PHYSICAL SCIENCE

Paper 0652/11
Multiple Choice

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

General comments

Candidates need to read the question and all of the answer options carefully before deciding which is the correct option.

Question 1

The idea that diffusion does not involve either loss or gain of energy is well known by a majority of the candidates. A significant proportion of the candidates thought that condensation does not involve energy loss or gain and chose option **D**.

Question 2

The majority of the candidates correctly identified X and Z as the coloured dyes in the black ink. However, a number of even the better candidates thought that the black ink contained coloured dye Y and chose option **C**.

Question 3

A majority of the candidates recognise that when a substance melts over a wide range it is impure.

Question 4

Many of the candidates understand the notation used to represent an atom. The fact that a significant proportion of the weaker candidates chose option **A** suggests that there is some confusion between nucleons and neutrons

Question 5

The structure of diamond is well understood by the better candidates.

Question 6

This proved to be an easy question for the majority of the candidates.

Question 7

This proved to be another easy question for the majority of the candidates.

Question 8

The concept of exothermic reaction is well understood by the candidates.

Question 9

The idea of oxidation and reduction is well understood by the candidates.

Question 10

The fact that carbon dioxide is given off when sodium carbonate reacts with hydrochloric acid is well known by the candidates.

Question 11

The reactions of gases are well known by a majority of the candidates.

Question 12

This proved to be an easy question for the majority of the candidates.

Question 13

The fact that transition metals have high melting points and conduct electricity is well known by the candidates; however, the fact that they often act as catalysts is less well known.

Question 14

The properties of metals and non-metals are well known by a majority of the candidates.

Question 15

The properties of zinc are well known by the majority of the candidates.

Question 16

There was evidence of guesswork. Candidates should know that hydrated copper(II) sulfate is blue and turns white when it is heated and that the reaction is reversible.

Question 17

The manufacture of lime by heating limestone is not known by many of the candidates and once again there was evidence of guesswork particularly among the weaker candidates.

Question 18

The fact that members of the same homologous series have the same functional group is well known by the candidates.

Question 19

The properties of the alkanes are well known by many of the candidates.

Question 20

A significant proportion of the candidates did not recognise that ethanol is used as fuel and chose option **D**.

Question 21

Although this question on measurement was well answered, one in five candidates forgot that there were two spheres, therefore choosing option **C**. As always, careful reading of the question is advised.

Question 23

A relatively popular distractor here was **D**. Candidates choosing this failed to realise that changing volume with constant mass must also change density.

Question 24

This question concerned the calculation of density, and a significant proportion of the candidates tended to choose **C**, ignoring the need to measure mass.

Question 25

A majority of the candidates opted for **D**, failing to notice that the question asked for the extension of the spring, and not its length.

Question 32

Here option **B** was as popular as the correct **A**. Candidates needed to consider each of the values given in every option.

Question 37

Many chose distractor **C** in this question on electrical safety, perhaps confusing electrical insulation with heat insulation.

PHYSICAL SCIENCE

Paper 0652/12
Multiple Choice

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

General comments

Candidates need to read the question and all of the answer options carefully before deciding which is the correct option.

Question 1

The idea that diffusion does not involve either loss or gain of energy is well known by a majority of the candidates.

Question 2

A majority of the candidates correctly identified X and Z as the coloured dyes in the black ink however a number of candidates thought that the black ink contained coloured dye Y and chose option **C**.

Question 3

A majority of the candidates recognised that when a substance melts over a wide range it is impure.

Question 4

Many of the candidates understand the notation used to represent an atom. The fact that a significant proportion of the candidates chose option **A** suggests that there is some confusion between nucleons and neutrons.

Question 5

The structure of diamond is well understood by the better candidates.

Question 6

This proved to be an easy question for the majority of the candidates.

Question 7

This proved to be another easy question for the majority of the candidates.

Question 8

The concept of exothermic reaction is well understood by the candidates.

Question 9

The idea of oxidation and reduction is well understood by the candidates.

Question 10

The fact that carbon dioxide is given off when sodium carbonate reacts with hydrochloric acid is well known by the candidates.

Question 11

The reactions of gases are well known by a majority of the candidates.

Question 12

This proved to be an easy question for the majority of the candidates.

Question 13

The fact that transition metals have high melting points and conduct electricity is well known by the candidates however the fact that they often act as catalysts is less well known.

Question 14

The properties of metals and non-metals are well known by a majority of the candidates.

Question 15

The properties of zinc are well known by the vast majority of the candidates.

Question 16

This proved to be an easy question particularly for the better candidates.

Question 17

The manufacture of lime by heating limestone is not known by many of the candidates. A significant proportion of the weaker candidates thought that lime is manufactured by adding limestone to calcium hydroxide and chose option **A**.

Question 18

The fact that members of the same homologous series have the same functional group is well known by the candidates.

Question 19

The properties of the alkanes are well known by many of the candidates.

Question 20

A significant proportion of the candidates did not recognise that ethanol is used as fuel and chose option **D**.

Question 21

Although this question on measurement was well answered, almost one in three candidates forgot that there were two spheres, therefore choosing option C. As always, careful reading of the question is advised.

Question 24

This question concerned the calculation of density, and a significant proportion of less able candidates tended to choose C, ignoring the need to measure mass.

Question 25

Around half of the candidates opted for D, failing to notice that the question asked for the extension of the spring, and not its length.

Question 32

Here option B was quite a popular distractor. Candidates needed to consider both frequencies given in each option.

Question 37

Many chose distractor C in this question on electrical safety, perhaps confusing heat insulation with electrical insulation.

PHYSICAL SCIENCE

Paper 0652/21
Core Theory

Comments on Specific Questions

Question 1

The question tested candidates' understanding of graphical representation of the motion of a uniformly accelerating body.

