CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

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

General comments

Candidates found **Questions 1**, **3**, **7**, **18**, **22** and **26** to have the least challenge.

Questions 11, **12**, **14**, **15**, **19**, **35**, **36**, **37** and **38** were most demanding.

Candidates should take care to read the whole question and options. In some questions candidates chose the partially correct options provided. Examples include **Question 12**, **25** and **31**.
Many candidates could not recall expected observations during chemical reactions such as effervescence, colour changes or gas tests.

Comments on specific questions

Question 4

Option **B**, the electron configuration of the atom, was the most common incorrect answer. This suggests that many candidates do not recognise the significance of the charge of the ion in terms of electron number. Few candidates chose options **A** or **C**.

Question 9

Option **D** was the most common incorrect answer. Candidates should recall the formula of iron(III) oxide as a named substance in the syllabus, present in both Topics 9.5 and 9.6 to rule out this option.

Question 11

Many candidates were unable to use mass ratio to determine the mass of the magnesium oxide product. Many candidates incorrectly used the 2:2 ratio to either double or to quadruple the correct value and incorrectly selected option **B** or option **C**.

Question 12

The electrolysis products of dilute sulfuric acid were not well recalled. Option **C** was the most common incorrect answer. Of those candidates who recalled the correct products, most assigned them to the correct electrode. Few chose option **B**.

Question 14

All the options were popular suggesting that candidates are confusing endothermic and exothermic reactions, and confusing neutralisation with redox.

Question 15

Option D was a common incorrect answer. It is expected that all candidates know that temperature remains constant during a physical change such as boiling for example. Similarly, all candidates should recognise that as matter does not appear or disappear, the mass of all the substance before and after a chemical or physical change is constant.

Question 19

The acidic and basic nature of oxides and their effect on thymolphthalein indicator was not well recalled overall. Stronger candidates answered this correctly.

Question 20

Option **C** was the most common incorrect answer. This may suggest that candidates have confused the observed colour change of the litmus from red to blue on contact with the ammonia gas, with the reaction of potassium with water which produces the alkali potassium hydroxide.

Question 25

Most candidates answered this question correctly. Option C was a common incorrect answer. Candidates must take care to read the full sentence when choosing their answer. In this case, it is correct that copper is used in electrical wiring, but it is not correct that it corrodes easily.

Question 31

Option **B** was the most common incorrect answer. Although option **B** links a source and an adverse effect, candidates choosing this option had not linked them to the question about methane.

Question 33

Candidates often find questions on organic nomenclature to be high demand. Overall, this question was reasonably well answered. Option **A** was the most popular incorrect answer where candidates confused chloroethane and chloromethane.

Question 34

Most candidates confused natural gas, methane, with the most common gases in clean, dry air and chose option **B** or option **D**.

Question 35

This question was not well answered. The meaning of the terms volatility and viscosity and their trend in petroleum fractions was not well understood.

Question 36

Options **A**, **B** and **C** were all common answers. This suggests that the test for ions is not well known.

Question 37

All the options were popular. This suggests that the expected observations for chemical reactions is not well known.

Question 38

Option **A** was the most common incorrect answer where candidates confused ethane with ethene.

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Paper 0620/22
Multiple Choice (Extended)

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

General comments

Overall candidates found **Questions 1**, **5**, **6**, **7**, **9**, **18**, **19**, **21**, **25** and **30** to be the easiest.

Questions 12, **24**, **32** and **36** were most demanding. These are reviewed below.

Candidates should take care to read the full question when answering. Some options may give answers which are either correct statements which do not answer the question or are statements which are only partially correct.

Comments on specific questions

Question 2

Option **D** was the most common incorrect answer. Weaker candidates tended to incorrectly choose positions where temperature was changing to identify state changes.

Question 12

Option **A** was the most common incorrect answer. This is the number of molecules rather than the number of atoms.

Question 13

Option **C** was the most common incorrect answer. The effect of halide concentration on the major gas produced at the anode was not well recalled by the weaker candidates.

Question 20

All options were popular, suggesting that the effects of temperature and pressure on the position of equilibrium were not well known by weaker candidates.

Question 24

Option **B** was the most common incorrect answer. This option describes the formation and collection of a soluble salt. Candidates may benefit from review of the differences between steps involved in the formation of soluble and insoluble salts.

Question 28

Weaker candidates had a tendency to choose option **A**, where they had confused bond strength with intermolecular forces or to choose option **B** where they had confused brass and bronze.

Question 31

Options **B** and **C** were commonly chosen by weaker candidates suggesting that many candidates either did not recognise that impure river water would have a different melting or boiling point than pure water, or they confused the colours of anhydrous salts.

Question 32

Option **A** was the most common incorrect answer, suggesting candidates did not understand that sedimentation is used to separate insoluble solids which are often in suspension in water.

Question 34

All incorrect answers were popular with weaker candidates. These candidates appeared to be uncertain about how the reaction removed pollutant gases and the direction of oxidation and reduction.

Question 35

Option **B** was the most common incorrect answer, where candidates had identified the reactant rather than the product of the reaction. Candidates should be encouraged to read the question in full before answering.

