PHYSICAL SCIENCE

Paper 0652/11
Core Multiple Choice

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

General comments

In the physics section, candidates found **Questions 24**, **26**, **36** and, particularly **Question 28,** very difficult

Comments on specific questions

Question 1

A majority of the candidates recognised that the particles in a liquid are randomly arranged and touching and chose option **B**.

Question 2

A significant number of the weaker candidates did not recognise the significance of the information about the melting point of the sample and simply chose option **C**, which is the pH of an acid.

Question 3

There was some confusion amongst many candidates about the differences between a compound and a mixture. A significant number of candidates therefore chose option **A**, indicating that a compound is a mixture of two or more elements.

Question 4

This question was well answered by the stronger candidates but weaker candidates found this challenging.

Question 6

This question was challenging for all but the very strongest candidates.

Question 7

The differences between the structures of diamond and graphite were not well understood by many of the candidates.

Question 8

Although stronger candidates answered this well, other candidates did not recognise that the subscript 3 referred to all the atoms inside the bracket and chose option **B**.

Question 9

The factors that affect the rate of a chemical reaction were well known by stronger candidates.

Question 10

Most candidates understood the concept of oxidation and reduction.

Question 11

A significant number of candidates did not recognise that an acidic substance with a pH value of less than 7 is required to neutralise an alkali.

Question 12

The test for zinc ions was known by a majority of the candidates, but the test for a chloride ion was less well known.

Question 13

The test for chlorine was known by many of the candidates. There was a misconception amongst a significant number of candidates that bromine water is used and they chose option **B**.

Question 14

Most candidates understood that an ionic compound is formed between a metal and a non-metal and knew where these elements are placed in the Periodic Table.

Question 15

The properties of aluminium that make it useful for the manufacture of aircraft parts were well known by most candidates.

Question 16

Almost all candidates understood that copper is the least reactive of the three elements but over half of these candidates thought that magnesium is more reactive that calcium and chose option **A**.

Question 17

Almost all candidates recognised that water is used as a solvent, but many candidates thought that water is a compound containing two parts of oxygen and one part of hydrogen and chose option **C**.

Question 18

A significant proportion of particularly the weaker candidates thought that either hydrogen or carbon monoxide are produced when butane is burned in excess air

Question 19

Stronger candidates recognised that the two structures that contain a carbon-to-carbon double bond decolourize bromine water.

Question 24

This question on moments was challenging for many candidates. Many candidates chose option **C**, probably confusing the moment with the work done by the force.

Question 25

The topic here was energy transfer, and only stronger candidates answered correctly. Many candidates believed that kinetic energy is decreasing and potential energy increasing at the highest point (option **B**).

Question 26

Many candidates thought that decreasing the weight of the load (option **D**) would increase the power output.

Question 27

Most candidates believed that installing transmission wires loosely prevents them from breaking when the temperature increases, failing to appreciate that heating causes expansion.

Question 28

This question on change of state was challenging for most candidates. Many thought that the temperature of a substance increases both when it melts and when it boils, with few candidates knowing that there is no change in either case.

Question 36

The topic here was factors affecting the resistance of a wire, and this was challenging for all but the strongest candidates. Most candidates recognised that decreasing the diameter increases resistance, a link that often causes confusion. However, many of these also believed that this inverse relationship applies to resistance and length, which is a less common misconception.

PHYSICAL SCIENCE

Paper 0652/12
Core Multiple Choice

There were too few candidates for a meaningful report to be produced.

PHYSICAL SCIENCE

Paper 0652/21
Extended Multiple Choice

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

General comments

In the physics section, only **Question 40** caused particular difficulty for many candidates.

Comments on specific questions

Question 1

The vast majority of the candidates recognised that the particles in a liquid are randomly arranged and touching and chose option **B**.

Question 2

The relationship between purity and melting point was well known by a majority of candidates.

Question 3

There was confusion amongst some of the weaker candidates with regard to the differences between a compound and a mixture. A number of the candidates therefore chose option **A**, indicating that a compound is a mixture of two or more elements.

Question 4

Many of the candidates recognised that the number of outer electrons determines the properties of an element.

Question 5

A significant number of weaker candidates thought that an ionic compound is made up of a lattice of positive atoms in a sea of electrons and chose option **D**.

Question 6

The 'dot and cross' diagrams were not well known by a significant number of the candidates.

Question 8

The vast majority of the candidates were able to calculate the relative molecular mass of ethyl ethanoate.

Question 9

The reason why increasing the temperature increases the rate of a chemical reaction was well understood by most candidates.

Question 11

Many candidates recognised that in order to neutralise an alkaline wasp sting a substance with a pH value of less than seven is required.

Question 14

The trends shown by the halogens were less well known. A significant number of candidates thought that the melting point of the elements decrease down the group and chose option **D**.

Question 16

Most candidates recognised that water is used as a solvent. However, a significant proportion of these candidates thought that water is a compound containing two parts of oxygen and one part of hydrogen and chose option **C**.

Question 17

The reactions involved in a catalytic converter were not well understood. Many weaker candidates thought that nitrogen oxides are removed by combustion and chose option **A**.

Question 19

A significant proportion of weaker candidates thought that either hydrogen or carbon monoxide are produced when butane is burned in excess air.

Question 20

The conditions used in the manufacture of ethanol by fermentation were not well known by many candidates. The vast majority of the candidates knew that yeast is used as the catalyst in the process but the pressure and temperature used in the process were less well known.

Question 25

In this question many candidates realised that the speed would reduce, but incorrectly divided the mass by the force to produce a deceleration of 0.20 m/s^2 (option **A**).

Question 27

The topic here was kinetic energy and many more candidates opted for **B** than the correct option **D**. This incorrect value is obtained by dividing the kinetic energy by the weight of the ball.

Question 28

Although most candidates correctly chose position **A**, a significant proportion of candidates believed that kinetic energy is decreasing and potential energy increasing at the highest point (position **B**).

Question 29

In this question many candidates thought that decreasing the weight of the load (option **D**) would increase the power output.