(a) The majority of candidates were able to identify the regions of the graph which showed constant speed and decreasing speed. The common error was the give a single point (e.g. B) rather than the region.

(b) This caused some difficulty with many candidates marking point **A** or the origin, others took insufficient care in marking the point and it was not clear that they were referring to point **D**.

(c) The calculation of the distance travelled was not done well. Although most candidates recognised that the distance travelled is equal to speed x time, few realised that the 'speed' in the equation refers to average speed and hence the necessity of using the area under the graph to find the distance travelled.

Answer: distance = 40 m

(d) Most candidates recognised that acceleration refers to a change of speed. However, the more detailed understanding that was required to answer **(ii)** was evident in only a very few answers. Many candidates thought that the 'constant' referred to the speed.

Question 2

The question tested candidates, knowledge and understanding of the homologous series of alcohols.

(a)(i) The majority of candidates who scored this mark, quite correctly, deduced the difference between the molecules of methanol and ethanol from the relevant formulae. The most common error was to include only the extra carbon atom in the ethanol molecule, ignoring the extra hydrogen atoms.

(ii) Although there were some good answers to this section there were many who showed little understanding and gave answers such as, 'they are all alcohols.'

(iii) This section was done rather well, which shows candidates understood the basic principles that were being tested, even where they did not do themselves justice in earlier parts.

(b) The stronger candidates were able to show their understanding of the nature of alcohols and gave good displayed formulae.

(c)(i) This was generally recognised as a condenser, although a number were confused this with fractional distillation.

(ii) This was done quite well, although a number thought it was to cool the apparatus rather than the vapour.

(iii) Again there were some very good answers to this section.

(iv) Amongst those who showed an understanding of the experiment, most recognised that the temperature would increase.

Question 3

The question tested the candidates' familiarity and understanding of a simple experiment.

(a) The majority of candidates recognised that the centre of mass of the aluminium plate lay somewhere on the plumbline, although careless drawing did cause some to lose the mark.

(b) Although candidates did recognise that the plate would swing back to the rest position, very few were able to relate this to the weight of the plate creating a turning effect about the pivot.

(c) Very few candidates were able to give a clear description of the next steps in the experiment which betrayed their inexperience in doing practical work.

Question 4

(a) This was done well by many. Amonget those who failed to score a common error was to name H_2O as hydrogen oxide. At this level we would expect them to recognise that it is water (or steam).

(b)(i) Most candidates were able to explain the meaning of an exothermic reaction.

(ii) This was not understood and very few candidates scored these marks.

(c) Although most candidates scored these marks a significant number thought that a glowing , rather than a lit, splint could be used.

(d) Although some candidates recognised that there would be no reaction, very few were able to relate this to the low reactivity of copper.

Question 5

(a) Most candidates showed an understanding of wavelength, although, once again carelessness in drawing the arrow cost some the mark. Examiners must mark what they see, not what the candidates might have meant.

(b) This was done pretty well, with many candidates scoring full marks and many of the remainder getting 3 of the marks.

(c) Candidates showed little understanding of this, with the majority thinking that the waves went through the barrier, rather than reflecting from it. Even amongst those who recognised reflection – there were very few who showed an understanding that the angle of reflection is equal to the incident angle.

Question 6

(a)(i) This was done well with many candidates scoring both marks.

(ii) The majority of candidates gave two metals, rather than materials that were not metals, as the question asked. Amongst those who gave a correct answer graphite was the most common.

(b)(i) There were a significant number who did not recognise that the main constituent of brass is copper, many thinking that it is iron.

(ii) This was done reasonably well – although candidates need to take care in how they express themselves.

(iii) This was not done well. The majority of candidates did not recognise that oxygen exists as a diatomic molecule rather than a single atom. Even amongst those that recognised this very few were able to balance the equation.

Question 7

(a)(i) Very few candidates recognised that the current through resistors in series is the same through each resistor. This is a basic piece of physics and without this understanding then an understanding of electrical circuits is going to be very limited.

(ii) The majority of candidates simply assumed that the third resistor had a resistance of 4.5 Ω and added this to the 10.5 Ω and 7.5 Ω resistors. This does not show that the total resistance is 22.5 Ω.

(iii) Amongst those that showed an understanding of the earlier parts this was done well.

(b)(i) In contrast to **(a)(i)**, this was done well, with the majority of candidates gaining the mark.

(ii) This resistance could be found either by recognising that the resistance of a parallel combination is less than the resistance of either of the resistances in the combination. Or it could be found using the current value in **(i)** in the equation $r = V/I$.

Question 8

(a)(i) This question was not done well. Most candidates recognised that the chlorine atom has 17 electrons. Few gave the correct symbol for the sodium ion, most giving the sodium atom. Even fewer gave the correct number of electrons in the sodium ion, most thinking that the atom gained, rather than lost an electron.

(ii) Although some candidates scored the mark here few showed an understanding.

(iii) Most candidates gave chlorine, clearly linking it back to the earlier part and confirming their lack of understanding of the meaning of an ion.

(b)(i) There were some good clear diagrams showing the electrons in ammonia. Common errors were to fail to include the hydrogen nuclei (which gives a single atom with 8 electrons in its outer shell) and to fit in an extra hydrogen linked to the lone pair.

(ii) Once more the majority of candidates were unable to balance the equation.

(c) Most candidates were able to give the percentage of nitrogen in clean air.

Question 9

(a) This, unsurprisingly, proved to be a very challenging question. However, there were a good number of candidates who thought about the science and gave a clear logical explanation of the action of the lock.

(b)(i) Those who understood the action of the lock generally, recognised that iron is magnetically soft.

