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PHYSICAL SCIENCE

Paper 0652/01
Multiple Choice

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19	**A**	39	**D**
20	**D**	40	**B**

General comments

The mean score on this paper was around 60%, which is better than some recent mean scores on this paper. However, this still indicates that many candidates were under-prepared for the demands of this examination.

Not all items revealed things worth commenting on, but the following points are worth making.

Comments on specific questions

Question 3

This question was found to be quite easy by all candidates. Chromatography appears to be a topic that candidates readily understand.

Question 11

Only 30% of the candidates answered correctly and this figure rose to 50% for the higher-scoring candidates but fell to 20% for the lower-scoring candidates. Indeed, these latter favoured response **B**. The question was perhaps, unusual in having two salts in the same solution but all of the tests involved are directly within the syllabus so that candidates had to sort out which tests were for the copper cation and which were for the anions. As regards the former, it is difficult to understand why candidates should think that the two alkalis should give precipitates of different colours. For the **C**-choosers they seemed to realize that the silver nitrate test gives a white precipitate in a blue solution but why not the same for the barium chloride test?

Question 12

This was also found hard across the ability range. The lower-scoring candidates favoured response **A** and response **D** was quite popular with the higher-scoring candidates. In essence, the question was about the release of ammonia from its salts by the action of an alkali and it is not easy to explain why candidates had such difficulty.

Question 14

Only 69% of the higher-scoring candidates correctly chose **A** as the key but the most popular answer amongst the lower-scoring candidates was response **D**. Did these latter candidates not read the question carefully enough? The syllabus is quite explicit about the trends of the Group I metals.

Question 19

This question did not discriminate as well as expected. It seems that candidates could not cope with the idea of a compound having two functional groups.

Question 20

It is disappointing that this question was found hard. It ought to have been a matter of recall that **D** is the key but over 40% of the candidates across the ability range chose response **C**.

Question 21

Over 25% thought that mm^3 would be suitable for the units on the measuring cylinder presumably not realising just how small 100 mm^3 would be.

Question 22

Most could read the correct value of the length of the cotton but around 25% ignored the fact that it was wound round the pen six times.

Question 27

Around two-thirds answered this question correctly but most of the rest thought it would be impossible to tell who produces most power.

Questions 30, 31, 32 and 33

These caused more problems that most, with candidates seeming to find **Question 33** particularly hard. These items are from the heat/waves/light section of the syllabus which always seems to cause difficulties for candidates for this paper. It really is inexcusable that half the candidates are not able to identify angles of incidence and refraction.

Question 34

Most candidates knew that voltmeters are connected in parallel with something, but a quarter did not spot that the question asked about p.d. across the cell, not a resistor.

Question 38

There was much uncertainty about the deflection of the cathode rays.

Questions 39 and 40

These two items indicated guesswork on a large scale.

Paper 0652/02

Paper 2 (Core)

General comments

With the change in the examination regulations, and only those candidates who were unlikely to score better than a Grade C in the examination being entered for this component, there was an inevitable shift in the profile of the responses. Nevertheless it was disappointing that so few candidates showed what could be considered to be a reasonable understanding and familiarity with the work. In particular there was clearly little understanding of the magnetising effect of an electric current (**Question 5**), and with thermionic emission and the cathode ray oscilloscope (**Question 14**). Also, more tried and tested favourites such as the effect of carbon monoxide on health produced some very disappointing answers for such a familiar topic.

Comments on specific questions

Question 1

The majority of candidates were able to plot the points correctly, however there were many candidates who either drew the line freehand or who joined point to point rather than drawing the line of best fit. Attempts to show that the spring was suitable for the task were very limited. Very few candidates showed any indication that they had used the graph to do this task despite the clear instruction in the question. Many candidates did successfully and accurately read the value from the graph.

It was, however, pleasing that the slightly unusual setting of, what is standard work, did not seem to cause undue difficulty.

Answer: Load = 930 N.