Question 36

Options **C** and **D** were popular incorrect answers, where many candidates did not recognise that the original molecule contained three identical CH_3 groups. It is often helpful in questions like this for candidates to sketch out, using a simple carbon stick model, all the possible products they can think of and then to cross out any that are duplicates.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Candidates were knowledgeable on changes of states and how to balance chemical equations.
- Questions on the topics of rusting, making salts and electrolysis were well answered, showing a very good understanding of these topics.
- Questions requiring simple calculations were well answered. For example, calculating the relative molecular mass of a compound.
- Questions on the more detailed aspects of the kinetic particle model were not answered well. There was a tendency for candidates to confuse the terms arrangement, separation and motion and use them incorrectly.
- It is important that candidates read the question carefully to understand what is being asked. Practice of reading and interpreting questions that involve data handling may be beneficial.
- Candidates would benefit from greater practice of chemical test questions. For example, many candidates did not describe the chemical test for hydrogen correctly.
- Organic content of the syllabus was not well known. More practice drawing displayed formulae and learning key definitions such as the term hydrocarbon is required.
- Questions requiring dot-and-cross diagrams were not answered well. Candidates would benefit from more practice completing these diagrams.

General comments.

Many candidates showed a good knowledge of core chemistry. It was evident that many candidates are using past paper practice as part of their revision programme however there are some aspects of this syllabus which require more attention.

Misinterpretation of the question happened in some cases. The most common misinterpretation was in **Question 5(b)** when asked to, 'Describe the arrangement and motion of the particles in liquid iron'. Where some candidates got terminology confused and others compared states. Some candidates also struggled with the questions about how the rate of the reaction differed with a change in conditions. Some mentioned how the time would change instead of the rate of reaction. Most candidates did not know why hydrochloric acid must not be used in the halide ion test. The uses of substances detailed in the syllabus were answered well and many candidates knew a use of 'stainless steel' and 'ethanol'. The balancing of equations was good, demonstrating that candidates had practiced these as part of their revision. Definitions from across the syllabus were reasonably well answered.

Questions with the command word 'deduce' and 'explain' were answered well by many candidates. Data handling type questions could have been answered better. Candidates often made slight mistakes and were not precise enough when answering these types of questions. Recall based questions were generally well answered.

The standard of English was very good. Some candidates need to be more explicit when writing about certain concepts and not use the words 'it' and 'they' to answer questions. Some stronger candidates wrote

their answers as short phrases or bullet points, which is good practice. Candidates are less likely to write vague statements or contradict themselves if this is done.

Comments on specific questions

Question 1

(a) (i) Weaker candidates gave a wide range of incorrect answers. These candidates may benefit from additional revision of suitable materials used as inert electrodes for electrolysis and their properties. Some candidates chose ions, suggesting they may also be struggling to identify which of the symbols and formulae given represent elements, ions and compounds.

(ii) Most candidates could answer this question correctly. A very common incorrect answer was Ba^{2+} showing confusion between loss and gain of electrons.

(iii) Candidates commonly chose CO_2 and CO as incorrect answers.

(iv) Candidates answered this question well. The most common incorrect answers were K^+ and CuO.

(v) This question was very well answered.

(vi) Many candidates could not recall an element used as a reactant in fuel cells. The most common incorrect answer was H_2O.

(b) This dot-and-cross diagram was not answered well. The most common error was three lone pairs around the central oxygen atom. Three electrons in the covalent bonds were also commonly seen.

Question 2

(a) Most candidates answered this question correctly. Some candidates got the metals in the wrong order. A few candidates gave metals that were not listed in the question. It is important that candidates read the question carefully and use the information they are given.

(b) Most candidates could describe one difference in physical properties but not two. Many candidates gave incorrect answers comparing reactivity between the two metals. Some candidates wrongly reversed the correct answers on physical properties for example ‘Lithium has a high melting point’.

(c) (i) Many candidates were unclear on what an alloy is demonstrated by answers which referred to ‘compounds being made or mixed’ and ‘metals being chemically combined’.

(ii) Most candidates could name one of the correct metals in this question. This was usually copper. Some candidates could not identify the second metal. Many different metals and compounds were seen especially aluminium, steel, iron and tin.

(iii) The most popular correct answer of ‘cutlery’. Many candidates could not recall a correct answer or gave uses of stainless steel that were too vague such as ‘utensils’, ‘cooking’ and ‘vessels’.

(d) (i) Most candidates knew the number of protons present. Some candidates were unable to calculate the number of neutrons and number of electrons in the ion shown. More practice working out the number of electrons, particularly in an ion would be beneficial.

(ii) Most candidates correctly stated the charge on a neutron. Weaker responses stated that the charge was ‘positive’ or ‘3+’.

Question 3

(a) Most candidates answered this question correctly. The most common incorrect answers were ‘sulfide’ and ‘sulfite’.

(b) (i) There were some very good fully labelled diagrams of the correct apparatus correctly connected together. Some candidates gave separate equipment rather than drawing assembled apparatus

and many included Bunsen burners and stop-watches. Some candidates drew correct equipment but labelled it incorrectly. For example, labelling conical flasks as beakers.

