in hydrocarbons.

(b) Few candidates answered this question completely correctly. Many candidates did not write essential details relating to boiling points, molecular size or masses and condensation of the fractions. Common errors included: the idea that the temperature in the column is higher at the top; missing out ideas about change of state; and trying to name fractions (often incorrectly).

(c) (i) Most candidates were able to state how the number of carbon atoms affects the boiling range either by reference to the average temperature of the boiling range or the differences in the values within each range. The commonest error was to omit the reference to the number of carbon atoms.

(ii) Most candidates were successful in determining the percentage by mass of fraction **F**.

(iii) A majority of the candidates realised that fraction **A** was mainly gaseous. The commonest error was to suggest either fraction **F** or fraction **B**.

(iv) Common incorrect answers often involved health or “facial scrub”. A considerable number of candidates suggested that it is a fuel. Although a fuel can be made from bitumen, it is not correct to suggest that bitumen itself is a fuel. A significant proportion of candidates did not respond to this question.

(d) (i) The commonest correct answers related to high temperature or heating. A large number of candidates disadvantaged themselves by simply writing temperature, without reference to “high”. Few candidates mentioned the use of a catalyst. A considerable minority of candidates suggested that water or oxygen should be added.

(ii) Many candidates were able to balance the equation for cracking successfully. The commonest errors were due to: mistakes in subtraction; addition of $C_{12}H_{26}$ to C_7H_{16}; or writing the formula for a simpler hydrocarbon, e.g. C_2H_4 or an element such as H or C.

Question 5

(a) Many candidates gave some general metallic properties of iron; electrical conductivity and high melting point being the commonest correct answers. Few candidates mentioned ductility or malleability or any chemical properties. Many candidates gave vague or irrelevant answers, e.g. “its relative atomic mass is 56” or “iron has a boiling point”. Common errors included “iron is brightly coloured” and “iron is grey in colour”. Many candidates did not write down five creditworthy points and many omitted to write about the chemical reactions of iron.

(b) (i) Few candidates focused on the information in the stem of the question that iron carbonyl is a covalent liquid. Many continued with the theme of iron, thinking that iron carbonyl must be like iron because it contains iron. Consequently, most candidates wrote incorrect answers such as “hard” or “high melting point”.

(ii) Many candidates realised than carbon monoxide is poisonous. Incorrect answers often related to carbon monoxide being “hazardous” or “corrosive”. A considerable minority of candidates focused on the iron compound instead of the carbon monoxide.

Question 6

(a) Most candidates recognised the symbol for a reversible reaction. Common errors included "a reaction which goes backwards" and ideas about amounts of products being formed without reference to reactants.

(b) Few candidates were able to state two conditions required for the hydration of ethene. Common errors included "low temperature" and "addition of hydrogen". Few candidates mentioned a catalyst.

(c) The majority of candidates suggested that the reaction is endothermic but then gave a reason which suggested that energy is released. Better-performing candidates gave answers that referenced the energy levels in the diagram.

(d) (i) Most candidates correctly described how the percentage yield of ethanol changed with temperature. The commonest error was not to mention the temperature at all.

(ii) This part was well answered with most candidates deducing the correct percentage yield.

(e) (i) The structure of ethanol was not well known. Common errors included drawing the structure of methanol; drawing the structure of a hydrocarbon; drawing a hydrogen atom with two bonds e.g. C–H–O or C=H; or including a C=O bond.

(ii) Some candidates gave a suitable use of ethanol. Other candidates referred vaguely to "used in chemistry labs" or "used for making chemicals". Few candidates mentioned its use as a solvent. Some candidates suggested that ethanol is used as a fuel, which was acceptable, but others suggested that it was the same as a particular fuel, e.g. "it's gasoline", which was not accepted.

(iii) Many candidates were able to balance the equation correctly. The commonest error was to try to balance with $2H_2O$ instead of $3H_2O$.

Question 7

(a) Most candidates gave a satisfactory description of how the reaction could be started. The commonest errors were either to suggest that the gas syringe had to be pushed in or that the zinc had to be heated.

(b) (i) A minority of candidates could explain why the volume of gas stays constant. Most incorrect answers referred either to the experimenter stopping the reaction or to some other external force, e.g. "the temperature had gone down".

(ii) Most candidates correctly deduced the time taken to produce 20 cm^3 of gas.

(iii) Some candidates realised that only the temperature changed. The commonest error was to draw the finishing line well above the line already present. A considerable minority of candidates either drew a line with a shallower gradient or drew a line with a steeper gradient but with an unacceptably large hump in it, which then came down to join the horizontal line.

(c) Some candidates realised that powdered zinc would produce a faster rate of reaction than pieces of zinc. Other candidates thought, incorrectly, that the pieces of zinc had a larger surface area than the zinc powder.

(d) (i) The definition of the word compound was not well known. Many candidates mentioned mixtures while others mentioned elements. Few candidates wrote about different atoms bonding or joining.

(ii) Few candidates gave a suitable source of elemental sulfur. The commonest incorrect source was "sulfuric acid". Many candidates thought that sulfur was extracted from foods or from bacteria. A significant proportion of candidates did not respond to this question.

(iii) Few candidates gave a suitable use of sulfur dioxide. A wide range of incorrect uses was seen ranging from "in the blast furnace" to the vague "in chemical reactions". Many candidates suggested that sulfur dioxide is used to make sulfuric acid. This was not accepted since the raw material is sulfur rather than sulfur dioxide. A significant proportion of candidates did not respond to this question.

Question 8

(a) Some candidates were able to interpret the graph in terms of changes in pressure and volume. Other candidates wrote inexact answers such as "the volume goes down with pressure" (instead of the volume goes down as pressure increases). Some candidates tried to introduce kinetic particle theory into their answers unnecessarily.

(b) Some candidates wrote a simple answer, referring to the increase in distance. Other candidates tried to over-complicate their answers by introducing volumes and kinetic particle theory.

(c) (i) The simple answer that oxygen is removed from the carbon dioxide was rarely seen. Many candidates wrote vaguely about carbon being on the right-hand side and magnesium getting the oxygen, without reference to the carbon.

(ii) Candidates who realised that a metal oxide does not contain carbon gave the correct answer.

(iii) Few candidates wrote about problems, such as ice-caps melting, desertification or an increase in extreme weather patterns. The most common correct suggestion was (an increase in) global warming.

CHEMISTRY

Paper 0620/41
Theory (Extended)

Key messages

Candidates need to be reminded to use the correct terms. For example, there was frequent incorrect use of the word “element” instead of “atom”.

Candidates should try to cover the entire syllabus as part of their revision. It was noticeable that many of the organic parts of **Question 6** were omitted.

Candidates need to be reminded that if **one** use of a substance is asked for, then no more than **one** use should appear in the answer, as any incorrect uses given could contradict correct uses.

Candidates need to be reminded that a word equation, unless specifically asked for, is not acceptable if a chemical equation is asked for.

Some good examination technique was seen, for example the underlining of command words in the questions, but some responses were a rewriting of the question. Candidates should look to make answers concise and keep to the space available. Simple use of bullet points, rather than long rambling paragraphs, may help candidates hit the key points of an answer.