Question 2

Basic attempts to give the structure of the isotopes O-16 and O-18 caused serious problems. Common mistakes were to think that the number of neutrons was 16 and 18 respectively, and not to give the arrangements of the electrons as asked, but only to give the total number. The bonding of oxygen and hydrogen in part **(b)** was done quite well, but a significant number of candidates failed to understand even this basic form of bonding.

Question 3

Whilst candidates often find the balancing of chemical equations challenging, it was of some disappointment that so few were able to complete the simple task set on this occasion. The attempt to calculate the relative molecular mass of methanol, however was done rather better, with many of the better candidates showing a full understanding. The final part of the question proved very difficult, with virtually no-one picking up the idea that the bonding forces in the carbon dioxide were much weaker than in the methanol.

Question 4

Some candidates clearly were aware that the increased surface area of a powder gave a greatly increased chance of a reaction taking place. Similarly many of these realised that diluting the acid and cooling it would slow the reactions down and thereby make them safer. However in this question it was clear that too many candidates had not read the question carefully, and did not answer the question that was set – even though they had some idea of the science involved.

Question 5

This question proved one of the most challenging on the paper with many candidates not even recognising that the effect that was being looked at was the magnetisation of the iron core by the current in the solenoid. Even where candidates did recognise the effect answers tended to be muddled and lacking direction. Typical answers being, ‘When the switch is closed current flows’, with no mention of the iron becoming magnetised and thereby attracting the steel bolt across. Some candidates did manage to score something in part **(b)** for saying that iron was a magnetic material, but few followed it up by saying that it makes a temporary magnet only. Part **(c)** caused great problems with the majority not even realising that no current would pass and therefore the door would not open.

Question 6

Examiners were looking for the fact that molecules give up potential energy as they move closer to each other on condensation, however, as soon as candidates see a question on the energy of molecules the overwhelming majority think only of changes of molecular speeds or kinetic energies. It needs to be emphasised that in a change of state it is a change of potential energy that occurs as bonds are made/broken, or as the molecules move closer together/further apart. Part **(b)** was done rather better with many candidates recognising the melting point of liquid **P** being the flat part of the curve and some were able to explain that the lack of a single melting point showed that liquid **Q** was a mixture.

Question 7

This was done quite well, most candidates realised that potassium is more reactive than magnesium, and that exothermic means that energy is given out in the reaction. Likewise there was widespread knowledge of the test for alkaline solutions and the presence of hydrogen.

Question 8

Some quite good attempts were made at this question, with many candidates recognising that the rubber band had elastic or strain (or merely potential energy) when it was twisted, which was converted into kinetic energy as it started to turn the propeller with some being lost to the surroundings as heating energy. Fewer however realised that work needed to be done to rewind the band. The two calculations in parts **(b)** and **(c)** were done very well, although significant numbers lost marks for incorrect units. Common errors were N/cm for **(b)** and km/h for **(c)**.

Answers: Moment = 7.5 Ncm; Speed = 3.0 m/s.

Question 9

The effect of carbon monoxide on health has been asked many times, but still candidates fail to truly explain, but merely say that it is a poison, rather than giving its effect of combining with the haemoglobin rather than the oxygen. Likewise in the second part the bold statement that sulphur dioxide causes acid rain, is not as complete as saying that it dissolves in the water and thereby forms acid rain.

Question 10

The attempts at drawing the structures of ethanol and ethanoic acid were quite variable, with a significant number of candidates making a good attempt at the former but few really being able to make much of an attempt at the latter. The uses of ethanol were again variable; too often the candidate was not sufficiently precise in the answer, for example in medical use is much too vague to score marks.

Question 11

Many candidates recognised the circuit diagram symbols, although the variable resistor (rheostat) did cause some problems. Few could explain that it altered the circuit resistance and thereby controlled the current. Attempts at drawing the graph were disappointing, only a tiny minority completed the line in both quadrants, and many made no attempt whatsoever. (Either a straight line going though the origin, or a curve showing increasing resistance as the current increased was acceptable).

Question 12

Some candidates were able to complete this simple statement, yet there were many who had little idea and who clearly resorted to guesswork.

