PHYSICAL SCIENCE

Paper 8780/01
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**C**	16	**C**
2	**C**	17	**D**
3	**C**	18	**A**
4	**B**	19	**C**
5	**B**	20	**C**
6	**C**	21	**C**
7	**C**	22	**A**
8	**C**	23	**B**
9	**C**	24	**C**
10	**C**	25	**D**
11	**A**	26	**D**
12	**B**	27	**A**
13	**A**	28	**D**
14	**A**	29	**B**
15	**D**	30	**C**

Key Messages: Chemistry

Some of the chemistry questions required candidates to recall knowledge; these included **Questions 11**, **13**, **15**, **17** and **26.** The level of success enjoyed by candidates in such questions varied considerably; in some cases many candidates were successful, in others, very few were. Thorough revision of basic topics is vital if candidates are to earn credit in question such as these.

General Comments

Candidates found **Questions 12**, **15**, **18**, **19** and **26**, **28** the most challenging. Candidates found **Questions 13** and **17** less demanding. On all but four of the chemistry questions in this paper, the correct answer was the one most frequently chosen by candidates.

Comments on Specific Questions

Section A

Question 11

A little less than half of the candidates recognised that the relatively low solubility of $Mg(OH)_2$ would cause it to be precipitated and so correctly chose **A** as their answer. Of the remainder, the majority chose **C**.

Question 12

About one third of candidates correctly deduced that the splint would relight and chose **B**. Almost as many candidates either ignored, or did not see the significance of the brown gas and selected **A**. If CO_2 had been the gas evolved, as deduced by this latter group of candidates, **C** would have also been true; therefore both **A** and **C** had to be wrong.

Question 13

This question was quite well answered, with well over two thirds of all candidates correctly choosing **A**. The most common incorrect answers were **B** and **D**; a few candidates selected **C**.

Question 14

Just over half of the candidates correctly deduced the volume of CO_2 to be $9.79\,m^3$ and selected **A**. The most common incorrect answer was **B**, suggesting that candidates who chose this response had used atomic numbers, rather than A_r values in their calculation. Relatively few candidates selected **C**, obtained by omitting the M_r value in the calculation, or **D**, obtained by incorrectly converting the mass of SiO_2 from kg to g values.

Question 15

Candidates found this challenging, with about one third correctly choosing **D**. The most common incorrect answer was **B**. This suggests that a significant minority of candidates misread the question and answered it in terms of the increase in oxidising power of the halogens, rather than halide ions down the group, as written in the question.

Question 16

Almost half of the candidates correctly deduced the answer to be **C**. There was a fairly even distribution among the incorrect answers, suggesting that many candidates lacked confidence in this area of the syllabus.

Question 17

This question was very well answered, with a high percentage of candidates correctly choosing **D**. There was an even distribution among the incorrect answers, suggesting that candidates lacked confidence in this area of the syllabus.

Question 18

Candidates found this question challenging. Marginally the most common answer was **D**, with about one quarter of candidates correctly choosing **A**. The even distribution of answers across the four alternatives suggests that many candidates lacked confidence in this area of the syllabus.

The question required candidates to show an understanding of what is meant by the enthalpy change for formation. The required equation must show the formation of one mole/molecule of product (eliminating **B**), from its elements (eliminating **D**) in their natural states under standard conditions. As **C** shows oxygen as atoms rather than as molecules, it is also incorrect.

Question 19

Candidates found this question challenging. Almost two thirds of candidates correctly deduced that **Z** would form the least number of isomers (just one) and so chose either **C** or **D**. Of these, a significant majority incorrectly opted for the symmetrical molecule, **X**, to have the most isomers (it has just three). The unsymmetrical isomer, **Y**, has the greatest number of isomers (four); relatively few candidates correctly deduced this.

Question 20

Many candidates found this question challenging. Just over half of the candidates deduced that the monomer was a butene (**B** or **C**); of these, a majority correctly selected **C**.

