PHYSICAL SCIENCE

Paper 0652/01
Multiple Choice

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

Chemistry

General comments

Overall the examination performed well with candidates gaining marks well distributed across the range.

The Chemistry questions performed well being very similar in difficulty to those in the Physics section.

Comments on specific questions

Question 6 proved to be very straightforward with a large majority of candidates scoring the correct response. **Questions 1**, **3**, **4**, **9** and **11** were more difficult.

Question 1 Option **B** was a common wrong response. This response was more popular than the correct answer. Candidates must realise that the separation of particles in a gas has little to do with the property of diffusion.

Question 2 The candidates chose the description of a metal (option **D**) rather than that of the ionic solid.

Question 4 Option **A** was more popular that the correct answer. The higher-scoring candidates tended to choose the correct response. Other candidates chose the equation containing the largest number of molecules and did not properly take into account the relative masses of the compounds.

Question 7 Some candidates chose option **D**, possibly because the number of atoms reduced. These candidates may need more practice in understanding the concept of chemical reduction.

Question 9 All responses had a roughly equal number of candidates selecting them.

Question 12 Many candidates chose option **C** instead of the correct answer, perhaps because one of the diagrams reminded them of an experiment that is commonly performed using magnesium. Candidates must be encouraged to consider all of the data available in the stem of a question.

Question 13 Some candidates chose option **B**, not appreciating that helium is unreactive.

Question 15 Option **D** was a common incorrect answer. Candidates who considered only the need for resistance to corrosion but not the need for low density would have selected this answer.

Question 17 Option **B** was a common incorrect answer. Candidates need to be made aware of the sequences associated with the supply of water.

Physics

General comments

Candidates found item **29** particularly difficult. Other items that were generally found challenging were **22**, **23**, **24**, **27**, **30**, **31**, **33**, **36**, **37**, **38** and **39.**

Comments on individual questions

Item **21** the distractor, option **A** was by far the most popular. It is likely that the candidates selecting this option needed to read the stem more carefully in order to note the requirement to measure volume and not mass.

Speed / time graphs were the topic for item **22**. More than a third of candidates incorrectly chose option **B**. It is possible that these candidates mistook the graph for a distance / time graph. The advice always to look carefully at the axis labels before interpreting a graph is highly recommended.

Many candidates incorrectly chose option **A** in item **23**, simply subtracting one reading from the other. The question required a more complex calculation, using the data given in the stem.

In item **24** on melting, option **D** was the most common incorrect answer.

Item **25** was better answered, the symmetry of the tile being a strong clue in addition to its suspension from the nail.

In item **26,** option **C** proved the most popular distractor.

Many candidates found item **27** very challenging. Candidates need to be aware of the concept of a lower fixed point on the Celsius scale.

Item **28** showed convection to be well understood, although nearly one in five incorrectly chose option **B**, the exact opposite of the correct response.

Item **29** was the physics question that the candidates found most challenging. The unfamiliar wave shape should not have deterred candidates from applying the knowledge that the 'crest-to-trough' height is twice the amplitude. Candidates should also be encouraged to look for the distance between repeated wave sections for the wavelength.

Item **30** required candidates to recall knowledge of the electromagnetic spectrum. Candidates should ensure that they know the order of the parts.

Item **31** required candidates to be familiar with reflection and refraction. Options **A** and **B** were popular distractors, perhaps because they represented symmetrical situations. Candidates need to be aware of the direction of refraction when light passes from a less optically dense medium to a more optically dense medium, or vice versa.

Item **32** showed a good level of knowledge of the graphical representation of a sound wave.

Item **33** concerned magnetic field patterns. Candidates continue to find this area of the syllabus challenging.

Ohm's Law seems much more widely known, with many candidates choosing the correct response for item **34**.

The electrostatics question, item **35**, was well answered, although a minority of candidates believed that the comb and foil would have opposite charges.

Item **36** concerned quite complex circuits and proved challenging for many candidates.

In item **37**, option **C** was the most popular incorrect choice, some candidates mistakenly linking a thinner cable to an increased ability to carry a current without overheating.

The cathode ray tube was covered by item **38** with almost as many candidates choosing option **B** as the correct response.

