PHYSICAL SCIENCE

Paper 0652/11
Multiple Choice

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

General Comments Chemistry

The majority of candidates chose the correct response for **Questions 2, 5** and **20**.

Candidates found **Questions 6** and **14** the most difficult.

Comments on specfic questions

Question 1

Candidates should be reminded that particles in a liquid are close together, as a significant number incorrectly chose option **D**.

Question 3

Candidates knew that the two were allotropes but those who were mistaken about their electrical properties incorrectly chose option **C**.

Question 6

Candidates knew reduction was taking place, but may not have read all of the options as option **B** was chosen more often the key **D**.

Question 10

Many candidates incorrectly chose option **B** possibly as the melting point and density were both reasonable high. However, the key **D** is a better match for a transition metal.

Question 14

The vast majority of candidates incorrectly chose option **B**, clearly not realising that water is produced when an acid reacts with a carbonate.

Question 15

Candidates should be reminded that acids lower the pH, as a small number of candidates incorrectly chose option **C**.

Question 16

Candidates who did not check the actual bonds in each structure incorrectly chose option **B** rather than the key **C**.

Question 17

A significant number of candidates incorrectly chose option **D**, not realising that natural gas is a fossil fuel.

General Comments Physics

Candidates found **Questions 22**, **28**, **32**, **34**, **38** and **40** difficult.

Comments on specific questions

Question 22

About one third of candidates realised that the acceleration due to gravity for the three balls shown would be the same (the reference in the question to dropping from a bench was aimed at reinforcing the fact that air resistance could be ignored).

Question 23

This question involved obtaining distance travelled from the area under a speed / time graph. Candidates who incorrectly chose option **D** had multiplied the maximum speed by the total time.

Question 27

In this question on energy sources many candidates believed that geothermal energy involved stored gravitational energy.

Question 28

This question on energy transfer required candidates to determine the chemical energy used by a car by adding all three amounts of energy produced. Nearly half ignored the gravitational energy gained, incorrectly choosing option **A**.

Question 32

This was one of the most difficult physics question for candidates. A majority of candidates incorrectly chose option **A**, being unaware that angles of incidence and reflection are always measured to the normal.

Question 34

Candidates had to know that aluminium is non-magnetic, so would not be affected by the magnet, but this was not well known.

Question 37

Most responses to this question about the role of the plastic insulation around a current-carrying wire were correct. A significant number incorrectly chose option **D** suggesting confusion over whether the plastic is acts as an electrical insulator or as a thermal insulator.

Question 38

This question concerned the effect of switching off the time-base of an oscilloscope. There was evidence of widespread guessing.

Question 40

Most candidates were unaware of the meaning of the term ‘nucleon’. Those who incorrectly chose option **B** may have confused it with ‘neutron’.

PHYSICAL SCIENCE

Paper 0652/12
Multiple Choice

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

General Comments Chemistry

The majority of candidates chose the correct response for **Questions 1, 5, 6, 7, 9, 18, 19** and **20**.

Question 15 was very difficult for almost all the candidates.

Comments on specific questions

Question 2

Candidates should be reminded that particles in a liquid are close together, as a significant number incorrectly chose option **D**.

Question 4

Candidates knew that the two were allotropes but those who were mistaken about their electrical properties incorrectly chose option **C**.

Question 8

Candidates knew reduction was taking place, but may not have read all of the options as option **B** was chosen more often the key **D**.

Question 12

Many candidates incorrectly chose option **B** possibly as the melting point and density were both reasonable high. However, the key **D** is a better match for a transition metal.

Question 14

Candidates should be reminded that acids lower the pH, as a small number of candidates incorrectly chose option **C**.

Question 15

The vast majority of candidates incorrectly chose option **B**, clearly not realising that water is produced when an acid reacts with a carbonate.

Question 16

A significant number of candidates incorrectly chose option **D**, not realising that natural gas is a fossil fuel.

Question 17

Candidates who did not check the actual bonds in each structure incorrectly chose option **B** rather than the key **C**.

General Comments Physics

Question 26 was very easy for almost all candidates.

Candidates found **Questions 27**, **30** and **40** difficult.

Comments on specific questions

Question 23

About one third of the candidates realised that the acceleration due to gravity for the three balls shown would be the same (the reference in the question to dropping from a bench was aimed at reinforcing the fact that air resistance could be ignored).

Question 25

This question involved obtaining distance travelled from the area under a speed / time graph. Candidates who incorrectly chose option **D** had multiplied the maximum speed by the total time.

Question 27

This question on energy transfer required candidates to determine the chemical energy used by a car by adding all three amounts of energy produced. Nearly half ignored the gravitational energy gained, incorrectly choosing option **A**.

Question 28

In this question on energy sources many candidates believed that geothermal energy involved stored gravitational energy.

Question 30

This was one of the most difficult physics question for candidates. A majority of candidates incorrectly chose option **A**, being unaware that angles of incidence and reflection are always measured to the normal.

Question 34

Most responses to this question about the role of the plastic insulation around a current-carrying wire were correct. A significant number incorrectly chose option **D** suggesting confusion over whether the plastic is acts as an electrical insulator or as a thermal insulator.

Question 39

Most candidates were unaware of the meaning of the term 'nucleon'. Those who incorrectly chose option **B** may have confused it with 'neutron'.

Question 40

This question concerned the effect of switching off the time-base of an oscilloscope. There was evidence of widespread guessing.

PHYSICAL SCIENCE

Paper 0652/21

Core Theory

Key Messages

Candidates need a sound knowledge of all the core topics in order to score well on this paper. They also need to express themselves clearly and have an understanding of basic scientific terminology as required in the syllabus.

General Comments

There were some pleasing papers but many where candidates demonstrated a need to learn the basics more thoroughly. An example is **Question 6**, where the concept of resistance is explored – candidates need to be clear about the meaning of the word *resistance* and not confuse it with *current* or *potential difference*, in order to be able to discuss how resistance varies with the thickness of a wire.

