PHYSICAL SCIENCE

Paper 0652/11
Core Multiple Choice

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

General comments

Candidates found **Questions 4, 8, 16, 19, 20, 23**, **27**, **35**, **36**, **40** and, particularly, **Question 22** more challenging.

Comments on specific questions

Question 1

A large proportion of the candidates understood that the particles in a solid are very close together.

Question 2

Most candidates knew that petroleum is separated by fractional distillation.

Question 3

Almost all of the candidates were able to identify the electron. However, there was some confusion about the identity of the proton and neutron amongst the weaker candidates.

Question 4

The properties of simple covalent compounds were not well known.

Question 5

Many of the candidates were able to determine the formula of the compound.

Question 6

Almost all candidates recognised that the reaction is exothermic but a significant number of candidates thought that the temperature of the solution decreased and chose option **C**.

Question 7

Most candidates recognised that an increase in the temperature increases the rate of the reaction.

Question 8

The fact that a significant number of the candidates chose option **C** indicated that there was a misunderstanding about the definition of oxidation and reduction.

Question 9

This question proved to be easy for a large proportion of the candidates.

Question 10

The test for oxygen and the approximate percentage of oxygen in the air were well known by a majority of the candidates.

Question 11

Most candidates recognised that metals are placed on the left hand side of the Periodic Table but the nature of the oxides was less well known even by stronger candidates.

Question 12

Candidates should be aware that the noble gases are unreactive and therefore are used to provide an inert atmosphere.

Question 13

The composition of brass was well known by many candidates.

Question 14

Most of the candidates were able to work out the reactivity of **Z** and **X** but many thought that **Y** was more reactive than **W** and chose option **B**.

Question 15

The chemical test for water was well known, particularly by stronger candidates.

Question 16

There was evidence of guesswork particularly amongst the weaker candidates.

Question 17

Most candidates recognised that hydrogen does not produce carbon dioxide when it is burned.

Question 18

Many candidates found this question challenging. The properties of alkanes were not well known or understood by many of the candidates.

Question 19

The idea that an unsaturated hydrocarbon contains a carbon to carbon double bond was not well understood by many candidates. A number candidates focused on the presence of a double bond and chose option **B**.

Question 20

Stronger candidates recognised that ethanol is used as a solvent but a significant proportion of the weaker candidates thought that it is used as a monomer in the manufacture of addition polymers and chose option **C**.

Question 22

In this question about a speed-time graph a large proportion of candidates failed to divide the final (maximum) speed by two when calculating the distance travelled, and therefore chose option **D** (100 m).

Question 23

Here the topic of mass and weight caused difficulty. Weaker candidates divided the mass in grams by 10 and stronger candidates multiplied it by 10, with both groups often failing to convert to kilograms first.

Question 27

Many candidates failed to recognise a geothermal power station, believing the source of energy to be either coal or gas.

Question 28

Weaker candidates appear to have guessed the answer to this question on convection and density.

Questions 29 and 30

These two questions on waves and the image formed by a plane mirror were the best answered in the physics section.

Question 35

This question on lamps in series and in parallel was challenging for candidates of all abilities.

Question 36

Many candidates believed that the combined resistance of the two resistors in parallel was greater than 20 Ω. These candidates probably confusing this with a series connection.

Question 40

A popular choice in this question on half-life was option **C**, this being half of the total time of decay.

PHYSICAL SCIENCE

Paper 0652/12
Core Multiple Choice

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

General comments

Candidates answered **Questions 2, 5, 8, 10, 13, 15, 16**, **22**, **24**, **35** and **39** very well. Those causing the greatest difficulty were **Questions 17, 18, 20**, **32**, **36**, **40** and, particularly, **Questions 26**, **29** and **38.**

Comments on specific questions

Question 1

A large proportion of the candidates thought that a liquid does not have a fixed shape.

Question 2

This proved to be an easy question for stronger candidates.

Question 3

Almost all candidates recalled that the aqueous sodium hydroxide is a solution but there was some confusion about the words solvent and solute.

Question 4

The properties of ionic and covalent compounds were quite well known by stronger candidates.

Question 5

Many of the candidates were able to determine the formula of the compound.

Question 6

Stronger candidates recognised that a decrease in the temperature of the reaction mixture is caused by an endothermic reaction.

Question 7

The vast majority of the candidates recognised that an increase in the temperature increases the rate of the reaction.

Question 8

Ideas about oxidation and reduction were well understood by many candidates.

Question 9

The fact that non-metal oxides are acidic was well known by candidates.

Question 10

The test for ammonia was well known by the vast majority of the candidates.

Question 11

The position of metals in the Periodic Table was is known by the vast majority of candidates.

Question 12

The reactivity of Group I elements and their reaction with water were well understood by stronger candidates.

Question 13

The properties of metals were well known by the vast majority of the candidates.

Question 14

Most of the candidates were able to work out the reactivity of **Z** and **X** but many of these candidates thought that **Y** was more reactive than **W** and chose option **B**.

Question 15

The chemical test for water was well known.

Question 16

The composition of clean air was well known.

Question 17

Stronger candidates understood that heating limestone causes it to undergo thermal decomposition.

Question 18

There was evidence of widespread guesswork even amongst stronger candidates. The properties of alkanes were not well known or understood by many of the candidates.

Question 19

The idea that an unsaturated hydrocarbon contains a carbon to carbon double bond was not well understood by many candidates. A significant proportion of the candidates focused on the presence of a double bond and chose option **B**.

Question 20

The use of ethanol as a fuel was not well known even by some stronger candidates.

Question 26

This question was about a gas being cooled at constant pressure, and every incorrect option was more popular than the correct option **A**. There seems to have been widespread confusion about the relationship between particle motion and the pressure and temperature of a gas.

Question 29

Almost all candidates took the given angle of 40° as the angle on incidence, rather than subtracting this from 90°; they therefore also chose this as the angle of reflection (option **A**).

Question 32

There was confusion about the nature of waves used for satellite television transmission, with many candidates choosing radio waves.

Question 36

There was a widespread belief here that the combined resistance of the two resistors in parallel was greater than 20 Ω, and these candidates probably confused this with a series connection.

Question 38

Generally candidates did not recognise that in order for the direction of the force to remain unchanged, the two changes must be to reverse the directions of both the current and the magnetic field.

Question 40

The topic here was half-life. Many candidates divided the initial rate of emission by four, rather than halving it four times.

PHYSICAL SCIENCE

Paper 0652/13
Core Multiple Choice

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

General comments

Candidates found **Questions 4, 8, 16, 19, 20, 23**, **27**, **35**, **36**, **40** and, particularly, **Question 22** more challenging.

Comments on specific questions

Question 1

A large proportion of the candidates understood that the particles in a solid are very close together.

Question 2

Most candidates knew that petroleum is separated by fractional distillation.

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Almost all of the candidates were able to identify the electron. However, there was some confusion about the identity of the proton and neutron amongst the weaker candidates.

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The properties of simple covalent compounds were not well known.

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Many of the candidates were able to determine the formula of the compound.

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Almost all candidates recognised that the reaction is exothermic but a significant number of candidates thought that the temperature of the solution decreased and chose option **C**.

Question 7

Most candidates recognised that an increase in the temperature increases the rate of the reaction.

Question 8

The fact that a significant number of the candidates chose option **C** indicated that there was a misunderstanding about the definition of oxidation and reduction.

Question 9

This question proved to be easy for a large proportion of the candidates.

Question 10

The test for oxygen and the approximate percentage of oxygen in the air were well known by a majority of the candidates.