Question 13

Whilst many candidates were able to state that argon is an unreactive gas, very few went on to explain that this stopped the tungsten filament reacting with it. In the second part of the question a good many candidates stated that tungsten's high melting point indicated that it is a transition metal, but fewer recognised that the high density was also a clear indication.

Question 14

This question caused serious problems for many candidates, and it seemed that some have not covered this part of the syllabus. Few candidates were able to conclude from the evidence that the particles were negatively charged, and even fewer recognised them as electrons. Familiarity with the working of the cathode ray tube was also rare, and few candidates knew that the roles of the X and Y-plates is to deflect the electron beam. The knowledge of the different traces on an oscilloscope was sketchy, although some of the better candidates did score rather better in this section.

Paper 0652/03

Paper 3 (Extended)

General comments

This alternative paper, targeted at the higher grades and containing 'extended' material, was successful in that realistic candidates for Grades D to A could demonstrate positive achievement. These candidates were able to show in their answers that they understood the questions and the instructions, that they could use information given early in a question later in the same question, that they could use scientific terms correctly in satisfactory English and that they not only had knowledge but also understanding of the topics listed in the syllabus.

However, some candidates did not have the knowledge and understanding, nor the ability to use the information provided to follow instructions, to cope with problems which tested mainly the supplement to the syllabus and required higher skills for this 'extended' curriculum. Many did not seem to recognise phrases and words from the syllabus. Others did not have sufficient mathematical skills to cope with the rearrangement of an equation, nor with the use of proportions, and did not seem to recognise when their calculations produced unrealistic answers.

Some candidates were careless with the names of chemical substances and with their symbols; and used capital letters incorrectly. All chemical symbols are shown on the Data Sheet at the back of the question paper. Candidates cannot score marks if they use chemical formulae and names, subscripts and superscripts, incorrectly.

Many candidates were careless with the symbols for physical quantities and for their units. It is important that the correct symbols are used for reliable communication between the candidate and the Examiner; all the symbols required at this level are listed in the syllabus. An answer involving a physical quantity requires the numerical value with its correct unit. Candidates cannot score the mark for the answer if they write the unit incorrectly or omit the unit. Candidates should note that the symbol *s* for a physical quantity represents *distance* **not** *speed* and that the symbol *m* for a unit represents *metre* **not** *mole*; the only abbreviation for *mole* is *mol*.

Some candidates were careless with their use of words such as atom, ion, molecule, element; often using one incorrectly for another. Sometimes answers contained contradictory statements so could not score marks.

It was clear from their answers that often candidates did not read the question carefully before attempting to write an answer or were unable to retrieve information given a few lines earlier. By contrast, the answers of some candidates were written neatly, giving the scientific information required in simple sentences with correct spellings, with equations and calculations set out clearly and with diagrams drawn and labelled correctly.

Most candidates completed this paper and scored a very wide range of total marks. Every part of each question received the maximum range from zero up to full marks.

Comments on specific questions

Question 1

(a) Few candidates could define *relative atomic mass* correctly as the average mass of one atom of the element compared to 1/12 mass of one atom of carbon-twelve.

(b) Some candidates handicapped themselves by not using calculators. Many used significant figures incorrectly. Some candidates correctly wrote down 5.0/30 for **(i)** then incorrectly calculated this as 6 instead of the correct 0.167 mol. In **(ii)** few correctly calculated 2.0/24 as 0.083 mol. For **(iii)** some incorrectly subtracted instead of dividing **(i)** by **(ii)** to obtain 2 (exactly) moles of metal **M** that react with 1 mole of oxygen gas. Few could use the answer from **(iii)** correctly to write the equation for **(iv)** as $2M + O_2 \rightarrow 2MO$. In **(iv)** some thought incorrectly that A_r = 30 for metal **M** referred to the atomic number of zinc; others thought incorrectly that A_r = 30 meant that the metal **M** was phosphorus.

(c) Some of those candidates who had deduced the correct equation for **(b)(iv)** then incorrectly calculated the relative formula mass of the oxide MO as 92 instead of the correct M_r = 46.

