CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

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

General comments

Some candidates performed reasonably well on this paper.

Questions 1, **3**, **28** and **31** proved to be particularly straightforward.

Candidates found **Questions 16**, **25**, and **36** more challenging.

Comments on specific questions

The following responses were popular wrong answers to the questions listed:

Question 2

Response **B** Candidates did not take account of the need to weigh the sample of magnesium.

Question 6

Response **A** Candidates did not take account of the fact that the question asked about an ion.

Question 11

Response **B** Candidates made the common error of confusing 'endo-' and 'exo-'.

Question 16

Response **C** Candidates missed the fact that excess alkali was added and therefore thought the solution ended up neutral. This response was more popular than the correct one.

Questions 25 and **36** had approximately equal numbers of candidates selecting each response. This indicates that many candidates were guessing.

Question 37

Response **D** Candidates confused the direction of the temperature gradient in the column or misunderstood the term 'volatile'.

Question 38

Response **B** Candidates did not know what the 'bromine test' showed.

Question 40

Response **D** Candidates were thinking of making a long-chain alkane from an alkene.

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Paper 0620/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on this paper.

Questions 1, **2**, **5**, **14**, **15**, **23**, **24**, **26**, **31** and **36** proved to be straightforward.

There were no questions that candidates found to be particularly difficult.

Comments on specific questions

The following responses were popular wrong answers to the questions listed:

Question 8

Response **B** Candidates did not take account of the relative molecular mass of the compound.

Question 9

Response **B** Candidates did not calculate that the calcium carbonate was in excess.

Question 11

Response **C** Candidates gave the answer that applied to inert electrodes. This response was more popular than the correct one.

Question 12

Response **C** Candidates made the common error of confusing 'endo-' with 'exo-'.

Question 13

Response **C** Candidates confused the energy change on making and forming bonds.

Question 17

Response **C** Candidates realised that the volume would increase but assumed, without considering the equilibrium, that this would result in the colour becoming lighter.

Question 20

Response **C** Candidates missed the fact that the alkali was in excess.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Better performing candidates read the stem of the question carefully in order to understand exactly what was being asked.
- Some candidates need more practice in answering questions involving qualitative tests.
- Many candidates need further practice in answering extended questions.
- Interpretation of data from tables and graphs was generally well done as were simple calculations.

General comments

Many candidates tackled this paper well, showing a good knowledge of core chemistry. Most candidates answered every part of each question. The standard of English was generally good.

Some candidates need more practice in reading and interpreting questions. In some questions, the rubric was misinterpreted or ignored. For example, in **Question 2(a)(ii)** and **5(d)(iii)** many candidates ignored the important phrases '**main** use of uranium' and '**major** contribution to climate change' and gave examples which were neither main uses or the main compounds responsible for climate change. In **Question 2(c)**, many candidates did not heed the words '**all** metals' and gave answers that only referred to transition elements. In **Question 5(a)**, many did not refer to a named acid or a named indicator. In **Question 6(b)(i)**, many candidates did not heed the instruction to refer to the equation and just gave a definition of reduction. In **6(b)(ii)**, a significant number of candidates gave a definition of exothermic, instead of referring to the energy levels or the arrow in the diagram.

Many candidates need practice in answering questions relating to qualitative analysis. Although some knew the test for hydrogen, many suggested that the test involved a glowing splint or just a splint. Very few candidates knew the test for sulfate ions. Many candidates did not take note of the word 'observations' in the stem of **6(d)(ii)** and wrote about the processes involved (transfer of ions or chromium being plated on the spoon) rather than focussing on what was seen (anode getting smaller or silvery coating on the cathode).

Some candidates need more practice in writing specific answers rather than providing vague unqualified statements. For example, in **2(a)(ii)** (main use of uranium), many suggested 'industry' or 'for radioactivity' whilst in **5(d)(i)** some candidates wrote 'factories' or 'chemical reactions'. In **5(d)(ii)**, many candidates wrote unqualified answers such as 'harmful' or 'affects the body'.

A minority of the candidates wrote good answers to the extended **Questions 3(c)(iii)** and **5(a)**. Others did not organise their work and wrote their answers down in a disordered fashion. Some candidates need more practice in answering questions about separation techniques and many did not use the information provided in the question. For example, in **Question 3(c)(iii)** many candidates did not use the differences in solubility given in the table and overlooked the word 'mixture' (of zinc and sulfur) and so tried to separate the solvent (often water) from a mixture of solvent and one of the elements only. In **Question 5(a)**, many candidates did not take note of the instruction to name the acid and the indicator.

Many candidates were able to extract information from diagrams of electronic structures as well as from tables and graphs. Others need more practice in answering questions about electroplating and electrolysis. Many candidates were able to undertake simple calculations involving relative formula mass and calculations involving simple proportion; others need to revise these areas.

Questions involving general chemistry including atomic and molecular structure, isotopes and homologous series were tackled well by many candidates.

Comments on specific questions

Question 1

This was one of the best answered questions on the paper. Many candidates identified at least four of the atoms correctly in **(a)** and performed well in **(b)**.

(a) (i) Most candidates identified the electronic structure of **C** (aluminium). The commonest error was to suggest **A**, which had a total of three electrons, rather than three electrons in the outer shell.

(ii) Many candidates identified the electronic structure of the noble gas. The commonest incorrect answer was **A** (lithium). A few candidates suggested **C**.

(iii) Nearly all the candidates identified the structure **E** as carbon. The commonest incorrect answer was to suggest **C** (aluminium).

(iv) This was almost invariably correct. Nearly all candidates identified the electronic structure **B** as having 18 protons.