(ii) Most candidates answered this question correctly.

(iii) This question was not well answered by many candidates. Many did not know 'why the reaction stops at 300 seconds'. Common incorrect answers were 'the reaction stopped', 'the maximum volume had been reached', 'all the hydrogen had been given out' and 'the temperature dropped'.

(iv) Most candidates could give a steeper curve that finished earlier. Some candidates thought that more gas was given off at the end of the experiment and drew a horizontal line that was above the original one, which was incorrect.

(v) Most candidates answered this question correctly. The most common error was to give an answer that was not comparative such as 'the reaction is slow'. Some candidates also confused rate with the time of reaction and stated that 'more time would be taken'.

(vi) Most candidates answered this question correctly. The most common error was not giving a comparative answer or confusing rate with time.

(c) Many candidates were unable to recall the correct test for hydrogen. Many candidates referred to the 'pop test' and needed to more fully describe the test and observations. Some candidates got confused with other chemical tests and incorrectly used litmus paper or limewater. Other candidates suggested 'flame test'.

Question 4

(a) (i) Stronger candidates correctly identified the functional group. Many other candidates were unable to identify the carboxylic acid functional group from the diagram. This is possibly because there are many functional groups present. We always recommend that candidates attempt the question rather than leaving it unanswered.

(ii) Most candidates were able to deduce the molecular formula of the given compound correctly.

(iii) Many candidates incorrectly stated that the compound was unsaturated because it had a 'carbon double bond' or just a 'double bond'. Correct terminology must be used by candidates to explicitly demonstrate they understand the difference between a saturated and unsaturated compound.

(iv) Stronger candidates were able to describe the chemical test and observations for an unsaturated compound. Other candidates could not recall the correct test.

(b) (i) This question was commonly misinterpreted. Many candidates incorrectly stated that the type of bonding was 'single' or 'unsaturated' bonding instead of the correct 'covalent' bonding.

(ii) Few candidates answered this question. Of the responses given many candidates did not identify the correct product. Some candidates also drew structures where hydrogen had two covalent bonds.

(iii) This question was not answered well. Many candidates could only recall part of the definition of a hydrocarbon. Many weaker candidates needed to specify either that hydrocarbons are compounds or that hydrocarbons contain only carbon and hydrogen in their answer.

(c) Most candidates answered correctly. Only a few candidates incorrectly answered with 'filtration' or 'simple distillation'.

(d) Most candidates gave the use of gasoline / petrol. Common errors were that petrol / diesel was used as 'jet fuel' and that bitumen was used as 'ships fuel'.

Question 5

(a) Most candidates were able to answer this question correctly.

(b) Candidates found this 'kinetic particle model' question much harder, in some cases misinterpreting the question. Some candidates confused terminology, writing down a correct answer for separation rather than arrangement. Some candidates also compared states, referring to ways of changing the state of the liquid iron. In many cases the candidates confused bulk properties with particle movement. Many candidates incorrectly described the speed or distance between particles.

(c) Candidates did very well on this balancing equation question.

(d) (i) Most candidates knew the main ore of iron, however many spelt hematite incorrectly.

(ii) Many candidates could not give the correct reason carbon is burned in the blast furnace when extracting iron from hematite. Examples of incorrect answers were 'to speed up the reaction' or 'to remove impurities'.

(iii) Most candidates did not know the name of the solid compound. 'Slag' was the most common incorrect answer, suggesting candidates were unable to identify the thermal decomposition reaction of calcium carbonate when it is added in the process of extracting iron from hematite. Candidates may benefit from some practice identifying different types of reaction involved in this process. Some candidates gave calcium carbonate, suggesting they were unable to identify limestone as calcium carbonate.

(e) The majority of candidates answered this question correctly.

(f) Most candidates could name one barrier method to prevent iron from rusting. The most common incorrect answer was 'sacrificial protection'.

Question 6

(a) Candidates generally answered this question well. Most candidates could name at least one of the three products. A few candidates incorrectly answered this question with 'salt' instead of the correct 'calcium chloride' or gave 'hydrogen' instead of 'water'.

(b) Most candidates could state the correct colour. A few candidates incorrectly gave 'blue' or 'yellow'.

(c) (i) Few correct answers were seen for this question. Many candidates did not recognise that halide ions present in the acid make it unsuitable for use in a test for halides. Common incorrect answers were that hydrochloric acid was 'too reactive', 'too acidic', 'reacts with halide ions' and 'has a pH that is too low'. Some candidates referenced 'chlorine' rather than specifying the chloride ion present.

(ii) Most candidates correctly suggested 'nitric acid'. Weaker candidates answered with 'hydrochloric acid'. Candidates should take care to consider information they have already been given in the question.

(d) Many candidates could not deduce the insoluble compound. It was evident that solubility rules were not well known. Candidates may benefit from greater concentration on this area of the syllabus.

(e) Few candidates knew the correct formula of the carbonate ion.

Question 7

(a) (i) Most candidates answered this question correctly. The most common incorrect answer was plastic.