Over half the candidates chose the correct response (option **C**) to item **39** on half-life, although slightly more than one in five only halved the value twice, concluding that option **B** was the correct response.

The final item **40** demonstrated that candidates have a sound knowledge of proton number.

PHYSICAL SCIENCE

Paper 0652/02
Core Theory

General comments

There were some very good papers where candidates had been thoroughly prepared and showed a good knowledge and understanding of large parts of the syllabus.

Some candidates struggled with **Questions 2a** (charge and current), **3(c)** (reflection), **4(b)** (stoichiometry), **6** (solidifying and melting), and **9(b)** (demagnetisation).

Question 8 (Periodic Table) was answered well, with many candidates scoring at least half of the available marks. Similarly **Question 5** (measurement of density) was answered well.

Although it is not an easy topic, there were a number of outstanding answers to **Question 11** (alkanes and alkenes) which demonstrated an excellent knowledge and understanding.

Comments on specific questions

Question 1

(a) The calculation of the relative formula mass was well done by many candidates. Other candidates transferred the information from the Periodic Table included at the back of the paper incorrectly, before using the information to calculate relative formula masses. A common error was to use the proton number (atomic number) rather than the nucleon number (mass number).

relative formula mass = 124 g / mol

(b) All the chemical formulae for the equation were given elsewhere in the question; consequently the question tested candidates' understanding of the concept of chemical equations. Whilst many candidates were able to give the required equation ($CuCO_3 \rightarrow CuO + CO_2$), many others showed that they need to develop their understanding further.

(c) (i) Many candidates failed to understand that a chemical test for carbon dioxide was required and simply referred back to the equation in their answer. Of those who did describe a chemical test, the majority correctly described the use of lime water but a significant number described the extinguishing of a lighted splint. Candidates must recognise that the latter test is not a definitive test for carbon dioxide; many other gases will extinguish a lit splint.

(ii) The definitive test for the presence of a metal is to test for electrical conduction. It is pleasing that many candidates described this correctly.

Question 2

(a) (i) The best answers showed a clear understanding that the spark carried charge from the charged sphere to the uncharged sphere, and that the charge then moved to Earth through the ammeter, thereby linking the idea of current to the movement of charge. Other answers demonstrated a poor comprehension of the concepts of charge and current and the link between these two concepts.

(b) The majority of candidates correctly applied the formula to find the potential difference across the resistor. More care, however, needs to be taken in checking that the quantities given in a question are given in the full unit rather than sub-multiples of the unit.

V = 60 mV or 0.060 V

Question 3

(a) The wavelength that needed to be identified in this question was fairly small; nevertheless candidates needed to take reasonable care indicating it. The easiest way is to draw two vertical lines at successive crests (or troughs) and to mark the distance between these with an arrow. Attempts to indicate the wavelength using only an arrow often introduced unintended uncertainties.

(b) The calculation of frequency was done well, with many candidates scoring full marks. It must be remembered that the full answer requires not just a numerical value but also a suitable unit.

frequency = 4.5 Hz

(c) (i) A few candidates recognised that the water surface acted as a mirror; consequently light from the lamp would be reflected to the boy's eye. Care needs to be taken to draw the rays so that the angles of incidence and reflection are equal. The explanation of the image formation requires the reflected ray be extended back to the image in a straight line. The slightly unusual context seemed to confuse many candidates, who often felt that refraction was involved in this process. Another common error was to try and draw a ray diagram as though the image were formed by a lens.

(ii) Candidates need to develop an understanding that a virtual image is an image which is formed by the brain tracing rays back as though they emanated from the image, rather than actually passing through the image itself. This is quite different from a real image where the rays actually pass through the image.

Question 4

(a) (i) The correct answer (hydrochloric) is deduced from an inspection of the chemicals which are involved (zinc and an acid forming zinc chloride). While many candidates correctly answered this section, the answers from other candidates indicated that they need practice in making this form of deduction.

(ii) The correct answer for this section (hydrogen) could be deduced from an understanding of the structure of acids.

