PHYSICAL SCIENCE

Paper 0652/01
Multiple Choice

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

General comments on whole paper

The mean of this paper was under 50%, which once again is a decrease on the previous exam. With the exception of **Question 31**, the questions are no more testing than before, and are all questions which are likely to appear on equivalent single-subject papers. Comments on individual questions are directed towards those that the candidates found difficult.

Comments on individual questions (Chemistry)

Question 2

As many as 50% of the lower-scoring candidates chose response **D** rather than the key (**C**), implying confusion between a burette and pipette.

Question 4

Amongst the the lower-scoring candidates, response **A** was the most popular choice - but in the diagram there are no protons in the ^{1}H nucleus.

Question 5

Again, some 71% of the lower-scoring candidates (and even a third of the higher-scoring candidates) seem to have been led astray in that they chose response **C,** apparently because of the '3' in the stem of the question and the '3' in the ammonia formula.

Question 6

Across the ability range nearly a third of the candidates chose response **D**. In this question the fuel is a substance that is oxidised not the oxidiser.

Question 8

Aqueous acids have a low pH so neutralisation leads to an increase in pH. The reaction is exothermic, thus key **A**.

Question 9

It is disappointing that this question was found so hard, with nearly 40% of candidates across the ability range choosing response **A** and only 30% of the higher-scoring candidates chose the key (**D**). This question relates to the tests used to identify aqueous anions and ought to have been straightforward recall of the reagent and the precipitate.

Question 11

It was disappointing that over 40% of the lower-scoring candidates chose response **B**.

Question 12

Response **B** was the most popular choice across the ability range, but **D** is a member of the transition elements, colour in their compounds being a characteristic.

Question 13

Amongst the lower-scoring candidates, the key (**D**) was the least popular choice with response **B** the most popular. However, in the given reaction, oxygen is removed from the water and it is, therefore, reduced.

Question 14

The lower-scoring candidates appear to have guessed

Question 15

Response **B** was popular across the ability range but mild steel does rust.

Question 17

This was a fairly difficult question, with response **B** being unduly popular across the ability range. Brass contains no iron and cannot, therefore, rust. Brass is used to make screws because of this property.

Question 18

Despite the use of bold type for the words "both" and "and', some 35% of the lower-scoring candidates chose response **B**. Ethanol contains carbon and hydrogen and gives both products on combustion but hydrogen cannot as an element, give carbon dioxide.

Question 19 and 20

The lower-scoring candidates appear to have been guessing in both question. In the latter question realisation that only ethene reacts with hydrogen would have led to the key (**B**). Overall, the organic **Question** (**18**, **19** and **20**) were found demanding by the lower-scoring candidates.

Comments on individual questions (Physics)

Candidates, in general, found **Questions 23** and **28** relatively easy. Questions which had a particularly low facility (i.e. a low proportion of candidates answering correctly) were **Questions 31**, **37** and **39**. The following comments about individual questions might prove to be instructive.

Question 21

All that was required was to multiply the area by the depth of water. Over a third clearly thought that the question was asking about the total volume of the tubes.

Question 24

A similar proportion answered **D** which was the density of water, not meths.

Question 26,

A large majority knew that the extension would increase, but a lot of these did not realise there would be no extension with no load, and so answered **C**.

Question 27

Questions of this type have been asked many times on Physics papers, so should be familiar to candidates. In this instance, less than half answered correctly, with a third mistakenly thinking that the person had energy of motion when she was standing at the top of the stairs.

Question 29

A large proportion chose **B**, a statement relating to conduction.

Question 30

Nearly two-thirds thought that the still water level would be that of the bottom of the waves. If this were the case, where would the water, above this level in the waves, go to?

Question 31

Most candidates found this question difficult, with the biggest number choosing option **A**.

Question 33

Most candidates spotted that balls Q and R would have opposite charges, but only about half of the candidates worked out correctly which had which charge.

Question 34

It should not be difficult to work out which pair of values of I and R multiply to give 3.0 V, but only 39% could manage this.