Comments on Specific Questions

Section A

Question 1

(a) (i) The majority of candidates were able to name a suitable thermometric liquid, with most giving either mercury or alcohol.

(ii) Many candidates demonstrated a need for a better understanding of the term *property* in this context. Many gave irrelevant answers. Another common error was to discuss the boiling or melting point of the liquid.

(b) (i) Many candidates had difficulty articulating their understanding of the term *fixed points* even when they clearly had some idea what it meant. When an explanation is asked for, it will help candidates to plan their answers before starting to write. A common error was to describe the fixed points as the highest and lowest temperatures that the thermometer could read.

(ii) The fixed points on the Celsius scale were quite well known, although a significant number of candidates gave the mean human blood temperature (37^{o}C) as one of the fixed points.

(c) Few candidates were able to complete this part – the class experiment of calibrating an unmarked thermometer is a useful exercise, not only in cementing the process but also in developing an understanding of temperature scales.

Question 2

(a) Knowledge of basic terms is important. While the majority clearly understood the term *Period* and were able to identify sodium as the Group 1 element in the same Period as chlorine, fewer knew the term *halogen* used to describe the Group 7 elements.

(b) Candidates must read question stems and instructions carefully. The question asked for compounds of chlorine. Many gave examples of compounds such as carbon dioxide, which do not contain chlorine.

Question 3

(a) Candidates were not expected to know the precise position of the centre of mass of the man, but needed to demonstrate an understanding that it would be on his torso and vertically above the tightrope. A common error was to place the centre of mass where the man's feet were in contact with the tightrope.

(b) (i) A few candidates were able to describe mass as the amount of matter in an object.

(ii) A significant number of candidates were able to calculate the weight of the man from his mass, A minority were confused about the relationship between mass and weight.

(c) (i) The majority of candidates were able to read the maximum speed. The most common error was to misread the scale leading to an answer of 6.5.

(ii) This is a challenging calculation. The best candidates recognised that distance travelled is equal to the area under the speed – time graph (½ maximum speed x time); the most common error was to multiply the maximum speed by the time taken.

(d) Candidates needed to demonstrate an understanding of energy types and changes. An understanding that kinetic energy is the energy due to the movement of an object was required. Although some recognised that the kinetic energy would be transferred to internal (heat or thermal) energy, very few went on to say that it would warm the man's feet and / or the ground.

Question 4

(a) (i) This was done quite well. Some candidates talked about a change to 'copper coloured'; this is not acceptable as it repeats information given in the stem.

(ii) Candidates must understand and learn the basic rules of chemical equations in order to be able to write balanced equations. In this example, the candidates were given a hint by the 'II' in the copper(II) oxide. They should also know that hydrogen is found as a diatomic element and that oxygen, being in Group VI, will take two electrons.

(iii) This was not done well, candidates failing to understand that hydrogen takes the oxygen from the copper, showing hydrogen to be more reactive than copper.

(b) Those that have had experience of reacting carbon with metals were far more likely to remember the method that they were asked to describe.

Question 5

(a) Few recognised that nitric acid was one of the two substances needed to make ammonium nitrate. More knew that ammonia or ammonium hydroxide was needed, although some made an error by putting simply ammonium.

(b) There were some good answers here, although careless arithmetic mistakes cost some candidates credit. Many answers were set-out poorly. Examiners can give credit for correct working even if, due to poor arithmetic, the final answer is wrong; they cannot do this if the method and working are not made clear.

(c) Candidates were asked to show that the percentage of nitrogen in ammonium nitrate was 35% by mass. The instruction '*to show*' means that it is not enough simply to write a few numbers to end up with the 35%, without some form of explanation.

Question 6

(a) This required candidates to draw a normal where the ray of light enters the glass block, before identifying the angles of incidence and refraction. The identification of a normal is a required precursor to the identification of the angles of incidence and refraction, as these angles lie between the ray and the normal.

(b) Candidates were told that the blue ray travelled along the same incident path – many candidates had it travelling along a totally different path. Candidates must read the question carefully.

(c) (i) There were some good diagrams showing the correct convergence of the rays; a little more care in the drawing would improve many candidates' responses. A common error was not to continue the rays as they diverged after converging to the principal focus. Every candidate should go into the examination with a suitable ruler with which to draw straight lines.

(ii) Few candidates demonstrated an understanding of focal length; those that did generally showed it with reasonable accuracy.

(d) This was a challenging question; it asked candidates to think about the problem and synthesise an explanation from the given information. A few candidates gave really good answers and there were a good number who recognised the phenomenon is due to the differing refraction of the different colours. Many misinterpreted the question, thinking that it was the edge of the lens that was coloured rather than the edges of the images; once more, careful reading is required.

Question 7

(a) Circuit diagram symbols should be familiar to all candidates; relatively few candidates recognised the symbol for the variable resistor. Of those that did recognise it, few were able to state that it was used to vary the current through (or the potential difference across) the constantan wire. Candidates were more confident in placing the voltmeter to measure the potential difference.

(b) The calculation was done quite well, with many candidates scoring two or three marks. Others demonstrate a misunderstanding of the term *resistance*, confusing it with terms such as *current* and *voltage*.

(c) Relatively few candidates recognised that two resistors in parallel have a resistance of less than either of the individual resistors. Most candidates were able to deduce the change in the current due to the change in the total resistance.

(d) Similarly, many candidates thought that the thicker wire would have an increased resistance because it was bigger. Of those who correctly stated that it would have a smaller resistance, only a very few were able to articulate why it has a smaller resistance. A common answer was, '... because thinner wires have greater resistance', which simply turns the question around. Candidates should be reminded that they need to give information in their answers additional to the information given in the stem of a question for credit.

Question 8

(a) Whilst a significant number of candidates correctly drew a gas syringe as the collecting apparatus, many candidates forgot to label their diagrams. This was not penalised provided the syringe was immediately recognisable – if it was not clear, the second mark could not be given. Candidates are reminded that they should label diagrams clearly by default.

(b) The standard test for carbon dioxide is bubbling through lime water. Many candidates described the extinguishing of a lighted splint. This is not a definitive test for carbon dioxide; it simply rules out a few other gases.

