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PHYSICAL SCIENCE

Paper 0652/01
Multiple Choice

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19	**A**	39	**C**
20	**D**	40	**C**

General comments

The paper achieved an overall mean mark of 24.2 with a standard deviation of 5.9: however, the mean mark of the Chemistry questions showed that candidates found these marginally more difficult than the Physics questions. These statistics nevertheless indicate that the paper was satisfactory in discriminating between candidates of differing competence in this 'mixed' subject.

As has been the case for several years, the paper is offered by candidates aiming for Grades A to C as well as those of more modest expectations. Of the Chemistry questions, there were some which the higher scoring candidates also found relatively demanding (see below). Nevertheless, the **Comments on specific questions** concentrate on aspects of the performance of the lower scoring candidates.

Taken together, **Questions 18**, **19** and **20**, point to some general lack of knowledge of organic chemistry.

The mean of this paper has risen since this time last year. All the items were those which appeared on equivalent papers at this level, so this represents a real improvement in standard, for which teachers and their candidates are to be commended.

Questions which candidates in general found relatively easy were **Question 21**, **22**, **25**, **26**, **34**, **35**, **36**, **37** and **40**, which covers a good range of Physics topics. Items which appeared to give a significant level of difficulty to many candidates were **Questions 28**, **32** and **33**. Not all items revealed things worth commenting on, but teachers might find the following points helpful.

Comments on specific questions

Question 1

In accordance with policy, this was an easy starter.

Question 3

Candidates found this slightly harder than anticipated. Amongst the lower scoring candidates, about two fifths chose each of **A** and **B** but this question ought to have been a simple matter of recall.

Question 4

Of the higher scoring candidates, just over half answered correctly and the others seem to have guessed. With regard to the lower scorers, the percentages amongst the four responses were fairly even – a sign of guessing. However, the characteristic properties of covalent and ionic compounds in conducting electricity is clearly within the syllabus.

Question 6

Only 38% of the lower scoring candidates answered correctly, response **D** being the most popular wrong choice. Such candidates appear to have been confused about the signs of metal and non-metal ions.

Question 9

This was found somewhat hard, rather surprising. Response **B** attracted as many as 45% of the lower scoring candidates and 25% of their higher scoring companions. The reversibility of anhydrous versus hydrated salts is also clearly within the syllabus.

Questions 12 and 13

These were both found decidedly hard, disappointingly so. In **Question 12**, nearly half of the lower scoring candidates chose **A** and a similar (if slightly smaller) percentage chose **B** in **Question 13**. Together, these questions point to definite misunderstanding of the properties of acids and alkalis.

Question 14

The overall percentage answering correctly was only 49%. This is rather low but the discrimination was also poor. Another aspect is that both groups of candidates found response **A** overly attractive. Why candidates continue, year on year, to believe that copper reacts with dilute acids is a mystery.

Question 15

This is something of a mystery. It discriminated very effectively between candidates as a consequence of the fact that only 16% of the lower scoring candidates answered correctly. The remainder of such candidates spread themselves fairly evenly amongst the other responses, i.e. 25%, 36% and 26% respectively. There seems to be no obvious reason why this question should have been found so hard by these candidates.

Question 18

Because it was found so hard across the ability range, it did not discriminate well. Indeed, it is rather disappointing that what appears to be a straightforward question on the incomplete combustion of a hydrocarbon should have been found so difficult. The disappointment depends strongly on the fact that about half of the candidates across the ability range appear to think that methane is a product of the incomplete combustion of ethane. Were the candidates expecting to see both CO and H_2O among the choices, becoming confused because CO was not on offer?

Question 19

This was a disappointment with about half of the candidates across the ability range choosing **C**. Was the charcoal or the acetylene (or both) the problem?

Question 20

Some 30% of the lower scoring candidates chose **A**, which is, admittedly, an oxidation product of et... not by combustion.

Question 23

A majority of candidates chose either **C** or **D**, but just as many chose **C** as chose **D**. It should be obvious that an object which has a positive value of speed (option **C**) cannot be at rest.