Question 35

Many candidates seem to have confused the properties of components in parallel and components in series.

Question 36

The overheating of electric cables always seems to cause candidates problems. Electrical safety will repeatedly feature in papers like this one.

Question 37

A majority of candidates had little understanding of the workings of the cathode-ray tube.

Questions 38 and **39**

Both questions concerned radioactivity, which, for some reason, seems to be a poorly understood topic.

Question 40

The majority of candidates realised that the number of electrons should match the number of protons, but there were still a quarter of candidates who thought that the number of electrons = number of protons plus neutrons.

PHYSICAL SCIENCE

Paper 0652/02

Core Theory

General comments

There were some pleasing responses to many questions but it was disappointing that answers to some of the questions revealed a lack of basic knowledge and understanding. Questions which caused major problems were **Question 6** (electric circuits), **8** (radioactivity), **9** (organic chemistry) and **10** (theory and use of the cathode ray tube). Whilst **Questions 8, 9, and 10** covered areas of the syllabus in which more difficult ideas are met, the real disappointment was **Question 8**, which showed an alarming lack of understanding of very basic circuitry.

Comments on specific questions

Section A

Question 1

The whole of this question was answered well by the vast majority of the candidates and gave many a flying start. The mark that was most commonly dropped was **(b) (ii)**, although most candidates recognised that the car was slowing down (1 mark), very few stated that the deceleration was constant/uniform, and inevitably there were many who made the usual blunder of stating that 'the car decelerated at constant speed'.

(a) 20 (m/s)

(c) 30 m

Question 2

(a) There were many good attempts to balance the equation, the correct values were 2,3,4,2.

(b) Although there were some good attempts to explain the dangers of carbon monoxide it was disappointing how many candidates could say little more than the gas is poisonous.

(c) It was a surprise that many candidates were unable to move away from the gas discussed in the first two parts of the question and did not think deeply enough to realise that complete combustion produces carbon dioxide.

Question 3

The formulae for sulphur dioxide and nitrogen dioxide were known by many candidates, but a significant number, surprisingly, got into all sorts of a muddle. Too many candidates were too vague when describing the sources of the pollutant gases, it is not enough to say 'industries' or 'factories'. Specific answers such as 'burning fossil fuels' are required.

Question 4

(a) The majority of candidates had a good understanding that the distance between two wavefronts is equal to one wavelength, although it is worth emphasising that it is important that the distance referred to is clearly marked.

The calculation of the frequency caused some problems for some candidates but a significant number had sufficient understanding to successfully complete the calculation.

frequency = 2.4 Hz

(b) This section explored the basis of refraction of water waves in an everyday situation. The ideas are not easy and it came as little surprise that it was only those candidates with a fairly deep understanding were able to gain both marks.

Question 5

Much confusion was caused in this question by candidates not realising that the third metal (copper) was in ionic form.

Apart from that there were some good answers to all all parts of the question, it was particularly pleasing that many were able to construct the simple equation.

Question 6

This question revealed an alarming lack of understanding of basic circuitry, with barely any candidates showing the understanding that would be expected at this level. The conclusion drawn from this is that the vast majority do not have a real understanding of the meaning of current or resatance.

(a) This asked, 'do candidates realise that resistors in parallel have a lower total resistance (therefore higher current) than a single resistor on its own – and that three will have lower resistance than two?'

(b) Examiners now ask if candidates understand that the current is the same through the complete series circuit. This is such a basic concept that it shows that many students, although able to do simple V = IR problems, really have little appreciation of circuitry and are just going through rote exercises.

(c) The final part goes back to **part (a)** and explores whether candidates understand that in a parallel circuit the current splits, and that a meter in a single branch would only measure the current in that branch.

Question 7

(a) This question was done well with the majority of candidates gaining the first three marks, and good many recognising the electron structure, although a minority thought that the nucleon number (relative atomic mass) gave the number of electrons.

(b) The majority of candidates were able to choose a Group I element, although a considerable number went down the Group to a more reactive element.