(c) (i) Virtually every candidate was able to plot the points correctly; the only common error was to miss the first point (0,0).

(ii) This was a challenging line to draw. Nevertheless there were some really good attempts. Candidates are reminded that they should not join the lines by a series of straight lines but instead draw smooth best-fit curve through all the points, recognising that the line may not go exactly through every single point. There should be no 'wobbly bits'.

(iii) Many candidates incorrectly offered the explanation that the calcium carbonate was used up, despite the statement in the early part of the question that the calcium carbonate was in excess.

(iv) The best answers showed clearly that the reaction proceeds at a faster rate, but finishes with the same volume of carbon dioxide collected. The most common error was to say that more carbon dioxide would be collected.

Question 9

(a) Most candidates knew that carbon dioxide is released when dilute sulphuric acid is reacted with sodium carbonate. Fewer recognised that copper will not react with dilute sulphuric acid and very few knew that hydrogen will be given off when it is reacted with magnesium. Candidates need to be familiar with standard reactions, preferably having observed them.

(b) Candidates answered this well.

Question 10

(a) This was answered well. A significant number of candidates gave fully correct answers and others gained some credit, usually for recognising the double bond between the two carbon atoms.

(b) The name of the alkane, butane, was not known by the majority of candidates. However, many were able to deduce the formula for it.

(c) The reactivity of ethane was well explained by many, although fewer were able to give a good reason for its value in the chemical industry, with comments such as *'it is highly reactive'* being common.

PHYSICAL SCIENCE

Paper 0652/22

Core Theory

Key Messages

Candidates need a sound knowledge of all the core topics in order to score well on this paper. They also need to express themselves clearly and have an understanding of basic scientific terminology as required in the syllabus.

General Comments

There were some pleasing papers but many where candidates demonstrated a need to learn the basics more thoroughly. An example is **Question 6**, where the concept of resistance is explored – candidates need to be clear about the meaning of the word *resistance* and not confuse it with *current* or *potential difference*, in order to be able to discuss how resistance varies with the thickness of a wire.

Comments on Specific Questions

Section A

Question 1

(a) (i) The majority of candidates were able to name a suitable thermometric liquid, with most giving either mercury or alcohol.

(ii) Many candidates demonstrated a need for a better understanding of the term *property* in this context. Many gave irrelevant answers. Another common error was to discuss the boiling or melting point of the liquid.

(b) (i) Many candidates had difficulty articulating their understanding of the term *fixed points* even when they clearly had some idea what it meant. When an explanation is asked for, it will help candidates to plan their answers before starting to write. A common error was to describe the fixed points as the highest and lowest temperatures that the thermometer could read.

(ii) The fixed points on the Celsius scale were quite well known, although a significant number of candidates gave the mean human blood temperature (37^{o}C) as one of the fixed points.

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Question 2

(a) Knowledge of basic terms is important. While the majority clearly understood the term *Period* and were able to identify sodium as the Group 1 element in the same Period as chlorine, fewer knew the term *halogen* used to describe the Group 7 elements.

(b) Candidates must read question stems and instructions carefully. The question asked for compounds of chlorine. Many gave examples of compounds such as carbon dioxide, which do not contain chlorine.

Question 3

(a) Candidates were not expected to know the precise position of the centre of mass of the man, but needed to demonstrate an understanding that it would be on his torso and vertically above the tightrope. A common error was to place the centre of mass where the man's feet were in contact with the tightrope.

(b) (i) A few candidates were able to describe mass as the amount of matter in an object.

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(ii) This is a challenging calculation. The best candidates recognised that distance travelled is equal to the area under the speed – time graph (½ maximum speed x time); the most common error was to multiply the maximum speed by the time taken.

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(ii) Candidates must understand and learn the basic rules of chemical equations in order to be able to write balanced equations. In this example, the candidates were given a hint by the 'II' in the copper(II) oxide. They should also know that hydrogen is found as a diatomic element and that oxygen, being in Group VI, will take two electrons.

(iii) This was not done well, candidates failing to understand that hydrogen takes the oxygen from the copper, showing hydrogen to be more reactive than copper.

(b) Those that have had experience of reacting carbon with metals were far more likely to remember the method that they were asked to describe.

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(a) Few recognised that nitric acid was one of the two substances needed to make ammonium nitrate. More knew that ammonia or ammonium hydroxide was needed, although some made an error by putting simply ammonium.

(b) There were some good answers here, although careless arithmetic mistakes cost some candidates credit. Many answers were set-out poorly. Examiners can give credit for correct working even if, due to poor arithmetic, the final answer is wrong; they cannot do this if the method and working are not made clear.

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(b) The calculation was done quite well, with many candidates scoring two or three marks. Others demonstrate a misunderstanding of the term *resistance*, confusing it with terms such as *current* and *voltage*.

(c) Relatively few candidates recognised that two resistors in parallel have a resistance of less than either of the individual resistors. Most candidates were able to deduce the change in the current due to the change in the total resistance.

(d) Similarly, many candidates thought that the thicker wire would have an increased resistance because it was bigger. Of those who correctly stated that it would have a smaller resistance, only a very few were able to articulate why it has a smaller resistance. A common answer was, '... because thinner wires have greater resistance', which simply turns the question around. Candidates should be reminded that they need to give information in their answers additional to the information given in the stem of a question for credit.

Question 8

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(b) The standard test for carbon dioxide is bubbling through lime water. Many candidates described the extinguishing of a lighted splint. This is not a definitive test for carbon dioxide; it simply rules out a few other gases.

(c) (i) Virtually every candidate was able to plot the points correctly; the only common error was to miss the first point (0,0).

(ii) This was a challenging line to draw. Nevertheless there were some really good attempts. Candidates are reminded that they should not join the lines by a series of straight lines but instead draw smooth best-fit curve through all the points, recognising that the line may not go exactly through every single point. There should be no 'wobbly bits'.

(iii) Many candidates incorrectly offered the explanation that the calcium carbonate was used up, despite the statement in the early part of the question that the calcium carbonate was in excess.

