PHYSICAL SCIENCE

Paper 0652/01

Multiple Choice

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

Comments on specific questions

Questions 1 to 20

Question 2 ought to have been an easy question but as many as 40% of the lower-scoring candidates chose response **B** (in which the ink being analysed would merely dissolve and diffuse in the solvent).

Question 3 ought also to have been found quite straightforward but only 19% answered correctly! Response **C** was popular across the ability range. This points to a notable lack of understanding of the basic ideas of proton and nucleon numbers.

Question 5 Response **C** was also the downfall of as many as 40% of the candidates across the ability range. The “(II)" in the name copper(II) oxide shows the oxidation state of the copper and not the number of atoms in its formula. It is perhaps a little surprising that candidates went for the less familiar oxide of copper.

Question 6 The lower-scoring candidates were overly attracted by response **A** and even response **C** was more popular than the key **(D)**. This appears to be another example of a simple lack of knowledge of simple chemical terms.

Question 7 The lower-scoring candidates appear to have been guessing between responses **A**, **B** and **C**. The question did require a little thought but, in essence, relates to the ideas that a catalyst increases the speed of a reaction without being ‘used up'.

Question 8 Another quite hard question in which response **A** and **B** were both more popular than the key **(C)** amongst the lower-scoring candidates. Did these candidates not read the question sufficiently carefully? The question refers to the mass of the crucible and its contents, not merely the mass of the magnesium.

Question 10 The lower-scoring candidates may have been guessing the answer to this question but response **C** was more popular with these candidates than the key **(A)**. However, it was expected that this question would be a simple case of recall.

Question 11 This question also, unfortunately, proved unexpectedly difficult. Fewer than half of the higher-scoring candidates answered correctly and over 40% of their lower-scoring companions chose response **C**. The question was, again, thought to be a matter of recall of two tests that are clearly in the syllabus.

Question 12 Lack of knowledge was also evident in the answers to this question in that only a third of the lower-scoring candidates chose the key **(B)**.

Question 14 This question required just a little more thought but some 60% of the lower-scoring candidates chose either response **B** or **A**! It should, it is hoped, have been obvious that either **C** or **D** was the key and the thinking required was that helium has only 2 electrons, giving **C** - and not **D** - as the key.

Question 18 was one of the questions where the overall facility was only a little below 50% and, therefore, one of the questions that candidates found not too difficult. Nevertheless, responses **A** and **B** were only a little less popular with the lower-scoring candidates than the key and this again points to a simple lack of recall knowledge.

Question 19 was another of the ‘not too difficult' questions but there was evidence that the lower-scoring candidates may have been guessing Response **A** was attractive to a third of these candidates. Presumably, they were responding to there being 4 hydrogen atoms in each molecule rather than simply looking for a difference of CH_2 as in the key **(C)**.

Question 20 Nearly 40% of the lower-scoring candidates chose response **C** and with these candidates the key **(B)** was only marginally more popular than response **A**. This question should also have been a straightforward matter of recall but it seems possible that careless reading caused the low facility, i.e. the stem says “unsaturated" rather than “saturated".

Questions 21 to 40

Items which candidates in general found relatively easy (over 70% facility) were items 21, 23, 24, 28,29, 30 and 36. Items which had a low facility (i.e. a low proportion of candidates answering correctly) were items 25, 27, 32, 33, 35 and 38. The following comments about individual items might prove to be instructive.

Exactly half the candidates answered **Question 22** correctly, but a surprising 29% answered **C**, 30 km/hour. The distance and the time both had a numerical value of 30, so how this was chosen as the answer is a bit of a mystery. Even if a candidate had used a rule to measure the direct distance from P to T, the answer would not have been 30 km/hour. The means by which energy sources deliver electricity is not well understood (**Question 25**). A big majority thought that hydroelectricity uses steam. Similarly, the energy changes in **Question 26** were not understood by most candidates, nor was the fact that temperatures remain constant during a change of state **Question 27**. In this last case, the vast majority thought that the temperature changes during either melting or boiling. It would appear that the heat section of the syllabus gave these candidates some trouble.

