PHYSICAL SCIENCE

Paper 0652/01
Multiple Choice

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

General comments on whole paper

At 45%, the mean on this paper was most disappointing. Candidates who hope to achieve good grades need to be better prepared for this.

Comments on specific questions (Physics only)

Many of the Physics items on this paper were well-answered, but there were a number of serious gaps in candidates' knowledge. The questions which candidates found easy (facility ≥ 70%) were **24**, **28**, **31**, and **34**. Questions which showed that candidates found the topic difficult were **23**, **26**, **33** and **39**. The following comments on selected questions may be of help to teachers.

Question 21 showed a candidate weakness, which can be summarised by the warning "Read the question carefully". Nearly half answered this item correctly, but almost as many chose **D**, which would only have been the correct answer if the question had asked for the elapsed time measured by stopwatch Y. Careless thinking affected answers to **Question 23**, with only a quarter of candidates answering correctly, whereas nearly two-thirds reversed the densities. A surprising lack of understanding of spring extensions showed itself in **Question 24**. 17% of candidates thought that the extension is found by adding the two spring lengths. A majority recognised that the air resistance in **Question 25** was 40 000 N, but over a quarter thought that friction acts forwards. The position of centres of mass in relation to stability is clearly not understood by a large number of candidates (**Question 26**), and in **Question 27**, 58% of candidates thought that the ball, despite losing energy during the bounce, still managed to rise back to the starting position *or higher*. It would be interesting to see what logic led to this conclusion.

On the other hand, it was pleasing to see the large proportion who were able to interpret the two heating curves in **Question 28** correctly. Wave questions often cause candidates some difficulty, so it was pleasing to see a high facility on **Question 31**. Another topic with which candidates often struggle is that of ray diagrams. In **Question 32** this was apparent. Only a quarter answered correctly, with a majority of the rest thinking that the ray went on to pass through the other principal focus.

Question 36 was answered correctly by half the candidates, with the remainder tending to go for the two common misconceptions that (i) the electricity gets progressively weaker the further it goes from the supply, and (ii) lamps in parallel must be dimmer. There was a lot of uncertainty about the direction of deflection of cathode rays in **Question 37**, and all the radioactivity items showed evidence of widespread guessing, as in each case all four options gained similar support.

Comments on specific questions (Physical Science Chemistry only)

The questions in the Chemistry section of this paper performed and discriminated well. They were of approximately equal difficulty to those in the Physics section.

Only **Question 9** proved to be significantly more straightforward than others, with a large majority of candidates selecting the correct option.

The following questions proved to be more difficult than average although most still discriminated well between the stronger and weaker candidates.

Question 4

This question discriminated well, but many weaker candidates opted for option **A** since they recognised a metal. They were clearly unsure of what other substances were able to conduct.

Question 13

This question too discriminated well with responses from weaker candidates equally split between the three incorrect options. This seems to indicate that they found the question confusing and guessed.

Question 14

Here option **D** was the most popular choice also being chosen by some of the stronger candidates. This can only be due to lack of understanding of the reactivity series, as the question was straightforward. The concepts involved are clearly in ***section 8.3*** of the syllabus.

In addition the most popular answer to **Question 19** was option **C**. This is a straightforward question and would seem to indicate that some candidates do not class a ‘test’ as a chemical reaction. In **Question 2**, option **D** was more popular than the correct option **C**. This links, perhaps, to the problems that many candidates seem to have with the ideas involved in exothermic and endothermic reactions.

PHYSICAL SCIENCE

Paper 0652/02

Core Theory

General comments

The improvement in general standards shown in recent years has been maintained, with many candidates showing good understanding of not only basic concepts but also more challenging ideas. Questions in which candidates showed their knowledge and understanding were **Question 1** (simple circuits and resistance), **Question 4** (halogens and the Periodic Table), **Question 5** (thermometry), **Question 8** (reactivity orders and properties of iron) and **Question 9** (magnetism).

The questions covering forces and springs (**Question 3**), refraction and reflection of waves (**Question 5**), beta radiation (**Question 11**) and the formation of copper chloride crystals (**Question 12**) caused more difficulties.

