PHYSICAL SCIENCE

Paper 0652/11
Multiple Choice Core

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

General comments

There were some questions that were answered well by many candidates. These included **Questions 25** and **37**. In **Question 25**, most candidates were able to apply the inverse relationship between power and time. The questions that were only answered well by stronger candidates tended to involve more than simple recall or calculation. There was often something else that needed to be considered and those candidates who were able to apply their understanding to unfamiliar situations were usually able to answer these questions correctly.

The topics in the syllabus need to be learnt and understood and one part of understanding is realising what is meant by an expression or equation and how it applies in more general cases.

Comments on specific questions

Question 1

Stronger candidates answered this correctly. Many weaker candidates thought that the particles in gaseous ammonia are in fixed positions and chose option **A** or option **B**.

Question 2

A majority of candidates thought that a measuring cylinder is used to measure an exact volume.

Question 3

Stronger candidates recognised that a pure substance produces a single spot on a chromatogram.

Question 4

The difference between neutrons and nucleons was not widely known by many candidates.

Question 5

The difference in properties of ionic and covalent compounds was well known by stronger candidates.

Question 6

The formula of carbon dioxide was well known by most candidates but the formula of chlorine was less well known even by stronger candidates. Many candidates did not recognise the difference between the formula and the symbol of an element and chose option **D**.

Question 8

Many candidates recognised that the negative electrode is the cathode but the name of the product at the negative electrode was less well known, even by stronger candidates.

Question 9

Many candidates recognised that the concentration of the hydrochloric acid decreases as time increases.

Question 10

The definition of oxidation was well known by the vast majority of the candidates.

Question 11

The fact that sulfur is a non-metal and produces an acidic oxide was well known by stronger candidates.

Question 12

The test for chlorine was well known by many candidates.

Question 13

The trend in the properties of the Group I elements was not well understood by many candidates.

Question 14

The properties of the transition elements were well known by stronger candidates but there was evidence of guesswork amongst weaker candidates.

Question 15

Ideas about the reactivity series of metals were not well understood by many candidates.

Question 16

The test for water using copper(II) sulfate was not well known by weaker candidates.

Question 17

Stronger candidates were able to calculate the starting volume of the sample of air.

Question 18

There was challenging for weaker candidates. Candidates are expected to know the formulae of compounds specified in the syllabus.

Question 19

The idea that aqueous bromine is used to identify an alkene and that alkenes undergo addition polymerisation was not recognised by a large proportion of candidates.

Question 20

Most candidates recognised that process 1 was fermentation, but a significant proportion of these candidates thought that process 2 was incomplete combustion and chose option **D**.

Question 23

Most candidates realised that the pressure exerted on the ground is related to the area of contact and that either option **C** or option **D** was correct. However, the pressure is inversely proportional to the area of contact. This is a concept that some candidates found challenging and more candidates chose option **C** than option **D**.

Question 24

Only the key, option **A**, involved a force moving through a distance. In the other options, the point of application of the force does not move. Although more candidates selected this option than any other, a number of candidates chose other options. There were candidates who may have learnt that the work done is related to the distance moved in the direction of the force, but who did not apply this understanding in these specific examples.

Question 26

The most popular answer given to this question was the option that suggested that the entire length of the thermometer tube is the distance that should be divided into a hundred equal parts. It is only the distance between the mark made at the level of the liquid in melting ice and that in boiling water that needs to be divided. These are the points that correspond to 0 °C and to 100 °C.

Question 27

To answer this question, candidates needed to know that the temperature of the substance that is being heated only remains constant when the state is changing. It was stated that the substance is solid at $t = 0$, therefore the different sections of the graph can be interpreted to be, in order: solid, melting, liquid, and finally, boiling. Once the graph had been correctly interpreted, candidates needed to read off the values and calculate the appropriate time for which the substance is a liquid.

Question 30

The correct answer, **D**, was only chosen by stronger candidates. The majority of candidates chose either option **A** or **C** which are options that suggested that the diagram was showing total internal reflection. The diagram showed light that is reflected at the surface of the glass with the air but it also showed light that had refracted out of the block. It is likely that some candidates did not recognise the significance of the word 'total' in the expression 'total internal reflection'. Of the candidates who were aware that total internal reflection was not taking place, more believed that the angle of incidence was greater than the critical than gave the key.

Question 36

Although candidates are expected to be able to calculate the combined resistance of resistors in series, they only need to know that resistance of a parallel combination is less than that of the resistance of any branch of the parallel part of a circuit. The resistances of the combinations options that consist entirely of series resistors can be calculated and in both cases the answer is greater than 100 W. Similarly, the resistance of the combination shown in option **B** cannot be less than 100 W as there is a 100 W resistor in series with something else. The fact that the combination in option **A** has resistance less than 100 W is a specific

syllabus point. Although many candidates chose the correct option, option **D** was quite often selected. It is possible that candidates noticed that the individual resistance values were smaller than in any other option and did not proceed any further.