Over two-thirds answered either **A** or **B** to **Question 31**, which means that they knew the basic pattern of the magnetic field around the bar magnet. One-third unfortunately chose the wrong direction. In **Question 32**, a big majority realised that rod 3 would be magnetised, but the majority of these did not take into consideration that if Q and U repelled, then rod 1 must also be magnetised. The statistics indicated that candidates probably did not read **Question 33** carefully. It was asking about the measurement of two voltages, but as over half answered **C**, it would seem that they just made the assumption that this was an "Ohm's Law" type measurement.

In **Question 35**, only a third answered correctly. Similar numbers thought that thinner wire would reduce the heat produced, or that thicker insulation would. Although candidates found **Question 34** relatively easy, there were still 1 in 10 who thought that atoms were given off from the heated cathode. In **Question 37**, almost all realised that gamma-rays are electromagnetic radiation, but they were not so sure about the nature of alpha-particles. Half-life (**Question 38**) was clearly not understood by most candidates, and a lot did not know the relative numbers of the particles in a neutral atom.

PHYSICAL SCIENCE

Paper 0652/02

Paper 2 (Core)

General comments

There were some very encouraging papers showing that much of the syllabus had been covered in detail and with care. Nevertheless there were some areas where the candidates found the concepts both difficult to comprehend, and to communicate any understanding they did have. This was particularly noticeable in **Question 2** (the understanding of the concepts of conduction, convection and radiation); and in **Question 8** (the explanation of boiling and evaporation in terms of the kinetic theory of matter).

Comments on specific questions

Question 1

(a) (i) Many candidates correctly added the H into the formula, however, common errors were to add it as an ‘HO', or as separate O and H both of which give unbalanced bonds.

(ii) This was done very well with many candidates showing a real knowledge and understanding of calculation of molar mass. (No penalty was made for inclusion of a unit).

M_R = 46

(b) (i) Some candidates worked hard to successfully balance the equation.

Answer: 2 and 3

(ii) The test for carbon dioxide was well known, however the test for water was less well known, with many candidates suggesting boiling at 100 °C, despite being asked for a chemical test.

(c) Too many candidates failed to answer the set question; they were asked for what happens to the pH number when sodium hydroxide is added to ethanoic acid (to excess). Many candidates failed to mention the pH number at all simply talking in terms of the solution becoming neutral, of those who did refer to the number many answered as though the ethanoic acid had been added to the sodium hydroxide. Even the minority of those who knew that the pH number would increase did not consider the effect of adding the alkali to excess, despite the term being highlighted in bold text in the question.

Question 2

(a) It was disappointing how many candidates were unable to recognise that caesium being in Group I and astatine being in Group VII would have 1 and 7 electrons in their outer shell respectively.

(b) This was a more challenging question, nevertheless it was disappointing how few candidates showed an understanding of the transfer of electron(s) in ionic bonding.

(c) This part of the question was done better than either of the other parts. However, many candidates tried to draw all 85 electrons in each of the astatine atoms, despite the examiners trying to help the candidates by clearly instructing them to draw only the outer electrons.

Question 3

(a) There were some very good answers to this section, with many candidates recognising that the brass would expand (more than the steel case thereby reducing the space for the gas to enter the burner.

(b) The explanations of conduction and convection caused major difficulties. Much more is needed than a bold statement such as ‘conduction is the transfer of heat through a solid”. Examiners were looking for an understanding in terms of energy being passed from molecule to molecule. Similarly with convection the concept of the circulation of energy due to hot air rising/cooler air falling was expected. More candidates recognised that radiation was the transfer of (heat) energy by electromagnetic waves. Also very few candidates linked the processes to the example given.

Question 4

It was considered that this might be a very challenging question, in the event candidates answered all parts well showing a good interpretation of the graph, a good understanding of the gravitational field of the Earth causing acceleration of the meteorite as it is pulled towards the Earth, and equally a good understanding of the frictional effect of the atmosphere on the meteorite, although very few candidates realised that work is done against the frictional force of the air.

Question 5

(a) (i) The vast majority of candidates appeared to understand the terms wavelength and amplitude, but care must be taken when showing distances on a diagram. It is not enough to have a double headed arrow approximately one wavelength long. It is recommended that two vertical lines are drawn, as near as possible to one wavelength apart and the double headed arrow drawn between them.

(ii) Similar care should be taken when drawing the amplitude.

