PHYSICAL SCIENCE

Paper 8780/01
Multiple Choice

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

Key messages

The performance of candidates this year was a little better compared to that of last year. Some of the chemistry questions required candidates to recall knowledge; these included **Questions 13**, **16**, **19**, **26**, **28** and **30**. In all of these questions, apart from **19**, the correct answers were the ones most frequently selected by candidates. This suggests that examination preparation had been a little more effective this year.

Candidates need to be able to convert between standard units.

General comments

Candidates found **Questions 5, 12, 15, 23** and **24** difficult and **Questions 9, 10, 26** and **30** relatively easy.

Comments on specific questions

Question 2

There were a significant number of candidates who did not recognise that the displacement on the *x*-axis represented the systematic error and consequently thought that **D** was the correct answer.

Question 3

Although the question was answered reasonably well, some candidates did not include the gravitational field strength when calculating the increase in the gravitational potential difference.

Question 4

Although the majority of candidates recognised the relationship between intensity and amplitude was a squared relationship, many got the relationship the wrong way round, thinking that intensity squared is proportional to amplitude rather than amplitude squared is proportional to intensity.

Question 5

Many candidates found this question difficult, with some candidates thinking that increasing the frequency would increase the amount of spreading due to diffraction, rather than decreasing it.

Question 7

Although it was clear that most candidates were familiar with the physics of the situation, a significant number lost the mark by forgetting to change minutes to seconds when working out the time.

Question 8

Some candidates thought that Kirchhoff's laws were based on the conservation of current (1st law) and charge (2nd law).

Question 11

Few candidates deduced that 28 g of nitrogen gas would contain one more of molecules and so correctly chose **C** as their answer. Almost as many candidates either used relative atomic mass values in their calculations or overlooked *molecules* in the right-hand column and incorrectly chose **B**.

Question 12

Some candidates correctly deduced that, when equal masses of each compound are used, the compound with the highest percentage of carbon, compound **B**, would produce the greatest mass of carbon dioxide.

Question 13

Some candidates recognised that aluminium, silicon and phosphorus all have the same inner orbital electron arrangement, and so have identical shielding of the outer shell electrons.

Question 16

This question required candidates to recall their knowledge of the Haber and Contact processes and to identify one feature common to both processes. Relatively few candidates correctly recalled the use of nitrogen gas in the Haber process and of oxygen gas in the Contact process and hence correctly chose **B** as their answer.

Question 17

Many candidates incorrectly chose **D** as their answer. While heating a halogenoalkane with aqueous KOH would give an alcohol (ethanol), which could be oxidised by acidified potassium dichromate to a carboxylic acid, the product would be ethanoic acid, not the propanoic acid required by the question. In order to increase the length of the carbon chain, it is necessary to convert the bromoethane into propanenitrile. Acid hydrolysis of this nitrile then gives the required propanoic acid.

Question 18

The most popular incorrect answer was **A**.

Question 19

Almost all candidates realised that propanone would give a positive test with 2,4-DNPH and so chose either **A** or **C**. Of these, however, a large majority incorrectly chose **A** as their answer.

Question 20

Relatively few candidates realised that only the C=C bonded carbon atoms would appear in the main polymeric chained of poly(but-2-ene), and correctly chose **D** as their answer. The most common incorrect answer was **B**, which shows all carbon atoms in the polymeric chain.

Question 21

The most common incorrect answer was **C**.

Question 22

Although the majority of candidates gave the correct answer, a significant number thought that the raindrop would fall with a constant acceleration of $9.81\,\text{ms}^{-2}$, ignoring the effect of air reasistance.

Question 23

Many candidates did not distinguish between the vector nature of momentum and the scalar nature of energy.

Question 24

Very few candidates showed an understanding that there is a net gain in potential energy when a solid melts or a liquid evaporates or boils and a net loss in potential energy with the reverse reactions.

Question 26

This question required candidates to use their knowledge of nitrogen and its compounds. The link between the low reactivity of nitrogen and the high strength of the N≡N bond was well known; as was the link between nitrate fertilisers and eutrophication.