Comments on specific questions

Question 1

(a) The connection of a voltmeter into a circuit always causes problems, so it was pleasing that many candidates understood that the voltmeter should be connected in parallel and across the bulb.

(b)(i) and (ii)
The vast majority correctly read off the current from the graph and were able to use it to calculate the resistance of the lamp, although a significant number lost marks by failing to include correct units.

(iii) Whilst many candidates correctly stated that the resistance of the lamp increased when the current was increased, very few related this to the increase in temperature of the lamp filament.

Question 2

(a) The majority of candidates were able to give the formula for potassium bromide, but fewer were able to give the formula for methane, and several seemed to think that methane was an element with the symbol, Me. More were able to state that methane is covalent and that potassium bromide is ionic.

(b) Whilst the sodium ion was correctly named, few gave the correct answer, chloride, for the second ion. The vast majority gave the answer chlorine. Surprisingly few gave the correct symbols for the ions, most simply giving the chemical symbols for sodium and chlorine, but failing to show the charge on the ion.

Question 3

(a) The majority of candidates understood that the weight of the body was equal to the mass multiplied by the Earth's gravitational field strength, although, surprisingly, many gave incorrect units. It was disappointing how few recognised that the forces on the mass were balanced and that the spring pulled it upwards with a force equal to the weight of the mass.

(b) Many candidates recognised that when the mass is pulled down a short distance and released, there would be an upward force on the mass. Answers given in the final section showed that many candidates failed to read the question carefully. What was asked for was a description of what would happen to the mass immediately after it is released. Examiners were looking for the fact that it would move upwards, which a lot of candidates recognised, and also that it would accelerate upwards, which virtually no candidates realised.

Question 4

(a) It was disappointing how few candidates recalled that elements in Group 7 of the Periodic Table are called halogens.

(b) More candidates, however, were able to state that bromine has seven electrons in the outer shell.

(c) The attempts to write a balanced equation for the reaction between sodium bromide and chlorine varied widely. Many candidates were totally confused, and invented a substance $NaBrCl_2$. Amongst the better efforts,` the failures to recognise that bromine will form a diatomic molecule was common, as was the recording of sodium chloride as $NaCl_2$.

(d) There were some good answers here, although a common response was to state that iodine is less reactive than bromide.

(e) Many candidates confused Period with Group, nevertheless the majority were able to state the relevant atomic number and the relative atomic mass of their chosen element.

Question 5

(a) Suitable liquids, which the majority were able to name, were mercury and alcohol. The thermometer had a range of 0 – 110 °C. The higher figure is well above the boiling point of ethanol which is therefore unsuitable for the job.

The vast majority of candidates were able to state that the liquid expands, but very few developed their answers. The question asked candidates to explain what happens to the liquid. Examiners were looking for an explanation either that the particles moved further apart or that the expansion means that the liquid moves along the capillary tube.

Disappointingly, few candidates recognised that the main method of energy transfer from the hot water to the thermometric liquid is conduction.

(b) The majority recognised that the boiling point of water is 100 °C (answers in the range 95 - 100 °C were accepted to allow for variations at different altitudes). The explanations of boiling were very disappointing, with very few candidates stating that it occurs at a fixed temperature or that bubbles (of vapour) are formed in the body of the liquid.

Question 6

(a) There was little recognition that the compounds listed were forms of alcohol or that the name given to this type of series of compounds is 'homologous'.

(b) It was encouraging to see a good number of candidates able to recall or deduce the formula for propanol.

(c) There were some excellent answers showing the structure of ethanol.

(d) Common errors here were to state that 'ethanol is used in industry' and that 'ethanol is used to make alcohol'. The former is far too vague and the latter is incorrect as ethanol is a type of alcohol.

Question 7

(a) The responses to this question showed little understanding of refraction of water waves. Whilst a minority recognised that there would be a change in direction of the waves on entering the shallow water, there were very few who drew a correct diagram clearly showing the correct change of direction and change of wavelength. Many candidates were unable to name the process as refraction.

(b) This part caused similar problems, with very few candidates showing any understanding of the effect.