Question 24

A lot of candidates thought that mass is a force.

Question 28

Only a surprisingly low number chose the key, with the vast majority thinking that the energy of the slowing car was converted into gravitational energy.

Question 29

Most candidates realised that the water expands, but a quarter of all the candidates thought that this would lead to an increase in density.

Questions 30 and 31

Very few thought that the waves just continued straight on (option **A**), but they showed some degree of disagreement about which of the other options was correct. Similarly, candidates appeared uncertain about the order of the regions in the e-m spectrum in **Question 31**.

Question 32

This was difficult to visualise, and this was reflected in the statistics of the candidate responses.

Question 33

Judging from the responses, some humans have a very unusual hearing range!

In general, items on electrical topics were well answered.

Question 38

A was chosen by one-third of candidates, but a lot regarded the emitted particles as ions.

Question 39

This worked well, but nearly one quarter of candidates thought that either alpha or beta particles would penetrate the lead walls.

Paper 0652/02

Paper 2 (Core)

General comments

The general standard of the work was compatible with the ranking of the paper; it showed that Centres had not included candidates who would have had a realistic chance of scoring grades better than C (the maximum that could be obtained on the paper). It was also pleasing that there were very few candidates who were not able to make an attempt, at least, on some parts of the paper.

Comments on specific questions

Question 1

The question, although apparently about the motor effect, also tested candidate's knowledge and understanding of the work on turning effect of forces.

(a) The first part of this question, which asked the candidates to calculate the moment of a force about an axle, was done with some skill, many candidates gaining two of the three marks, losing only that for the unit. Indeed, some candidates went a stage further than was expected by converting the distance, 5 cm, to metres and giving a correct answer in Nm. The majority of the candidates who correctly calculated the turning effect recognised that the turning effect on the other side of the coil would be the same, and that the total turning effect was the sum of the two. Indeed even amongst those candidates who could not calculate the turning effect correctly many recognised these points.

(b) Again there were good answers to both parts of the question, however, there was a tendency not to answer the question set. The question, quite clearly asked for the effect on the moment of the force about the axle it did not ask for comments about any change in speed of the rotation of the axle, which is a much more complex problem involving other variables.

(c) Whereas many candidates were able to give good examples, primarily, motors, galvanometers, electric drills, electric food mixers etc., some made the predictable error of muddling this effect with the generator.

Answers: **(a)(i)** 40 Ncm or 0.4 Nm, **(ii)** 40 Ncm or 0.4 Nm, **(iii)** 80 Ncm or 0.8 Nm.

Question 2

(a) It was surprising, and disappointing, that relatively few candidates recognised the experiment as describing Brownian Motion, the probable reason for this is that the usual way it is taught is using smoke in air, it is important that candidates do realise that this is only one of many possible examples of Brownian motion.

(b) Despite the failure to recognise this type of motion candidates had little difficulty in filling in the passage correctly describing Brownian Motion.

Question 3

The question, which tested basic thermal physics in a realistic context, caused a great deal of difficulty, and showed a sad lack of understanding of the basic physics.

(a) Many candidates thought the rising of hot water to the tank was an example of evaporation (perhaps the boiler in the diagram led them to this thought?). Even amongst those that recognised it as convection few gave a good description of why this occurs: expansion of the heated water (*not* the water molecules!), becoming less dense therefore rising to the top.

(b) More candidates were able to state that the energy passed through the walls of the boiler by conduction. The completion of the sentence was done quite well, although the third mark proved, as expected, the most difficult for candidates to score, exothermic was the answer the Examiners were looking for, although irreversible was also accepted.

(c) Although there were some good answers there were far too many candidates who clearly did not think about what they were writing, such as "not to have the same system for cold and hot water".

Question 4

The question was quite well done showing a knowledge of chromatography, the most common error was not to read the question carefully; it asked for which SUBSTANCE in part **(a)**, and which COMPONENT in part **(b)**.