Question 39

This question was very challenging for many candidates. Although most candidates gave an answer consistent with a beta-particle being an electron, a significant minority chose an option that suggested that a beta-particle is a helium nucleus. This is a matter of factual knowledge which candidates needed to know. The emission of an electron from a nucleus was not fully comprehended.

PHYSICAL SCIENCE

Paper 0652/21
Multiple Choice Extended

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

General comments

Several questions were answered well and these included **Questions 29**, **32** and **33**. In general, the best answered questions were set in very standard contexts. The questions that were only answered well by stronger candidates tended to involve more than simple recall or calculation. There was often something else that needed to be considered and those candidates who were able to apply their understanding to unfamiliar situations were usually able to answer these questions correctly.

The topics in the syllabus need to be learnt and understood and one part of understanding is realising what is meant by an expression or equation and how it applies in more general cases.

Comments on specific questions

Question 1

The link between relative molecular mass and the rate of diffusion was well understood by stronger candidates.

Question 2

Most candidates recognised that a balance was required to measure the mass of the calcium carbonate but only stronger candidates recognised that a pipette was required to measure an exact volume of hydrochloric acid.

Question 3

Many candidates recognised that the R_f value is the ratio of distance travelled by the spot over the distance travelled by the solvent front. A significant proportion of these candidates calculated the distances from the bottom of the paper rather than the baseline and chose option **D**.

Question 4

Most candidates recognised that the concentration of the solution decreases when water is added to the solution. Many weaker candidates did not identify the salt as the solute and chose option **C**.

Question 6

Stronger candidates identified the link between the number of pairs of electrons to the number of covalent bonds in the molecules.

Question 7

The structure of diamond was well known, particularly by stronger candidates.

Question 8

Calculations involving stoichiometric reacting masses, volumes of gases and solution concentrations were not well understood by many candidates.

Question 9

Most candidates knew that sodium would be discharged at the cathode but a large proportion of these candidates thought that the ions lose electrons and chose option **D**.

Question 11

The concept of oxidation was well understood by most candidates.

Question 12

Most candidates recognised that an acid is a proton donor and a base is a proton acceptor.

Question 13

Most candidates knew that chloride ions produce a white precipitate with acidified silver nitrate but the fact that a blue solution is produced when an excess of aqueous ammonia is added to copper(II) ions was less well known.

Question 14

The trend in the properties shown by the Group I elements was well known by a majority of candidates.

Question 17

The products of complete and incomplete combustion were well known by many candidates but the fact that carbon dioxide rather than carbon monoxide is a greenhouse gas was less well known.

Question 18

Stronger candidates knew that lime is manufactured by the action of heat on limestone.

Question 19

The products of combustion of an alkane were well known by many candidates. There was a misconception amongst some weaker candidates that hydrogen is product of combustion.

Question 20

This was challenging for weaker candidates. Candidates are expected to be able to identify the type of hydrocarbon from a molecular formula.

Question 22

Almost as many candidates selected **C** as chose the key. This option suggests an increasing acceleration which was not correct. It is possible that candidates interpreted the phrase 'increasing acceleration' to mean an acceleration that causes an increase in velocity rather than its accurate meaning. It is important for candidates to distinguish between 'increasing' and 'positive'.

Question 25

Although this question was set in the context of a kinetic energy calculation, it was essentially a question that assesses the use of units. Most equations included in the syllabus only generate the correct answer when the values substituted are in terms of the standard SI units. In this case, the most commonly chosen option was obtained by using the mass value in g that was given in the question. Candidates needed to convert values to SI standard units and for mass the appropriate unit is the kg.

Question 26

Nuclear fission power stations are often seen as entirely different from any other type of power station. In fact, nuclear fission power stations are similar to chemical fuel and geothermal power stations in that the turbine is driven by steam produced by boiling water. The unique feature of a nuclear fission power station is that in a nuclear reactor nuclear energy is transferred to thermal energy and that this energy is transferred to the water in the boiler. This understanding led directly to the key, option **D**. This was the most frequently selected option but each of the other options was selected by a significant number of candidates.

Question 31

Deducing the answer to this question required candidates to know the order of the frequencies or wavelengths of the main regions of the electromagnetic spectrum. The correct option was **D**. The most popular choice was option **C** which supplies the regions in reverse order with the region with the very smallest wavelengths listed on the right. The order in this option was exactly that which occurs in a common expression of the electromagnetic spectrum and it gave four contiguous regions. The regions supplied in the key were in increasing order of wavelength, but they were not all contiguous in a complete spectrum.