(ii) There were very few correct answers seen. Methane was the most common incorrect answer.

(iii) Most candidates gave the correct answer.

(b) Most candidates could work out the correct answer for this calculation using the given data. There were a few candidates who incorrectly applied the given data in their calculation. Some candidates were a factor of 10 or 100 out.

(c) Many candidates were unable to give a correct method. Some candidates needed to be more specific. For example, many candidates who gave incorrect answers responded with 'Burn less fuel' rather than specifying 'burn less fossil fuels'.

(d) Many candidates incorrectly described the properties of ionic compounds. Candidates would benefit from further study on the physical properties of simple molecular compounds.

Question 8

(a) (i) The most common incorrect answers seen were using the formulas of both ions instead of using the formulas of the correct elements, stating chloride was a product instead of chlorine and giving the correct products but at the wrong electrodes.

(ii) This question was well answered by many candidates. Some candidates incorrectly gave the name of an ion, cation or anode.

(b) Many candidates identified potassium ethanoate and spelled the chemical name correctly, although there were a few close spellings such as 'ethanote'. Incorrect answers such as 'potassium hydroxide' and 'potassium sulfate' were also seen.

(c) Most candidates answered this question correctly.

(d) Most candidates were able to calculate the relative molecular mass of ethanoic acid correctly. Common incorrect answers included 58 and 59 where candidates had incorrectly interpreted the number of hydrogens in the formula.

(e) (i) Few correct answers were seen on this question. Candidates were unable to recall the correct conditions for the industrial manufacture of ethanol from ethene and steam. Some candidates needed to be more specific in their response. For example, giving 'high temperature' rather than just 'temperature'. Some gave the correct conditions for fermentation rather than for the process of producing ethanol by hydrating ethene with steam.

(ii) There were many correct answers seen for this question. Some candidates gave vague answers such as 'medicine' and 'cleaning'. Candidates should be encouraged to learn at least one use for each of the substances mentioned in this syllabus.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

- Dot-and-cross diagrams were done well overall, but candidates should be advised to draw electrons in pairs. It is easier to count four pairs of electrons than attempting to draw eight individual electrons which can lead to omissions and additions to the required number of electrons.
- Candidates should take care when answering observation questions to give statements regarding something that can be seen (observed). For example, when colourless gases are emitted statements such as 'gas produced' or 'gas given off' are not observations as the key point is that effervescence/fizzing/bubbling needs to be seen before it can be concluded that a gas is given off or a gas is formed.
- Candidates should refer to the Periodic Table provided to check their answers.

General comments

The standard seen from the candidates was very high, with even the most challenging of questions answered well. Syllabus knowledge was very strong, and key definitions had been learnt with correct terminology.

The standard of handwriting was good, and candidates clearly showed an 'a' or an 'e' in suffix names of alkanes and alkenes.

Comments on specific questions

Question 1

(a) to (e) Candidates answered well on all parts.

(f) Most candidates were able to correctly recall the number of particles in one mole. Most candidates gave the syllabus value of 6.02×10^{23}. There is no need for candidates to give this value to 4 significant figures, 6.022×10^{23}.

Question 2

(a) Many candidates correctly gave the key points that an ionic bond is an attraction between ions and that the attracted ions are of opposite charges. Weaker responses described how an ionic bond forms, describing electron transfer from one atom to another in order to form complete octets. A few candidates described metallic bonding.

(b) The dot-and-cross diagram of the ions in potassium sulfide was done well. Omission of the third shell of 4 pairs of dots on the potassium ions was a common error. Weaker candidates just gave the ionic charges. All candidates should be encouraged to attempt all parts of the question.

(c) (i) Most candidates were able to arrange alternating charges on the ions. A common error was to draw all the ions on the lower face of the cube as '–' and all the ions on the top face as '+'.

(ii) Most candidates were able to give 'cations' as the correct name for any positive ion.

(d) (i) Most candidates were able to give 'electrolysis' as the correct name given to the process of decomposition by the passage of an electric current.

(ii) Many candidates were unable to give the correct balanced ionic half-equation for the reaction taking place at the anode. Common errors included negative ions gaining electrons ($2Br^- + 2e^- \rightarrow Br_2$), molecules becoming ions ($Br_2 \rightarrow 2Br^- - 2e^-$), Br rather than Br_2 as the product, and including K atoms or K^+ ions. These errors suggest this topic was not well understood and candidates may benefit from additional practice constructing ionic half-equations.

(iii) The question was well answered by many candidates. Effervescence/bubbling/fizzing as observations were commonly seen. Many candidates gave hydrogen as the correct product at the negative electrode. Some candidates were unable to give the correct products at the positive electrode. Some candidates did not know that oxygen is a product at the negative electrode, and candidates frequently gave bromine rather than water as a product. Weaker candidates tended to give ions such as H^+, K^+, OH^- or Br^- as products.

Question 3

(a)–(f) These questions were answered well by most candidates. Weaker candidates did not use the Periodic Table provided. A common incorrect answer for **(b)** was '4'.