Question 8

(a) This question was made difficult, not by the content, but because it made the candidate think to analyse the results of an experiment. Both parts were made marginally harder because the results included the random element in counting radioactive emissions. **Part (i)** was designed to be simpler in that all that was needed was to apply the basic knowledge that beta-particles are absorbed by aluminium. **Part (ii)** was difficult in that two types of radiation were emitted, one absorbed by paper and one which was only absorbed by lead. This should have led candidates to realising that alpha and gamma radiation were emitted. Although many candidates had a basic knowledge of the penetrations of the different types of radiation, they did not apply it to the results and merely gave a list .

(b) The answers here were much too vague. It is not enough to say wear protective clothing with no more detail. The idea that the emissions should not be able to penetrate was required. Likewise detail was required in the safe storage of radioactive sources – it is meaningless to say 'in a safe place'.

Question 9

It was clear that several candidates had not adequately covered the work on organic chemistry, where the work had been covered the answers were of varying quality. The best showed an in depth knowledge and understanding of the concept of saturated and unsaturated hydrocarbons and their identification, whereas others showed a much sketchier understanding.

Question 10

(a) Conceptually this was the most challenging question on the paper, nevertheless, thermionic emission is required (and important) knowledge. Very few candidates were able to show any understanding at all, the majority not even recognising that was a **K** cathode and **A** an anode.

(b) Candidates fared marginally better in this part, but often were unable to justify their choice, which made the answers little more than guesses and therefore valueless.

Question 11

(a) The majority knew that the main constituent of limestone is calcium carbonate, although it was surprising how many failed to give the correct formula.

(b) Although there were many candidates who clearly stated that calcium oxide can be made from limestone by heating it, there also a significant number who, whilst clearly knowing that basic fact, did not make it clear but simply said 'in a blast furnace'. Candidates need to spell out clearly the process that is being used. In the second part surprisingly few gave the correct answer, water, many saying hydrogen. The vast majority gave an acceptable explanation of an exothermic reaction.

(c) Too many candidates either said as a fertiliser or to make the crops grow better. The former is clearly incorrect, whilst the later has some truth in it but is too vague to gain credit.

Question 12

This question was plain bookwork, and as such it was not done at all well. Few candidates correctly traced the ray through the block to give an emergent ray parallel to the incident ray, few even got the correct refraction at the first surface (towards the normal). Similarly very few candidates had any idea of what the angles of incidence and refraction are. It is imperative that candidates learn the basic facts.

Question 13

(a) Although there were many good answers, ('to kill bacteria/micro-organisms') there were also many vague answers such as 'to purify the water'.

(b) All three of the molecules named are molecules met frequently during the course, and whilst many got two out of three they were clearly put off by having to use the same type of bonding more than once. Candidates must have the self-confidence to put down what they believe.

(c) This section caused a great deal of problems. It was disappointing that many were unable to give the correct symbol for the chloride ion, often not distinguishing it from the chlorine atom. Similarly the number of electrons in the outer shell was rarely correct, although those who got **parts (i)** and **(ii)** correct picked up on the idea that both the ion and the noble gas had a full outer shell of electrons.

PHYSICAL SCIENCE

Paper 0652/03

Extended Theory

General comments

There were some pleasing responses to many questions but it was disappointing that answers to some of the questions revealed a lack of basic knowledge and understanding.

Comments on specific questions

Section A

Question 1

(a) Whilst a significant number of candidates recognised that the net force on a body moving at constant velocity is zero it was slightly disappointing that the majority clearly did not understand this basic fact.

(b) This was generally done better although there were a considerable number of unit errors, and many did not recognise that it was a deceleration, thus the figure should have been negative, or qualified in some way.

(c) The majority of candidates were able to complete this part, although some, when using the formula F = ma, introduced unrelated accelerations or tried to convert the mass of the car to its weight.

(b) 11.0 m/s^2
(c) 13200 N

Question 2

(a) The majority of candidates had a good understanding that the distance between two wavefronts is equal to one wavelength, although it is worth emphasising that it is important that the distance referred to is clearly marked.