Question 8

(a) Whilst there were many good attempts at ordering the reactivity of the three metals, many candidates included carbon in their list. Fewer candidates were able to place carbon in the series and very few gave a good reason for their choice of position, a common misconception being that because carbon is a non-metal it can not be placed in the list.

(b) This caused surprising problems – common errors were ‘iron ore’, ‘steel’, and other metals.

(c) Uses of stainless steel were well answered, however, many candidates were unable to describe mixtures of metals as alloys.

Question 9

(a) There were many good answers to this part. Most candidates correctly identified the poles of the magnet and were able to state that the magnets balance because the two north poles repel. However, very few completed the explanation by including a statement regarding this force of repulsion balancing the gravitational pull on the second magnet.

(b) Those candidates who had a good understanding of the work recognised that both ends of the iron bar would be attracted to the south seeking pole of the magnet.

(c) Answers here tended to follow on from the previous part. Many recognised that the iron bar would now be magnetised, although somewhat fewer went on to say that one end of the bar would now repel the south seeking pole of the magnet.

Question 10

(a) Although the majority of candidates correctly described the process as oxidation, terms like ‘oxygenation’ were quite common.

(b) The most common error here was to state that the products formed would be iron oxides rather than the generic term, oxides.

(c) It was surprising how few candidates scored both marks in this part. This is a fundamental experiment, of which the vast majority should have had a thorough knowledge.

Question 11

(a) It was disappointing how few candidates were able to identify β-radiation as electrons. Amongst those who did, only a minority went on to say that they were high energy/fast moving or that they were emitted from the nucleus in radioactive decay.

(b) If the radiation had not been identified, it made this part of the question much more difficult. Nevertheless some candidates were able to give a reasonable answer. The most common errors were to decrease the proton number of the daughter, rather than increase it, and to invert the proton number and nucleon number of the β-particle.

Question 12

(a) Although a minority of candidates correctly balanced the equation, it was disappointing that so many were unable to do so.

(b) A simple study of the equation should have enabled candidates to identify the gas and it was disappointing how many were unable to do this. Where the gas was correctly identified the majority were able to describe the use of lime water as the correct test, although a minority gave the inconclusive test of extinguishing a lighted splint.

(c) Few candidates recognised that the first step in the process of obtaining pure crystals of copper chloride from the mixture is to filter it. Even those who did recognise this step often failed to make it clear that it was the filtrate that was then evaporated to obtain the crystals.

PHYSICAL SCIENCE

Paper 0652/03
Extended Theory

General comments

After several years of continuous improvement, there seems to have been a slight dip in performance, with a significant number of candidates showing neither the basic knowledge, nor the understanding expected at this level. In particular, there was little understanding of the use and structure of the thermocouple, (**Question 3(b)**), reflection and diffraction of water waves, (**Question 5**), the action of a catalytic converter, (**Question 6(a)(ii)**), and the nature of beta decay, (**Question 9(a)** and **(b)**).

On a more positive note, it is pleasing to see the excellent understanding, shown by a large number of candidates, of the links between the Periodic Table and the electron structure of the atom, (**Question 4**).

Comments on specific questions

Question 1

(a) The majority of candidates understood that the weight of the body was equal to the mass multiplied by the Earth's gravitational field strength, although, surprisingly, many gave incorrect units. It was disappointing how few recognised that the forces on the mass were balanced and that the spring pulled it upwards with a force equal to the weight of the mass.

(b) The majority of candidates recognised that when the mass was pulled down an extra 1.5 cm and released, there would be an upward force on the mass.

(c) The majority of candidates recognised that the elastic limit is when the load – extension graph ceases to be linear.

(d) Whilst the vast majority were able to establish that the force on the mass upon release was 1.9 N, very few recognised that to calculate its acceleration the formula, F = ma, had to be used. The majority saw the term 'acceleration', were working with a graph, and so immediately tried to find the gradient of the graph.

Question 2

(a) Many candidates knew that the term galvanising means coating the steel with another metal, but failed to specify that the metal used is zinc. Most of those who correctly identified zinc as the coating, were able to give a good explanation of the sacrificial nature of the protection. A common error, however was to confuse it with the protection given by the oxide layer produced by aluminium.