(g) (i) Weaker candidates did not recognise that Cl^- ions were the missing product and many introduced K^+ ions. Some candidates also did not recognise that the ionic equation needed to be balanced.

(ii) Stronger candidates answered this question well. Many weaker candidates gave generic descriptions of redox reactions and needed to specifically refer to Cl_2 or I^- or to electron transfer.

(h) Most candidates answered this question well. Some candidates did not know the colour of iodine at room temperature, with 'blue-black' frequently seen.

Question 4

(a) The idea of a closed system was well known with some very good answers based upon the idea of reactants/products not being able to leave (or enter) the reaction vessel. One common misconception was that energy/heat could not be transferred to or from the reaction vessel. Many candidates repeated the information in the question by describing a sealed/closed container whilst others gave definitions of an equilibrium.

(b) Most candidates recognised the symbol and 'enthalpy change' or 'energy change of reaction'. Some candidates needed to be more specific in their response. For example, some candidates gave only 'enthalpy' or 'energy change'. Weaker responses stated 'activation energy'.

(c) Most candidates correctly stated the value was negative. Weaker candidates gave a description of an exothermic reaction (for example, 'gives out heat') without mentioning the minus sign.

(d) Most candidates knew that ΔH for the reverse reaction would involve a change of sign of the ΔH for the forward reaction. Missing the '+' sign was the most common error, and other candidates changed the magnitude.

(e) Many candidates understood how changing factors can affect an equilibrium.

(f) Many candidates were able to calculate correct answers. Most were able to calculate the energy needed to break the bonds in the reactants. The most common error was to subtract the magnitude of the enthalpy change ($105\,kJ/mol$) rather than add it for step 2. Many candidates also wrote '680' or '680 + x' as the second answer rather than giving the bond energy of $COCl_2$ suggesting they may not understand what they are calculating at each step.

(g) Most candidates completed this covalent dot-and-cross diagram very well. Weaker responses omitted non-bonding electrons, particularly on the oxygen atom. Many candidates opted to choose a third symbol in addition to the dots and the crosses. Candidates should be encouraged to complete diagrams of covalent bonding using just dots and crosses.

Question 5

(a) Most candidates answered this question correctly. Many weaker candidates were not able to deduce the number of protons, neutrons or electrons in the calcium ion. Incorrect numbers of electrons in the ion were a particularly common error. Candidates may benefit from additional practice working out the number of electrons in an ion.

(b) (i) Candidates performed well in this question. The common error was to use the term 'transitional'.

(ii) Candidates performed well in this question. Many candidates used the term 'valency' rather than oxidation state.

(iii) Candidates performed well in this question. Weaker candidates often gave formulae with 2 Mn atoms, for example, Mn_2O and Mn_2O_3. Occasionally, Mg was used in place of Mn.

(c) (i) Many candidates were able to correctly define the term reducing agent. Some candidates used ambiguous phrases such as: 'a substance that helps reduce another substance' or ' … and oxidises itself' (instead of '… is itself oxidised'). Candidates should be encouraged to be specific in their terminology when giving definitions. Weaker responses referred to electron gain/loss or oxygen loss/gain. A common error was to omit the oxidation of the reducing agent.

(ii) Most candidates understood that the missing product was aluminium oxide. Many candidates could not give the correct formula. Some candidates gave the correct formulae and could balance the equation. A frequently seen error was to give 6 Mn rather than 9 Mn.

(d) (i) This calculation was done successfully by most candidates. Many weaker candidates could not use the stoichiometry of the equation to determine the number of moles of Cl_2 formed from the moles of HCl used. Many did not convert the moles of Cl_2 into a volume of Cl_2 in cm^3 due to multiplying by 24, instead of 24 000.

(ii) Most candidates knew that bleaching of damp litmus paper is the test for chlorine gas. Some candidates confused chlorine with chloride and gave the formation of a white precipitate on addition of aqueous silver nitrate.

(iii) Most candidates stated that the particles have less kinetic energy. A common error was to state that there were 'less collisions' or there was 'less chance of a collision' rather than stating that the frequency of collisions decreases. Few candidates stated that a lower proportion/percentage of collisions had energy greater than activation energy. Weaker responses needed to be more specific. For example, using 'collisions with energy greater than activation energy' rather than 'successful collisions'. Weaker candidates commonly stated incorrectly that decreasing the temperature decreased the activation energy.

Question 6

(a) Most candidates correctly applied general statements in their responses, such as 'same functional group' and 'same general formula'. Some candidates answered in terms of the two compounds **A** and **B**. Common errors included stating 'Same molecular formula of C_nH_{2n}' where candidates confused molecular and general formula, and 'differ by a $–CH_2–$ molecule'. Some candidates also gave answers that needed to be more specific when referring to functional group. For example, stating that both compounds had a 'double bond' or 'carbon double bond' rather than specifying the carbon-carbon double bond.

(b) Most candidates answered this question correctly. Weaker responses did not specify that hydrocarbons contain only carbon and hydrogen atoms, or referred to carbon and hydrogen bonds and did not reference atoms.