Question 36

The phenomenon of electromagnetic induction was poorly understood. An induced e.m.f. opposes the change that causes it. Here, the magnet is moving from right to left. The e.m.f. causes a current in the coil which creates a magnetic field that causes a force on the magnet. To oppose the motion of the magnet, the force must act to the right. The most popular choice was option **C**. However, a force to the left would not oppose the motion of the magnet but would cause the magnet to accelerate.

Question 38

Many candidates were aware that in a magnetic field, gamma rays are undeflected and these candidates could immediately see that the key had to be options **B** or **D** and both of these were frequently chosen. Candidates needed to know or to be able to deduce the charge on the radiation that was deflected up the page. Many candidates were able to do this and option **B** was most commonly selected. Option **D** was the second most commonly selected option and this suggested that many candidates were unable to deduce the charge on the radiation.

Question 40

To obtain the correct half-life, the part of the count rate due to background radiation (20 counts / min) needed to be subtracted from the readings on the graph. This gave an initial corrected count rate of 80 counts / min which, after one half-life had elapsed, had decreased to 40 counts / min. At this point the measured count rate was 60 counts / min. Option **B** which ignored the background count rate was by far the most frequently selected incorrect answer.

PHYSICAL SCIENCE

Paper 0652/31
Core Theory

Key messages

Candidates should attempt all questions. Where they are required to select from an option, they should use their knowledge to eliminate incorrect options before making an informed guess. Many candidates left answers spaces blank rather than choosing one of the options.

In questions involving calculations, working should be shown. Where an appropriate correct equation is given, partial credit may be awarded even if any subsequent working is incorrect.

General comments

Where a question is set in a particular context candidates should answer referring to the context. An example was **Question 5(b)** about hot food placed on a cold plate. Simply stating that thermal energy moves from an area of high temperature to low temperature was not adequate. Candidates' responses should have made clear reference to the context. In this example, this included mentioning the food and the plate. Another example was **Question 4(d)** where stating that the equation 'moment = force × distance' but not referring to the crane did not provide a full explanation.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly selected A*l* from the list.

(ii) Fewer candidates identified A*l* and there was some evidence that candidates were reluctant to use A*l* twice. The question clearly stated that an option could be used once, more than once or not at all.

(iii) K^+ was the expected answer and this was provided by many candidates.

(iv) The question asked for a non-metal with two electron shells. The answer carbon was frequently seen but so were metals like copper.

(v) Both Cl^- and Ca^{2+} were correct answers and so either of these was awarded credit.

(vi) Many candidates were able to identify Cu as the metal less reactive than hydrogen, but answers like potassium and non-metals like chlorine were seen quite frequently.

(b) This question was generally answered well. Most candidates gained partial credit for having a pair of electrons shared with each of the H atoms. Many also got credit for the lone pair on nitrogen, but some had extra electrons on the H atoms or on the nitrogen.

(c) The test for ammonia gas was not widely known. Of those who did know it, many gained partial credit for identifying litmus paper. Common errors were getting the change from red to blue the wrong way round or not stating the initial colour. "It turns damp litmus paper blue" was awarded partial credit.

Question 2

(a) Most candidates answered this correctly and gained full credit. Some candidates gained partial credit as a common error was to start by using the incorrect equation, 'distance = speed/time'. Those candidates who started with the more familiar 'speed = distance/time' could be awarded partial credit even if their final answer was incorrect.

(b) Most candidates correctly showed the acceleration for the first 5 seconds on their graph and gained partial credit. However, others only showed the constant speed section lasting 25 seconds. This was possibly due to misreading the question which said that the cyclist continued for a further 30 seconds. Some candidates then added extra sections showing what they thought might have happened subsequently. The question provided no information about events after 35 seconds and so the graph should not have extended beyond 35 seconds.

(c) Most candidates who had correctly drawn the graph in **(b)** were then able to shade the appropriate area on the graph. Credit was given for shaded areas that represented their acceleration period or for the first 5 seconds of their acceleration period.

(d) This question was challenging for many candidates. Calculating the total distance travelled (450 m) or the total time elapsed (60 s) was awarded partial credit. Several incorrect methods were seen. These included finding the average speed for each of the two sections and then either adding them or averaging them. Many correct answers showed the 'speed = distance /time' formula complete with the word total before both distance and time.

Question 3

(a) (i) Stronger candidates answered this correctly. Other candidates described isotopes as elements. Just saying they were atoms/molecules/compounds/substances that had the same number of protons was not sufficient. Credit for a different number of neutrons was more frequently awarded.

(ii) Most candidates answered this correctly.