The alternative methods of protecting iron and their limitations were generally understood, painting being the most common choice.

(b) It was disappointing that many candidates failed to understand that aluminium is more reactive than iron and that it is the formation of the oxidised layer, that stops further corrosion.

(c) There was widespread understanding that alloying the aluminium increased its strength, although only a minority of candidates understood that it is the different sizes of atom introduced in the process that stop planes of atoms slipping over each other. Many gave a vague explanation along the lines of the alloy taking the best properties from each of the constituent metals.

Question 3

(a) The vast majority of candidates were able to state that the liquid expanded but very few developed their answers. The question asked candidates to explain what happens to the liquid. Examiners were looking either for an explanation that the particles moved further apart or that the expansion means that the liquid moves along the capillary tube.

(b) There was strong evidence that many candidates had little or no knowledge of the thermocouple. Any two suitable metals were accepted as possible materials for the wire. Metals like sodium or magnesium were rejected, as there would be too great a danger of chemical reactions being triggered by any heating.

Very few candidates had any idea how to calculate the temperature indicated by the thermocouple, a common answer being 2.4 °C.

Little understanding was shown of the advantages, (quick acting, measurement at a point, remote measuring), of the thermocouple. Even where a suitable advantage was identified, many candidates failed to explain why the thermocouple exhibited the property. One common error was to state that the thermocouple could measure two temperatures at the same time. Another error was to describe the thermocouple as ‘more accurate’. This is totally incorrect as the accuracy will depend on how well it is calibrated. Neither is it ‘more sensitive’, as that will depend on the sensitivity of the voltmeter.

Question 4

(a) This first part was done very well, with candidates showing an excellent grasp of electron configurations.

(b) This was also done very well, with the vast majority showing a good understanding that the Group number is determined by the number of electrons in the outer shell.

(c) There was, in some cases, slight confusion in establishing the formula for calcium iodide, which was disappointing after the earlier good work.

In **part (ii)** many candidates failed to follow the trend through the halogens to make the conclusion that astatine would be black in colour.

Question 5

(a) The responses to this question showed little understanding of refraction of water waves. Whilst a minority recognised that there would be a change in direction of the waves on entering the shallow water, there were very few who drew a correct diagram clearly showing the correct change of direction and change of wavelength.

(b) This was done marginally better than the previous part, although diagrams lacked precision. Few candidates used a compass to draw the circles, and although freehand drawings could gain full marks, this makes it much harder for the candidates. Many did not maintain consistent wavelengths or centre the circles on the centre of the gap. However, it was pleasing that the majority recognised the effect being demonstrated as diffraction.

Question 6

(a) This question was answered quite well by many candidates, however, a significant number wrote down a series of possible problems, such as causing pollution, causing global warming or destroying the ozone layer, which appeared to have been chosen without thinking of the particular pollutant. Examiners were looking for reasoned arguments such as, ‘nitrogen oxide dissolves in water to form acid rain, which will fall into ponds and rivers causing damage to living organisms.’

Following on from this, the best descriptions of the action of the catalytic converter were excellent. However, there were too many vague responses such as, ‘it converts the nitrogen oxide to less harmful gases.’

(b) The calculation of the mass of carbon dioxide produced when propanol is burnt was often spoilt by a lack of clarity, in both thought processes and the laying out of the calculation. Clear calculations of the relative atomic masses of propanol and carbon dioxide show them each to be 44. The mass of carbon dioxide produced by burning 1 kg of propanol can then be determined simply by referring to the chemical equation.

To find the volume of the carbon dioxide, candidates needed to find out how many moles were produced and then multiply this by 24 dm^3/mol. A common error by those who had reached this stage in the calculation, was to forget that the mass had been calculated in kilograms.

(c) The electron configuration for carbon dioxide was done well, with many candidates showing good comprehension and scoring full marks.

Question 7

(a) Disappointingly few candidates recognised this as cracking of alkanes, and of those who did, many thought it was cracking of ethane. Common mistakes were fractional distillation, removing water from alcohols.

