PHYSICAL SCIENCE

Paper 8780/01
Multiple Choice

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

Key Messages

In order to do well on the physics part of this paper, candidates need a thorough knowledge of the basic formulae and to be able to recall them as needed to complete the paper in the time allowed. The paper allows about a minute per question and candidates should be aware that if they spend significantly more than this on a single question they may not be able to complete the whole paper in 40 minutes.

General Comments

Candidates need to work carefully and to ensure that units are consistent throughout a calculation. One way of ensuring this, is to include units in equations and subsequent working at the time of solving the problem. Space for working is provided throughout the paper and candidates should be encouraged to make use of this space when working their way to the solutions.

Candidates found many of the questions challenging and only **Questions 1** and **6** were answered really well. **Questions 5**, **8**, **21** and **23** proved very difficult.

Comments on Specific Questions

Section A

Question 1

The majority of candidates had little difficulty with this question. The most common error was to rank them from largest to smallest which showed a lack of care in reading the question.

Question 2

Candidates should be familiar with the use of the cathode ray oscilloscope and although a many candidates gave the correct answer, a significant number of candidates failed to understand the information given about the time-base setting, thinking that took the signal 2 ms to travel to and from the satellite.

Question 3

Although the question was answered correctly by many candidates, a significant number who thought that the amount of work done against friction was the total force applied multiplied by the distance moved.

Question 4

This is not an easy concept, yet the question was answered well. The key to scoring the mark was to recognise that the acceleration is proportional to the applied force and then to use the formula $P = Fv$.

Question 5

Only 15% of candidates gave the correct answer. The majority of candidates failed to recognise that if the density increases, the volume decreases and hence the change in volume is a negative quantity. Those that recognised this were generally able to complete the calculation satisfactorily.

Question 6

The question was answered quite well, although a significant number of candidates failed to think the problem through. The string is more stretched in position **3** than in position **2** and therefore it must have more elastic potential energy, limiting the choice to options A or B. It is higher in position 3, thus it must have more gravitational potential energy.

Question 7

This tested basic understanding of diffraction and in particular the relationship between wavelength and gap width. Whilst a good number of candidates did know the relationship, there were many who thought that an increase in frequency or gap width would increase the amount of diffraction. Candidates need to experience practical situations where changing factors alters the amount of diffraction.

Question 8

This question caused a great deal of difficulty with only a small minority of candidates getting the correct answer. This is a two-step problem. Candidates were required to calculate the current (0.25 A) from $P = IV$ and then using current = number of electrons per unit time x electronic charge to find the number of electrons passing per second.

Question 9

Although the question was answered well, there was a considerable number who did not know the formula $V = I^2R$. Candidates are expected to be able to perform this type of calculation at this level.

Question 10

To complete this type of question, candidates need to work through the whole problem in a logical manner. Some candidates, who tried a short-cut to the solution, invariably chose option B and forgot that the total resistance in the divider was not R, but $(n + 1)R$.

Section B

Question 21

The responses to this question suggested that candidates were not familiar with a simple practical in which two trolleys collide. Although the majority thought (correctly) that statements **1** and **3** were correct; the majority were unaware that the two bodies could collide and rebound (statement **2**).

Question 22

Candidates showed a genuine understanding of the principle tested in this question, with the majority recognising that the arrows on the vector diagram must all follow in the same direction round the triangle (for equilibrium).

Question 23

This was another question that showed candidates had a good knowledge of basic facts, although a large number did not think in sufficient depth. The lower part of the diver is slightly deeper than the higher part; consequently the pressure is slightly higher, thus producing buoyancy.

Question 24

The question showed that many candidates had a good understanding of the conditions needed for coherence, although a significant number thought that the waves needed to be exactly in phase, which is a common misunderstanding. All that is needed is for there to be a constant phase difference between the two sets.

Question 25

The majority of candidates showed their understanding of what is meant by an isotope. The only common error was that some thought that isotopes had the same mass number.

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Paper 8780/02

Short Response Questions

Key Messages

Candidates are expected to be able to recall standard definitions such as the torque of a couple, as specified in the learning outcomes of the syllabus. Candidates should be able to describe redox processes in terms of electron transfer and write balanced equations for redox reactions.

General Comments

This paper is designed to assess candidate's understanding over a wide range of syllabus material and successful candidates demonstrated a good understanding of both chemistry and physics concepts.

There were some very good scripts seen, but generally, candidates found **Questions 4, 5**, **6** and **10** challenging.

Question 4 required candidates to show an understanding of the effect ionisation has on a transition metal atom, which is a fundamental requirement of chemistry at this level. **Question 5** required an understanding of the redox behaviour observed in a specified system to be shown, which candidates should be able to recall. In **Question 6** few candidates were able to define a couple. Also, few candidates showed a real understanding of the graph in **Question 10**. Many did not recognise that the resistance is the ratio of potential difference to current and that the gradient of the graph can only be used to calculate the resistance of a component if the current is proportional to the potential difference across it.