Section B

Question 26

This question required candidates to use their knowledge of the electrolytic processes used in producing aluminium and copper metals. Candidates were asked to identify common features in these two processes. Candidates found this question challenging, with just over one tenth of the candidates correctly selecting **D**. The most common incorrect answer was **C**.

Response **1** is incorrect, as copper metal is used as the cathode in the copper process; response **2** is incorrect as the solvent in the aluminium process is molten cryolite and response **3** is incorrect as the graphite anode in the aluminium process burns away.

Question 27

This question required candidates to display an understanding of basic kinetic theory. Just under a half of all candidates correctly selected **A** by recognising that responses **1** and **3** effectively say the same thing and the consequence of response **1** is a decrease in collision rate. Response **4** is incorrect, as the two experiments are performed at the same temperature and no catalyst is used in either experiment. The most common incorrect answer was **C**.

Question 28

Well over half of the candidates selected either **C** or **D**, suggesting that they had correctly ruled out the possibility of converting propanone into propanoic acid (response **1**) and using $NaBH_4$ as an oxidising agent (response **3**). Having correctly rejected **A** and **B**, a large majority of these candidates thought that propan-2-ol could be converted into propanoic acid and so chose **C**. Just under a quarter of candidates correctly selected **D**.

Question 29

Just under half of the candidates correctly selected **B**. The most common incorrect answer was **C**, suggesting there was some confusion as to the nature of the reaction occurring with ethanolic sodium hydroxide. As both substitution and elimination occur concurrently whichever solvent is used, response **1** is correct and response **2** must be incorrect. In ethanol, the main reaction is elimination forming propene as the major product (response **3**).

With this type of question, when response **1** is correct and response **2** is wrong, response **3** must be correct and response **4** wrong. Logically, in such circumstances, **B** has to be the correct answer.

Question 30

This question required candidates to identify CH_3^- as being a nucleophile and to recognise that it will attack partially positive atoms (such as $C^{\delta+}$ atoms found in halogenoalkane molecules). As responses **2** and **4** are both halogenoalkanes, the correct answer is **B**. Less than half of the candidates made this deduction.

The numbers of candidates choosing **A**, **C** and **D** were approximately equal, suggesting that many candidates were not confident with this area of the syllabus.

General Comments: Physics

Questions 17 and **22** were done very well, whereas candidates found **Questions 5** and **6** particularly challenging.

Comments on Specific Questions

Section A

Question 1

The question was done well, with the majority of candidates showing a good understanding of the prefixes used to vary the sizes of basic units.

Question 2

A majority of candidates recognised that only the accuracy of a reading is affected by a zero error. A significant minority were under the misapprehension that both accuracy and precision are affected. Candidates who performed well, had a good understanding of key terms like *accuracy* and *precision*.

Question 3

Candidates were not confident in this area of the syllabus. Only a minority recognised that force is defined as the rate of change of momentum, with a large number thinking that it is defined by work done divided by displacement. Candidates who performed well understood that work is defined as force multiplied by displacement.

Question 4

A large majority of candidates showed an understanding of the term *centre of gravity*.

Question 5

This question showed that the vast majority of candidates have little understanding of forces acting on a body. The only forces acting on the pendulum bob were the weight of the bob and the tension on the string. The centripetal force is the horizontal component of the tension in the string and **not** a separate entity in itself.

Question 6

Candidates were not confident in this area of the syllabus. The extra pressure is balanced by the height difference between the columns of liquid in the two arms. The vast majority of candidates thought that it is the distance the liquid moves in a single column.

Question 7

The vast majority of candidates recognised that the amount of diffraction increases with decreasing gap width. Some candidates also recognised that the amount increases with increasing wavelength.

Question 8

Most candidates correctly worked out the circuit resistance as 60 Ω. Many candidates did not recognise that the resistance of the thermistor was this value minus the value of the fixed resistor in the circuit.

Question 9

Virtually all candidates recognised that the power ratio was 4:3. Nearly half of those did not recognise the inverse relationship between power dissipated and resistance.