(b) Good attempts were made to both parts of this, although relatively few made it clear that the hand must be moved up and down more times per second to increase the frequency, moving the hand faster is not quite good enough to get both marks in this section as the hand could be moved faster but through a larger amplitude giving the same (or even lower) frequency.

(c) Whilst the better answers referred to the vibration of the string, very few took this further by explaining that this would lead to the air particles vibrating.

Question 6

(a) A common error was to state that helium is less dense than hydrogen. Many candidates, however, did recognise either that hydrogen is potentially explosive or that helium is chemically unreactive, few made both points.

(b) As in the previous part many recognised that argon is chemically unreactive, very few recognised that (the oxygen in) the air would react with the white hot filament. Many candidates here seemed to expect an explosion if air were used in the bulb.

(c) A good understanding of the nuclear notation was shown with the first two marks being scored on a regular basis. However the electron configuration caused many more problems.

Question 7

(a) Candidates should be congratulated on doing the calculation well and including the correct unit.

Resistance = 6 Ω

(b) Again the idea of magnetic induction was well understood as was the concept that the iron core and the nails would lose their magnetism as the current was decreased, and some of the most alert candidates realised that the lower nail would drop first as its magnetic strength would be smaller than the upper nail.

Question 8

(a) Knowledge of the properties of transition elements was generally good with the majority of candidates scoring at least one mark and a significant number scoring both.

(b) There were also some good answers explaining how the reaction might be speeded up, it is important, however, that full explanations are given; a statement that the surface area of the iron is increased, is not as good as a statement saying that the iron should be cut into smaller pieces to increase its surface area. A statement simply saying that the surface area should be increased, without reference to the iron, is worthless.

Question 9

(a) The graph was both plotted and drawn well, with relatively few instances of candidates joining the points with a series of straight lines.

(b) Attempts to find the half life were generally good with many candidates scoring both marks.

Half life = 38 s

(c) The completion of the equation for the decay of neon 23 by beta-decay caused many more problems. Many candidates showing little understanding; not recognising a beta particle as an electron, or failing to realise that its proton number is -1, or just putting random numbers in the two spaces.

Question 10

(a) Very few candidates showed any understanding of the application of the kinetic theory to the process of boiling. The vast majority talked of the molecules/particles gaining kinetic energy, whereas the whole point is that at the boiling point there is no change in kinetic energy of the particles, hence the constant temperature. All the energy is converted into potential energy of the particles as work is done in separating them.

(b) This section caused as many problems as the previous section. Candidates could either explain in microscopic terms; particles do not all have the same energy and it is the most energetic which escape thus lowering the average kinetic energy of the remainder, or in macroscopic terms; that it requires energy for particles to escape from the surface and that energy is taken from the body of the liquid.

(c) Again very few candidates were able to relate the ideas expressed in terms of liquid **P** being a pure liquid and liquid **Q** being a mixture, not understanding the first part they had little chance of understanding part **(ii)**.

Question 11

(a) This question was done well with candidates recognising the process of charging by friction, inevitably there were some who confused the concept with magnetism or who thought that the rod could be charged by attaching to a power supply.

(b) The basic idea of like charges repelling and unlike charges attracting were well known, though many fell into the trap of confusing the process with magnetism and thinking that the rods would repel in **(iii)** when approached to the opposite end of the suspended rod. Also relatively few candidates recognised that charged objects are attracted to uncharged objects.

PHYSICAL SCIENCE

Paper 0652/03

Paper 3 (Extended)

General comments

The standard was quite variable; some candidates displayed a very good knowledge of the syllabus and the better candidates also showed a very good understanding of the science. There were, unfortunately other examples where the candidates showed scant knowledge of the syllabus. In general the areas of the syllabus which caused the most problems were the understanding of boiling and evaporation, and perhaps predictably electromagnetic induction.

There was also a noticeable lack of care when it came to using/including units. It must be emphasised that a number without a unit is scientifically meaningless!

Comments on specific questions

Question 1

(a) Most candidates were able to score two of the four marks on offer, either for an arrow vertically downwards and a correct calculation of the weight of the masses, or for an arrow vertically downwards and an arrow vertically upwards. It was relatively rare, however for candidates to score all four marks.