Question 11

Most candidates recognised that metals are placed on the left hand side of the Periodic Table but the nature of the oxides was less well known even by stronger candidates.

Question 12

Candidates should be aware that the noble gases are unreactive and therefore are used to provide an inert atmosphere.

Question 13

The composition of brass was well known by many candidates.

Question 14

Most of the candidates were able to work out the reactivity of **Z** and **X** but many thought that **Y** was more reactive than **W** and chose option **B**.

Question 15

The chemical test for water was well known, particularly by stronger candidates.

Question 16

There was evidence of guesswork particularly amongst the weaker candidates.

Question 17

Most candidates recognised that hydrogen does not produce carbon dioxide when it is burned.

Question 18

Many candidates found this question challenging. The properties of alkanes were not well known or understood by many of the candidates.

Question 19

The idea that an unsaturated hydrocarbon contains a carbon to carbon double bond was not well understood by many candidates. A number candidates focused on the presence of a double bond and chose option **B**.

Question 20

Stronger candidates recognised that ethanol is used as a solvent but a significant proportion of the weaker candidates thought that it is used as a monomer in the manufacture of addition polymers and chose option **C**.

Question 22

In this question about a speed-time graph a large proportion of candidates failed to divide the final (maximum) speed by two when calculating the distance travelled, and therefore chose option **D** (100 m).

Question 23

Here the topic of mass and weight caused difficulty. Weaker candidates divided the mass in grams by 10 and stronger candidates multiplied it by 10, with both groups often failing to convert to kilograms first.

Question 27

Many candidates failed to recognise a geothermal power station, believing the source of energy to be either coal or gas.

Question 28

Weaker candidates appear to have guessed the answer to this question on convection and density.

Questions 29 and 30

These two questions on waves and the image formed by a plane mirror were the best answered in the physics section.

Question 35

This question on lamps in series and in parallel was challenging for candidates of all abilities.

Question 36

Many candidates believed that the combined resistance of the two resistors in parallel was greater than 20 Ω. These candidates probably confusing this with a series connection.

Question 40

A popular choice in this question on half-life was option **C**, this being half of the total time of decay.

PHYSICAL SCIENCE

Paper 0652/21
Extended Multiple Choice

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

General comments

Questions 7, 14, **17**, **18**, **22**, **26**, **27** and **34** were found to be the most difficult questions on this paper.

Comments on specific questions

Question 1

A large proportion of the candidates understood that the particles in a solid are very close together.

Question 2

The vast majority of candidates knew that petroleum is separated by fractional distillation.

Question 3

The combination of a metal and non-metal by transfer of electrons forming an ionic compound was well known by stronger candidates.

Question 4

The properties of diamond were well known by a majority of the candidates.

Question 5

This question proved to be easy particularly for stronger candidates.

Question 6

The calculation of the relative formula mass was well done by most candidates

Question 7

A majority of the candidates recognised which bonds are broken in the reaction but a large proportion of even stronger candidates thought that the bond breaking process is exothermic and chose option **D**.

Question 8

The definition of oxidation and reduction was well understood, particularly by stronger candidates.

Question 9

A majority of candidates knew that metallic and non-metallic elements form basic and acidic oxides respectively, but only stronger candidates recognised that they can also form amphoteric and neutral oxides.

Question 10

The link between the number of electrons in the outer shell and group number was well known by the vast majority of the candidates.

Question 11

The relative density of the alkali metals was less well known then the relative reactivity.

Question 12

The composition of brass was well known by many candidates.

Question 13

Stronger candidates identified the order of reactivity of the metals.

Question 14

There was evidence of widespread guesswork even amongst stronger candidates.

Question 15

The chemical test for water was well known, particularly by stronger candidates.

Question 16

Many candidates recognised that hydrogen does not produce carbon dioxide when it is burned.

Question 17

There was evidence of confusion between general formula and molecular formula.

Question 18

There was evidence of widespread guesswork even amongst stronger candidates. The properties of alkanes were not well known or understood by many of the candidates.

Question 19

Many candidates were able to deduce the formula of the hydrocarbon **Y** but a significant number of these candidates thought that **Y** was an alkane and chose option **A**.

Question 20

The idea that an unsaturated hydrocarbon contains a carbon to carbon double bond was not well understood by weaker candidates. Many candidates focussed on the presence of a double bond and chose option **B**.

Question 22

This question about the speed and acceleration of a falling ball before it reaches terminal velocity was only answered well by the strongest candidates. Many candidates chose option **D**, correctly identifying that the speed of the ball would increase, but believing that its acceleration would remain constant. These candidates did not recognise that the increasing air resistance would decrease the acceleration of the ball.

Question 24

Here **B** was the most popular of the incorrect options. This was possibly due to some confusion with moment of a force.

Question 26

The topic of this question was the transfer of kinetic energy to gravitational potential energy. Many opted for **C**, and it would seem that either they omitted the factor of ½ in the formula for kinetic energy or lost it somewhere during their calculations.

Question 27

This was another challenging question for many candidates and weaker candidates appeared to guess. Stronger candidates understood that the change to the capillary bore would decrease the sensitivity of the thermometer, but many also believed that the range would not be affected.

Questions 29

Weaker candidates confused frequency with amplitude here, and chose option **A**.

Question 30

This was generally well answered but there was sometimes a belief that the speed of the light is greater in the glass than in the vacuum.

Question 33

Option **C** was more popular in this question than the correct option, **A**. Candidates choosing **C** failed to convert the time from hours to seconds.

Question 34

Here, option **C** was again chosen by many candidates. This value was obtained by failing to convert the time to seconds, failing to convert the energy to joules, and multiplying the power (or the energy) by the current, instead of dividing. Candidates should be reminded to look carefully at the units used in a question, and to convert them to those that are appropriate to use with a learned equation.

Question 37

This question on transformers was challenging for many weaker candidates who appeared to guess.

Question 40

Half-life was the topic for the final question. Although many candidates correctly deduced that the background count rate was 5 counts per minute, some failed to subtract this value from 25 to find the initial count rate due to the source and therefore chose option **C**.

PHYSICAL SCIENCE

Paper 0652/22
Extended Multiple Choice

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

General comments

In the section **Questions 1, 2, 4, 5, 10, 21**, **23** and **29** were very well answered, with the correct option being chosen for **Question 32** by almost every candidate. **Questions 17**, **18**, **20**, **27** and, particularly **Question 22**, caused more difficulty.

Comments on specific questions

Question 1

A large proportion of the candidates understood that the particles in a solid are very close together.

Question 2

The vast majority of candidates knew that petroleum is separated by fractional distillation.

Question 3

The combination of a metal and non-metal by transfer of electrons forming an ionic compound was well known by stronger candidates.

Question 4

The properties of diamond were well known by a majority of the candidates.

Question 5

This question proved to be easy particularly for stronger candidates.

Question 6

The calculation of the relative formula mass was well done by most candidates

Question 7

Most candidates recognised which bonds were broken in the reaction but a large proportion of even stronger candidates thought that the bond breaking process was exothermic and chose option **D**.

Question 8

The definition of oxidation and reduction was well understood, particularly by stronger candidates.

Question 9

Most candidates knew that metallic and non-metallic elements form basic and acidic oxides respectively but many of even the stronger candidates did not recognise that they can also form amphoteric and neutral oxides.

Question 10

The link between the number of electrons in the outer shell and group number was well known by the vast majority of the candidates.

Question 11

The relative density of the alkali metals was less well known then the relative reactivity.

Question 12

The composition of brass was well known by many candidates.

Question 13

Stronger candidates identified the order of reactivity of the metals.