As a consequence, **A** and **B** were by far the most common answers. A majority of candidates correctly chose **A** as their answer.

Question 27

This question required candidates to select the design features which, if incorporated into a new fuel burning power station, would most effectively reduce the emission of acidic gases. It was clear that most candidates appreciated that the use of sulphur-free methane or low-sulfur coal would be of benefit.

Question 28

This question required candidates to demonstrate their knowledge and understanding of the electrolytic extraction and purification of copper.

A large number of candidates chose **C** or **D**, which ruled out the use of aqueous $CuSO_4$ as electrolyte.

Question 29

The most common incorrect answer was **C**.

Question 30
This question required candidates to recall facts about various addition polymers. It was well answered, with many candidates correctly choosing **B** as their answer.

PHYSICAL SCIENCE

Paper 8780/02

Paper 2: Short Response

Key messages

A sound knowledge and understanding of the basic definitions, concepts and procedures is a prerequisite for success in this type of examination.

General comments

A significant number of candidates omitted answers to some parts of questions. This was particularly noticeable in **Questions 2** and **6**.

Many candidates were able to demonstrate a good understanding of the factor affecting ionisation energy.

Many candidates found the paper challenging and did not show the level of understanding expected at this level. There were a minority who were able to display their knowledge and understanding.

Comments on specific questions

Question 1

Very few candidates were able to correctly read the values on the micrometer. There were a considerable number who recognised that the initial reading showed a zero error and that the actual diameter of the sphere was the difference between the two readings.

Question 2

(a) Many candidates wrote correct equations; errors were quite common. Of the two equations, the one showing the decomposition of limestone was more frequently omitted or incorrect.

Despite the formulae of sand and slag being given in the question, errors in both were occasionally seen.

Equations containing carbon or calcium atoms were not uncommon.

A number of candidates included Fe atoms in one or both of their equations. Some offered two equations, both of which contained SiO_2.

(b) Some candidates gave acceptable answers here; many did not. There was confusion on how acids and bases should be defined in this context.

Some selected the decomposition equation, defining the products as acid (CO_2) and base (CaO). Some, who included carbon in the equation for the decomposition process, identified this as the acid-base reaction with carbon being identified as the base. Others identified $CaSiO_3$ as being acidic, or based their answers on oxidation number changes. Some answers were incomplete in that either the acidic oxide or the basic oxide was identified but not both.

A few candidates attempted answers in terms of Brønsted conjugate acid-base pair and tried to fit proton transfer into their equations.

Question 3

(a) Better responses showed an understanding that the force acting on the satellite is the gravitational force of the moon on the satellite.

(b) (i) Most candidate recognised that work is equal to force multiplied by displacement; relatively few understood that the displacement must be in the same direction as the line of action of the force.

(ii) Answers tended to be rather vague, such as ‘no work is done because the movement of the satellite and the force are not in the same direction’. Other candidates considered the special situation where one complete orbit occurs, hence no displacement.

Question 4

A significant number of candidates made no attempt at one or both parts of this question.

(a) The correct expression for calculating q was well known and frequently used. Many candidates used 25.0 cm^3/g, the volume/mass of one of the reactants, instead of using the total volume/mass of the reaction mixture of 50.0 cm^3/g, in their calculation of q. The use of other masses, for example 1 g, 2.41 g, 18 g, 20 g, 100 g and 2400 g, were also seen. A few candidates used 279.7 (6.7 + 273) as their ΔT value.

Some candidates ignored the instruction to use the quoted values for density and specific heat capacity of the final solution and attempted to calculate these values.

(b) While the amount of hydrochloric acid, 0.025 mol, was quite often used in this calculation, the total amount of reactants (0.0625 mol) or the amount of NaOH (0.0375 mol) were frequently seen.

A few candidates attempted to perform Hess’s law or bond energy calculations here, while others made no attempt at the question. A few candidates offered values around that of the standard value of $\Delta H^{\ominus}_{\text{neutralisation}}$ for this reaction of (–57.9 kJ mol^{-1}) but showed no working to justify this answer.