(b) (i) Most candidates knew that the graph started as a straight line from the origin and many recognised that it curved once it had exceeded the limit of proportionality. However the majority had the line curving in the wrong direction, perhaps being more familiar with the graph being drawn (incorrectly) with the load (the independent variable) on the y-axis. This shows the importance of candidates reading the question carefully and studying graphs and diagrams with equal care.

(ii) Most candidates recognised the limit of proportionality, although lack of care regularly cost candidates their mark. The limit of proportionality is where the graph **starts** to curve.

(c) The vast majority of candidates used the formula, potential energy = *mgh* but converting to the correct units caused major difficulties. The calculation for maximum speed caused much more difficulty, with many candidates not even realising that the kinetic energy needed to be equated with the potential energy.

potential energy = 0.2 J
speed = 1.3 m/s

Question 2

(a) (i) The ore was generally correctly named, however some candidates were rather hopeful in naming it as ‘iron ore'.

(ii) The knowledge of the chemistry involved in the formation of carbon monoxide in the blast furnace was disappointing, very few candidates realising that it is a two stage process with carbon dioxide being formed first, and then capturing another carbon atom to form carbon monoxide.

(iii) The candidates were told what the initial chemicals were involved in the reaction and the chemicals which resulted, so it was very disappointing that so many candidates did not even get the correct chemicals in the equation, it is accepted that balancing the equation was a much more challenging task.

(b) The calculation was a challenging one and it was pleasing that the strongest candidates were able to work their way through it. Even amongst those that did not get to the final answer there were many who got part way. Candidates would help themselves if they set out their calculations, explaining what they are doing, in a simple logical way. Examiners can not give stage marks if they can not decipher what the candidate is trying to do.

Mass of iron = 0.56 tonne

Question 3

(a) Most candidates recognised that the experiment was showing reflection. It was surprising how much difficulty candidates had in measuring and calculating the wavelength of the waves, however the attempts to use the frequency and the calculated wavelengths to find the speed were much better. However many candidates who tried to convert from centimetres to metres made careless arithmetic errors – the message is keep it simple.

wavelength = 2.5 cm
speed = 5.0 cm

(b) Diffraction was often confused with refraction, but the attempts to describe the relationship between the slit width and the amount of diffraction were quite good, although sometimes spoilt by just referring to what is seen in the demonstration and not discussing in terms of the general effect.

Question 3

(a) It was surprising how many candidates were unable to recognise that the solid formed in the reaction was copper. The equation was somewhat easier to construct than the previous balanced equation so it was disappointing how much difficulty candidates found, many having no idea of the formulae for such simple compounds as copper II sulphate.

(b) These were easy marks for the overwhelming majority, which shows candidates have a good knowledge of the reactivity table.

(c) In general candidates were well aware that it is aluminium oxide which acts as a protective layer, whereas the iron oxide flakes off. There were some good answers to the second part, with candidates from many Centres showing a good knowledge of sacrificial protection.

Question 4

(a) Whilst the majority of candidates recognised the brown solid as copper, there was a sizable minority, even amongst the otherwise more knowledgeable students who gave totally incorrect answers. The equation was very much easier to construct and balance than the one in **Question 2**, nevertheless difficulty was encountered by many. Clearly this is a skill that needs to be developed.

(b) The reactivity series was well known and the vast majority of candidates were able to show their knowledge. Well done.

(c) There were some excellent answers to both these sections, many candidates showing a full understanding of how aluminium forms a protective layer of aluminium oxide. Equally answers to **(ii)** showed good appreciation of the chemistry, and candidates from some Centres clearly had a sound knowledge of sacrificial corrosion.

Question 5

(a) (i) Electromagnetic Induction is undoubtedly one of the most difficult topics on the syllabus. However it was disappointing, in the extreme, that so many candidates failed to even name the process.

(ii) There were some quite good attempts to give methods of increasing the output voltage, although candidates continue to confuse ‘bigger magnets' with ‘stronger magnets', also moving the magnets closer together is not an option in this case where the coil would foul on the magnets.

(iii) Attempts to explain why an alternating potential was formed showed, at best, little understanding. Very few candidates even scored the first mark for explaining that the coil cuts the magnetic field.