(b) The equation gave candidates the opportunity to show their knowledge and understanding of the chemistry. It is pleasing that many provided perfect answers.

(c) Examiners were not looking for a named catalyst, and no penalty was given if a candidate gave an incorrect substance so long as it was clear that its job was to catalyse the reaction. Many candidates, however, incorrectly named 'heat'.

Question 8

(a) The calculation was done quite well by the majority of candidates, although relatively few converted the kilowatts to watts.

(**b)** The concepts in power distribution are not easy and it was no real surprise that only a few candidates showed any more than a very rudimentary understanding. Many talked about a high voltage being needed as it goes to many homes, others showed a little more understanding in stating that there would be less energy lost.

Most recognised the device as a transformer and many correctly calculated the turns ratio. Those who made an error in calculating the turns ratio were often doubly penalised because they did not show their working clearly. Examiners always try to give credit if they can see valid points, but where working is just a jumble of numbers, then it is often impossible to find anything worthy.

(c) Statements were often vague or incorrect. It was common to see, 'voltage input = voltage output', which shows understanding of neither the operation of a transformer nor of efficiency. Somewhat better were statements like, 'no energy is lost'. But, the real explanation that was wanted and expected was that the energy (or power) input is equal to the energy (or power) output.

Question 9

(a) It was disappointing how few candidates were able to identify β-radiation as electrons. Amongst those who did, only a minority went on to say that they were high energy/fast moving or that they were emitted from the nucleus in radioactive decay.

(b) If the radiation had not been identified than it made this part of the question much more difficult. Nevertheless some candidates were able to give a reasonable answer. The most common errors were to decrease the proton number of the daughter, rather than increase it, and to invert the proton number and nucleon number of the β-particle.

(c) Answers here tended to be vague and not linked to the particular example. It was clear that the understanding of the term half-life is not well understood. Many candidates stated that after 16.2 days all the radioactive material would have decayed. Very few candidates picked up on the idea that the daughter element produced in the decay, xenon, is a noble gas and being unreactive would have no chemical side effects.

PHYSICAL SCIENCE

Paper 0652/05

Practical Test

General Comments

Overall performance was rather poor and probably slightly worse than last year. Many appeared to be ill-prepared for a practical examination, and routine operations such as labelling axes for a graph, measuring a gradient and using the chemistry notes on the back page of the question paper were all poorly performed.

Comments on specific questions

Question 1

Many did not set up the metre rule as shown in Fig.1.1. If the zero was at the bottom it was impossible for the position with 200 g mass to be greater than the position with no mass. Although no mark was deducted on this occasion, it was poor practice. Too many candidates were confused between millimetres and centimetres. A mark was lost if the positions were not recorded in millimetres. Most were able to produce four times for 20 oscillations, but a surprising number were unable to calculate the time for 1 oscillation. The instruction was to calculate $\mathbf{T}^2$ to two decimal places, and failure to do so lost a mark. The graphs were very poor. The axes were frequently incorrectly labelled or not labelled at all. Scales were badly chosen, and usually very cramped. Many had no idea how to calculate a gradient. Failure by so many to do this meant the abandonment of a mark for accuracy. In the event, a mark was given for a correct substitution and calculation in **(g)**. The most common answer to **part (h)** was to repeat the experiment. Very few thought of increasing the number of experiments by using different masses or by increasing the number of oscillations.

Question 2

Every year this report says that ‘milky’ is not an acceptable answer for ‘white precipitate’, yet it still occurs. **Part (a)(ii)** was generally well done. The observation mark in **part (iii)** was usually scored but deductions were very poor. **Part (b)** was an opportunity to score three easy marks, and many were able to do so. However, once again the observation was a red-brown precipitate (see notes) and not a red colour. A fair number correctly reported loss of colour in **(c)(i)**. **Part (c)(ii)** was seldom answered correctly. The barium ions produce a white precipitate which dissolves or mostly dissolves in the acid. Very few managed to produce a green precipitate in **(iii)** and those who did obtain an acceptable colour had no idea that the iron(III) had been changed into iron(III).