Comments on Specific Questions

Question 1

The question showed that many candidates were unclear as to the meaning of base units, many including the newton as one. Of those who recognised the newton as kg m s^{-2}, many were able to work through to show the correct base units of the constant, *k*.

Question 2

(a) Many candidates showed little understanding of centripetal acceleration. The basic starting point in answering this question is a simple understanding that a change in the direction of the velocity of an object means that it is accelerating and therefore there must be a resultant force on the object.

(b) The resultant force acts horizontally towards the centre of rotation and is therefore the direction of the acceleration. Many candidates, perhaps understandably, showed a force going upwards through the line of the skaters' arms. If this were the case the female skater would be accelerated upwards as well as towards the centre of the circular path.

Question 3

This question was quite well answered. A large proportion of candidates correctly stated the orbitals from which the first electron would be removed from each atom. In a few cases, these electrons were incorrectly identified as being $2p^1$ and $2s^2$, rather than the correct Period 3 electrons. A small number of candidates failed to identify one or both of these electrons.

Candidates were often let down by their explanations of why the outer electron of aluminium atoms would require less energy to remove them compared to magnesium atoms. Some candidates seemed to have confused this deviation from the general trend in ionisation energy across a period with the deviation involving sulfur. Explanations centred on there being extra stability of the spin pair in magnesium were quire often seen. Many candidates, however, did write appropriate explanations based on the higher energy present in the $3p^1$ electron, its greater distance from the nucleus compared to the $3s^2$ electron or to the extra shielding provided to the $3p^1$ electron by the $3s^2$ electrons.

Question 4

Only a very few candidates recognised that the electrons to be removed first from $1s^22s^22p^63s^23p^64s^23d^7$ would be the $4s^2$ electrons, leaving $1s^22s^22p^63s^23p^63d^7$. These electrons being furthest from the nucleus also experience the greatest shielding by inner orbital electrons.

The most common mistake, by far, was the removal of two electrons from the 3d orbital, leaving $1s^22s^22p^63s^23p^64s^23d^5$. Some candidates added, rather than removed electrons to give $1s^22s^22p^63s^23p^64s^23d^9$ or arrangements such as $1s^22s^22p^63s^23p^64s^23d^54p^2$.

Question 5

No candidates were able to write correct equations for the redox reaction between concentrated sulfric acid and sodium bromide. It is possible that candidates failed to read the question carefully enough as most attempts related to the acid-base reaction between sodium chloride and concentrated sulfuric acid forming hydrogen bromide.

$$NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$$

The question specifically required an equation for the <u>redox</u> reaction, an example of which is shown below.

$$2Br^- + H_2SO_4 + 2H^+ \rightarrow SO_2 + 2H_2O + Br_2$$

The second mark in this question was for identifying the reducing agent in the reaction. While a number of candidates correctly deduced this to be the bromide ion, many incorrect answers were also seen. Overall, it appears that many candidates simply tried to guess the answer here.

Question 6

A basic knowledge of the terms used in the syllabus is a prerequisite for success. Many candidates described the *moment about a point* rather than giving the formal definition of a couple.

Question 7

Candidates needed to interpret the graphs and use either the equation, $v = f\lambda$ or $v = s/t$. If using the former, candidates needed to calculate the frequency from the inverse of the time period. If using the latter, then they needed to ensure that they used the same number of waves for each quantity. Either way, to ensure full marks, care needed to be taken in reading the graphs. This was quite a challenging question and it was encouraging to see some of the better candidates scoring well.

Question 8

(a) This question was well answered, with a large majority of candidates able to show some understanding of the economics of the cracking process.

(b) Many good attempts were seen and fully correct equations were quite common. Mistakes, however, were also quite frequently seen. These included errors in the formulae of the alkenes (for example C_4H_8), the inclusion of more than one alkane product and the inclusion of impossible formulae such as $C_{11}H_{17}$. Some candidates gave ethene and propene in a 1:1 ratio, having ignored the information given in the question that they should be in a 2:1 ratio. Ohers applied the ratio the wrong way round.

Question 9

This question was a well answered by many candidates. All but a few candidates recognised that they had to multiply each mass number by its corresponding relative abundance and then add the totals together; this was pleasing to see. Many candidates then went on to divide this total by the total abundance (11.5) and deduced the correct answer of 190.3.

In some cases, however, candidates assumed that the relative abundances were all percentages and so, incorrectly, divided the correct total by 100. A few candidates attempted to convert the relative abundance values into percentage abundance values before proceeding with the main calculation. Although this process tended to generate 'rounding errors' some candidates were able to deduce an acceptable value for A_r.