Question 30

This question was generally well answered. Nearly all candidates knew which thermometer had the greater range, but some of these candidates thought that thermometer P was also the more sensitive of the two. Although it had a scale that was three times as long as that of thermometer Q, the temperature range it covered was more than three times greater, making it less sensitive.

Question 31

The most popular incorrect choice in this question on waves was option **D**. This was found by using the full distance shown of 6 cm as the wavelength in the wave equation, rather than the correct value of 4 cm.

Question 36

In recalling the definition of e.m.f. many candidates confused power with energy, leading them to opt for the incorrect option, **D**.

Question 38

Some candidates confused neutrons with protons and therefore chose option **C** as the different isotope.

Question 40

This question on β-emission caused problems for many candidates. Options **A** and **C** were both more popular than the correct option, **B**.

PHYSICAL SCIENCE

Paper 0652/22
Extended Multiple Choice

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

General comments

Candidates generally performed very strongly in the physics section of this paper. **Questions 21**, **29**, **33** and **36** were answered well, with only **Question 38** causing widespread difficulty.

Comments on specific question

Question 1

The vast majority of the candidates recognised that the particles in a liquid are randomly arranged and touching and chose option **B**.

Question 2

The relationship between purity and melting point was well known by a majority of the candidates.

Question 4

Only the strongest candidates answered this question correctly. The concept of multiple bonds was not well understood by many candidates.

Question 5

A significant number of candidates thought that the weak bonds between the layers of atoms are responsible for the fact that graphite is a good conductor of electricity and chose option **D**.

Question 9

Most candidates recognised that the reaction was exothermic. However, some of these candidates thought that he energy needed to make the bonds is greater that the energy released when breaking bonds and chose option **C**.

Question 11

Many candidates recognised that in order to neutralise an alkaline wasp sting a substance with a pH value of less than seven is required.

Question 12

The methods used to prepare salts were not well understood by a large proportion of the candidates. Candidates should know that the only method used to prepare insoluble salts is precipitation.

Question 13

Stronger candidates understood the trends in properties across a period of the Periodic Table. There was a misconception amongst the some weaker candidates that elements with the fewest number of the electrons in the outer shell, those on the left-hand side of the Periodic Table (i.e. metals), form acidic oxides.

Question 16

Most candidates recognised that water is used as a solvent. However, a significant proportion of these candidates thought that water is a compound containing two parts of oxygen and one part of hydrogen and chose option **C**.

Question 17

The reactions involved in a catalytic converter were not well understood. Many weaker candidates thought that nitrogen oxides are removed by thermal decomposition and chose option **D**.

Question 20

Many candidates recognised that alkenes undergo addition reactions with bromine. However, a significant number of weaker candidates thought the reaction is a polymerisation and chose option **D**.

Question 22

Few candidates were unable to calculate density by the method of displacement.

Question 23

This question required a calculation to find the position of a mass to balance a rule. The most common error was for candidates to misread the question and therefore not to add 50 cm to the correctly calculated distance from the pivot, leading to the incorrect choice of option **B**.

Question 25

The topic here was work done by a force. Option **B** proved attractive to many candidates, who probably divided the work done by the mass instead of the force acting.

Question 25

Although most candidates correctly chose position **A**, a significant proportion of candidates believed that kinetic energy was decreasing and potential energy increasing at the highest point (position **B**).

Question 29

Candidates had a secure knowledge of the processes of thermal energy transfer and performed very well on this topic.

Question 32

This calculation required candidates to recall the speed of light and then use this to calculate a distance. Some candidates did not convert the time into seconds and therefore incorrectly chose option **C**. A similar number divided the speed by the time in minutes, leading them to option **B**.

Question 35

Some candidates chose option **C** after calculating e.m.f. by dividing energy transferred by time, rather than by charge.

Question 38

This question was challenging for most candidates. Many candidates took the period as the time for a half, rather than a full cycle and/or failed to notice that the time axis values were in milliseconds.

Question 40

This question on β-emission was challenging for many candidates and responses were spread across all options.

PHYSICAL SCIENCE

Paper 0652/31
Core Theory

Key messages

Candidates should follow the instructions in the question carefully. Some candidates offered a symbolic equation or a formula when the question asked for a word equation or the name of a compound.

When answering calculation questions, candidates should ensure they give clear working to ensure they are able to access marks for method.

General comments

There was a mixed performance on this paper with many candidates answering questions very well, while others did not show a strong understanding of some areas of the syllabus.

Candidates need to understand the difference between structure, properties and uses of a material. For example, it was common to see a question about structure being answered with ideas like “has a high melting point”, “is used in pencils”.

Comments on specific questions

Section A

Question 1

(a) (i) Most candidates were able to identify sand as the material which would be retained in the filter paper.

(ii) Most candidates identified ethanol as the substance to be collected first when the filtrate was distilled. Water was frequently chosen while other candidates probably misunderstood the term filtrate and so answered sand.

(iii) Most candidates were able to identify salt as the material which would be left behind at the end of the process.

(b) This proved to be a more challenging question with many candidates incorrectly offering the boiling point of water being 100 °C as a test for water.

Question 2

(a) Some candidates offered “accelerating at constant speed”. This was a contradiction of acceleration and was not taken to mean constant acceleration. Partial credit was available for recognising that there was some form of constant behaviour so “accelerating at constant speed”, which was a common answer, was awarded partial credit for the use of constant.

(b) (i) Almost all candidates showed they were able to determine the speed of the car.

(ii) Only the strongest candidates answered this question correctly. Most candidates assumed constant speed and then used distance = speed x time.

(c) (i) Most candidates were able to select person C as the person who would take most time to cross the road. However, a significant proportion chose person A. This was possibly a result of not reading the question carefully, or focusing on the word *most* and choosing the largest value in the table.

(ii) The calculation of the time taken to cross the road was performed well by most candidates. ECF from the answer given in **(i)** was allowed.

(iii) Any sensible idea, with detail, was given credit. However, the mention of safety without reference to details about cars/people/accidents was considered too vague.

Question 3

(a) Most candidates were able to state the correct number of protons and neutrons.

(b) A large majority of candidates answered this question correctly. However, some candidates did not appear to understand the term *electronic structure*.