Question 10

The question was done well, with only a small minority showing any confusion.

Section B

Question 21

The vast majority recognised that diagram 4 showed a system in which there was a couple only (with the resultant translational force being zero). Half of those candidates also recognised that diagram 2 also showed a situation where there is a couple only.

Question 22

The question was done very well, showing a good qualitative understanding of the microscopic reasons why a gas exerts a pressure on the walls of a container.

Question 23

Most candidates recognised that equal frequencies and coherence are needed for interference to be observed. A significant number thought that the waves also had to be in phase.

Question 24

Candidates found this question challenging, showing a lack of understanding of the use of Kirchhoff's laws. There was no single common error, with almost equal numbers of candidates giving each response.

Question 25

The question was done well, with the majority of candidates showing an understanding of the term *random.*

PHYSICAL SCIENCE

Paper 8780/02
Paper 2: Short Response

Key Messages

The importance of a solid knowledge of basic facts and terminology cannot be overestimated in the search for success at this level.

A fair number of candidates were reasonably well prepared for this examination; others were not. This was particularly noticeable in questions that required simple recall or the application of standard techniques. Success at this level can only be achieved thorough preparation.

General Comments

There were some excellent papers from some candidates, where it was clear that these candidates had developed a clear understanding of the theory and concepts tested in the paper. There were others where there was a good understanding of the basic science, but where difficulty was experienced when dealing with some ideas. **Questions 6** and **12(a)** were done well. In contrast, candidates found **Question 8** more challenging.

Many candidates struggled with questions based on required syllabus knowledge. In particular, the attempts in **Question 5** (shapes of molecules) and in **Question 9(a)** (structural isomerism) revealed widespread misunderstanding of these topics.

Poor handwriting made the marking of the work of a small minority of candidates rather difficult.

Comments on Specific Questions

Question 1

This question tested candidates' comprehension of a sphere falling with significant resistive forces. Many candidates showed a good understanding. There were many who did not express themselves clearly. Better performing candidates identified the forces acting on the sphere, the gravitational force / weight and the resistive / frictional force. They recognised that it was the increase in the resistive force as the sphere's speed increased that caused the acceleration to decrease. These candidates also recognised that when the resistive force is equal to the gravitational force, then the ball fell at constant speed. Some candidates were careless in their use of terminology; for example, stating that the ball moved with constant speed when the acceleration was equal to the resistive forces.

Question 2

Overall, this question was well answered. Many candidates were able to correctly deduce the empirical formula. Some candidates did make mistakes, such as the use of 24.3 as the A_r(Na) and 32 as the A_r(O); representing the sodium atom as 'S'; multiplying the percentages by the A_r values and quoting the empirical formula as $Na_2Cr_2O_7$, with no working shown.

Question 3

The understanding of definitions is an important facet of developing an appreciation of physics. Terms without a precise meaning are of no use in the subject. In this case, candidates needed to understand that they were defining a unit (of charge), that had to be defined in terms of other more fundamental units. Better performing candidates used the units of current and time (the ampere and the second), not in terms of the quantities current and time.

Question 4

Candidates needed to recognise the circuit symbol for the diode and then to recognise that this is the significant component in the circuit. In order to do this, candidates needed a through grounding in working with electrical circuits and circuit diagrams. Many candidates showed their lack of understanding of electrical circuitry by thinking that the current was used up in the resistor and did not reach the ammeter.

Question 5

This question was poorly answered, suggesting that most candidates lacked practice with questions involving the shapes of molecules.

Very few candidates were able to draw, or name, the shape of the PCl_5 molecule. Most of the diagrams drawn in **(a)(i)** showed a clearly planar pentagonal molecule. Very few candidates attempted to draw a three-dimensional diagram of the molecule. Some diagrams incorrectly showed the presence of lone pairs of electrons.

Similarly, in **(a)(ii)**, very few candidates offered trigonal bipyramid as the name of the shape of this molecule; the most common incorrect name was tetrahedral. A small number of candidates gave partially correct names such as bipyramidal, trigonal pyramidal or trigonal biplanar.