The calculation of the frequency caused problems for some candidates, many trying to use the relationship between frequency and periodic time, but the majority had sufficient understanding to successfully complete the calculation. The vast majority were able to go on from the calculation of the frequency to calculate the wave speed successfully.

frequency = 2.4 Hz
speed = 0.96 m/s

(b) This section explored the basis of refraction of water waves in an everyday situation. The ideas are not easy and it came as little surprise that it was only those candidates with a fairly deep understanding were able to gain both marks.

Question 3

(a) Most candidates recognised that the speed of reaction increased as temperature increased, although in the second part a considerable number lost marks because they did not relate the variants to suitable reactants. For example they would simply state 'concentration' rather than concentration of a solution.

(b) **Parts (i)** and **(ii)** were done well, although when candidates are asked to name reactants they should give the full name rather than just the chemical formula, there were also a fair number who confused chlorophyll with chloroplasts. The detail, in **part (iii)**, that an enzyme is not just a catalyst, but a protein was often missed.

(c) There were several possible answers to this question: reductuion, endothermic, gaining electrons being the most common acceptable ones. A common answer was photochemical, this was just a repetition from the stem of the question, candidates should avoid doing this.

Question 4

(a) The ray tracing was done well, with the majority of candidates completing the drawing with sufficient accuracy.

(b) The calculation was done well, although, inevitably, there were some candidates who got into a muddle on rearranging the formula and evaluating it. This really does emphasise the necessity to show working clearly and accurately. A number of candidates knew that the refractive index had something to do with sines of the angles but did not write out the full formula (simply stating sini/sinr). Without a subject this statement does not mean anything and consequently no credit can be given.

angle of refraction = 31.3°

Question 5

(a) The description of the term native was too often far too vague, comments such as 'found naturally', or 'found pure' are not precise enough, the answer needs to be in terms of being found in its elemental form. The majority of candidates knew that gold is found in its native form and a few correctly named platinum. The majority scored reasonably well, although it is important that the question is read carefully – with some candidates losing marks because they gave a property as a use.

(b) A surprising number of candidates were unable to name the ore of aluminium. The second part produced an array of answers the best recognising that aluminium foil containers are covered with a plasticized layer, equally acceptable, and much more common, was the idea of the formation of an aluminium oxide layer.

The uses of aluminium were generally acceptable and usually involved aircraft parts. The reasoning was not always well done; it is the low density that makes it suitable, and although good answers could be given in terms of comparison of its low weight compared with other metals a simple answer of it being 'light' is not enough at this level.

Question 6

(a) The majority recognised the circuit symbol as a diode, but very few understood its role in the circuit.

(b) Electromagnetic induction is a difficult concept, nevertheless it was very disappointing how few candidates were able to give an explanation of the workings of the transformer. Many thought that the current goes through the iron core, and many clearly do not even understand the difference between current and potential difference.

(c) Despite not really understanding transformer action, the majority were able to apply the formula with little difficulty.

number of turns = 90

(d) Although most candidates recognised that the charge passing is equal to the product of current and time, very few candidates converted the hours to seconds and even fewer the milliampere to ampere. Also many gave a raw answer with no working – in which case they were doubly penalised, if the answer was wrong, in that no stage marks could be awarded.

Question 7

(a) This part of the question clearly asked for a physical trend, very often the chemical trend was given, or no trend but a statement such as 'high melting point' was given. Amongst those who did correctly identify the physical trend the vast majority recognised that magnesium was the exception.

(b) As in the previous part there was a failure to identify the chemical trend.

(c) Writing the equation for the reaction between calcium and water was not done well, with only a minority recognising that the formula for calcium hydroxide is $Ca(OH)_2$. Very few failed to conclude that the universal indicator test showed that calcium hydroxide is alkaline. Answers to the final part were much more variable, many interpreting the table as saying that barium does not react with water, other expecting an explosive reaction. Even though the question clearly asked what would you see (emboldened), many candidates stated that they would 'see' hydrogen given off. They would not, they would see bubbles being formed/ effervescence/ fizzing.