(b) (i) Perhaps put off by the previous parts of the question few candidates made a realistic attempt at this section, all that examiners were expecting were a diode and a load resistor. It also, perhaps displays a lack of confidence of students using electrical terms, how many times do we see students talking about a voltage flowing through a wire?

(ii) Some quite good answers were seen, but candidates must read carefully; it is alarming how many confused ‘conventional' with ‘convectional'!

Question 6

(a) Another example where candidates deprived themselves of marks by not reading the question that has been set. It is no good describing the different bonding of diamond and graphite when you have been asked to describe differences in their properties. Examiners treated the whole of the section as one, but even so many candidates did not describe a single difference in their properties, making it impossible for marks to be credited.

(b) (i) There were some better answers here with many candidates recognising that the delocalised electrons were able to carry the charge to form the current.

(ii) Some candidates gave excellent answers, realising that the atoms were in layers and that the layers could slide over one another, while others showed not even a basic understanding.

(c) This followed the same pattern as the previous part, with some candidates giving excellent explanations, in terms of the different sized particles making it difficult for slippage to occur, with others having little comprehension.

Question 7

(a) Very disappointing. At this level one would expect a knowledge and understanding of the difference between evaporation and boiling. This question did not expect a detailed understanding in terms of the kinetic theory, only the knowledge that boiling occurs at a specific temperature whereas evaporation occurs at a range of temperatures, that boiling takes place throughout the liquid whereas evaporation is a surface effect.

(b) Whilst most candidates realised that the molecules in a vapour are further apart than a liquid, very few went on to discuss the comparative repulsive forces between molecules that occur when liquids and vapours are compressed.

(c) A good number of candidates gave not only the correct answer but good explanations as to why the refrigerator actually warms the air.

(d) The calculation of the current was not well done with many candidates clearly only familiar with the formula, $V = IR$, and not familiar with power = VI. It was also pleasing that most candidates used the correct units.

current = 0.5 A
resistance = 440 Ω

Question 8

(a) Whilst some candidates had a good idea of the meaning of the term homologous series, many others had little idea.

(b) (i) Whereas many candidates recognised that ethanol can be made by combining water and ethane, many did not realise that the water must be in the form of steam and that the steam needs to be at very high temperatures and pressures. At lower temperatures the reaction will be so slow as to nonexistent.

(ii) Of the three equations that were asked for on the paper this one was done by far the best.

(iii) Most candidates were able to identify fermentation, though a common error was to say ‘fermentation of yeast', rather than by yeast.

(iv) Sensible industrial uses were named by most candidates.

(c) The electron diagrams of methanol were excellent, with many candidates gaining full credit on this challenging task.

PHYSICAL SCIENCE

Paper 0652/05

Practical Test

General comments

The degree of difficulty of questions was very similar to previous years as was the standard of candidates' work. All marks were used and there was no indication that the time allocation was insufficient. There is good evidence to suggest that candidates are not well practised in carrying out the Chemistry tests. Most of **Question 2** was devoted to applying the tests as printed on page 12 of the question paper but many answers suggested that candidates are not familiar with these tests.

Comments on specific question

Question 1

Question 1. This question was well answered. However, the following comments may be helpful. The majority of candidates were able to accurately cut out the card and produced a 70-71 mm value for the distance **CE**. A very small number recorded the value in centimetres and lost the mark. Values of **x** in the table, Fig. 1.3 were chosen sensibly but values of **y** were sometimes incorrect, suggesting that the distance **GD** was measured rather than the clearly marked distance **y**. (A few recorded values in excess of 100 mm, the size of the card!) A wrong measurement here was an important error as this produced the wrong graph. Unnecessary marks were lost by this mistake. The marks lost included one of the four allocated to the graph and both marks in **(b)(ii)**. Graph plotting was good. The value of $\mathbf{y_o}$ was expected to be 73 – 75 mm. A careful drawing and accurate measurement should have produced a value 124 – 126 mm for the line **AG**.