(c) Most candidates answered this question correctly. Some candidates were unable to balance the equation. A common error amongst weaker candidates was to assume carbon dioxide and hydrogen were the products or to omit oxygen as a reactant.

(d) Most candidates were able to deduce the empirical formula of **A**. Common incorrect answers included CH_3 where candidates have not correctly interpreted the structural formula given or C_3H_6 where candidates have given the molecular formula.

(e) A common incorrect response was 'butene'. When naming unbranched alkenes with more than three atoms, it is essential that candidates use the IUPAC convention to identify the position of the double bond, as exemplified in section 11.2.3(a) of the syllabus.

(f) Most candidates correctly drew the displayed formula of but-1-ene. The most common error was to draw but-2-ene. Some candidates drew pentavalent or trivalent C atoms.

(g) (i) Most candidates were able to recall that in an addition reaction only one product is formed. Weaker candidates answered in terms of breaking double bonds, explaining saturation or stating bromine is added.

(ii) Many candidates did not know that the colour of aqueous bromine used in this test should be orange. Many responses referred to the colour 'red' suggesting candidates may be confusing liquid bromine with aqueous bromine.

(iii) Many candidates answered this question correctly. Some weaker candidates gave answers such as 'bromide butane' suggesting they did not know how to name the product of an addition reaction of alkenes with bromine. Some candidates could not give the correct nomenclature and common incorrect answers included 'dibromobutane', '1,2-dibromobutane' and '2,3-dibromobutene'.

(h) (i) Many candidates were not able to draw the displayed formula of the carboxylic acid with 2 carbon atoms. Common errors included incorrect numbers of carbons in the compound, and omitting the O–H bond in the carboxylic group. This suggests the overall structure of carboxylic acids and the number of carbons within this structure that make up the carboxylic functional group is not well understood. Candidates may benefit from practice drawing displayed formulas for compounds with different functional groups and total number of carbons.

(ii) Many candidates were able to name the carboxylic acid with 2 atoms.

(iii) Many candidates answered this question correctly. The most common error was to not balance the equation.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

- When plotting graphs, points should be plotted as a cross (x) or an encircled dot (⊙) and not obscured by the graph line, which should be drawn using a sharp pencil. A line of best fit can be curved or straight – whichever is the best fit for the data points. Straight lines should be drawn with the aid of a ruler and not drawn freehand, curves should be smooth and not just a line which moves from point to point. Graph scales should be chosen such that the plotted data takes up at least half of the available space. It is recommended that each major grid line should be equivalent to 1, 2 or 5 (or those numbers multiplied by 10^n) - this is indicated in the Presentation of Data section of the syllabus in the section entitled 'Graphs' (and also recommended by the Association for Science Education (A.S.E.)).

- Readings recorded from a given item of apparatus should all be recorded to the same resolution (the same number of decimal places).

- In the qualitative analysis question (**Question 2**), candidates are expected to use the term 'precipitate' when describing the formation of a solid from the reaction between two solutions; if when two solutions are mixed the product becomes cloudy and opaque then a precipitate has been formed.

- When a question asks candidates to identify an ion or ions, candidates may name ions or give formulae.

- In qualitative analysis, not all of the tests described will necessarily give a positive result; a negative test result is useful since it tells us that a certain ion is not in the compound being tested.

General comments

The paper was generally well answered.

In **Question 1**, most candidates obtained results that showed the expected trend in temperature changes.

When answering the planning question (**Question 3**), there is no need for candidates to spend time writing a list of aims of the experiment, safety precautions or variables. Candidates should be encouraged to explain what the apparatus is used for, rather than just list the items.

Comments on specific questions

Question 1

(a) Most candidates successfully completed the investigation and recorded results for all eight times in both experiments. Most candidates were able to calculate all of the temperature changes from 0 s correctly. Some candidates calculated the temperature change from the previous reading rather than from 0 s. Most candidates obtained a maximum temperature change in Experiment 1 that was similar to that noted by the supervisor and a greater temperature change in Experiment 1 than in Experiment 2.

(b) Many candidates correctly plotted the graph and drew curves of best fit. Weaker candidates selected difficult *y*-axis scales such as each large grid square being equivalent to 4 seconds, 6 seconds, 7 seconds or 8 seconds. These candidates often then plotted points incorrectly. Some candidates also plotted points at the incorrect times. Most candidates drew correct curves of best fit. Some candidates drew lines which connected each point or were made up of straight sections. Many candidates did not label the curves of best fit.

(c) Most candidates successfully extrapolated their graph line for Experiment 1. Some of the extrapolated graph lines showed a decline in temperature change that was too steep. The reading at 240 seconds was completed successfully by most candidates and most candidates remembered that units of °C were required. Some candidates omitted the unit.

(d) Many candidates answered this question correctly. A common error was to explain Experiment 1 being the more exothermic due to reaching a higher temperature rather than it having a higher temperature change. Candidates should be encouraged to link their answers to the results of the experiment.

(e) Many candidates understood that after three hours the reaction in Experiment 1 would be complete and the reaction mixture would lose heat energy to the surroundings and return to room temperature. Some candidates attempted calculations possibly based on previous temperature increases or decreases.