Question 2

(a) Some candidates wanted to put the object into the measuring cylinder despite the clear statement that the object was too large for this. Others unnecessarily wrote about weighing the object and calculating its density despite the clear instruction to measure (only) the volume. Although few candidates made clear that water is put into the displacement can up to the spout, many then correctly placed the measuring cylinder under the spout and carefully lowered the object into the displacement can (until completely immersed). Not all these candidates then made clear that the volume of water displaced into the measuring cylinder was the volume of the object.

(b) Most candidates in **(i)** successfully stated a unit for density as listed in the syllabus, g/cm^3 or kg/m^3; some incorrectly used *gr* instead of *g* as the symbol for *gram* or incorrectly wrote a capital *K* in the symbol for *kilogram*. For **(ii)** most candidates correctly calculated 15.4/0.8 as 19.25 (g/cm^3) for the density of the sample of metal then stated correctly for **(iii)** that, from the table of densities, this was most likely to be gold. Few candidates considered for **(iv)** the probable uncertainties in experimental measurements.

(c) Although many candidates correctly stated gravitational field strength to be weight/mass, few changed the mass of 85 g into 0.085 kg and very few then stated the answer correctly as 1.65 N/kg (or 1.6 N/kg). Some did not use capital *N* as the symbol for newton. Many incorrectly tried to use a value for the gravitational field strength on Earth, about 10 N/kg, in their calculations.

Question 3

(a) Often candidates did not realise that the temperatures listed were measured in kelvin and wrote incorrectly that all these elements had high melting points. Others wrote incorrectly about going *down* instead of *across* Period 3. Those who went on to state that the melting points increased to silicon and then decreased still scored the mark. Some candidates wrote statements that were too vague to score this mark.

(b) There was considerable confusion between the very different processes of *melting* and *decomposing*. Silicon is an element and cannot be decomposed. Some wrote incorrectly about 'intermolecular' forces. Few of those who wrote correctly about strong forces of attraction between the atoms in silicon went on to suggest this was due to the covalent bonding in the giant structure.

(c) Many candidates correctly deduced all four: **(i)** sodium; **(ii)** phosphorus; **(iii)** magnesium; **(iv)** argon. Some candidates wrote symbols incorrectly for these elements, using incorrect capitals A, M, N or incorrect 'small' a, g. Others incorrectly used elements from other parts of the Periodic Table despite the instruction to use elements from those given at the beginning of the question.

(d) Few candidates went to first principles to suggest that because sodium ions have a +1 charge and magnesium ions +2 therefore the forces of attraction in the metallic bonding are weaker for sodium than for magnesium. Many had part of this in their answers yet did not make clear the comparison between sodium and magnesium.

Question 4

(a) Very few candidates showed the resistance wire connected correctly across the voltmeter or, in this circuit, across the battery.

(b) Some candidates handicapped themselves by not using calculators, others used significant figures incorrectly. Although some candidates used incorrect letters in the equation R = V/I, many used the values correctly as 4.3/2.1 yet not all these wrote the answer correctly as 2.05Ω (or 2.0Ω). Some omitted the unit or wrote an incorrect unit.

(c) Although some candidates thought incorrectly that doubling the length of the wire halves the resistance, confusing current and resistance, most correctly wrote a value for this new resistance that was twice the value in **(b)**, 4.1Ω (or 4.0Ω).

(d) There was considerable confusion and misunderstanding of this part of the syllabus. Few explained clearly that, because the shorter wire has less resistance, the current through the shorter wire is greater than through the longer wire and therefore the shorter wire will be hotter than the longer wire. Some stated correctly that a higher temperature might cause the wires to have increased resistance yet did not make clear this effect would be more likely for the shorter wire.

(e) Again, there was considerable confusion and misunderstanding of this part of the syllabus. Many wrote incorrectly about 'voltage flowing through the wire'. Few made clear that a very short length of resistance wire would allow a large current to flow through the ammeter which could cause this to overheat, etc.

(f) Very few candidates remembered a cathode-ray oscilloscope can measure p.d.