Question 2

As already suggested, this question could have been answered better, considering almost all the information was provided in the notes on page 12. Candidates must be able to practice these tests on as many occasions as possible and familiarise themselves with the use of a simple term such as precipitate. It is also necessary to emphasise the importance of negative tests and not to assume that all tests will produce a gas. Almost all candidates recorded the distinct effervescence in the reaction between solid **A** and sodium carbonate. This should have instantly suggested that **A** was the acid. However, very few were able to make this conclusion. Test **(b)** was poorly answered. Far too many assumed a gas was given off in each test and concluded such gases as chlorine, hydrogen and oxygen. Often accompanied by the correct test, but totally incorrect for the given reactions. In fact only solid **B** would react and produce ammonia, thereby indicating that **B** was a base. Familiarity with the notes provided would show that the formation of a precipitate with aqueous ammonia would suggest a metal ion and therefore solid **C** to be a salt. Answers to part **(d)** were very poor and showed a lack of understanding of even the simple fundamentals of the subject. Answers to part **(e)** were variable. Again, it was a case of simply carrying out the tests given in the notes. Some very strange observations were made and some candidates failed to read the first sentence. How could a nitrate be the answer for the anion when the information given was for a sulphate or chloride.

PHYSICAL SCIENCE

Paper 0652/06

Alternative to Practical

General comments

The paper followed the usual pattern of three questions about chemistry and three that are about physics. However, there was some cross-over between the subjects. This is shown in **Questions 4** and **6**, where ideas about the kinetic theory of gases and the density of liquids occur in chemistry questions.

The Examiners have tried, as usual, to include the three sections of the syllabus devoted to practical work: observation and recording, drawing conclusions from the data and devising extensions of the experiments. In addition to these, it is expected that candidates will know how to carry out well-known laboratory procedures, for example to test for gases and ions in solution. Questions can refer to any part of the physical science syllabus.

The parts of the questions concerned with observation and recording were usually well done. The Examiners noted that many candidates showed a very poor knowledge of standard tests for gases and metal ions. Answers from candidates who had learned the tests by rote demonstrated that they did not understand the tests. For example, it was rare to find a candidate who knew that the addition of aqueous ammonia to the solution of heavy metal ions produced a precipitate of the metal hydroxide. The A* candidates revealed their superior abilities by such details in their answers.

Comments on specific questions

Question 1

Procedures such as the analysis of limestone are carried out using standardised solutions of an acid. The Examiners avoided reference to such solutions by giving a simple relationship between the volume of acid and the mass of calcium carbonate that it dissolves. Most candidates scored well in answering this question.

(a) The question about identifying and testing the gas given out when acid reacts with calcium carbonate was not always successfully answered. Some candidates said that the gas was hydrogen. They could score a mark by giving a correct test for an incorrect gas. Those who identified the gas as hydrogen often lost this mark by suggesting that it would "pop" when a glowing splint is inserted into the tube, instead of a flame.

(b) (i) and (ii) Candidates had to read balance scales and find the mass of limestone by subtraction; this was almost always well done.

(c) How to tell when the reaction was finished? Some wrote that "all the limestone would have dissolved" despite having been told that it contained sand as an impurity.

(d) (i) and (ii) The reading of the burette scales was found more difficult. Some candidates read the scale the wrong way up, so that when a scale showed that 26.2 cm^3 had been delivered, the answer given was "27.8 cm^3". This showed the lack of experience at the laboratory bench. Correct subtraction could gain a mark even if the scales were wrongly read.

(e) Finally the mass of calcium carbonate in the limestone sample could be calculated. Most candidates found this easy to do. Credit was given to a mass based on an incorrect answer to part **(d)**.

Most candidates gained high marks in this question.

Question 2

This question, like **Question 3**, was based on the corresponding question in the practical examination, paper 5, where the candidates had to find the centre of mass of an irregular lamina.

(a) Candidates must use a ruler graduated in mm. to find the position of the pin from which the plumb-line and the lamina were suspended, and the point at which the plumb-line crossed the lower edge of the lamina. This could not be done by candidates who, despite the warnings that mathematical instruments would be needed, had brought no ruler to the examination room. Other candidates filled in the values 10 and 15, to match the rest of the **x** distances, instead of measuring them, a bad error.

(b) (i) and (ii) Some candidates misunderstood the command "plot **y** on the vertical axis" despite this use of the mathematical convention. Others adopted scales that were impossible to use, such as "9 millimetres = 10 small squares". The Examiners had carefully chosen the size of the graph grid to suit the range of values in Fig. 2.2. More practice is needed in plotting graphs using data derived from laboratory investigations. Then the best straight line had to be drawn and extended to cut the vertical axis A number of candidates either did not extend the line or extended it to cut the horizontal axis. Many good candidates were able to plot the graph and derive the value of $\mathbf{y_o}$ that was required.