(iv) The best answers showed clearly that the reaction proceeds at a faster rate, but finishes with the same volume of carbon dioxide collected. The most common error was to say that more carbon dioxide would be collected.

Question 9

(a) Most candidates knew that carbon dioxide is released when dilute sulphuric acid is reacted with sodium carbonate. Fewer recognised that copper will not react with dilute sulphuric acid and very few knew that hydrogen will be given off when it is reacted with magnesium. Candidates need to be familiar with standard reactions, preferably having observed them.

(b) Candidates answered this well.

Question 10

(a) This was answered well. A significant number of candidates gave fully correct answers and others gained some credit, usually for recognising the double bond between the two carbon atoms.

(b) The name of the alkane, butane, was not known by the majority of candidates. However, many were able to deduce the formula for it.

(c) The reactivity of ethane was well explained by many, although fewer were able to give a good reason for its value in the chemical industry, with comments such as *'it is highly reactive'* being common.

PHYSICAL SCIENCE

Paper 0652/31
Extended Theory

Key Messages

In order to score well on this paper, candidates should have a sound knowledge of the basic concepts and facts in the syllabus.

General Comments

There were some very good papers with candidates showing impressive level of knowledge and understanding.

Candidates need to structure their numerical answers so that their working is laid out clearly. In questions such as **4(c)** and **6(b)**, where a calculation was asked for, but the structure of the calculation had been left to the candidate, there was often just a jumble of figures. This made it very difficult, when the final answer was incorrect, to ascertain if the candidate had followed a correct method and could be awarded credit for that.

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates were able to identify the expansion / contraction of the thermometric liquid as the relevant property.

(ii) Candidates who understood the meaning of fixed points had no difficulty with the question. However, there was a significant number who gave readings directly from the ruler. The question clearly asked for the fixed points on the Celsius scale.

(iii) There were some good answers to this question, particularly from candidates who had answered the previous question correctly.

(b) (i) The best candidates gave a good definition of sensitivity. Others confused sensitivity with accuracy or speed of response. Some of those who answered only part-correctly struggled to articulate themselves clearly. Answers defining sensitivity of the thermometer such as, '*the sensitivity of the liquid to temperature change*,' are simply repeating the question. Candidates need to ask themselves if their answers give information additional to the information given in the stem of a question – if an answer does not do this, it is unlikely to be able to gain credit.

(ii) Candidates needed to be more precise in their answers to this question. Answers such as '*Make the glass tube smaller*' could have one of several meanings: '*make the bore narrower'*, '*make the glass surrounding the bore thinner*' or '*make the tube shorter'*. The first example would increase the sensitivity of the thermometer; the second would only make the thermometer respond more quickly, and the third would have no effect.

(c) The best candidates gave good clear answers, such as electrical resistance or pressure of a gas, but many gave examples of particular types of thermometer, such as thermocouple, or bimetal thermometer.

Question 2

(a) (i) This was done well. There was a clear understanding that the information that could be used to determine the metallic nature or otherwise of an element is the number of electrons in the outer shell or the melting point.

(ii) Many candidates struggled to answer this question, despite answering the first part well. It is important that candidates read the question carefully and fully.

(iii) Once more there were some good answers to this question. Unfortunately, many candidates answered with both density and melting point; the latter does not show trend.

(b) This was done well. Some candidates gave the ionic formula, which was accepted provided it was fully correct ($Mg^{2+}Cl^{-2}$).

(c) There were some good answers in this section with candidates generally recognising the existence of delocalised electrons (or a sea of electrons). Similarly a good number described the fixed positive ions; a few candidates spoilt their answers either by referring to the ions as protons or by not emphasising that the ions were positively charged. The important point regarding the malleability of metals is that complete layers of atoms slide over one another, not just individual atoms.

Question 3

(a) The best candidates explained the *centre of mass* as the point where the mass <u>appears</u> to be concentrated; many candidates referred to the *centre of* mass as the point at which the body balances. Most candidates confused the *centre of mass* with the *centre of gravity*, or failed to include the term 'appears', saying that the whole mass is actually concentrated at that single point.

(b) This section took candidates through a straightforward moments problem. Many candidates failed to calculate the weight of the beam from its mass. Candidates need to be encouraged to set out problems in a logical manner, so that the steps in a calculation can easily be seen; this will encourage the development of understanding of what is being done.

Question 4

(a) There were some excellent answers to this, showing that many candidates were well practised in this type of practical work. Very few candidates gained credit for the washing and drying of the calcium sulfate crystals, sometimes because it was not made clear that it was the residue that was washed and dried, but mostly because this step was omitted.

(b) Many candidates struggled with the writing of balanced equations. In this case the formulae of three of the compounds had been given in the previous stem, and this should have helped greatly. Candidates may benefit from extra practice in this type of exercise. Relatively few candidates attempted to include state symbols, and of those that did, few correctly identified the correct states of the compounds.

(c) There were many good attempts to solve this problem with many candidates gaining full marks and even those who found difficulty with later parts of the question often showing an understanding of how to calculate the relative molecular masses. The setting-out of the calculation was often poor; this made it very difficult, when the final answer was incorrect, to ascertain if the candidate had followed a correct method and could be awarded credit for that

Question 5

(a) (i) This section tested candidates' understanding of refraction at a surface and was generally done quite well with many scoring the mark. Some candidates thought the ray refracted away from the normal whilst others showed refraction in the centre of the prism.

(ii) This was done very well, with many candidates scoring full marks. Some lost marks as they thought refractive index is equal to the angle of incidence divided by the angle of refraction.

(iii) Candidates needed to demonstrate an understanding of the rules regarding refraction at a boundary. Many treated the triangular prism as if it were a parallel sided block, making the emergent ray parallel to the incident ray.

(b) Even if candidates had not met dispersion by knowing, understanding and applying simple rules they should have been able to predict the path of the red ray.