(f) The fact that copper is a good conductor of heat was well known. The most common error was to incorrectly state that copper would react with something. Copper will not react with zinc, iron or copper(II) sulfate solution.

(g) A common incorrect answer was to state that a thermometer should not be used to stir. Stirring with a thermometer will not change the accuracy of the experiment. Some candidates proposed using a digital thermometer, suggesting a confusion between the resolution of the reading and the accuracy. Some candidates suggested changes to the design of the experiment rather than to the apparatus used.

Question 2

(a) Many candidates noted the formation of a green precipitate. Some candidates noted the much more difficult to see observation of effervescence. A number of candidates stated that the precipitate was white. This is not possible given that a chromium(III) salt was used.

(b) Most candidates noted a green precipitate forming and that the precipitate remained when excess aqueous ammonia was added. Some candidates incorrectly stated that the precipitate turned brown near the surface. This aerial oxidation is not possible with chromium(III). Some candidates reported the precipitate as white, which is also not possible given that a chromium(III) salt was used.

(c) Most candidates noted a green precipitate forming and that the precipitate dissolved when excess aqueous sodium hydroxide was added. Some candidates incorrectly stated that the precipitate turned brown near the surface. Some candidates reported the precipitate as white. This is not possible given that a chromium(III) salt was used.

(d) Most candidates correctly stated that a white precipitate formed. Some candidates then gave a contradictory statement and stated that the precipitate dissolved. Some candidates stated that the

precipitate was green; often these candidates had stated that the precipitates in **2(b)** and **2(c)** were white.

(e) Most candidates correctly identified solution **A** as chromium(III) chloride.

(f) The expected flame colour of red was given by many candidates. The most common incorrect answer was orange-red, possibly due to contamination by sodium ions giving a mixture of the sodium and calcium flame colours.

(g) Most candidates answered this question correctly. The most common error was to state that the acidified aqueous potassium manganate(VII) became colourless. Some candidates stated 'no change'. While there is no reaction when purple acidified aqueous potassium manganate(VII) is added to solution **B**, candidates were required to record observations. In this case that the solution becomes pink.

(h) Most candidates correctly stated there was no reaction. Some candidates gave white precipitate or effervescence as an observation. These observations are not possible given the reagents used.

(i) Most candidates correctly stated that a white precipitate would form.

(j) Many candidates answered correctly. The most common error was to state that solid **B** contained sulfite ions. One of the tests carried out was the test for sulfite ions. This test should have given a negative result showing that solid **B** was not a sulfite.

Question 3

Some excellent and clear descriptions of electroplating were seen. Common errors included omitting a power supply from their diagram and giving incorrect materials for electrodes and electrolyte. For example, using the spoon as the anode rather than the cathode, using an inert electrode rather than silver as one of the electrodes, and using molten silver nitrate rather than a solution of aqueous silver nitrate as the electrolyte. A few candidates also labelled the named cathode with a positive charge. Candidates also commonly did not include washing and drying the spoon after electroplating in their plans. Some candidates did not draw a diagram, and others did not address missing the mass of the silver electroplated onto the spoon. Candidates should be encouraged to read and attempt all parts of the task stated in the question.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

- When plotting graphs, points should be plotted as a cross (x) or an encircled dot (⊙) and not obscured by the graph line. A line of best fit can be curved or straight – whichever is the best fit for the data points. A best-fit line does not need to pass through every point. The graph line should be drawn with a sharp pencil. Straight lines should be drawn with the aid of a ruler and not drawn freehand, curves should be smooth and not just a line which moves from point to point. Graph scales should be chosen so the plotted data takes up at least half of the available space. It is recommended that each major grid line should be equivalent to 1, 2, or 5 (or those numbers multiplied by 10^n) - this is indicated in the Presentation of Data section of the syllabus in the section entitled 'Graphs' (and also recommended by the Association for Science Education (A.S.E.)).

- Readings recorded from a given item of apparatus should all be recorded to the same resolution (the same number of decimal places).

- In qualitative analysis candidates are expected to use the term 'precipitate' when describing the formation of a solid from the reaction between two solutions. When two solutions are mixed if the product becomes cloudy and opaque then a precipitate has been formed.

- When a question asks candidates to identify an ion or ions, candidates may name ions or give formulae.

- In qualitative analysis, not all tests described will necessarily give a positive result. A negative test result is useful since it tells us that a certain ion is not in the compound being tested.

- All parts of the task described in the question should be attempted. Candidates should take care to read the questions carefully.

General comments

The paper was generally well answered.

When answering the planning question (**Question 4**), there is no need for candidates to spend time writing a list of aims of the experiment, safety precautions or variables. Candidates should be encouraged to explain what the apparatus is used for, rather than just list the items.

Comments on specific questions

Question 1

(a) Most candidates were able to identify the two errors. The most common incorrect answers included stating that a lid should not be used or that a solvent front had not been drawn. Other common incorrect answers were that the water should reach the baseline or that the water should not be used as the solvent. Weaker responses were often too brief, such as 'ink dots' or 'solvent' alone. These responses needed further explanation.