(v) This was the least well answered of the **(a)** questions. The commonest error was to suggest the electronic structure of lithium (**A**), which forms an ion with a single positive charge rather than a single negative charge.

(b) Most candidates knew the correct electronic structure of silicon. The commonest errors were: drawing two or eight electrons in the outer shell; drawing four or more shells; drawing four electrons in the inner shell; drawing an excessive number of electrons in all the shells, e.g. 10 or 12.

Question 2

This was one of the best answered questions on the paper. Many candidates were able to deduce the correct number of electrons and neutrons in **(a)(i)**, complete the sentences correctly in **(b)** and give two physical properties of metals in **(c)**. Fewer gave the main use for uranium-235 in **(a)(ii)**. A majority of the candidates were able to balance the equation in **(d)** as well as calculate the relative formula mass in **(e)**.

(a) (i) Most candidates deduced the number of electrons and neutrons correctly. The commonest error was to confuse the electrons with the neutrons and suggest 143 electrons and 92 neutrons. A significant number of candidates suggested 235 (the mass number) for the number of electrons.

(ii) This was the least well answered part of **Question 2**. Many candidates ignored the important word 'main' in the stem of the question and gave general uses for radioactive isotopes such as 'to cure cancer' or 'to check for leaks in pipes'. Others gave vague answers such as 'in industry' or 'in weapons'. A significant number of candidates did not appear to understand what was being asked and gave a definition of isotopes rather than a use.

(b) Many candidates wrote at least two of the three words from the list in the correct spaces. The commonest errors were to suggest 'molecules', 'compounds' or 'elements' instead of 'atoms' in the first space and 'electrons' or 'compounds' instead of 'elements' in the second space. Most candidates knew that isotopes have different numbers of neutrons. A few suggested 'electrons' instead of 'neutrons'.

(c) Many candidates selected two suitable physical properties, which are characteristic of all metals. The commonest error were to suggest properties of typical transition elements such as high density high melting point and 'they are hard'. Candidates should realise that Group I metals have relatively low density and low melting point and are relatively soft.

(d) Many candidates gained at least two of the three marks available for the equation. Most candidates drew the correct sign for a reversible reaction. The commonest error here was to draw a single arrow, sometimes pointing backwards. The commonest balancing errors were 2 or 4 (H_2) and 4 (UH_3).

(e) A majority of the candidates calculated the relative formula mass correctly. A few did the calculations in the boxes correctly but did not add the value for the uranium or left the answer line blank. The commonest mathematical error was to suggest that 2 × 19 = 36 (for the fluorine). Very few candidates used atomic numbers instead of relative atomic masses.

Question 3

Some candidates performed well in **(a)(i)**, **(a)(ii)**, **(c)(i)** and **(d)**. Others made basic errors in the calculation in **(a)(iii)** and in balancing the equation in **(a)(iv)**. Very few candidates knew the test for sulfate ions in **(b)**. Many candidates gained one of the two marks available for balancing the equation in **(c)(ii)**; fewer gained both marks. Some candidates knew how to approach the separation of iron from sulfur in **(c)(iii)** by adding the organic solvent to the mixture. Others did not understand that the mixture needed to be separated and added either solvent or water to separate samples of zinc or sulfur.

(a) (i) Most candidates identified bromide ions. The commonest errors were to suggest sulfate ions (the highest not the lowest concentration) or iron ions (the lowest concentration of positive ions rather than negative ions).

(ii) Most candidates identified potassium bromide correctly. A few gave just one of the ions, e.g. 'bromide' or 'potassium'. The commonest error was to separate the ions and to write the negative ion incorrectly as 'potassium and bromine'.

(iii) Some candidates used simple proportion and calculated the mass of calcium ions correctly. Others either tried to do mole calculations (which is not on the core syllabus) or made simple mathematical errors by dividing by 100 rather than 1000 to get an answer of 110. Other common errors were 176 (4 × 44) and 294 (250 + 44).

(iv) Some candidates balanced the equation correctly by adding a single electron. Others disadvantaged themselves by adding two or more electrons so that the equation became unbalanced. Other common errors were e^+, F^- or just a negative sign without the e symbol.

(b) A minority of the candidates gained both marks for suggesting barium nitrate or barium chloride and the result as a white precipitate. In a few responses, instead of adding nitric acid they added sulfuric acid, which negates the point of the test. A wide variety of incorrect test reagents was seen including potassium manganate(VII), silver nitrate, sodium hydroxide and litmus.

(c) (i) Most candidates defined the term *sublimation* correctly. The commonest error was to suggest gas to liquid.

(ii) Many candidates balanced the sulfuric acid correctly by adding a 2 in front of it. A majority then put a 2 in front of the product SO_2, ignoring the fact that there was an additional S on the left hand side of the equation. Another common error was to suggest $4SO_2$.

(iii) Very few candidates gained full credit for this question. The best answers involved starting by adding the mixture of zinc and sulfur to the organic solvent, followed by the filtration of zinc from the solution with zinc being the residue. Many candidates either assumed that the solvent had been added already or that the solvent to be added was water. A significant minority did not use the mixture and added the zinc and sulfur to separate portions of either water or organic solvent. Many did not filter the zinc from the sulfur and so could not gain further marks. Others did not make it clear that it was the solution of sulfur that was being evaporated or implied that a solution of the mixture or zinc was being evaporated. There were many confusing or contradictory answers. Others gave answers which were insufficient such as 'dry the solution'. Some method of drying or evaporation was required e.g. 'leave on the windowsill for the solvent to evaporate'.

(d) Many candidates wrote the correct molecular formula. A considerable minority either miscounted the atoms, e.g. FSO_3 or SF_3O or gave a partially structural formula, e.g. SF_5OH.