(c) (i) Any correctly balanced equation was accepted including for example, all values doubled. If the space before Cl_2 was left blank, this was treated as being the same as '1'.

(ii) Few candidates gained full credit. Very common errors were not including charges in the formula of the ion and naming the chlorine ion as chlorine and not chloride.

Question 4

(a) Most candidates realised that the ray that just missed the edge of the bowl represented the point at which the coin would disappear from view. Candidates who did not answer correctly usually attempted something quite unrelated such as drawing a ray from the other side of the coin to the eye in its original position.

(b) Many candidates were able to draw a normal ray at the correct location. Many different angles were labelled as being the angle of incidence. Not surprisingly, the angle of refraction was often labelled as the angle of incidence because candidates had not taken into account the direction of the ray.

(c) (i) Both convex and diverging were acceptable answers for the type of lens shown.

(ii) The question tested the understanding of the rules for drawing ray diagrams of convex lenses by asking candidates to show the path of the rays prior to them entering the lens. Some did this well but many drew random angle changes at the lens.

(iii) Any image correctly drawn given the candidate's ray diagram was given credit. Partial credit was awarded for recognising that the foot of the image is on the principal axis and further credit was awarded for the recognition that the tip of the image is at the intersection of their two rays. Candidates who drew non-intersecting rays did not answer the question fully.

Question 5

(a) (i) Many answers were not related to the structure of graphite which is what the candidates were asked to describe. Some answers contained references to double bonds but seemed to involve hydrogen atoms as well, while others gave the number of electrons in the shells of a carbon atom. Those candidates that wrote about structures tended to do quite well provided they did not describe a diamond structure.

(ii) This part was correctly answered much more frequently than **(i)**. Good electrical conductor was the most popular response but some candidates gave a use for graphite e.g. pencil lead.

(b) This was often answered correctly.

(c) (i) Most candidates correctly named oxygen in answering this question.

(ii) Candidates were asked for a word equation. Credit was given for a symbolic equation with both formulae and balancing correct.

(d) Iron was commonly offered as a metal which could be extracted from its ore by carbon. However, aluminium and sodium were also seen in a number of answers.

(e) (i) Few candidates could both name and give a formula for a compound of carbon and hydrogen that that contained a single carbon atom. Some answers were groups of compounds like alkanes while others contained other atoms, for example methanol.

(ii) Few candidates were able to name hydrocarbons as being the group of compounds consisting of hydrogen and carbon only.

Question 6

(a) Few candidates gained full credit. Only the steel absorber had any noticeable effect on the radiation from **D,** so this was the gamma source. The paper reduced the radiation from **A** down to very low levels so this was the alpha source. The radiation from source **C** was reduced by the paper but was reduced a lot more by the thick steel suggesting two types of radiation were present.

(b) It was expected that candidates would notice that the level of radiation never dropped below about 20 counts per minute. If the absorber had stopped all the radiation from the source this low reading would be the background count. Many candidates were confused and offered values of around 900 counts per minute. This would be the count from the source with no shielding present.

(c) Many ideas for the variation in counts when the experiment was repeated. Very few candidates considered the natural variation/randomness of radioactive decay.

Question 7

(a) Most candidates were able to identify lead as the missing product for molten lead bromide. Few were able to name oxygen as the missing product from the electrolysis of dilute sulfuric acid. Sulfur was the most common answer.

(b) The question was well answered with most candidates correctly giving the order of reactivity.

Question 8

(a) (i) Some candidates misquoted the density formula or they incorrectly rearranged it.

(ii) The question was usually well answered but the appropriate units were not always given.

(b) (i) Potential energy alone was not sufficient to indicate gravitational potential energy.

(ii) Although the correct answer of chemical energy was frequently seen, many candidates believed heat energy is stored in fuels.

(c) Most candidates were able to say that when the dumper truck completed the task in less time, this would involve greater power.

Question 9

(a) (i) The majority of candidates correctly stated that there were two N atoms present.

(ii) Many answers correctly stated that there were 9 atoms present in the molecule.

(b) (i) A majority of answers were incorrect. Sulfuric acid was a common incorrect response but answers like limestone were also seen.

(ii) Only the strongest candidates answered this question correctly. The most common error was the use of litmus as an indicator which would not reveal the point of neutralisation.

(c) Many candidates gained partial credit for saying that the limestone increased the pH of the soil. However, few went on to explain that this was because limestone is basic.

Question 10

Many candidates used poor terminology when explaining what happened to the charged balloons. The balloon was frequently described as having a negative pole and many candidates stated “like poles repel” suggesting confusion with magnetism. Some used the word *term* for *charge* as in “like terms repel”.

(a) Some very good answers were seen but there was often confusion which particles moved. To gain full credit the particle (electron or negative particle) and the direction of movement needed to be specified.

(b) (i) The majority of candidates selected the correct option.

(ii) Those candidates that answered correctly in the previous part went on to correctly explain that both balloons had the same charge.

(c) Candidates generally performed well on this part even if they had not done so on previous parts of the question. Most chose diagram R and correctly stated that the hair and balloon had opposite charges.

Question 11

(a) Candidates were often able to state that unsaturated implied the presence of double bonds but many failed to explain that these were between carbon atoms.

(b) (i) Fractional distillation was the only acceptable answer to this question.

(ii) This proved to be a challenging question with few candidates stating that cracking was the process.

(c) Many candidates were capable of drawing a diagram giving the bonding structure of ethene. Care should be taken to show the bonding pairs of electrons in the overlapping parts of the orbitals and that the correct number of non-bonding electrons are drawn in the remainder of the orbital.

Question 12

Terminology used by candidates was often very poor with charges and poles mixed up as well as possibly charges and electric currents. Many candidates found all parts of this question challenging.

(a) (i) Partial credit was available for the idea of repulsion and further credit for the idea that the coil had a magnetic field/became a magnet.

(ii) Many candidates assumed the plastic sheet just fell down and did not interpret the reversing of connections to the pole as being a reversing of the current in the coil.