Question 14

There was evidence of guesswork even amongst stronger candidates.

Question 15

The chemical test for water was well known, particularly by stronger candidates.

Question 16

Most candidates recognised that hydrogen does not produce carbon dioxide when it is burned.

Question 17

There was some confusion between general formula and molecular formula amongst candidates.

Question 18

The properties of alkanes were not well known or understood by a significant proportion of the candidates.

Question 19

Many of the candidates were able to deduce the formula of the hydrocarbon **Y** but a significant number of these candidates thought that **Y** is an alkane and chose option **A**.

Question 20

The idea that an unsaturated hydrocarbon contains a carbon to carbon double bond was not well understood by weaker candidates. A significant proportion of the candidates focussed on the presence of a double bond and chose option **B**.

Question 22

This question about the speed and acceleration of a falling ball before it reaches terminal velocity was only answered well by stronger candidates. Many candidates chose option **D**, correctly identifying that the speed of the ball would increase, but believing that its acceleration would remain constant. These candidates did not recognise that the increasing air resistance would decrease the acceleration of the ball.

Question 26

The topic of this question was the transfer of kinetic energy to gravitational potential energy. Many candidates opted for **C**, and it would seem that either they omitted the factor of ½ in the formula for kinetic energy or lost it somewhere during their calculations.

Question 27

This was another question which challenged many candidates and the incorrect options **C** and **D** were popular choices. Many candidates believed that changing the internal diameter of the capillary bore would have no effect on the range of the thermometer.

Questions 32

The topic here was the ability of sound to travel in a solid but not in a vacuum, and nearly all candidates answered correctly.

Question 33

Option **C** was almost as popular in this question as the correct option **A**. These candidates failed to convert the time from hours to seconds.

Question 34

Here, option **C** was again a common choice. This value was obtained by failing to convert the time to seconds, failing to convert the energy to joules, and multiplying the power (or the energy) by the current, instead of dividing. Candidates should be reminded to look carefully at the units used in a question, and to convert them to those that are appropriate to use with a learned equation.

Question 35

This question was generally well answered, but weaker candidates appeared to have guessed the effect caused by adding a second resistor to the circuit.

Question 40

Half-life was the topic for the final question. Although many candidates correctly deduced that the background count rate was 5 counts per minute, slightly many then failed to subtract this value from 25 to find the initial count rate due to the source, and therefore chose option **C**.

PHYSICAL SCIENCE

Paper 0652/23
Extended Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**B**
2	**D**	22	**C**
3	**C**	23	**D**
4	**A**	24	**A**
5	**B**	25	**B**
6	**C**	26	**B**
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11	**D**	31	**D**
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The vast majority of candidates knew that petroleum is separated by fractional distillation.

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The link between the number of electrons in the outer shell and group number was well known by the vast majority of the candidates.

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The relative density of the alkali metals was less well known then the relative reactivity.

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This question on transformers was challenging for many weaker candidates who appeared to guess.

Question 40

Half-life was the topic for the final question. Although many candidates correctly deduced that the background count rate was 5 counts per minute, some failed to subtract this value from 25 to find the initial count rate due to the source and therefore chose option **C**.

PHYSICAL SCIENCE

Paper 0652/31
Core Theory

Key messages

Candidates should ensure that they read each question carefully and that their responses answer the question as it has been set.

General comments

The paper was accessible with a range of performances seen.

Comments on specific questions

Section A

Question 1

(a) (i) Almost all candidates were able to determine that car C completed the race in the shortest time.

(ii) The majority of candidates were able to recognise that the gradient of the graph gave the acceleration and so correctly selected car C.

(iii) Almost all candidates were able to interpret the graph to establish that car A had the lowest final speed.

(b) This was a far more challenging question and many candidates appeared to have intuitively selected "top speed". Successful candidates used the idea that the distance travelled divided by the time taken gives the average speed, which was the correct answer.

(c) Few candidates were able to identify the area under the curve as being an indication of the distance travelled.

Question 2

(a) The great majority of candidates were awarded at least partial credit with many achieving full credit. There appeared to be some confusion between mass number and atomic number which then led to the wrong number of electrons in a Lithium atom and/or the wrong mass number.

(b) Almost all candidates were able to balance the equation correctly.

Question 3

(a) (i) Any renewable energy source was accepted. Some candidates incorrectly suggested nuclear energy was renewable.

(ii) Any non-renewable energy source was accepted. A small number of candidates seemed to get renewable and non-renewable the wrong way around.

(b) (i) Almost all candidates were able to identify solar power as the most appropriate source.

(ii) Almost all candidates were able to identify hydroelectric power as the most appropriate source.

(iii) Almost all candidates were able to identify geothermal power as the most appropriate source.

(c) (i) The expected answers to this question were the costs of construction, managing nuclear waste and of decommissioning the power station at the end of its life. Other answers like costs of security and safety/health measures were also accepted. Only the strongest candidates gained full credit for this question.

(ii) Many candidates found the question about energy transfers demanding. Many did not recognise that the reference to 'fast moving' indicated that the neutrons had kinetic energy. Far more candidates were able to identify that there was thermal energy in steam.

(d) Stronger answers referred to the larger roofs having a greater surface area. Simply stating that there could be more solar panels was accepted.

Question 4

(a) This question was challenging for many candidates. They often thought of copper compounds and stated that the product would be blue. Those that understood that the product was copper metal were able to give the correct answer.

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(a) (i) The majority of candidates were able to identify the anode and cathode. Some candidates used the correct names but incorrectly labelled the connections to the anode and cathode at the power supply rather than the electrodes themselves.

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Question 7

(a) A common error when drawing the structure of ethane was to omit the C–C bond between the two $–CH_3$ groupings.

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PHYSICAL SCIENCE

Paper 0652/32
Core Theory

Key messages

Candidates should ensure that they read each question carefully and that their responses answer the question as it has been set.

General comments

The paper was accessible with a range of performances seen.

Comments on specific questions

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(a) (i) Almost all candidates were able to determine that car C completed the race in the shortest time.

(ii) The majority of candidates were able to recognise that the gradient of the graph gave the acceleration and so correctly selected car C.

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(a) The great majority of candidates were awarded at least partial credit with many achieving full credit. There appeared to be some confusion between mass number and atomic number which then led to the wrong number of electrons in a Lithium atom and/or the wrong mass number.

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(a) (i) Any renewable energy source was accepted. Some candidates incorrectly suggested nuclear energy was renewable.

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(b) (i) Almost all candidates were able to identify solar power as the most appropriate source.

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PHYSICAL SCIENCE

Paper 0652/33
Core Theory

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PHYSICAL SCIENCE

Paper 0652/41
Extended Theory

Key messages

When doing calculations candidates should start by giving the complete equation, for example when asked to find the power of an electric heater, write $P = VI$ not just VI.

General comments

Although there were some very good answers, there were a number of weaker candidates who did not demonstrate a full understanding of the syllabus.

Generally candidates were quite good at working with known equations but struggled when they were expected to think about a problem and show their understanding. This was shown in **Question 6 (c)(ii)** where candidates were asked to find the potential difference across a resistance wire having been given the e.m.f. of a battery and the potential drop across a lamp (the only other component in the circuit). The majority of candidates tried to use the formula $V = IR$.

Comments on specific questions

Question 1

(a) The calculation of the average velocity of the athlete caused few problems with most candidates gaining full credit. The errors which were made came from trying to include the mass of the athlete.