Question 5

Most candidates had the idea that electric field strength is the force per unit charge; few recognised that the charge must be stationary. Another common errors was to state that the field was equal to the force on 1 coulomb of charge, which is only true if SI units are being used. The definition must refer to the general case, not specific cases.

Question 6

A significant number of candidates made no attempt at one or both parts of this question. Overall, this question was poorly done.

(a) Some candidates were able to demonstrate a familiarity with this type of displacement reaction, and quoted appropriate observations. Descriptions of the formation of white precipitates, often associated with $NaCl$ or $NaCl_2$, were quite common. In some cases, observations such as the formation of a pale yellow solution of F_2(aq) when chlorine water is added to NaF(aq) were seen.

A few candidates offered no observations but simply described the chemistry involved.

(b) Many candidates incorrectly attributed the difference in reactivity of the halogens to differences in their electronegativities, rather than to differences in their oxidising powers/reactivities. As electronegativity is defined in terms of covalent bonds, and reactions of this type involve the formation of ionic products, the electronegativity argument is not correct in this context.

Some references to the formation of a covalent bond between the halogen and sodium were seen, or of sodium reacting with chlorine.

Quite frequently, candidates stated that chlorine is more reactive than fluorine or that bromine is more reactive than chlorine.

Question 7

(a) There was a significant number of candidates who did not seem to recognise that the post was in equilibrium and therefore the total upward force must equal the total downward force.

(b) There were some good answers to this from those who showed an understanding of part **(a)**. Others made an attempt, sometimes spoilt by minor arithmetic mistakes with no clear working shown.

Question 8

Most candidates made an attempt at this question.

(a) Many candidates were aware that barium reacts well with cold water but suggested hot or hotter water as being sufficient to react readily with magnesium. Some simply said that the required conditions decreased down the group. For the reaction to be rapid, magnesium has to be strongly heated in a stream of water vapour/steam; whereas, barium requires no more than cold water.

In a few cases, the trend in reactivity down the group was wrong, with candidates suggesting lower temperatures for magnesium than for barium.

(b) Many candidates seemed to be unaware that the high temperature needed to cause magnesium to react with water gives a different type of product (oxide) to the low temperature reaction of barium with water (hydroxide). In some cases, both equations showed hydroxides while in others both products were oxides. Relatively few candidates wrote appropriate equations for both reactions.

While some candidates wrote correct equations here, mistakes were quite common. Hydrogen was quite often omitted completely from the equations or was written as 2H. Some equations were not balanced; for example, the equation showing barium hydroxide as product frequently contained only a single molecule of water.

Some equations contained incorrect formulae, such as BaO_2 and Ba(OH), others contained O_2 molecules or Be/Br in place of Ba.

Question 9

(a) This was done well. There was a lack of true explanation of the steps that candidates were taking, but a large number of candidates showed a good understanding of developing the required formula.

(b) There were some good answers seen, which either directly recognised the compressibility of air or less directly, that the density of the atmosphere decreases with height. A common error was to state that the pressure change cannot be proportional to the height as the pressure decreases with height, which did not recognise that the change, not the increase, in pressure was being considered.

Question 10

Most candidates made an attempt at this question and some very good answers were seen.

(a) Many candidates wrote appropriate answers here. Some incorrect or confused answers were also seen. Some candidates attributed the higher ionisation energy of argon to its ‘stable’ full outer shell, rather than to the extra shielding or to the greater size of a potassium atom.

A few confused explanations were seen that attributed the higher ionisation energy of argon to potassium having less shielding than argon.

(b) Many candidates recognised that the K^+ ion has the same number of shells as an Ar atom; or that the ionisation of a potassium atom involved the loss of the outer electron shell.

Rather fewer made reference to the two species having the same electron numbers or arrangement or being isoelectronic or to the K^+ ion having one extra proton than an atom of argon.