(iii) Many candidates who recognised that hydrogen was the gas formed in the reaction also recognised that hydrogen is less dense than air so that suitable methods of collecting the gas are to use an inverted tube, a gas syringe or over water

(b) A significant number of candidates were able to calculate the relative formula mass of zinc chloride (a task made more difficult because there are two chlorine atoms in each molecule) and the best candidates were able to complete the calculation. It is worth noting that there is no simple algorithm for working out this type of calculation and numerical logic needs to be applied to questions of this nature. Candidates need to think before they start writing and then lay out their mathematical work in a clear and concise manner, explaining what they are trying to do. If this approach is followed, part marks can be given where the final answer is not correct or the calculation is not complete. If the answer consists of a jumble of figures without explanation, a wrong answer will often lead to the candidate scoring no marks at all.

mass of zinc = 130 g

Question 5

(a) The first part of the question took a straightforward experiment and asked candidates to name apparatus suitable for carrying out the experiment. Candidates must ensure that they use suitable measuring instruments in questions such as this one – for example a beaker is not a suitable instrument with which to measure volume as it cannot measure volume with the precision needed for this experiment.

Section **(ii)** asked candidates to describe the experimental procedure. The best answers showed a clear understanding of the steps in finding the density of the sea water, using a measuring cylinder to find the volume of sea water. Both the mass of the empty cylinder and the mass of the cylinder partly filled with sea water must be measured. Lower scoring answers failed to make it clear that both masses had to be measured. Likewise, correct terminology must be used; 'amount of water' is too vague, and fails to indicate whether the candidate is referring to either mass or volume. The term 'scales' was accepted for balance, although it must be emphasised that the correct scientific term *is* balance.

The best answers to **(iii)** made clear how mass of the sea water was found from the measured masses and that this was then divided by the measured volume. Others missed the crucial stage of finding the mass of sea water from the two measurements of mass.

(b) The calculation was done well with many candidates correctly rearranging the formula for density and successfully carrying out the calculation.

volume = 250 cm^3

Question 6

(a) Many candidates recognised that, during the period from 30 to 100 seconds, the liquid was at constant temperature and in the best responses this constant temperature was linked to the solidification of the naphthalene.

(b) Many candidates recognised that the temperature differences between the bottles of water were due to the ice taking time to melt. Very few then went on to link this to either the experiment described in ***section A*** or to the idea that a great deal of energy had to be absorbed to melt the ice.

Question 7

(a) Many candidates recognised that combustion of sulfur involved the combination of sulfur and oxygen atoms. Although the majority correctly identified the gas formed as sulfur dioxide, a significant minority thought it was sulfur oxide. Those who recognised the gas as sulfur dioxide generally gave the correct formula.

(b) There were some excellent answers discussing the formation of acid rain and its affect on buildings and pond life. To gain full marks, candidates needed to be specific; general statements such as 'bad for animals and crops', were considered too vague to be awarded marks. Another common insufficiency was to state simply that the gas was a pollutant. A common mistake was to say that the gas damaged the ozone layer.

Question 8

This question was done particularly well with many candidates scoring full marks. The most common error was in identifying the element in the given period whose ion carried a charge of -1.

Question 9

(a) This part was quite well done, with most candidates recognising that a magnet needed to be placed in the base of the players. An answer that was not as good, but which the examiners felt showed sufficient thought to be worth a mark, was 'a south seeking pole'. The majority of candidates recognised that the light controller also contained a magnet and that the orientation of this magnet must be opposite to that of the dark controller.

(b) Very few candidates were familiar with demagnetisation by placing a magnet into an alternating current solenoid and slowly reducing the current. A minority, only, of candidates realised that the demagnetised controller would now attract both north and south poles and hence both colours of player.

Question 10

(a) Candidates showed some awareness that both hydrogen and ethanol were clean fuels, although it is not quite true to state that ethanol does not produce any polluting gas, as the combustion of ethanol produces the greenhouse gas carbon dioxide. A common error was to state that a disadvantage of hydrogen was that it is explosive – all fuels are explosive to a greater or lesser extent. The best answers for the disadvantages of hydrogen referred to the expense of producing hydrogen or the problems of its storage.

(b) (i) Many candidates correctly recognised water as the product of combustion of both gases, although many seemed to think that both gases also produced carbon dioxide.

(ii) Various answers were given here, distillation being the most common error.