(b) Many candidates seemed to have overlooked that the question stated that the apparatus was a simple loudspeaker. Therefore many explained that a sound would be produced when the plastic sheet hit the cup which was not an acceptable answer. A minority of candidates realised that the sheet would move rapidly up and down but very few went on to say that this would make the air vibrate/cause sound waves in the air.

PHYSICAL SCIENCE

Paper 0652/32
Core Theory

There were too few candidates for a meaningful report to be produced.

PHYSICAL SCIENCE

Paper 0652/41
Extended Theory

Key messages

- Candidates should ensure they read the questions carefully and should provide the exact answer required in the instructions.
- Candidates should ensure they are familiar with the scientific terminology needed to answer questions precisely.

General comments

While there were many stronger answers, candidates showed weakness with their knowledge of energy level diagrams, half-life determinations from graphs, conductors in a magnetic field and rate of reaction.

Candidates who performed well ensured they answered the question asked. If 'in terms of' appears in the question, then answers must relate to this. For example, **Question 5(d)**, 'in terms of proton transfer' – answers had to include a reference to proton transfer. Comments regarding pH or effect on an indicator did not answer the question.

Comments on specific questions

Question 1

(a) (i) Some candidates only repeated the term in their explanation, for example 'it is the centre of mass'; these responses could not receive credit.

(i) The idea that stability is increased was well known.

(ii) Some responses did not include labels or used diagonal lines. Some candidates did not answer this question.

(iv) It was common to see a description of a force rather than a stated value of 0 N.

(b) Units were often given incorrectly. Some responses showed a lack of knowledge of the equation for determining kinetic energy, with candidates forgetting to divide by 2.

Answers: **(a)(iv)** 0 N **(b)** 245 000 J

Question 2

(a) There was sometimes a lack of understanding of the difference between particle separation, arrangement and motion.

(b) Most responses stated changing state occurred at **X**. It was less common to see correct descriptions in terms of energy absorbed, forces of attractions broken and increased separation between particles.

Question 3

(a) Most responses gave a clear explanation of convection currents.

(b) (i) It was very common to see explanations that referred to stopping cold escaping.

(ii) Candidates were familiar with delocalised electrons but less confident with the effect of these mobile electrons. It was common to see answers in terms of conduction of electricity.

(c) A minority of candidates stated that heat was reflected, or light was not absorbed.

Question 4

(a) Candidates who used the terms parallel and perpendicular to describe the direction of motion of longitudinal and transvers waves were usual correct. Where those terms were not used, candidates often struggled to express themselves clearly. It was rare to see a description of particle vibration.

(b) Candidates found this question challenging and often discussed waves being spread out.

(c) Many correct calculations were seen. Where errors were made, it was in the recall of the equation. It was common to see speed multiplied by frequency or frequency divided by speed.

(d) This was generally well known. There were a few vague statements such as 'it affects the ear drum' but these were not specific enough for credit.

Answer: **(c)** 1.25 m

Question 5

(a) Many clear explanations were given.

(b) Most responses gave a correct value for the M_r.

(c) Many candidates were not familiar with what constitutes a hydrocarbon and thought the presence of a double C = C bond made ibuprofen not a hydrocarbon.

(d) Most candidates were able to define an acid as a proton donor. It was not sufficient to restate the question and refer to transfer of protons, without stating the direction of transfer. A few candidates discussed pH and effect on universal indicator or litmus but these responses did not answer the question.

(e) (i) A common error was to give the formula an overall negative charge.

(ii) Oxygen and nitrogen were common errors.

(f) Many candidates stated fractional distillation but not all discussed evaporating the ethanol. Almost all responses included a comment about avoiding a naked flame.

Answer: **(b)** 206

Question 6

(a) Most candidates were able to determine the A_r of CO_2 correctly or were able to obtain credit due to an error carried forward. Candidates who performed well showed all of their workings and set these out in a clear and logical way.

(b) The production of carbon monoxide was well known. There was some confusion about acid rain and global warming.

(c) Candidates found this challenging. Ionic attempts were common, missing double bonds and more than 8 electrons in outer shells were seen.

(d) **V** was often overlooked. Some responses stated covalent compounds had high melting points.

Answer: **(a)** 14.67 g

Question 7

(a) (i) Most responses determined a correct value for total resistance.

(ii) The current was usually correct. Stronger candidates tended to include an expression for determining current.

(iii) The power was usually correct. Stronger candidates tended to include an expression for determining power.

(b) Many candidates found this question challenging. A common error was to include the 6 Ω resistor in the calculation. It was also common to see determinations based on resistance in series.

Answers: **(a)(i)** 4.5 Ω **(ii)** 2.0 A **(iii)** 18 W **(b)** 2.57 Ω

Question 8

(a) Many correct responses were seen.

(b) (i) Fermentation was usually given. Incorrect responses included cracking and oxidation.

(ii) Solvent and fuel were correctly seen in many answers. Using ethanol as an alcohol was not sufficient to gain credit as candidates were told this in the question.

(c) (i) This was not well known and many responses incorrectly referred to rate of a reaction.

(ii) Candidates were not confident with rate of reaction. Many answers stated that reaction rate decreased. Many responses referred to surface area. It was rare to see correct responses in terms of collisions.

(d) Candidates found this particularly challenging with diagonal and vertical lines seen. Many responses indicated a lack of knowledge of energy level diagrams.

Question 9

Candidates found this question one of the most challenging on the paper.

Question 10

(a) (i) There was a general confusion between oxidising and reducing agents. Some candidates were too vague in their explanations and it was not clear whether responses referred to the oxidising agent being oxidised or that these agents cause oxidation in another substance.

(ii) Many answers referred to the reactivity series rather than decreasing reactivity down Group VII.

(b) Stating ‘iodide’ as a product was common, as was ‘bromine iodide’.

(c) The symbol and melting point were usually correct. Liquid was a common incorrect state and a darker colour was often incorrect or missing.

Question 11

(a) Many responses did not include a correct beta particle. Those that did, often determined an incorrect atomic number for Pb.

(b) Candidates were unfamiliar with how to determine half-life from a graph and found this question the most challenging one on the paper. Only the strongest candidates answered correctly and many other candidates did not offer an answer.