Question 6

(a) The majority of candidates scored well on all three parts of this section, being able to interpret the experimental results and give the correct order for the reactivity of the elements, recognising that copper will not react with dilute hydrochloric acid and that magnesium ribbon will react more slowly than magnesium powder.

(b) Many candidates found this a challenging calculation. The best candidates had a good idea of the strategy that should be taken, and knew to start by calculating the number of moles of hydrogen given off. Unfortunately, of those who started at the right point, many failed to convert the cm^3 into dm^3 (or vice versa) and so found the number of moles of hydrogen collected as 7.5, rather than 0.0075. Another common fault was not recognising that for every mole of hydrogen collected 2 moles of hydrogen chloride were required.

Many candidates also found the calculation in **(b)(ii)** challenging. The simplest way to approach this was to recognise that there were 0.015 moles (2 x 0.0075) of hydrogen chloride in 100 cm^3 of the hydrochloric acid and therefore in 1 dm^3 there would be 0.015 x 1000/100 = 0.15 moles.

Question 7

(a) Very few candidates could explain what is meant by e.m.f., many simply repeating the question and giving *'electromotive force'* as the answer. Candidates can help themselves in the preparation for these examinations by learning simple definitions.

(b) (i) The majority of candidates were able to calculate the power produced by the battery although a minority failed to include a unit or gave an incorrect one.

(ii) The majority of candidates knew that the total charge was equal to current multiplied by time; many failed to convert the hours into seconds.

(iii) This question caused difficulty. There were several ways the correct answer could be calculated: power x time, e.m.f. x charge, or e.m.f. x current x time.

(c) That microwaves are part of the electromagnetic family and the position of microwaves in the electromagnetic spectrum were the important factors.

Question 8

(a) Whilst much of this section was familiar to candidates, very often candidates needed to be more precise, organised and complete in their answers. On a piece of extended writing, candidates need to pick out the important points and plan what they are to say. Although most candidates recognised that an oxide layer forms on the aluminium, few went on to say that this layer prevents oxygen (or water) form reaching the underlying aluminium. The most common error when explaining why steel containers are zinc plated was to confuse this with galvanising and sacrificial protection.

(b) Some candidates indicated confusion between lightness and density. Precise terminology is important.

(c) Many candidates gave a simple answer regarding the adoption of properties of the host material and the impurities and needed to add more detail, explaining the introduction of different sized atoms stopping the slippage of atomic planes.

Question 9

(a) The diagram of the a.c. generator should be familiar from practical work building a simple generator or motor using either commercial kits or cotton reels.

(b) There were some good attempts to explain why a current is generated. As stated elsewhere, candidates must pick out the important points and plan what they are to say.

(c) (i) Candidates need to remember that the primary function of a diode is to allow current in only one direction. .

(ii) Even amongst those candidates who recognised the use of the diode as a rectifier, few were able to draw a diagram showing correctly half wave rectification. A most common mistake was to show a smoothed d.c. current

Question 10

(a) Most candidates knew that in an exothermic reaction energy is released into the surroundings and some went on to explore the idea that energy is required to break bonds or energy is released when bonds are made. The best answers took the final step of comparing the two amounts of energy.

(b) The majority recognised fermentation as the method by which ethanol is manufactured, and some equally correctly named hydrolysis of ethene.

(c) The majority gave a sensible use for ethanol, although candidates must avoid saying things like, ‘As alcohol’. This is simply repeating the information in the stem; ethanol *is* an alcohol!

PHYSICAL SCIENCE

Paper 0652/32
Extended Theory

Key Messages

In order to score well on this paper, candidates should have a sound knowledge of the basic concepts and facts in the syllabus.

General Comments

There were some very good papers with candidates showing impressive level of knowledge and understanding.

Candidates need to structure their numerical answers so that their working is laid out clearly. In questions such as **3(c)** and **5(c),** where a calculation was asked for, but the structure of the calculation had been left to the candidate, there was often just a jumble of figures. This made it very difficult, when the final answer was incorrect, to ascertain if the candidate had followed a correct method and could be awarded credit for that.

Comments on Specific Questions

Section A

Question 1

(a) Few candidates tackled this well. The important point is that the number of electrons in the outer shell increases by one you go across the group.

(b) The most common error here was to think that silicon is a metal.

(c) (i) Although the majority of candidates were able to deduce the formula for calcium chloride, several lost the mark for using lower case 'c' in the symbol for chlorine in the formula.

(ii) A disappointing number of candidates described covalent bonding, despite part **(i)** which should have alerted them to ionic bonding.

(d) This section enabled candidates to apply the rules of covalent bonding in an unusual situation. Dative (covalent) bonding is not on the syllabus and Examiners were not looking for a perfect answer – just the application of the rules, as the syllabus demands. As such there were some very creditable answers.

Question 2

(a) The best candidates explained the *centre of mass* as the point where the mass appears to be concentrated; many candidates referred to the *centre of* mass as the point at which the body balances. Most candidates confused the *centre of mass* with the *centre of gravity*, or failed to include the term 'appears', saying that the whole mass is actually concentrated at that single point.

(b) This section took candidates through a calculation equating kinetic energy lost by a high jumper with gravitational potential gained in order to find the take-off speed. The first section asked candidates to find the potential energy at the top of the athlete's flight. It was done quite well, the common seen error being the use of the total height of the athlete above the ground, rather than the change in position of the centre of gravity.

The second part was answered less well, with few candidates recognising that the initial kinetic energy must be at least equal to the potential energy gained.

(c) The stronger candidates showed some understanding and scored well on this section, although some failed to recognise that this was a different jump from that in the previous parts and used their earlier figures. This demonstrates the need to read the question carefully.

(d) Few candidates were able to supply a reasonable answer to this. This is a slightly unusual way of asking the question about the inefficiency of energy conversions, or the action of air resistance on motion, but it tested the candidates' ability to think about the physics of a real situation.

Question 3

(a) This is a standard experiment with which candidates should be familiar. Many answers did not state that that the magnesium oxide must be added in excess so that all the acid is reacted. Whilst the majority correctly described filtration of the reacted mixture, they also needed to state whether it is the filtrate or the residue from which crystals are obtained. Candidates need to be aware of the importance of clearly identifying which of these two is used when describing an experimental procedure involving filtering.