(ii) Most candidates erroneously thought that the spring pulled the bolt back out of the wall.

Question 10

(a) A fair number of candidates correctly identified bromine and iodine as the products which caused the colour changes in the experiment. A common error was to think that the bromide and iodide ions caused the changes.

(b) Relatively few candidates recognised the relative reactivity of the different halogens. Quite often candidates thought as they had the same number of electrons in their outer shells, they all had the same reactivity.

(c) Most candidates thought that the mixture would go green, a failure to recognise that fluorine is more reactive than chlorine.

(d) A common answer was ‘they are all halogens’. Surprisingly, few gave the full answer, many just saying that they all had the same number of electrons in the outer shell, which tells us they are all in the same group, but not that they are in Group 7.

Question 11

(a) There were many candidates who gave the correct answer to both parts, a common error was to think that the proton number was 111.

(b)(i) This was not done well, although many recognised that the atomic number remains unchanged, but most thought that the proton number increased, rather than decreased by one.

(ii) In line with the common error in **(a)**, many erroneously identified the daughter element as roentgenium.

PHYSICAL SCIENCE

Paper 0652/22
Core Theory

Comments on Specific Questions

Question 1

The question tested candidates' understanding of graphical representation of the motion of a uniformly accelerating body.

(a) The majority of candidates were able to identify the regions of the graph which showed constant speed and decreasing speed. The common error was the give a single point (e.g. B) rather than the region.

(b) This caused some difficulty with many candidates marking point **A** or the origin, others took insufficient care in marking the point and it was not clear that they were referring to point **D**.

(c) The calculation of the distance travelled was not done well. Although most candidates recognised that the distance travelled is equal to speed x time, few realised that the 'speed' in the equation refers to average speed and hence the necessity of using the area under the graph to find the distance travelled.

Answer: distance = 40 m

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Question 2

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(a)(i) The majority of candidates who scored this mark, quite correctly, deduced the difference between the molecules of methanol and ethanol from the relevant formulae. The most common error was to include only the extra carbon atom in the ethanol molecule, ignoring the extra hydrogen atoms.

(ii) Although there were some good answers to this section there were many who showed little understanding and gave answers such as, 'they are all alcohols.'

(iii) This section was done rather well, which shows candidates understood the basic principles that were being tested, even where they did not do themselves justice in earlier parts.

(b) The stronger candidates were able to show their understanding of the nature of alcohols and gave good displayed formulae.

(c)(i) This was generally recognised as a condenser, although a number were confused this with fractional distillation.

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(ii) This was not understood and very few candidates scored these marks.

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(b)(i) There were a significant number who did not recognise that the main constituent of brass is copper, many thinking that it is iron.

(ii) This was done reasonably well – although candidates need to take care in how they express themselves.

(iii) This was not done well. The majority of candidates did not recognise that oxygen exists as a diatomic molecule rather than a single atom. Even amongst those that recognised this very few were able to balance the equation.

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(ii) The majority of candidates simply assumed that the third resistor had a resistance of 4.5 Ω and added this to the 10.5 Ω and 7.5 Ω resistors. This does not show that the total resistance is 22.5 Ω.

(iii) Amongst those that showed an understanding of the earlier parts this was done well.

(b)(i) In contrast to **(a)(i)**, this was done well, with the majority of candidates gaining the mark.

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(c) Most candidates thought that the mixture would go green, a failure to recognise that fluorine is more reactive than chlorine.

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(ii) In line with the common error in **(a)**, many erroneously identified the daughter element as roentgenium.

PHYSICAL SCIENCE

Paper 0652/31
Extended Theory

Key messages

For success in this paper candidates need to be able to use their knowledge in unfamiliar situations.

General comments

There were a few outstanding scripts and many good quality scripts. There were fewer scripts where candidates demonstrated little knowledge or understanding of the syllabus.

Questions 1, **4** and **8** were done exceptionally well with candidates demonstrating a sound knowledge and understanding of the work. Candidates found **Question 6** and **Question 10** very challenging, with few candidates showing an understanding of the blast furnace and the reasons behind the different properties of diamond and graphite.

Comments on specific questions

Question 1

The question tested candidates' understanding of graphical representation of the motion of a uniformly accelerating body.

(a)(i) The majority of candidates knew how to find the speed of the car from the ticker tape. The most common mistake was not recognising that there are four gaps between points **B** and **C**, which was equivalent to 0.04 s, not 0.4 s, nor 0.05 s.

Answer: speed = 160 m/s

(ii) This caused some difficulty with many candidates thinking that the speed decreases rather than increases.

(b) The graph was well drawn by those candidates who could interpret the ticker tape accurately.

(c) The best answer to this was to state that the acceleration is equal to the gradient of the graph. Candidates were awarded credit if they explained clearly that the initial speed and final speed of the car could be read from the graph and the difference between the two was divided by the time taken.

Question 2

(a) The majority of candidates recognised that mixing the two solutions would lead to a rise in temperature.

(b) Most candidates had a simple understanding of the term *exothermic*. Fewer were able to give a full explanation why this reaction is exothermic; this needed to include the comparison of the energy required to break bonds and the energy released in making new bonds. The most common error was to explain that energy was released in breaking bonds.

(c) Virtually every candidate was able to give a simple way in which the rate of the reaction could be increased.

(d) About half the candidates were able to balance the equation.

(e)(i) There were some excellent answers, with the calculation set out neatly and logically. Clear and readable layout allowed those candidates who made a single arithmetic error to gain part credit.

(ii) This was done well, the most common error being the omission of the role of the chloroplasts in absorbing the energy.

Question 3

(a)(i) This presented few problems, with the majority of candidates gaining the marks. The most common error was to multiply the weight by *g*.