(b) The calculation of the acceleration was done quite well, and most candidates recognised that the acceleration was equal to the gradient of the graph or could be found using the change in velocity divided by time. Unfortunately many candidates chose the incorrect time when using the second method. A common error in giving the unit was to give it as m/s^{-2}.

(c) This caused many problems and only the strongest candidates were able to express themselves clearly. Although there were lots of ideas regarding changes in direction, few candidates linked these ideas to the fact that velocity is a vector (= displacement/time) and the displacement after 1 lap is zero because the athlete finishes the race at the same place as she started it.

Question 2

(a) Most candidates recognised that the process being described was diffusion.

(b) (i) The calculation of the relative molecular masses caused very few problems.

(ii) Although many candidates were able to give the correct equation for the reaction of ammonia and hydrogen chloride, few even attempted to give the state symbols and amongst those who did, many gave aqueous for the hydrogen chloride and ammonia and gaseous for the ammonium chloride.

(c) Candidates needed to state that the ammonia molecules are less massive than the hydrogen chloride molecules, but credit was given for the idea that the ammonia molecules move faster than the hydrogen chloride molecules. It was not enough to say that ammonia diffuses faster than hydrogen chloride – this does not explain why the reaction takes place at **X**. Other candidates discussed the idea of movement from the concentrated to the less concentrated area.

Question 3

(a) (i) There were various ways in which candidates could gain credit on this extended writing question. Generally there were some very good responses from stronger candidates and weaker candidates were often able to gain partial credit. A common error was to describe the particles themselves as getting hot and/or becoming less dense, but both these ideas were incorrect. The individual particles gain kinetic energy and they move further apart.

(ii) Only the strongest candidates answered this question correctly and the simple practical way of lagging the hot water tank was not given by many candidates. Many discussed painting the tank either silver or black, and credit was given for the former as it would (slightly) reduce the energy loss. However, painting it black would have the reverse effect as the tank is hotter than the surroundings and therefore it would increase the rate of energy loss by radiation.

(b) This question proved challenging for many candidates. Many candidates established the idea of free/delocalised electrons, but few then reverted to describing the movement of electric charge.

Question 4

(a) Most candidates recognised that it was the wide range of the melting points of solid **A** that showed that it was impure. A common error was to think that it was the significantly higher temperature of the melting point that was the evidence.

(b) Few candidates demonstrated any understanding as to why the melting point of the mixture changed from that of the pure solids. Those who had some idea lacked the ability to express their thoughts clearly.

(c) This question was also challenging. Following on from the work on melting point and purity in the earlier parts, candidates either stated that chromatography was not a method to identify impurities or that the melting point was too high for chromatography to work.

Question 5

(a) (i) Only stronger candidates were familiar with the concept of homologous series.

(ii) Most candidates recognised the series to be alkanes.

iii) Although candidates had a vague idea of the information regarding saturation in this series, few identified the definitive point that there were no carbon double (or triple) bonds.

(b) (i) This was done quite well, but some candidates did not qualify temperature and pressure. It is necessary to have <u>high</u> pressure and <u>high</u> pressure, as in all situations there is a temperature and a pressure.

(ii) Common incorrect answers were CH_2 and H_2O. Nevertheless, most candidates answered this correctly.

Question 6

(a) This was rarely answered correctly. It is a fundament concept that the charge carriers in metals are electrons, which are by nature negatively charged. Conventional current is considered to be the movement of positive particles: thus the two are in opposite directions.

(b) Most candidates recognised that a voltmeter is connected in parallel with the main circuit. However, a significant number of candidates did not realise that to measure the potential difference across the component, the voltmeter must be connected across that component and that component only.

(c) (i) Many candidates were confused as they tried to use the formula $R = V/I$ whereas the information given required the use of $P = VI$.

(ii) This required an understanding that the sum of the potential differences round a circuit is equal to the e.m.f. of the power supply. This was not widely understood and only stronger candidates gained credit for this question.

(iii) This was answered better than the previous two questions and candidates recognised the well-known formula.

(d) Few candidates recognised the inverse relationship between the diameter of a wire and its resistance and only a tiny proportion of those recognised that the resistance of the wire is inversely proportional to its cross sectional area and therefore, its diameter squared.

Question 7

(a) Stronger candidates gained full credit for this question. Common errors were to calculate the mass of 2 molecules of both ZnS and ZnO. For example, 2ZnO was calculated as 2 × 65 +16 = 146 rather than 2 × (65 + 16) = 162)

(b) (i) Stronger candidates answered this question well. However, the range of answers given by other candidates suggested that many did not really understand the process of reduction.

(ii) There were many generic answers such as greenhouse gas, global warming etc. Although many candidates gained partial credit there were relatively few who gave a precise answer regarding the displacement of oxygen in the blood depriving the body by not allowing the transport of oxygen.

(iii) Just under half the candidates were able to answer this question, with a very good performance from the strongest candidates who recognised that removal of carbon monoxide uses a catalytic convertor to oxidise the monoxide to the dioxide.

(c) There were some excellent accounts of how galvanising steel protects it, but there were many muddled and rather incoherent accounts which often contradicted statements made earlier in the answer.

(d) Answers tended to be a little bit vague, but generally they were of sufficient clarity to gain credit.

Question 8

(a) The completion of the ray diagram was done well. The refracted ray was drawn well by most candidates. The emergent ray caused more problem. It should have been parallel to the incident ray. Virtually all candidates used a ruler and/or a protractor when drawing the rays, which is good practise and should be encouraged.

(b) Many candidates gained full credit for this calculation. Inevitably, there were candidates who despite stating refractive index = sin *i*/sin *r,* then proceeded to ignore the sines, or made the given refractive index as sin 1.48.

(c) This was done less well with only stronger candidates aware of the equation refractive index of a material = speed of the light in air/speed of light in the medium.

Question 9

(a) Only the strongest candidates answered this question on electromagnetism well. Working in three dimensions and understanding the interaction between the magnetic fields of the magnet and of the electric current were extremely challenging for many other candidates. The confusion between the motor effect and electromagnetic induction was another problem, and this was evident in the majority of answers.

(b) (i) Many candidates identified the labelled part of the motor as a split ring commutator.

(ii) Only stronger candidates were able to give a clear explanation of the role of the split ring commutator in the working of the motor.

Question 10

(a) (i) Very few candidates recognised that for there to be a current in an ionic substance, it must be molten so that the ions (Mg^{2+} and $C\ell^{-}$) are able to move. These are the charge carriers not electrons.

(ii) The most common error in this question was to state that magnesium and chloride ions were liberated at the two electrodes.

(iii) Only stronger candidates showed the correct charges on the diagram. Usually, either they were totally left off or the magnesium was given a single positive charge. The second chloride ion was often missed and following that error, the magnesium ion had a single electron in its outer shell.

(b) (i) This was done quite well with a majority of candidates gaining credit.

(ii) Few candidates correctly referred to the trend of the reactivities within the group.

Question 11

(a) Explanations here varied considerably, and a common error was to state that it was the radioactivity left after the isotope is removed. This statement was ambiguous and it wasn't clear if it mean that the count in the absence of the isotope or the count due to radiation lingering after the isotope is removed.

(b) Although some candidates showed some understanding of the meaning of half-life, only a small minority understood that to calculate the half-life of the isotope, the background count rate needed to be subtracted from each of the count rates in the table. A significant number of candidates tried halving the nucleon number (149) identifying the neodymium isotope, which showed a total lack of understanding of the topic.

Question 12

(a) A number of candidates gave an acidic pH, possibly this was because they failed to understand the question or did not recognise that a neutrality is pH7.

(b) Although many candidates recognised that acids are proton doners, there was a significant minority who did not know this basic fact.