Question 11

(a) The best answers clearly stated that there were single bonds between the carbon atoms in alkanes, but a double bond in the alkenes. Less precise answers stated that there was 'one single bond or one double bond', or described alkanes as saturated and alkenes as unsaturated.

(b) The correct answers were often seen and most candidates, even when giving the incorrect answers, recognised that the alkane ended in 'ane', and the alkene in 'ene'.

(c) This section proved the hardest section in the question. Nevertheless, there were several excellent answers describing the use of bromine water.

(d) A significant number of candidates gave suitable answers to this section.

Question 12

(a) Candidates need to be aware of simple precautions when using radioactive materials. In this example, the use of tongs is the most appropriate answer. A positive statement is required, rather than a negative one such as 'do not handle the source with bare hands'.

(b) Candidates should be aware of the existence of background radiation and that this must be allowed for in all experiments involving measuring radiation levels.

(c) Candidates need to be aware that radioactive decay is a random process and consequently the recorded rates of emissions will vary in a random fashion.

(d) There were some good responses to this section which required candidates to interpret the results of an experiment. Many candidates correctly deduced the absence of β-particles and the best were able to reason that the small change between the reading with a card absorber and with the aluminium was evidence for this. The explanation for the presence of γ-rays proved more challenging; the majority of the candidates thought that the lead stopping the rays was the relevant evidence. In practice it is either the fact that a lot of radiation penetrated the aluminium or that a small amount (greater than background radiation) penetrated the lead that leads us to the conclusion that γ-rays are present.

Question 13

A large number of candidates recognised that at a higher temperature, the initial rate of reaction would be faster and that with larger marble chips, the initial rate of reaction would be slower. Candidates needed to recognise that, with everything else constant, the same final volume of carbon dioxide would be collected.

PHYSICAL SCIENCE

Paper 0652/03
Extended Theory

General comments

The examination proved challenging for some, with evidence that these candidates could perhaps have benefitted from being entered for the core examination. Many answers contained repetition or contradiction, indicating that candidates could be well advised to think carefully about their intended answers before writing them down. Candidates need to be encouraged to plan what they are going to say in order to facilitate the production of clear concise answers.

Although many candidates were able to give good answers to the introductory parts of questions, the more challenging parts of several questions were less well answered. In particular, **Question 2(c)** (diffuse reflection), **Question 3(c)** (stoichiometry) and **4(a)** (relation between charge and current) fell into the latter category.

It was encouraging that many candidates scored well on **Question 8**.

Comments on specific questions

Question 1

(a) (i) The vast majority of candidates correctly stated the pH of the solution as being between 1 and 6.

(ii) It is important the candidates read the question carefully and think about their answer. The question asked how the pH would change as sodium hydroxide is added *'to excess'*. Most candidates realised that the pH of the solution would increase; a complete answer, however, would have stated that the pH would increase to a level greater than 7.

(iii) To monitor pH, either Universal Indicator or pH-meter must be used. Although a litmus test will distinguish between alkalis and acids, it will not accurately show changes in pH.

(iv) Candidates are required to know the formula of simple compounds and to be able to balance simple equations. The most common error in this example was a failure to recognise the there are two sodium atoms in one molecule of sodium hydroxide. This can easily be surmised from the sodium atom forming a single positive ion (a Group 1 metal) and the sulphate ion being a double positive ion.

(c) Many candidates mistakenly thought that the base was the proton donor. This possibly arises from confusion between the Bronsted-Lowry and Lewis definitions of a base. The Bronsted Lowry definition defines the acid as a proton donor (the proton being the H^+ ion) and the base as a proton acceptor. In the Lewis definition the acid is defined as an electron acceptor and the base as an electron donor. Candidates need to be clear of the distinction between the two definitions.

Question 2

(a) (i) The wavelength that needed to be identified in this question was fairly small; nevertheless candidates needed to take reasonable care indicating it. The easiest way is to draw two vertical lines at successive crests (or troughs) and to mark the distance between these with an arrow. Attempts to indicate the wavelength using only an arrow often introduced unintended uncertainties.

(ii) The diagram clearly showed the wavelength getting shorter as the wave moves across the pool from **B** to **C**. It was also clear from the diagram that the pool becomes shallower towards end C. The majority of candidates focussed on this point; they did not, however, link the change in depth to the refraction effect which is caused by the wave speed slowing in the more shallow water. Apart from the omission of the second part of the explanation, a common error was to think that the decrease in wavelength was due to an increase in frequency.