Question 5

This was, conceptually, the most challenging question on the paper, and few candidates really sco Many gave descriptions of the materials' properties rather than a description of their molecular struc The sort of comments the Examiners were looking for were: two dimensional, layered, each carbon w three (covalent) bonds, strong bonds within layer/weak bonds between layers, for graphite. Four (covalent) bonds for each atom, 3-D structure, tetrahedral, all strong bonds, for diamond.

Question 6

Many candidates gave good answers to all parts of this question, a common error in part **(a)** was to state that the iodine atom needed to lose three electrons in order to form an ion. While it is not obvious where this misinformation comes from, candidates should be advised to look at the Periodic Table to check in which group the elements occur. The most common error in part **(b)** was to state that the potassium and iodine atoms shared an electron and/or that a covalent bond was formed.

Question 7

This question tested candidate's genuine understanding of simple electric circuits, rather than just follow a set pattern to do simple straightforward calculations without really understanding the physics of the situation.

(a)(i) This tested the recognition that the current is the same all the way round a simple series circuit, and it was clear that the majority of candidates understood this basic fact, although it was not uncommon for candidates to double the current to 1.5 A.

(ii) The calculation of resistance, though done well by the better candidates, caused more problems, with many candidates doubling the current thereby showing a very tenuous understanding.

(iii) The majority of candidates, even if they had made an error in the previous calculation, recognised that the resistance of one bulb would be half that of two in series.

It was also encouraging that most candidates used the correct units throughout the question.

(b) This part showed that many candidates do not understand the theory of simple parallel circuits, with the majority of candidates giving the current as 1.5 A.

(c) This also caused major difficulties and even those candidates who correctly identified the current as being larger in the second circuit did not give a meaningful explanation as to why it was larger. To score the second mark it was not sufficient to say simply that it was because it is a parallel circuit, this shows rote learning rather than understanding; Examiners were looking for an explanation in terms of there being a larger current through each bulb, or better that there was a the full (4.5V) potential difference across each bulb.

Answers: **(a)(i)** 0.75 A, **(ii)** 6 Ω, **(iii)** 3 Ω; **(b)** 3 A.

Question 8

The majority of candidates gave the correct formula and a significant number were able to calculate the relative molecular mass. The equation in part **(b)** caused more problems, many were able to give the correct formulae for all the reactants, however, only the most able were able to balance the equation.

Question 9

(a) The understanding of the term reduction varied widely, in some cases there was a clear understanding of the term, but elsewhere candidates had little comprehension – often resorting to describing its meaning in everyday language. Even when there was a clear understanding, however, many candidates failed to link it to the reaction detailed in the question.

(b) The attempts at describing properties of copper which show that the metal is a transition element also varied, often good reasons being given, such as high density, coloured salts, high melting point or the careless; heavy, colourful, high boiling point.

Question 10

(a) Carelessness cost a great number of candidates credit in this question, those who ign presence of the excess magnesium in the mixture, showed little understanding of the importa taking care in chemical preparations and were penalised accordingly.

(b) This test was widely known, but even now far too many candidates describe not a lighted splint, but a glowing splint, with which the reaction is unlikely to happen.

Question 11

(a) Most candidates were aware that there is a change in direction when light goes from air to water. However, the refraction was often away from the normal, and even when candidates gave the correct refraction on one of the rays the refraction on the second ray was not compatible, with the two rays no longer diverging. There was also difficulty in identifying the angle of incidence, but the majority, at least recognised that the effect being demonstrated was refraction.

(b) This part confused quite a lot of candidates; many not reading the question carefully and then saying that the car was being viewed in a mirror. Nevertheless, a good number recognised that the image would be re-reversed when viewed in a rear view mirror, however, despite the instruction to use scientific terms only a handful used the term 'lateral inversion'.

Question 12

This question was not done well, only a few scripts said the change of colour was due to the liberation of iodine from potassium iodide, and of those that got near, a significant number wrote iodide not iodine, technically incorrect. Following on, all that was required were statements that bromine is more reactive than iodine and less reactive than chlorine – but few candidates really showed a genuine understanding.