Question 5

(a) Many candidates in **(i)** wrote the correct electronic structure for calcium as 2, 8, 8, 2 and for fluorine as 2, 7. Although many candidates in **(ii)** described correctly the transfer of electrons from calcium atoms to fluorine atoms, few went on to state that the Ca^{2+} ions and F^- ions formed attract each other to form calcium fluoride. Some candidates did not use capital letters or 'small' letters correctly in writing the formula CaF_2 for **(iii)**; many incorrectly wrote the symbol for fluorine as F*l*; another common mistake was to write C*l* for calcium.

(b) Some candidates confused 'molten' and 'liquid' with 'aqueous'. Some incorrectly thought that the calcium in the compound calcium fluoride still had its metallic properties. Many carelessly wrote 'calcium' when they should have written 'calcium fluoride' or 'fluoride' when they should have written 'fluorine'. Some candidates wrote incorrectly about electrons moving freely in molten calcium fluoride. Few candidates explained clearly that solid calcium fluoride does not conduct electricity because its ions are held in the lattice, that molten calcium fluoride conducts electricity because its ions are free to move, that liquid fluorine does not conduct electricity because although its molecules are free to move they are not charged.

Question 6

(a) There were many incorrect values for n in the speed of light, 3×10^n m/s. Few candidates wrote the correct value, n = 8.

(b) Again some candidates handicapped themselves by not using calculators, or again used significant figures incorrectly. Although many candidates correctly wrote an equation such as speed = distance/time not all of these could change this correctly into time = distance/speed. Often these equations in symbols seemed to use *s* as the symbol for speed; this is *not* correct because *s* is the symbol for distance; *u* or *v* are the correct symbols for speed, as listed in the syllabus. Candidates who wrote correctly time = 80/340 usually managed to obtain the correct value of 0.235 s (or 0.24 s) for the time. Many incorrectly calculated 340/80 = 4.25 s and clearly did not recognise this as an unrealistic time for sound travelling only 80 m.

(c) Few candidates in **(i)** seemed to realise the experimental importance that, because light travels so fast, the delay at the start in seeing the smoke is negligible and that, because sound travels much more slowly, there is sufficient time for the observer to respond to stop the watch. Although some candidates in **(ii)** confused 'open space' with 'vacuum' or with 'large distance', many realised the importance of decreasing the possibility of echoes which would confuse the observer.

(d) In this question also candidates handicapped themselves by not using calculators, or used significant figures incorrectly. Few candidates succeeded in writing the equation correctly *and* using the value given earlier in the question for the speed of sound *and* converting the frequency from kHz to Hz. Those who wrote $v = f\lambda$ correctly did not always change this into the correct $\lambda = v/f$. Those who correctly wrote 340/3500 did not all calculate the correct answer of 0.097 m. Some wrote an incorrect unit or omitted the unit and therefore did not score the mark for the answer even if the correct numerical value had been calculated for the wavelength.

Question 7

(a) Some candidates wrote statements about temperatures that were too vague to score marks: a warm temperature less than 40˚C is best. Others wrote vague statements about enzymes instead of clearly stating that yeast is required.

(b) Many candidates correctly stated the name of the method for **(i)** as 'fractional distillation'. Few candidates could sketch satisfactorily for **(ii)** a labelled diagram of laboratory apparatus showing the flask of solution being heated, the vapour rising up a fractionating column, a thermometer in the top of this column with its bulb opposite the tube leading down through a water-cooled condenser and into a collecting vessel; many could not sketch the standard diagram for a condenser showing the correct places for the water entering and leaving the outer tube.

Question 8

(a) Few candidates successfully entered all 5 missing words: thermometer; changes; equal; range; sensitive.

(b) Many candidates were too vague in naming a specific type of device for measuring temperature; many then confused 'property' with 'purpose'. A mercury or alcohol liquid-in-glass thermometer depends on the volume of the liquid changing as the temperature changes. A thermocouple depends on its emf changing as the temperature changes.

Question 9

(a) Most candidates stated correctly that limestone is added to the blast furnace to remove impurities from the ore.

(b) Few candidates wrote acceptable equations for **(i)** and **(ii)**, using capital letters and 'small' letters and subscripts incorrectly and did not score these marks.