Question 4

The name of the salt in **(a)** was well answered, as was the graphical work in **(b)(i)** and **(b)(ii).** Some candidates drew a correct line to show how the volume of hydrogen changes with time in **(b)(iii)**. Many others drew lines that only fitted one of the marking points. Parts **(c)** and **(d)** were generally well answered by a majority of the candidates.

(a) Nearly all the candidates gave the correct name for the salt as zinc chloride. A few suggested hydrogen or put down the name of both products.

(b) (i) Most candidates deduced the volume of hydrogen gas correctly. The commonest errors were due to misreading the graph by 2 units, e.g. 56, 52 or misreading the scale and suggesting a value of 47.

(ii) A majority of the candidates placed **S** on the curved portion of the graph. Others either placed a dot and an **S** at the two-minute mark or on the horizontal portion of the graph.

(iii) A significant proportion of the candidates drew lines of a shallower gradient and ended up at a volume below 70 cm^3. Others drew good lines with a greater gradient but made the final volume smaller or greater than 70 cm^3. Some candidates drew a straight line which did not curve and cut the 70 cm^3 line and continued further without curving. A significant number of candidates did not respond to this question.

(iv) Many candidates scored at least one of the marks available. Others disadvantaged themselves by writing vague answers, which did not refer to rate such as 'it takes longer to complete', 'the reaction goes further' or 'more products are formed'. Other common errors were to suggest that decreasing the temperature has no effect on rate or that the reaction rate decreases when zinc powder is used.

(c) Some candidates knew that the test for hydrogen involves using a lighted splint. Others suggested using a glowing splint or just a splint. A significant number of candidates wrote 'pop test' without any further elaboration. Others just suggested heating the test-tube rather than applying a flame or gave the chemical reaction 'hydrogen gives water when burnt'.

(d) A majority of the candidates scored both marks for the correct order of reactivity. The commonest error was to reverse the order of reactivity of zinc and iron. A few candidates also reversed the order of reactivity of strontium and magnesium.

(e) The calculation was answered correctly by a minority of the candidates. Others did their calculations in several steps and either rounded or truncated their answers.

Question 5

Parts **(b)** and **(c)** were generally well answered by a majority of the candidates. Many candidates need more practice at answering extended answer questions such as **(a)** (reactions of bases). Many candidates did not appear to know the reaction of ammonium salts with sodium hydroxide. Others did not write specific enough answers. Some candidates gave good answers to all sections of **(d)**. Others wrote statements that were too vague, especially in **(d)(i)** and **(d)(ii)**.

(a) Many candidates scored two out of the five marks available; fewer gained full credit. Many did not read the instructions to name an acid or to name an indicator and hence could not be given credit for specific names such as sodium chloride or specific colour changes such as red to blue. Many suggested that a salt and water were formed. The commonest error for the reaction between sodium hydroxide and an acid was to suggest that hydrogen is formed. Few candidates knew that ammonia is released when sodium hydroxide reacts with an ammonium salt. A common misconception was to suggest that there was no reaction because they were both bases. Another common error was to confuse ammonia with ammonium salts and suggest that ammonium was formed and ammonia was a reactant. Many candidates did not give the name of an indicator or gave an incorrect colour change for litmus (to red) or methyl orange (orange).

(b) A majority of the candidates realised that the pH of aqueous ammonia was pH 10. A considerable minority suggested either pH 5 or pH 7.

(c) Many candidates correctly identified the compounds present in fertilisers. Others chose only one correct option, usually sodium phosphate. The commonest error was to suggest sulfur dioxide. Others suggested copper(II) oxide.

(d) (i) Some candidates realised that oxides of nitrogen are formed in car engines and a few suggested the action of lightning. Others gave answers that were too vague such as ‘from factories’, ‘from chemical reactions’, ‘from engines’ or ‘from exhaust gases’. Some further qualification is required from these answers.

(ii) Some candidates recognised that particular parts of the body would be affected and in addition gave qualifying terms such as ‘irritates’ or ‘damages’. Others either wrote vaguely about ‘breathing problems’ or suggested ‘infections’ or ‘diseases’ that have implications of bacteria or viruses being involved. A significant minority muddled the effect of oxides of nitrogen with the effects of carbon monoxide and suggested ‘oxygen starvation’ or ‘combines with red blood cells’.

(iii) Some candidates correctly suggested carbon dioxide, methane or both. Others confused the effect of climate change with that of acid rain and suggested sulfur dioxide. Many candidates did not heed the important phrase in the stem of the question ‘major contributor to climate change’ and suggested other gases such as CFCs and carbon monoxide.

Question 6

This was one of the least well answered questions on the paper. In **(a)(i)**, a minority of the candidates wrote convincing arguments relating electrolysis to the reactivity of the metal. In **(a)(ii)**, many candidates suggested the correct electrolysis products. In **(b)(i)**, some candidates just gave a definition of reduction without referring to the equation. In **(b)(ii)**, many candidates did not refer to the diagram and just gave a definition of exothermic. Part **(c)** was generally well answered but many candidates did not state which elements they were writing about. In **(d)(i)**, many candidates did not identify the cathode or electrolyte correctly and in **(d)(ii)** and **(d)(iii)** many vague answers were seen.

(a) (i) Few candidates made reference to the relative reactivity of chromium. The best answers generally related that either chromium was a reactive metal or that chromium was higher in the reactivity series than carbon. Many thought that chromium metal would react with carbon or that chromium is less reactive than carbon. Others referred to boiling points, melting points or bonding without any further explanation.