(c) Candidates were very unfamiliar with the energy diagram. Most of the credit awarded for this section was for putting the reactants on the left hand side and the products on the right hand side, showing the progress of the reaction with time.

PHYSICAL SCIENCE

Paper 0652/42
Extended Theory

Key messages

When doing calculations candidates should start by giving the complete equation, for example when asked to find the power of an electric heater, write $P = VI$ not just VI.

General comments

Although there were some very good answers, there were a number of weaker candidates who did not demonstrate a full understanding of the syllabus.

Generally candidates were quite good at working with known equations but struggled when they were expected to think about a problem and show their understanding. This was shown in **Question 6 (c)(ii)** where candidates were asked to find the potential difference across a resistance wire having been given the e.m.f. of a battery and the potential drop across a lamp (the only other component in the circuit). The majority of candidates tried to use the formula $V = IR$.

Comments on specific questions

Question 1

(a) The calculation of the average velocity of the athlete caused few problems with most candidates gaining full credit. The errors which were made came from trying to include the mass of the athlete.

(b) The calculation of the acceleration was done quite well, and most candidates recognised that the acceleration was equal to the gradient of the graph or could be found using the change in velocity divided by time. Unfortunately many candidates chose the incorrect time when using the second method. A common error in giving the unit was to give it as m/s^{-2}.

(c) This caused many problems and only the strongest candidates were able to express themselves clearly. Although there were lots of ideas regarding changes in direction, few candidates linked these ideas to the fact that velocity is a vector (= displacement/time) and the displacement after 1 lap is zero because the athlete finishes the race at the same place as she started it.

Question 2

(a) Most candidates recognised that the process being described was diffusion.

(b) (i) The calculation of the relative molecular masses caused very few problems.

(ii) Although many candidates were able to give the correct equation for the reaction of ammonia and hydrogen chloride, few even attempted to give the state symbols and amongst those who did, many gave aqueous for the hydrogen chloride and ammonia and gaseous for the ammonium chloride.

(c) Candidates needed to state that the ammonia molecules are less massive than the hydrogen chloride molecules, but credit was given for the idea that the ammonia molecules move faster than the hydrogen chloride molecules. It was not enough to say that ammonia diffuses faster than hydrogen chloride – this does not explain why the reaction takes place at **X**. Other candidates discussed the idea of movement from the concentrated to the less concentrated area.

Question 3

(a) (i) There were various ways in which candidates could gain credit on this extended writing question. Generally there were some very good responses from stronger candidates and weaker candidates were often able to gain partial credit. A common error was to describe the particles themselves as getting hot and/or becoming less dense, but both these ideas were incorrect. The individual particles gain kinetic energy and they move further apart.

(ii) Only the strongest candidates answered this question correctly and the simple practical way of lagging the hot water tank was not given by many candidates. Many discussed painting the tank either silver or black, and credit was given for the former as it would (slightly) reduce the energy loss. However, painting it black would have the reverse effect as the tank is hotter than the surroundings and therefore it would increase the rate of energy loss by radiation.

(b) This question proved challenging for many candidates. Many candidates established the idea of free/delocalised electrons, but few then reverted to describing the movement of electric charge.

Question 4

(a) Most candidates recognised that it was the wide range of the melting points of solid **A** that showed that it was impure. A common error was to think that it was the significantly higher temperature of the melting point that was the evidence.

(b) Few candidates demonstrated any understanding as to why the melting point of the mixture changed from that of the pure solids. Those who had some idea lacked the ability to express their thoughts clearly.

(c) This question was also challenging. Following on from the work on melting point and purity in the earlier parts, candidates either stated that chromatography was not a method to identify impurities or that the melting point was too high for chromatography to work.

Question 5

(a) (i) Only stronger candidates were familiar with the concept of homologous series.

(ii) Most candidates recognised the series to be alkanes.

iii) Although candidates had a vague idea of the information regarding saturation in this series, few identified the definitive point that there were no carbon double (or triple) bonds.

(b) (i) This was done quite well, but some candidates did not qualify temperature and pressure. It is necessary to have <u>high</u> pressure and <u>high</u> pressure, as in all situations there is a temperature and a pressure.

(ii) Common incorrect answers were CH_2 and H_2O. Nevertheless, most candidates answered this correctly.

Question 6

(a) This was rarely answered correctly. It is a fundament concept that the charge carriers in metals are electrons, which are by nature negatively charged. Conventional current is considered to be the movement of positive particles: thus the two are in opposite directions.

(b) Most candidates recognised that a voltmeter is connected in parallel with the main circuit. However, a significant number of candidates did not realise that to measure the potential difference across the component, the voltmeter must be connected across that component and that component only.

(c) (i) Many candidates were confused as they tried to use the formula $R = V/I$ whereas the information given required the use of $P = VI$.

(ii) This required an understanding that the sum of the potential differences round a circuit is equal to the e.m.f. of the power supply. This was not widely understood and only stronger candidates gained credit for this question.

(iii) This was answered better than the previous two questions and candidates recognised the well-known formula.

(d) Few candidates recognised the inverse relationship between the diameter of a wire and its resistance and only a tiny proportion of those recognised that the resistance of the wire is inversely proportional to its cross sectional area and therefore, its diameter squared.

Question 7

(a) Stronger candidates gained full credit for this question. Common errors were to calculate the mass of 2 molecules of both ZnS and ZnO. For example, 2ZnO was calculated as 2 × 65 +16 = 146 rather than 2 × (65 + 16) = 162)

(b) (i) Stronger candidates answered this question well. However, the range of answers given by other candidates suggested that many did not really understand the process of reduction.

(ii) There were many generic answers such as greenhouse gas, global warming etc. Although many candidates gained partial credit there were relatively few who gave a precise answer regarding the displacement of oxygen in the blood depriving the body by not allowing the transport of oxygen.

(iii) Just under half the candidates were able to answer this question, with a very good performance from the strongest candidates who recognised that removal of carbon monoxide uses a catalytic convertor to oxidise the monoxide to the dioxide.

(c) There were some excellent accounts of how galvanising steel protects it, but there were many muddled and rather incoherent accounts which often contradicted statements made earlier in the answer.

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Question 8

(a) The completion of the ray diagram was done well. The refracted ray was drawn well by most candidates. The emergent ray caused more problem. It should have been parallel to the incident ray. Virtually all candidates used a ruler and/or a protractor when drawing the rays, which is good practise and should be encouraged.

(b) Many candidates gained full credit for this calculation. Inevitably, there were candidates who despite stating refractive index = sin *i*/sin *r,* then proceeded to ignore the sines, or made the given refractive index as sin 1.48.

(c) This was done less well with only stronger candidates aware of the equation refractive index of a material = speed of the light in air/speed of light in the medium.

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(a) Only the strongest candidates answered this question on electromagnetism well. Working in three dimensions and understanding the interaction between the magnetic fields of the magnet and of the electric current were extremely challenging for many other candidates. The confusion between the motor effect and electromagnetic induction was another problem, and this was evident in the majority of answers.

(b) (i) Many candidates identified the labelled part of the motor as a split ring commutator.

(ii) Only stronger candidates were able to give a clear explanation of the role of the split ring commutator in the working of the motor.

Question 10

(a) (i) Very few candidates recognised that for there to be a current in an ionic substance, it must be molten so that the ions (Mg^{2+} and $C\ell^{-}$) are able to move. These are the charge carriers not electrons.

(ii) The most common error in this question was to state that magnesium and chloride ions were liberated at the two electrodes.