In a few instances, candidates calculated an incorrect sum for the total abundance; 22.5 was a common error. The A_r value obtained in this case was clearly incorrect.

It is suggested that centres emphasise the fact that the relative atomic mass value must lie within the range of the mass numbers used. Any answer outside of this range (188 to 192 in this question) has to be incorrect and so a check should be made to find the mistake responsible for the error.

Question 10

(a) The question was not well answered, with many candidates under the misapprehension that the resistance of the component is equal to the gradient (or the inverse of the gradient) of the graph at a point.

(b) Whilst many candidates recognised that the resistance of the component decreased with increasing current, few were able to link this to the behaviour of a thermistor or other suitable semi-conducting device. It was not required that candidates stated that the thermistor was of negative coefficient type, as this is the only type included in the syllabus.

Question 11

The majority of candidates simply quoted the law of conservation of energy. Few recognised that potential difference between two points is the work done by unit charge as it moves between the points. If a charge starts and finishes at the same point in a loop, then it must be at the same potential at the finish as the start, hence the energy lost or gained must be zero.

Question 12

(a) Many candidates correctly attributed the relatively high boiling point of hydrogen fluoride to the presence of hydrogen bonding between its molecules, or explained this in terms of a large difference in electronegativity between the hydrogen and fluorine atoms. Many candidates, however, simply referred to fluorine being electronegative or, incorrectly, experiencing large van der Waals' forces.

(b) A minority of candidates correctly attributed the increase in boiling point from HCl to HI to an increase in the strength of the van der Waals', resulting from an increase in the number of electrons present in each molecule. In some instances, candidates hedged their bets by referring to increases in both the number of protons and the number of electrons. In a few cases, the trend was explained solely in terms of an increase in proton number.

Some candidates described a decreasing trend in boiling point from HCl to HI, despite the data in the table showing an increase. In a few instances, the increase from HCl to HI was incorrectly attributed to changes in the strength of the dipole-dipole attractions.

Question 13

While a fair number of candidates drew acceptable shapes for these two orbital types, errors were numerous.

It was not unusual to see the *s*-orbital drawn as a circle situated on one of the axes, rather than in the centre; or, for it to be given the same shape as a *p*-orbital. Some candidates offered no shape here.

For the *p*-orbital, several incorrect shapes were seen. These included drawing the correct shape but aligned in-between a pair of axes; drawing two, or more commonly three *p*-orbitals on different axes; drawing an *s*-orbital; or drawing a *d*-orbital shape between the axes in one plane.

Question 14

Where a comparison between two models is required, a full answer should include reference to both models. There were some good answers, with many candidates showing a clear understanding of the Bohr model. However, there were also many candidates who lacked a full understanding of the differences between models for the atom. A sound knowledge of these basic ideas is fundamental for chemistry at this level.

Question 15

The difference between the terms *random* and *spontaneous* is subtle and it is therefore not surprising that some candidates found this difficult. More candidates showed an understanding of random, but many of those that had an understanding spoilt their answers by not giving meaningful experimental evidence. Instead, they only gave an explanation of the meaning or referred to the behaviour of a single nucleus, which is impossible to observe.

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Paper 8780/03

AS Structured Questions

Key Messages

A minority of candidates were able to demonstrate a very good knowledge and understanding of the syllabus. However, there were many whose knowledge, at best, was superficial and whose understanding was very limited. At this level, candidates need to demonstrate that their comprehension of the subject is sufficient to enable them to make further progress in the subject at a higher education establishment.

General Comments

This examination reinforced the evidence from the first examination in 2011, that many candidates had not covered the work in sufficient detail or depth. Simple errors, such as failing to include units where they are not given on the answer line, and failing to convert units to base units before using them to calculate quantities in derived units were common.

There was evidence that many candidates were not sufficiently prepared, which resulted in marks being lost in questions that should have been readily available. This was particularly evident in **Question 15**, where many candidates were unable to recall straightforward details concerning the electrolytic extraction of aluminium.

Comments on specific questions

Question 1

(a) The majority of candidates recognised that the collisions of gas molecules with the walls of the container cause the pressure on the container. However, it was rare to find a script that took this much further. For example, at this level candidates need to understand why this causes a pressure. Each collision with the wall causes a change in the momentum of the molecule hence there is a force on the molecule and a reaction force on the wall, the sum of the reaction forces leads to the pressure on the wall.

(b) Although there was some recognition that the reduced volume increased the number of collisions, many candidates failed to appreciate that it is not the absolute increase in the number of collisions, but the increase in the rate of collisions which increases the pressure.