General comments

Candidates seemed well prepared. There was no evidence that there was insufficient time to complete the paper and there was little evidence of problems encountered in understanding wording of the questions.

Comments on specific questions

Question 1

(a) Most candidates were able to show that they had a good understanding of the structure of the atom. Many candidates did not realise that it was the relative charge that was asked for; “+1”, rather than “+”, for the relative charge of a proton was expected.

(b) (i) Most candidates realised that the number of neutrons is different from the number of protons but many candidates did not connect this difference specifically to atoms. Frequently, responses such as “elements with same number of protons but different numbers of neutrons” were seen.

(ii) Most candidates were aware that isotopes have the same numbers of electrons but only the better-performing candidates knew that the similarity of chemical properties was due to isotopes having the same number of outer electrons.

(c) Better-performing candidates realised that the particle in line three was an ion of an isotope of potassium and were able to use the correct mass number and atomic number.

Question 2

(a) This structured calculation was successfully completed by many candidates. It was clear that some candidates had not met the concept of the mole and struggled to complete the first answer. The third part showed that the conversion of a molar quantity to a gaseous was an unfamiliar concept to many candidates.

(b) (i) The syllabus definition of a base being a proton acceptor was well known. Superfluous comments about solubility and pH were often seen.

(ii) The formula of magnesium hydroxide proved challenging for many candidates, but those who were able to determine this generally were able to complete the rest of the equation successfully.

(c) In many cases, candidates did not address the question and did not describe the experiments needed, along with the key observation that insoluble aluminium oxide would dissolve in their chosen acid and base. Some candidates stated that aluminium oxide should be reacted with both an acid and a base.

(d) (i)(ii) Most candidates knew that the bonding within the giant structure was covalent; some candidates were unable to recall the typical properties of giant covalent structures.

(e) (i) The simple statement that ionic bonding is an attraction between oppositely charged ions was missed by many candidates who chose instead to describe how the ions were formed.

(ii) Having been given the formula of the phosphate ion, better-performing candidates were able to deduce the correct formula of calcium phosphate. Candidates who performed less well struggled to produce reasoned formulae. A common error was to give the formula of calcium phosphide, despite the phosphate ion being given as PO_4^{3-} in the question.

(f) (i) Many candidates were not aware of the conventions of energy level diagrams. It is expected that the products should be identified by a clear horizontal line with the formula above the line. The enthalpy change should be represented by a single headed vertical arrow (in this case pointing downwards) starting exactly from the energy of reactants and ending exactly at the energy of the reactants.

(ii) Better-performing candidates were able to rationalise that the total energy of bond breaking minus the total energy of bond making was equal to 780 kJ being lost. Thus, the energy taken in for bond breaking was 2 × 160 kJ (320 kJ) and this meant that the energy lost in bond making must have been 1100 kJ. The final step was to realise that 4 S–F bonds were made, so that the individual S–F bond energy was 1100/4 = 275 kJ.

(g) (i) The reason for chlorinating water was well known by nearly all candidates.

(ii) Many candidates answered this question successfully. Some candidates were unsure and responses suggesting copper(II) chloride was the compound followed by a colour change of white to blue were seen, suggesting confusion with the anhydrous copper(II) sulfate test.

(h) (i) The idea of a complete outer shell of electrons being responsible for argon's lack of reactivity was well known.

(ii) One use of argon was known by most candidates. Incorrect responses included “in neon lights” or “as lamp filaments” rather than “in filament lamps”.

Question 3

(a) Most candidates were able to suggest that one of the reactants should be added last if the reaction were not to start before the timing began.

(b) (i) It was not universally appreciated that in order for the concentration to double, the volume of thiosulfate needed to be doubled yet the total volume be kept constant by reducing the volume of water added. Likewise, if the reaction rate were to double (due to a doubling of concentration) then the time taken for the experiment must be halved.

(ii) Most explanations for the reason for the increase in rate of reaction due to increased concentration did not give the two key points required. Incorrect and imprecise responses included phrases such as "there are more collisions" (there are not, as the number of collisions is the same; it is simply that they are able to occur in a shorter time); "There are more collisions per second" would have been acceptable. Another imprecise term was "the particles collide more", rather than "the particles collide more frequently".

(c) Most explanations for the reason of the increase in rate of reaction due to increased temperature did not give the key points required. Comments about a higher proportion of collisions have energy above the activation energy at higher temperature were almost universally omitted. Imprecision in many responses was seen, with phrases such as "particles collide faster" or "collisions have more energy".

Question 4

(a) (i) Most candidates knew the change was reduction but erroneously attributed the electron gain to the Cu (atoms) rather than Cu^{2+} (ions).

(ii) Many candidates were able to describe the release of Cu^{2+} ions from the anode and many went close to the second mark by describing the removal of Cu^{2+} ions onto the cathode. Many candidates did not state that the rates of these processes were equal.

(b) Almost all candidates were able to suggest that the copper anode should be replaced by one of nickel. Although many candidates went on to suggest using a nickel salt such as nickel(II) nitrate or sulfate, a significant proportion of candidates were unable to appreciate this change was also needed.

(c) Candidates are advised to read questions carefully. The question asked for three *different* properties of transition metals which set them apart from other metals. Thus, repeating the properties already given in the question received no credit and the frequently seen "good electrical conductivity" was an incorrect response.

Question 5

(a) Most candidates did not realise that the much of the sulfur used in the Contact process is the unwanted sulfur extracted from fossil fuels before they are combusted.

(b) The details of the Contact process were not universally known. Some very strong responses were seen but these were in a minority. Most candidates were able to state the temperature used. As vanadium has many oxides, it was the specific vanadium(V) oxide which was required as the catalyst. Equations, when seen, were generally well done but the reversible nature of the reaction was frequently omitted.

(c) Most candidates either knew, or were able to deduce, the formula of oleum.

(d) (i) Most candidates mentioned effervescence but did not go on to describe two other observations. Several candidates contradicted themselves by describing the carbonate dissolving and forming a precipitate.

(ii) Most candidates knew the three products of this reaction.

(e) (i) This new part of the 2016–2018 syllabus was known by relatively few candidates.

(ii) Consequently, hardly any candidates provided the expected response of "dehydration" and a variety of different reaction types were seen.

Question 6

(a) Most candidates knew the names of the two processes needed to obtain alkenes from crude oil. Candidates who performed less well described the processes rather than naming them.

(b) (i) The occasional incorrect answer "additional" was seen.

(ii) Very few candidates realised that the empirical formula of an addition polymer is the same as that of the monomer.

(iii) Only a minority of candidates were able to draw two repeat units of the polymer correctly. Frequent errors were to leave double bonds in the carbon chain or to join up six carbons in one single row, rather than four carbons with two $-CH_3$ side chains.

(c) The structure of the two alcohol isomers of C_3H_8O were drawn successfully by most candidates.

(d) (i) The identity of the catalyst needed to convert an alcohol and a carboxylic acid into an ester was rarely known.

(ii) Many of the candidates were successful in the naming of methyl ethanoate.

(iii) The drawing of the structure was done well.

(iv) The incorrect response of "nylon" was seen almost as frequently as the correct one of "*Terylene*".