Question 8

(a) Conceptually this was the most challenging question on the paper, nevertheless, thermionic emission is required (and important) knowledge. A few candidates were able to show a genuine understanding, but the majority got no further than recognising that was a **K** cathode (or negative) and **A** an anode (or positive).

(b) Candidates fared marginally better in this part. Of those who showed understanding many made the error of calculating the time interval between the end of the first signal and the beginning of the second, rather than between the beginnings of them both. Again failure to convert milliseconds into seconds was a common error in the calculation, which would gave an answer of a fraction of a metre per second – which in itself should tell candidates to check their working.

speed of sound = 320 m/s

Question 9

(a) A simple statement that was all that was required. It was very disappointing that many candidates did not make it clear that copper oxide is added in excess to ensure that all the acid is used. The second part was done very well, most candidates correctly calculating that 0.1 moles of acid were used and that the relative molecular mass of copper is 80. The stronger candidates realised that this led to 0.125 moles of copper oxide being used; a clear excess.

(b) Surprisingly, the description of the experiment to obtain clean dry crystals of copper sulphate was not done well. It is a straight forward experiment, yet many candidates failed to filter off the excess copper oxide, and those that did filter at this stage thought the copper sulphate would be caught in the filter paper. Even those who did use the filtrate rarely described well the partial evaporation of the water and subsequent washing and drying.

Question 10

This question was made difficult, not by the content, but because it made the candidate think to analyse the results of an experiment. It was made marginally harder because the results included the random element in counting radioactive emissions. It was also made challenging in that two types of radiation were emitted, one absorbed by paper and one which was only absorbed by lead. This should have led candidates to realising that alpha and gamma radiation were emitted. Although many candidates had a basic knowledge of the penetrations of the different types of radiation they merely gave a list of how well the different radiations penetrated and did not apply it to the results of the experiment.

PHYSICAL SCIENCE

Paper 0652/05

Practical Test

General comments

The paper discriminated well and there were no particular difficulties. Many candidates performed well, particularly in **Question 1**. The overall standard was marginally better than last year. All the indications were that the questions suited the time allocation.

Comments on specific questions

Question 1

Parts **(c)** and **(d)** were concerned with gathering the data and did not appear to cause a problem. The length **y** was meant to cover a good range and include a value in excess of 85 cm. Individual current values were not marked but it was necessary to have the correct trend, showing a decrease as the length increased. Values in excess of two amperes were occasionally written, suggesting bad reading from the ammeter. Such high values were not allowed. Many candidates were able to score six marks in this part of the question.

The graphs were generally good and most used sensible scales. Despite the instruction to draw a curve, a few decided to ignore this and draw a straight line. Explanations in part **(g)** varied greatly, although the majority drew a curve above the experimental one. The explanation needed to show that the candidate realised that an increased voltage would increase the current for the same wire, and therefore the value of I**R** must increase for a given length.

Question 2

Most candidates completed part **(a)** correctly. Some lost a mark in part **(b)** because they failed to indicate that the test was actually carried out. Many used a phrase such as "if a white precipitate formed etc." and lost a mark. Despite the chloride and sulphate tests being described on page 8 of the paper, some candidates failed to describe the test correctly. The most common error was the failure to use the word precipitate, a widely used term in chemistry, but clearly not understood.

The major failure in part **(c)** is the incorrect use of words such as clear and transparent. Neither word means colourless and they were not acceptable. The only acceptable term in this part of the question is 'colourless'. It may be worth pointing out that a solution of copper sulphate is clear but certainly not colourless. Many candidates failed to notice the bubbles in **(c)(ii)** and consequently were unable to appreciate the presence of a carbonate. Part **(d)** caused no problem to those who understood the word precipitate, and the terms soluble or insoluble in excess. Part **(e)** required names for **Y** and **Z** and it was necessary to associate the formation of precipitates in **(d)** with sodium hydroxide and the bubbles in **(c)** with a carbonate such as sodium carbonate.