(iii) Only stronger candidates showed the correct charges on the diagram. Usually, either they were totally left off or the magnesium was given a single positive charge. The second chloride ion was often missed and following that error, the magnesium ion had a single electron in its outer shell.

(b) (i) This was done quite well with a majority of candidates gaining credit.

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PHYSICAL SCIENCE

Paper 0652/43
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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 performed calculations accurately and correctly. However, some candidates seemed less able to draw conclusions backed up by evidence they had gathered.

Comments on specific questions

Question 1

(a) Most candidates produced a full set of temperatures for the mixture of aqueous hydrochloric acid and aqueous sodium hydroxide over the five-minute period of timing. 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 not been followed. As expected, most sets of results showed an initial increase in the temperature followed by a decrease.

(b) (i) Although most candidates used linear, labelled scales on the axes of their graphs, in many cases the scale chosen was too small. 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 one-half of a small grid square of the actual value.

(ii) The instruction to draw two best fit straight lines – one for the increasing temperatures and one for the decreasing temperatures was often not followed. Some candidates drew two curves and others joined the plots from point to point. Credit was awarded for the temperature at which the lines crossed, if correct, from the point of intersection of whatever the candidate had drawn – straight line or curve.

(c) The calculation of the thermal energy produced by the reaction was usually correctly done. The most common error was to use the highest temperature reached in the given equation, rather than the temperature increase of the mixture.

(d) Most candidates were unable to give two reasons why the value for the thermal energy calculated in **(c)** was less than the expected value. Many candidates were able to give one reason, which was usually that heat losses would occur. These candidates usually went on to suggest that an improvement would be to use a lid or to lag the beaker with insulation or to use a polystyrene cup instead of a beaker.

A valid second reason was seldom seen. A small number of stronger candidates correctly referred to the precision of the measuring cylinder used to measure the liquid volumes and stated that it would be better to use a burette or a pipette.

(e) This final part of the question was challenging for many candidates. A few of the very strongest candidates realised that if the 25 cm^3 of hydrochloric acid were replaced by the same volume of sulfuric acid of the same concentration, then the same amount of thermal energy would be produced by the reaction and gained partial credit.

Question 2

(a) Most candidates recorded a correct description of the appearance of solid A and the appearance of solution A after 20 cm^3 of distilled water had been added to solid A.

(b) (i) When candidates are asked to record their observations when different chemical substances are mixed together, it is best for them to avoid the use of terms such as, “no observation”, “nothing” or “nothing happens”. Acceptable answers for the observation when nitric acid and aqueous silver nitrate were added to solution A were “no change”, “no precipitate” or “stays blue”.

(ii) Most candidates observed the correct colour, blue/green, for the flame test when a splint dipped in solution A was placed in a Bunsen flame.

(iii) The most common answer given here was copper, despite the question asking candidates to name compound A. The flame test indicated that it was a copper compound, which was in fact, copper sulfate. Few correct answers were seen.

(c) Most candidates observed that a blue precipitate was obtained when solutions A and B were mixed. Far fewer deduced the solution B was ammonia (solution).

Question 3

(a) (i) The scale reading on the metre rule when the 50 g mass and the piece of soft modelling clay balanced the rule on the pivot was usually within the tolerance allowed and recorded to the nearest millimetre.

(ii) The majority of candidates substituted into the equation correctly and obtained a correct value for the mass of the modelling clay.

(iii) Most candidates stated one difficulty in carrying out the balancing experiment. The most obvious difficulty was that it is very difficult to achieve an exact, perfect balance. Other acceptable answers referred to the masses obscuring the readings on the rule beneath them and the pivot moving when the experiment was being carried out.

(b) (i) The measurement of the diameter of the ball produced when the modelling clay was rolled by hand was usually sensible and nearly always within the allowed range of 3.2 ± 0.5 cm.

(ii) Most labelled diagrams showed the clay ball sandwiched between the two blocks. However, there was some careless drawing where candidates did not have both blocks touching opposite sides of the ball of modelling clay.

(iii) The required measurements of the diameter of the ball from two more places on its circumference were almost always present. In calculating the average of all three readings taken candidates often did not use the original measurement and only averaged the two extra measurements.

(iv) The volume of the ball of modelling clay was usually calculated correctly. However, many candidates did not give their answer to a suitable number of significant figures, as instructed. Rounding errors upon truncating the final answer were common.

(v) The density calculation was usually correct. Correctly rounded or truncated answers were accepted here.

(c) (i) The reading on the measuring cylinder when the soft modelling clay was immersed in the water was always present and sensible.

(ii) The volume of the modelling clay was usually calculated correctly by subtraction of the two volumes.

(iii) Candidates almost always obtained a second value for the density of the modelling clay. Values quoted to too few/many significant figures were not penalised for this calculation.

(d) Most candidates produced an evaluation of both methods of measuring the volume of the modelling clay, suggested the method they considered to be the more accurate and gave a relevant explanation. Many commented upon the fact that the shape of the hand-moulded ball of clay was not a perfect sphere. Far fewer candidates made a comment about the resolution of the scale of the measuring cylinder used, and that it only measured to the nearest $\frac{1}{2}$ cm^3 or 1 cm^3.

Question 4

Credit was available for listing any additional apparatus needed to complete the investigation. Most candidates realised that a stopwatch/timer was needed, but many omitted the obvious, namely that a ruler/measuring tape would be needed to measure the length of the pendulum.

Most candidates also gained credit by stating that the length of the pendulum must be measured and that the corresponding time for 1 (or more) oscillations of the pendulum must be measured.

Because the investigation being planned was to investigate the relationship between the period of a pendulum and its length, candidates needed to state that the procedure had to be repeated for different pendulum lengths. However, very few candidates mentioned this.

Most candidates gained credit for listing one relevant control variable in this investigation, usually that the mass/volume of the bob should remain constant.

Many candidates did not note the instruction to list the precautions they would take to ensure that the results are as accurate as possible. Of those candidates who did, the most popular correct answer was to read the scale of the ruler perpendicularly (to avoid parallax error). Very few candidates listed any other sensible precautions such as, placing the ruler close to the string when measuring or time 10 or more oscillations (and divide) or repeating the readings for each length.

The majority of candidates gained at least partial credit for by drawing an appropriate table of results and giving relevant headings. Only two columns labelled length and time (or period) were required. Stronger candidates also included the units of the measured quantities for full credit here.

PHYSICAL SCIENCE

Paper 0652/52
Practical Test

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(b) (i) The measurement of the diameter of the ball produced when the modelling clay was rolled by hand was usually sensible and nearly always within the allowed range of 3.2 ± 0.5 cm.

(ii) Most labelled diagrams showed the clay ball sandwiched between the two blocks. However, there was some careless drawing where candidates did not have both blocks touching opposite sides of the ball of modelling clay.

(iii) The required measurements of the diameter of the ball from two more places on its circumference were almost always present. In calculating the average of all three readings taken candidates often did not use the original measurement and only averaged the two extra measurements.

(iv) The volume of the ball of modelling clay was usually calculated correctly. However, many candidates did not give their answer to a suitable number of significant figures, as instructed. Rounding errors upon truncating the final answer were common.

(v) The density calculation was usually correct. Correctly rounded or truncated answers were accepted here.

(c) (i) The reading on the measuring cylinder when the soft modelling clay was immersed in the water was always present and sensible.

(ii) The volume of the modelling clay was usually calculated correctly by subtraction of the two volumes.

(iii) Candidates almost always obtained a second value for the density of the modelling clay. Values quoted to too few/many significant figures were not penalised for this calculation.