(iii) Fewer candidates knew there were 16 neutrons present in the nucleus. A common incorrect response was 30.

(b) Only stronger candidates answered this fully correctly. One common insufficient response was stating positive or negative for relative charge. A numerical charge e.g., +1, 1 or '+' was accepted for the relative charge on a proton. For the relative masses, some candidates gave the electron a negative mass. Other used the proton number and mass number of the silicon isotope as the relative mass.

(c) (i) Compound was a common incorrect response and a significant number of candidates did not respond to this question.

(ii) Only stronger candidates answered this correctly. Credit was given to specific examples of improvement like stronger. Answers had to be comparative, so just strong was not accepted.

Question 4

(a) Although this question was answered well, a common error was to start with an incorrect relationship between mass, density and volume and in these cases no credit could be given.

(b) Most candidates were able to calculate the weight of the block.

(c) (i) Although some good answers were seen, most answers were not given credit. Many candidates interpreted 'not 100% efficient' to mean the crane could not lift the load. Candidates were expected to mention that more energy was used by the crane than was transferred to the load, or to indicate that some energy had not been used (to lift the load) or that some energy had been wasted.

(ii) Generally, candidates were able to state that more power was required by the electric motor. The answer more energy was seen quite frequently.

(d) The question asked candidates to 'explain in terms of moments'. Most candidates did not mention moments or turning forces and so could only be awarded partial credit. Initial credit for the idea of balancing the crane/maintaining equilibrium or stability was awarded to most candidates. A simple equation without reference to the crane was not considered to be an explanation.

Question 5

Many candidates interpreted the word radiation as being synonymous with ionising radiation/radioactivity.

(a) (i) Few candidates took note of the phrase in the question 'so you can see the food cooking'. Light/visible light was the correct response but gamma and beta were far more common responses.

(ii) The only answers given credit were 'infrared'/'IR'.

(b) Most candidates correctly stated that there was energy transfer from the hot food to the plate. Some did not mention any process, while others incorrectly stated convection. Radiation was ignored as being very much a minor contributing factor.

(c) (i) Two key ideas were required: the idea that the liquid in the thermometer became hot and that as a consequence it expanded. Many candidates gave these. However, some candidates gained no credit as they explained that it was the role of the thermometer to measure temperature and so the liquid rose to indicate the temperature.

(ii) Only stronger candidates answered this correctly. A very common response was "no difference". It appeared that these candidates were answering a question about the temperature the thermometer would indicate, rather than the height of the liquid in the tube. Unfortunately, some scientifically correct statements about sensitivity and response time did not answer the question that was asked and so gained no credit.

Question 6

(a) (i) Most candidates were able to identify the anode and cathode but some got them wrong way round. However, identifying Z as the electrolyte proved to be far more demanding.

(ii) Although this was a simple selection of one option from three, many candidates did not offer any response. Molten was the most common answer, but the gas and solid options were quite frequently selected.

(iii) The expected answer was an inert material like carbon or platinum. Because many candidates may have seen the electrolysis of copper sulfate solution, copper was also accepted.

(b) The correct answers of bubbles/effervescence/fizzing were very common. However, some candidates stated that the gas would come from the cathode. This is a location and not an observation.

Question 7

(a) (i) A majority of candidates answered this correctly. Aluminium and steel were frequently suggested.

(ii) Some candidates did not indicate the direction of change and just stated "the number of turns" without saying whether this was an increase or decrease. Other candidates wrote "increase the power supply" without identifying any quantity like current or voltage. "Increasing power" was ignored as there was no direct means of adjusting the power.

(b) (i) This question was usually answered correctly. Some candidates concentrated on the context that the apparatus was to be used in as a loudspeaker and stated that the card would vibrate.

(ii) Many candidates gained full credit here.

(c) The answer 20 Hz was very often seen and of the incorrect answers, 200 Hz and 20 000 Hz were most common.

Question 8

This question was about the uses of, and the refining of oil. Some weaker candidates seemed not to recognise the context and, for example, answered as though the initial diagram was of a blast furnace.

(a) (i) Only stronger candidates were able to successfully explain what a hydrocarbon was. Together with identifying carbon and hydrogen as components, the term compound or molecule was required. Mixture, element or substance were not awarded credit.

(ii) Crude oil and petroleum were the only acceptable answers. Some candidates misunderstood the question and gave answers such as iron ore, bauxite, limestone.

(iii) Heating was the correct answer and was often seen. Those candidates who thought the process was cracking in **(iv)** answered decomposition.

(iv) The full answer, fractional distillation, was required. Many candidates were awarded credit but others just answered distillation which was insufficient.

(v) Almost all candidates correctly stated that bitumen was used for surfacing roads.