PHYSICAL SCIENCE

Paper 0652/06
Alternative to Practical

General comments

The paper has been designed in the usual way, incorporating elements from the Assessment Criteria for Practicals given in the syllabus. These invite the candidate to display knowledge of laboratory procedures and tests, read and record results and then draw conclusions. As usual, answers given by candidates from some Centres revealed that they have done little or no experimental work. This may be because of lack of appropriate facilities or because of time-table restrictions. The Examiners wish to emphasise once more that adequate experience at the laboratory bench is essential for success in this paper. This conclusion is reinforced by comments on individual questions below.

Comments on specific questions

Question 1

(a) (i) A dropping pipette is filled with liquid by squeezing the teat and then releasing it when the tube is under the liquid. Very many candidates omitted the release of the teat and said that the pipettte would fill when the teat is squeezed.

(ii) The scale of the cylinder showed only 1 cm^3 graduations. Almost all candidates wrote that it can be found by transferring one pipette-full into the cylinder. The better candidates placed several pipettes-full into the cylinder and then divided the volume by the number of times the pipette was emptied, and so gained the full marks.

(iii) A considerable number said that they would withdraw one drop from the measuring cylinder containing a pipette-full, or even place one drop into the empty measuring cylinder. The answer needed was the division of 1.8 by the number of drops counted when the pipette is emptied.

(b) (i) Most candidates were able to answer this correctly, but some gave the colours of Universal Indicator. Candidates should be taught that, while Universal Indicator can be used to find approximate pH values, to follow a reaction between an acid and an alkali, a simple indicator is preferable so that there is only one change of colour.

(ii) Again, most answered this correctly.

(iii) The better candidates followed the logic of the question and correctly answered that it was the alkali, sodium hydroxide, which was the more concentrated solution.

(iv) Most candidates correctly answered that the beaker of water was used to wash out the pipette.

(v) By now, weak candidates appeared to have forgotten the information given above the diagram for **part (b)**, and were unable to answer that the salt was sodium chloride.

A commendable number of candidates scored well in this question but it was rare to find an answer gaining full marks.

Question 2

(a) (i) It was a simple matter to read the stopclock dials as 15 s and 17 s, although sometimes the second time was stated as 15.2 s.

(ii) Division by 20 to find **T**, the time for one oscillation was usually done correctly.

(iii) Many candidates found it difficult to calculate $\mathbf{T}^2$.

(b) Plotting the graph of $\mathbf{T}^2$ against the mass of the load was a simple task for almost all candidates, as the axes were already labelled. However, some candidates who had not managed to work out the two missing values of $\mathbf{T}^2$ now read these off the graph. Examiners had been careful to ensure that this procedure did **not** lead to the correct values. Some candidates failed to draw a straight line as instructed, so lost a mark. Others made their line pass through the point (0,0) contrary to the given statement that it would not do so.

(c) The gradient of the straight line had now to be found. Candidates found this much more difficult. Initially, a triangle had to be drawn on the line, the dimensions of which would lead to the calculation of the gradient. Alternatively, it could be indicated on the graph how values of *x*- and *y*-had been derived. These values were then used to find the gradient. Common errors included finding *x*/*y* instead of *y*/*x*, counting squares to find the values of *x* and *y* instead of using the real values, and incorrectly calculating the value of (say) 0.48/300.

(d) The use of the given formula led to a value of **g**, the acceleration due to gravity, of around $9.5\,\text{ms}^{-2}$. Errors carried forward were allowed, so some unrealistic values were seen and allowed.

(e) Acceptable answers showed that the spring and weight holder had their own mass, therefore at mass 0 oscillation would still occur. However, some candidates wrote that $\mathbf{T}^2$ was not directly proportional to the mass, which was also accepted.

The better candidates scored well on this question, although the maximum mark was not often awarded.

Question 3

(a) The meanings of the state symbols (aq) and (s) were usually given correctly, but “aquatic” and “aquarius”, sulphur, sodium and solution were also suggested.

(b) Most candidates answered this correctly.

(c) Those who had never carried out this task could not explain it satisfactorily. Many candidates suggested making a radial cut or just pushing the circle of paper into the funnel. The Examiners looked for two folds to make a 90° segment, then opening it out to form a cone.