CHEMISTRY

Paper 0620/42

Theory (Extended)

Key messages

Candidates should recognise importance of learning definitions precisely.

Candidates should ensure that they know the differences between giant ionic structures held together by ionic bonds and giant metallic structures held together by metallic bonds.

Candidates should learn the formulae (including charges) of common ions referred to in the syllabus, as well as the relationship between the ionic charge and group number in the Periodic Table.

Candidates should be aware that rust is impure hydrated iron(III)oxide. It follows from this that **iron** is the only metallic element that can (form) rust.

If an equation is required as part of an extended answer, as in **Question 6(b)(i)** and **Question 6(c)**, the equation should be written on one line. All chemical equations should be balanced.

Candidates should know how to carry out tests to identify oxidising agents and reducing agents, as well as the results of these tests.

Comments on specific questions

Question 1

(a) All parts to this were answered extremely well by the vast majority of candidates. The exception was part **(viii)** where beryllium was seen regularly and boron occasionally. Some candidates may have been of the opinion that each element had to be used once and once only, but this was not the case.

(b) (i) This was answered well by a large number of candidates. The symbol for boron was sometimes written as Ba, Be or Br.

(ii) This was usually answered well, although a wide variety of incorrect answers was seen.

Question 2

(a) (i) The word *number* was an essential part of the answer to this question. Although the position of an element in the Periodic Table is based on its atomic number, the definition of atomic number is the number of protons *in one atom* of an element. The phrase “in one atom” was often missing.

(ii) The word *number* was an essential part of the answer to this question. It was also essential to state that nucleon number is the number of protons and neutrons *in one atom* of an element. Electrons were sometimes referred to inappropriately, and a small number of candidates confused nucleons with neutrons.

(b) Large numbers of candidates scored full credit in this question. The nucleon number of sodium was sometimes given as the more common 23, rather than the correct value of 24 for this isotope. Candidates should be aware that the proton number defines the element, as opposed to the nucleon number.

Question 3

(a) (i) There were many misconceptions and omissions evident here. Negative ions / anions were mentioned as well as positive ions. Protons or atoms were mentioned instead of positive ions. Those candidates who drew particles with a positive charge did not always refer to these particles as positive ions. Some candidates drew individual atoms or ions. The *attraction* between positive ions and electrons was usually omitted.

(ii) Reference to *movement* of electrons or *mobile* electrons was essential in the answer to this question. “Free electrons”, “sea of electrons” or “delocalised electrons” was insufficient for the mark to be awarded. Some candidates referred to moving ions instead of moving electrons.

(b) This was usually answered well. The most common error was due to lack of knowledge of the formula and charge of the sulfate ion.

(c) (i) The formula and charge of the nitrate ion was known to only a minority of candidates.

(ii) Many candidates were able to deduce the formula of the sodium salt successfully from the information given and also to balance the equation successfully.

(d) This was answered very well by the majority of candidates.

Question 4

(a) Most candidates knew that catalysts were used to increase the rate of reactions. Some candidates chose to say only that catalysts *alter* the rate of a reaction. It is wrong to say catalysts do not take part in reactions, as many candidates did. The preferred terminology is that the catalyst is chemically unchanged at the end of a reaction.

(b) Candidates needed to address the problems caused by lower temperatures, as opposed to the advantages of using higher temperatures.

(c) The majority of candidates knew that increased pressure would lead to increased rate of reaction, although a small number of candidates mentioned increased yield.

(d) Candidates gave one of a wide number of correct answers to this question.

(e) (i) Many candidates correctly stated that electricity was required for electrolysis to take place, although it was also common to see references to anodes, cathodes and electrons. It was less common to see a correct statement regarding an electrolyte being chemically changed during the process. Those candidates who referred to a method of separation risked confusion between physical changes and chemical changes.

(ii) This was answered correctly by the majority of candidates. Inappropriate metals were occasionally seen.

(iii) Candidates continue to find ionic equations and ionic half-equations difficult. Formulae were often incorrect and electrons often appeared on the wrong side of the equation.

(iv) This was usually answered correctly, although a small but significant number of candidates read the question as “why” instead of “where” and so went on to answer incorrectly.

(v) This was usually answered correctly. Silver nitrate was occasionally seen as an incorrect reagent.

(f) This was often correct. Common errors included incorrect formulae, such as hydrogen as “H” and chlorine as “Cl”.

(g) It was unusual for candidates to score all of the credit available. Sodium hydroxide was the substance most likely to be incorrect. Chemical reactions of sodium hydroxide were usually given as opposed to uses. The three substances are manufactured industrially, and as such are *not* used to produce naturally occurring products. The most common error concerning this misunderstanding is that hydrogen was thought to be used to produce water.

Candidates should make clear whether a substance is used to produce other substances for a specific purpose, or whether it is itself used for a specific purpose. For example, sodium hydroxide is used in the manufacture of soaps and detergents but would be totally unsuitable if used as a soap or detergent itself.

Question 5

(a) (i) Excess of a reactant means *more than enough* to react with the other reactant or reactants. In this case "an excess of oxygen" means that there is more than enough oxygen than is required to react with all the hydrocarbon.

(ii) This was almost always answered correctly.

(iii) Candidates found this more challenging. Answers were not always expressed as the *smallest* ratio (e.g. 10:75:50 was fairly commonly seen), nor were they always expressed as *whole numbers* (e.g. 1:7.5:5 was also a common response).

(iv) Candidates also found this question challenging. The answers $C_{10}H_{20}$, C_5H_{20} and C_5H_{20} were seen as incorrect formulae.

(b) (i) This was almost always answered correctly.

(ii) The preferred answer to this question was that an unsaturated molecule is a molecule that does not contain only single bonds between the atoms. A small number of candidates stated that unsaturated means containing single bonds only.

(iii) This was answered very well by the majority of candidates.

(c) (i) This was usually answered correctly. "Additional" and "condensation" were seen occasionally as answers.

(ii) In addition polymerisation there is only one product, so the maximum mass of the polymer must be equal to the mass of the monomer. Many candidates attempted mole calculations in which 42 (or multiples of 42) were commonly seen as the answer. *Deduce*, as opposed to calculate, was intended to be a clue to suggest that no calculation was required.

(iii) One of the characteristics of addition polymerisation is that the monomer and polymer have the same empirical formula. Formulae never begin with numbers, nor can they ever include *n* as an indeterminate integer. The responses "$–CH_2–$" and "$–(CH_2)_n–$" were both occasionally seen.

Question 6

(a) (i) Roasting or heating strongly were often omitted.

(ii) A variety of reactants and products were seen. Those candidates who gave correct reactants and products often left their attempted equation unbalanced.

(b) (i) The production of heat by the exothermic combustion of coke in air scored least regularly. Many candidates thought that "hot air" provided the heat. An equation for the production of carbon monoxide was only seen occasionally. Most candidates successfully wrote an equation for the reduction of zinc oxide.

(ii) This was usually answered correctly. Sublimation was seen occasionally.

(iii) This was usually answered quite well, although there were several candidates who referred to the temperature inside the furnace and the boiling point of zinc, but made no comment about the relative magnitude of both. The high temperature inside the furnace, without qualification, was insufficient to gain credit.