(b) Many candidates answered about incomplete combustion and the production of carbon monoxide. This was not what the question asked and so could not be credited. Any mention of ozone depletion negated any reference to global warming.

(c) Only stronger candidates were able to state that hydrogen was a fuel that did not contain carbon. References to renewable fuels and nuclear fuel were ignored.

Question 9

(a) Only stronger candidates answered this correctly even though it was testing knowledge of 'like charges repel, unlike attract' which most candidates could probably have stated.

(b) Partial credit was available for naming electrons as the particles which were transferred as the rod was being charged. Further credit was awarded for the direction of transfer of negative particles. This was challenging for many candidates but many were able to gain at least partial credit.

(c) The command word used was 'suggest'. Very few candidates mentioned metals being good conductors (of electricity) which would have been given credit without explaining that charges (electrons) could move through the metal and return to the cloth.

Question 10

(a) (i) This question was answered well with the majority of candidates gaining full credit. However, air was not regarded as sufficient as candidates needed to refer to oxygen.

(ii) Nearly all candidates named one of painting, oiling or galvanising as barrier methods.

(b) Only stronger candidates knew that the reactivity of iron was between that of zinc and copper.

(c) The question asked for a word equation and those who attempted to write an equation in symbols set themselves a far more demanding task. Partial credit was available for the reactants, iron + hydrochloric acid (or Fe + HC*l*) and this was awarded quite often. Few candidates gained further credit for iron chloride and hydrogen. Water was often incorrectly named as a product and those candidates who tried to write the symbolic equation needed to get the formulae correct and also balance the equation. In practice, hardly any candidates who attempted the symbolic equation did this accurately.

(d) This was only answered well by the strongest candidates. Many answers gave uses that involved many materials. These answers were ignored. A commonly seen example was buildings. While steel may be used, many buildings contain very little if any steel.

Question 11

Radioactivity appeared to be a demanding topic for most candidates.

(a) Credit was awarded for the breakup or disintegration of a nucleus and for the idea that particles or energy was emitted from the nucleus. Simply reordering the words in the question were not regarded as creditworthy e.g., “decay of nuclei”. Some candidates clearly thought it referred to the end of the process where a radioactive sample’s activity dropped to zero.

(b) Most candidates gained partial credit usually for selecting ‘half the nuclei decay in 2 hours’. Only stronger candidates answered this fully correctly. ‘All the nuclei decay in 4 hours’ was frequently selected.

(c) (i) Air or paper were the expected answers for the material that absorbs alpha radiation but not beta or gamma.

(ii) Aluminium was the expected answer but any low density material was accepted**.** Very common incorrect answers were iron, lead, and concrete.

(d) Very few candidates knew how radiation could be detected.

PHYSICAL SCIENCE

Paper 0652/41
Extended Theory

Key messages

- Stronger candidates included their working in calculations so that partial credit could be awarded for a correct method even if the final answer was incorrect.
- Many candidates found it challenging to give clear and concise descriptions or explanations, particularly to the physics questions.

General comments

Candidates are advised to attempt every question. A number of candidates did not give a response to every question, particularly when a response was needed on a diagram.

Ray diagrams and symbol equations are areas of the syllabus that candidates found challenging.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to select **E** as the substance with the molecular formula C_2H_6.

(ii) Some candidates found this challenging.

(iii) Most candidates could identify **E** as an alkane.

(iv) **C** was usually correctly identified. **F** was a common incorrect answer.

(v) **F** was usually correctly identified.

(vi) Occasionally, **B** was incorrectly chosen as a lubricant.

(b) Most candidates were able to draw a double bond between C and each oxygen. Fewer could give the lone pairs on the oxygens.

Question 2

(a) (i) A common error was to multiply the load and extension and to give the unit as Ncm.

(ii) Most candidates could name the limit of proportionality. Answers that were not accepted included 'limit of extension', 'proportionality' and 'limit of proportion'.

(b) Most candidates named a micrometer. Occasionally, 'macrometer' was seen.

(c) Weaker candidates did not identify whether it was an increase or decrease in length and cross-sectional area that affected their stated change in resistance. For example, "resistance increases when length is changed", did not make it clear that this applies when length is increased.

Question 3

(a) (i) The sodium ion was most likely to be correct. The charges were often correct but 2+ and 2– and reversed charges were also seen. Some candidates did not use the symbols provided of dots for sodium electrons and crosses for chloride electrons.

(ii) Most candidates could describe the ionic structure of sodium chloride.

(b) This was answered well with a small number of candidates confusing period number with group number.

(c) Candidates found the symbol equation very challenging and few were able to provide a correct, balanced equation for the reaction. Cl_3, Cl and Fe_3 were commonly seen.

(d) A darker colour than red-brown was usually given. Liquid was a common incorrect response.