(b) The equation was written quite well with many candidates scoring the first two marks. However, the state symbols caused many problems, with many omitting them entirely and other answers confusing (s) and (aq).

(c) This section was done well with many candidates scoring full marks and all but a few successfully calculating at least one of the formula masses.

Question 4

(a) The most common error was a result of candidates not reading the question carefully, and giving information about energy changes rather than the type of energy possessed by the wind. The best answers recognised that it is the kinetic energy of the moving molecules in the air which is the wind.

(b) Candidates had difficulty in articulating their understanding, even when they had some idea of the meaning.

(c) This question was done well with the majority of candidates scoring full marks.

Question 5

(a) Candidates are reminded that they need to take care while reading graphs; many candidates gave answers of 35 s, where the graph is clearly not horizontal. Although part **(ii)** was done well, there were several candidates who described the magnesium as 'dissolving' rather than reacting with the acid.

(b) Many candidates were able to draw a suitable line to show the effect of using a more concentrated acid. The most common error amongst those who did not score full marks was to indicate that more hydrogen would be produced.

(c) Very few candidates knew where to start this calculation, which of its type was fairly straightforward. The only way for candidates to develop the skills to handle this type of calculation is by constant practice.

Question 6

(a) While there were some good diagrams showing the correct convergence of the rays, a little more care in the drawing would have improved many candidates' responses. A common error was not to continue the rays as they diverged after converging to the principal focus. Every candidate should go into the examination with a suitable ruler with which to draw straight lines.

(b) Very few candidates were able to draw the ray diagram correctly.

Question 7

(a) This section required candidates to recognise that in a pure metal the positive ions are all of the same size and can easily slip past each other, whereas in an alloy the 'impurity' ions are of a different size to the host ions preventing this slippage. Many candidates gave simplistic answers referring to the adoption of properties of the host material and the impurities.

(b) The majority knew the meaning of galvanising and recognised that it is used to prevent the steel from rusting. Although most candidates had some idea of the process by which the zinc protects the iron, many explanations needed more detail, for example, expanding comments such as 'zinc is more reactive than iron/steel' to explain why this protects the steel.

(c) Most candidates recognised that the primary reason copper is used for saucepans is that it is a good conductor of heat. It is important that candidates make it clear, when they refer to a good thermal conductor, that it is the conduction of *heat* that is being referred to.

Question 8

(a) Few candidates recognised that the current in the circuit could be controlled with the variable resistor. However, the calculation in part **(ii)** was done very well, with many candidates not only scoring full marks, but also setting out their answers in a sensible, logical manner.

(b) The vast majority of the candidates thought that halving the diameter would decrease the resistance of the wire. The few who recognised that it would cause an increase in resistance fell into the trap of thinking the resistance would double, forgetting that the area would be quartered.

Question 9

(a) Most candidates recognised that unsaturated means that it there is a double bond, most of these needed to add more detail refer to the double bond being between two carbon atoms.

(b) Many candidates mentioned cracking, but then spoilt their answers by introducing another chemical process such as fermentation.

(c) Whilst a good proportion of candidates were able to give the displayed formula for ethane, few remembered that to make a polymeric chain of *n* units, *n* ethene molecules are required.

Question 10

(a) (i) The idea of electromagnetic induction is difficult and this was reflected by the answers to this question. Although many candidates referred to cutting flux, very few related this to a conductor.

(ii) Candidates also found this question challenging. Candidates needed to specify that the input current causes the magnetic field, and therefore that the constantly changing alternating current produces a changing magnetic field.

(iii) A common error was to suggest that a non-ferromagnetic metal, such as copper, is used.

(iv) The best candidates knew that the role of the core is to strengthen the magnetic field. Many candidates stated that the core conducts electricity from the primary to the secondary coil and were not awarded credit.

(b) (i) Candidates need to take care to get the ratio the right way round. Another commonly seen error was to put just a single number, rather than a ratio.

(ii) The best answers showed a good understanding of the idea of voltage transformation. Another commonly seen error was to change the frequency instead of the amplitude.

PHYSICAL SCIENCE

Paper 0652/51

Practical Test

Key message

- It is important to refer to observations or results when instructions specifically ask for an explanation using observations or results.

General comments

Candidates were able to complete this paper in the time available and the majority of candidates carried out the practical work well.

Comments on specific questions

Question 1

The experiment was usually carried out well and consequently useful sets of results were obtained. It was felt that candidates should be prepared to present their results to the same accuracy throughout a column in the table. Values to the nearest centimetre were allowed because this was adequate for graph plotting and values to the nearest millimetre were allowed since this was the accuracy of the rule provided. In part **(b) (i)** candidates were expected to calculate 1/*m* and round the answer appropriately. For this reason 0.016, 0.0142 and 0.012 were not accepted. A significant number of candidates recorded 1/60 as 0.016 recurring, which was not credited, and most of these went on to plot this as 0.016 anyway.

The graph was not done as well as usual. Common errors were not giving the units with the label for the vertical axis, poor plotting of the points caused by difficulties in reading the horizontal scale, not drawing a straight line as instructed and not drawing the best straight line. For a best fit straight line there should be a fairly equal spread of points above and below the line unless they all happen to lie on the line. It is still acceptable to ignore points that are clearly anomalous when drawing the best fit line.

For the gradient working mark, candidates had to use a triangle with a vertical distance of at least 4 cm (or a distance representing a change in *d* of at least 10 cm); this linked choosing a big enough triangle to the use of the grid when plotting the graph. Candidates should be encouraged to use large triangles when finding gradients. The most common error was not reading the coordinates correctly; very few candidates inverted the expression to calculate the gradient. A number of candidates incorrectly used the data from the table to calculate the gradient but many of these gained marks anyway as the points in question were exactly on their line. Part **(c) (iii)** was well done despite incorrect gradients resulting in values for the mass of the rule close to 300 g. Very few candidates appreciated the advantage of plotting a graph over using the average *md* value.