Question 2

This is a relatively straightforward question designed to test candidates' recall of the nature and use of the Maxwell-Boltzmann distribution of molecular energies. Performance varied considerably. Some excellent answers were seen, but also some very poor ones, which suggest that some candidates were poorly prepared to answer questions on this topic. In a significant number of cases, no attempt was made to answer all or parts of this question.

(a) While a significant number of candidates were able to quote correct axes labels in part **(a)(i)**, a large number of incorrect answers were also seen. This was disappointing as the question required nothing more than simple recall. Incorrect answers included references to rate, temperature, time and activation energy. Some candidates reversed correct labels or omitted them all together.

Candidates coped better with part **(a)(ii)**, but mistakes were still numerous. Incorrect answers included references to the shaded area representing those molecules that had reacted or had the highest reaction rate (as they had the most energy). Here candidates incorrectly believe that the area is the activation energy. Some candidates suggested that there is no activation energy anymore or that the area shows the energy of the products.

An acceptable distribution line at higher temperature was drawn by the better candidates but, again, errors were frequently seen. These included errors in the position of the modal peak/value, which was frequently shown as being higher than and/or to the right of the original peak, lines that failed to cross the original line and lines that crossed the original line more than once or that touched the *x* axis.

(b) A fair number of candidates correctly attributed the increase in rate to an increase in the proportion or number of molecules possessing activation energy. Relatively few, however, explained that the large rate increase was due to a large increase in this proportion/number. Many candidates incorrectly attributed the large rate increase to an increase in collision rate. The increase in collision rate can only account for one or two percent of this rate increase. Other errors included references to an increase, or to a decrease, in the activation energy or a simple reiteration of the question.

Question 3

(a) This question tested candidates' understanding of the difference between random and systematic errors as well as how to reduce the former. Most candidates recognised that taking a series of measurements and averaging them is one way to reduce random uncertainties, but few extended this to either taking the measurements at different orientations or along the length of the wire.

(b) This proved to be a challenging question. Candidates needed to recognise that the percentage (or fractional) uncertainty in the diameter is required and then, in order to calculate the uncertainty in area, this needed to be doubled (as the area is dependent on diameter squared), prior to finding the absolute uncertainty in the cross sectional area. A common error in this question was to calculate the radius and then give that the same absolute uncertainty as the diameter.

Question 4

This question involved a relatively straightforward mole calculation. Some candidates were clearly experienced in performing this type of calculation and earned all, or almost all, of the marks available. Candidates who were not so well practiced in chemical calculations tended to struggle and many made no attempt at all or parts of this question.

(a) This question required the straightforward calculation of the number of moles of a solute. It was well answered by a fair number of candidates, but errors were quite frequent. These included failing to convert the volume of sodium hydroxide into dm^3, dividing the volume by the concentration (and vice versa) and using the M_r of NaOH in place of its concentration.

(b) Part **(b)(i)** required candidates to use the mole ratio of 1:2 correctly by dividing their answer in part **(a)** by 2 and then, in part **(b)(ii)**, multiplying this answer by 10 to scale up the number of moles of H_2X from that present in $25\,cm^3$ to that present in $250\ cm^3$. Many candidates were able to do this but, again, errors were common. These included the incorrect use of the mole ratio, a second use of the volume of sodium hydroxide and errors for which no explanation is possible.

(c) The final mark was for calculating the M_r of H_2X by dividing 1.92 by the answer from part **(b)(ii)**. Most of the candidates who had progressed this far earned this mark.

Question 5

(a) (i) The double amplitude of the signal covered 2.6 squares, leading to an amplitude of 3.3 V. Whilst some latitude was allowed, candidates need to take real care when making this type of measurement. Other candidates lost the mark because they gave the double amplitude.

(ii) Candidates should recognise that the period of the signal can be found directly from the graph and that the frequency is therefore the inverse of the period.

(b) Candidates who realised that the question involved superposition scored quite well, recognising that the amplitude doubled when the two signals were in phase and that they would produce a straight line when they were 180^{o} out of phase. A small number of candidates lost credit for not giving an explanation of the effect.

Question 6

This question required candidates to quantitatively analyse data from a thermochemical experiment. Performance was mixed and very few candidates were able to cope effectively with the whole of the question.

(a) Part **(a)(i)** was, overall very well answered. Almost all candidates used the correct expression to obtain a value for the heat change, ***q*** and correctly calculated this value. In a few instances, errors such as the omission of the mass of water from the expression, the use of the value of the gas constant ***R*** in place of the heat capacity of water, ***c***, and the addition of 273 to the temperature change were seen.

Similarly, part **(a)(ii)** was very well answered. The main, and infrequent, source of error was the use of incorrect values for the M_r of propan-1-ol.