(i) $CaCO_3 \rightarrow CaO + CO_2$

(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(c) Many candidates explained briefly and clearly that zinc is more reactive than iron so that even when the zinc-coating is damaged the zinc still reacts with damp air and protects the iron. Few explained clearly that, by contrast, paint is inert so that when the paint-coating is damaged, damp air causes the iron to rust.

Paper 0652/05
Practical Test

General comments

The standard was good and there were no very poor candidates. **Question 1** was answered better than **Question 2**. Supervisors were very good in providing a set of results and there were no reports of difficulties. These reports are very important and often the results achieved by the Supervisor act as a standard against which the candidates work can be marked. There was no indication that candidates were short of time and all parts of the paper were accessible to all candidates.

Comments on specific questions

Question 1

Answers to this question were generally very good. Although most scored the first mark for measuring **h**, it should be pointed out that the measurement must be recorded to the nearest millimetre. Many measured **h** quite correctly, between 9.4 and 9.6 cm, but others made it 10 cm. This should be recorded as 10.0 cm and although on this occasion it did not incur a penalty it may well do so on other occasions. It was necessary to be within 0.4 mm of the value provided by the Supervisor. Candidates regularly fail to appreciate appropriate accuracy in reading instruments and a greater emphasis could be placed on this skill. The brief description in **(a)(ii)** needed mention of a measuring cylinder and the volume recorded had to be within 10 cm^3 of the Supervisor's value. Almost all used volumes increasing by 20 cm^3 in **(b)(ii)** and gave sensible values for **d**. A penalty was applied for those who recorded in cm and another for those who produced results in order to exactly fit on a straight line. On this occasion such results are clearly 'fiddled' as the correct line is a curve, not a straight line. The question asked for a straight line for simplicity and the volume when **d** = 0 is very close to the volume of the cup. Graph drawing was good with axes being labelled correctly and although some were caught out by selecting scales that did not allow the volume for **d** = 0 to be read, many did choose suitable scales. Candidates should be encouraged to read through what is required before reaching the point of no return. The result for **V** needed to be within 10% of the answer in **(a)**. Part **(d)** tended to be three marks or zero. Those who knew what to do readily scored three marks. The exception was for those who measured the displacement in a beaker. This was deemed to be worth only one mark. A beaker would not enable the displacement of the water to be measured accurately.

Question 2

Almost no candidate detected an inflammable gas and few observed the lime-water turning milky. In part this would have been a failure to heat the solid strongly enough because it readily turns black and this observation was rare. However, it may also be due to the fact that most only test once for a gas. Clearly if that test is carried out before adequate decomposition has occurred, the test will be negative. Solid **A** produces plenty of inflammable gas once the decomposition begins. As a result, few scored well in part **(a)**. Most detected carbon dioxide in part **(b)**, although it is worth mentioning that 'no reaction' when a lighted spill is extinguished, is not a valid observation. The distinction between clear and colourless was not understood and the incorrect use of the former word did not score. Likewise '**X** disappeared' did not score although 'the colour of **X** disappeared' was allowed. Most deduced **A** to be an acid although few concluded a weak acid. A small number thought a solution of **B** was neutral whereas it is weakly alkaline, about pH 9. Part **(e)** was almost always correct. Part **(f)** was not well done. The simplest method would involve mixing the solids, adding water and collecting the gas in a syringe or in a measuring cylinder over water. Some described a method involving loss of mass that would work except most forgot to mention the necessity to know the mass of water added. Diagrams when given, were poor.

Paper 0652/06
Alternative to Practical

General comments

As usual, some candidates reached a very commendable standard in this examination, but many entrants showed that they had a lack of experience in laboratory work. The Examiners always try to ensure that the wording of the questions is simple and that sentence construction is not complex. In spite of this, too many candidates seemed to find the descriptions of the experiments very hard to understand; coupled to their ignorance of laboratory apparatus and procedures, this meant that their scores were poor.