Question 2

A large variation in the volumes of unused soil washings was seen, reflecting the difficulty of carrying out a titration with a dropping pipette. Despite this, many candidates were able to obtain two readings within 0.4 cm^3. Those candidates who used all 10 cm^3 of soil washings each time, when no such problem was reported by the Supervisor, were unable to score the mark in **(a) (i)** and the first and third marks in **(a) (ii)**. It is worth noting that when recording values to 1 decimal place 3 cm^3 should be recorded as 3.0 cm^3. Parts **(a) (iii)** and **(iv)** did not cause any difficulties. Most candidates were able to perform the calculation in **(a) (v)**. Poor rearrangement of the equation was rare as was inappropriate rounding of the answer. Parts **(b)** and **(c)** gave fairly consistent results providing the instructions were followed carefully. Allowances were made for unusual colours when this was pointed out by the Supervisor. Some candidates gave a pH range and were only awarded marks if the extent of their stated range fitted the mark scheme. A wide range of answers was

seen for part **(d)** varying from excellent use of the results from **(b)** and **(c)**, as instructed, to wrongly treating this part as a theory question quite separate from the practical work.

PHYSICAL SCIENCE

Paper 0652/61
Alternative to Practical

Key Message

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, thermometers, stopwatches etc.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on specific questions

Question 1

This question covered aspects of radioactivity including nature, detection and half-life.

(a) A small number of candidates included the 00 when transferring the time into the correct space in in the table. The vast majority then correctly determined the counts per second.

(b) Most candidates realised that alpha and beta radiation would be stopped by a thick sheet of aluminium. The expected material for preventing the passage of gamma rays was lead; a number of candidates wrote concrete but this was not awarded credit.

(c) Most candidates identified that alpha and beta rays were deflected by a magnetic field, gaining credit. Most candidates knew the correct charges for the particles to account for their deflection in opposite directions, gaining full credit.

(d) Candidates were required to determine the half-life of a radium isotope from a radioactive decay graph. Most followed the instruction to draw lines on the graph and determined the half-life correctly. Very few used incorrect figures.

Question 2

In this question candidates are using moments to calculate the mass of a metre rule.

(a) Many candidates did not read the question properly and tried to find *d* straight away. This and the fact that many candidates read the scales incorrectly meant that few candidates gained full credit. As candidates were instructed to record their values to three decimal places, other values were not credited.

(b) Most candidates plotted their points accurately and draw good straight lines. Some candidates plotted their incorrect readings from part **(a)** and joined the points with straight lines from point to point making it look like a mountain range. Candidates are instructed to show clearly on the graph how they obtained the values that they used when finding a gradient - a tiny pencil dot or two is not 'clearly'. Examiners are expecting a triangle below the line showing the horizontal and vertical values chosen.

(c) A correct calculation using the candidates own value for the gradient was credited. A value in the region of 110 g was expected.

Question 3

The pretext of a farmer's crop being poor was just a setting for some neutralisation experiments.

(a) Examiners were expecting references to the same mass of soil or the same volume of water used, instead candidates tended to discuss practical details picked out from information already given in the question for instance the fact they were all washed or all filtered, and were not credited.

(b) The expected answer, blue to red, was often reversed.

(c) A significant number of candidates were unable to read off the values from the measuring cylinders. Large number of candidates were unable to calculate the volumes used in the experiment, i.e. subtracting their value from 10. A number of candidates were unable to calculate the average.

(d) This was done reasonably well by those candidates who had followed the instructions to part **(c)** correctly.

(e) Few candidates realised that the ions form insoluble hydroxides in alkaline solution.

Question 4

This was an experiment concerning the rate of reaction between magnesium ribbon and dilute hydrochloric acid.

(a) Most candidates coped with the inverted scale, but a few candidates recorded 50.4 and 80.6 instead of 54 and 86.

(b) Candidates had to measure the length and width of a piece of magnesium ribbon drawn for them to the nearest millimetre. Most measured carefully but very few recorded the length as **6.0** cm, most leaving it as '6'. The calculation of surface area was usually carried out successfully to give an answer of 3.6 cm^3, but some candidates forgot to take account of the two sides, despite a reminder to do so in the question, leading to the common incorrect answer of 1.8 cm^3.

(c) Many candidates calculated the correct answer of 6.9. Candidates were not penalised further for an incorrect value in part **(b)** provided the subsequent mathematical calculations were correct. However it was not uncommon to see inverted fractions or multiplication rather than division. Candidates were not awarded credit for incorrect rounding of 6.944 to 7 or 7.0.

(d) Candidates were expected to explain that the reaction rate speeds up due to reactions taking place faster at higher temperatures. Excellent answers included reference to kinetic energy and collision rate of particles. There were several candidates who related the observation to surface area increase only and could not be awarded credit.

Question 5

A candidate was given five solutions of sodium compounds and by using four tests was able to identify them. This question was set showing the candidates plan with some answers missing.

(a) Almost all candidates gained full credit for knowing that Universal Indicator turns green in a neutral solution and a purple / blue colour in alkaline solution.

(b) The sodium sulfate solution could be identified as on addition of aqueous barium chloride to one of the neutral solutions, a white precipitate was formed.

(c) The two remaining neutral solutions were tested with aqueous silver nitrate, the one forming a white precipitate was the chloride and the one without the precipitate was the nitrate.

(d) This part identified the hydroxide and carbonate. As dilute hydrochloride was added, the litmus in both solutions turned red, but the carbonate would also produce bubbles.

(e) Candidates had to name the precipitate formed in test two: barium sulfate, and explain what a precipitate was. There are many ways of defining a precipitate; the Examiners credited the idea that a solid was being formed in or from a solution. An answer of 'an insoluble solid' was also creditworthy.

Question 6

This question covered some aspects of electricity using a 240 V filament lamp.

(a) Most candidates were able to complete the energy change from electrical energy to heat and light. Fewer could name the gas inside the lamp that prevents the filament burning out, with a significant number of candidates incorrectly naming 'oxygen'. Any of the inert gases were credited or the group name.