Answer: work done = 42 500 J

(ii) Although candidates generally had some idea of the meaning of efficiency, few recognised that 'output energy' needs to be defined as the useful work done. If the term 'useful' is not included it would mean that all machines would be 100% efficient, as all of the energy 'input' into a machine is 'output' in some form or another.

(b) Although there were some candidates who did not fully understand the term 'power', the majority successfully completed this problem.

Question 4

(a) Almost all candidates were able to deduce the order of reactivity of the metals.

(b) Candidates struggled with this question. The most common error was to state that aluminium is strong – in practise, it is not strong, and can only be used to in aircraft production when alloyed with other metals.

(c) There was a fair understanding of the structure of metals and how this leads to good conduction of electricity. Candidates need to recognise that the ions in the metallic structure are very much larger than the delocalised electrons and their diagrams, as well as being clearly labelled, should reflect this.

Question 5

(a)(i) Candidates needed to take care in drawing the diffracted waves. The best answers demonstrated the use of a compass, with the centre of each arc at the midpoint of the gap and the wavelength of the diffracted wave the same as that of the incident wave.

(ii) The majority of candidates recognised this as diffraction, although the spelling of the word was quite variable.

(iii) Candidates found it challenging to explain the movement of the boats. The important point is that diffraction causes the waves to spread around into the area where the boats are moored.

(b)(i) This was done reasonably well. A significant number of candidates tried to apply the equation $c = f\lambda$, even though there was not enough information to do this. Others failed to convert the time from minutes to seconds.

(ii) To do this question successfully, candidates needed to realise that the distance between successive crests is the wavelength.

Answer: wavelength = 25 m

(iii) Those who had negotiated **parts (i)** and **(ii)** generally answered this correctly.

Answer: speed = 1.25 m/s

Question 6

(a) Less than half the candidates recognised that malachite is an ore of copper.

(b)(i) A minority of candidates recognised that the reason carbon can be used to extract iron from its ore is that it is more reactive than iron.

(ii) Only a few candidates demonstrated an appreciation of the chemistry of the blast furnace.

(iii) The equation caused significant difficulty, with many thinking that iron forms a diatomic molecule.

(c) A reasonable number of candidates recognised that the role of limestone in the smelting of iron is to remove impurities.

(d) Relatively few candidates were able to give the word equation for the decomposition of calcium oxide. Although many recognised this as a decomposition reaction, very few gave the full description, ‘thermal decomposition’.

Question 7

(a) The majority of candidates demonstrated an understanding that the sum of the potential differences across the resistors in a series circuit is equal to the e.m.f. of the supply.

Answer: p.d. = 1.2 V

(b)(i) Most candidates were familiar with the formula necessary to calculate the energy dissipated in the resistor, although a minority forgot to convert the time from minutes into seconds.

Answer: energy = 504 J

(ii) Candidates needed to apply their understanding that the current in a series circuit is the same all the way round the circuit.

Answer: current in $\mathbf{R_B}$ = 0.40 A

Answer: current in $\mathbf{R_B}$ = 0.40 A

(c)(i) This was generally done quite well, although there were candidates who failed to invert from the equation; $1/R_{total} = 1/R_1 + 1/R_2$. Candidates who showed the correct working up to this point were able to get the first mark; those that gave the wrong formula (i.e. $R_{total} = 1/R_1 + 1/R_2$) were denied both marks.

Answer: resistance = 4.5 Ω

(ii) Most candidates had no problem with this calculation.

Answer: current = 2.0 A

(iii) This was also done well. The most common mistake was to divide the time by 60.

Answer: charge = 60 C

Question 8

(a) The majority of candidates spotted the trend and were able to give a sensible estimate of the radius of the strontium atom.

(b) Most candidates recognised that barium, being a Group II element, would have two electrons in its outer shell. The occasional candidate thought it would have six.

(c) This was also done well, with many candidates scoring 3 or 4 marks. Points that were often missed were: the electrons used to fill the outer shell of the chlorine atoms comes from the magnesium atom; the correct charges on the ions (Mg^{2+} and Cl^-); and that two chlorine atoms are ionised by a single magnesium atom.

In addition, a small number of candidates described the bonding as covalent, with the atoms sharing electrons.

Question 9

(a) About half of the candidates were able to identify the components.

(b) Very few candidates were able to give a reasonable outline as to why the e.m.f. is induced.

(c)(i) Many candidates had some idea that in a.c. the current continuously changes direction. Relatively few were able to go further than this.

(ii) Most candidates showed some understanding that the current varied. Many were careless with their drawing and consequently lost marks.

The question asked for two complete cycles; candidates needed to draw at least two complete wavelengths to score full marks. The wavelength needed to be consistent for both cycles, as did the amplitude.

Question 10

(a) Candidates found this question challenging.

In **part (i)**, few candidates referred to the strong covalent bonds between atoms in both diamond <u>and</u> graphite when explaining the hardness of diamond and graphite. A larger proportion referred to the weaker bonds <u>between layers</u> in graphite, and that in graphite, atoms are strongly bonded to three other carbon atoms but in diamond they are bonded to four other carbon atoms.

In **part (ii)** very few candidates recognised that the presence of strong bonds in each structure meant that a lot of energy is needed to break them.

(b) Few candidates recognised this as a (catalytic) addition reaction. Many candidates stated that the process is fermentation.

(c) Most candidates were able to draw the electron arrangement in ethene.

PHYSICAL SCIENCE

Paper 0652/32
Extended Theory

Key messages

For success in this paper candidates need to be able to use their knowledge in unfamiliar situations.

General comments

There were a few outstanding scripts and many good quality scripts. There were fewer scripts where candidates demonstrated little knowledge or understanding of the syllabus.