Comments on specific questions

Question 1

This question was based on a very simple method for comparing masses using a beam clamped at one end. The mention of a beam led some candidates to conclude that the principle of moments was involved. The word *displacement* was also difficult for some.

(a) Fig. 1.3 showed a scale of the displacement for two different loads. It was often read ascending rather than descending.

(b) The relationship between load and displacement was approximately proportional, but a simple statement such as "the displacement increases with the load" was accepted.

(c) Accuracy can be achieved by repeating the experiment and finding the average, a standard answer for almost all experiments with a numerical outcome.

(d) The results of changes to the thickness or length of the beam were usually well described.

(e) A sensible and full description of the correct procedure for finding the mass of an object was seldom given. Some candidates found the phrase "that weighed between 200 g and 500 g" very hard to understand, so there were lengthy explanations involving placing masses of 200 g, 300 g and 400 g on the beam and finding the average of the displacements. Only a very few candidates suggested plotting a graph of the data in Fig. 1.2 and then using the displacement to find the mass of the object.

Question 2

The meter reading and graph plotting in this question were deliberately kept simple, in contrast to **Question 6** where a much harder graph plotting exercise was set. The question explored the change in current passing through a lamp as the resistance of the circuit was lowered.

(a) Most candidates achieved all three marks in reading the ammeter and voltmeter dials.

(b) The graph was already shown with the labelling and scales of the axes. Most candidates successfully plotted the two points on the graph and drew a line: the Examiners allowed either a curved line plotted through the points, or a "best straight line" to be drawn.

(c)(i) The idea of electrical resistance is a difficult one, so it is not surprising that a large proportion of candidates wrote that the brightness of the bulb decreased when the resistance was decreased.

(ii) Experience of using a low voltage electrical circuit inevitably includes the "blowing" of the bulb when too great a current is passed. Some candidates also suggested that a fuse in the circuit might have melted, which was accepted as an answer here, but most candidates did not realise what could interrupt the flow of electricity through the circuit.

(d) Ohm's Law can be illustrated in the laboratory by the drawing of a graph of **V** against **I** to show that it is a straight line. If the candidate drew a straight line for **(b)**, the answer that the bulb obeyed Ohm's Law, because the graph was a straight line, was accepted. Just a few candidates knew that the resistance of a conductor increases with temperature, so the bulb does not obey the Law, but this information was not necessary to gain the mark.

Question 3

This question took the candidates through the process of preparing a salt using a metal and acid, but with some complications so that a quantitative exercise was involved.

(a) The scales were to be read ascending, but alas, a few candidates read the balance windows in the question the wrong way. As well as this, the first decimal place was expected to be included in the mass of the beaker and copper, so that it was 60.0 g not merely 60 g.

(b) Some candidates wrote about the "pH" of the gas being lower than 7, but the Examiners wanted the change in colour of litmus paper from blue to red, or of Universal Indicator Paper to red, as the experimental observation.

(c) This was a hard mark, for the balance reading had to be correct and then a subtraction made from the mass of the beaker + copper at first, to find the mass of the copper, 3.2 g, that had been used up. A commendable proportion of candidates achieved this mark.

(d) Some candidates incorrectly interpreted the information that "copper(II) nitrate crystals decompose if they are heated" to mean that the solution could not be evaporated by boiling it. However, they could obtain one of the two marks by suggesting that leaving in sunlight or in the air would evaporate the solution. In practice, the hydrated salt is rather deliquescent, so the use of a desiccator is advisable. There were some good descriptions of the usual way to obtain crystals of a salt by partial evaporation and then cooling, and some better candidates wrote about the use of a boiling water bath.

(e) This last weighing was rather more straightforward, and many candidates earned the two marks, finding that 9.5 g of copper nitrate crystals had been formed.

(f) The student making the copper(II) nitrate crystals would not have achieved a good yield if the advice of many candidates had been followed! However, the question dropped heavy hints about possible reasons for a low yield, such as decomposition of the salt due to heating during crystallisation and the loss of some of the water of crystallisation. A few candidates also mentioned that he might have spilled the solution. Just a handful also pointed out that some of the copper nitrate was left in the solution after crystals had been obtained.