PHYSICAL SCIENCE

Paper 0652/06

Alternative to Practical

General comments

The Alternative to Practical paper aims to test candidates' skills in laboratory procedure. A thirteen-point description of the questions can be found on page 21 of the Syllabus document. The paper set in November 2007 covers most of the points. To adequately test the whole range of abilities, each of the six questions in the paper contained easy items and also harder ones. As described below, some of the questions included subtly difficult parts that were comprehended and answered only by the most able candidates. Some candidates are to be highly commended for the very good scores awarded. The time allocated for the paper was adequate for the vast majority.

Comments on specific questions

Question 1

Candidates were invited to study the diagram of a water storage system powered by solar energy, calculate the work done by a pump and suggest improvements to the system. It may be argued that this was not a laboratory experiment, yet this type of system could easily be replicated on the laboratory bench.

(a) The solar energy trapped by the photoelectric cells was stored in a battery and used in an electric motor linked to a pump that raised water up from a well to a storage tank. **(i)** Chemical energy was converted to **(ii)** kinetic (motion) energy and then to **(iii)** gravitational potential energy in this system. Many candidates gained all three marks, but **(i)** and **(ii)** proved equally difficult for others.

(b)(i) It was easy to read the dials of the ammeter and voltmeter.

(ii) Mistakes in calculating the work done in joules from the time, the current and the voltage were rare. Those who did slip up forgot to convert 10 minutes to 600 seconds.

(iii) A different way of calculating the work done was provided here, by multiplying the mass of water by the distance raised in metres and by 10, the acceleration due to gravity in m/s^2, although these units were not given in the question. Almost every candidate gained the mark.

(c)(i) Candidates had to study the diagram, which included an electrical circuit, and suggest what might happen if the electric motor **does not** stop working. Fairly obvious answers are that the water storage tank will overflow or the well will run dry. A number of candidates suggested that the electric motor will overheat (and then stop working). This was expressly precluded by the question, so they earned no marks for this suggestion.

(ii) Following on from the answer to **(c)(i)**, a method of controlling the electric motor was asked for. A simple switch placed in the circuit would gain the mark, but the better answers suggested a sensor in the tank to operate the switch by a relay. If in part **(i)** the candidates suggested that the motor would overheat, a mark was given here for a simple way of preventing this, for example by water- or air-cooling. Those who suggested that the solar panel should be covered to stop the pump working did not earn a mark.

Question 1 was well answered by the majority of candidates.

Question 2

This question was based on the corresponding question in **Paper 5**, the Practical paper. Practical candidates had to carry out simple experiments on three solutions. Two of them, solutions **Y** and **Z** were alkaline and one, solution **X**, was acid. Also, the colours of indicator **P** were given in acid and in alkali. Finally they had to show the presence of hydroxide ions in one alkaline solution and carbonate ions in the other.

(a) Given the colours of an indicator in the three solutions, the candidates had to state whether they were alkaline or acid. Candidates who got this wrong had not read the first paragraph where the responses of indicator **P** had been given.

(b) (i), (ii) and **(iii)** This was a slightly different way of asking how to show the presence of sulphate ions in solution. Having stated that a soluble barium salt must be added, giving a white precipitate, the name of an acid containing sulphate ions had to be given. Only the better candidates scored well here.

(c) In this part of the question, candidates had to imagine that the acid, solution **X**, was being added drop by drop to a mixture of indicator **P** and the alkaline solution, **Y**.

(i) The examiners were looking for a clear statement that alkaline solution **Y** was still in excess so that the end-point of the reaction, and the colour change of indicator **P**, had not been reached. There were many vague answers, including that “no reaction takes place until enough acid has been added”.

(ii) For many candidates this part of the question was too far away from part **(a)**, so many ridiculous answers were given.

(iii) Those who had followed the logic of the question were able to state that the reaction was neutralisation.