Question 13

This was another question where the standards varied. The best answers were excellent, but for such a straightforward piece of science there were far too many scrappy, half correct answers. A common misconception was that to kill bacteria in water, designed for a 'water supply', boiling would be suitable, this might work on an individual scale but not on a large scale.

Question 14

The diagrams for ethane and ethene were done very well indeed, which made it disappointing that relatively few candidates talked about double and single bonds in their answers to part **(b)**.

Question 15

(a)(i) The majority of candidates recognised the meaning of the term isotope, although some still imagined that it also meant that the material was radioactive, also vague statements such as 'the same element but with a different mass', is not good enough to gain marks. Examiners were looking for the same number of protons/proton number/atomic number, but different number of neutrons/neutron number.

(ii) Fewer candidates correctly described a β–particle, several saying that it was a beta particle! The sort of answer that was expected was that it is an electron which is very fast moving, or which is produced when a nucleus decays.

(c) Whilst there were some candidates who got this part totally correct throughout, there were many who really had little idea of the meaning of the figures in nuclide representation. Similarly they did not know that electron is the only particle which is not found in the nucleus.

(d) Those candidates who did not understand the nuclide representation could hardly be expected to be able to use that representation in this situation, however, of those who did understand, it was encouraging how many made a good, if not always totally successful, attempt at this final part.

Paper 0652/03

Paper 3 (Extended)

General comments

It is pleasing to report that the majority of candidates entering this paper were able to make significant progress on the paper and responded positively to many of the questions set. Most candidates made appropriate use of units and showed their working in an acceptable manner. It is a concern that a minority of candidates mixed quantities and units within one equation recording for example, $A = P/V$ instead of $I = P/V$ or $W = VI$ instead of $P = IV$. T here was little evidence that a significant number of candidates found timing to be a problem and the Examiners reported that virtually all scripts were complete.

Comments on specific questions

Question 1

This question was generally well answered with significant numbers of candidates completing the whole question to a high standard. Most candidates correctly calculated the number of moles in 4.8 g of **X**. Fewer candidates recognised that this meant that there would also be the same number of moles of oxygen needed to react completely and that this meant that there would also be the same number of moles of H_2XO_3 formed. With error carried forwards, more candidates scored at least one mark in **(a)(iv)** to calculate the mass of $H_2\mathbf{X}O_3$ formed. Few candidates completed the balanced equation correctly but most recognised **X** to be sulphur because of the relative atomic mass.

Answers: **(a)(i)** 0.15 (mol), **(ii)** 0.15 (mol), **(iii)** 0.15 (mol), **(iv)** 12.3 g balanced equation:
($H_2\mathbf{X}O_3$ + 2 NaOH) → Na_2XO_3 + $2H_2O$.

Question 2

This question was very well answered. Most candidates knew the work and power formulae well and were able to apply them appropriately to the three instances shown. There were occasional uncertainties with units and weaker candidates had difficulties with using the overall force in **C**, but generally answers were correct.

Answers: Case **A**: 0, 0; Case **B**: 3.3 J, 4.7 W; Case **C**: 1.5 J and 2.1 W.

Question 3

Another well answered question. Most candidates made use of the correct period and applied their knowledge and understanding to select the correct element in part **(a)**. Reasons for the low boiling point of argon were varied but most candidates recognised that it meant that there were weak forces between the argon atoms. Although most candidates realised that sodium has only one outer electron and aluminium three, few candidates could explain clearly why this meant that sodium was more reactive than aluminium – the fact that aluminium forms an oxide layer was too frequently seen as the explanation for this.