By contrast, part **(a)(iii)** was poorly answered. Very few candidates seemed to be aware that the enthalpy change, ΔH_c, is the heat change when 1.00 mol of propan-1-ol is burned completely. All that was needed to calculate this value was to divide ***q*** by the number of moles of the alcohol that had been burned. Of those candidates who were aware of how to perform this calculation, a fair number spoiled their answer by omitting the negative sign for ΔH_c. While the value of ***q*** may be quoted without a sign, ΔH_c must be identified as being exothermic or endothermic by the inclusion of the appropriate sign. Many candidates made no attempt to answer this part of the question.

(b) A majority of candidates recognised that heat loss to the surroundings, or to the calorimeter, would constitute major sources of error in this experiment. Very few, however, were able to explain that this heat loss would lead to a reduction in the measured temperature change and reduction in the value of ***q*** leading to the calculated value of ΔH_c, being below its true value. A minority of candidates either omitted this part or offered suggestions that appeared to have been made up on the spur of the moment.

Question 7

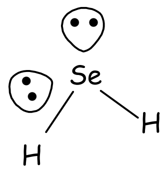
This question required candidates to correctly balance an equation, to deduce the shapes of two molecules and to demonstrate an understanding of the influence electron-pair repulsion has on producing these shapes. The level of understanding displayed by candidates varied considerably.

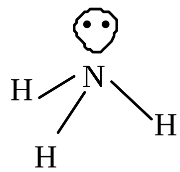
(a) This question was well answered with a large majority of candidates successfully balancing the equation

(b) A fair number of fully correct diagrams were seen; however, many candidates drew dot-and-cross diagrams rather than diagrams showing the relative positions of the bonds. It is necessary when drawing diagrams such as these, and also in displayed formulae, that all bonds are represented by lines, dot-and-cross diagrams are not acceptable as a means of showing the shape of a molecule. The majority of candidates correctly deduced the numbers of lone pairs of electrons on the molecules although some candidates drew diagrams showing no lone pairs at all.

The quality of the line drawings was better this year, with most of the candidates who attempted to draw line diagrams producing acceptable *bent* and *pyramidal* shapes. It was disappointing, however, that a significant minority of candidates persisted in drawing dot-and-cross diagrams.

It was pleasing to see many diagrams similar to the ones shown below.





The quality of the explanations offered in part **(b)(ii)** was less good. Both of these shapes are produced by distortion of a regular tetrahedral shape due to the presence of lone pairs of electrons in place of some bonding pairs. While many acceptable answers were seen, there were also many poor attempts. All that was required was a reference to there being more lone pairs of electrons on selenium, together with an explanation based on the fact that that lone pair of electrons repel more strongly that bonding pairs of electrons do. Some candidates clearly understood this concept and gave more comprehensive explanations that this. Many candidates simply compared the numbers of lone pairs of electrons present. Many others made irrelevant points of failed to attempt this part.

Question 8

(a) The majority of candidates recognised the meaning of the term *isotopes*, although a few confused them with isomers. Precise wording is required to demonstrate a complete understanding, the pointy being that isotopes have the same number of protons but different numbers of neutron. Comments regarding different masses (or mass / nucleon numbers) do not fully describe isotopes.

(b) Moving to AS level requires candidates to write equations for a somewhat more complex nuclear reaction than simple alpha or beta decay. The syllabus gives an example where one particle is absorbed, forming a new nucleus, which in turn decays, emitting another particle. Very few candidates were able to complete this correctly. It was also of concern that many candidates were unable to give the nuclear representation of the neutron and the proton.

(c) The plotting of the nuclides on a simple grid is a useful and straightforward skill which tests candidates' understanding of nuclear processes. In this example candidates should have had little difficulty in ascertaining the nuclear notation for carbon-14 and should know that the emission of a beta-particle causes no change in the nucleon number and an increase of 1 in the proton number, thus forming an isotope of nitrogen. Candidates should have a basic knowledge of radioactive decay and nuclear notation at this level.

Question 9

This question required candidates to show an understanding of the effect changes in conditions would have on the formation of ammonia. Some very good answers were seen but, overall, candidates tended to struggle with the question.

(a) A high proportion of candidates correctly positioned the cross (**X**) at around the junction of lines **4** and **1**. Many candidates recognised that at this point, the rates of the forward and backward reactions were equal and that the amount of ammonia present in this equilibrium mixture would remain constant. Some candidates spoiled their answers by stating that no more ammonia would be formed or gave nonsense answers such as *the two lines join*.

(b) In part **(b)(i)**, a fair number of candidates correctly linked increased pressure to experiment **3** and increased temperature to experiment **2**. However, incorrect answers were common. As the reaction produces fewer moles of product, an increase in pressure would result in an increase in the amount of ammonia formed (experiment **3**).