(d) **Fig**. **2.2** gave details of tests **1** and **2** carried out on solutions **Y** and **Z**. From the results candidates were asked to deduce the names of the solutions. Test **1** showed that solution **Y** could have been sodium hydroxide or aqueous ammonia. Test **2** showed that there was a soluble carbonate present, which could be sodium or any Group I metal carbonate. Most candidates suggested that a carbonate was present but failed to name a metal, which was necessary for the mark.

Answers to **question 2** were often very disappointing and showed that many candidates had a poor knowledge and understanding of simple tests for acids and alkalis.

Question 3

This question was based on the physics part of the Practical examination, in which candidates had to record the current flowing along, and calculate the potential drop across, lengths of resistance wire. Then they plotted a graph of the potential drop against the length of wire.

(a)(i) This question corresponds to item **(e)** of the list on page 21 of the syllabus, referred to in the general comments above. Three ammeter readings were shown. The second decimal place of each reading had to be found by interpolation. The second reading was more difficult than the first; many candidates suggested 0.51 A, when it was clearly at least 0.52 or 0.53. The third reading was similar.

(ii) The formula for calculating the resistances of the 25 and 60 cm lengths of wire was given. A mark could be gained by correct calculation of one of these resistances.

(iii) Three values of **V**, the potential drop, were calculated from the resistances in ohms and the current in amps. Two marks were allowed for any two correct answers, not one mark as shown on the question paper. Errors were carried forward in marking.

(b) Candidates were asked to plot a graph of the potential drop against the length of the wire. The clear instruction to plot the length of the wire on the horizontal axis was ignored by some candidates who lost a mark. The axes had to be correctly labelled, including at least one of the units (volts or centimetres). There were errors in using consistent increments in the scales. At least four of the five points, correctly plotted, were necessary for the second mark. Then a smooth curve, passing through the origin, had to be drawn for the third mark.

There were many completely correct answers for this demanding part of the question. Whole groups of weaker candidates could not draw the graph, showing failure to cover the necessary mathematics.

(c) Finally, candidates were asked to deduce the shape of the graph when a larger voltage was applied to the circuit. The question asked "Explain how you decided this" but no answer lines were provided for the answer, although space was available, so a maximum of one mark was awarded for a line drawn and labelled, above the line drawn in **(b)**. This compensated for the change of marks in part **(a)(iii)**.

Question 4

Candidates are unlikely to have seen an experiment similar to the one described in this question. A volatile hydrocarbon having a boiling point of 80°C, contained in a hypodermic syringe, is injected into a gas syringe surrounded by a steam jacket, and the volume of vapour is measured at 100°C.

(a)(i) The gas syringe scales before and after the injection of the hydrocarbon were shown. Most candidates read these correctly.

(ii) The balance windows for the masses of the hypodermic syringe before and after injection are shown. Rather more errors in reading were made here than in part **(i)**.

(iii) The mass and volume of the vapour were found by simple subtraction.

(b) The candidates were asked to suggest the temperature of the syringe after steam had been passed into the jacket for a few minutes. This proved harder than anticipated by the examiners, so relatively few gave the answer, 100°C. Rather more suggested that it was the boiling point of the hydrocarbon, 80°C.

(c)(i) Given the fact that one mole of the vapour would be 30 dm^3, candidates were asked to calculate the mass of one mole using the data from an experiment already provided, not from their own answers to part **(a)**. This proved hard. Too many answers showed no grasp of proportionality.

(ii) From their answer to part **(i)**, candidates were now asked to choose the formula of an alkane that would fit the data. Errors were carried forward in marking, so that even an incorrect answer to **(i)** could be used to suggest an answer.

Despite the unusual nature of the question, a commendable proportion of candidates scored well.

Question 5

This question is based on a familiar experiment, the production of carbon dioxide from pieces of marble and hydrochloric acid. However, there were some subtle twists to the procedure which caught out many candidates. The experiment was to be carried out at measured temperatures and the time to collect a test-tube full of gas noted.

(a)(i) A diagram of the apparatus was shown. The names of two essential pieces of apparatus, the thermometer and the source of heat, missing from the diagram, had to be provided. Most candidates managed to give at least one of them, although the name of the famous scientist Bunsen was often misspelt.