(b) Most candidates correctly stated that a pencil should be used to draw the baseline.

(c) (i) Most candidates correctly stated that either the blue or the yellow ink contained only one coloured dye. A few candidates incorrectly gave the green ink as the answer, possibly because the green was made from the yellow and the blue dyes.

(ii) Most candidates correctly stated that the orange ink could be mixed with the blue ink. The most common error was to select the purple ink, which would result in a mixture which lacked the yellow dye.

(iii) Most candidates correctly stated that the yellow dye was contained in the orange, green and black inks.

Question 2

(a) Most candidates were able to read the thermometer diagrams correctly. The most common error was reading the first diagram as 33 rather than 33.5. Most candidates were able to calculate the temperature changes from 0 s. Some candidates calculated the temperature change from the previous reading and some subtracted the temperature from the time. Some candidates repeated the times that had already been recorded on the table, rather than calculating the change. Many candidates did not consistently record temperatures to the nearest half scale division.

(b) Many candidates correctly plotted the graph and drew curves of best fit. Weaker candidates selected difficult *y*-axis scales such as each large grid square being equivalent to 4 seconds, 6 seconds or 7 seconds. These candidates often then plotted points incorrectly. Some candidates also plotted points at the incorrect times. Most candidates drew correct curves of best fit. Some candidates drew lines which connected each point or were made up of straight sections. Many candidates did not label the curves of best fit. When plotting the graph, if candidates find they have data in the table which does not fit on the grid, candidates are advised to revisit their calculations.

(c) Most candidates successfully extrapolated their graph line for Experiment 1. Some extrapolated graph lines showed a decline in temperature change that was too steep. The reading at 240 seconds was completed successfully by most candidates and most candidates remembered that units of °C were required. Some candidates omitted the unit.

(d) Many candidates answered this question correctly. A common error was to explain Experiment 1 being the more exothermic due to reaching a higher temperature rather than it having a higher temperature change. Candidates should be encouraged to link their answers to the results of the experiment.

(e) Many candidates understood that that after three hours the reaction in Experiment 1 would be complete and the reaction mixture would lose heat energy to the surroundings and return to room temperature. Some candidates attempted calculations possibly based on previous temperature increases or decreases.

(f) The fact that copper is a good conductor of heat was well known. By far the most common error was to incorrectly state that copper would react with something. Copper will not react with zinc, iron or copper(II) sulfate solution.

(g) A common incorrect answer was to state that a thermometer should not be used to stir. Stirring with a thermometer will not change the accuracy of the experiment. Some candidates also proposed using a digital thermometer, suggesting a confusion between the resolution of the reading and the accuracy. Some candidates suggested changes to the design of the experiment rather than to the apparatus used.

Question 3

(a) Most candidates were able to state correctly that a green precipitate would form and that the precipitate would dissolve in excess aqueous sodium hydroxide. A few candidates incorrectly stated that a colourless solution would form in excess aqueous sodium hydroxide, rather than green solution.

(b) Most candidates understood that the test carried out was the test for sulfate ions, and that there is no change as chromium(III) chloride does not contain any sulfate ions. A common error was to state that a white precipitate would form, this being the expected result for a positive sulfate test.

(c) Most candidates stated correctly that a white precipitate would be seen. Some candidates gave the precipitate colours for other halide ions.

(d) Many candidates were not able to clearly describe how to carry out a flame test. Candidates commonly did not state the type of Bunsen flame used. The placement of the test substance was commonly given as near the flame or over a flame rather than within the flame. Some candidates suggested tongs or spatulas be used to hold the test sample. Candidates should be familiar with the use of a wooden splint of nichrome (or platinum) wire to hold the test sample inside a flame.

(e) Many candidates did not understand that to warm a portion of solution B after aqueous sodium hydroxide had been added and test any gas given off with damp red litmus paper was a test for ammonium ions. Ammonia gas would have been given off if ammonium ions had been present. A common error was to confuse this test with the test for nitrate ions, where aluminium foil would also need to be added. Many candidates gave answers involving metal ions, such as zinc or aluminium. These responses may have been based on the addition of sodium hydroxide to the solution.

(f) Many candidates answered this question correctly. The most common error was to state that solid **B** contained sulfite ions suggesting that candidates recognised that **test 2** carried out was the test for sulfite ions. This test gave a negative result, as the acidified aqueous potassium manganate(VII) was not decolourised. Candidates should be familiar with both positive and negative results for a test.

Question 4

Some excellent and clear descriptions of electroplating were seen. Common errors included omitting a power supply from their diagram and giving incorrect materials for electrodes and electrolyte. For example using the spoon as the anode rather than the cathode, using an inert electrode rather than silver as one of the electrodes, and using molten silver nitrate rather than a solution of aqueous silver nitrate as the electrolyte. A few candidates also labelled the named cathode with a positive charge. Candidates also commonly did not include washing and drying the spoon after electroplating in their plans. Some candidates did not draw a diagram, and others did not address missing the mass of the silver electroplated onto the spoon. Candidates should be encouraged to read and attempt all parts of the task stated in the question.