Questions 1, **4** and **8** were done exceptionally well with candidates demonstrating a sound knowledge and understanding of the work. Candidates found **Question 6** and **Question 10** very challenging, with few candidates showing an understanding of the blast furnace and the reasons behind the different properties of diamond and graphite.

Comments on specific questions

Question 1

The question tested candidates' understanding of graphical representation of the motion of a uniformly accelerating body.

(a)(i) The majority of candidates knew how to find the speed of the car from the ticker tape. The most common mistake was not recognising that there are four gaps between points **B** and **C**, which was equivalent to 0.04 s, not 0.4 s, nor 0.05 s.

Answer: speed = 160 m/s

(ii) This caused some difficulty with many candidates thinking that the speed decreases rather than increases.

(b) The graph was well drawn by those candidates who could interpret the ticker tape accurately.

(c) The best answer to this was to state that the acceleration is equal to the gradient of the graph. Candidates were awarded credit if they explained clearly that the initial speed and final speed of the car could be read from the graph and the difference between the two was divided by the time taken.

Question 2

(a) The majority of candidates recognised that mixing the two solutions would lead to a rise in temperature.

(b) Most candidates had a simple understanding of the term *exothermic*. Fewer were able to give a full explanation why this reaction is exothermic; this needed to include the comparison of the energy required to break bonds and the energy released in making new bonds. The most common error was to explain that energy was released in breaking bonds.

(c) Virtually every candidate was able to give a simple way in which the rate of the reaction could be increased.

(d) About half the candidates were able to balance the equation.

(e)(i) There were some excellent answers, with the calculation set out neatly and logically. Clear and readable layout allowed those candidates who made a single arithmetic error to gain part credit.

(ii) This was done well, the most common error being the omission of the role of the chloroplasts in absorbing the energy.

Question 3

(a)(i) This presented few problems, with the majority of candidates gaining the marks. The most common error was to multiply the weight by *g*.

Answer: work done = 42 500 J

(ii) Although candidates generally had some idea of the meaning of efficiency, few recognised that 'output energy' needs to be defined as the <u>useful</u> work done. If the term 'useful' is not included it would mean that all machines would be 100% efficient, as all of the energy 'input' into a machine is 'output' in some form or another.

(b) Although there were some candidates who did not fully understand the term 'power', the majority successfully completed this problem.

Question 4

(a) Almost all candidates were able to deduce the order of reactivity of the metals.

(b) Candidates struggled with this question. The most common error was to state that aluminium is strong – in practise, it is not strong, and can only be used to in aircraft production when alloyed with other metals.

(c) There was a fair understanding of the structure of metals and how this leads to good conduction of electricity. Candidates need to recognise that the ions in the metallic structure are very much larger than the delocalised electrons and their diagrams, as well as being clearly labelled, should reflect this.

Question 5

(a)(i) Candidates needed to take care in drawing the diffracted waves. The best answers demonstrated the use of a compass, with the centre of each arc at the midpoint of the gap and the wavelength of the diffracted wave the same as that of the incident wave.

(ii) The majority of candidates recognised this as diffraction, although the spelling of the word was quite variable.

(iii) Candidates found it challenging to explain the movement of the boats. The important point is that diffraction causes the waves to spread around into the area where the boats are moored.

(b)(i) This was done reasonably well. A significant number of candidates tried to apply the equation $c = f\,\lambda$, even though there was not enough information to do this. Others failed to convert the time from minutes to seconds.

(ii) To do this question successfully, candidates needed to realise that the distance between successive crests is the wavelength.

Answer: wavelength = 25 m

(iii) Those who had negotiated **parts (i)** and **(ii)** generally answered this correctly.

Answer: speed = 1.25 m/s

Question 6

(a) Less than half the candidates recognised that malachite is an ore of copper.

(b)(i) A minority of candidates recognised that the reason carbon can be used to extract iron from its ore is that it is more reactive than iron.

(ii) Only a few candidates demonstrated an appreciation of the chemistry of the blast furnace.

(iii) The equation caused significant difficulty, with many thinking that iron forms a diatomic molecule.

(c) A reasonable number of candidates recognised that the role of limestone in the smelting of iron is to remove impurities.

(d) Relatively few candidates were able to give the word equation for the decomposition of calcium oxide. Although many recognised this as a decomposition reaction, very few gave the full description, ‘thermal decomposition’.

Question 7

(a) The majority of candidates demonstrated an understanding that the sum of the potential differences across the resistors in a series circuit is equal to the e.m.f. of the supply.

Answer: p.d. = 1.2 V

(b)(i) Most candidates were familiar with the formula necessary to calculate the energy dissipated in the resistor, although a minority forgot to convert the time from minutes into seconds.

Answer: energy = 504 J

(ii) Candidates needed to apply their understanding that the current in a series circuit is the same all the way round the circuit.

Answer: current in $\mathbf{R_B}$ = 0.40 A

Answer: current in $\mathbf{R_B}$ = 0.40 A

(c)(i) This was generally done quite well, although there were candidates who failed to invert from the equation; $1/R_{\text{total}} = 1/R_1 + 1/R_2$. Candidates who showed the correct working up to this point were able to get the first mark; those that gave the wrong formula (i.e. $R_{\text{total}} = 1/R_1 + 1/R_2$) were denied both marks.

Answer: resistance = 4.5 Ω

(ii) Most candidates had no problem with this calculation.

Answer: current = 2.0 A

(iii) This was also done well. The most common mistake was to divide the time by 60.

Answer: charge = 60 C

Question 8

(a) The majority of candidates spotted the trend and were able to give a sensible estimate of the radius of the strontium atom.

(b) Most candidates recognised that barium, being a Group II element, would have two electrons in its outer shell. The occasional candidate thought it would have six.