(d) Most candidates produced an evaluation of both methods of measuring the volume of the modelling clay, suggested the method they considered to be the more accurate and gave a relevant explanation. Many commented upon the fact that the shape of the hand-moulded ball of clay was not a perfect sphere. Far fewer candidates made a comment about the resolution of the scale of the measuring cylinder used, and that it only measured to the nearest $\frac{1}{2}$ cm^3 or 1 cm^3.

Question 4

Credit was available for listing any additional apparatus needed to complete the investigation. Most candidates realised that a stopwatch/timer was needed, but many omitted the obvious, namely that a ruler/measuring tape would be needed to measure the length of the pendulum.

Most candidates also gained credit by stating that the length of the pendulum must be measured and that the corresponding time for 1 (or more) oscillations of the pendulum must be measured.

Because the investigation being planned was to investigate the relationship between the period of a pendulum and its length, candidates needed to state that the procedure had to be repeated for different pendulum lengths. However, very few candidates mentioned this.

Most candidates gained credit for listing one relevant control variable in this investigation, usually that the mass/volume of the bob should remain constant.

Many candidates did not note the instruction to list the precautions they would take to ensure that the results are as accurate as possible. Of those candidates who did, the most popular correct answer was to read the scale of the ruler perpendicularly (to avoid parallax error). Very few candidates listed any other sensible precautions such as, placing the ruler close to the string when measuring or time 10 or more oscillations (and divide) or repeating the readings for each length.

The majority of candidates gained at least partial credit for by drawing an appropriate table of results and giving relevant headings. Only two columns labelled length and time (or period) were required. Stronger candidates also included the units of the measured quantities for full credit here.

PHYSICAL SCIENCE

Paper 0652/53
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 performed calculations accurately and correctly. However, some candidates seemed less able to draw conclusions backed up by evidence they had gathered.

Comments on specific questions

Question 1

(a) Most candidates produced a full set of temperatures for the mixture of aqueous hydrochloric acid and aqueous sodium hydroxide over the five-minute period of timing. 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 not been followed. As expected, most sets of results showed an initial increase in the temperature followed by a decrease.

(b) (i) Although most candidates used linear, labelled scales on the axes of their graphs, in many cases the scale chosen was too small. 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 one-half of a small grid square of the actual value.

(ii) The instruction to draw two best fit straight lines – one for the increasing temperatures and one for the decreasing temperatures was often not followed. Some candidates drew two curves and others joined the plots from point to point. Credit was awarded for the temperature at which the lines crossed, if correct, from the point of intersection of whatever the candidate had drawn – straight line or curve.

(c) The calculation of the thermal energy produced by the reaction was usually correctly done. The most common error was to use the highest temperature reached in the given equation, rather than the temperature increase of the mixture.

(d) Most candidates were unable to give two reasons why the value for the thermal energy calculated in **(c)** was less than the expected value. Many candidates were able to give one reason, which was usually that heat losses would occur. These candidates usually went on to suggest that an improvement would be to use a lid or to lag the beaker with insulation or to use a polystyrene cup instead of a beaker.

A valid second reason was seldom seen. A small number of stronger candidates correctly referred to the precision of the measuring cylinder used to measure the liquid volumes and stated that it would be better to use a burette or a pipette.

(e) This final part of the question was challenging for many candidates. A few of the very strongest candidates realised that if the 25 cm^3 of hydrochloric acid were replaced by the same volume of sulfuric acid of the same concentration, then the same amount of thermal energy would be produced by the reaction and gained partial credit.

Question 2

(a) Most candidates recorded a correct description of the appearance of solid A and the appearance of solution A after 20 cm^3 of distilled water had been added to solid A.

(b) (i) When candidates are asked to record their observations when different chemical substances are mixed together, it is best for them to avoid the use of terms such as, “no observation”, “nothing” or “nothing happens”. Acceptable answers for the observation when nitric acid and aqueous silver nitrate were added to solution A were “no change”, “no precipitate” or “stays blue”.

(ii) Most candidates observed the correct colour, blue/green, for the flame test when a splint dipped in solution A was placed in a Bunsen flame.

(iii) The most common answer given here was copper, despite the question asking candidates to name compound A. The flame test indicated that it was a copper compound, which was in fact, copper sulfate. Few correct answers were seen.

(c) Most candidates observed that a blue precipitate was obtained when solutions A and B were mixed. Far fewer deduced the solution B was ammonia (solution).

Question 3

(a) (i) The scale reading on the metre rule when the 50 g mass and the piece of soft modelling clay balanced the rule on the pivot was usually within the tolerance allowed and recorded to the nearest millimetre.

(ii) The majority of candidates substituted into the equation correctly and obtained a correct value for the mass of the modelling clay.

(iii) Most candidates stated one difficulty in carrying out the balancing experiment. The most obvious difficulty was that it is very difficult to achieve an exact, perfect balance. Other acceptable answers referred to the masses obscuring the readings on the rule beneath them and the pivot moving when the experiment was being carried out.

(b) (i) The measurement of the diameter of the ball produced when the modelling clay was rolled by hand was usually sensible and nearly always within the allowed range of 3.2 ± 0.5 cm.

(ii) Most labelled diagrams showed the clay ball sandwiched between the two blocks. However, there was some careless drawing where candidates did not have both blocks touching opposite sides of the ball of modelling clay.

(iii) The required measurements of the diameter of the ball from two more places on its circumference were almost always present. In calculating the average of all three readings taken candidates often did not use the original measurement and only averaged the two extra measurements.

(iv) The volume of the ball of modelling clay was usually calculated correctly. However, many candidates did not give their answer to a suitable number of significant figures, as instructed. Rounding errors upon truncating the final answer were common.

(v) The density calculation was usually correct. Correctly rounded or truncated answers were accepted here.

(c) (i) The reading on the measuring cylinder when the soft modelling clay was immersed in the water was always present and sensible.

(ii) The volume of the modelling clay was usually calculated correctly by subtraction of the two volumes.

(iii) Candidates almost always obtained a second value for the density of the modelling clay. Values quoted to too few/many significant figures were not penalised for this calculation.

(d) Most candidates produced an evaluation of both methods of measuring the volume of the modelling clay, suggested the method they considered to be the more accurate and gave a relevant explanation. Many commented upon the fact that the shape of the hand-moulded ball of clay was not a perfect sphere. Far fewer candidates made a comment about the resolution of the scale of the measuring cylinder used, and that it only measured to the nearest $\frac{1}{2}$ cm^3 or 1 cm^3.

Question 4

Credit was available for listing any additional apparatus needed to complete the investigation. Most candidates realised that a stopwatch/timer was needed, but many omitted the obvious, namely that a ruler/measuring tape would be needed to measure the length of the pendulum.

Most candidates also gained credit by stating that the length of the pendulum must be measured and that the corresponding time for 1 (or more) oscillations of the pendulum must be measured.

Because the investigation being planned was to investigate the relationship between the period of a pendulum and its length, candidates needed to state that the procedure had to be repeated for different pendulum lengths. However, very few candidates mentioned this.

Most candidates gained credit for listing one relevant control variable in this investigation, usually that the mass/volume of the bob should remain constant.

Many candidates did not note the instruction to list the precautions they would take to ensure that the results are as accurate as possible. Of those candidates who did, the most popular correct answer was to read the scale of the ruler perpendicularly (to avoid parallax error). Very few candidates listed any other sensible precautions such as, placing the ruler close to the string when measuring or time 10 or more oscillations (and divide) or repeating the readings for each length.