Some candidates were able to deduce and draw a tetrahedral shape for this ion in **(b)**. A large majority of candidates experienced difficulty in drawing this shape; the most common error was showing the ion as being square planar in shape.

A significant minority of candidates drew dot-and-cross diagrams for both species.

Question 6

The question was done well, with very few candidates counting four subdivisions after the six and thinking that the reading was 6.4 mA. Similarly the candidates could generally use the calibration graph correctly.

Question 7

A fair number of candidates were able to show some familiarity with the trend in first ionisation energy across Period 3. A significant number of candidates found this question challenging.

Some candidates correctly explained, in **(a)**, the increase in ionisation from sodium to magnesium in terms of the proton number. Many gave incorrect explanations based on atomic size, the presence of a stable electron pair/full orbital or the presence of an extra electron in the outer shell.

The answers offered in **(b)** were, overall, of much better quality than those given in **(a)**. Many candidates correctly identified the electron removed from the Mg atom as coming from the $3s^2$ electron pair, and that from the A*l* atom as coming from a 3p orbital. Acceptable explanations of why A*l* has a lower first ionisation energy than Mg were also quite frequently seen.

Question 8

Candidates found this question very challenging. Amongst those who did show some understanding, the most common error was to translate the angle between the tension force and the vertical as 35° not 55° (90–35). Other mistakes were not having the directions of the three forces in the correct sense, all going round the triangle in closed loop.

Question 9

In **(a)**, most candidates indicated that isomers have the same molecular formula, but relatively few then went on to state that structural isomers have different structural formulae. Many candidates completed their definitions with a vague reference to their having different arrangement of atoms or different displayed formulae; statements that could equally well apply to stereoisomers/cis-trans isomers.

Some good attempts were seen in **(b)**, with candidates drawing unambiguous structures for methylbutane and dimethylpropane. There were also a considerable number of duplicated, inaccurate or chemically impossible structures.

A significant minority of candidates drew one or both structures having molecular formulae different to that of pentane, C_5H_{12}. Others simply drew twisted versions of pentane. It was not unusual for structures to carry a terminal CH_2 group, a C=C bond or an excess of hydrogen atoms.

Question 10

There were some reasonably good answers to this question. Many candidates did not express themselves clearly. It is important that candidates read what they have written, to ensure that it says what they intend and does not contradict itself.

Question 11

In **(a)(i)**, most candidates correctly named the process as cracking. A few gave more than one name, with an incorrect name contradicting the correct one. The most common incorrect answer was fractional distillation; hydrolysis, polymerisation, contact process, hydrocarbonisation, fracking and combustion were also seen.

Many candidates coped quite well with the equation in **(a)(ii)**; mistakes were also quite common. There were two possible correct equations, one showing single molecules of propene and butene, the other showing two of each.

Some incorrect equations showed hydrogen as a product. In most cases, incorrect equations showed products where the combined number of carbon atoms was not seventeen.

The question states that there should be three different product molecules (propene, butene and one other product); it was not unusual to see an equation with more than three different product molecules.

Many candidates found **(b)** challenging and were not able to demonstrate familiarity with polymerisation equations. In most instances, the repeat unit in the structure of the polymer showed four carbon atoms, all in a line; the correct repeat unit has only two such carbon atoms, one of which carries an ethyl group side-chain.

A significant number of candidates were able to draw an acceptable displayed formula for but-1-ene.

Question 12

(a) The vast majority of candidates recognised this as alpha (α) decay. Answers such as a helium nucleus /ion were also accepted. However, it is worth pointing out that if the question had asked for the type of decay, only alpha (or α) would have been acceptable

(b) Some candidates found it difficult to understand that a neutron decays into a proton and thus the number of protons in the nucleus increases by one, but there remains the same number of nucleons

PHYSICAL SCIENCE

Paper 8780/03

Paper 3: Structured Questions

Key Messages

It was clear from many of the answers seen that a significant number of candidates had not read the questions carefully enough to allow them to give appropriate answers. This was particularly noticeable in **1(a)**, **1(b)(ii)**, **6(c)(ii)**, **7(c)(ii)** and the observations given in **8(c)(iv)**.