(e) Weaker candidates stated that neon is non-reactive, which did not explain why it does not react with chlorine. Stronger candidates referred to the full outer shell of electrons.

Question 4

(a) Most candidates could name the three types of radiation but a significant minority either left this blank or referred to names such as 'thermal', 'refraction', 'attraction', 'the sun' or 'heat'.

(b) (i) Some candidates recognised **C** had a lower mass. Sometimes **A** and **C** were confused. A number of candidates were unable to provide an explanation.

(ii) Most candidates suggested **B** had no charge. Weaker candidates simply repeated the question "**B** is not deflected by an electric field".

(c) (i) Common errors included referring to the transfer of positive particles, not addressing where the particles were transferred from/to, or reversing the direction.

(ii) Some candidates were able to state that opposite charges attract whilst others struggled to phrase their answers in a clear and coherent manner.

Question 5

(a) A variety of incorrect reaction types were seen, the most common being 'redox' and 'addition'.

(b) Candidates performed well on this calculation.

(c) Weaker candidates stated that the product was 'toxic' or 'a pollutant'. Some named carbon dioxide but did not explain why it is an atmospheric pollutant. The strongest candidates named carbon dioxide and explained that it is a greenhouse gas that contributes to global warming or climate change.

(d) This was generally answered well but occasionally the neutralisation of acidic soils by calcium carbonate was not stated.

(e) Most candidates identified 'basic'. 'Amphoteric' was a common incorrect choice.

Question 6

(a) Many candidates gave the correct equation, substituted the correct numbers and determined the answer. Others multiplied the moment by distance.

(b) (i) **B** was usually correctly selected. Fewer candidates also selected **D**.

(ii) **C** was usually correctly selected. **D** was a common incorrect answer.

(c) Candidates struggled to answer this clearly.

Question 7

(a) A suitable pH was suggested by nearly all candidates.

(b) Candidates performed well and described the difference between acids and bases in terms of proton transfer. A small minority did not answer in terms of both acids and bases.

(c) (i) Oxygen was a common error.

(ii) Correct responses were common with most candidates stating that the magnesium is in excess. Fewer candidates identified the acid as the limiting reactant and the use of this term was rarely seen.

(d) Many candidates recognised that aluminium has an oxide layer. Incorrect answers included “aluminium is unreactive” or “aluminium is neutral”.

(e) Resistance to corrosion and low density were usually stated.

(f) This was only answered well by the very strongest candidates and most candidates stated ‘addition’.

Question 8

(a) (i) Most candidates could draw an arrow to indicate amplitude. A number of candidates did not give a response to this question.

(ii) 3 was usually correctly given but 2 was also seen.

(iii) Many candidates were able to determine the wavelength. Stronger candidates included working out. Candidates were awarded credit if they clearly used their stated number of complete waves from **(ii)**.

(iv) Candidates found this challenging and many incorrect responses were seen. Including full working benefitted candidates who could go no further than stating the equation for frequency. Candidates were awarded credit if they clearly used their answers from **(ii)** and **(iii)**.

(v) Some candidates could determine speed. Including full working benefitted candidates and they should be encouraged to always show their working in calculations.

(b) Candidates struggled to describe a transverse wave clearly.

Question 9

(a) **X** was usually correctly shown. Occasionally, candidates did not give a response to this question.

(b) Many candidates were unable to name the fraction at **Y**. A variety of answers were seen including suggestions that were not fractions including ‘carbon dioxide’, ‘propanol’ and ‘fermentation’.

(c) Most candidates identified naphtha as a fuel, which was credited. Fewer referred to the syllabus use of ‘feedstock’.

(d) Most candidates could compare one property, but few gave two. Weaker candidates did not provide a comparison and some confused **W** and **Y**.

Question 10

(a) The angle of incidence was often incorrectly given as 60°.

(b) (i) The speed of light in the glass block was determined by many candidates and full working was seen in a number of responses. Weaker candidates tried to make use of $\sin i : \sin r$.

(ii) This was answered well by many candidates. Occasionally, $\sin i$ and $\sin r$ were incorrectly placed in the equation.

(c) (i) Ray diagrams were not well understood by the majority of candidates. Full credit was rarely awarded.

(ii) Many candidates could describe diminished and inverted but fewer could describe real.

PHYSICAL SCIENCE

Paper 0652/51
Practical Test

Key messages

To do well in this examination, candidates need to have a good understanding of practical work. During the course, candidates should have as much personal experience of carrying out experiments themselves as possible.

Centres are provided with a list of required apparatus well in advance of the examination date. Where centres wish to substitute apparatus, it is essential to contact Cambridge to check that the change is appropriate and that candidates will not be disadvantaged. Any changes made must be recorded in the Supervisor's report.