(b) The calculation of frequency was performed well, with many candidates scoring full marks. Candidates should be reminded that a full answer requires not just a numerical value but also a suitable unit.

frequency = 7.5 Hz

(c) (i) A few candidates recognised that the water surface acted as a mirror; consequently light from the lamp would be reflected to the boy's eye. Care needs to be taken to draw the rays so that the angles of incidence and reflection are equal. The explanation of the image formation requires the reflected ray be extended back to the image in a straight line. The slightly unusual context seemed to confuse many candidates, who often felt that refraction was involved in this process.

(ii) This part explored candidates' ability to think about an observed phenomenon. There were some good diagrams with rays which were reflected to the boy's eye showing evidence of diffuse reflection. The written explanation also produced some answers where the candidate clearly explained that the rays would reflect in many different directions producing multiple images. There was the occasional outstanding answer which went much further than had been anticipated, and which explained that the wave was continuously moving and hence the images would also be moving. Those candidates who explored this avenue deserve praise.

Question 3

(a) (i) The importance of careful reading of the question was shown by many of the incorrect answers to this question. A significant number of candidates explained how ethanol was produced by adding steam to ethane, whereas the question asks for an explanation of fermentation. Those who described fermentation generally gave good responses, recognising that fermentation is the process of yeast acting on sugar solutions. The best answers also included a reference to the most effective temperature range for fermentation.

(ii) Many candidates showed the ability to write and balance simple chemical equations. Some candidates demonstrated the need to learn basic molecular formulae more thoroughly and to have greater practice in the skill of balancing equations.

(b) It is worth noting that there is no simple algorithm for working out this type of calculation and numerical logic needs to be applied to questions of this nature. Candidates need to think before they start writing and then lay out their mathematical work in a clear and concise manner, explaining what they are trying to do. If this approach is followed, part marks can be given where the final answer is not correct or the calculation is not complete. If the answer consists of a jumble of figures without explanation, a wrong answer will often lead to the candidate scoring no marks at all.

volume of ethanol = 417 dm^3

(c) The best answers showed a good understanding of the concept and process of cracking hydrocarbons. A number of answers confused cracking with fractional distillation.

Question 4

(a) (i) The best answers showed a clear understanding that the spark carried charge from the charged sphere to the uncharged sphere, and that the charge then moved to Earth through the ammeter, thereby linking the idea of current to the movement of charge.

(ii) There were some good responses which showed a good understanding of the energy transformations involved in this example i.e. electric (potential) energy to light, heat and sound energy.

(b) (i) The majority of responses showed the ability to apply the basic formula, $V = IR$. Many candidates, however, needed to take into account that the current given was in milliamperes, not amperes. This error was then, often, carried forward throughout the question.

potential difference = 0.060 V or 60 mV

(ii) Once more the equation was generally applied correctly.

charge = 1.8×10^{-9} C

(iii) Fewer answers showed the correct application of the equation for the energy dissipated, a common error being the calculation of power rather than energy.

energy = 1.08×10^{-10} J

Question 5

(a) The majority of candidates recognised that the Group Number is equal to the number of electrons in the outer shell of the atom. Others saw a relationship, but did not explain their understanding clearly or made vague comments such as 'the group number is proportional to the number of electrons in the outer shell'.

(b) There was a good understanding shown that the nature of elements in a period changes from metallic to non-metallic/covalent, although some responses did try to explore the effect down a group.

(c) The correct formula for lithium oxide was generally given and many responses showed a clear understanding that there is electron transfer from lithium atoms to oxygen atoms. The best answers went on to state that the outer electron from each of two lithium atoms was given to an oxygen atom. Common errors were that the electrons are shared / the bond is covalent.

(d) The question asked for the arrangement of all the electrons in a nitrogen molecule. Candidates are expected to know that nitrogen is diatomic, so that a diagram of a single nitrogen atom was not considered relevant. Nevertheless, there were many good diagrams, showing three pairs of shared electrons and a further two in the outer shell. The very best answers also included the two inner electrons.