Some answers were confused in that the ionisation energy of a K^+ ion was compared with that of a K atom. A few candidates tried to explain the difference in terms of spin-spin repulsion, even though the two species are isoelectronic.

Question 11

Many candidates recognised that the resistance of the parallel combination was less than the resistor on its own. Some did not recognise that this means that there is an increase in the current in the circuit, with the result there is a larger potential drop across the upper resistor and a reduced potential difference across the parallel combination.

PHYSICAL SCIENCE

Paper 8780/03
Paper 3: Structured Questions

Key messages

- Candidates should be reminded to read all questions carefully so that the answers they give relate directly to the questions asked.
- Candidates should practise the application of straightforward mathematical techniques to solve physical problems and ensure they set out any calculations in a clear, logical way.
- Candidates should ensure that their handwriting is clear and that all work can be read. There were some issues with illegible figures in numerical questions.

General comments

Some very good answers were seen both in the physics and in the chemistry questions. There was a strong performance in some topic areas. This tended to be in those questions which required logical application of knowledge and understanding. Performance in questions requiring recall was less strong.

A significant number of candidates did not answer some parts of the questions. This was particularly evident in **Question 8**. However, there was no indication that candidates were short of time as these omissions occurred throughout the paper rather than just at the end.

Comments on specific questions

Question 1

(a) The vast majority of candidates recognised the difference between the vector nature of velocity and the scalar nature of speed.

(b) The majority of candidates recognised that as the cyclist was traveling at a constant velocity the resultant force is zero.

(c)(i) Although there were some good attempts at this question, many candidates produced illegible answers which prevented them from earning credit.

(ii) The majority of candidates recognised that the resultant force acted in the opposite direction to the cyclist's velocity, although many did not explain themselves clearly giving answers such as 'in the opposite direction'.

Question 2

(a) There were some good answers to this question. Common errors were to treat the beta-particle as though it had a charge of +1 and also to consider decay just by the emission of a single alpha-particle and a single beta-particle. A number of weaker candidates thought that the resulting isotope was an isotope of uranium, even though the proton number had clearly changed.

(b) Most candidates understood that isotopes have the same number of protons but a different number of neutrons. Many stated that the number of protons equalled the number of electrons which determines the chemical behaviour of the isotopes. Fewer then went on to describe the link between the number of neutrons and a specific physical property.

Question 3

(a)(i) Many candidates were able to describe the macromolecular structure of silicon and to attribute its high melting point to the large amount of energy needed to break its covalent bonds. It was not unusual, however, to see references to van der Waals' forces, to ionic bonding or to metallic bonding being present in the structures. In some instances a reference to, for example, intermolecular forces contradicted a correct statement regarding the macromolecular nature of the structure.

(ii) Some candidates correctly identified these elements as having simple molecular structures, while others gave correct formulae for their molecules. In many cases, however, either no mention was made of their structures or phosphorus and chlorine were described as having simple molecular and sulfur as having giant molecular structures. A significant minority of candidates correctly identified the intermolecular forces present as being generated by temporary/instantaneous/induced dipoles. Some, however, simply assigned this type of intermolecular force to chlorine and referred to dipole-dipole forces between molecules of the other elements or vice-versa. Relatively few candidates convincingly described the link between the number of electrons in each molecule and the strength of the instantaneous dipole-induced dipole/van der Waals' forces present. A significant minority of candidates attempted to explain the difference in melting points in terms of the breaking of covalent bonds. In a few instances, candidates described the bonding in phosphorus and sulfur as being ionic.

(b)(i) This was generally very well answered.

(ii) Many candidates offered correct answers in terms of the high activation energy of a reaction or of energy being required to break bonds. It was not unusual, however, for candidates to describe how heating would increase the rate of collision between molecules, rather than describing how heat would increase the proportion of collisions having sufficient energy to cause a reaction to occur.

(iii) Many fully correct answers were seen here. However, some candidates gave the electronic configurations of the Zn^{2+} ion, the S^{2+} ion or the S atom. In a few cases, arrangements showing 4p, 4d and 5f electrons in the zinc arrangement, or a $4s^2$ electron pair in sulfur, were given.