PHYSICAL SCIENCE

Paper 0652/42
Extended Theory

Key messages

- Candidates should ensure they read the questions carefully and should provide the exact answer required in the instructions.
- Candidates should ensure they are familiar with the scientific terminology needed to answer questions precisely.

General comments

While there were many stronger answers, candidates showed weakness with their knowledge of energy level diagrams, rate of reaction and work done calculations.

Candidates who performed well ensured they included their working in any calculations. This included a full expression such as $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ rather than simply $\frac{1}{R_1} + \frac{1}{R_2}$ or W = mgh rather than mgh.

Comments on specific questions

Question 1

(a) (i) Many candidates were not familiar with a balance. The answer of 'scales' was not sufficient to gain credit.

(ii) Some good descriptions were seen that included identifying a suitable container to carry out the experiment. Candidates who performed less well referred to beakers and did not specify that the volume of water should be measured. Vague terms such as 'level' were commonly used.

(b) The calculation for the density of the rock was usually correct.

(c) (i) The method for determining work done was not well known. Common errors included multiplication by two lots of 10 and incorrect recall of the equation, W = mgh.

(ii) Friction was usually correctly stated.

Question 2

(a) Some candidates were not clear about the meaning of particle separation, arrangement and motion. Solid and gases were sometimes confused.

(b) There were many good explanations about what is happening between points A and B on the graph. Most candidates stated that the temperature is constant and recognised that this corresponded to a change in state. It was less common to see further detail, such as that heat or energy is released.

Question 3

(a) The names of both waves were well known.

(b) (i) It was insufficient to state that point **Y** is near red light.

(ii) Most candidates knew that black is a good absorber of radiation.

(c) Many responses identified rarefactions and compressions but did not reference particle vibration. Common errors included identifying sound waves as transverse and referring to sound waves as moving perpendicular.

Question 4

(a) It was well known that a range of temperatures for melting point indicated impurities.

(b) (i) Common errors included using coloured dyes, or universal indicator.

(ii) Some of the descriptions given did not refer to the spots and simply discussed comparing the chromatograms, without saying what needed to be compared. A minority referred to Rf values.

(c) The M_r was usually determined correctly.

(d) Stronger responses referred to the presence of carbon-carbon double bonds rather than just double bonds.

(e) The formula was often correctly determined. Occasionally, ions with a – or + charge were given.

(f) (i) A difference in the number of neutrons was well known. A few responses stated a difference in proton number.

(ii) Stronger responses included the idea that it was the outer shell electrons that are the same. It was not sufficient to refer to the same number of electrons alone.

Question 5

(a) The reflected ray was usually correctly drawn with a ruler and protractor to ensure the angle of incidence equalled the angle of reflection. The image was often positioned in an incorrect location.

(b) (i)(ii) The ray through **C** was usually correctly shown. However, the ray which should have been initially parallel with the principal axis, did not always then go through **F**.

(c) A few real and diminished characteristics were seen.

Question 6

(a) The mass of ammonia was often correct. Some errors were seen with the *M*r of ammonia and the mole ratio.

(b) Occasionally, double or single bonds between the two nitrogen atoms were seen. Good responses labelled each atom with N to indicate the diagram represented nitrogen, N_2. Errors were seen in the number of lone pairs in each N atom.

(c) (i) It was rare to see a correct word equation for nitrogen monoxide reacting with carbon monoxide. Some candidates chose to give symbol equations and these were usually incorrect. If a word equation is asked for, this is what is expected as the response.

(ii) The role of a catalyst to increase the rate of the reaction was well known.

Question 7

(a) (i) The resistance in parallel was often confused with series. Better responses included an expression such as $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$. Weaker responses omitted this entirely or simply state $\frac{1}{R_1} + \frac{1}{R_2}$; this was not sufficient as it is not clear whether it referred to $\frac{1}{R}$ or R.

(ii) Total resistance was usually correct.

(iii) The current was often correct.

(iv) Some responses rounded to one significant figure; two significant figures were expected.

(b) (i) Candidates found this question challenging and were confused about resistance decreasing and current increasing. Vague or incorrect comments about voltage were often incorrect.

(ii) This was often incorrect. Some candidates answered in terms of a parallel circuit and domestic lights.

Answers: **(a)(i)** 2.0 Ω **(ii)** 50 Ω **(iii)** 0.12 A **(iv)** 5.8 V

Question 8

(a) A reference to being an alcohol was usually correctly stated.

(b) Some responses incorrectly stated combination reactions.

(c) Candidates were unfamiliar with the reason why the rate of reaction increases. Many responses did not refer to collisions.

(d) Many responses were incorrect or the question was left blank. Candidates did not appear to be confident with energy level diagrams. The direction of the arrow heads was often correct. Equally, diagonal, curved and horizontal lines were seen.

Question 9

(a) Most candidates knew that alpha particles are positive charged and that opposite charges attract.

(b) The attraction to the positive plate was well known. The deflection being greater than that for alpha particles was less well known.

(c) The equation for the emission of an alpha particle was usually correctly shown.

Question 10

(a) (i) Some candidates referred to bromide instead of bromine. Some responses made chlorine bromide.

(ii) It was common to see oxidation or reduction but this was not sufficient as both were required.

(b) Candidates appeared reluctant to predict there would be no reaction. Astatine was sometimes referred to as a noble gas or thought to be more reactive than chlorine. Occasionally, the reactivity of sodium was discussed.

(c) The symbol for iodine and its melting point were usually correct. The state was often given as solid and a lighter colour was sometimes not suggested.

PHYSICAL SCIENCE

Paper 0652/51
Practical Test

Key messages

To do well in this examination, candidates need to have a thorough grounding in 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. The majority of candidates were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of both practical tests were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. However some candidates seemed less able to derive conclusions backed up by evidence they had gathered.

Comments on specific questions

Question 1

(a) (i) Most candidates produced a full set of temperatures for the addition of the pieces of magnesium ribbon to the hydrochloric acid. Despite the instruction that the temperatures were to be recorded to the nearest 0.5 °C, it was obvious from the results of many candidates that this instruction had been ignored. Most sets of results, as expected, showed an increase in the highest temperature reached as the number of pieces of magnesium ribbon added to the acid increased.