Question 4

Most candidates found this question to be confusing. Although the stem of the question refers to the block as being a thermal conductor, many candidates argued that heat was transferred through it by convection and radiation. Both conduction models (i.e. free electron transfer and inter-ionic collisions) were given credit but the electron model was far more rarely seen in scripts. Very few candidates recognised that thermal equilibrium meant that the rate of heat being gained must be equal to the rate of heat being lost to the surroundings – most candidates thought that it referred to the whole block reaching the same temperature, even with it being heated at only on point in the diagram. Again most candidates were confused by painting the block dull black; many simply recognised that the material would now be a better absorber (but failed to realise that infra red radiation was not reaching the whole block) – missing the point that the block would now be a better emitter too and that radiation could be emitted by the whole block so that the temperature was now likely to rise at a much slower rate or remain constant at any point on the block.

Question 5

Although most candidates were able to draw the arrangement of the electrons in shells for carbon a atoms, they often failed to clearly show the two double bonds in carbon dioxide. Despite this they we to talk about full shells for carbon and oxygen, even though their diagrams failed to show shared octets gained them some credit in part **(a)(iii)**. Few candidates were able to explain how the differences in struct between carbon dioxide and magnesium chloride meant that magnesium chloride has a much higher melting point than carbon dioxide – answers to this often focused entirely on the fact that magnesium is a metal.

Question 6

This question was reasonably well answered by most candidates. The majority of candidates were able to measure the distance between the wavefronts as the wavelength, however, weaker candidates did not usually multiply their value by twenty to give full size. Around half the candidates knew that the process observed was diffraction – several candidates lost a potential mark here by calling it "defraction" – this spelling cannot be given credit since it is unclear whether the candidate thinks the process is diffraction or refraction. Most candidates correctly recalled the wave equation ($v = f\lambda$) and with error carried forwards were able to calculate the wave speed; there was some confusion with units here – candidates calling 60 cm/s, 60 m/s being common. Part **(d)** was too frequently found to be confusing with many candidates showing standard ray diagrams for reflection by a mirror or refraction by a glass block. The best candidates tended to make very clear suggestions of what could be used as a reflector and how the depth could be reduced to show refraction.

Answers: **(b)** wavelength = 0.20 m; **(d)** wave speed = 0.6 m/s.

Question 7

This question was a very good discriminator, being well answered by those candidates scoring well overall and being answered poorly by weaker candidates. Most candidates recognised that oxygen and nitrogen needed to be combined but not all candidates stating this made it clear that it was the oxygen and nitrogen in the air that were being combined at high temperature. Most candidates were aware that carbon monoxide was produced as the result of the incomplete combustion of hydrocarbons – although many candidates simply stated this as being "incomplete combustion". Answers to part **(b)** were roughly evenly split between the correct oxides of sulphur or lead compounds and the incorrect sulphur or carbon dioxide. Although it was clear that most candidates understood the formation of acid rain and how it would react with limestone many candidates were unable to phrase this in a clear and accurate way. The acid "corroding" the limestone was a common response that was not credited. A surprisingly large number of candidates failed to complete the equation for the reaction between nitrogen monoxide and carbon monoxide correctly because they showed the formation of nitrogen atoms – this mistake meant that no marks could be awarded because no credit can be given for balancing an incorrect equation.

Answer: balanced equation: $2NO + 2CO \rightarrow N_2 + 2CO_2$.

Question 8

Parts **(a)**, **(b)(i)** and **(b)(ii)** of this question were well answered but the other parts generally not so well. Most candidates correctly identified a step down transformer and were able to write some sort of turns ration equation; it was then apparently random whether or not the turns ration was the required secondary to primary or primary to secondary. Candidates should be encouraged to write the equation for this and then rewrite it below with the known values substituted. The vast majority of candidates were able to calculate the current and resistance and correctly recalled the power and resistance equations. Virtually none of the candidates understood the reason why the initial current through the bulb would be greater than its working current. Instead of stating that the resistance increases with temperature as the filament warms up, most candidates incorrectly related the reason to the transformer changing voltage.

Answers: **(a)(i)** 0.0.027; **(b)(i)** 0.30 A, **(ii)** 20 Ω.