Question 6

(a) Candidates need to be aware of simple precautions when using radioactive materials. In this example, the use of tongs is the most appropriate answer. A positive statement is required, rather than a negative one such as 'do not handle the source with bare hands'.

(b) Candidates should be aware of the existence of background radiation and that this must be allowed for in all experiments involving measuring radiation levels.

(c) (i) Candidates need to be aware that radioactive decay is a random process and consequently the recorded rates of emissions will vary in a random fashion.

(ii) There were some good responses to this section which required candidates to interpret the results of an experiment. Many candidates correctly deduced the absence of β-particles and the best were able to reason that the small change between the reading with a card absorber and with the aluminium was evidence for this. The explanation for the presence of γ-rays proved more challenging; the majority of the candidates thought that the lead stopping the rays was the relevant evidence. In practice it is either the fact that a lot of radiation penetrated the aluminium or that a small number (greater than background radiation) penetrated the lead that leads us to the conclusion that γ-rays are present.

(d) (i) The best efforts showed real thought, discussing the high ionising effect of α-particles and that this meant that there was a high chance of collisions with the cancerous cells, some answers even developing the idea that the particles would be absorbed by the cancerous tissue and not effect surrounding healthy tissue.

(ii) As in the previous question the best responses showed real thought, recognising that the short range of α-particles meant that they would not reach the tumour and may even damage healthy tissue on the way.

In answering the type of question asked in part **(d)**, candidates need to think carefully about what they want to say, to avoid repetition and vague answers, such as, in **(d)(ii)**, 'cause further cancers' without any qualifying explanation.

Question 7

(a) (i) There were some almost perfect answers to this part of the question, Other candidates showed confusion about the role of the limestone in the process and in the removal of oxygen from the iron ore. Candidates need to develop a clear understanding of the principles of industrial chemical processes like this.

(ii) Most candidates who understood the two part process of the formation of carbon monoxide were able to complete the relevant equations. The most common error was a failure to recognise the diatomic nature of the oxygen molecule.

(b) Much of what was said about the calculation of **Question 3(b)** is equally relevant to this question; clear working must be shown or marks may well be lost.

mass of iron(III) oxide = 85 700 tonnes

(c) Most candidates recognised that alloys of iron consist of a mixture of iron plus traces of other metals or carbon. The best answers gave a clear indication that this was achieved by melting the iron and alloying metals and mixing them together. The comment regarding the reasons for producing alloys was answered satisfactorily but the best answers were well thought out and clear.

(d) The best answers clearly stated that aluminium is more reactive than carbon and hence the carbon would not remove the oxygen from the ore. Less well thought out answers were not comparative, merely stating that aluminium is very reactive. There were a significant number of candidates who thought that the oxide layer on aluminium prevented any reaction.

Question 8

(a) The first part of the question took a straightforward experiment and asked candidates to name apparatus suitable for carrying out the experiment. Candidates must ensure that they use appropriate measuring instruments in questions such as this one – for example the use of a eureka can to measure volume was not suitable here, the uncertainties involved making the answer too imprecise.

Section **(ii)** asked candidates to describe the experimental procedure. The best answers showed a clear understanding of the steps in finding the density of the stone, using a balance to measure the mass of a stone and a measuring cylinder to find the volume. The best answers went on to explain that the mass must be measured and the measuring cylinder is partly filled with water; that volume is measured, the stone is totally immersed and the new volume measured. Other answers failed to make it clear that both volumes needed to be measured. Likewise, correct terminology must be used; 'amount of water' is too vague, and fails to indicate whether the candidate is referring to either mass or volume. The term 'scales' was accepted for balance, although it must be emphasised that the correct scientific term *is* balance.

The best answers to **(iii)** made clear how the volume of the stone was found and that this was divided into the measured mass. Others missed the crucial stage of finding the volume of the stone from the two measurements of volume.

(b) The calculation was done well with most candidates correctly rearranging the formula for density and successfully carrying out the calculation.

volume = 2.5 cm^3

PHYSICAL SCIENCE

Paper 0652/05

Practical Test

General Comments

There were some very good answers and very few poor ones, covering the whole range of marks. The questions were readily accessible and did not appear to present any time problems. Supervisors played their part in preparing the examination and carrying out the experiments. A complete set of results is essential as the Examiners can learn a great deal from these and ensure candidates achieve the marks that are merited.