As the reaction is exothermic, an increase in temperature would reduce the amount of ammonia (experiment **2**). In both cases, there would be an increase in rate, so the graph lines would be initially steeper than line **1**. In most of the incorrect answers, one of the correct answers had been replaced by experiment **4**, which shows an increase in rate but no change in the yield of ammonia.

Part **(b)(ii)** was not well answered by many candidates. While some excellent answers were seen, the majority of attempts were either incomplete or confused. Relatively few candidates made any reference to there being fewer ammonia molecules than reactant molecules or how this would drive the equilibrium to the right. Many candidates made little or no headway here, with a significant minority making no attempt to answer this part.

In part **(b)(iii)**, very few candidates referred to the line for the catalysed reaction by number (**4**). Without a specific reference to this line, no comparison with the line for experiment **1** is possible. Fortunately, a fair number of candidates did make reference in their answer to the yield of the catalysed reaction being the same as that of experiment **1**, as well as stating that the catalysed reaction was faster. So, credit could be awarded for such an answer. The answers given by many candidates were incomplete as they simply referred to the catalysed reaction being faster, or to it having lower activation energy, but made no reference to the yield of ammonia or to line **2**.

Question 10

(a) (i) Whilst most candidates knew that momentum is the product of mass and velocity, many lost credit because they failed to give a unit or they used grams rather than kilograms for the mass of the ball and gave an incorrect unit.

(ii) Although it was possible to calculate the force on the ball from the racquet by calculating the acceleration of the ball and using the formula $F = ma$, it was much quicker to use force = rate of change of momentum.

(b) The majority of candidates were able to calculate the kinetic energy of the ball, although some lost credit for failing to convert the mass of the ball to kilograms.

(c) (i) At this level it is expected that candidates give a full explanation of phenomena and although the majority recognised that the loss of kinetic energy was due to air resistance, very few took the argument further and explained that the loss of energy was due to the work being done against the air resistance force.

(ii) There was quite a lot of confusion here, with a considerable number of candidates thinking that the ball gained gravitational potential energy. Those who recognised that the energy is converted to heat failed to give an explicit answer; satisfying themselves with the simplistic statement along the lines of ‘it goes to heat’. A full answer states explains where the heat is transferred to, for example, ‘the ball and/or its surroundings’.

Question 11

(a) (i) The majority of candidates had a good idea of the field shape between charged, parallel plates. Edge effects were not required and candidates were neither penalised not rewarded for including them. Some candidates failed to include arrows (or put them in the reverse direction) showing the direction of the field. The diagram is incomplete without them. It is also important to recognise that field lines start and finish on one of the plates and that they never touch nor cross.

(ii) The majority of candidates knew how to calculate field strength. However, credit was lost by many for either failing to include a unit or giving the wrong unit. Care must be taken to ensure units are compatible with the units given in the stem of the question.

(b) Candidates need to learn how to draw smooth curves. Although there was no penalty for poorly drawn curves as such, they needed to be a reasonably accurate parabola, not dipping down below the horizontal at the beginning of the drawn curve, not curving either before entering or after leaving the field and not continuing straight beyond the plates for some distance before a sudden change in direction.

(c) This tested candidates' understanding of the flight of a body through a uniform field and their understanding of vectors. The force on the particle is perpendicular to the plates, thus only the component of the velocity of the particle in this direction will be affected and its magnitude will increase uniformly. The component parallel to the plates will not change.

Question 12

This question required candidates to show understanding of the nomenclature, reactions, reaction mechanisms and structural/stereoisomerism associated with halogenoalkanes and alkenes. Overall, it was very poorly done.

(a) While a small majority of candidates correctly named compound **A**, incorrect answers were frequently seen. Incorrect names were mainly based on ethane, propane or pentane, although a few candidates thought the molecule was a bromoalkene. A number of candidates gave the molecular formula of **A** and/or made no attempt to name it.

In part **(a)(ii)**, while many candidates correctly deduced that the formation of an alkene proceeded by an elimination reaction, the majority of candidates either offered no response or suggested incorrect reaction type such as cracking, addition or substitution.

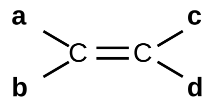
In part **(a)(iii)**, only a relatively small minority of candidates identified sodium/potassium hydroxide dissolved in alcohol as the required reagent/condition. The use of a catalyst, concentrated sulfuric acid, an oxidising agent or sodium hydroxide without mention of an alcoholic solvent was frequently suggested. Many candidates offered no response here.

Part **(a)(iv)** was very poorly answered. Only a very small number of candidates deduced the other isomer to be 4-methylpent-2-ene. The most common error was to reproduce a structure identical to alkene **B**. Also, bromoalkenes, and linear alkenes were often seen. Nonsense structures having molecular formulae different to that of alkene **B**, or showing carbon/hydrogen atoms with incorrect numbers of bonds, were quite common. Many candidates offered no response here.