Question 9

This question elicited mixed responses with several candidates producing fully correct answers and equal numbers scoring nothing. A large number of candidates correctly suggested that a soluble chloride should be added to the lead(II) nitrate; few then suggested that they would stop adding the solution when no more precipitate formed. A slight majority of candidates suggested filtering the solution but few went on to suggest that the residue should be washed with water. A number of answers were based on totally incorrect techniques – chromatography, fractional distillation or simply evaporating the filtrate. Diagrams usually reflected the technique that was described in part **(a)(iii)** but not always. The standard of drawing was generally good.

Paper 0652/05

Practical Test

General comments

The overall standard of answers was good. Candidates were well prepared for the examination and scored good marks. The time required to complete the questions appeared to be adequate and the mark scheme worked well. Supervisors played their part very well and must be complimented.

Comments on specific questions

Question 1

Despite the length of time taken when using the lowest concentration of acid and the variation in that time, candidates performed well and managed to give a time for all four experiments. The times needed to be within 20% of those recorded by the Supervisor to score marks. Some lost a mark for failing to convert their times to seconds.

Graphs were usually good but marks were lost for failing to draw a smooth curve. Some reversed the axes and lost a mark whilst others plotted the time in minutes and also lost a mark. A few actually plotted the volume of water rather than the concentration which was careless. Clearly it made no difference to the shape of the graph but had a knock on effect for part **(c)(ii)**. In part **(d)** the answer had to be in terms of rate rather than time. An easy mark and most scored. Part **(e)** was answered well with few silly answers, such as condensing the hydrogen to a liquid. Most seem to appreciate the use of a syringe or upturned measuring cylinder to measure a volume. The commonest error was failure to weigh the magnesium.

Question 2

Most values of *f* were realistic and all three marks were usually scored. Completion of Fig. 2.3 was not easy although a good number scored well. A numerical value for the image position was acceptable. The standard of drawing in part **(c)** was varied but most completed the diagram. A sharp pencil would have been helpful in some instances as the distance needed to be within the range 23-27 mm. A small number could not record their value in millimetres.

Paper 0652/06

Alternative to Practical

General comments

This paper was devised for candidates to show experience of laboratory techniques, read and record data to be used in drawing conclusions and to suggest modifications or further experiments. A good knowledge of the syllabus content is also required, and last but by no means least, candidates should have used and learned the Notes For Use In Qualitative Analysis printed on page 22 of the syllabus. The Alternative-to Practical paper is therefore not an easy option for candidates, and the year-on-year statistics support this statement. However, some Centres find it a useful alternative to the Practical examination.

This session’s paper was successful in all the above aims. The Examiners have been pleased to mark many excellent scripts, and some Centres have entered whole groups of candidates that attained creditable results.

Comments on specific questions

Question 1

The Examiners expected this question to be fairly easy, but it proved to be quite difficult to many candida
especially those who had not carefully studied the notes referred to above.

(a) The Law of Conservation of Mass says that matter (or mass) is neither created nor destroyed during a chemical reaction. For both marks, candidates had to refer to this statement as well as point out that masses did not change during the experiments. Many did not do so.

(b) This proved to be a real problem. Many candidates used vague statements about "the insoluble result of a reaction" or left out the word insoluble altogether. Solutes, solutions, suspensions, colours, floating mass and other descriptions abounded. The Examiners looked for the idea that a reaction in solution (or in a liquid) produced a solid.

(c) The colours of the precipitates were often obviously guesses!

(d) The name barium sulphate was the one most often correctly stated. The others were often given as sodium salts. Iron oxide or hydroxide was not enough for the Examiners, they needed iron(II) hydroxide for the last answer here. It was easy to identify candidates who had seen or performed the tests for anions or cations.

(e) Here, a surprising number of candidates stated that the flask was now lighter because gases have densities lower than liquids or solids, or possess no weight at all! It was not enough to say that the gas would be evolved or given off from the liquid. The diagram shows that the gas will escape from the flask through the cotton wool; only then will the total mass decrease. To state that "the mass decreases because it is given off from the solution" is only to re-state the question. Comparatively few candidates showed that they had studied the diagram, stating that gas would pass through the cotton wool and so the mass of the flask would decrease.