(ii) In the diagram shown, gas was being collected in a test-tube over a trough of liquid. This liquid was not named as water (it could have been a saturated solution of carbon dioxide) so the better candidates who knew that carbon dioxide is soluble in water may have been confused. The question asked “What must the gas collection tube be filled with, before each experiment begins?” The answer could have been “the liquid in the trough”. This answer was almost never provided. The examiners were looking for a realisation that the tube must contain a liquid before gas can be trapped in it, so the answer “water” (although in practice one would not collect carbon dioxide over water) was awarded the mark. This was the answer given by most good candidates. Those who had no practical experience of collecting gas over water gave a variety of incorrect answers, including “a vacuum” or the name of a gas such as air, oxygen or nitrogen.

(iii) Far too many gave “hydrogen” as the answer here.

(b) Two digital clocks were shown, displaying two missing times for the evolution of a test-tube of gas. The times had to be recorded in seconds. A few candidates could not translate 02:05 into seconds.

(c) The question asked for one change to the method, to improve the accuracy of the experiment. Measurement of the volume of acid and the mass of marble, or the use of a gas syringe to collect the gas, were the most frequent correct answers. At least one candidate suggested collecting the gas over oil. (See **(a)(ii)** above). “Repeat the experiment and find the average times” also earned a mark.

(d) The time taken to fill a tube of gas decreased as the temperature of the acid was raised, and this misled some candidates into thinking that the reaction rate slowed down. Candidates were asked to show that the time decrease meant a faster rate of reaction. Some candidates stated that “the time taken was faster” at high temperatures, an answer that makes no sense.

(e) Finally, an explanation of **(d)** in terms of the higher kinetic energy, increased speed of movement or greater collision frequency of the reacting particles was sought. Some candidates stated that the reacting particles “vibrated more” at higher temperatures. This answer was rejected.

A completely correct answer to **question 5** was rarely seen, but there was a good proportion of thoughtful answers to the subtleties of the question.

Question 6

The experiment on which this question is based concerns the thermal conductivity of metals. Candidates were told this in the first sentence, but many lost track of the logic of the question. One end of a bar of metal was heated and a dent made in it. After cooling, a glass bead was placed in the dent and held there by wax dripped from a candle. The other end of the bar was heated in a Bunsen flame and the time taken for the wax to melt and the bead to fall off was recorded.

(a) Two digital timers were shown for candidates to read and record the missing times. The same errors occurred here as in question **5(b)**.

(b)(i) Candidates had to suggest the property of the bar that enabled a dent to be made in the heated metal. At this point many candidates confused the two stages of heating of the bar and then completely forgot the concept of thermal conductivity.

(ii) Asked which metal was hardest to dent, candidates correctly chose steel. Unfortunately for the candidates, this metal was also the metal taking the longest time to conduct heat to melt the wax. This led many candidates to try to find a reason for choosing steel from the data in the table, which was unconnected with the real reason why steel is the hardest metal; it is an alloy, whereas all the rest are pure metals.

(c) Candles are common enough for candidates to realise that wax is a hydrocarbon and from a petroleum fraction. However, animal fat and beeswax were also accepted as sources.

(d) This question asked for a reason why magnesium should not be used for this experiment. Vague answers such as “magnesium is a dangerous substance” or “it is too reactive” were not accepted. The examiners looked for a clear indication that heated magnesium reacts with oxygen and burns vigorously, or a statement that its melting point is too low.

(e) The use of equal-sized pieces of metal, or of a more controlled form of heating, were accepted as answers. “Repeat the experiment and find the average times” was also given the mark.

(f) The last question asked for a reason, based on the properties of metal and glass, why the experiment did not work with a glass bar. Candidates who had forgotten the purpose of the experiment gave answers that made no sense.

Candidates who had studied the phenomenon of conduction of heat and whose knowledge included facts about the properties of metals gave good answers to this question. Many other candidates gave poor answers.