Part **(a)(v)** was very poorly answered. Over half of all candidates either offered no response here or stated that **B** could show cis-trans isomerism. Of those candidates who stated that **B** could not show cis-trans isomerism very few were able to offer a convincing explanation.

For a compound to be capable of existing as cis- and trans- isomers there must be a non-rotatable (double) bond. Alkene **B** has such a bond and a fair number of candidates commented on this fact.

However, the compound must also satisfy the following criterion;

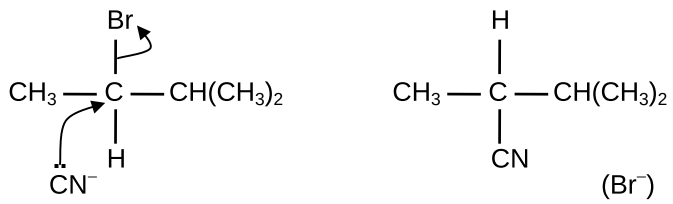


a ≠ **b** and **c** ≠ **d**

where **a**, **b**, **c** and **d** are substituents on the unsaturated carbon atoms of the alkene.

Alkene **B** has two methyl groups on the right-hand carbon (C^2) and so, as **c** = **d**, cis-trans isomerism is not possible.

(b) The reaction of compound **A**, bromoalkane, with cyanide ions involves the substitution of the bromine atom by the cyanide ion. The S_N2 mechanism for this reaction is shown below; an S_N1 mechanism would also have been acceptable.



Very few candidates were able to draw this mechanism, or to deduce the structure of the nitrile (2,4-dimethylbutanenitrile) produced in the reaction. Errors in the position and direction of the curly arrows, and in the structure of the final product, were numerous. Many candidates offered no response here.

Question 13

(a) The vast majority of candidates understood the meaning of a vector.

(b) (i) Candidates should understand and be able to analyse forces acting on a body which is in equilibrium. Very few candidates recognised the three forces acting on the box as its weight (vertically down), the reaction force from the slope (perpendicular to the slope) and the tension in the string (acting along the string). Many seemed to think that there is a force acting down the slope, others thought that there is a force downwards and perpendicular to the slope. Even amongst those who recognised the three forces, very few recognised that for equilibrium the forces must pass through a single point.

(ii) Too many candidates did not gain credit for failing to change the mass of the body to kilograms before finding the weight.

(c) Predictably, where candidates were unable to identify the forces acting on the box, they were unable to complete the vector diagram. Much more practice at this type of problem is needed, starting at the identification of the forces acting on the body.

(d) This required candidates to recognise that the removal of the force from the tension in the string would lead to a resultant force on the body of the same magnitude but in the opposite direction. There were some good attempts, which showed that candidates were able to think an unusual problem through in a sensible way.

Question 14

This question required candidates to show understanding of the thermal decomposition of Group II nitrates and of the effect of water on the oxide residue. It was very poorly done.

(a) In the reaction sequence described in the question, compound **X** (a nitrate) decomposes producing a brown gas (NO_2), a gas that relights a glowing splint (O_2) and a residue (a metal oxide) that dissolves in water to form an alkaline solution (soluble metal hydroxide). Candidates were asked to explain these observations. A fair number of candidates correctly identified oxygen, but some failed to justify this deduction by reference to the glowing splint. Very few candidates got beyond this point, many offering no response here.

(b) Only a handful of candidates correctly deduced that **X** was a Group II nitrate; an even smaller number wrote a correct balanced equation. Very few candidates recognised that **X** had to be a nitrate. Of those that did, some identified it as sodium nitrate, despite the evolution of brown NO_2 gas on heating. Many incorrect answers were seen, such as MgO, NH_3, Fe_2O_3, KBr and $BaCO_3$. Many candidates offered no response here.

Question 15

This question required candidates to simply recall details of the electrolytic extraction of aluminium from purified bauxite. Some good answers were seen but excellent answers were rare. It was very poorly done by a large majority of the candidature, suggesting that many candidates were insufficiently well prepared for questions of this type. Many candidates offered no response to one or both parts of this question.

(a) A good answer would have included a description of purified aluminium oxide being dissolved in molten cryolite and then being subjected to electrolysis using graphite electrodes. Electrode equations would have been given and the high cost would have been attributed to the massive amount of electricity used in the process. Such answers were rare.

Many candidates wrote at length but either missed out important details or simply described the uses of aluminium. Some described aluminium oxide/bauxite reacting with cryolite or reacting with limestone (confusion perhaps with the extraction of iron); many answers seemed to have been made up on the spur of the moment. Relatively few candidates attempted to account for the high costs of the process; of those that did, the cost of maintaining a high temperature was quoted more frequently than the high cost of electricity.