(c) This question produced a wide variety of answers. Most candidates referred to zinc being more reactive than iron / steel. Several candidates referred to loss of electrons by zinc, but the destination of the electrons was referred to less often. The question referred to *in terms of electron transfer* but several candidates gave little or no reference to electrons.

(d) (i) Some candidates had the colours the wrong way round. Various spellings of the word precipitate were seen.

(ii) The word *types* was often ignored. Specific compounds were often given.

(iii) The word *types* was often ignored. Specific compounds were often given.

(iv) Many candidates misinterpreted this question.

(v) Many candidates misinterpreted this question.

CHEMISTRY

Paper 0620/43
Theory (Extended)

Key messages

Candidates should read all parts of every question carefully in order avoid missing a question part out and to help ensure they answer what has been asked.

Candidates need to ensure they are familiar with quantitative work, including mole based calculations for solids, gases and solutions.

Clear working should be shown for calculations.

Chemical equations should be balanced symbol equations, unless the question specifically asks for a word equation. In this case, a symbol equation should **not** be given as the answer.

General comments

There was no evidence that candidates ran out of time. Some excellent answers were seen to all questions on the paper.

Candidates found the organic chemistry question and the moles-based calculation to be more challenging; they need to be familiar with these areas of the syllabus.

Comments on specific questions

Question 1

(a) This question tested understanding of the reactions that occur in the blast furnace; candidates found this challenging. Many candidates seemed reluctant to give the same answer in both parts **(iv)** and **(v)**.

(b) Many fully correct answers to part **(i)** were seen; incorrect responses such as "iron" and "oxygen" were also given.

The most common error in part **(ii)** was to suggest that the calcium silicate (slag) was removed from the very bottom of the blast furnace. Candidates should be aware that calcium silicate is less dense than iron and so is removed from above the iron.

Many correct answers were seen in part **(iii)** although some candidates suggested substances that are not gases and so could not be correct.

(c) Some candidates made careless errors in part **(i)** or gave incomplete answers that did not describe the changes in both variables. A common response was "as the percentage of carbon changes, the malleability of iron gets less". Since how the percentage of carbon is changing (increasing or decreasing) is not specified, this response was not sufficient.

In part **(ii)**, many candidates had the correct general idea of the oxidation of carbon using oxygen, but they implied that just introducing oxygen into the impure iron to would be sufficient. In fact, the oxygen must be forced or blown into the impure iron.

Question 2

(a) Many candidates could name **F** as being butane but many candidates did not read the question carefully and wrote the formula rather than gave the name.

(b) The majority of candidates could identify two members of the same homologous series but it was common for other candidates either to name the compounds or to give their formulae, rather than give the general formula of the homologous series, as requested.

(c) Many fully correct answers were seen although some candidates found this question challenging. It was not uncommon for two compounds which were not isomers to be selected. Many candidates who selected two isomeric compounds could not complete the explanation successfully and commonly referred to "the same chemical formula", rather than referring to having the same *molecular* formula.

(d) Some candidates did not read the question with sufficient care. While many candidates attempted to explain why **B** is unsaturated or why **B** is a hydrocarbon, relatively few tried to explain why it is *both* unsaturated and a hydrocarbon. It should be noted that an unsaturated compound will have a multiple bond between two (carbon) atoms; unsaturation is **not** defined in terms of having as much hydrogen joined to the carbon atoms as possible.

(e) The conversion of ethene to ethanol was not well known. Despite the question stating that **D** is made from **B**, many candidates could not write the correct formulae for the reactants and products.

(f) The most common error was to draw a structure that showed four repeat units of poly(ethene), rather than two repeat units of poly(but-2-ene). When addition polymerisation occurs, the only part of the alkene molecule that reacts is the double bond between the carbon atoms. Therefore, a repeat unit can only have two carbon atoms in the chain between the two continuation bonds.

Question 3

(a) While many candidates could name two other constituents of clean dry air, some just repeated the names of the gases listed in the question or claimed that dry air contained water. A few candidates suggested that there were solids in the air and a significant number thought that air contains hydrogen gas.

(b) It was not uncommon for candidates to suggest pollutant gases that they had either already stated were components of clean dry air or that were not gases. Those candidates who did correctly identify pollutant gases, often did not state how each was produced. Some candidates gave vague answers such as "by industry" or "by cars" but more detail was required. For example, sulfur dioxide is produced by the burning of fossil fuels which contain sulfur; and nitrogen oxides are formed when atmospheric nitrogen and oxygen react with each other at the high temperatures in a car engine.

Question 4

(a) In part **(i)**, many good answers were seen that clearly described a potassium atom losing an electron and the electron then being gained by an iodine atom. Some candidates incorrectly tried to describe the sharing of electrons.

There were many very poor answers to part **(ii)**. Rather than describing the structure of solid potassium iodide, many candidates tried to describe the bonding again. Those who did try to describe the structure often wrote about the wrong sorts of particles and confusion between ionic and metallic structures was common.

Part **(iii)** was also poorly answered. Common errors included relating the melting point of the compound to the reactivity of the compound or its constituent elements, or to the melting point of the elements. Those candidates who knew that melting point depends on the forces of attraction sometimes incorrectly described the particles as molecules. Some candidates decided to use comparative terms and used phrases such as "the attraction between the particles is stronger". Many questions do require comparative answers but this one did not, since nothing was being compared. Saying something is strong*er* does not mean it is strong.

(b) In part **(i)**, some candidates were able to give complete and clear descriptions of what should have been a familiar laboratory technique (making a salt by precipitation). Some candidates did not add water to form solutions at the start of the process, and many candidates omitted the important step of washing the precipitate after filtration. Some candidates gave answers which suggested that they have never carried out a precipitation reaction, for example involving heating. There was evidence that some candidates did not read the question carefully as they used reagents other than the two specified in the question.

The ionic equation in part **(ii)** was only correctly given by the better-performing candidates; many candidates tried to write full chemical equations or wrote word equations.

(c) Many colours were suggested for the colour changes in part **(i)**. Candidates were required to recall that potassium chloride and potassium iodide are colourless, or that chlorine gas is green and that aqueous iodine is brown.

Some excellent responses were seen in part **(ii)** although some candidates thought the reducing agent was the species that got reduced rather than the species which reduced something else.

Question 5

(a) A number of candidates stated that there was effervescence because there was a reaction, or because the reaction was exothermic or a neutralisation reaction. It was evident that some candidates were not familiar with the word effervescence.

(b) In part **(i)**, the colour of the methyl orange indicator was fairly well known with the most common error being to state it was orange. The mole calculation which followed was very poorly answered and many candidates did not attempt many of the steps. There was a lack of working from many candidates. It is important that candidates show full and clear working, as credit can be awarded for correct working even if the final answer is incorrect.

Part **(ii)** required the use of the equation moles = concentration × volume (in dm^3). When an equation was stated by candidates, it was often incorrect.

In part **(iii)**, many candidates gave answers that were totally unconnected to their previous answer.

Part **(iv)** required use of the equation concentration = moles/volume (in dm^3) and this was often stated incorrectly. Many candidates were not familiar with calculations of this type.