The majority of candidates gained at least partial credit for by drawing an appropriate table of results and giving relevant headings. Only two columns labelled length and time (or period) were required. Stronger candidates also included the units of the measured quantities for full credit here.

PHYSICAL SCIENCE

Paper 0652/61
Alternative to Practical

Key messages

Candidates would benefit from more focus on qualitative analysis knowledge and application in interpreting and predicting results of test-tube reactions. Candidates are reminded that reference to both colour and state is needed in precipitation reactions, that testing for gases involves a test and a result, and that an observation of no reaction is a positive result in itself.

Candidates need more practice, hopefully aided by practical work, in suggesting improvements and comparing different approaches.

Graphs should be drawn with due attention to the clarity of the information represented. Units must be included in the labelling of axes, and the scale should be chosen so that the points cover over half of the paper, to allow for accurate interpolation and extrapolation.

Candidates must read general instructions as well as specific question instructions carefully, particularly with regard to showing all working and consideration of the degree of approximation of their answers respectively.

When planning, candidates must aim to address all bullet points. A labelled diagram is often useful as well as a table with headings or a graph with appropriate labelling of axes.

General comments

Most candidates found the paper accessible, with few questions left unattempted.

Few candidates failed to complete the paper in the time allowed and there was evidence that candidates read questions and instruments carefully.

Comments on specific questions

Question 1

Candidates were expected to determine the thermal energy produced in a neutralisation reaction graphically and then by calculation. They needed to comment on the discrepancy between measured and expected values, and finally to predict the value when a dibasic acid replaced the monobasic HCl.

(a) Most candidates read both thermometers correctly and realised that one decimal place was required to match the data already entered in the table.

(b) (i) Most candidates chose linear scales and labelled the axes correctly, but a few reversed the axis or forgot units. Plotting was usually correct, but the choice of scale was poor.

(ii) Best fit lines needed to be ruler drawn and chosen sensibly for both the increasing and decreasing temperatures, then extended until they crossed. Some candidates did this successfully, but more care needed to be taken by others over their choice of 'best fit'.

(c) Quite a few candidates forgot to subtract the start temperature from their highest temperature, but substitution into the given formula, followed by evaluation, was straightforward for most candidates.

(d) Very few candidates were able to suggest the expected adjustments to improve the accuracy, focussing on preventing heat loss and more accurate measurement of volume. Taking more frequent and repeat readings, use of a more accurate thermometer, improved stirring and less rounding were not considered significant improvements in the context of this experiment.

(e) This was challenging for many candidates. Candidates who gained credit for equal thermal energy produced usually attributed it to same concentrations rather than involving the concept of excess. A few candidates gained credit for doubling their previous answer in recognition of the change in equation stoichiometry.

Question 2

Candidates were expected to apply their knowledge of qualitative analysis to confirm the presence of copper sulfate by predicting the observed results of test-tube tests, suggesting how to test for ammonia gas, and predicting the outcome on mixing the two together.

(a) Only the strongest candidates answered this question fully correctly. Most candidates could predict the flame colour, and expected a positive result on adding silver nitrate. Many candidates identified the white precipitate with barium ions and the blue precipitate with hydroxide ions, but then needed to address the state as well as the colour.

(b) Several candidates knew the litmus test for ammonia, with the occasional blue turning red, but they were expected to at least warm the solution to test the gas.

(c) Few candidates spotted that this was the reverse of the normal reaction as here the ammonia solution was in excess first, so a reversal of the usual result was expected. Partial credit was given for the standard result or only the reporting of the final blue precipitate.

Question 3

Candidates were expected to find the density of soft modelling clay by finding its mass through balancing, followed by its volume by two different methods, which were then compared.

(a) (i) Nearly all candidates found the centre of mass to be at 80 cm.

(ii) Most candidates successfully substituted their position P into the given formula and evaluated the mass correctly.

(iii) Some candidates realised that the difficulty lay in the balancing of the rule or the obscuring of the scale by the masses. A few referred to the irregularity of the clay, but this was not awarded credit.

(b) (i) Nearly all candidates measured the diameter of the ball accurately.

(ii) Candidates either recognised the difficulty presented in measuring the diameter of a spherical object, leading to them correctly place two blocks, one on either side of the ball, and measuring between them, or incorrectly placed a number of blocks around a curved surface, or just used one block. Several candidates did not attempt this part.

(iii) Most candidates were able to average three numbers correctly. Those who did not gain credit here forgot to divide after adding the three numbers together, or did not show working, leading to ambiguity as to whether they had actually averaged or just provided the same answer as in **(i)**

(iv) Most candidates substituted then evaluated correctly, but only two or three significant figures were acceptable here from the data provided.

(v) Density was usually evaluated correctly after substituting the values of mass and volume into the given formula.

(c) (i) Most candidates read the new water level correctly. However, some candidates misread 72 as 70.2, and a few measured from the top of the ball.

(ii) This was usually answered correctly.

(iii) Most candidates successfully substituted into the given formula and evaluated their second density value correctly.

(d) Candidates were expected to opt for method 2 as the more accurate due to the assumption that the clay is a perfect sphere or the difficulty in measuring its diameter in method 1. The greater reliability, fewer errors or fewer calculations involved in using water displacement were not deemed creditworthy. A few candidates did not recognise that the question addressed inaccuracy in volume rather than mass measurement and mentioned problems in balancing the rule or reading the centre of the masses again.

Question 4

Candidates were asked to plan an experiment to investigate how the length of a pendulum affects its period. A few candidates did not attempt this planning question, but most candidates gained at least partial credit.

Several candidates did not measure the varied lengths and so did not use a ruler, and control variables such as mass of bob and angle of swing were often missing. Precautions which were rarely referred to included avoidance of parallax errors and the use of a fiducial aid.

Most candidates changed measured lengths, timed for at least one oscillation and then averaged, and repeated experiments at a given length, but table headings often lacked units.

PHYSICAL SCIENCE

Paper 0652/62
Alternative to Practical

Key messages

Candidates would benefit from more focus on qualitative analysis knowledge and application in interpreting and predicting results of test-tube reactions. Candidates are reminded that reference to both colour and state is needed in precipitation reactions, that testing for gases involves a test and a result, and that an observation of no reaction is a positive result in itself.

Candidates need more practice, hopefully aided by practical work, in suggesting improvements and comparing different approaches.

Graphs should be drawn with due attention to the clarity of the information represented. Units must be included in the labelling of axes, and the scale should be chosen so that the points cover over half of the paper, to allow for accurate interpolation and extrapolation.

Candidates must read general instructions as well as specific question instructions carefully, particularly with regard to showing all working and consideration of the degree of approximation of their answers respectively.

When planning, candidates must aim to address all bullet points. A labelled diagram is often useful as well as a table with headings or a graph with appropriate labelling of axes.

General comments

Most candidates found the paper accessible, with few questions left unattempted.

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(c) Quite a few candidates forgot to subtract the start temperature from their highest temperature, but substitution into the given formula, followed by evaluation, was straightforward for most candidates.

(d) Very few candidates were able to suggest the expected adjustments to improve the accuracy, focussing on preventing heat loss and more accurate measurement of volume. Taking more frequent and repeat readings, use of a more accurate thermometer, improved stirring and less rounding were not considered significant improvements in the context of this experiment.

(e) This was challenging for many candidates. Candidates who gained credit for equal thermal energy produced usually attributed it to same concentrations rather than involving the concept of excess. A few candidates gained credit for doubling their previous answer in recognition of the change in equation stoichiometry.

Question 2

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Question 4

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PHYSICAL SCIENCE

Paper 0652/63
Alternative to Practical

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