(ii) Some candidates recognised that chromium is formed at the negative electrode and oxygen at the positive electrode. Others gained a mark for the two correct products at the wrong electrodes. Common errors were either to suggest that hydrogen is formed at one of the electrodes or that the ions rather than the elements are the products formed. A significant number of candidates misread the question and gave the answers ‘anode’ and ‘cathode’.

(b) (i) Many candidates just gave a definition of reduction without referring to the equation for the reaction. Others were not specific enough and referred to aluminium gaining oxygen rather than focussing on the chromium oxide. Many wrote vague statements about chromium. Candidates should realise that in answering this type of question, chromium atoms appear on both sides of the equation, so it is important to distinguish whether it is the chromium oxide or the chromium that is being referred to. Another common error was to suggest that oxygen is reduced. In the context of this question, the word reduced has a specific chemical meaning and it cannot be interpreted as ‘being removed from’.

(ii) Some candidates referred to relative energy levels of the reactants and products in the energy level diagram. Others just gave a definition of exothermic without sufficient reference to the diagram as instructed in the stem of the question. Others misinterpreted the diagram and gave answers such as ‘more reactant and less product’ or wrote statements that were too vague such as ‘the reactants are above the products’ in which there was no reference to energy.

(c) Many candidates performed well. Others did not state which element was being discussed. Statements such as 'it has a higher density' were given credit since chromium is the first subject in the stem but others could not be given credit because it was not clear which element was being referred to, e.g. 'they have high density' suggests that both chromium and sodium have high density. Some candidates gave general metallic properties such as electrical conductivity, which was not accepted. Others suggested that chromium itself was a coloured metal.

(d) (i) Many candidates thought that the cathode was the chromium rod or the wires in the circuit rather than the spoon itself. Many candidates mislabelled the position of the electrolyte, pointing instead to the anode or cathode. Candidates should also ensure that the arrowhead or end of their line from the label is carefully drawn. An arrowhead pointing towards the cathode but not joining it, could be interpreted as an (incorrect) electrolyte label, especially if that is the only thing that has been labelled.

(ii) The best answers referred to the chromium bar becoming smaller or being 'eaten away' or 'the spoon becomes shiny and silvery'. Most candidates did not give observations and wrote statements such as 'the chromium is on the cathode' or 'the ions go towards the cathode'.

(iii) The best answers suggested 'to reduce corrosion' or 'to make it more attractive and shiny'. Others wrote answers that were too vague to be awarded credit such as 'they react', where it is not clear whether the 'they' refers to the plating or the metal which is being plated. Some candidates referred to electrical conductivity, which was not accepted because it is a metal that is being plated with another metal.

(e) A majority of the candidates selected **K**, the diagram in which three different types of atom were randomly arranged. The commonest error was to suggest **J**, where there is a regular arrangement of the three different types of atom. A significant number of candidates chose **L**, where there is an irregular arrangement but only two types of atom.

Question 7

This question was well answered by some candidates. Others misinterpreted the negative numbers in **(a)(ii)** and did not give full enough answers in **(a)(iii)**. The electron arrangement in **(b)(i)** was generally well answered as was the matching of the petroleum fractions in **(d)**. The word equation for the combustion of an organic compound was not always well known in **(b)(ii)**. Many candidates were able to gain at least two of the three marks available for **(c)** (homologous series).

(a) (i) Some candidates realised that increasing the number of carbon atoms increases the boiling points. Many others misinterpreted the negative numbers and suggested that the boiling points decreased as the number of carbon atoms increased. A minority of the candidates did not score because they did not relate the boiling points to the number of carbon atoms.

(ii) Some candidates recognised that propane had the lowest melting point. The commonest incorrect answer was butane, which had the highest melting point. Methane was also a common incorrect answer, perhaps chosen because it has the least number of carbon atoms.

(iii) Many candidates correctly deduced that butane is liquid at –50 °C. Fewer gave a full reason for this. Some mentioned that this temperature was higher than the melting point or lower than the boiling point but only a minority mentioned both in relation to –50 °C. The best answers suggested that –50 °C is higher than the melting point but lower than the boiling point.

(b) (i) A majority of the candidates gave the correct electron arrangement for methane. The commonest errors were to add extra (unpaired) electrons either to the carbon atom or the hydrogen atom or draw three electrons in each of the overlap areas. A few candidates disadvantaged themselves by omitting an electron from one of the overlap areas.

(ii) A minority of the candidates were able to name both carbon dioxide and water as the products of the complete combustion of methane. Many suggested either carbon dioxide or water. The commonest errors included hydrogen (instead of water) or methane oxide (instead of either carbon dioxide or water). Carbon monoxide and methanol were other incorrect answers.

(c) Many candidates scored at least two of the three marks available. The commonest error was to suggest physical properties instead of chemical properties. Other candidates confused alkenes and alkanes and gave the answer in the first space as alkenes rather than the more general term, hydrocarbons. The idea of functional groups was well known.

(d) Most candidates were able to match the fraction to its use. The commonest error was to suggest that kerosene was used to make chemicals.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

When candidates are asked for observations, this means they must describe:
– colour changes
– physical states, i.e. solid, liquid or gas
– the formation of precipitates
– effervescence or bubbling when a gas is evolved.
It is unnecessary to give the names of substances when asked for observations or to give tests for gases unless they are requested.
If a certain number of answers is requested, e.g. 'Describe **two** differences', it is **not** advisable to give less than or more than the number requested.
Candidates should be aware that the correct procedure for writing an equation is to first write the correct formulae and then carry out the balancing.
Candidates should be aware of the distinction between bonding and structure and to know examples of each.
Candidates should be aware of the differences between chemical and physical properties and to know examples of each.