Question 2

This question is based on a simple investigation, requiring only different concentrations of acid, a few centimetres of magnesium and a stop-clock. Several skills are involved in giving correct answers; despite the problems, a significant number of candidates scored full marks on this question.

(a)(i) Some candidates did not see the easy way to calculate the concentrations of acid; find the fraction *volume of acid/100* and then multiply it by 4. It is likely that many candidates perceived the answer without doing any mathematics. Some wrongly gave the concentration in experiment 4 as 0.3 or 0.33 mol/dm^3.

(ii) As usual in questions of this type, a few candidates tried to fill in the table without reading the information given in part **(ii)**, so the times given were 24 and 96 seconds. A few candidates interpreted 1 minute 50 seconds as 150 seconds.

(b) Weaker candidates made errors of several sorts. Here are some of them: axes were reversed so that time was plotted on the horizontal axis, labelling (especially the units) of axes was omitted, the concentration was shown decreasing from 4 to 0, points were joined by straight lines instead of a smooth curve. Others plotted the volume of acid in cm^3 instead of the concentration of the mixture. A few candidates, having correctly numbered and labelled the axes, drew the "mirror image" of the correct line, showing the minimum time at concentration 1.0 mol/dm^3. However, many candidates drew perfect graphs.

(c) Most candidates deduced the correct answer for the time taken for the magnesium to dissolve at concentration 2.5 mol/dm^3, about 32 s. The errors in graph drawing were "carried forward" so that the Examiners accepted the value shown on the candidates' own graphs.

(d) Many suggestions were unworkable. Candidates who did not realise that hydrogen is gaseous showed liquids being collected in closed tubes. Some diagrams showed the 100 cm^3 of gas being collected in containers that were too small such as a test tube. Often, the reaction vessel was a beaker with a lid, or a beaker beneath a filter funnel that led the gas away to be collected. The better-prepared candidates drew good diagrams of a reaction vessel fitted with a stopper and a delivery tube that led gas to be collected into a measuring cylinder inverted over water or into a graduated syringe.

Question 3

Like **Question 2**, this is based on the corresponding question in the November 2005 Practical exa[m]. Candidates' answers clearly showed if they had used lenses in the ways specified in the syllabus.

(a) The Examiners tried to find out if candidates knew how to use lenses to produce a real image a[t] the focus using parallel rays of light, for instance from a light source several metres away. Alas, too many answers placed the light at one end of a metre rule and the screen at the other; candidates were desperately trying to find clues from the rest of the question! Some candidates talked about the lens (or the screen) reflecting the light; others suggested that light rays could actually be seen crossing at the focus. The focal length was occasionally stated as the distance from the source to the lens. There were many accurate descriptions of the image being formed on the screen and then the measurement of the correct focal length.

(b) This exercise tested awareness of distance and scale and was nothing to do with light rays. The weak candidates gave answers that showed their lack of use of a metre rule.

(c) All the correct answers are provided in the question, yet some candidates did not seem able to tell the difference between *upright* and *inverted*, terms that are essential in describing images produced by refraction through a lens. One mark was awarded for each correct description of the image; smaller and inverted, same size and inverted, larger and inverted. Many candidates scored all three marks.

(d) Careful reading of the instructions enabled candidates to draw the ray diagram correctly. Many could not do so, suggesting that experience of ray diagrams was almost essential for success in this part. Some did not draw a straight line from point **C** through the centre of the lens, so the image was formed in the wrong place and was upright rather than inverted; the information given in part **(c)** had not been understood.

(e) When candidates had drawn an image that was not like any of those shown in part **(c)**, this presented a problem both to the candidate and to the Examiner. The object at point **C** was between one and two focal lengths away from the lens, therefore the diagram should conform to experiment No. 3. This was the only answer accepted.

Question 4

Success in answering this question depended on correctly understanding the two experiments in which hot water was added to cold. Full marks were rarely awarded.