(b) This part was omitted by a number of candidates. It may have been that candidates did not 'see' the mark allocation.

(c) Most candidates read the dials correctly and completed the table. However some candidates read 0.6 as 0.52 and 12 as 10.2. Candidates need to be reminded to carefully check dial scales.

(d) The calculation caused few problems.

(e) Few candidates realised it was the large amount of heat energy wasted by this type of bulb and that this requires an increase in electricity generated (often by the combustion of fossil fuels), that contributes to global warming.

PHYSICAL SCIENCE

Paper 0652/62
Alternative to Practical

Key Message

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, thermometers, stopwatches etc.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on specific questions

Question 1

This question followed a student finding a value for the electrical resistance of a piece of wire.

(a) Most candidates gained full credit for accurate readings of the ammeter and voltmeter dials and the subsequent calculation of resistance. Some candidates did not read the analogue scales correctly, used an incorrect number of decimal places or did not notice that the divisions on the ammeter dials were different to the divisions on the voltmeter dials. There was some evidence of careless rounding.

(b) There are a number of reasons why the calculated values for resistance of 100 cm of wire are slightly different. Experimental error and human error are too vague to gain credit, but answers showing where the error could have been, e.g. the contact was not exactly on the mark or the readings were not accurate enough were creditworthy.

(c) A more accurate value is obtained by totalling the five results and dividing by five to find the average.

Question 2

In this question candidates investigated forces acting at various angles.

(a) Most candidates were able to read the angles correctly, but were then unable to convert this to a sine value, despite the values being presented in the table.

(b) Candidates had to plot a graph of the sine value against mass, five points. However a number of candidates plotted the values from an incorrect table (and thus plotted many more points which produced a curve). Candidates should check that they following the instructions. The best straight line had to be drawn, extended to the value of sine =1.0. Most candidates suggested friction for part **(iii)** gaining credit.

(c) Candidates were asked to suggest how the results would be different if the experiment was carried out on the moon. Only the most able candidates realised that there would be no difference to the results as the reduced force of gravity still exerts an equal force on all the masses.

Question 3

In the practical examination, solid **A** and solution **B** were analysed. The same tests are used in this question. Candidates must complete the descriptions of the test, results and conclusions. Candidates should be able to recall the standard tests for cations and anions and be able to deduce the composition of a mixture of ions using these logical steps.

Generally candidates who had experience of these analytical tests scored well, but a significant number gained little or no credit.

(a) When a metal reacts with a dilute acid effervescence occurs and the gas evolved, hydrogen pops with a lighted splint.

(b) The cation in solution **B** is iron(III), therefore on addition of aqueous sodium hydroxide a red / brown precipitate should be formed.

(c) The addition of metal **A** to solution **B** changed the iron(III) to iron(II), therefore a green precipitate of iron(II) hydroxide is formed.

(d) A chloride is detected by the use of silver nitrate in the presence of nitric acid, a white precipitate being produced.

(e) The metal in solid **A** could be magnesium or zinc.

(f) The formula of the compound in solution **B** is $FeCl_3$.

Question 4

This question looked at chemical reactions that involved a change in temperature.

(a) The majority of candidates noted that experiment 1 showed a rise in temperature and experiment 2 had a fall in temperature.

For part **(iii)** the words exothermic and endothermic in the correct places gained credit. Incorrect spellings such as 'enothermic' are not creditworthy.

(b) Candidates had to name the type of bonds in oxygen (covalent) and in the white powder produced, sodium oxide, (ionic) to gain credit.

(c) Candidates had to explain how the covalent bonds were formed. Candidates who knew this part of the syllabus often gained full credit for their answer. There were a number of different ways candidates gained credit, but most often they drew a 'dot and cross' diagram of a water molecule or wrote about atoms sharing pairs of electrons.

Question 5

This question examined the effect that changing the temperature had on the rate of reaction between marble chips and dilute hydrochloric acid.

(a) Candidates had to count the number of marks made, representing bubbles seen, at various temperatures. A significant number of candidates were unable to count the number correctly.

(b) The graph was usually plotted correctly, but some candidates did not label the axes or state the units used and thus unable to gain full credit.

(c) Although many candidates realised that the rate of reaction would increase further if a higher temperature was used few suggested why this would prove difficult in this experiment.

For part **(ii)** Examiners awarded credit for comments such as 'the particles gain more energy' or 'move faster resulting in more frequent collisions'.

(d) Candidates were asked to construct a word equation for the reaction between carbon dioxide and limewater. Some tried to write a symbol equation. Few candidates knew the chemical name for limewater or that calcium carbonate was formed. Fewer still could say that the limewater turned milky due to insolubility of calcium carbonate.

Question 6

This question concerned the density of ice.

(a) Candidates were instructed to read the balance with the four ice cubes in the beaker. Some candidates did not read the question carefully and thought the balance reading was the mass of the ice alone, others had difficulty in reading the balance.

(b) The same four pieces of ice were placed in 50 cm^3 hexane in a measuring cylinder. This time candidates had to read the volume and calculate the volume of the ice. Even with a diagram of the ice and hexane in the cylinder some candidates again confused what had to be taken from what. Many candidates have trouble reading scales and a number read the scale as 90.5 instead of 91, despite being instructed to record the value to the nearest 1 cm^3.

(c) The density of the ice had to be calculated using the candidates' values of mass and volume. A correct calculation was awarded full credit. Partial credit was awarded if the correct values were used but the answer incorrect. Where a candidate divided volume by mass no credit was given.

(d) Candidates had to deduce two properties of hexane from the information provided in the question. Prior knowledge of hexane was not required to state that it is not as dense as ice, it has a melting / freezing point of less than –5 °C and it does not react or dissolve ice.

(e) Finally the properties of ice were linked to polar bears. For both parts, candidates the answers could be expressed in many ways, but a two part answer was expected. For example for part **(i)** the ice floats, so the animals have a dry habitat to live in and for part **(ii)** the ice will melt, destroying the habitat of the bears were creditworthy.