(d) There were many incorrect answers here, instead of the simple “pour water through the funnel containing the precipitate”.

(e) The Examiners looked for a simple visual test such as “if there is a precipitate when a few drops of potassium carbonate are added, not enough was added at first.”

(f) The question specified that the sample must be pure, and therefore partial evaporation followed by cooling is necessary. Crystals will form but impurities will remain dissolved. “Evaporate to dryness” gained only one mark.

The answers to this question were, on the whole, very disappointing and showed a lack of practice in the skills tested.

Question 4

(a) This was usually answered correctly.

(b) This provided slightly more difficult tasks, since the scale showed temperatures at two-degree intervals.

(c) This was almost always correctly calculated.

(d) (i) Again, this was often correctly answered.

(ii) Given the usual value of 4.2 J to raise the temperature of 1 g water by 1 °C, candidates were asked to suggest the source of error in the experiment. This could be due to the loss of heat energy, incorrect timing or an incorrect mass of water used, since the thermometer, ammeter and voltmeter readings were said to be correct. A correct answer was relatively rare, but the best candidates were able to make sensible suggestions.

Candidates scored fairly well in this question, if they had experience in reading meters and thermometers and possessed some mathematical skills.

Question 5

(a) (i) Many candidates ignored the units given in the results table and recorded distances in centimetres. Some other candidates ignored the "initial level" mark and measured from the lower end of the tube, while others gave 120, or even 1200, as the first answer, instead of 12.

(ii) All three tubes were placed in the same water-bath to ensure that all had the same temperature rise. Candidates who wrote vaguely of "the same conditions" were not credited.

(iii) There were suggestions that stirring the water in the water-bath "prevented the water from boiling", or "increased the heating effect", instead of merely ensuring the same temperature throughout the bath.

(b) There were many theories about the water not being able to expand past the air, or the air dissolving in the water. The air would expand more than the water, causing increased pressure and forcing water up the expansion tube giving an inflated result. The better candidates wrote about this effect.

(c) (i) This could be answered by reference to the actual results of the experiment during which it was obvious that the liquids had expanded more than the glass, or by stating that the particles of glass were held together by greater forces than the molecules of liquids. A surprising number of candidates wrote that glass expands more than the liquids, showing ignorance of the kinetic theory and inability to reason from the experimental results.

(ii) Weaker candidates almost without exception wrote that forces between ethanol molecules were greater, showing that the idea of intermolecular forces within a liquid was not understood.

The scores for this question mirrored quite closely the mark awarded for the paper as a whole. Candidates should be prepared for this type of question, which explores, in a novel way, ideas that should be familiar to them.

Question 6

(a) (i) Only the best candidates correctly stated that the precipitate formed is white, showing that a sulphate is present.

(ii) The Examiners did not accept the answer “a gas is given off” since this is stated in the question. What is seen is bubbling or effervescence and the dissolving of the magnesium. The gas given off is tested with a lighted spill and is stated to be hydrogen. Such answers as “the lighted spill went out with a pop“ were credited, however, candidates must understand the important idea that that the gas ignites.

(iii) This time, it is what happens to the spill that is important – the flame dies. The effect of the gas on limewater was the observation that was most often correctly described in this question.

(b) (i) Better candidates correctly described the brown precipitate.

(ii) Aqueous silver (or lead) nitrate gives a white precipitate.

(c) (i) The correct answer to this part is that the precipitate is green or grey-green.

A large proportion of candidates, including whole Centres, scored very low marks for this question. Not only was the knowledge of these standard tests for ions in solution very poor, it was apparent that many candidates were unable to follow the relationship between a test, the observation and the conclusion. Although the form of this question as part of the Alternative to Practical paper is quite usual, it was clear that many teachers have not given their candidates practice in answering such questions, let alone the necessary experience of seeing the tests in the laboratory.

The “Notes for use in Qualitative Analysis” given in the syllabus, should be carefully studied by all candidates, not just those who have the opportunity to carry out practical experiments. The description of the Alternative to Practical examination should be familiar to all teachers of candidates for this paper.