General Comments

Despite there being a number of candidates who had not been thoroughly prepared for the examination, there was a pleasing improvement in the general standard shown in the answering of the physics questions. Many candidates showed a genuine understanding of the basic principles and also had the ability to apply those principles in more complex situations.

As mentioned last year in the report on the chemistry questions, there was clear evidence of a lack of effective preparation on the part of a significant number of candidates. However, the overall level of performance in areas such as calculations and organic chemistry did show some improvement on previous years.

A significant number of candidates omitted answers to some parts of questions. It is likely that this was due to lack of specific preparation, rather than to time constraints, as such omissions occurred throughout the paper rather than just at the end.

Comments on specific questions

Question 1

The answers to this question showed that many candidates had a good knowledge of the basics of Rutherford's alpha scattering experiment. A considerable percentage showed a real understanding of the detail and of the relevance of the experiment to the development of the understanding of the atom.

(a) The most common error in this section was a failure to recognise that there was a model of the atom prior to the 'solar system' model. Where this error occurred, it inevitably led to confusion when the candidate tried to draw conclusions in **part (b)(iii)**.

(b) (i) There were many good answers with candidates adding detail such as 'the experiment was done in a vacuum' and giving details of the detection system. The most common error was to give the incorrect radiation that was used to bombard the gold leaf; atoms, ions, electrons and protons were often seen. Another error, less commonly seen but still not unusual, was for candidates to imagine that an individual gold atom was bombarded.

(ii) Again, there were many good answers, the best making clear that it was only a tiny fraction of the incoming alpha particles that were deflected through large angles.

(iii) The better candidates showed a clear understanding of how the results led to the idea that the atom has a small, positive nucleus which holds the majority of the mass of the whole atom.

Question 2

This is a question that tested candidates' knowledge and understanding of periodicity and the effect that intermolecular forces have on the physical properties of substances. Some candidates coped well with the question; however, many struggled.

(a) This question required candidates to use their understanding of the trend in acid-base behaviour across Period 3. Those candidates who were familiar with this topic were able to write an appropriate equation in **(a)(i)**; however, many candidates struggled here. Equations showing incorrect species such as: H_2 or O_2 as products; $Na_2(OH)_2$; NaO and NaO_2 were quite common. The question carried two separate answer lines and the question asked for more than one equation to be written. Despite this, some candidates attempted to write a single equation to cover both oxides.

Some candidates correctly identified basic, amphoteric and acidic oxides across Period 3; others described the change from basic on the left to acidic on the right. All such candidates earned credit in **(a)(ii)**. Other candidates ambiguously described the oxides as becoming more acidic across the period. Such statements could be interpreted to mean that all the oxides were acidic and that the acidity increased across the period; or, conversely, that they were all bases and that the basicity decreased across the period. Such answers earned no credit. A number of candidates linked the acidic or basic nature of the oxides to the elements being metallic or non-metallic, rather than to the position of the elements in the period.

A few candidates got the trend completely wrong by suggesting that the oxides become more basic across the period.

The syllabus requires candidates to interpret the trend in acid-base behaviour in terms of bonding and electronegativity. In **(a)(iii)**, very few candidates were able to do this. The trend in the bonding present in the oxides from ionic to covalent was only very rarely described. Attributing this trend to a decrease in the electronegativity difference between oxygen and the element was not seen. The ionic nature of basic oxides and the covalent nature of acidic ones was mentioned by a few candidates.

The meaning of the term *amphoteric* was well known and clearly explained in **(a)(iv)**.

(b) Overall, **(b)(i)** and **(b)(ii)** were well answered. Many candidates correctly named the two types of intermolecular force present. In some instances, candidates named the same intermolecular force in both parts or reversed the correct answers.