(iv) Many candidates correctly described the transfer of electrons from zinc to sulfur. Of these, a high proportion deduced that two electrons would be involved in this transfer. However, some candidates described the transfer of electrons from sulfur to zinc or referred to the product as having dative/covalent bonding.

Question 4

(a) Most candidates recognised that the collisions of molecules with the walls of the container caused the pressure, but many were unable to explain further than this.

(b) There was some recognition that there would be an increase in the frequency of collisions of the molecules with the walls, however many candidates could not clearly explain why this led to an increase in pressure.

Question 5

(a)(i) To answer this question correctly it was necessary for candidates to deduce that the equation for Stage 2 could be obtained by subtracting the equation for Stage 1 from the overall equation. While many candidates completed this successfully, a significant number offered equations which were not based on this logic. Incorrect equations showing O_2, H_2O_2, H_2SO_4 or SO_2 (on the left hand side) were frequently seen.

(ii) Most candidates followed the rubric of the question and quoted oxidation numbers in their answers. In a large majority of cases the sulfur in H_2S was correctly deduced to have an oxidation number of –2. However, an oxidation number of –4 was occasionally seen here. Some candidates then deduced the oxidation number of elemental sulfur to be zero, but made no mention of the oxidation number of the sulfur in SO_2. It is possible that such candidates had based their deductions on the overall equation, rather than on the Stage 1 equation. Other candidates deduced the oxidation number of sulfur in SO_2 to be +4 but made no mention of elemental sulfur. In some cases the oxidation number of sulfur in SO_2 was incorrectly deduced to be –4 or +2. A few vague responses referred simply to sulfur being oxidised/reduced or were based on the gain or loss of oxygen. Some responses described an increase or decrease in oxidation number but quoted no oxidation number values.

(iii) While many correct answers were seen here, errors were quite common. Some candidates used a mole ratio for H_2S:S of 2:1 (perhaps based on the Stage 1 equation), rather than the correct 1:1 ratio shown in the overall equation. In some cases, atomic number values were used in the calculation, rather than A_r/M_r values. Some candidates used the M_r value for H_2S (34.1), rather than the A_r value of S (32.1), when determining the amount of sulfur produced. Other candidates argued that, because of the 1:1 mole ratio between hydrogen sulfide and sulfur, the required mass of hydrogen sulfide would be the same as that of the sulfur (4.78 tonnes).

(iv) Overall, this question was quite well answered. Almost all candidates made use of the ideal gas equation in their calculation. However, a very small number attempted to use other relationships. Most candidates correctly converted the temperature to the Kelvin scale although some omitted to do this, made an arithmetic error or subtracted 273 from 380 to give 107 K. A small number of candidates thought that the unit for the answer provided by the gas law was dm^3, and so incorrectly divided their answer by 1000. A few candidates used 1.5×10^5 as the amount of H_2S, rather than the stated amount of 1.54×10^5 mol, or divided the stated amount by 34.1 (perhaps having assumed that 1.54×10^5 was the mass of H_2S in grams).

(b)(i) While many candidates drew acceptable diagrams of a water molecule, a large number offered dot-and-cross diagrams or drew linear molecules.

(ii) While many candidates correctly recalled the bond angle present in water, angles of 107.5° (perhaps ammonia) and 109.5° (standard tetrahedral bond angle) were often seen.

Question 6

(a) Most candidates correctly identified the amplitude of the wave, although a common error was to give double the amplitude. Some candidates drew the arrow indicating the amplitude incorrectly. It needed to run from the equilibrium line to the point of maximum displacement (either positive or negative).

(b) In many answers there was a lack of logic in the working, which led to candidates making unnecessary errors in their calculation. Another common error was to treat a microsecond (μs) as 10^{-3} s not 10^{-6} s.

(c) This was answered well with many candidates gaining full credit.

Question 7

(a) A basic definition of the term ‘superposition’ was required here, but relatively few candidates were able to define this accurately.