(c) This was also done well, with many candidates scoring 3 or 4 marks. Points that were often missed were: the electrons used to fill the outer shell of the chlorine atoms comes from the magnesium atom; the correct charges on the ions (Mg^{2+} and Cl^{-}); and that two chlorine atoms are ionised by a single magnesium atom.

In addition, a small number of candidates described the bonding as covalent, with the atoms sharing electrons.

Question 9

(a) About half of the candidates were able to identify the components.

(b) Very few candidates were able to give a reasonable outline as to why the e.m.f. is induced.

(c)(i) Many candidates had some idea that in a.c. the current continuously changes direction. Relatively few were able to go further than this.

(ii) Most candidates showed some understanding that the current varied. Many were careless with their drawing and consequently lost marks.

The question asked for two complete cycles; candidates needed to draw at least two complete wavelengths to score full marks. The wavelength needed to be consistent for both cycles, as did the amplitude.

Question 10

(a) Candidates found this question challenging.

In **part (i)**, few candidates referred to the strong covalent bonds between atoms in both diamond <u>and</u> graphite when explaining the hardness of diamond and graphite. A larger proportion referred to the weaker bonds <u>between layers</u> in graphite, and that in graphite, atoms are strongly bonded to three other carbon atoms but in diamond they are bonded to four other carbon atoms.

In **part (ii)** very few candidates recognised that the presence of strong bonds in each structure meant that a lot of energy is needed to break them.

(b) Few candidates recognised this as a (catalytic) addition reaction. Many candidates stated that the process is fermentation.

(c) Most candidates were able to draw the electron arrangement in ethene.

PHYSICAL SCIENCE

Paper 0652/51
Practical Test

General comments

If a question asks for a colour to be recorded, then this is the required answer, rather than any other descriptions of the mixture.

Comments on specific questions

Question 1

In part **(a)**, a variety of acceptable headings for columns two and three in Table 1.1 were seen. The heading for column one was often omitted. When time was given for column one, it was rare to see incorrect units.

In part **(b)**, most candidates were able to carry out this experiment in full and produce suitable observations. 'Transparent' was accepted as an observation in this context however candidates should use the term 'colourless,' or a stated colour.

Part **(c)** produced a full range of marks because 'diffusion' was rarely stated.

For **(d)** the idea of a control was not fully understood. Better candidates suggested the idea of eliminating water as a cause of the blue-black colour.

In parts **(e)(i)** and **(ii)** a relatively small number of candidates realised that the iodine would change to brown in the bag.

In part **(e)(iii)**, the test for reducing sugars was well known.

Question 2

Some candidates confused cation and anion in part **(a)** despite the tests being stated in the Notes for Qualitative Analysis on the last page of the examination paper. It was pleasing that more candidates were specifically observing precipitates than in previous sessions. A number of candidates recorded a positive test for a chloride. **J** was a sulfate so may have given a slight white precipitate with silver nitrate solution but not the heavy white precipitate produced by a chloride.

In part **(b)(i)**, an acceptable description of the gas observed was usually seen, often as 'bubbling'. Few candidates recorded the appearance of the resulting solution although many candidates identified the gas as hydrogen along with the appropriate test.

In part **(b)(ii)**, care was needed when adding sodium hydroxide solution to the solution of zinc ions. Consequently some candidates did not observe the white precipitate although most realised that the cation was zinc.

The displacement reaction in **(c)** worked well. The appearance of the filtrate varied enormously depending on the relative quantities used. Again, in **(c)(ii)**, the outcome depended on relative quantities. Allowance was made for this in certain circumstances.

In part **(d)**, most candidates recognised this as a displacement reaction.

Question 3

This was a relatively simple practical to carry out. It is important for candidates to read all instructions carefully to establish the level accuracy for the recording of results.

The length in part **(a)(i)** had to be 60.0 ± 0.2, subject to the Supervisor's report.

In **(a)(ii)**, a sensible precaution often involved viewing close-up and at 90°.

Good results were often seen in part **(b)** which incorporated an accuracy mark.

Dividing by twenty in **(c)** was carried out successfully in most cases. The squaring and rounding to one decimal place caused problems for many.

For the graph in **(d)**, candidates were asked to include the origin on the axes. Those who did realised that the origin was effectively a point and consequently drew a better straight line. Many candidates did not indicate on their graph the values chosen to calculate the gradient. The wording of the question for a gradient has been kept the same to help candidates. A significant number of candidates calculated the gradient incorrectly as x/y.

Part **(e)** incorporated an accuracy mark.

In **(f)**, candidates are still reluctant to look at the spread of their results around the best-fit straight line and discuss this in terms of experimental error.

PHYSICAL SCIENCE

Paper 0652/52
Practical Test

General comments

When suggesting the values for a variable in a plan, it is important to provide a suitable number of values (usually five) over a realistic and acceptable range.

Comments on specific questions

Question 1

This was a slightly challenging exercise but the majority of candidates carried it out well and generated useful results with evidence that the reaction was slowing at the end.

In parts **(a)** and **(b)**, the table was completed well. Some candidates had not realised that results had to be recorded to 0.1 cm.

The plotting of points for the graph in **(c)** was generally done well; at least half of the grid should be used on both axes. There were many well drawn curves or straight lines. There were some curves which joined all the points and this was unlikely to be correct.

It was pleasing that many candidates for part **(d)** suggested that extra readings should be taken to provide more points to check the curve.

In part **(e)**, the test for oxygen was well known by those who had read and understood the stem of this question.

Part **(f)(i)** was well answered however it was rare to see an adequate number and range of temperatures for part **(f)(ii)**.

Question 2

Generally candidates carried out this thermochemistry exercise well producing meaningful results. The practical skill needed for making up solutions of different concentrations is probably rarely practised. Consequently some odd results were seen.