(ii) The rise in temperature for each reaction was usually calculated correctly.

(b) Most candidates were able to describe at least one observation that they made to show that the magnesium had reacted completely with the hydrochloric acid. The most common observations given were that the magnesium ribbon disappears, and that the temperature of the mixture stops rising.

(c) The relationship between the number of pieces of magnesium ribbon and the temperature rise of the reaction was deduced correctly by the majority of candidates from the results that they had recorded. However, some candidates merely stated that the temperature increased as the number of pieces of magnesium ribbon increased.

(d) A correct control variable for this reaction was identified by the majority of candidates. The most common correct answers were concentration/volume of acid.

(e) (i) Only a minority of candidates gained any credit here. Although many candidates stated the colour of the universal indicator in the hydrochloric acid correctly, far fewer were able to describe the colour changes which took place in the boiling tube.

(ii) The gas given off during the reaction was usually identified correctly as hydrogen. Most candidates were able to describe the test they used.

(f) The standard of diagram drawing was poor. Many diagrams were drawn free hand, without the use of a ruler. Many candidates gained partial credit by drawing a flask/closed container connected to a delivery tube. However, many candidates ignored the instruction given in the question to collect and measure the volume of the gas collected. The gas collection apparatus needed to be a syringe or an upturned measuring cylinder in water. The instruction to draw a diagram and to label it was frequently ignored.

Question 2

(a) The height of the triangular-shaped hole of the illuminated object was usually present and measured correctly to the nearest millimetre.

(b) The table was usually completed and the value of the ratio of object to image height, *J*, calculated correctly for each distance of the illuminated object from the lens.

(c) (i) Although most candidates used linear, labelled scales on the axes of their graphs, in many cases the scale chosen was too small. Many candidates ignored the instruction given in the question, that there was no need to start the graph at the origin (0, 0). Generally, candidates should make sure that the scale that they choose enables at least half of the grid space to be occupied.

Most points were plotted accurately and were within half of a small grid square of the actual value.

(ii) Many candidates produced well-judged, best-fit, straight lines. There was a tendency for the best-fit lines to be drawn too thickly. Candidates should attempt to make the thickness of their graph lines no thicker than the thickest lines on the grid provided. A few candidates drew point-to-point graphs.

(d) Although most candidates understood what the term *gradient* meant, there were many poor gradient calculations. Candidates often used data points from the table that did not lie on their best-fit line or chose points which were too close together. The instruction to indicate on the graph the values chosen to calculate the gradient, was frequently ignored.

(e) Stronger candidates were able to state one precaution that they took whilst carrying out their experiment to ensure that their readings were as accurate as possible. Acceptable answers were to use a darkened room/mark the position of the centre of lens on the holder/ensure that the object and the (centre of) the lens are at the same height/move the screen slowly to obtain the sharpest image.

(f) Candidates found the final part of the question challenging. Only a small minority of candidates were able to suggest a sensible improvement to the arrangement of the apparatus to overcome the stated difficulty. Suitable improvements include fixing a ruler or grid to the screen/support the ruler in a stand/use a translucent screen and view from behind.

Question 3

(a) (i) Most tables were complete with the lengths l of the spring recorded for the different loads. In the majority of cases all values of length l were increasing. Occasionally the length values were not recorded to the nearest millimetre, as requested in the question.

(ii) The extensions *x* of the spring for the different loads were almost always calculated correctly.

(b) Most candidates substituted correctly into the given equation and obtained a value for k_1, the spring constant of the spring. Candidates were asked to record their answers to a suitable number of significant figures. Any value of k_1 expressed to 2 or 3 significant figures was accepted.

(c) (i) A sensible value of the length of the series combination of the two springs was usually recorded.

(ii) Most candidates measured and recorded the length of the series combination of springs when a 3.0 N load was added. The extension of the combined springs was usually calculated correctly.

(d) Most candidates substituted correctly into the given equation and obtained a value for k_2, the spring constant of the combined springs.

(e) Most candidates were able to state whether or not their results supported the statement given.

Far fewer candidates were able to give a convincing justification for their statements. The idea of experimental tolerances and whether two quantities are close enough to be considered equal was not well understood by the majority of candidates. Generally, if the values differ by 5 per cent or less, the expected answer is “yes, they are the same”. If the values differ by more that 10 per cent the expected answer is “no, they are different”. Between the values of 5 per cent and 10 per cent, either answer is acceptable provided that it is qualified by a phrase, such as “yes, they are close enough” or “no, they are too far apart” to be considered equal.

(f) Many candidates suggested a sensible change to the procedure that would enable the student to investigate the relationship between k_2 and k_2 in more detail. The most common correct answer was to use a greater range of loads.

Question 4

Candidates were asked to state the apparatus needed to carry out the investigation. Most candidates realised that a container of some sort e.g., test-tube, beaker or a conical flask would be needed to hold the juice. Far fewer mentioned that a pipette/burette or measuring cylinder would be needed to measure the volume of alkali added to the lemon juice or the lime juice. Descriptions of the method were often vague, lacked structure and a logical sequence.

Candidates should be encouraged to consider the separate stages involved in performing the investigation before they start to construct their response.

Candidates were required to include a brief description of the method used to implement the plan and to state and explain any safety precautions taken, and why these were needed. Many candidates did not mention that an indicator would be needed to determine when the acid in the fruit juice had been neutralised by the aqueous sodium hydroxide. Details of how the exact end point of neutralisation would be determined were frequently absent from the description. Most candidates mentioned the use of goggles as a safety precaution, but did not state why they were needed, as requested in the question.

Most candidates listed a relevant control variable in this investigation, usually that the same volume/amount of juice and/or indicator should be used.

Although most candidates stated that the volumes of the fruit juice taken should be measured, most omitted to state that the volume of aqueous sodium hydroxide needed to neutralise the acid in the fruit juices needed to be measured as well. Of the minority of candidates who mentioned this, few actually explained how the volume would be determined.

Only a few candidates explained how the results would be processed so that a conclusion could be drawn. Stronger candidates correctly stated that the larger the volume of aqueous sodium hydroxide needed to neutralise the acid in the juice, the more acid that the juice contained.