General comments

Writing correct formulae was challenging for candidates who otherwise performed well.

In questions that require a comparison, for example in **Questions 3(d)** and **6(f)**, candidates did not always make it clear what their answer referred to.

Candidates found **Questions 3(e)(iii)**, **4(b)**, **5(e)(ii)** and **6(g)(ii)** to be particularly challenging.

Candidates were often confused between the terms *weak* and *dilute* in **Question 4(c)(ii)**.

Comments on specific questions

Question 1

Most parts were answered extremely well by the vast majority of candidates.

In **(b)**, even though X_2O was given as the formula, magnesium and aluminium were seen quite often.

Question 2

(a) This was answered extremely well and very few errors were seen. Occasionally, 11 protons in **C** and a charge of –1 in **A** were seen.

(b) (i) This was answered well. Better performing candidates began their answer with 'An element is a substance….'. In some cases, answers suggested that an element is a type of particle as opposed to a type of substance.

Those who suggested that elements cannot be broken down, needed to qualify this statement with 'by chemical means' or 'into simpler substances'.

(ii) This was answered extremely well and there were very few errors. Occasionally, the neutron column showed 11, 12 and 13.

Question 3

(a) This was answered extremely well. Liquid and gas were only seen very occasionally.

(b) This was answered extremely well. Better performing candidates tended to draw non-bonding electrons in pairs.

(c) Common errors included representation of the formula of fluorine as F rather than F_2. The symbol of fluorine was occasionally given as F*l*. Occasionally, Na_2, Na_2F and NaF_2 were seen as incorrect formulae.

(d) This was answered quite well. Common errors included saying that fluorine was more reactive without stating what it is more reactive than. Some candidates compared the reactivity of sodium or sodium fluoride with chlorine instead of making the required comparison of reactivity of the two halogens.

(e) (i) This was answered reasonably well. A common incorrect formula was Pb_2F. This was presumably because some candidates thought that a compound whose name began with lead(II) must have a formula beginning with Pb_2. Other incorrect formula were seen, such as PbF_4; Pb(II)F_2 was only seen very occasionally.

(ii) This was answered very well. Ionic bonding was only seen very occasionally.

(iii) Candidates found this question challenging and there were many incorrect answers. Macromolecular and simple molecular were both common errors. Metallic was seen occasionally. Candidates should be aware that '*ionic'* is a type of bonding as opposed to a type of structure.

(iv) Intermolecular forces were mentioned in lead(II) fluoride, either as well as, or instead of, ionic bonds. Other contradictions such as ionic bonds between *atoms* meant that the mark did not score for ionic bonds in lead(II) fluoride. The term *electrostatic force of attraction* was used by some candidates who suggested that it meant the same as ionic bonding.

Vague statements such as 'lead(II) fluoride is ionic and there are strong forces between the particles' were insufficient because the particles should have been identified as ions.

Some candidates only referred to one of the two substances and explained why they had either a high melting point (strong bonds) or a low melting point (weak bonds) without offering a comparison. Candidates often referred to covalent bonds and intermolecular forces in tetrafluoromethane without making it clear which ones were broken when the substance melted.

The incorrect phrase 'weak covalent bonds' was often seen. Candidates should be aware that:

covalent bonds are strong

covalent bonds remain unbroken when simple molecular substances change state.

(f) (i) This was answered well. A small number of candidates made unnecessary references to saturated solutions. Some candidates stated that unsaturated substances do not contain single bonds.

(ii) This was answered well.

(iii) This was answered well. Dot-and–cross diagrams were unexpected, but scored if they were drawn correctly.

(iv) This was answered well. Continuation bonds were occasionally omitted. Brackets and –n were occasionally included.

(v) In addition polymerisation the polymer always has the same empirical formula as the monomer. This is because polymerisation occurs without loss of atoms. Many candidates were unaware of this. $(CF_2)_n$ or nCF_2 were occasionally seen. It should be noted that only general formulae contain 'n'.

Question 4

(a) The question instructs candidates to use 'the words *increases*, *decreases* or *no change*'. A minority of candidates did not follow this instruction and could not gain credit.

(b) Candidates found this question to be one of the most challenging on the paper.

The addition of the reagent magnesium or a carbonate produced the most marks. Candidates were expected to state the exact name of the substance they would add to the acid. Instead, they often used generic terms such as 'acid' or 'carbonate'. Sodium, which is far too reactive to add to an acid safely, was commonly suggested. Calcium, potassium and lithium would present similar problems, although candidates occasionally suggested their use.

Those candidates who used aqueous sodium hydroxide rarely mentioned that heat being produced is the only way to decide that a reaction has occurred. Formation of bubbles was a common incorrect suggestion. There are no other observations because two colourless liquids react to produce another colourless liquid.

Those who suggested the formation of an ester, by reaction with an alcohol, should be aware that this only occurs with carboxylic acids as opposed to acids in general.

Formulae such as $(CH_3COO)_2Mg$ or $(CH_3COO)_2Ca$ in equations were often incorrect.

(c) (i) Candidates should be aware that an acid is a proton donor. No other term adequately applies to all acids. References to pH, chemical reactions, effect on indicators or concentration, even if correct, were unnecessary.

(ii) There is a considerable amount of confusion concerning the terms weak and dilute. Many irrelevant references to pH were seen. Incomplete ionisation was only seen occasionally.

(d) (i) A variety of conditions were seen. The use of yeast was very common as were vague statements such as 'high temperature' or 'high pressure'. Conditions for other reactions on the syllabus were often seen.