(b) Although some candidates recognised that the maximum is caused when the two waves are in phase when they meet, most gave a generalised answer without referring to the particular situation given in the question.

(c) Many explanations were incomplete and showed only limited understanding of the physics involved.

Question 8

(a)(i) Many candidates correctly deduced the systematic name for compound **A**. In some cases, the substituents were correctly identified but the location numbers of these substituents were wrong; for example, 1-bromo-2-methylpentane. A few candidates misplaced the location numbers and gave, for example, 2, 3-bromomethylpentane. A relatively small number of candidates described the main carbon chain as being based on propane or on hexane, rather than on pentane.

(ii) Many candidates correctly identified the reaction type to be elimination. A few described it as being dehydration and in some instances contradicted a correct statement. A few candidates offered substitution, oxidation or reduction as an answer.

(b) This question proved challenging for most candidates. Many incorrectly offered structures of compounds with different carbon skeletons to those possessed by compounds **A** and **B**. In some instances, structures with tri- or penta-valent carbon atoms were drawn. Some candidates replicated the structure of compound **B** drawn from a different perspective. While a sizable minority of candidates drew acceptable structures for trans-3-methlypent-2-ene, very few attempted to draw a structure for 3-methylpent-1-ene.

(c) This question proved challenging. The question referred to there being two different types of isomerism displayed by compounds **B**, **C** and **D**. In **(i)** and **(ii)**, candidates were required to identify two pairs of compounds, each pair showing a different type of isomerism. Some candidates misinterpreted this and identified a cis-isomer in **(i)** and the corresponding trans-isomer in **(ii)**, or vice-versa. A small number described the type of isomerism as being just cis-isomerism or trans-isomerism. Others wrote down the formulae of a selection of substituents instead.

(d)(i) This part was quite well answered. Candidates tended to answer in their own words and in many cases it was clear that they understood the meaning of the term ‘addition reaction’.

(ii) This mechanism was only shown well by the strongest candidates. Very little understanding or experience of this electrophilic addition mechanism was evident. In many instances, candidates drew curly arrows moving from hydrogen to the double bond, or drew a curly arrow from the bond to the bromine atom in HBr. In a significant number of cases, no curly arrows at all were shown. Those candidates who did draw a curly arrow from the double bond towards the hydrogen atom usually did not draw a second curly arrow showing the cleavage of the H—Br bond.

The required mechanism related to the formation of compound **A** from compound **B**. As compound **A** has the bromine atom attached to C^2, the carbonium ion/carbocation intermediate should have shown the positive charge on C^2. Relatively few structures for the carbonium ion intermediate were drawn. Of those that were given, only a few showed the positive charge on the correct carbon atom. In the final step of this mechanism, a curly arrow from a lone pair on the bromide ion towards the positively charged carbon atom of the carbonium ion intermediate was required. In many instances, this arrow was omitted. When it was drawn, in some cases it was not shown to be starting from the lone pair on the bromide ion.

Question 9

(a)(i) Few candidates recognised that the total resistance in the circuit was 2 kΩ plus 0.1 Ω (2000.1 kΩ).

(ii) Only the stronger candidates realised that the maximum current is limited by the internal resistance and were able to give a suitable explanation as to why it acts as a safety device.

(b)(i) Many candidates were able to calculate the resistance of the parallel combination. However, few took this forward to correctly calculate the total resistance in the circuit. This was then used to calculate the current through the power supply and, hence, the potential difference across it.

(ii) Many candidates recognised that the resistance of the thermistor decreases as the temperature rises but were unable to give a logical explanation as to why the reading on the voltmeter fell further.

Question 10

(a)(i) Many candidates showed understanding of the equality in rate of the forward and backward reactions, or appreciated that the concentrations of reactants and products remain constant. Relatively few, however, described both of these properties as being present in a dynamic equilibrium. A significant number of candidates simply described a reversible reaction, rather than one in a state of equilibrium.