PHYSICAL SCIENCE

Paper 0652/52
Practical Test

Key messages

To do well in this examination, candidates need to have a thorough grounding in 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. The majority of candidates were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of both practical tests were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. However some candidates seemed less able to derive conclusions backed up by evidence they had gathered.

Comments on specific questions

Question 1

(a) (i) Most candidates produced a full set of volumes for the mixture of hydrochloric acid and magnesium ribbon over the four-minute period of timing. Most sets of results, as expected, showed a continual increase in the volume of gas produced.

(ii) As in **(i)**, most candidates produced a full set of volumes for the mixture of hydrochloric acid and magnesium ribbon over the four-minute period of timing. Most sets of results, as expected, showed a continual increase in the volume of gas produced, but with smaller volumes of hydgrogen gas produced every 30 s.

(b) Although most candidates used linear, labelled scales on the axes of their graphs, in many cases the scale chosen was too small. Candidates should usually make sure that the scale that they choose enables at least half of the grid space to be occupied. Most points were plotted accurately and were within half of a small grid square of the actual value.

The instruction to draw two lines of best fit was usually followed. Despite the instruction to label the lines H and J being given in the question, some candidates did not do this.

(c) Most candidates deduced correctly from their graphs which of the two acids H or J was the more concentrated by comparing the gradients of the graphs.

(d) Candidates usually gained at least partial credit by drawing a line above line H. Only a small minority of stronger candidates realised that the line they had drawn should end at the same volume of hydrogen, as their previous line.

(e) Many candidates gave a sensible suggestion about how to make a change to the apparatus to improve the accuracy of the investigation. Candidates did not realise that the measuring cylinder should be replaced by a pipette/burette or a syringe so that a more accurate value of the volume of gas produced could be recorded.

Question 2

(a) A sensible value for the unstretched length of the spring was usually recorded to the nearest millimetre. Occasionally it was obvious that the loops at the end of the spring had been included in the measurement, despite the instruction not to do so.

(b) The length of the spring after the 300 g mass had been added was usually recorded and the corresponding extension of the spring calculated correctly.

(c) Most candidates substituted correctly into the given equation and obtained a value for *k*, the spring constant of the spring.

(d) (i) The time for 20 oscillations of the mass on the spring was usually recorded, but its value often fell outside the range accepted. A range of 12 s to 14 s was allowed. It was obvious from the times recorded by many candidates that they had timed half-oscillations, and not full oscillations even though the diagram given in the question explained exactly what was meant by 1 complete oscillation.

(ii) Most candidates divided their answer to **(i)** by 20 correctly to record the period of oscillation of the mass on the spring.

(iii) The value of T^2 was usually calculated correctly, but was not always expressed to 2 significant figures, as asked for in the question.

(e) Most candidates substituted correctly into the given equation and obtained a value for *k*, the spring constant of the spring.

(f) Most candidates were able to state whether or not their two values of *k* agreed with each other within the limits of experimental error. Far fewer candidates were able to give a convincing justification for their statements. The idea of experimental tolerances and whether two measured quantities are close enough to be considered equal was not well understood by the majority of candidates. Generally, if the values differ by 5 per cent or less, the expected answer is “yes, they are the same”. If the values differ by more than 10 per cent the expected answer is “no, they are different”. Between the values of 5 per cent and 10 per cent, either answer is acceptable provided that it is qualified by a phrase, such as “yes, they are close enough” or “no, they are too far apart” to be considered equal.

(g) Many candidates explained how to avoid line-of-sight (parallax) errors when measuring the length of the spring. The idea of viewing perpendicularly to the scale, at the reading being taken, was well known. Far fewer gave an adequate explanation of how to avoid parallax errors whilst timing the oscillations. The idea of having one’s eye at the same level as the top/bottom/middle of the oscillations (depending upon where they were timing from) was not known to most candidates.

Question 3

(a) Most candidates knew the symbol for a voltmeter and drew it connected correctly so that the potential difference between P and Q could be measured.

(b) Sensible values of the current and potential difference were usually recorded in the table.

(c) The values of the current and the potential difference across P and Q were usually recorded, but often not to the precision required. Some candidates had obviously reconnected the lamps incorrectly because the current recorded was greater than that recorded in **(b)**, when it should have been less.

(d) (i) The unit of resistance, the ohm, was known by the majority of candidates.

(ii) The resistance of circuits 1 and 2 was usually calculated correctly. Answers were accepted to any number of significant figures >1.

(e) Most candidates were able to state whether or not their results supported the statement given. Far fewer candidates were able to give a convincing justification for their statements. The idea of experimental tolerances and whether two quantities are close enough to be considered equal is not well understood by the majority of candidates. Generally, if the values differ by 5 per cent or less, the expected answer is “yes, they are the same”. If the values differ by more than 10 per cent the expected answer is “no, they are different”. Between the values of 5 per cent and 10 per cent, either answer is acceptable provided that it is qualified by a phrase, such as “yes, they are close enough” or “no, they are too far apart” to be considered equal.

(f) There were some good attempts at answering this more challenging final part to the question. Stronger candidates used the information given in the question and realised that the two lamps are at different temperatures or would have different resistances than expected.

Question 4

Candidates were asked to state the apparatus needed to carry out the investigation. Most candidates realised that a container of some sort e.g., test-tube, beaker, evaporating basin or a conical flask would be needed to hold the acid. Far fewer mentioned that a pipette/burette or measuring cylinder would be needed to measure the volume of aqueous sodium hydroxide added to the acid. Descriptions of the method were often vague, lacked structure and a logical sequence.

Candidates should be encouraged to consider the separate stages involved in performing the investigation before they start to construct their response.

Candidates were required to include a brief description of the method used to implement the plan and to state and explain any safety precautions taken. Many candidates did not mention that an indicator would be needed to be added to the hydrochloric acid to determine when the acid had been neutralised by the aqueous sodium hydroxide. Details of how the exact end point of neutralisation would be determined were frequently absent from the description.

The instruction to prepare a sample of sodium chloride solid was often ignored. Few candidates mentioned that the resulting sodium chloride solution should be heated to remove the water.