(ii) This was answered reasonably well. The name was often correct even if there were errors in the structure. The structure of the ester functional group caused difficulties; ethyl methanoate was occasionally given as the name.

(iii) This was answered reasonably well. The name sometimes contained inappropriate numbers.

Question 5

(a) (i) This was answered well. Distillation on its own was seen rarely.

(ii) Candidates should be aware that carbon monoxide is toxic or poisonous and this is the reason it should not be released into the atmosphere. Many tried to give an unnecessarily detailed explanation of toxicity. Global warming and acid rain were seen occasionally.

(b) This calculation was answered very well. The only common error was to divide by 24 instead of multiplying by 24 in the final stage.

(c) (i) Almost all of the candidates were able to do this correctly.

(ii) This was often incorrect due to incorrect formulae. $NaCl_2$ was seen quite often. $NaCl_4$ was seen occasionally.

(iii) This was answered very well.

(d) (i) Candidates often responded by giving names of products rather than observations. Precipitates were often described.

(ii) This was answered correctly by most candidates.

(iii) Many answers commented on the fact that titanium was not very reactive. Only a few stated that titanium was less reactive than hydrogen, which is why titanium does not react with dilute hydrochloric acid (or produce hydrogen when added to any acid).

(e) (i) This was answered very well. Magnesium and chlorine were occasionally seen as incorrect products.

(ii) Candidates found this challenging. Many candidates thought that changing the electrodes would cause magnesium to form. A few suggested a more concentrated aqueous solution of magnesium chloride. A molten solution was mentioned occasionally.

Question 6

(a) Hardness and strength were occasionally mentioned, even though they were referred to in the question. Similarly, reference to being cut with a knife was seen. Chemical properties were occasionally seen, which led to difficulties for these candidates in **(b)** and **(c)**.

(b) Chemical properties were sometimes given. 'Being a solid' or 'being a metal' were the common incorrect answers. The correct statement that all metals conduct electricity when solid was mentioned rarely. Conductivity was occasionally mentioned without clarifying whether this referred to heat or electricity.

(c) This was answered well. Physical properties were occasionally seen.

(d) This was answered quite well. The colour change from blue to pink was occasionally reversed. The colour change for anhydrous copper(II) sulfate instead of cobalt(II) chloride was often given, i.e. from white to blue.

(e) (i) This was answered very well.

(ii) This was answered very well. Chromium was seen very occasionally.

(f) This was answered reasonably well. 'Copper is less reactive' was seen quite often but it was not made clear that copper is less reactive **than iron** and it could have incorrectly meant that copper is less reactive than magnesium.

(g) (i) $FePO_4$ was often incorrect, which meant that the response did not score highly.

(ii) Candidates found this extremely challenging. Many tried to explain why the iron(III) phosphate did not produce rust instead of explaining that it acted as a barrier. Thus, contact between the iron object and air/water was prevented.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

Burettes should be read to one decimal place for all readings including the differences.
In qualitative analysis exercises, candidates must follow the instructions given and record all observations, e.g. In **Question 2(f)** 'heat the solid gently and then more strongly'.
Candidates should be aware that the mark allocation reflects the number of valid points to be made for parts of questions, e.g. In **Question 2(b)** three marks were rarely obtained as only one or two observations were given.

General comments

The majority of candidates successfully completed all questions and there was no evidence that candidates were short of time. The paper as a whole differentiated very well and the complete range of marks was seen.

Supervisors' results were submitted by all of the Centres with the candidates' scripts.

In **Question 1(f)**, some candidates gave answers that suggested chemicals could enter your mouth when using a pipette – mouth pipetting should **not** have been experienced by any candidate as safety fillers should always be used.

Comments on specific questions

Question 1

(a) and **(b)**

Almost all candidates completed the tables of results. Common errors were:
- not recording all readings to one decimal place
- initial burette readings in **(a)** recorded incorrectly at values other than 0.0 cm^3
- final burette readings recorded incorrectly as values less than initial burette readings or values greater than 50 cm^3

Most candidates recorded results that were close enough to the supervisor's results to gain the accuracy marks.

(c) (i) Many candidates described the product of the reaction as a green solution instead of a precipitate and were penalised. Some candidates described a brown precipitate, which indicated that a fresh sample of solution **C** had not been tested as requested.

(ii) A majority of candidates correctly observed that a (red-)brown precipitate was formed. A minority described the precipitate as red or yellow, which indicated that the Notes on page 7 had not been used.

(d) (i) This was generally well-answered with solution **A** being identified as the more concentrated solution as less of it was used. Some explanations referred mistakenly to rate instead of volume.

Candidates who thought solution **B** was more concentrated as a larger volume of it was used showed a lack of knowledge and understanding.

(ii) This question was answered correctly by most candidates. Some candidates unsuccessfully tried to calculate an exact answer from their readings.

(e) (i) Most candidates correctly calculated the volume of solution **B** required but went on to give approximate values in their calculations, which were not credited. A significant number of explanations did not refer to the volume of solution **C** doubling and just said 'more **C** was used' or 'the concentration had changed'.

(ii) Better performing candidates realised that more than 50 cm^3 of solution was greater than the capacity of a burette and that this problem could be solved by refilling the burette or using two burettes. A large number of candidates focussed on issues with the conical flask not realising that the size of conical flask on the required apparatus list is specified to hold volumes of around 100 cm^3 so this was not an issue. Many candidates decided that a measuring cylinder should be used instead of a burette, which was an inappropriate idea.