(c) This calculation was poorly answered. Many candidates gave no working or confused working and an incorrect final answer.

Question 6

(a) Although many fully correct equations were seen in part **(i)**, there were a number of errors in the formulae of hydrogen chloride and ammonia, both of which were given on the Question Paper, and the identity of the single product.

Almost all candidates were able to correctly name diffusion in part **(ii)**.

In part **(iii)**, most candidates could correctly identify where the solid formed, and stated that ammonia molecules moved faster than hydrogen chloride molecules. Fewer candidates were able to link the speed of movement to the mass of the particles concerned. It is not sufficient just to say "ammonia is less dense" as this does not refer to the masses of the individual particles.

In part **(iv)**, many candidates realised the ring would form more quickly; most candidates then incorrectly linked this to the rate of reaction, rather than the speed of movement of the particles.

(b) Better-performing candidates were familiar with the ion tests in part **(b)**. For other candidates, there was common confusion between ammonium and ammonia and between chloride and chlorine. Consequently, tests for the wrong species were often stated.

(c) The majority of candidates could identify covalent bonding in ammonia in part **(i)**.

Part **(ii)** was frequently incorrect or left blank. One of the most common errors was to include a double bond between the nitrogen atoms.

Many candidates did not answer this question or gave incorrect responses. Better-performing candidates were able to name the amide link in part **(i)**.

Fewer candidates were able to describe the difference between nylon and proteins in part **(ii)**. A common error was to state that nylon is man-made but proteins are natural; this is a true statement but does not answer the question asked. Better-performing candidates stated that proteins are made from 20 amino acids while only one or two monomers are involved in nylon.

Only a minority of candidates knew the hydrolysis products of proteins in part **(iii)**.

In part **(iv)**, more candidates tried to draw the structure of the polymer than the structure of the monomer, as asked.

CHEMISTRY

Paper 0620/51
Practical Test

Key messages

Candidates should be familiar with the technique of carrying out a flame test and with the different colours of the silver halide precipitates.

In qualitative analysis exercises, candidates must follow the instructions given and record all observations.

Candidates should be aware that the mark allocation reflects the number of valid points to be made for the individual parts of questions.

Candidates should be prepared to answer a question requiring the planning of an investigation and would benefit from attempting past examination questions on this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

General comments

The majority of candidates successfully attempted and completed **Questions 1** and **2** and there was no evidence that candidates were short of time.

Most Supervisors submitted results for **Questions 1** and **2**; a few did not carry out **Question 2**. The Supervisor's results are used in the marking of both questions.

A number of Centres recorded unexpected volumes of acid in Experiments 1, 2 and 3 in **Question 1**. Centres should ensure that the Confidential Instructions, which clearly specify the concentrations of the solutions for **Question 1**, are followed. A minority of Centres supplied phenolphthalein to candidates instead of thymolphthalein. This should have been indicated on the Supervisor's Report.

The Question Paper included a planning question for the first time on the new syllabus for 2016–2018. Some candidates did not appear prepared for this type of question, as no attempt was made to answer the question.

Comments on specific questions

Question 1

(a)(b) The tables of results were completed by all of the candidates. A minority of candidates recorded initial burette readings greater than the final burette readings. Some candidates recorded volumes to the nearest whole number only. Burette readings should be recorded to one decimal place. There was sometimes a wide variation in the results produced by different candidates from the same Centre. A significant number of candidates had burette readings over 30 cm^3 in Experiment 2.

(c) Incorrect colour changes, such as blue to clear or white, were frequently seen. Some candidates confused the initial and final colours.

(d) The observation that bubbles / effervescence / fizzing occurred was correctly given by some candidates. "Gas / carbon dioxide given off" is not an observation. Some vague answers referred to temperature changes.

(e) This was well answered. Most candidates recognised that Experiment 2 needed the largest volume of acid.

(f) Having used a measuring cylinder in the experiments, many candidates were able to suggest the use of a pipette or burette to measure the volume of the aqueous sodium carbonate.

(g) Better-performing candidates understood that warming the reactant would have no effect on the results as there was no change in concentration. A large number of candidates stated that the reaction would be quicker, not realising that the rate of reaction was not being measured. Reasons in terms of energy and movement of particles were not relevant for this question.

(h) (i) A ratio or some quantitative indication was required in the comparison. The majority of candidates recorded a correct ratio from their results; merely stating that more or less acid was used was insufficient.

(ii) Better-performing candidates realised that solution **B** was more concentrated than solution **A** because a smaller volume of **B** was used to neutralise the alkali. Incorrect answers referred to **A** being more concentrated as a larger volume of **A** was used, which showed a lack of knowledge and understanding. Some confused answers discussed the difference in the rate at which the two acids reacted.

(i) The question asked for a *different* method from titration that could be used to compare the concentration of the two acids. Despite this introduction, many candidates used the same method with a different alkali.

Vague answers such as “use a metal” or “use a reactant” and the use of unsafe reactants such as sodium were also seen. A large number of candidates suggested adding a different indicator, e.g. Universal Indicator, phenolphthalein or litmus, to the acids. Indicators are not reactants and would also not distinguish the two acids. Some answers suggested an electrical method with a bulb in a circuit which also would not work.

(j) This was well answered by the majority of candidates. Some answers were too vague.

Question 2

Solid **C** was sodium bromide. Solution **D** was aqueous chromium(III) chloride. The full range of marks was awarded for this question. Some observations bore no resemblance to those expected.

(a) Most candidates were able to test an aqueous solution of solid **D** and record a pH value close to the Supervisor’s value. The addition of aqueous silver nitrate in part **(ii)** should have resulted in a cream precipitate. A significant number of white precipitates were recorded. References to milky and cloudy were also seen.

(b) This was generally correct. There was evidence that some candidates had never performed a flame test from answers such as “lighted splint pops”.

(c) Some correct responses were seen.

(d) (i) Generally, the appearance of the solution was correctly described as green / blue. The inclusion of the term solid or precipitate was incorrect.

(ii) The incorrect use of terms was prevalent. The terms soluble, insoluble, dissolves and solution were often confused.

(iii) Reference to the formation of white precipitate showed a lack of care in observing the reactions.

(iv) Generally, this question was well answered with the recognition of the formation of a white precipitate. Some candidates used terms such as milky, cloudy or solid.

(e) Only the better-performing candidates answer this correctly. Many candidates incorrectly concluded that solution **D** was iron(II) sulfate. The presence of halide ions was well described and many answers indicated that solid **D** was a chloride.

Question 3

Most candidates weighed and burnt the calcium. Many methods described showed a lack of knowledge and understanding. The use of gas syringes to collect and measure the calcium oxide formed was common. References to heating calcium / calcium oxide and testing for oxygen with a glowing splint were common. There was confusion in the use of the terms volumes and moles of calcium and calcium oxide. Adding water to the calcium was a method that would not work.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

Centres should ensure that the solutions provided to candidates are of the required concentration. Where there is any doubt over the concentration of a reagent, then it should be standardised using normal volumetric techniques.

Candidates should be familiar with the technique of carrying out a flame test.

In qualitative analysis exercises, candidates must follow the instructions given.