(a) This part was usually done correctly and the second and third temperatures given as 37.5 and 53.5°C.

(b) Too many candidates could not find the temperature changes by subtraction. In marking, errors were carried forward from **(a)**.

(c)(d) Here, the problems started for candidates who had not read the question. Into the given equation, they had to insert the mass of water raised to the higher temperature, and the mass of water cooled to the lower temperature, equal to 100 g each time. This gives an answer around 6500 J.

(e) This was the hardest part of the question, for candidates had to realise that the temperature change was dependent both on the mass of water and the amount of heat energy exchanged; both of these quantities were equal in the two experiments.

(f) Answers to this part were nearly as poor as the previous one. A suggestion to insulate the mixing vessel or to use a more sensitive thermometer was accepted, as was "repeat the experiments and average the results". Merely to repeat the experiment was not acceptable.

Question 5

This question explored the understanding of oxidation and reduction, using simple reactions. The r
of an oxide by carbon monoxide is a reaction of the highest commercial importance.

(a) Proper understanding of what was happening was really necessary, because there was no reaction in experiment No. 1; nearly all the "guessers" fell into the trap. A surprising number who knew that copper was left behind in experiment 5 said that a blue solid would be seen.

(b) Far too many did not know a test for water, so they suggested the use of an indicator. Determination of boiling or freezing point, or the use of anhydrous copper sulphate or of cobalt chloride paper were the expected answers.

(c) Many candidates gave definitions of oxidation and reduction but were unable to link them to the reactions in any of the experiments. This link was essential for the marks. The best way to demonstrate the concepts was to refer to the reaction between copper oxide and either carbon monoxide or hydrogen. Many candidates said that oxidation was loss of electrons and reduction was gain, but the link to the reactions was not explained, especially if the reaction between oxygen and carbon was chosen to illustrate their definitions. The mnemonic "OILRIG" is not always the best way to remember or explain redox reactions.

Question 6

The whole area of energy conversions is relevant to modern life, for we live in an age where it is important to achieve the maximum efficiency of conversion from, say, thermal to electrical energy.

Many candidates do not seem to appreciate that energy is a universal currency whether it is potential, kinetic, solar, nuclear or of any other type.

(a) The 5 kg mass is shown falling from its highest point, so its energy is potential and kinetic; either gained the mark. The pulley is rotating and has kinetic energy. "Electrical" or "electric" or "electricity" was accepted for the energy in the circuit.

(b) The voltmeter and ammeter were shown in reverse order compared to the answer lines, this misled a few candidates only.

(c) The symbol for the acceleration of gravity, **g**, was wrongly used by a few candidates who multiplied it by 5 kg, not noticing that this mass was already mentioned in the equation. Most found the work done as 50 J.

(d) The work done in lighting the lamp, 17.6 J, was easily found. Examiners marking this item carried forward errors from **(b)**.

(e) Sensible answers to this part included the idea that the generator was not efficient so energy was lost as heat. Heat loss was also caused by friction in the bearings of the pulley system and by resistance in the connecting wires. It is important to note that heat loss by the bulb is not acceptable as an answer, since this is part of the 17.6 J converted by the bulb. A few candidates also scored by suggesting that heat and sound would be caused by the 5 kg mass hitting the bench. It was in this part that many candidates displayed their ignorance of the idea that all energy is converted from one form to another, not simply lost. Their answers said that there could be no agreement between the two figures simply because they were calculated using different variables.

(f) A surprising number of candidates could not answer this question. The Examiners looked for an *observation* that would be made as a result of the faster descent of the mass. Acceptable answers included a shorter time of fall and increase in ammeter or voltmeter reading. Wrong answers said that the work done would be less (or, in some cases, more!), but the actual work done would be just the same as before with the same mass and the same distance of falling. Other candidates said that the bulb would light up "faster". Some candidates suggested that the mass would be greater, but this answer was not accepted, since the faster descent could be caused by reduced friction in the pulley system.