In **(b)(iii)**, a large number of candidates paid too little attention to the wording of the question, which asks why the boiling point of water **is so much higher** than that of hydrogen sulfide. To earn credit here, the much higher strength of the hydrogen bonding needed to be emphasised.

Question 3

(a) (i) This part-question was done well by many candidates, but there were a number who showed no real understanding of the graphs nor of how to use them to find the period of the oscillation and hence the frequency. Amongst those who showed a good understanding the most common error was to miss the point that the time axis was calibrated in milliseconds, not seconds.

(ii) It was encouraging that a good number of candidates recognised the relationship between frequency and amplitude.

(iii) Although many candidates were able to follow up **part (ii)** correctly, there was a significant number who showed their lack of understanding of the consequence of the intensity being proportional to the amplitude squared rather than just the amplitude.

(b) (i) The majority of candidates recognised that the sound variation was due to the interference between the incident and reflected sound waves. Explanations needed to discuss the idea that the loudness varied according to the phase difference between the two sets of waves - the loud sounds being heard where the two sets of waves are in phase (and therefore the contributions adding), and quieter sounds being where the waves are out of phase (and therefore the contributions subtracting). To gain full marks, candidates also needed to show some recognition that the phase differences are caused by the two sets of waves travelling different distances.

Common misconceptions were that soft sounds would be heard where two troughs meet and loud sounds where two peaks meet. This shows a fundamental misunderstanding of superposition.

(ii) Many candidates recognised that it was necessary to calculate the wavelength of the sound waves, and this was done correctly by most. However few took the step of realising that the phase difference required for destructive interference is equal to ½ a wavelength, and that the reflected wave travels to and from the reflective surface so the distance between a maximum and a minimum is ¼ of a wavelength.

(iii) This section required candidates to use their understanding of the graphs and to recognise that the amplitudes of the two sets of waves were different, and hence that even when 180° out of phase they would not fully cancel. This is a sophisticated idea of which few candidates showed an appreciation.

Question 4

Overall, this question was quite well done, although some candidates struggled with **(b)(i)** or experienced problems in **(b)(iii)** due to the calculated M_r value being lower than that of anhydrous sodium carbonate.

(a) Most candidates correctly determined the number of moles of $NaCl$ and $NaHCO_3$. Applying the mole ratio to determine the number of moles of Na_2CO_3, however, was frequently omitted and many candidates gave a final mass that was double the correct one.

(b) In **(b)(i)** a large proportion of candidates correctly calculated the amount of HCl, however errors here were quite common.

In **(b)(ii)**, a small number of candidates correctly applied the mole ratio to their answer from **(b)(i)** to obtain the amount of sodium carbonate present in the sample. Many candidates, including most of those who had forgotten to apply the mole ratio, were then able to use the mass of the sample and the amount of sodium carbonate present to determine a value for the M_r of the washing soda.

Question 5

(a) (i) The majority of candidates were able to use the correct formula but a very common error was to ignore the mass of the bullet in the calculation. Also, a significant number of candidates did not convert the mass of the bullet from grams to kilograms, a fundamental error at this level.

(ii) Candidates needed to recognise that the kinetic energy of the bullet before impact (in the absence of the other changes described in the assumptions) would all be converted to gravitational potential energy.

(b) (i) This was done reasonably well, but again there was a failure to use the correct units by a number of candidates.

(ii) This section caused a great deal of problems with many candidates showing no understanding of how to proceed. Those that did recognised that they needed to use the principle of conservation of momentum.

(iii) Most candidates understood that for a collision to be elastic, the kinetic energy of the approaching bullet needed to be equal to the kinetic energy of the block and bullet after the impact. However, there was some confusion in the actual comparison and also in candidates' ability to express themselves clearly.

Question 6

(a) Many candidates were able to recall the triple bonding present in nitrogen molecules. Of these, some, but by no means all, went on to attribute the unreactive nature of nitrogen to the great strength of this bond. Some candidates recognised the great strength of the bond but made no reference to it being a triple bond. Both points were required if credit was to be awarded in **(a)(i)**.