Specific Comments

Question 1

Not surprisingly, no two lamps are identical and therefore the values of current in the experiments were not likely to be exactly what the theory indicates. For example, the current when two lamps were in series was unlikely to be exactly half that when one lamp was used. However, results should have been sufficiently close for candidates to realise that the statement was correct. Many were able to deduce this from their results and score two marks. When results could not support the statement, one mark was awarded providing the candidate stated that the results could not support the statement. Candidates do need to be familiar with the meters they are using to avoid misreading a current of say 0.1 A and reporting it as 1.0 A. The majority were able to draw a correct circuit for the two lamps in parallel and construct a suitable table. Parts **(e)** and **(f)** were marked in a similar fashion to parts **(a)** and **(b)**, that is making an allowance for experimental error in the values for current.

Question 2

Candidates need to understand that heating strongly means just that and do not stop heating as soon as one change is seen. Heating the compound iron(II) ammonium sulfate produces many observations including ammonia, a white solid followed by a brown solid, a white smoke and a gas that turns litmus red. Ammonia was correctly identified in part **(b)** by almost all candidates. Candidates should be reminded to use the work 'precipitate' where appropriate, as it is more specific than general descriptions such as 'cloudy' or 'milky', which cannot be credited. **(c)(i)** is the sulfate test, described on the back page of the question paper. Part **(ii)** is the chloride test but in this instance did not produce a white precipitate; therefore the substance cannot be a chloride. Silver ions are reduced by the iron(II) to a suspension of silver producing a brown precipitate. Variations on the colour brown were acceptable answers. Many correctly recorded the colours green and brown for **(d)(i)**. The most common answer for **(ii)** was blue which was not surprising since copper sulfate was being added. A blue precipitate or a deepening of the blue colour was required. Many candidates were able to correctly deduce the three ions and it was particularly good to see that most were able to distinguish between ammonium and ammonia.

PHYSICAL SCIENCE

Paper 0652/06

Alternative to Practical

General comments

Questions 2 and **3** of are based on the corresponding experiments in the Practical examination, paper 5, so that this paper is also firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated a good practical knowledge. However, some candidates demonstrated a poor appreciation of the principles and practice of physical science, especially in the chemistry **Questions 1**, **3** and **6**. The answers given by candidates who performed well presented evidence of exposure to practical work.

Comments on specific questions

Question 1

The properties of metals are explored in this question.

(a) The mass of five coins is found and the coins are then placed in a measuring cylinder containing 25 cm^3 of water so that the total volume of the coins can be measured. From these observations the volume of the coins and the density of the metal alloy can be calculated. Most candidates obtained marks in this section.

(b) (i) Metal from a coin reacts with acid and a gas is evolved. Candidates are asked to describe a test which could ascertain if the gas is hydrogen or not. A large proportion of candidates mentioned a glowing splint, rather than a lit splint, and so earned no marks for their answer.

(ii) Candidates must name a metal that could be in the alloy that will react with acid to give hydrogen. Many candidates wrongly named copper as the possible metal. Correct answers would have named magnesium, zinc, aluminium, iron or tin

(c) The brown-red residue for the reaction of the alloy with acid is dissolved in nitric acid to give a blue solution.

(i) The Examiners expected the answer "a blue precipitate" to this question.

(ii) Excess ammonia is then added so that the precipitate dissolves giving a dark blue solution.

Part **(c)** was the least well answered part of **Question 1**, with many inaccurate suggestions.

Question 2

In this question, candidates are comparing the power used by one lamp with that used by two similar lamps in series and in parallel.

(a) The applied voltages, around 1.5 V, must be accurately read from the voltmeter dials and then multiplied by the current to give the power in Watts. Only a minority of candidates stated that the unit of power is the Watt.

(b) A circuit must be completed to show two lamps connected in parallel. An ammeter dial is then read, to find the current and power output as before. Most candidates gained two marks for this section.

(c) A comment is needed on two statements: two lamps in series use only half the power of a single lamp, and two lamps in parallel use twice the power of the single lamp. Candidates are expected to state that when the data obtained from parts **(a)** and **(b)** are compared, these statements are true; any slight discrepancies can be explained by slightly varying applied voltages, due to internal resistance of the cells used.