(f) Many candidates mistakenly thought that an advantage of a measuring cylinder is that many different volumes could be measured, having ignored the fact that the question specified measuring 25 cm^3 of solution **C**. Credit was given for mentioning the speed or ease of measurement. Reference to convenience was ignored. Some candidates gave answers that suggested that chemicals could enter your mouth when using a pipette – **mouth pipetting should not have been experienced by any candidate as safety fillers should always be used.**

The disadvantage of using a measuring cylinder was often correctly identified in terms of less accuracy. Some candidates misread the question and gave answers that would have been correct if the question had asked for one advantage and one disadvantage of a *pipette*.

(g) Many incorrect references to solution **C** containing iron(II) ions **and** iron(III) ions were seen. Only better performing candidates realised that iron(II) had been oxidised to iron(III) in Experiment 3. Vague references to iron were common and several candidates thought chromium ions were present.

Question 2

Solution **D** was aqueous sulfuric acid.
Solid **E** was basic magnesium carbonate.

(a) This was generally well answered; a few candidates gave pH values of 4 or more. Solution **M** was strongly acidic.

(b) The vast majority of candidates reported effervescence and gave the correct test for hydrogen. Some candidates reported that they obtained a pop using a glowing splint or that they obtained the result of a pop without any test being conducted.

Some candidates reported that blue litmus turned red. It is not possible for hydrogen to do this and it is probable that spray from the acid left red spots on the litmus paper, suggesting that the technique used to test the gas with litmus paper was not good.

A few candidates gave impossible results such as the bleaching of litmus or limewater becoming milky.

(c) Some candidates reported the formation of a white precipitate. A significant number of candidates implied a colour change or effervescence. This test for a halide should be negative and responses such as no change, no reaction or no precipitate were expected.

(d) The formation of a white precipitate was often described. A minority of candidates referred to the precipitate as a solution or liquid and discussed the precipitate dissolving, which was incorrect.

References to cloudy or solid formation instead of the term *precipitate* were ignored.

(e) Most candidates correctly stated that the solid was white. References to a colourless solid gained no credit.

(f) (i) Only a minority successfully noted the formation of liquid drops or condensation on the walls of the test-tube. Vague answers such as gas or smoke scored no marks. Many candidates stated that there was no change or no reaction because they did not follow the instruction to heat the solid gently and then more strongly. A number of candidates reported that the solid melted, which it does not. What can be seen is the particles of powder moving about as a gas is given off.

(ii) If the candidates had followed the instructions, the solid would have decomposed on strong heating to form calcium oxide, which forms an alkaline solution with a pH > 7. It was evident that some candidates had not heated the solid strongly as they reported a pH of 7.

(g) Candidates gained credit for recording the effervescence seen when solid **E** and solution **D** were mixed. A significant number of candidates correctly described limewater turning milky. A minority tested for carbon dioxide using a lighted splint, which is not good practice.

(h) The formation of a white precipitate was often described. A minority of candidates referred to the precipitate as a solution or liquid and discussed the precipitate dissolving, which was incorrect.

References to cloudy or solid formation instead of the term *precipitate* were ignored.

(i) Many candidates correctly identified the presence of a sulfate. There were some references to acid. Better performing candidates named the solution correctly as sulfuric acid.

(j) Most candidates identified the presence of calcium or magnesium ions; a number stated that alkali metal or Group I metal ions were present. Most managed to identify the presence of carbonate ions from the test in **(g).** Most candidates successfully named the solid as calcium or magnesium carbonate.

Question 3

This was a good discriminating question with the full range of marks seen and some excellent answers.

Despite the fact that they were measuring the rate of reaction between magnesium ribbon and dilute hydrochloric acid, a number used sulfuric acid and tried to grind magnesium ribbon into a powder. Using a gas syringe was a common correct method. Those that used collection over water often used a test-tube instead of a measuring cylinder but still claimed they would be able to measure the volume. A few candidates measured the loss in mass of the reactants using a balance and were able to score full credit. Weaker responses described less appropriate methods, such as counting bubbles or timing how long it took for the gas produced to give a pop with a lighted splint.

Common errors included:

- not using a timer or being clear when timing or volume measurement was to take place
- no mention of keeping the amount of magnesium constant
- no mention of keeping the volume of acid constant
- using a single experiment which varied temperature during the gas collection
- omitting a comparison statement.

Only the better performing candidates could describe how the results could be used to find the rate of the reaction. Vague references to the rate being the same as the time of the reaction or ‘draw a graph’ were common.

Good answers gave experimental details such as:

- weighed amount of magnesium or set length of ribbon
- known volume of hydrochloric acid
- method of measuring the volume of gas using a gas syringe or measuring cylinder over water
- use of a stopwatch or timer
- measure volume of gas at set time or at fixed time intervals
- repeat at different temperature
- compare results or conclusion or using rate = volume ÷ time.

A significant number of candidates did not include a diagram as advised.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

All burette readings should be read to one decimal place, i.e. 15.0 rather than 15 cm^3.
When asked for observations, expected responses will include things that can be seen, such as bubbles, but not 'that a gas is given off'.
Candidates should be aware that the mark allocation reflects the number of valid points to be made for parts of questions.

General comments

The vast majority of candidates successfully 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 1(b)**, **1(d)** and **2(d)(ii)**, more demanding than the others.

In **Question 2(e)**, some candidates gave answers that suggested chemicals could enter your mouth when using a pipette – mouth pipetting should **not** have been experienced by any candidate as safety fillers should always be used.

Comments on specific questions

Question 1

(a) This was well answered. Electrolysis was the common correct response.

(b) A lack of familiarity with a Bunsen burner was evident from many responses to this question. Most answers concerned putting the flame close to the substance, removing the gauze or increasing the gas supply. Vague references to valves, knobs and taps were common. Only the candidates with practical experience of using a Bunsen burner realised that opening the air hole to increase the air supply was the adjustment needed to give a very hot flame.