Most candidates mentioned the use of goggles as a safety precaution, but did not state why they were needed, as requested in the question.

Although most candidates stated that the volume of the hydrochloric acid used should be measured, most omitted to state that the volume of aqueous sodium hydroxide needed to neutralise the acid needed to be measured as well. Of the minority of candidates who mentioned this, few actually explained how the volume would be determined.

The reference to preparing a pure sample of sodium chloride was almost always ignored. Only a few candidates stated that to prepare a pure sample, the experiment should be repeated without adding the indicator once the volume of aqueous sodium hydroxide needed for neutralisation had been determined.

PHYSICAL SCIENCE

Paper 0652/61
Alternative to Practical

Key messages

- Candidates should be reminded to read questions carefully to ensure they are clear on the exact requirements.
- Teachers are encouraged to allow candidates to undertake as much laboratory work as possible in preparation for this paper.
- Candidates must match the degree of approximation of values already present when entering values in a table, and when given a choice must give as many significant figures as the minimum in the data provided but not more than can be justified in the context of the experiment.
- Candidates need more experience in predicting numerical values from established trends in given data.
- Candidates must show working on a graph when instructed to do so.
- Candidates should be reminded to address all the bullet points in the planning question as often this limited their answers.

General comments

The paper proved accessible to most candidates. There were very few questions left unanswered and candidates appeared to have sufficient time to complete the paper.

Most candidates seemed reasonably familiar with all the syllabus content. General areas of weakness include degree of approximation, graph drawing, practical based comments, and giving suggestions for improvements in terms of procedure and accuracy of results. A few candidates were unable to make a simple measurement or to read a value from a basic scale accurately.

Comments on specific questions

Question 1

(a)–(g) Candidates needed to answer questions on the temperature and pH changes in the reaction between hydrochloric acid and magnesium.

Most candidates could read thermometers, but 1dp was needed in all readings to match the data in the table.

As the number of strips of magnesium increased, the temperature rise or change increased, and the amount of acid needed to be controlled, not the temperature which was changing.

Here, too few candidates considered improved accuracy of volume measurement or prevention of heat loss, instead falling back on 'repeating and averaging'. Repeating and averaging in this case would simply have recorded similar measurements

The predicted heat rise should have been about twice the 5 pieces value and often was, but a lack of understanding of the concept of excess was sometimes evident..

(h) Most candidates realised that the magnesium was at least used up, but there were several references to the reaction with magnesium instead of relating specifically to the process being followed by the acid. When testing for hydrogen the splint must be lit/burning, not glowing.

(i) Drawing skills were variable, but most candidates drew a recognisable reaction vessel. However, fewer labelled a syringe for gas measurement. Quite a few candidates did not attempt a drawing.

Question 2

Candidates were required to investigate the magnification produced by a converging lens, including the graphical representation of the variation in image height with the distance between object and lens, and to comment on the method.

(a) Most candidates were able to measure the height of the triangle, to evaluate J and enter the information in a table to match the accuracy of given values.

(b) Graphical representation of data was not always strong enough in this question. Axes were not labelled or were reversed in equal numbers. The chosen scales must ensure that the plotted points cover at least half the scale in both directions, and the presence or not of an origin must be carefully considered before beginning to plot points to avoid running out of space and changing the scale to enable all points to be plotted. Errors in plotting often occur to the right of a graph.

Most candidates drew a best-fit straight line.

(c) Often there was a lack of any evidence on the graph of a gradient having been measured. Ideally a large triangle was expected, but two sets of coordinates, two pairs of horizontal and vertical lines, or even the ringing of two points were also accepted.

(d) Sensible precautions were rarely seen. These included the slow movement of the screen to obtain the best image and the use of a darker room or brighter lamp. Reference to zero errors on rulers or reading at eye-level were not credited here.

(e) Most candidates did not realise that both the ruler and the hand must not interfere with the light source, so use of a clear ruler did not fully answer the question. Stronger candidates realised that it should be viewed from behind and for that, there needed to be a translucent screen, or they attached a grid to the screen. Unacceptable answers included turning the light off or moving it so that it could not cast a shadow.

Question 3

Candidates needed to measure the length of an unstretched spring, to compare with it the different lengths when varying loads were attached, to calculate a spring constant for one spring, and then two, and finally to compare them.

(a) Several candidates could interpret the ruler scale, but there were a number of candidates who either misinterpreted the scale or did not subtract in order to find a difference.

(b) Many candidates correctly suggested reading at eye-level, with or without a fiducial aid, but keeping the spring still was not judged worthy of credit.

(c) Some candidates did not read the instructions as to how to calculate x. Instead they subtracted l from L. They gained some credit if all answers were to one decimal place to match the other values in the table.

(d) More practice is needed in spotting patterns which allows correct numerical predictions.

(e) All data was given to a minimum of two significant figures. Therefore, in the context of the experiment two or three significant figures were allowed.

(f) The spring constant for the combined strings was calculated correctly by most candidates. However, comments on the suggestion being supported by the values within experimental error

needed a comparison of their figures and an implicit understanding of needing to halve the single spring constant to determine that of the combined springs.

(g) Some candidates realised that repeating the experiment for a wider range of loads, or repeating and averaging, would allow more detailed investigation of the relationship. However, several candidates wanted to separate the springs and work on them individually. There was very little mention of constructing a graph.

Question 4

Candidates needed to plan an experiment to compare the amount of acid in lemon juice and in lime juice.

Stronger candidates planned their answer before beginning to write it up and noted all of the given bullet points. Apparatus marks were scored from a labelled diagram.

Some weaker candidates seemed unfamiliar with the concept of titration, and confused strength and concentration of acids, so used the colour of the added universal indicator to incorrectly compare strength rather than amount. There were also suggestions of collecting the gases released in gas syringes, use of reactions to form a precipitate which could be dried and weighed, or fractional distillation of the two juices. However these candidates gained some credit if they addressed both apparatus and method, including the control of variables and consideration of safety.

PHYSICAL SCIENCE

Paper 0652/62
Alternative to Practical

There were too few candidates for a meaningful report to be produced.