(iii) This value had to be used to draw the position of the plumb-line and so label **M**, the centre of mass of the lamina. Again, a ruler was needed.

(c) Finally, an explanation was asked for the inability of the lamina to balance horizontally on a different point, **N**. The simple statement that "**N** is not the centre of mass" was accepted. The good candidate usually answered that "One side of the card was heavier than the other".

Many candidates achieved high marks in answering this question.

Question 3

The Examiners were disappointed to find that this reasonably simple question about the reactions of acids, bases and salts was often very poorly answered. Rote learning of standard tests for acids, bases, salts and gases should be encouraged, but it is no substitute for actually doing the tests.

(a) Three substances, sodium carbonate, ammonium chloride and aqueous ammonia are to be added to an acid, a base and a salt. Candidates were invited to indicate which pairs of substances would react together. There were 5 possible correct answers from the nine combinations. Alas, few candidates scored the two marks awarded for the four correct answers needed.

(b) Solid **B** reacted with sodium carbonate to give a gas that turned lime-water milky. What conclusion can be drawn? The answer "solid **B** is an acid" was rare indeed, maybe there is a perception that all acids are liquids!

(c) (i) and (ii) Solid **A** reacted with ammonium chloride to give a "strong-smelling" gas. A test to confirm the presence of ammonia was asked for. Many candidates thought that ammonia turned litmus red. What can be concluded about solid **A**? The answer that it is alkaline or basic was rare.

(d) (i) and (ii) Now candidates were told that aqueous ammonia reacts with a solution of **B** giving a temperature rise, and with a solution of **C** giving a white precipitate that will redissolve in excess of ammonia. What kind of reaction occurs between ammonia and **B**? "Endothermic" was given as often as "exothermic" and neutralisation quite rarely. The name of the precipitate "zinc hydroxide" was rarely given. "Zinc" was sometimes given, it is true, but this only reveals ignorance of the weakly alkaline nature of aqueous ammonia and its reaction with metal ions in solution.

(e) The final part of the question asked the candidate to suggest a test that would confirm the presence of a sulphate in solution. Again, only the very good candidates were able to give details of the test for a sulphate using barium chloride or nitrate.

Answers to this question were almost universally poor, and very few candidates scored 10 marks.

Question 4

This question is based on the phenomenon known as the effusion of gases. Gases are emitted from a small hole at a rate that depends on the mass of the molecules; the smaller the mass, the faster is the rate of effusion. This is akin to diffusion, which forms part of the syllabus.

(a) Candidates were invited to suggest an important step in the procedure for the experiment to find the time needed for 100 cm^3 of the gas to flow out of a small hole. The syringe is first filled above the 100 cm^3 mark and the gas is allowed to escape. Timing begins when the syringe contains exactly 100 cm^3 of gas. A few very good candidates realised this.

(b) Most candidates correctly read the stop-watches to find the times for 100 cm^3 of methane and chlorine to flow out.

(c) The r.m.m. of these two gases had to be calculated. Since this is a practical rather than a theory paper, only one mark was awarded for both correct answers.

(d) A way of making the hydrogen for use in this experiment was asked for. There were many careless and incorrect answers, ranging from "the addition of a metal to an acid" to "fractional distillation of liquid air". What was needed was the addition of a suitable named metal to hydrochloric or sulphuric acid. "Electrolysis of water" was also accepted. Some candidates even suggested the dangerous procedure of adding a Group 1 metal such as sodium to acid. Here again, candidates betrayed their lack of laboratory experience. The addition of magnesium or zinc to hydrochloric acid, followed by the lighted splint test for hydrogen, should surely be amongst the most basic of experiments to be experienced by all candidates.

(e)(i) and (ii) Four suggestions were given, to explain the data of the effusion experiment. Most candidates were able to choose the correct explanation, that molecules having greater mass flow more slowly, then use the data to confirm this theory.