When describing the colour changes when solutions are mixed together, candidates should be made aware that 'clear' is not a suitable description of a colour.

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical techniques in chemistry and physics.

Stronger candidates were able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of the practical tests were attempted and there was no evidence of candidates running short of time.

It is important that candidates record readings to a suitable number of decimal places as stated in the question.

Comments on specific questions

Question 1

(a) (i) The vast majority of candidates were able to follow the procedure allowing them to record readings in their data table. Typical errors included not recording readings to the nearest 0.1 cm^3, or an error in following the procedure which meant that the volumes of hydrochloric acid did not increase when the higher concentrations of sodium hydroxide were used.

(ii) Nearly all candidates correctly identified that a pipette was needed to make more accurate measurements. The use of a measuring cylinder was the most common incorrect response.

(b) (i) Most candidates were able to calculate the difference between the initial and final readings to find the volume of dilute hydrochloric acid added.

(ii) Only stronger candidates identified repeating the procedure as a suitable improvement and followed this with a suitable explanation.

(c) (i) Graphs were typically drawn with neat, clear plots and sharp pencil lines. However, there was at least one error on most of the graphs drawn. In a minority of cases, candidates had swapped the axes and therefore plotted a variable on the incorrect axis. Nearly all graphs were labelled with a variable, but some of these labels did not include appropriate units. Where suitable scales were used, candidates were often able to plot accurately.

(ii) Often, candidates found it challenging to draw a suitable best-fit line. Some candidates forced their line through the origin even if their plots suggested otherwise.

(iii) Most candidates successfully identified the relationship between the two variables. There were occasions where candidates did not refer to 'concentration' or 'volume' in their response.

(iv) Many candidates gave a value without identifying on the graph how they had calculated their answer.

(v) Some candidates correctly drew a line that was below the existing best-fit line. Only a small number of stronger candidates recognised that the values on this line should be half of those on the existing line.

Question 2

The majority of candidates gave a correct observation and subsequently identified the ion present. In a small number of cases, more than one ion was identified for a single observation e.g. sodium chloride or calcium chloride for the white precipitate.

Question 3

(a) Most candidates recorded appropriate times for 10 oscillations. Some candidates did not record this to the nearest 0.01 s.

(b) (i) Nearly all candidates successfully calculated the time for one oscillation.

(ii) The majority of candidates were able to calculate a value for T^2. Some candidates found it challenging to correctly record this to two significant figures.

(iii) Many candidates were unable to determine the correct unit for T^2 and stated 's' instead.

(iv) Responses to explain why timing 10 oscillations gives a more accurate value were often too vague, for example, stating that it reduces or removes the error. The strongest candidates were able to recognise that one oscillation was too quick to time accurately.

(c) Candidates were required to answer this question with reference to their data, but many did not refer to this and therefore were unable to give a sufficient justification for their answer.

(d) (i) Many candidates only provided one value which, along with the original two lengths, would not provide enough data to plot a suitable graph and identify the relationship. Candidates should recognise that, typically, a minimum of five values are required.

(ii) Often candidates did not recognise that pendulum lengths shorter than 10 cm would result in a very short period. Similarly to **(b)(iv)**, incorrect responses were often vague, such as stating that the value was too small to plot on a graph.

(e) Only a small number of stronger candidates described a suitable method that allowed an accurate measurement to the centre of the pendulum bob, recognising the difficulties posed by its spherical shape. Other candidates referred to general precautions when making measurements such as avoiding parallax error and the use of set squares, which would not help ensure that measurement is to the centre of the pendulum bob.

Question 4

The majority of candidates were able to give a brief description of a procedure that would allow them to conduct the investigation and identified a stopwatch as an additional item of apparatus. However, many descriptions did not contain sufficienct detail and did not make it clear that the timing should take place over a fixed distance. Most candidates successfully identified at least one control variable, which was typically a feature associated with the size of the ball but others also referred the height of the liquid. On some occasions, candidates did not outline an appropriate investigation and instead described a displacement procedure to find the volume of an object.

Often candidates were able to receive credit for identifying the correct headings for their results table, but many did not give any units for these headings. Only stronger candidates were able to clearly articulate how they would use their results to reach a conclusion. Common errors were either stating a prediction based on theory instead of describing how the use the results or giving a vague statement that mentioned comparing the results but did not include what to look for in this comparison. Few candidates gave an explanation which involved drawing a graph.

PHYSICAL SCIENCE

Paper 0652/61
Alternative to Practical

Key messages

Candidates should be encouraged to take part in practical work wherever possible as this is essential when answering practical-based theory questions.

Candidates must read questions through carefully, including paying attention to the mark allocation which often indicates the number of points expected to be covered in the response.