The equation in **(a)(ii)** was, generally, correctly written.

(b) Many candidates understood that the *activation energy* is required if collisions between particles are to be successful. However, very few earned credit in **(b)(i)** by defining the activation energy as the *minimum* energy required for a reaction to occur/for a collision to be successful.

Most candidates made a fair attempt at drawing the energy profile for the reaction. In some instances the activated state was represented by a series of straight lines, rather than by a hump; both representations could earn credit in **(b)(ii)** and **(b)(iii)**.

Many candidates drew an acceptable diagram but some lost credit by misplacing the E_a and ΔH energy change labels and/or by the incorrect positioning or directions of the energy change arrows.

Many candidates correctly drew a catalysed energy profile with a lower E_a value and so earned credit in **(b)(iii)**. In a few instances, the catalysed profile was not drawn from the reactants to the products lines, scoring no credit.

A relatively small number of candidates were unable to draw appropriate energy profiles, suggesting a lack of understanding or a lack of effective preparation in this area.

(c) Almost all candidates correctly positioned E_a(cat) on the *x*-axis and so earned credit in **(c)(i)**. A few candidates drew lines typical of a Maxwell-Boltzmann distribution at a different temperature and labelled this line E_a(cat).

Some candidates correctly interpreted the requirements of **(c)(ii)** and recognised the significance of their answer to **(c)(i)** which showed a higher proportion of molecules possessing energy greater than E_a.

What was being tested here was the understanding that, in the presence of a catalyst, a higher proportion of molecules possess energy greater than E_a, so that a higher proportion of collisions would be successful. Answers along these lines tended to earn full credit.

Question 7

(a) The vast majority of candidates recognised this as a uniform field and made a credible attempt at drawing it. Marks were sometimes lost where candidates did not take sufficient care to start and finish the lines on the two plates and in not spacing their lines roughly equal distances apart.

(b) (i) Those candidates who understood the meaning of a uniform field were able to do this without difficulty.

(ii) This was fairly straightforward, although a common error was to confuse electrical and gravitational potential energy.

(c) (i) This was done with little difficulty by many, although, once again candidates lost marks for the incorrect use of units.

(ii) Candidates often failed to recognise that the upward force on the oil drop must be equal to the gravitational force downwards on the drop, its weight. So all that was being asked was for candidates to use the formula $W = mg$.

(iii) This part-question required a genuine depth of understanding, hence only the better candidates could proceed in a successful manner.

(iv) Those candidates who understood the earlier parts of the question generally proceeded to complete the calculation. The vast majority realised that you cannot have a fraction of an electron and correctly rounded to the nearest whole number above or below their figure.

Question 8

While some candidates coped well with the early parts of this question, others struggled and many omitted one or more parts of the question.

(a) This question required a two-part answer. Firstly, what is meant by the term *strong acid* and, secondly, what is a Brønsted-Lowry acid. Many candidates successfully addressed one or other of these points but relatively few addressed both. Some candidates referred to the formation of $H^+(aq)$ ions (an Arrhenius acid), rather than to the acid being a proton donor.

(b) The operating conditions required in **(b)(i)** were quite well known, although it was not unusual to see operating temperatures that were either too high or too low and for the oxidation state of the proposed vanadium oxide to be either incorrect or unspecified.

Many candidates made a fair attempt in answering **(b)(ii)**. The shift of the equilibrium position to the right when the pressure is increased was frequently correctly predicted; often this was accompanied by an appropriate reference to the reduction in the number of gaseous molecules in the forward direction. The Le Chatelier argument to support this prediction was also quite well explained. Many candidates earned full credit here and very few candidates earned no credit.

Most candidates struggled with the equation in **(c)(i)** as the reaction between a Brønsted-Lowry acid and a water molecule to generate an H_3O^+ ion, and the anion (conjugate base) of the acid was not well known. However, some candidates did manage to produce an acceptable equation.