(b) This part was quite well answered by many candidates. Good answers tended to focus on the conservation of non-renewable resources, on specifically described energy savings, on a reduction in the need to mine/use landfill or on a reduction in atmospheric pollution from the process itself or from energy production. A significant number of candidates, however, either offered no response here or wrote too vaguely to earn credit. Vague references to reducing atmospheric pollution, saving the ozone layer, saving energy or reducing litter were quite often seen.

PHYSICAL SCIENCE

Paper 8780/04

Advanced Practical Skills

Key messages

Candidates should take more care in recording and processing data. Candidates should use the appropriate number of significant figures in recorded and processed data. Candidates coped equally well with the demands of the Physics and Chemistry questions.

General comments

The paper set for this, the second year of this AS level examination, was appropriate for the candidates who were entered for it. The marks were comparable to those of last year.

This practical examination proved to be the right level of difficulty in that it enabled all candidates to attempt all parts of both questions and produced a satisfactory distribution of marks with nearly the full range available being used.

Candidates had enough time to complete the paper; there is no evidence that they ran out of time.

The practical skills required proved to be within the capabilities of most candidates. Where candidates lost marks it was often due to candidates not taking enough care with the titration or in drawing graphs and processing results. Where candidates experienced difficulties it was possibly because they had not had enough previous opportunity to do practical work.

Some candidates, fewer than previously, did not make enough consideration of the use of consistent significant figures and/or decimal points when making measurements in the Physics question.

Comments on specific questions

Question 1

This experiment seems to have worked very well for most candidates.

It proved to be well within the capabilities of most candidates to carry out the experiment and to obtain valid results.

Most candidates followed the instructions well and were able to make a reasonable attempt at the experiment. Where they lost marks it was because they made mistakes in the graph drawing and following parts of the question.

(b) Almost all candidates were able to obtain a measurement for the current (I). A few gave the answer in amps but failed to amend the unit printed on the question paper.

(c) Almost all candidates were able to construct a suitable table to record values of l, I and V.

The most common errors were to omit the units from the headings but to write them after each recorded measurement. This practice is not an appropriate way of including units.

The use of significant figures was better than last year, but some candidates are still showing inconsistencies in the significant figures they quote in their data.

Most candidates were able to calculate V and they were able to include the necessary conversion from mA to A.

(d) The standard of graph drawing was generally good. It was pleasing to see that fewer candidates used an awkward scale than last year or tried to joint points instead of a straight line. Units were sometimes omitted from the axes labels.

Candidates did not always show how they had attempted to calculate a gradient. Others used a very small triangle - at least half the data line should be included. A valid gradient cannot be calculated directly from the results table - readings from the graph must be used. There are still a few candidates who try to calculate a gradient from a single reading.

Some candidates did not understand the meaning of an intercept.

(e) Many candidates did not understand what was required of them here. They were not able to relate the formula given to the intercept and gradient that they had obtained.

(f) Suggested sources of error must be clear. Answers such as “parallax” or “don’t know exactly where the contact is” are insufficient. Candidates should be able to give more detail.

Question 2

The vast majority of candidates were able to carry out the tests and obtain results. Where marks were lost it was because of careless experimentation or disorderly recording.

During wet tests candidates need to state ‘white precipitate’ where appropriate. The terms ‘milky’, ‘chalky’ or ‘white cloudiness’ are not acceptable. These are **only** acceptable in the limewater test for carbon dioxide.

(a) (i) Most candidates were able to draw up a suitable results table. However, burette readings must be labelled as “readings” not “volumes” as only the titres are volumes.

Some candidates used ml instead of cm^3. Whilst this is not incorrect, it is better for the up to date units to be used.

Candidates need to record all their readings for accurate titrations to 0.05 cm^3: This means that their readings should end in .00 or .05.

It is expected that candidates should obtain two concordant titres within 0.1 cm^3 of each other.

(ii) Candidates tended, incorrectly, to calculate the average of all their titres rather than just using the concordant ones.

(iii) Some calculations were the wrong way round and others did not use an appropriate number of significant figures in the answer and/or their workings.

(iv) A significant number of candidates thought that changing the volume also changed the concentration. Whilst there were many good attempts at a qualitative answer, few tried to include a quantitative argument which would have gained the second mark.

(b) This section was generally well answered by most candidates.

It was good to see fewer candidates using vague answers such as ‘cloudy’ when ‘white precipitate’ is needed. Not all answers made clear statements about being soluble in excess, for example there were some ‘soluble solutions’ rather than the precipitate dissolving.

Most candidates correctly identified zinc ions and gave the correct evidence that the white precipitate dissolving in both ammonia and sodium hydroxide. Many candidates got this right here even if their observations in the results table were incorrect.