(f) Finally, candidates had to suggest a safety precaution to adopt during the experiments. There were many general comments such as "cover the face with a mask because the gases are poisonous "; however, more specific advice was looked for by the Examiners. The most successful answers were "avoid flames in the laboratory because hydrogen (or methane) is flammable" and "do not inhale chlorine (or, keep chlorine in a fume cupboard), because it is poisonous".

The Examiners were most disappointed by the response to part **(d)**, otherwise many candidates scored reasonably well in this question.

Question 5

This physics question appears to cover some of the same ground as the previous chemistry question, in that it involves gases and refers to the kinetic theory. However, the apparatus used is different and a purely physical property of gases is tested.

(a) A gas syringe containing air is gradually warmed in a water bath. Two thermometer readings showing the temperature of the bath, and the corresponding syringe scales giving the volume of air, had to be read. Each graduation of the syringe scale denoted 2 cm^3, a fact that confused some candidates. Most candidates recorded at least two readings correctly.

(b) Data including these readings had to be plotted, then a "best fit" straight line had to be drawn. The choice of scales and the plotting of the points were harder than in **Question 2**, but many candidates scored well. There was the usual misunderstanding of the term "vertical axis", and many candidates did not draw "the best straight line" despite the clear instruction to do so.

(c) Candidates had to explain why air expanded as the temperature rose. The Examiners were looking for a more accurate answer than that offered by the weaker candidates, who often wrote that "molecules moved faster and so occupied more space". Equally incorrect were those who wrote that "molecules vibrate more" and were confusing the behaviour of gas molecules with those in a liquid or solid. Gases confined in a syringe surrounded by the atmosphere are occupying the space because they collide with the syringe walls. Expansion that occurs when the gas is heated is due to increasing energy of the collisions, leading to increased pressure. Candidates should be aware of this type of behaviour of gaseous molecules. This question was well answered by a significant number of candidates.

(d) A graph of volume against temperature was shown for a hydrocarbon gas near its boiling point, and candidates asked to explain why there is a sudden large drop in volume as cooling takes place. Gases usually turn to liquid on cooling, but many candidates wrote that "the gas becomes a solid" and this was accepted as an answer.

Many candidates scored well in this question.

Question 6

A question about four common liquids, designated by the letters **A** to **D**, concluded the examination. The liquids had to be matched with their given names using information about their densities and miscibility with water.

(a) The balance scales showing the masses of 50 cm^3 of each liquid were shown. The masses had to be correctly recorded to the nearest first decimal place. Again as in **Question 5**, each graduation of the scale represented 0.2 g: this posed a problem for many candidates. Others wrote the first three masses correctly but failed to give the first decimal place for the last mass and wrote "50" instead of "50.0"

(b) A simple key showed the true identity of the four liquids. Candidates had to insert, into the first line of the key, the letters of the liquids answering to the descriptions of their densities. Some candidates laboriously calculated the densities of the liquids instead of relying on the mass in grams being numerically more than, less than or equal to the volume in cubic centimetres. A few candidates tried to write the names, instead of the letters, showing that they had not read the question.

(c) A diagram showing the result of mixing the four liquids with water, told candidates that liquid **C** and water are immiscible. This gave them the information to fill in the last line of the key. Some candidates failed to understand the key at this point.

(d) How to tell the difference between an alcohol and a hydrocarbon liquid? This is not found in the syllabus as such, but a very few candidates suggested a test such as "the alcohol will react with sulphuric acid" or "the alcohol can be made into an ester". The most obvious answer is that ethanol (the only alcohol that candidates will know about) burns with a blue flame, but a hydrocarbon burns with a yellow flame. One or two candidates even suggested that alcohol reacts with phosphorus(V) chloride, showing an advanced knowledge of the subject. This question was found to be the most difficult in the examination.

(e) Candidates were asked for a test "to confirm the identity of the salt solution". The term "confirm the identity" was perhaps difficult for the candidates for whom English is their second language to understand, but they had already been told that the salt solution contained sodium chloride. The addition of silver nitrate would "confirm" that a chloride was present in solution. The better candidates were able to give this answer and a few mentioned the possibility of using a flame test to show the presence of sodium.

Despite the unusual nature of the question, containing a key, many candidates were able to score 6 or 7 marks. It was in parts **(d)** and **(e)** that most marks were lost.