Question 4

This question describes the behaviour of balloons filled with gases. Many candidates may not have had the experience of holding a hydrogen balloon, but it should be part of their general knowledge that some gases are less dense than air.

(a) The dials of the stopclocks showed seconds. A few candidates wrote "63" for the time taken for gas D to rise, but this was not realistic.

(b) The notion of "density" reminded most candidates to use this term rather than "light" or "heavy". Others just did not know its meaning, and wrote that hydrogen was the densest gas because it rose the quickest.

(c) The gases were light (less dense), or heavy (more dense) and this property had to be correctly matched to their behaviour for only one mark. For the second mark, the comparison with air had to be made. A commendable proportion of candidates made this connection.

(d) Strictly, the answer should be "so that the experiment is fair", that is, so that every gas is treated in the same way. The Examiners also accepted "so that the results are accurate."

(e)(i) The answer to this question rested on the knowledge that hydrogen is the "lightest" gas.

(ii) The test for hydrogen is simple, and one would hope that every candidate has had the experience of testing for the gas, using a lighted splint and hearing the explosion. However, there were many references to "relighted" splints and "glowing" splints, showing that their response depends only on book learning. This is a shame, since the excitement of doing real chemistry ought to be part of the experience of every candidate.

Question 5

This is the question about analytical chemistry that usually forms part of this examination; as usual, there was ignorance of these very basic procedures to test for gases, acid and alkali. The number of candidates scoring full marks in this question was very low.

(a) What does limewater look like? This caught out many candidates who clearly were lacking in "hands on" experience.

In test 2, "the flame was extinguished" was a signal to some candidates that hydrogen was present, since when hydrogen is burned by inserting a lighted splint, the flame goes out with a Pop! When a gas does not support combustion, the presence of nitrogen or carbon dioxide is a possible conclusion; the absence of oxygen is another.

Examiners were reminded that in a few countries, a Universal Indicator that does not conform to the colour changes of the BDH Universal Indicator is used. An effort was made to ensure that candidates who were familiar with this product were not penalised. In test 4, only the final colour of the indicator, yellow or green-yellow, was marked.

(b) Most successful candidates drew diagrams of a vessel having a delivery tube leading either to a graduated syringe or to a graduated tube collecting gas over water. Many fanciful diagrams were drawn.

Question 6

This question, like **Question 5**, corresponded to the question in the Practical Examination, Paper 5. The candidates were invited to find the volume of a drinking cup in cm^3 and then to add a measured number of grams of water to it, while it stood in water, until it sank. The two amounts should be approximately equal if the mass of the drinking cup is ignored, thus illustrating a statement shown at the beginning of the question, that "when the mass in g of a vessel placed in water is just greater than its volume in cm^3 it will sink."

(a) A dropper or pipette or even a burette can be used to place the final few drops of water in the full cup.

(b) A simple subtraction of the volume remaining in a measuring cylinder, from its full volume, gives the capacity of the cup, 147 cm^3.

(c) A millimetre ruler is used to find, from a full-size diagram, the height of the cup standing out of the water after measured amounts of water have been added. Instead of using the ruler, some candidates guessed these heights, others tried to find them, more or less successfully, from the graph in part **(d)**.

(d)(i) The graph grid was shown with no labelling. The terms "horizontal" and "vertical", as in previous years, were often not known. In the table of data, Fig. 6.3, the volumes were given in the first column, so many candidates automatically plotted these on the vertical axis in contravention of the instruction. This meant that the extension of the graph to cut the horizontal axis did not show the volume in the cup at **h** = 0. The expected answer to part **(ii)** was the same as the answer for **(b)(ii)**, 147 cm^3.

(iii) The cup sank when **h** = 0, an easy answer.

(e) This was probably the hardest question in the paper. Candidates had to compare the mass in the cup when it sank, taken from the graph, with the volume of the cup. The expected answer was that the two are identical at 147 cm^3, so the statement at the head of the question is correct. However, if they were not identical, the candidate could earn the mark by pointing out this fact. A very few candidates did gain this mark.