This reaction is a displacement reaction and copper was produced. Some candidates did not describe the colour of the solid after the reaction and so did not identify copper in **(a)(iii)**.

The plotting of points in part **(b)** was done well. The best-fit straight line should give an even scatter about the line. Some candidates did not draw the line through the origin as requested.

Part **(b)(iii)** required the candidate to consider how close the points (data) were to the line (direct relationship). This was not done well.

In part **(c)**, most candidates correctly recognised this as an exothermic reaction. Some suggested that it was a displacement reaction which is true but did not answer the question.

A range of acceptable responses was seen in **(d)**. A digital thermometer is not necessarily more accurate so needs to be accompanied by more detail, such as ‘a digital thermometer accurate to 0.1 °C’.

Question 3

In part **(a)**, *a* and *b* were measured well although not always recorded to 0.1 cm as requested. Most candidates knew how to ensure that the centre of the modelling clay was directly above the 15.0 cm mark. Not all candidates were able to communicate this effectively even with the help of a diagram.

Mass *M* in part **(b)** was not always recorded to the nearest gram. This did not affect the ability to score subsequent marks.

In part **(c)**, mass *m* was usually calculated correctly. Sometimes too many significant figures were used.

Most candidates scored the marks in parts **(d)** **(e)** and **(f)**. Occasionally an inappropriate number of decimal places was used for recording the distances.

Many candidates were able to suggest one reason in part **(g)**. Two reasons were seen rarely.

PHYSICAL SCIENCE

Paper 0652/61
Alternative to Practical

Key messages

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 to be able to describe experimental procedures. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, stopwatches, rulers, thermometers etc. and record the values to the requested number of significant figures. Candidates need to be able to plan experiments and discuss the presentation of results.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of a very high standard, although sometimes not to the accuracy requested. Describing experimental detail proved to be very difficult for many candidates. The standard of graph drawing was generally high but chosen scales need to cover at least half of the grid and where a straight line is appropriate, it should be drawn with a ruler and be one single line of constant gradient. Designing an experiment proved to be very difficult for many candidates.

Comments on specific questions

Question 1 – Movement of molecules through a membrane

(a) Candidates found this quite difficult. The first column unit was often given as m or secs or 2 mins and the second column was frequently given as results which is too vague to be creditworthy.

(b) More able candidates gained some credit, usually for the reaction of starch and iodine. Many candidates thought that starch moved out of the membrane or that the starch was breaking down into sugar which then moved out of the membrane.

(c) (i) Few candidates gave a correct colour; the most common responses were colourless and blue-black.

(ii) The majority of candidates repeated the question that the starch breaks down into sugar without appreciating that all of the starch would be broken down.

(iii) Benedict's reagent and its associated colour changes were quite well known although heating was frequently omitted. Common incorrect responses included iodine, biuret, blue and brown.

Question 2 – Identification of ions

(a) (i) The test was quite well known. Common incorrect responses included nitric acid, barium nitrate and electrolysis. Of those that gave the correct reagent, the colour was often correct although brown was quite common but precipitate was often omitted.

(ii) The test was not very well known. Common incorrect responses included sodium hydroxide, silver nitrate and electrolysis. Of those that gave barium nitrate, few also added nitric acid and a significant number thought only nitric acid was the reagent.

(b) (i) Most candidates gained credit. A few thought the gas produced was oxygen.

(ii) The test for zinc was not well known. The most common incorrect response was bubbles. Of those that gave the white precipitate, few had it redissolving in excess.

(c) (i) The most common incorrect response was dissolving but others included: reaction with sodium hydroxide, destruction of the cation and zinc being used up.

(ii) Thermal and combustion were quite common incorrect responses.

Question 3 – Period of a pendulum

(a) (i) The majority of candidates measured the length correctly. Common errors: recording the length in mm, 7 and 0.65.

(ii) Common incorrect responses included giving the same answer as **(a)(i)** or dividing by 10.

(iii) Candidates found this difficult with many repeating the question, ‘measure from the clamp to the centre of the bob’, or, ‘measure accurately’.

(b) Many candidates rounded the reading correctly but omitted the .0 when recording it.

(c) Many candidates calculated the two values correctly but then didn’t record the values commensurate with the significant figures of the values already printed in the table.

(d) A significant number of candidates did not use more than half of the printed grid. Many candidates plotted the last four points correctly but plotted the first point at 60. Some drew a line between the four points clearly in a straight line and then joined this line to the anomalous point.

(e) Able candidates gained credit but many stated only that the line was a straight line which was not creditworthy as the question asked for a straight line to be drawn.

Question 4 – Effect of acid on seedling growth

(a) (i) Most candidates measured the lengths correctly.

(ii) The vast majority of candidates calculated the averages correctly.

(b) (i) Many candidates labelled the bars on the x-axis but didn’t give a unit for the height on the y-axis and also many did not use at least half of the grid. The plotting of the points was usually correct but a few plotted the average results.

(ii) Common non-creditworthy responses included: for accuracy, to compare and reliability.

(c) Many candidates gained partial credit for the stunted growth but only the most able appreciated the quantitative link between the variables. A small number thought that the acid either killed or increased the growth of the seedlings.

(d) A significant number of candidates incorrectly gave the answer as water.

Question 5 – Investigating five gases

(a) The majority of candidates gained credit but a few thought hydrogen or carbon dioxide.

(b) (i) The names of suitable indicators were well known by most candidates but many didn't give any observations or only gave one. There was also some confusion between the colours of litmus and the colours of Universal Indicator. A few candidates only discussed pH numbers with no reference to an indicator or a meter.