In **(c)(ii)**, a reagent is, by definition, a chemical compound. Some candidates deduced that cyanide ions were involved in the first reaction. However, candidates needed to identify a cyanide salt, such as potassium cyanide, as the reagent in order to earn credit. Candidates who referred simply to cyanide or CN^- earned no credit.

A wide range of attempts at writing the name of compound **Y** were seen in **(c)(iii)**; some were correct, many were not.

Candidates tended to struggle in **(c)(iv)**; relatively few candidates earned significant credit here.

Very few deduced, from observation 1, that **Q** was not a carboxylic acid.

Rather more deduced the presence of a carbonyl group from observation 2; of these some went on to correctly interpret the negative Tollens' reagent test and predicted the presence of a ketone group.

Very few candidates used observation 3 to deduce the presence of a primary alcohol group. Some used this observation to deduce the presence of an aldehyde group; however, such a group is precluded by observation 2.

In **(c)(iv)**, relatively few candidates managed to deduce an acceptable structure for compound **Q**.

Some suggested formulae which were not isomeric on the molecular formula of $C_4H_8O_2$ of compound **Z**. Others omitted one or more of the functional groups described above.

PHYSICAL SCIENCE

Paper 8780/04
Advanced Practical Skills

Key Message

Candidates needed to record readings and/or observations carefully; using acceptable terminology with units clearly indicated where required.

General comments

To gain maximum credit, statements about observations had to be precise and complete, and candidates needed to make appropriate use of consistent significant figures and/or decimal points when recording measurements.

Comments on Specific Questions

Question 1

Satisfactory readings/results were obtained by most candidates.

Credit was gained for accurate recording and processing of results.

(a) Most candidates were able to measure the diameter of the marble correctly; their answer needed to be recorded to the appropriate number of significant figures.

(b) Units needed to be included in the answer to **(i)**.

Whilst most candidates obtained three measurements for x_1 and correctly calculated the average a few did not include the first reading in their calculation.

(c) In order to gain credit, candidates needed to obtain 3 readings for x_2, and *h* approximately equal to 65 cm.

(d) The use of the set square or a small ruler held horizontally was needed for the measurement of *h*. Answers which involved parallax or looking at eye level were not accepted.

The use of cocktail sticks/splints to show the edges of the crater formed in the sand was a good method for measuring *x*. Methods which did not disturb the sand and/or marble were accepted.

(e) This was often done well especially **(ii)** and **(iii)**. However, the uncertainty in *h* was often given as a factor of 10 too small.

(f) Candidates were expected to use their values of *h* and *y* to calculate two values of *K*, then to apply uncertainty and finally to make a valid comment.

Partial credit was given when *K* was calculated once only or when uncertainties were used to calculate *K*.

(g) Many candidates did not describe how to verify that y^2 is proportional to *h*.

Question 2

(a) In the table, candidates were required to include the headings.

Candidates needed to include their first temperature reading (i.e. with no acid added) in the table. Not doing so resulted in a final volume total of approximately 48 cm^3 instead of 44 cm^3.

Readings needed to be given to the appropriate number of decimal places; one for temperature and one or two for burette readings with the second place being 0 or 5 if present.

(b) The use of suitable scales for the graphs was required; at least half of the grid was the minimum accepted. Candidates needed to draw two curves as specified in the question.

Reading the volume from correct graphs was usually done well. When giving the temperature rise, the initial temperature needed to be deducted from the reading.

Candidates made a reasonable attempt at calculating the concentration of the sulfuric acid.

(c) In **(i)** the volumes of sodium hydroxide solution and sulphuric acid should have been used to calculate the mass of the reaction mixture. Many candidates used "1" for the mass; others used one or other of the volumes to obtain a mass instead of both added together.

In **(ii)** those who had a value for the acid or alkali molarity were often able to use it correctly to calculate the molar enthalpy.

(d) Credit was given for answers about heat energy loss. The direction of the effect on temperature change needed to be stated and candidates needed to clearly state that it would be "smaller".