Candidates should be prepared to answer a question requiring the planning of an investigation and would benefit from attempting past examination questions on this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

General comments

Most candidates had few difficulties with the qualitative analysis practical in **Question 2**.

The Question Paper included a planning question for the first time on the new syllabus for 2016–2018. Some candidates did not appear prepared for this type of question, as no attempt was made to answer the question.

Comments on specific questions

Question 1

(a) Almost all candidates were able to complete the total volume column in the table; some candidates did not record their results to the expected one decimal place. Data read from the same piece of apparatus should always be recorded to a consistent number of decimal places. A small minority of candidates completed the times in minutes and seconds, despite the unit required being given in the column heading. A few candidates recorded decreasing times.

(b) Some excellent graphs were seen. Some candidates used inappropriate graph scales. The requirement for graph scales is that they are linear and that the plotted points take up over half the available space (see Section 8.5 of the syllabus). Some curves were also seen.

(c) In part **(i)** many candidates were able to extrapolate the line and read a value from it. Some candidates omitted the units or gave cm^3 as the units of time. Better-performing candidates had no difficulty adding the higher temperature line to the graph in part **(ii)**. Some candidates incorrectly thought the higher temperature would slow the reaction down and so make the times longer or that the lines would cross.

(d) The vast majority of candidates were able to state that the starch acted as an indicator or were able to describe the colour change it caused.

(e) A number of candidates stated that pipettes were quick to use as an advantage in part **(i)** but that they were inaccurate. The main advantage of using a pipette to measure volume is its accuracy; with the main disadvantage in this experiment being that it would take too long and therefore it would be difficult to know when to start timing.

(f) Most candidates realised that it would be difficult to swirl the beaker. A significant minority of candidates thought that the flask and the beaker were being used for measuring and so incorrectly wrote about scale divisions and accuracy.

Question 2

Solid **E** was sodium sulfite and solid **F** was urea.

(a) In part **(i)** some candidates seemed to be uneasy having no visible change in the first observational task, and so recorded some impossible observations.

Most candidates reported the appearance of a white precipitate in part **(ii)** although adding of nitric acid produced a range of answers, from no change through to completely dissolving.

Part **(iii)** was straightforward for those candidates who followed the instructions and the change from purple to colourless was reported by the majority of candidates. Some candidates commented on the colour change of litmus paper (from blue to pink) showing that they had not followed the instructions.

(b) This part required a flame test to be carried out. Some candidates reported blue, green or lilac flames for sodium ions and did not appear to be familiar with how to conduct these tests, as there were some reports of lighted splints popping or solids bubbling and giving off strong smelling gases.

(c) Most candidates who had correct test observations were able to draw correct conclusions about solid **E**. Candidates should try to make good use of the “Notes for use in Qualitative Analysis” provided towards the back of the Question Paper. These notes give the names and formulae of the ions that occur in compounds analysed in this practical examination. Using the notes should preclude the possibility of giving incorrect formulae for ions or of suggesting ions that are not covered by the syllabus.

(d) Most candidates correctly described **F** as being white. Some candidates did not state the colour.

(e) In part **(i)**, most candidates stated that the red litmus became blue; some incorrectly reported that it was bleached. The majority of candidates noticed that the solid became a liquid, but many missed the pungent smell. In part **(ii)**, the actual shade of colour produced depends on the degree of heating in part **(i)**, but if **F** is heated strongly, as instructed, a pink solution is obtained. Some candidates reported a blue precipitate, which suggests that they ignored the residue and just added sodium hydroxide to copper(II) sulfate solution.

(f) A range of incorrect test results was seen, including bleaching of damp litmus paper and turning limewater milky.

(g) Many candidates worked out that solid **F** contained ammonium ions, either from their results in **(h)** or **(e)(i).**

Question 3

The inclusion of a planning task was new for this year and some candidates found this challenging. There were two clear aspects required in the plans: how to make the salt (potassium sulfate) and then how to obtain pure crystals of it from the reaction mixture. Many candidates gave details of only one or other aspect, rather than both. Some excellent descriptions of how to make a solution of potassium sulfate were seen; common errors were to use Universal Indicator (which is not suitable since it gives a gradual colour change); not to use any indicator (and so there was no way of knowing when there were stoichiometric quantities of the acid and alkali); or to use an indicator but to leave it in the reaction mixture during the subsequent crystallisation stage. It was common for candidates to evaporate their solutions to dryness rather than just until they were saturated. There were some excellent descriptions of obtaining saturated solutions from some candidates.

CHEMISTRY

Paper 0620/53
Practical Test

Key messages

Conclusions are not required when a question requires observations to be given.

Candidates should be aware that the mark allocation reflects the number of valid points to be made for the individual parts of questions.

Candidates should be familiar with the technique of carrying out a flame test.

Candidates should be prepared to answer a question requiring the planning of an investigation and would benefit from attempting past examination questions on this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

General comments

There was no evidence of candidates running short of time and most candidates successfully reported results and observations for the practical tasks in both questions.

The Question Paper included a planning question for the first time on the new syllabus for 2016–2018. Some candidates did not appear prepared for this type of question, as no attempt was made to answer the question.

Comments on specific questions

Question 1

(a) Almost all candidates were able to complete the initial and final temperatures correctly with the final temperature being higher than the initial. There were very few errors in calculating the temperature rises. A small number of candidates reported a larger temperature rise with iron that with zinc.

(b) The majority of candidates reported a correct test and result for hydrogen. Some candidates gave only the result and did not state the test; the test is not "the squeaky pop test", it is to expose the gas to a lighted splint, the result of which is the squeaky pop. Some candidates reported impossible test results which suggested the gas to be oxygen, carbon dioxide or chlorine.

(c) Almost all candidates recorded suitable results that showed good agreement to the Supervisor's results. Candidates found the observation more challenging. Reports of no reaction were not uncommon, despite the fact that the temperature had been reported to rise. Many candidates did not notice the formation of a brown solid.

(d) The requirement to draw a bar chart caused candidates few problems; a small minority drew bars to the wrong height or tried to draw a line graph. The most common error was selecting an inappropriate *y*-axis scale that resulted in the highest point coming to less than half way up the axis.

(e) Almost all candidates answered part **(i)** correctly. Part **(ii)** required the idea of a comparison, not just that magnesium was reactive but that it was *more* reactive than the other metals.

(f) This was well answered by candidates who had reported the correct test and result.

(g) Most candidates realised that because potassium was so reactive the reaction would become unsafe; some candidates suggested that potassium was unreactive and would do nothing.

(h) Many candidates did not answer this part correctly.

(i) Many candidates suggested repeating the experiment, however, the question asked for a *change*; repeating is not a change, it is doing the same thing again.

Question 2

The mixture contained two solids. Solid **G** was hydrated zinc nitrate and solid **H** was lithium carbonate.

(a) In parts **(i)** and **(ii)**, some candidates added too much sodium hydroxide or ammonia at once and so missed the initial formation of the white precipitate. The fact that in part **(i)** three marks were available should have suggested to candidates that there was more to it than “no change”. It was not uncommon for candidates to report a white precipitate in part **(iii)** which is not a possible result. In part **(iv)**, the use of aqueous sodium hydroxide and aluminium foil should have alerted candidates to the fact that this was the test for nitrate ions and so they should be testing for the formation of ammonia. Many correct gas test results were seen although a number of candidates reported impossible results.