(ii) A majority of candidates appreciated that the yellow colour of the solution indicated that the equilibrium position lay to the left, so that the concentration of chromate(VI) ions was greater than the concentration of dichromate(VI) ions. However, some attributed the yellow colour to there being a greater number of moles of chromate(VI) ions in the stoichiometric equation.

(b)(i) Stronger candidates gave a clear explanation in terms of the increased hydrogen ion concentration resulting in an increase in the rate of the forward reaction. This was frequently accompanied by an explanation, based on Le Chatelier's principle, for the shift to the right in the equilibrium position of the reaction. Most candidates made at least some of these points and earned credit here.

(ii) Many candidates recognised that the addition of sodium hydroxide would neutralise the acid in the acidified solution. However, some described this on the 'predicted observation' line and omitted to describe the change in colour of the orange solution to yellow which would follow. It was not unusual for the conversion of dichromate(VI) ions into chromate(VI) ions to be described as an oxidation process.

Question 11

(a)(i) Although many candidates correctly gave the base units of the physical quantities, there were many who did not understand the meaning of base units.

(ii) This was only answered correctly by the strongest candidates. The most common error was to incorrectly cancel a positive power on the top line of the fraction with a negative power on the bottom line.

(b)(i) Many candidates were able to calculate the percentage uncertainty in the diameter of the ball.

(ii) This question proved challenging. Some candidates realised that because the radius is cubed, to find the volume, the percentage uncertainty in the diameter of the ball needed to be tripled. However, few candidates went on to calculate the percentage uncertainty in the mass, and hence the percentage uncertainty in the density.

PHYSICAL SCIENCE

Paper 8780/04
Advanced Practical Skills

Key Messages

Candidates should record findings and observations carefully using the appropriate terminology.

Answers should be given with a consistent number of significant figures and/or decimal points.

General comments

There was a good level of performance on the paper, with many candidates showing strength in the manipulative work required and in processing their results.

There was no evidence of candidates having insufficient time to complete the paper.

Question 1

Most candidates carried out this experiment well. They were able to follow the instructions and made a reasonable attempt at the experiment. Satisfactory readings and results were obtained by most candidates. However, weaker candidates made mistakes in the recording and processing of their results.

(a) Most candidates were able to produce a table with all the necessary columns. A few missed out a column for *T*. They used *t* instead of *T* to draw their graphs. The units for d^2 and/or T^4 were sometimes incorrect and cm and s were used instead of cm^2 and s^4.

(b), (c) Most candidates completed the tables correctly. Sometimes too many significant figures were given, especially for d^2. Some candidates divided 20 by *t* to get *T* instead dividing *t* by 20. A few candidates used values of *d* which were too small either only up to about 50 instead of the 90 cm instructed or using values well below 35 cm.

(d) The choice of scales were generally very good with only a few less suitable scales such as 3 squares = 10, etc. Plotting was generally good as was the line of best fit drawn.

(e) The determination of the gradient was usually correct with only a few candidates using numbers from their results table instead of readings from the graph. Only a few candidates used a triangle which was too small.

Most candidates correctly read their *y*-axis intercept to obtain T^4 but some did not process this to obtain *T*.

Question 2

(a) Most candidates answered this question correctly. However, some answers gave the correct observation but did not name the gas.

(b) A few candidates missed out one or more units from their table. A very small number gave titres only without any burette readings. Averages were calculated correctly arithmetically but some candidates used all their results or all their accurate ones instead of just their concordant values.

(c) Some candidates correctly stated that the use of measuring cylinders was the possible cause of the error and that they should use a pipette or burette instead. Many, however, tried to replace two measuring cylinders with one, which was incorrect. Others incorrectly referred to parallax when taking readings.

(d) Many candidates correctly calculated 0.0125 as the moles of NaOH and 0.00625 as the moles of H_2SO_4. Some candidates who did not get the NaOH correct, were able to include a factor of 2 correctly. The division by their average titre value was less common.

Many candidates were able to correctly divide their answer to **(i)** by 10 to get an answer for **(ii)**. Common incorrect answers to **(iii)** were 0.075 and 0.025. Only the strongest candidates answered **(iv)** correctly.