(c) A lack of detail was prevalent with many of the answers given. Good answers referred to effervescence or production of a green gas and the formation of chlorine. Many candidates only gave an observation and did not explain this; others confused chloride ions with chlorine.

(d) Many responses showed an understanding that iron was not inert or that it was reactive but then incorrectly stated that iron would react with zinc or zinc chloride or the electrolyte instead of chlorine.

(e) (i) A number of responses did not refer to both the different observation, (bubbles or no silver solid), **and** the explanation, (hydrogen was formed). Better performing candidates realised that hydrogen was below zinc in the reactivity series.

(ii) The test for chlorine bleaching litmus was generally well known. The vague term 'indicator' was insufficient. Some candidates were confused and described a test for chloride ions.

(f) The majority of candidates understood the need for using gloves or eye protection such as goggles. Random answers involved fume cupboards and keeping zinc chloride away from water.

Question 2

(a) and **(b)**

All candidates completed the tables of results. Common errors were:

- failing to record all readings to one decimal place
- confusing the initial and final readings
- adding the values instead of subtracting to find the difference.

(c) (i) This was generally well-answered, with solution **A** identified as the more concentrated solution as less of it was used. Some explanations referred mistakenly to rate instead of volume.

Candidates who thought solution **B** was the more concentrated, as a larger volume of it was used, showed a lack of knowledge and understanding.

(ii) This question was answered correctly by most candidates.

(d) (i) Most candidates correctly calculated the volume of solution **B** required but went on to give approximate values in their calculations, which were not credited. A significant number of explanations did not refer to the volume of solution **C** doubling and just said 'more **C** was used' or 'the concentration had changed'.

(ii) Better performing candidates realised that 60 cm^3 of solution **B** was greater than the capacity of a burette and that this problem could be solved by refilling the burette or using two burettes. A large number of candidates focussed on issues with the conical flask, e.g. overflowing and spillage, not realising that this was not an issue. Many candidates decided that a measuring cylinder should be used instead of a burette, which was an inappropriate idea.

(e) Many candidates mistakenly thought that an advantage of a measuring cylinder is that many different volumes could be measured, having ignored the fact that the question specified measuring 25 cm^3 of solution **C**. Credit was given for mentioning the speed or ease of measurement. Reference to convenience was ignored. Some candidates gave answers that suggested that chemicals could enter your mouth when using a pipette – **mouth pipetting should not have been experienced by any candidate as safety fillers should always be used.**

The disadvantage of using a measuring cylinder was often correctly identified in terms of less accuracy. Some candidates misread the question and gave answers that would have been correct if the question had asked for one advantage and one disadvantage of a *pipette*.

(f) Many incorrect references to solution **C** containing iron(II) ions **and** iron(III) ions were seen. Only better performing candidates realised that iron(II) had been oxidised to iron(III) in Experiment 3. Vague references to iron were common and several candidates thought chromium or copper ions were present.

Question 3

This question tended to differentiate between candidates who had experience of laboratory practical work and past papers and those who had not.

(a) This was generally well-answered. A number gave a pH range, e.g. 0 to 6, which was penalised, and the commonest incorrect answer was pH 4.

(b) The vast majority of candidates reported effervescence and gave the correct test for hydrogen, using a lighted splint. Some candidates used a glowing splint or just a splint to obtain a pop or gave the result of a pop without any test being conducted,

(c) A significant number of candidates stated a colour change, the formation of a white precipitate or effervescence. Candidates were informed that solution **D** was sulfuric acid and therefore this test for a halide should be negative. Responses such as no change, no reaction or no precipitate were expected.

(d) Candidates realised that this was a test for sulfate ions and the formation of a white precipitate was often described. A minority of candidates discussed the precipitate dissolving, which was incorrect.

References to cloudy or solid formation instead of the term *precipitate* were ignored.

(e) Many candidates correctly identified the gas produced in test 2 as carbon dioxide or CO_2.

(f) Many candidates identified the presence of calcium or magnesium ions; a number stated that alkali metal or Group I metal ions were present. Most managed to identify the presence of carbonate ions from test 2 and successfully named the solid as calcium or magnesium carbonate.

Question 4

This was a good discriminating question with the full range of marks seen and some excellent answers.

Despite the fact that they were measuring the rate of reaction between magnesium ribbon and dilute hydrochloric acid, a number used sulfuric acid and tried to grind magnesium ribbon into a powder. Using a gas syringe was a common correct method. Those that used collection over water often used a test-tube instead of a measuring cylinder but still claimed they would be able to measure the volume. A few candidates measured the loss in mass of the reactants using a balance and were able to score full credit. Weaker responses described less appropriate methods, such as counting bubbles or timing how long it took for the gas produced to give a pop with a lighted splint.

Common errors included:

- not using a timer or being clear when timing or volume measurement was to take place
- no mention of keeping the amount of magnesium constant
- no mention of keeping the volume of acid constant
- using a single experiment which varied temperature during the gas collection
- omitting a comparison statement.

Only the better performing candidates could describe how the results could be used to find the rate of the reaction. Vague references to the rate being the same as the time of the reaction or 'draw a graph' were common.

Good answers gave experimental details such as:

- weighed amount of magnesium or set length of ribbon
- known volume of hydrochloric acid
- method of measuring the volume of gas using a gas syringe or measuring cylinder over water
- use of a stopwatch or timer
- measure volume of gas at set time or at fixed time intervals
- repeat at different temperature
- compare results or conclusion or using rate = volume ÷ time.

A significant number of candidates did not include a diagram as advised.