(ii) Many thought that either red litmus staying red or blue litmus staying blue was an indication of neutrality and a significant number gave litmus going green. Quite a few candidates gave Universal Indicator with no result or gave cobalt chloride paper going pink.

(c) Candidates found this very difficult. Many poured water from the bowl into the tubes or poured the tubes into the bowl containing water.

(d) Few correct responses with even fewer gaining full credit. The most common responses were hydrogen and oxygen with some nitrogen.

(e) Many candidates gained credit although a few described the test for hydrogen or oxygen.

Question 6 – Resistance

(a) A common error was to reverse the meters.

(b) Many candidates read the current correctly although 0.7 and 0.70 were quite common responses. The voltage proved to be more difficult. Common responses included 1.2, 1.25, 1.3, 1.4, 1.6 and 1.8.

(c) V/A was a common response for the unit and a significant number of candidates rounded the value for wire M incorrectly.

(d) Candidates often failed to gain any credit. Many repeated the experiment in the question but only for one more length of wire. Few chose a control variable and most presented the results in a table.

PHYSICAL SCIENCE

Paper 0652/62
Alternative to Practical

Key messages

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 a variety of measuring instruments and record the values to the requested accuracy. Candidates should have performed identification tests on the range of substances detailed in the syllabus.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. The standard of graph drawing was generally high although candidates need to remember to include units on the axes and to draw smooth curves with a single line. Knowledge of identification tests for ions was limited.

Comments on specific questions

Question 1 – Percentage Composition of Calcium Carbonate

(a) Many candidates read the scale correctly although a significant number did not record the value to 0.05 g.

(b) The most able candidates gained credit. The most common incorrect responses were less dense than air or lighter than air.

(c)(i) Most candidates read the scale correctly.

(ii) The majority of candidates performed the calculation correctly.

(d)(i) Many candidates completed the diagram correctly. A significant number left a gap where the point of the filter paper should be.

(ii) Many candidates performed the calculation correctly.

(iii) Many candidates subtracted the values correctly but a significant number added the values.

(e)(i) Many candidates performed the calculation correctly.

(ii) Many candidates performed the calculation correctly.

(f) The most able candidates gained credit. Some candidates thought the reason was that the mass of magnesium carbonate was also included. A significant number of candidates omitted this part.

Question 2 – Effect of concentration on temperature change in a reaction

(a) (i) The most common incorrect response was Fe(III).

(ii) Most candidates read the thermometer scales correctly but a significant number recorded T_i as 23 rather than 23.0.

(b) (i) Almost all candidates subtracted the values correctly.

(ii) Many candidates chose an appropriate linear scale and plotted the points correctly. Quite a few found drawing the line more difficult. Many joined the points rather than drawing a straight continuous line with a ruler and a significant number did not put the line through the origin.

(iii) Many candidates stated that the line was a straight line which was not creditworthy as the question asked for a straight line to be drawn.

(c) (i) Common incorrect responses included combustion and endothermic.

(ii) Non-creditworthy responses included same initial temperature and stirring.

Question 3 – Determining mass by moments

(a) Candidates should be encouraged to gain more experience of answering this type of question. Many repeated the question answering with 'put the centre of the cube on the 15 cm mark'.

(b) (i) Most candidates read the scales correctly. A small number recorded 30.6.

(ii) The majority of candidates subtracted correctly.

(iii) The majority of candidates subtracted correctly.

(c) (i) Common incorrect responses included: 84.43, 84.40 and 84.

(ii) Many candidates calculated correctly but then gave their answer to too many significant figures. A small number inverted the division.

(d) Candidates found this very difficult. Incorrect responses included clay contains air, clay contains water, the density of the clay will change and the distances are inaccurate.

(e) Many candidates had both distances either increasing or decreasing.

Question 4 – Refraction

(a) (i) Few candidates gained credit. A significant number omitted this part or stated that the ray needs to go through the container.

(ii) The more able candidates appreciating the rays would be parallel. Many candidates drew a single line continued from the incident ray.

(iii) The majority of candidates gained credit. Some recorded 11 cm.

(iv) Many candidates put the labels on the ray leaving the water.

(v) This was well done.

(vi) 'As ray passes through water' was a common response.

(b) (i) Many candidates appreciated that this was reflection and gained full credit. A significant number of candidates drew the ray refracted.

(ii) A wide variety of angles were given.

Question 5 – Identification of solutions

(a) (i) The majority of candidates gained credit. Nitric acid was seen quite often.

(ii) More able candidates gained credit. Some gave either white or precipitate but not both and some just said that it reacted.

(iii) The chloride test was not well known. The majority of candidates used litmus or another indicator or sodium hydroxide or limewater.

(iv) The test was well known but a significant number of candidates thought the precipitate would redissolve. A significant number thought the precipitate was white.

(b) (i) Many candidates chose an appropriate piece of apparatus. Beaker was the most common incorrect response.

(ii) Indicator names were well known but many confused the colours of litmus and Universal Indicator. A significant number gave a named indicator paper rather than a solution.

(iii) Most able candidates gained credit. The majority thought that the volume of solution was already known and so the indicator was not needed or that it was there as a control.

(iv) Filter and crystallise were the two most popular non-creditworthy responses.

Question 6 – Conduction of heat

(a) Most candidates read the scales correctly.

(b) Many candidates chose scales which covered more than half of the grid and gained credit for the points and the curves but many did not include units on the axes. Some of the curves were feathery with more than one line.

(c) (i) Of those candidates who chose **G,** many repeated the question rather than explaining their choice in terms of temperature. Many candidates chose **F**.

(ii) Many candidates gained credit as error carried forward from **(c)(i)**. A significant number chose two metals or two non-metals.

(d) Common incorrect responses included 0°C, 10°C and 60°C.