Attention should be paid to the graphical representation of data to ensure that answers are both accurate and give a clear indication of the relationship between two variables.

Candidates must address the bullet points given in the question when they answer the planning question.

General comments

Candidates need to take much greater care drawing graphs. Axes must be clearly labelled including units, scales must be linear and chosen to cover over half the grid, and points must be plotted carefully to the nearest half-square with clear crosses. Candidates should judge a line of best fit so that it goes through, or as close to as many points as possible. If they are instructed to draw a smooth curve it must be that, not point-to-point, and avoiding maxima or minima. There should be just one line, and if a label is requested it should be provided clearly to avoid ambiguity.

When reading off their graph, candidates need to show full working with the minimum being a point on their line, or two lines, one from each axis.

Candidates need to read questions carefully, especially with regard to making procedural improvement to experimental methodology, taking readings from apparatus, including the direction of the scale, and in providing the expected degree of approximation, matching the other values in a given table or to the requested number of significant figures.

Comments on specific questions

Question 1

Some candidates understood that the divisions on the burette were 0.1 in value but many read the scale as increasing upwards instead of downwards. Two decimal places were required to match the table entries but a wider allowance was made in **(b)**.

Either a burette or pipette were expected for more accurate measurement of the alkali. A syringe is not commonly used in the chemistry laboratory so was not credited. A number of candidates answered 'measuring cylinder' which was already being used in the question and so was clearly not an improvement.

The procedural improvement expected to give more confidence in the volumes added was expected to be to 'repeat and identify/exclude anomalies'.

Credit for plotting could not be awarded against a non-linear scale and this meant that many candidates did not gain full credit here. Also, some candidates did not include the units when labelling the axes.

Most candidates drew a reasonable best-fit straight line which was extended to an axis, and nearly all realised that both variables increased with each other, but for direct proportion to be credited their line needed to have gone through the origin.

Most candidates could read a value from their graph but full working was not always shown.

Very few candidates attempted to draw line E, and of those who did, the majority did not realise that less volume rather than more would be needed if the concentration increased.

Question 2

Although most candidates realised that sodium caused a yellow flame, very few were able to gain credit for the method as they did not use a wire and put it into a blue (Bunsen) flame, rather than over, on or near it.

Some candidates confused the test for chlorine with chloride so bleaching litmus was a very common incorrect response.

Most candidates realised that a chloride caused a white precipitate to form, but incorrect reagents often included sodium hydroxide or the omission of nitric acid.

Question 3

Most candidates measured the pendulum length correctly but the scale factor was too often reversed to give half their original length.

Very few candidates recognised that the bob was three dimensional so often the length was measured horizontally with a ruler or at eye-level, rather than between wooden blocks or by using a micrometer or callipers to measure the diameter. The measured length then had to be halved and added to the length of the string.

In **(b)** accuracy was in the question so was ignored in answers, as were references to it being hard to measure without the reason of one oscillation being too quick to measure.

In **(c)** the table caused problems of interpretation and some candidates found this difficult to complete. Although many candidates correctly divided by 10, units were often missing or not squared. The most common answer in **(iii)** was 1.17 which was achieved by candidates subtracting 0.1 to match the first row but then not squaring T. Several candidates did not follow the instruction to record their answer to two significant figures.

Allowance was permitted in the estimation of T for length 30 cm so several candidates estimated 10.8 +/– 0.1 correctly, but in **(d)** their prediction had to be linked to their previous answer. Where this was correctly evaluated, the expected answer was ‘yes’ as 1.6 is close to double 0.79. However, where 1.17 was used, the expected answer was ‘no’, and in both cases a justification had to include numerical reference to the table.

In **(e)** some candidates either included values already given in the question when asked to provide additional values, or provided fewer than three additional values which are needed in order to have confidence in plotting a graph.

The expected answers that the oscillation would be too quick to time or the length too small to either measure or time were only given by stronger candidates.

Question 4

There were some very good answers here which were awarded full credit. These candidates addressed all the bullet points in the question.

Some candidates did not gain full credit, either through describing rather than drawing a table which included units, or by not providing a conclusion, either by comparing data and inspecting the relationship between them rather than by predicting a relationship, or by drawing a graph of stated variables.

Nearly all candidates used a stopwatch to measure time and controlled the appropriate variables, but they needed to measure the time for the ball to hit the bottom, having started above or on the surface of the liquid

rather than in it. Some candidates stated “to fall through the liquid” which was simply repetition of the question.

Weaker candidates addressed the measurement of volume through displacement in calculating density, or seemed to be investigating the effect of different ball size, different volumes of the same liquid, usually water, or even dropped the ball from different heights and found the time to hit the liquid surface.