(d) The candidates were asked what other piece of apparatus is needed in order to find the total energy used by the lamps in the circuits. A timer of some sort was suggested by only the best candidates.

Question 3

In the practical examination, compound **X**, a light green crystalline solid, was analysed using various tests; the same tests are used in this question. Candidates must complete the descriptions, results and conclusions (for this experiment) of the various tests. In this question, the candidates are essentially being asked to recall the standard tests for cations and anions, and from the results of these tests, use logic to deduce the composition of a mixture of ions.

(a) Only one strong-smelling gas, ammonia, is liberated when sodium hydroxide reacts with a salt. Ammonium ions must be present.

(b) A green hydroxide precipitate that turns brown in air should always indicate to candidates that iron(II) ions are present, being oxidised to iron(III) in the air.

(c) This was based on the standard test for a sulphate.

(d) A chloride is detected by the use of silver or lead nitrate in the presence of nitric acid.

Some candidates scored very well on this question.

Question 4

The temperature of 50 g of cold water can be increased by passing steam through it; an observation that forms the basis of this question.

(a) - (d) Candidates were asked to read from diagrams of the thermometer scales and the balance windows before and after passing the steam to find the increase in temperature, 21.6^0, and in mass, 2.1 g, of the cold water. Most candidates scored well here.

(e) If steam at 100^0 C becomes water at 100^0 C, heat is liberated. Candidates were asked to name this process (condensation) and then use their knowledge of the kinetic theory to explain why heat is liberated. There were many confused answers, some even naming that this process as "boiling". Collisions between molecules, when these were mentioned at all, were wrongly said to give out energy.

(f) The condensed steam gives 2.1 g of water that is still at 100^0 C, so when it cools down to the final temperature of the water, 44.8^0 C, more heat is liberated. Few candidates suggested this as a source of heat, most saying that heat was radiated from the Bunsen burner or the surroundings.

Question 5

This question referred to an experiment designed to find out how a wheelbarrow's design helps a user to lift a heavy load. The experiment uses a metre rule and a Newton-meter to model the wheelbarrow and measure an effort force.

(a) (i) The Newton-meter scale shows the efforts used to lift different loads, measured in grams. Some candidates misread the scale of the meter, which increases from top to bottom, not from bottom to top; often, 4.7 was wrongly stated as 5.3

(ii) Conversion of the mass in grams to Newtons was found difficult by some candidates, even though they are told that 1000 g = 10 Newtons.

(b) (i) The candidates were asked to draw a graph of load / Newtons against effort / Newtons. Those candidates who ignored the instruction given in the question to plot load on the vertical axis lost a mark, as did those who failed to draw a straight line.

(ii) The slope of the straight line must be found. The line does not pass through the origin as an effort is needed to lift the metre rule (or wheelbarrow) when there is no load. Too many candidates tried to determine the gradient from the x- and y- values of a single point on the line, so giving an incorrect answer. Many candidates failed to show, on the graph, how the x- and y- values used to calculate the gradient are derived. A correct answer would have given the gradient as around 2.5.

(iii) The gradient must now be used to find the effort needed to hold a total wheelbarrow load of 400 kg. Candidates are reminded that 1 kg is 1000 g. This information distracted many who multiplied by 1000 instead of 10 to convert 400 kg to Newtons. Division of 4000 by the gradient, 2.5, should give an effort of about 1600 Newtons.

Many candidates scored well on this question.

Question 6

Study of the Periodic Table should include the properties of Groups of elements such as the halogens.

(a) A few candidates who answered correctly knew the colours of liquid bromine and solid iodine.

(b) More candidates knew that chlorine bleaches litmus or turns it white.

(c) (i) Many candidates realised that starch solution would be turned blue or black by the displaced iodine.

(ii) A few candidates were able to give a properly constructed equation for the reaction between chlorine and potassium iodide solution.

(d) Candidates were asked which hydrocarbon gas reacts with bromine, and why? The more able candidates were able to produce good answers to this question.

(e) Heated iodine crystals vaporise and then turn back to a solid. The colour of the vapour and the name of the process were only given by the higher scoring candidates.