(b) Those candidates who did not observe a precipitate in parts **(a)(i)** and **(a)(ii)** struggled to identify the cation. This should have caused them to reconsider their observations and repeat parts **(a)(i)** and **(a)(ii)**. The formation of ammonia in part **(a)(iv)** lead some candidates to conclude incorrectly that solid **G** contained ammonium ions.

(c) This was often answered correctly although some candidates gave conclusions, rather than observations. If a candidate has conducted a test to show the gas produced is carbon dioxide, then the observation they record should be the correct test and positive result for carbon dioxide.

(d) Many correct flame colours were seen; some unlikely colours were also recorded. It was clear from some of the answers that some of the candidates did not know what a flame test was and so performed tests with lighted and glowing spills.

(e) Fully correct answers were common.

Question 3

The inclusion of a planning task was new for this year and some candidates found this challenging. There were three clear aspects required in the plan: a diagram showing how to obtain water from the hydrated crystals; the expected observations; and how to test to show the product is pure water. Most candidates heated the salt; some incorrectly started by adding water to the hydrated salt. Many candidates gave a correct observation of a colourless liquid being collected but very few commented on the colour change of the hydrated solid they would expect. This is despite the fact that in the testing stage many, incorrectly, tested using anhydrous copper(II) sulfate and knew there would be a colour change between the anhydrous and hydrated forms. These candidates were unable to make the link between this and an expected colour change in going from hydrated to anhydrous nickel(II) sulfate.

CHEMISTRY

Paper 0620/61
Practical Test

Key messages

Observations are those which you can see. For example, “fizzing” is an observation, “a gas was given off” is not. Smells, such as the pungent smell of ammonia and the bleach or swimming pool smell of chlorine, are acceptable as observations.

Questions requiring candidates to plan an investigation should be answered with details of the apparatus to be used, substances involved, and practical procedures clearly specified with some idea of a conclusion. Preliminary notes are advisable before writing the plan.

General comments

The vast majority of candidates successfully attempted all of the questions. Candidates found the last question, **Question 4**, more demanding than the others. **Question 4** was a planning task involving a quantitative method.

The majority of candidates were able to complete tables of results from readings on diagrams, as in **Question 2**.

Comments on specific questions

Question 1

(a) Candidates had difficulty identifying the fractionating column. The column was often referred to as a test-tube or reference was made to the overall process of fractional distillation. Many candidates correctly named the tripod. Some candidates mistakenly identified it as a Bunsen burner or a stand and, in a small number of cases, a “dipod”. These candidates were not familiar with two dimensional diagrams.

(b) Incorrect answers used air instead of water. Steam or other named gases were also seen.

(c) A lot of candidates realised that the distillate / ethanol should not be heated. Some candidates wanted to lower the position of the thermometer. Others suggested that the water flow in the condenser was incorrect; the round-bottomed flask was unstable; or that it should be heated with an electrical heater.

(d) This was well answered. Some candidates did not compare the boiling point of ethanol with that of water.

(e) A large number of responses referred to controlling the heating or heating evenly. These answers were not credited.

Question 2

(a) This was often well answered. The most common error was to omit the decimal place with the initial reading of zero and to give “0” instead of “0.0”. Some candidates reversed the initial and final readings while others misread the burette diagrams, e.g. giving “13.2” instead of “12.8”. A few candidates gave the initial reading for Experiment 1 as “25.0” or “50.0”.

(b) This was poorly attempted despite the information that was given in the stem of the question of Experiment 2 and showed a lack of knowledge and understanding. Orange to pink / red was a common incorrect answer. Many other colours were cited including blue, colourless and green.

(c) This table of results was often completed correctly. A few candidates reversed the initial and final readings, while others misread the burette diagrams.

(d) This was also well answered, with the majority suggesting bubbles, fizzing or effervescence. There were a minority who stated that a gas or carbon dioxide would be produced but did not describe the observation. A significant number of candidates referred to a colour change or a temperature change.

(e) Most candidates could correctly identify Experiment 2 as needing the largest volume of acid to change the colour of the indicator.

(f) Most candidates understood that using a pipette or burette would be a more accurate method. Some candidates thought that a beaker or a measuring cylinder with more graduations would be appropriate.

(g) This question was only answered correctly by better-performing candidates. Most candidates thought that the rate was increased and gave the reason in terms of particles colliding. The minority that realised that there would be no effect on the results explained that there was no change in the concentration of the reactants in this acid-alkali titration.

(h) (i) This was well answered but the ratio was sometimes given as 1:2 rather than 2:1.

(ii) This was not always interpreted correctly from the ratio in part **(h)(i).** Many candidates suggested that a ratio of 2:1 for **A**:**B** volumes meant that the concentration of **A** was greater than the concentration of **B**.

(i) The question asked for a *different* method from titration that could be used to compare the concentration of the two acids. Despite this introduction, many candidates used the same method with a different alkali.

Vague answers such as “use a metal” or “use a reactant” and the use of unsafe reactants such as sodium were also seen. A large number of candidates suggested adding a different indicator, e.g. Universal Indicator, phenolphthalein or litmus, to the acids. Indicators are not reactants and would also not distinguish the two acids. Some answers suggested an electrical method with a bulb in a circuit which also would not work.

Question 3

(a) Many answers identified sodium bromide. Chloride and iodide were offered instead of bromide and a selection of metals, including other Group 1 metals, instead of sodium. This showed a lack of knowledge.

(b) A minority correctly of candidates described the appearance of the solution as green / blue.

(c) (i) The use of the terms soluble, insoluble, dissolves and solution was often confused.

(ii) Some candidates gave the expected observation of a grey-green precipitate which was insoluble in excess sodium hydroxide. Reference to the formation of white precipitate was common.

(iii) This was generally well answered with the recognition of the formation of a white precipitate. Some candidates thought that there would be no reaction and others suggested that the precipitate would dissolve.

(d) This was well answered and candidates are well aware of safety precautions that are necessary.

Question 4

Most candidates weighed and burnt the calcium. Many methods described showed a lack of knowledge and understanding. The use of gas syringes to collect and measure the calcium oxide formed was common. References to heating calcium / calcium oxide and testing for oxygen with a glowing splint were common. There was confusion in the use of the terms volumes and moles of calcium and calcium oxide. Adding water to the calcium was a method that would not work.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

Candidates should use a sharp pencil for plotting points and for drawing lines of best fit on their graphs. This allows them to correct any errors. Points are best plotted with a cross (×) to ensure that they are not obscured by either the grid lines or the line of best fit. The question might require the line of best fit to be a curve or a straight line, as appropriate. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

Observations are those which you can see. For example, "fizzing" is an observation, "a gas was given off" is not. Smells, such as the pungent smell of ammonia and the bleach or swimming pool smell of chlorine, are acceptable as observations.

When a question asks for the name of a chemical, a correct formula is always acceptable; an incorrect formula is not.

General comments

The vast majority of candidates successfully attempted all of the questions. No question proved to be more demanding than the others.

Question 4 was a planning task testing the preparation of a soluble salt. There were several acceptable routes, most of which seemed familiar to candidates. The quality of answers was generally good.

The vast majority of candidates were able to complete tables of results from readings on diagrams and plot points successfully on a grid, as in **Question 2**.

Comments on specific questions

Question 1

(a) Most candidates answered correctly.

(b) Most candidates put their arrow in the correct place, below the copper(II) oxide. A number of candidates did not attempt this question.

(c) The colour change was not generally well known, with many blues and whites seen.

(d) Most candidates knew that condensation took place in the U-tube surrounded by ice. A description of the process of condensation was acceptable.

(e) Water was identified by the majority of candidates. The "chemical test" was often correct, but a large minority gave a test for purity. When using copper(II) sulfate, it is important to specify anhydrous. Use of the formula $CuSO_4$ is ambiguous.

Question 2

(a) Nearly all candidates could read the clocks correctly. A few recorded times in minutes and seconds, or simply ignored the minutes.

(b) Most candidates chose an appropriate scale which enabled extrapolation in part **(c)**. The graph was plotted correctly by nearly all candidates and a ruler was generally used for the straight line.

(c) Nearly everyone correctly extrapolated the straight line to a reading at 4 cm^3. The most common error in taking this reading was to omit the units. The sketch of the line expected at a higher temperature was more challenging, with many assuming incorrectly that a higher temperature must be a higher line.

(d) Many candidates knew that the starch was used as an indicator or to make the colour change more obvious. The most common incorrect answer was that it acted as a catalyst.

(e) The use of a pipette to measure the volume of the hydrogen peroxide caused difficulties for many candidates. Most knew that it would be more accurate, but few could give valid disadvantages. A large number of candidates misunderstood the term pipette as meaning a teat pipette.

(f) Candidates found this question challenging.

Question 3

(a) Most answers correctly stated that sodium sulfite was white; "colourless" was seen fairly frequently.

(b) Most candidates realised that there would be no reaction with sodium hydroxide solution, but white precipitate was still a fairly common answer. Nearly all candidates realised that potassium manganate(VI) goes from purple to colourless in the presence of sulfur dioxide.

(c) The correct answer, a yellow flame test, was often seen; a significant number of candidates answered "red" and "lilac".

(d) Most candidates correctly identified ammonia.

(e) The ammonium ion was the most common answer but many nitrates were seen.

Question 4

Nearly everyone attempted this question but only the better-performing candidates answered this fully correctly. Many candidates correctly suggested a titration method but other acceptable methods were seen. It was expected that a suitable indicator would be named. Universal Indicator is not suitable for titration as it does not have a sharp single colour change at the end-point.

Some candidates were able to provide a description of obtaining pure crystals from the solution by crystallisation. Ideally, this would have been evaporation until the point of crystallisation, followed by cooling, filtration, rinsing and drying. Sometimes candidates' answers gave sequences which showed confusion. Evaporation to dryness would not give pure crystals.

CHEMISTRY

Paper 0620/63
Alternative to Practical

Key messages

Questions requiring candidates to plan an investigation should be answered with details of the apparatus to be used, the method involved and with quantitative information clearly specified.

Observations are those which you can see. For example, "fizzing" is an observation, "a gas was given off" is not. Smells, such as the pungent smell of ammonia and the bleach or swimming pool smell of chlorine, are acceptable as observations.

General comments

The majority of candidates attempted all of the questions. The full range of marks was seen. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates found **Questions 3** and **4** most challenging.

The majority of candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid, as in **Question 2**.

Comments on specific questions

Question 1

(a) Most candidates labelled the apparatus as a syringe. Some candidates appeared to be unfamiliar with common laboratory apparatus.

(b) Most responses placed an arrow under the copper. A common incorrect answer was to place the arrow over the top of the tube containing the copper.

(c) Few candidates identified both colours. A large number of candidates referred to blue, white and green.

(d) Better-performing candidates worked out that 10 cm^3 of oxygen was used and correctly calculated that 20% of the air was oxygen. A large number of candidates did not read the question and worked out that 80% of the air was nitrogen.

Question 2

(a) The vast majority of candidates correctly completed the temperatures in the table from the thermometer diagrams.

(b) This question was well answered with hydrogen being recognised by many candidates.

(c) The vast majority of candidates correctly completed the temperatures from the thermometer diagrams.

(d) Most candidates drew the bars on the grid correctly. A large number chose an appropriate scale for the *y*-axis. Some labels were not clear, being positioned on the edge of two bars. A minority of candidates drew smooth line graphs, while others joined the points with straight lines drawn with a ruler.

(e) (i) This was well answered, with experiment 3 being correctly identified as producing the largest temperature rise.

(ii) Most candidates realised that magnesium produced the largest temperature rise and linked this to the greater reactivity of the magnesium compared to the other metals.

(f) Better-performing candidates discussed the displacement of copper by iron, which was the more reactive metal. Many responses showed a lack of knowledge and understanding, concluding that the brown deposit formed was rust or iron oxide. Other candidates discussed the relative magnitude of the temperature changes without referring to the observations given.

(g) Many candidates realised that using potassium would be dangerous as it is very or too reactive. Some vague and incorrect answers referring to the lack of reactivity of potassium were seen.

(h) Some candidates realised that an advantage of using a measuring cylinder was that it is quick and easy to use. Mistaken references to the accuracy or precision of a measuring cylinder were prevalent.

(i) The commonest correct improvement given was to use a pipette or burette instead of a measuring cylinder. There were very few references to preventing heat losses by insulating the boiling tube or by using a polystyrene cup. Many responses mentioned repeating the experiments and taking an average which did not answer the question.

Question 3

It was evident that some candidates had no knowledge of the tests required to complete the observations in the table.

(a) (i) A white precipitate soluble in excess aqueous sodium hydroxide was seldom known. Some candidates thought that the precipitate would be coloured. Additional incorrect observations, such as effervescence, were seen.

(ii) A white precipitate soluble in excess aqueous sodium hydroxide was seldom known. Some candidates thought that the precipitate would be insoluble in excess. Additional incorrect observations, such as effervescence, were seen.

(iii) Candidates generally did not realise that this test for a halide would be negative, having been told that the anion present was nitrate. Correct responses of “no change”, “no precipitate” and “no reaction” were seen. A large number of answers gave the formation of coloured precipitates.

(iv) The test for ammonia was described by many candidates using red litmus paper which turned blue. Very few references to bubbles or fizzing were recorded. A significant number of candidates did not know the test for nitrate ions and incorrectly discussed the evolution of hydrogen and lighted splints popping.

(b) The presence of lithium carbonate was identified by the better-performing candidates. Potassium, transition metals and carbon dioxide were common incorrect responses.

Question 4

Some candidates were clearly not prepared for this type of question.

Many candidates referred to heating and then collecting a sample of water. A lack of knowledge and understanding was often then evident, with answers mentioning adding water to the nickel(II) sulfate crystals. These candidates did not understand that water of crystallisation was part of the structure of the hydrated crystals. Common incorrect responses involved filtration of the crystals.

Many candidates did not read the question, which asked for a test for pure water and instead gave tests to show the presence of water.